

# MATES V

Multiple Air Toxics Exposure Study  
in the South Coast AQMD



FINAL APPENDICES  
AUGUST 2021



**SOUTH COAST AIR QUALITY  
MANAGEMENT DISTRICT**

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# **Multiple Air Toxics Exposure Study V**

## **MATES V**

**FINAL APPENDICES**

**August 2021**

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**Cancer Potency Factors and Chronic RELs**

## Appendix I

### Cancer Potency Factors and Chronic RELs

The estimated concentration of a substance is combined with the cancer potency factors and Reference Exposure Levels (RELs) to estimate the potential for health effects. The calculations used in MATES multiplies the estimated or measured annual average levels for potential carcinogens by the cancer potency factor, molecular weight adjustment factor, combined exposure factor, and multi-pathway adjustment factor to determine cancer risks.

The equations below show the cancer risk and chronic hazard index calculations.

*Potential Cancer Risk*

$$= \text{Concentration} * \text{Cancer Potency Factor} * \text{Cancer Multi pathway Factor} \\ * \text{Molecular Weight Adjustment Factor} * \text{Exposure Duration}$$

*Hazard Index*

$$= \frac{\text{Concentration} * \text{Chronic Multi pathway Factor} * \text{Molecular Weight Adjustment Factor}}{\text{Chronic Inhalation REL}}$$

The molecular weight adjustment factor is only used when a toxic metal has a cancer potency factor and applies only to the fraction of the overall weight of the emissions that are associated with health effects of the metal (California Office of Environmental Health Hazard Assessment, 2015). The combined exposure factor accounts for the exposure factor for each assigned age bin. Each assigned age bin is made up of the daily breathing rate, exposure duration of the age bin, fraction of time at home, and an age sensitivity factor. The daily breathing rate is calculated using the California Air Resources Board (CARB) and California Air Pollution Control Officer Association's Risk Management Policy (RMP) Using the Derived Method methodology. The method assumes a 95th percentile breathing rate for children from the last trimester through age 2 and an 80th percentile daily breathing rate for other age groups.

The multi-pathway adjustment factor is used to account for substances that may contribute to risk from exposure pathways other than inhalation, such as ingestion of soil or homegrown vegetables (South Coast Air Quality Management District, 2017). The multi-pathway adjustment factors used in MATES V are shown in Table I-1.

For chronic non-cancer hazard index calculations, the annual average concentrations for each pollutant were multiplied by the molecular weight adjustment factor and multi-pathway adjustment factor, and then divided by the applicable chronic REL to determine a hazard quotient. The hazard quotients are then summed for each target organ for all applicable toxic substances, and the maximum hazard quotient from all the target organ is reported as the hazard index. A hazard index of less than one indicates that the levels of that pollutant (or group of pollutants) are unlikely to cause chronic non-cancer risk health effects for any of the target organs. A hazard index greater than one does not mean that adverse health effects will occur, but rather that the risk of chronic non-cancer health effects increases with increasing levels of the pollutant.

The potential cancer risk for a given substance is expressed as the incremental number of potential cancer cases that could be developed per million people, assuming that the population is exposed to the

substance at a constant annual average concentration over a presumed 30-year period. These risks are usually presented in chances per million. For example, if the incremental air toxics cancer risks were estimated to be 100 per million, the probability of an individual developing cancer due to a lifetime exposure would be increased by a hundred in a million above background levels of cancer risk (e.g. based on other factors, such as age, diet, genetics, etc). This would predict an additional 100 cases of cancer in a population of a million people over a 70-year lifetime period.

Table I-1. OEHHA Cancer Potency Factors, Chronic RELs, and Multipathway Adjustment Factors for species analyzed in MATES V.

Species	CAS/CARB Emittant ID	Inhalation Cancer Potency Factor (mg/kg-d) <sup>-1</sup>	Multipathway Adjustment Factor for Cancer Risk	Chronic Inhalation REL (ug/m <sup>3</sup> )	Multipathway Adjustment Factor for Chronic Non- Cancer Health Impacts
Acetaldehyde	75-07-0	0.01		140	
Acrolein	107-02-8			0.35	
Arsenic	7440-38-2	12	9.71	0.015	88.03
Benzene	71-43-2	0.1		3	
Benzo(a)anthracene	56-55-3	0.39	23.12		
Benzo(a)pyrene	50-32-8	3.9	23.12		
Benzo(b)fluoranthene	205-99-2	0.39	23.12		
Benzo(k)fluoranthene	207-08-9	0.39	23.12		
Beryllium	7440-41-7	8.4		0.007	
Bromomethane	74-83-9			5	
1,3 Butadiene	106-99-0	0.6		2	
Cadmium	7440-43-9	15		0.02	1.98
Carbon Tetrachloride	56-23-5	0.15		40	
Chlorine	7782-50-5			0.2	
Chloroform	67-66-3	0.019		300	
Chrysene	218-01-9	0.039	23.12		
Cobalt	7440-48-4	27			
Dibenz(a,h)anthracene	53-70-3	4.1	7.99		
1,2-Dibromoethane	106-93-4	0.25		0.8	
1,4-Dichlorobenzene	106-46-7	0.04		800	
1,2-Dichloroethane	107-06-2	0.072		400	
Diesel Exhaust	9901	1.1		5	

Species	CAS/CARB Emittant ID	Inhalation Cancer Potency Factor (mg/kg-d) <sup>-1</sup>	Multipathway Adjustment Factor for Cancer Risk	Chronic Inhalation REL (ug/m <sup>3</sup> )	Multipathway Adjustment Factor for Chronic Non- Cancer Health Impacts
Ethyl Benzene	100-41-4	0.0087		2000	
Formaldehyde	50-00-0	0.021		9	
Hexavalent Chromium	18540-29-9	510	1.6	0.2	2.44
Indeno(1,2,3-c,d)pyrene	193-39-5	0.39	23.12		
Lead	7439-92-1	0.042	11.41		
Manganese	7439-96-5			0.09	
Methylene Chloride	75-09-2	0.0035		400	
Methyl tertiary-butyl ether (MTBE)	1634-04-4	0.0018		8000	
Naphthalene	91-20-3	0.12		9	
Nickel	7440-02-0	0.91		0.014	
Perchloroethylene	127-18-4	0.021		35	
Selenium	7782-49-2			20	195.58
Styrene	100-42-5			900	
Toluene	108-88-3			420	
Trichloroethylene	79-01-6	0.007		600	
Vinyl Chloride	75-01-4	0.27			
Xylene (m-, p-)	1330-20-7			700	

Table I-2. Species analyzed in MATES V that do not have OEHHA Risk Assessment Health Values for Cancer Potency or Chronic Non-cancer REL.

<b>Species</b>	<b>CAS/CARB Emittant ID</b>
Acenaphthene	83-32-9
Acenaphthylene	208-96-8
Acetone	67-64-1
Aluminum	7429-90-5
Ammonium Ion	14798-03-9
Anthracene	120-12-7
Antimony	7440-36-0
Barium	7440-39-3
Benzaldehyde	100-52-7
Benzo(e)pyrene	192-97-2
Benzo(g,h,i)perylene	191-24-2
Calcium	7440-70-2
Cesium	7440-46-2
Chloride	16887-00-6
Chromium	7440-47-3
Copper	7440-50-8
Coronene	191-07-1
Cyclopenta(c,d)pyrene	27208-37-3
1,2-Dichlorobenzene	95-50-1
1,2-Dichloropropane	78-87-5
EC1	
EC2	
EC3	
Elemental Carbon	
Fluoranthene	206-44-0

<b>Species</b>	<b>CAS/CARB Emittant ID</b>
Fluorene	86-73-7
9-Fluorenone	486-25-9
Galactosan	644-76-8
Iron	7439-89-6
Levoglucozan	498-07-7
Magnesium	7439-95-4
Mannosan	14168-65-1
Methyl Ethyl Ketone	78-93-3
Molybdenum	7439-98-7
Nitrate	14797-55-8
OC1	
OC2	
OC3	
OC4	
Organic Carbon	
PM2.5 Mass	88101
Perylene	198-55-0
Phenanthrene	85-01-8
Phosphorus	7723-14-0
Potassium	7440-09-7
Potassium Ion	24203-36-9
Propionaldehyde	123-38-6
Pyrene	129-00-0
Retene	483-65-8
Rubidium	7440-17-7
Samarium	7440-19-9

Species	CAS/CARB Emittant ID
Sodium	7440-23-5
Strontium	7440-24-6
Sulfate	14808-79-8
Sulfur	7704-34-9
Thallium	7440-28-0
Tin	7440-31-5
Titanium	7440-32-6
Total Carbon	
Uranium	7440-61-1
Vanadium	7440-62-2
Yttrium	7440-65-5

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**APPENDIX II**  
**MATES V**  
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**APPENDIX III**  
**MATES V**  
**FINAL REPORT**

**Monitoring and Laboratory Analysis Protocol**

**DISCLAIMER**

Any or all reference made in this Appendix to a specific product or brand name does not constitute an endorsement of that product or brand by the South Coast Air Quality Management District.

## Appendix III

### Monitoring and Laboratory Analysis Protocol

#### III.1. INTRODUCTION

##### III.1.1 Background

In 1986, the South Coast Air Quality Management District (South Coast AQMD) performed a study of ambient air toxics impacts in the South Coast Air Basin. Although this study involved only limited measurements, it was an important beginning of the Multiple Air Toxics Exposure Study (MATES). In 1998, the South Coast AQMD conducted a follow up to that initial study, but included an intensive ambient air toxics monitoring program, which became MATES II. The objective of MATES II was to establish a baseline of existing air toxics ambient emissions, exposure and risk level data and an assessment of model accuracy. Sampling for MATES II was performed over a one-year period at ten sites throughout the South Coast Air Basin (Basin). The MATES II Final Report was approved by the South Coast AQMD Board in March 2000.

As a follow up study to MATES II, MATES III was conducted from April 2004 through March 2006. The initial scope of the study was for one year, however, sampling continued for a second year due to concerns of the impact of heavy rains on data collected during the first year. The MATES III Final Report was published in September 2008.

From July 2012 through July 2013, MATES IV monitoring was performed to build upon prior ambient toxics data sets, to evaluate spatial and temporal trends and better understand current risk associated with air toxics in the Basin. Black carbon (BC) and ultrafine particle (UFP) measurements were included in this study. The MATES IV report was released in May 2015<sup>1</sup>.

For MATES V, sampling was conducted for a year from May 2018 through April 2019. In addition to continued monitoring efforts for air toxics measured in previous MATES, this study incorporated measurements for biomass burning indicators (sugars) and bromomethane (methyl bromide).

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<sup>1</sup> South Coast Air Quality Management District (2015). *MATES IV*. <https://www.aqmd.gov/home/air-quality/air-quality-studies/health-studies/mates-iv>

## III.2. MONITORING EQUIPMENT

### III.2.1 Introduction

For the purposes of this appendix, the descriptions and operational and maintenance procedures of the following equipment are stated.

**Table III-2-1. MATES V Samplers**

Sampler Type	Vendor and Model Number
Volatile Organic Compounds (VOCs)	Xontech 910A/ 912
Carbonyls	ATEC 8000
Metals, Hexavalent Chromium (Cr <sup>+6</sup> )	Xontech 924
PM <sub>2.5</sub> Speciation	Met One Instruments SASS
Black Carbon (BC)	Teledyne API 602 (Aethalometer)
Ultrafine Particles (UFPs)	Teledyne TSI 651 (CPC)
Polycyclic Aromatic Hydrocarbons (PAHs)	TISCH Polyurethane Foam (PUF+)

The siting, acceptance testing, and calibration functions for each type of equipment identified above are defined below.

### III.2.2 Equipment Characteristics

#### III.2.2.1 Siting

- A) Monitoring site selection criteria was the same for all fixed sites. Site uniformity was achieved to the greatest degree possible. Descriptions were prepared for all sampling sites and can be found in the South Coast AQMD Annual Network Plan<sup>2</sup>. The description includes, at a minimum, the type of ground surface, the direction, distance, and approximate height to any airflow obstruction, and the direction and distance to any local pollutant sources.
- B) The sampler platform was located in an area with unobstructed airflow, especially in the direction of any known sources of the sampled compounds. This is critical since turbulence and eddies from obstructions will cause non-representative results. The distance between an obstruction and the sampler is not to be closer than two times the height of the obstruction.

<sup>2</sup> South Coast Air Quality Management District (Current). *Monitoring Network Plan*. <http://www.aqmd.gov/home/air-quality/clean-air-plans/monitoring-network-plan>

- C) Locations significantly influenced by nearby pollutant sources, activities potentially impacting air quality, or where reactive surfaces may cause chemical changes in the air sampled were avoided. Micro-meteorological influences caused by nearby hills, bodies of water, valley drainage flow patterns, etc. were considered when selecting a monitoring site.
- D) The recommended intake probe height for criteria pollutants is 3 to 15 meters above ground level as near breathing height as possible with the additional criteria that a site is not placed where a building is an obstruction or where equipment is easily vandalized.
- E) The probe extends at least two meters away from the supporting structure. If the probe is located on a building, it is mounted on the prevailing windward side of the building.

#### **III.2.2.2 Acceptance Testing**

Acceptance testing was performed on all instrumentation and sampling equipment approximately one month after receipt. After acceptance testing was completed and instruments were found to meet acceptance criteria, they were deployed in the field and ambient sampling commenced. Acceptance testing was conducted according to the following steps:

- A) All instruments were carefully unpacked from their shipping containers and checked for completeness, broken parts, and correct subunits.
- B) The units were assembled according to manufacturer guidelines and prepared for start-up.
- C) The flowrate/flow meter portion of the pneumatic system, if any, was checked using the most appropriate calibration-transfer standard to verify the operating flow/flowrate.
- D) Timer accuracy was evaluated by comparing it to an elapsed-timer standard. All timers must hold their accuracy to  $\pm 5$  minutes over a 24-hour period.
- E) Any deficiency was corrected and addressed following the manufacturer's recommendations and procedures as stated in operations manuals.

#### **III.2.2.3 Calibration**

At each sampling site, final dynamic calibrations were performed on each analyzer and sampler prior to the start of the program. At the end of the sampling period, an "As Is" calibration was performed on each analyzer to ascertain the amount of analyzer drift.

#### **III.2.2.4 Sample Pickup**

The sampling media were prepared in the South Coast AQMD laboratory and retrieved by Air Quality Instrument Specialists (operators). Filters and carbonyl cartridges were transported at  $<4^{\circ}\text{C}$  in coolers with blue ice and the canisters were capped during transportation. Once the

filters and carbonyl cartridges were used to collect samples, they were refrigerated at <4 °C until returned to the South Coast AQMD Laboratory.

### **III.2.2.5 Troubleshooting**

The routine maintenance and quality control checks were based on U.S. EPA *Quality Assurance Project Plan for the Air Toxics Monitoring Network*<sup>3</sup> and U.S. Environmental Protection Agency (EPA) *National Air Toxics Trends Stations Technical Assistance Document (NATTS TAD)*<sup>4</sup>. For the instruments that were not included in the NATTS program, a maintenance guide based on the equipment manufacturers suggested operating procedures was the basis for maintenance activity including frequency and quality control checks for each instrument. If an instrument drifted out of the criteria, or if there was a component failure, the operator immediately contacted the South Coast AQMD STA/AM Support and Repair Section to schedule a repair.

### **III.2.2.6 Repair**

The potential failure of instrument and equipment components such as pumps and flow controllers were addressed by South Coast AQMD maintaining an inventory of staff replaceable spare parts.

## **III.2.3 SAMPLING EQUIPMENT**

### **III.2.3.1 Xontech 910A and 912**

#### **III.2.3.1.1 Xontech 910A - Description**

The Xontech 910A air sampler is designed to take air samples at a constant flow rate for a known sampling period. It is durable, serviceable and accurate within NATTS program criteria, making it useful for sampling a wide variety of gases.

Specifically, the 910A sampler takes air from the sample inlet and injects it into a canister at a constant flow rate for the preset duration. Excess air is exhausted through a bypass exhaust. The constant flow rate and elapsed time allow the operator to calculate the integrated air sample volume. Airflow to the canister is uniformly maintained by a mass flow controller that fills each canister with a representative sample volume and sufficient pressure for analysis. The Xontech 910A is operated according to the guidelines documented in the South Coast AQMD SOP00080 *Standard Operating Procedure for Xontech 910 Canister Sampler/912 Multi-Channel Controller*.

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<sup>3</sup> U.S. EPA. (2001). *Quality Assurance Project Plan for the Air Toxics Monitoring Network*. <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=200120XJ.PDF>

<sup>4</sup> U.S. EPA (2016). *Technical Assistant Document For The National Air Toxics Trends Stations Program*. [www3.epa.gov/ttn/amtic/files/ambient/airtox/NATTS%20TAD%20Revision%203\\_FINAL%20October%202016.pdf](http://www3.epa.gov/ttn/amtic/files/ambient/airtox/NATTS%20TAD%20Revision%203_FINAL%20October%202016.pdf)

### **III.2.3.1.2 Xontech 912 - Description**

The Xontech 912 adapter may be added to the Xontech 910A to enhance sampling capability over a reduced duration. It cannot operate independent of the 910A. It is designed to route gas samples to a maximum of 16 canisters. An internal time base can be used to step a rotary valve from canister to canister at a user-selected rate. The 912 also accepts timing signals from the model 910A. The Xontech 912 adapter was operated according to the procedures in the South Coast AQMD SOP00080, *Xontech 910 Canister Sampler/912 Multi-Channel Controller*.

### **III.2.3.1.3 Cleanliness Check**

To ensure data quality objectives are met, sampling units are checked for contamination and bias following the South Coast AQMD Standard Operating Procedure for *Time-Integrated And Instantaneous Canister Sampling*, SOP 00199. To perform a system bias check, zero air was passed through the sample manifold to fill one, 3-hour canister. Additionally, the 24-hour sampler was tested by increasing its sample flow to fill a canister in approximately 6 hours. A field blank canister was filled at the site by flowing zero air into an evacuated cylinder. A difference of less than 1 part per billion (ppb) per compound between the field blank and the bias test samples is the acceptance criteria for this test and indicates that the system is not contaminated (non-biasing). A value greater than 1 ppb per compound required investigation and corrective action. A system bias check was repeated until all biases were demonstrated to be eliminated. The District's Ambient Monitoring Support Group performed system repairs. This group assembled, leak checked, disassembled, and cleaned the sample manifold, and the Auditing Group calibrated the mass flow controller (MFC) for flow.

### **III.2.3.1.4 Canister Sample Pickup**

Field operators retrieved verified clean silica lined stainless steel canisters from the South Coast AQMD Laboratory. Evacuated canisters were transported by vehicle to the respective air monitoring stations. Each canister had an informational tag attached (Appendix III-E). This tag contains the following information: sample site, operator initials, and sample date. The air monitoring station operator recorded sampling information on this tag once the canister was set up for sampling. Once the canister was filled and disconnected from the 910A or 912 sampler, and prior to returning the sampled canister to the Laboratory, the canister number, start vacuum, end pressure (psig), and elapsed time was recorded on the MATES V sample log (Appendix III-D). The times on the QC chart was also checked and adjusted. This value was required to be within  $\pm 10$  minutes of actual Local Standard Time.

## **III.2.3.2 ATEC 8000**

### **III.2.3.2.1 Description**

The ATEC Model 8000 sampler is designed for the unattended collection of ambient air samples used in the determination of carbonyl compounds (aldehydes and ketones) in ambient air using acidified DNPH cartridges, according to EPA Compendium Method TO-11A. The ATEC 8000 has eight ports; each port can be programmed to collect samples over a specific time period.

Flow rates are regulated using mass flow controllers (MFC). Optional channels can be configured for collocated sampling. A touch screen display provides information on the samples, including sampling date, start time, stop time, average flowrate, minimum flowrate, maximum flowrate, total volume sampled, sampling time duration, and error status.

### **III.2.3.2.2 Operation**

To setup for sampling, the operator attaches the DNPH cartridges to the ATEC sampler and programs the instrument for collection of samples by selecting the channels/ports used and entering sampling parameters (flow rate, start time, stop time) and identification labels. Leak checks are performed prior to sampling to verify cartridge connections are leak free prior to sampling. Detailed operational procedures are available in the South Coast AQMD SOP 00119, *ATEC Model 8000 Automated Sampler*.

### **III.2.3.3 Xontech 924**

#### **III.2.3.3.1 Description**

The Model 924 Toxic Air Samplers are designed to collect ambient air particulate samples on a variety of filter materials and sorbent media in unattended field use. Samples collected using this sampler were brought to the South Coast AQMD headquarters for Laboratory analysis. The sampler controls the sampling time and flowrate through each sampling head using a microprocessor and mass flow controller (MFC). Sampler design is modular to facilitate installation of individual sampling channels. Each sampler accommodates eight sampling channels for two types of sample collection media: one that accepts 37- or 47-millimeter filters and another that accepts sorbent tubes.

The sampler consists of three modules, each contained in a separate enclosure. The heart of the system is the control module. This module contains the microprocessor, controller, mass-flow controllers, and front panel, displays, printer, and keypad. The difference between the Model 920 and 924 is that the electronics have been upgraded in the 924 to reflect the increase in microprocessor functionality presently available that was not available in the circa 1995 Model 920. The sampling module is equipped with isolation valves that protect the sampling media from passive sampling before or after sampling or sample loss after sampling. The sampling inlet height is 1.2 meters above ground level. The third element of the sampler is the pump module. It contains the vacuum pump that provides capacity for simultaneous operation of three, 30 liters per minute (lpm) and 200 cubic centimeters per minute (ccm) sampling channels.

#### **III.2.3.3.2 Operation**

To use the sampler, the operator inserts the sample filter cassette or sorbent tube into the sampling head and keys in the filter or sorbent head number. Start and stop times, and flow rates are pre-programmed or can be manually input. Following the sampling period, a report is automatically printed which is removed from the printer and submitted to the Laboratory with the filter for analysis.

Operational specifications are discussed in South Coast AQMD SOP 00094, *RM Environmental Systems Inc. (RMESI) 924 Toxics Sampler*.

### **III.2.3.4 MET One SASS**

#### **III.2.3.4.1 Description**

The MET One Speciation Air Sampling System (SASS) accommodates up to five sampling canisters which can hold multiple 47-millimeter filters to capture PM<sub>2.5</sub> particles. The PM<sub>2.5</sub> separation is produced by a sharp cut cyclone (SCC) that removes both solid and liquid coarse particles. Particle penetration through the SCC mimics the PM<sub>2.5</sub> cutoff curve of the WINS impactor as defined by the U.S. Environmental Protection Agency. All routine maintenance can be done in the field. Filter containers are transported to the Laboratory for inspection, cleaning and unloading/loading of sampling substrates. Every element of the sampler contacted by the sampled air stream ahead of the filter, including the inlet can be cleaned with each sample change. The SASS was designed with individual sharp cut cyclone inlets. Particles larger than 2.5 micron aerodynamic diameter are removed by the cyclonic inlet mounted with each filter container. The filter containers are equipped with a diffusion denuder ahead of the filter to remove selected gaseous compounds. Additional sampler description and operation is available in the South Coast AQMD Standard Operating Procedure, SOP00086 for the *Collection of PM<sub>2.5</sub> Air Samples with the Met One Instruments Speciation Air Sampling Systems (SASS) SOP00086*.

#### **III.2.3.4.2 Module and Media Description**

The integrated SASS canister contains the following components: a sharp cut cyclone, a denuder to remove nitric acid or ammonia gases, a 47 mm front filter for particle capture, a 47 mm tandem or backup filter as needed, and a cover to protect the components.

Several types of filter media are needed for assaying the different chemical constituents of ambient air particles. The chosen filter media are suitable for the type of analysis intended. For example, Teflon filters were used for gravimetric mass and trace metal determinations. Quartz fiber filters were used for elemental and organic carbon analysis as well as anions and cations analysis.

### **III.2.3.5 Black Carbon Measurements Using an Aethalometer**

The term soot often refers to impure carbon particles resulting from the incomplete combustion of fossil fuels and various types of biomass burning. Soot is a key component of atmospheric aerosols because of its strong ability to absorb solar radiation, causing a warming effect on global and regional climate. Soot is also of interest because of its potential adverse health effects.

Various analytical methods have been developed to quantify the concentration of atmospheric soot. Depending on the measurement method used, the non-Organic Carbon fraction of soot is referred to as Black Carbon (BC) or Elemental Carbon (EC). While BC is an "optical term" that is used to denote strong light-absorbing carbon, EC is a "chemical term" that refers to thermal-

refractory carbon with a graphite-like structure. Thus, BC and EC are two methodologically defined species that are typically measured using optical (summarized here and described in greater detail in Appendix VI) and thermal-optical methods (described in section III.2.3 of this Appendix), respectively.

The Aethalometer® (developed by Magee Scientific, Berkeley, CA) is an instrument that uses optical analysis to determine the mass concentration of BC particles collected from an air stream passing through a filter. Aethalometers are the most common instruments used to measure BC in real time. The operation of the Aethalometer is described in detail in the South Coast AQMD's *Standard Operating Procedure For the Operation, Maintenance, and Calibration of the Aethalometer – Teledyne "Dual Spot" Model 633 (Magee/Aerosol AE33)*, SOP00142. During sampling, the gas stream (frequently ambient air) briefly passes through a filter material which traps the suspended particulates, creating a deposit of increasing density. A light beam projected through the deposit is attenuated by those particles which are absorbing ('black') rather than scattering ('white'). Measurements are made at successive regular time intervals. The increase in attenuation from one measurement to the next is proportional to the increase in the density of optically absorbing material on the filter. This, in turn, is proportional to the concentration of the material in the sampled air stream. The sample is collected as a spot on a roll of filter tape. When the density of the deposit spot reaches a pre-set limit, the tape advances to a fresh spot and the measurements continue. Measurement of the sample gas flow rate and knowledge of the instrument's optical and mechanical characteristics permit a calculation of the average concentration of absorbing particles in the gas stream during the sampling period. Aethalometers may operate on time-base periods as rapid as 1 second, providing quasi-real-time data. One minute to one-hour averages are commonly used in most field applications. Comparison of aethalometer data with other physical and chemical analyses allows the output to be expressed as a concentration of BC. A more detailed description of the Magee Scientific Aethalometer along with monitoring results can be found in Appendix VI.

### III.2.3.6 Ultrafine Particle (UFP) Measurements

Ultrafine Particles (UFPs) are typically defined as particles with an aerodynamic diameter less than 100 nm. UFPs are emitted from both natural and anthropogenic sources, although in most urban environments vehicular fossil fuel combustion constitutes the major contributing source. The terms UFPs and nanoparticles (NP; diameter < 0.05  $\mu\text{m}$ ) are sometimes used interchangeably, and the definitions of each generally vary with the study or application. While fine particulate matter ( $\text{PM}_{2.5}$ ) dominates the mass distribution of atmospheric particles, UFPs account for about 90% of the total particle number. For this reason, their concentration is usually expressed in terms of total particle count (i.e. # per cubic centimeter of sampled air, or  $\#/ \text{cm}^3$ ), even though a small fraction of the particles being counted may be above 100 nm.

Condensation Particle Counters (CPCs) are instruments that provide the total number concentration of particles above a lower size limit (~3-20 nm, depending on make and model) in real-time. By means of CPCs, UFPs are grown through condensation in a controlled supersaturation environment to larger sizes and then measured/counted using a photodetector. Although CPCs are the most widely used instruments in most applications, they do not provide any information on the original size of the particles counted.

The CPC used to measure the ambient number concentration of UFPs at the ten fixed MATES V sites is commercialized by Teledyne Advanced Pollution Instrumentation PI (Teledyne API, San Diego, CA). This particular model (651) was specifically designed for network operation and its performance was evaluated by South Coast AQMD Staff prior to the beginning of MATES IV. The Teledyne 651 CPC utilizes a patented laminar-flow, water-based condensation growth technique. Particles which are too small (nanometer scale) to scatter enough light to be detected by conventional optics are grown to a larger size by condensing water on them. An air sample is continuously drawn through the CPC inlet via an external pump and a portion of the flow is sent to the exhaust as bypass flow. The aerosol sample is pulled through a cool region saturated with water vapor and its temperature is equilibrated. The sample then passes to a growth section where wetted walls are heated to produce an elevated vapor pressure resulting in a thermodynamic "supersaturation" condition. The small cool particles in the flow stream act as nuclei for condensation and grow into micron sized droplets. The droplets are passed through a laser beam and create a large light pulse. Every particle pulse event is detected and counted. In this technique, particle concentration is measured by counting every particle in the air stream. The CPC model 651 is able to detect particles as small as 7 nm in diameter and is operated with an upper size cutoff of approximately 600 nm. The detection range is between 0 and 1,000,000 #/cm<sup>3</sup>. The instrument is operated according to South Coast AQMD's SOP00143, *Operation, Maintenance, and Calibration of Teledyne's Ultrafine Particle Monitor Model 651*.

### **III.2.3.7 Polycyclic Aromatic Hydrocarbons (PAH)**

Polycyclic Aromatic Hydrocarbons (PAHs) are collected using TISCH Environmental Polyurethane Foam (PUF+) samplers designed to hold a circular 4-inch diameter quartz fiber filter and a 2.5 inch diameter by 5 inch long cylindrical glass cartridge containing a 3 inch PUF sorbent trap and granular solid sorbent material. The South Coast AQMD Laboratory staff prepared sample collection canisters using sampling media supplied by ERG, deconstructed the samples post-sampling, and mailed samples back to ERG for analysis. The South Coast AQMD Instrument Technicians setup the PUF instrument for sample collection, retrieved the canisters after sampling, and returned PUF samples to the South Coast AQMD Laboratory for deconstruction. Chain of Custody was maintained beginning from receipt of sampling media from ERG until the samples were shipped to ERG for analysis. South Coast AQMD staff was responsible for calibrating, calculating and reporting of the total air volume of each sample. This included calibration of the sampling instrument flow rate. The TISCH sampler was operated and maintained according to SOP00114, Standard Operating Procedure for TISCH PUF+ POLY-URETHANE FOAM (PUF) SAMPLER. A short method description is given in Appendix III-K.

## **III.3. LABORATORY PROCEDURES**

### **III.3.1 Introduction**

In 2008 the National Air Toxics Trends Stations (NATTS) program was implemented in the South Coast Air Basin. Some of the existing sampling instruments for NATTS, additional U.S. EPA programs, and South Coast AQMD programs, were utilized in MATES V. Hence, many of the procedures and protocols for the MATES V program were based on the South Coast AQMD

*Quality Management Plan for Environmental Measurement Programs* (2016), the South Coast AQMD *Quality Assurance Project Plan (QAPP) for PM<sub>2.5</sub> Speciation Program* (2013), and the EPA NATTS TAD<sup>5</sup>. However, MATES V also utilizes several analytical methods not performed under the federal programs and the procedures included herein are based upon manufacturer's measurement and quality control procedures that are intended to ensure that the data quality is suitable for the intended purposes of MATES V.

The South Coast AQMD utilized Air Quality Instrument Specialists to collect, retrieve, and deliver samples to the Laboratory. The Laboratory sample custodians handled sample logging within the South Coast AQMD Laboratory. Procedures for proper sampling and initial chain-of-custody are outlined in the South Coast AQMD standard operating procedures (SOPs).

### III.3.2 SAMPLE HANDLING

All sampling media were handled according to Laboratory standard practices for toxics analysis and particulate matter network programs, as applicable. Operators completed the sampling information and chain-of-custody forms<sup>6</sup>, and delivered samples to the Laboratory for receipt by sample custodians. .

#### III.3.2.1 Canister Cleaning

The South Coast AQMD Laboratory has a canister cleaning oven system operated according to SOP00091 "*Canister Cleaning System (CCS) Ovens 3 & 4 Toxics.*" These systems use humidified nitrogen to flush and clean canisters in a heated oven to less than 5 ppb total non-methane organic carbon (TNMOC). The canisters are held at 80°C and are flushed a minimum of seven times over a 2 ½ -hour period. Canisters are removed from the canister cleaning oven and batch analyzed for residual hydrocarbons. Data collected in performance of SOP00091 demonstrates the cleaning procedures satisfy cleanliness requirements and long-term experience has proven that the canister-cleaning oven system is sufficient to provide clean canisters meeting federal PAMS and NATTS cleanliness requirements. Any hydrocarbons and TNMOC above the threshold concentrations in one or more canisters trigger investigation and corrective action. All canisters (8) in the batch are re-cleaned and tested again to assure they meet cleanliness requirements. The cleaning date and operator are noted on the canister tag and in an electronic database that serves as the primary chain-of-custody.

#### III.3.2.2 Field Canister Use

Canisters are transported by Instrument Specialists to the site and are installed in accordance with the South Coast AQMD Standard Operating Procedure for *Xontech 910A Canister Sampler/912 Multi-Channel Controller* (SOP00080).

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<sup>5</sup> U.S. EPA. (2016). *National Air Toxics Trends Stations Technical Assistance Document*. [https://www3.epa.gov/ttn/amtic/files/ambient/airtox/NATTS%20TAD%20Revision%203\\_FINAL%20October%202016.pdf](https://www3.epa.gov/ttn/amtic/files/ambient/airtox/NATTS%20TAD%20Revision%203_FINAL%20October%202016.pdf)

Once sample collection was completed and the sample time, canister number, and start and stop vacuum were documented in the MATES V Sample Log (Appendix III-D) that accompanied the canister, samples were promptly returned to the Laboratory for receipt, log-in, and distribution to appropriate staff.

### III.3.2.3 Sample Distribution within the Laboratory

The Laboratory sample custodians logged received samples and distributed them to the appropriate staff member following established Laboratory procedures.

### III.3.3 Analytic Methods – Appendix III-A Compounds

Gaseous compounds listed in Appendix III-A were analyzed using gas chromatography with mass spectrometry (GC/MS) after cryo-focusing. This technique provides for instrument sensitivity sufficient for meeting MATES V measurement criteria. The method generally follows EPA Method TO-15; *Determination of Volatile Organic Compounds (VOCs) in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)*. Procedures specific to the South Coast AQMD Laboratory are found in South Coast AQMD SOP0008B. A short method description for sampling and analysis of VOCs by GC/MS can be found in Appendix III-J.

Carbonyl measurements were performed according to EPA Method TO-11, *Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Pressure Liquid Chromatography*, with NATTS sampling and analysis criteria delineated in the NATTS TAD (2016). The California Air Resources Board (CARB) toxic network design method was followed using the Xontech 924 with a carbonyl channel. A potassium-iodide-coated ozone denuder was also used in all carbonyl samplers. Waters® silica gel cartridge impregnated with dinitrophenyl hydrazine was used to sample for carbonyl compounds. A short method description for the carbonyl sampling and analysis can be found in SOP #00094 and in Appendix III-F.

TSP metals samples were collected on cellulose filters using Xontech 924 samplers and were analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) following the procedure found in South Coast AQMD SOP00096 *Standard Operating Procedure for the Determination of Metals in Ambient Particulate Matter by Inductively Coupled Plasma Mass Spectrometry*.

For PM<sub>2.5</sub> samples, a Teflon filter was used, and Energy Dispersive X-ray Fluorescence (ED-XRF) was used for metals analysis following the procedure found in South Coast AQMD SOP00004 *Standard Operating Procedure for the Analysis of PM<sub>2.5</sub> Filter Samples by Energy Dispersive X-Ray Fluorescence Spectrometry*. A short method description for sampling and analysis of elements by XRF is attached to this document as Appendix III-G.

Hexavalent chromium in ambient air was measured by collecting total suspended particulate matter (TSP) on cellulose filters impregnated with sodium bicarbonate solution using a Xontech 924 Toxic Air Sampler. The samples were analyzed by a Thermo Scientific ICS-5000 ion chromatograph (IC) equipped with a UV-Vis detector following South Coast AQMD SOP00046

*The Analysis of Hexavalent Chromium (Cr(VI)) in Ambient Air by Ion Chromatography.* The method description for hexavalent chromium sampling and analysis is found in Appendix III-L.

Particulate filter samples for PM<sub>2.5</sub> were analyzed for metals, ions, total mass, organic carbon (OC), elemental carbon (EC), and total carbon (TC). The procedure for mass and ion determinations follows the methodology used in support of South Coast AQMD (federally recognized) PM<sub>2.5</sub> Network activity. Analysis for EC, OC and TC of PM<sub>2.5</sub> filter samples was performed using the Interagency Monitoring of Protected Visual Environments A (IMPROVE A) method. The method evolves carbon from filters by heating and optically monitors carbon as it is evolved from the filter. After catalysts oxidize then reduce the carbon, it is measured by a flame ionization detector. A more detailed description of the IMPROVE A method can be found in Appendix III-I.

Particulate filter samples for PM<sub>2.5</sub> were analyzed for levoglucosan and other monosaccharide anhydrides. A portion of the quartz fiber filter sample was extracted in acetonitrile, derivatized with a silanizing reagent, and analyzed using a Gas Chromatograph/Mass Spectrometer. A detailed description of the method can be found in Appendix III-M.

The compounds listed in Appendix III-A were sampled on a one-day-in-six sampling schedule synchronized with the national PM<sub>2.5</sub> network schedule (BC and UFP measurements are real time). These samples were integrated 24-hour samples. South Coast AQMD personnel and contract employees conducted both the sampling and analysis with the exception of polycyclic aromatic hydrocarbons (PAHs), where the analysis was performed by Environmental Research Group, LLC (ERG).

### **III.3.4 Sampling Schedule**

MATES V sampling was conducted on the same schedule as used by the air-monitoring network. The air monitoring network sampling schedule can be found on the U.S. EPA website at; [www.epa.gov/tnn/amtic](http://www.epa.gov/tnn/amtic), and follows a six-day monitoring schedule for TSP lead, PM<sub>2.5</sub> and VOCs. This sampling schedule has several benefits:

- 1) Data from MATES V can be correlated with ambient data taken on the same day.
- 2) Additional staff time to service and maintain MATES V sampling equipment and instrumentation was minimized.
- 3) Sample set-up, retrieval, and delivery time to the Laboratory was minimized.

### **III.3.5 Quality Control/Quality Assurance**

Appendix V contains the objectives, procedures, documentation, and data review techniques that were used by the South Coast AQMD to quality assure that MATES V data that met or exceeded the acceptance criteria for its intended use.

## **III.4. Data Processing and Reporting**

### **III.4.1 Introduction**

MATES V monitoring and analysis of ambient air toxics has generated a large database which is available for future data analysis. The purpose of this chapter is to outline the data handling of this large database. This section will only pertain to laboratory work performed and not to the meteorological, criteria pollutant, or monitor calibration data.

The aim of reporting is to generate a database for electronic transfer to interested parties. The data was reviewed (verified) for errors, to assure that it meets DQOs and for adherence to other QA criteria such that the data represent the most accurate determinations possible, and is both defensible and suitable for MATES V use. The Laboratory made every effort to disseminate the data in a timely fashion to facilitate feedback.

### **III.4.2 Data Processing**

Data was processed, reviewed, and reported routinely during the MATES V monitoring period. AQ Chemists processed data generated from Laboratory instruments using analytical software and uploaded data to the Laboratory Information Management System (LIMS). The data was then reviewed by peer AQ Chemists, followed by Senior AQ Chemist review, and finalized by Principal AQ Chemists.

The continuous BC and UFP data was also processed, reviewed, and reported routinely during the MATES V monitoring period. Air Quality Instrument Specialists processed and reviewed data acquired from DMS using analytical software, followed by Air Quality Specialist review, and finalized by a Program Supervisor.

### **III.4.3 Database Compilation**

Data from the MATES V database was exported from the LIMS and stored in a MS Access database. The MATES V database is comprised of PM<sub>2.5</sub> mass and its components (ions, metals, carbon, sugars), VOCs, carbonyls, TSP metals, and PAHs results for ten fixed sampling locations. The continuous BC and UFP data is stored in a separate MS Excel database. The database contains information regarding station names, station abbreviations (four letter acronyms), sampling dates, sample types, analyses, analytes, concentrations, units, MDLs, invalid qualifiers, and comment qualifiers.

## APPENDIX III-A Air Contaminants Measured in MATES V Program

Pollutant Category		Measured Pollutants
<b>Ultrafine Particles (UFPs)</b>		UFPs
<b>PM2.5</b>	Ions	Ammonium Ion, Chloride, Nitrate, Potassium Ion, Sodium, Sulfate
	Sugars	Galactosan, Levoglucosan, Mannosan
	Metals	Aluminum, Antimony, Arsenic, Barium, Cadmium, Calcium, Cesium, Chlorine, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Molybdenum, Nickel, Phosphorus, Potassium, Rubidium, Samarium, Selenium, Silicon, Strontium, Sulfur, Thallium, Tin, Titanium, Uranium, Vanadium, Yttrium, Zinc
	Other	PM2.5 mass, Black Carbon (BC), Elemental Carbon (EC), Organic Carbon (OC), Total Carbon (TC)
<b>Total Suspended Particulate (TSP)</b>	Metals	Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Cesium, Chromium, Cobalt, Copper, Cr6+ (hexavalent chromium), Iron, Lead, Manganese, Molybdenum, Nickel, Potassium, Rubidium, Selenium, Strontium, Tin, Titanium, Uranium, Vanadium, Zinc
<b>Volatile Organic Compounds (VOCs)</b>	Carbonyls	2-Butanone (Methyl Ethyl Ketone), Acetaldehyde, Acetone, Benzaldehyde, Formaldehyde, Propionaldehyde
	Other	1,2-Dibromoethane, 1,2-Dichlorobenzene, 1,2-Dichloroethane, 1,2-Dichloropropane, 1,3-Butadiene, 1,4-Dichlorobenzene, 2-Butanone (Methyl Ethyl Ketone), Acrolein (2-Propenal), Acetone, Benzene, Bromomethane, Carbon Tetrachloride, Chloroform, Ethylbenzene, m+p-Xylene, Methyl tert-Butyl Ether (MTBE), Methylene Chloride, o-Xylene, Styrene, Tetrachloroethylene (Perchloroethylene), Toluene, Trichloroethylene, Vinyl Chloride
<b>Polycyclic Aromatic Hydrocarbons (PAHs)</b>		9-Fluorenone, Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(e)pyrene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Coronene, Cyclopenta(c,d)pyrene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-c,d)pyrene, Naphthalene, Perylene, Phenanthrene, Pyrene, Retene

**APPENDIX III-B WSD Monthly Quality Control Maintenance Check Sheet**

**SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT**

**MONTHLY QUALITY CONTROL MAINTENANCE CHECK SHEET**

MAKE/MODEL \_\_\_\_\_ Wind Speed and Direction System

Location \_\_\_\_\_ Month/Year \_\_\_\_\_

Station No. \_\_\_\_\_ Specialist \_\_\_\_\_

Control No. \_\_\_\_\_ Reviewed by \_\_\_\_\_ Date \_\_\_\_\_

Date	Zero Speed		Zero Direction		Visual Wind Transmitter Check	Chart Time	
	As Found	Final	As Found	Final		As Found	Final

**OPERATOR INSTRUCTIONS:**

Daily Checks: Chart trace and time.

Weekly Checks: Zero speed and direction inking system

Visual wind transmitter check. The station operator will visually check the wind transmitter to confirm the direction coincides with recorder. Notify supervisor immediately if problem occurs.

Bi-monthly

Maintenance:

DATE	COMMENTS OR MAINTENANCE PERFORMED

Calibration Date: \_\_\_\_\_

Operator \_\_\_\_\_

APPENDIX III-C PAH (PUF) Chain of Custody (COC)



ERG Lab ID #

601 Keystone Park Drive, Suite 700, Morrisville, NC 27560

### SVOC SAMPLE CHAIN OF CUSTODY

Lab Pre-Sampling	Site Code: <u>BUCA</u>	Container #: <u>319</u>				
	City/State: _____	Collection Date: <u>4/22/21</u>				
	AQS Code: _____	Collocated Event (Y/N): _____				
	Cartridge Certification Date: _____	SUR ID: <u>1004005</u>				
	Relinquished by: <u>RIC</u> Date: <u>3/4/21</u>	XAD Lot: <u>BIC3101-K8</u>				
		PUF Lot: <u>134597</u> Filter Lot: <u>17014295</u>				
Field Setup	Received by: <u>MARQUEZ</u> Date: <u>04/20/21</u>	System #: <u>1001 081</u>				
	Site Operator: <u>MARQUEZ</u>	Elapsed Timer Reset (Y/N): <u>Y</u>				
	Set-Up Date: <u>04/20/21</u>					
Field Recovery	Recovery Date: <u>04/27/21</u>	<b>Collection System Information:</b>				
		Elapsed Time	Temp. (°C)	Barometric ("Hg)	Magnehelic ("H <sub>2</sub> O)	Flowrate (std. m <sup>3</sup> /min)
		Start <u>00:00</u>				
		End <u>24:00</u>				
		Average	<u>14.4</u>	<u>28.9</u>	<u>34.7</u>	<u>0.225</u>
		Total Collection Time (Minutes) <u>1440</u>	Total Collection Volume (std. m <sup>3</sup> ) <u>323.45</u>			
Lab Recovery	Status: <input checked="" type="radio"/> <b>Valid</b> <input type="radio"/> <b>Void</b> (Circle one)	Site Operator: <u>NMARQUEZ</u>				
	Relinquished by: <u>NMARQUEZ</u> Date: <u>04/27/21</u>					
	Received by: _____ Date: _____ Container #: _____					
	Status: <b>Valid</b> <input type="radio"/> <b>Void</b> (Circle one)	Uncorrected Temperature: _____				
If void, why: _____	Corrected Temperature: _____					
	Thermometer: <b>IR1</b> <input type="radio"/> <b>IR2</b> (Circle one)					
	<b>Samples stored in Refrigerator # 7</b>					

07-2017

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

White: Sample Traveler

Canary: Lab Copy

Pink: Field Copy



South Coast Air Quality Management District  
Tisch/Thermo Sampler for Ambient PAH Measurements  
Field Work Sheet

Station:	RUCA		Location:	Rubidoux	<u>A</u>	B
Sampler Control #:	<u>1001-081</u>	1001-078	Property #:	33144		
Run Date:	4-22-2021		Day of Week:	M	T	W <u>Th</u> F Sat Sun

Filter Data

Filter Assembly ID #: <sup>EL 4644</sup> 13 15 Initial: PL

Placed on Sampler	Date: <u>04/20/21</u>	Time: <u>14:10</u>	Initial: <u>NM</u>
Removed from Sampler	Date: <u>04/27/21</u>	Time: <u>11:30</u>	Initial: <u>NM</u>
Returned to AQMD Lab	Date: <u>04/27/21</u>	Time: <u>13:00</u>	Initial: <u>NM</u>
Sent to ERG Lab	Date: <u>04/27/21</u>	Time: <u>14:35</u>	Initial: <u>PL</u>

Sampler Calibration Date: 08/13/20

Remarks:

Above Entries by: MARQUEZ

APPENDIX III-D MATES V Sample Chain of Custody (COC)



**South Coast Air Quality Management District**

MATES V Sample Log

Location: \_\_\_\_\_ Lab No: \_\_\_\_\_

Sample Type: \_\_\_\_\_

Sample Begin Date: \_\_\_\_\_ Retrieved By: \_\_\_\_\_

Sample End Date: \_\_\_\_\_ Retrieval Date: \_\_\_\_\_

Sample Load Date: \_\_\_\_\_

**ATEC 8000 S/N:**

Sample Type	Sample No.	Cartridge No.	Elapsed Time	Volume (L)	Comments
Carbonyls					

**Xontech 924 S/N:**

Sample Type	Sample No.	Cartridge No.	Elapsed Time	Volume (L)	Comments
Metals by ICP/MS					
Hexavalent Chromium					

**Xontech 910S/N:**

Sample Type	Sample No.	Canister No.	Start Vacuum		End Pressure	
			Sampler	Canister	Sampler	Canister
TO-15 NATTS						

**Comments:** |

**Chain of Custody:**

Relinquished By \_\_\_\_\_ Received By \_\_\_\_\_ Section/Group \_\_\_\_\_ Date/Time \_\_\_\_\_

Relinquished By \_\_\_\_\_ Received By \_\_\_\_\_ Section/Group \_\_\_\_\_ Date/Time \_\_\_\_\_

APPENDIX III-E VOC Canister Tag

VOC CANISTER TAG

		CANISTER #					
		1	2	3	4	5	6
Field	Code						
	Date						
	Time						
	Initial Pressure						
	Final Pressure						
	Initials						
	Non-Routine Sample?						
	Comments						
Laboratory	Analyst						
	Cleaner						
	Blank Reference						
	Comments						

### APPENDIX III-F Method Description for Sampling and Analysis of Carbonyls by UHPLC at the South Coast AQMD Laboratory

**Sampling** - Ambient air is drawn through an acidified dinitrophenylhydrazine (DNPH) coated silica cartridge mounted on an ATEC 8000 sampler. The samplers are located inside South Coast AQMD monitoring stations. A denuder is located upstream of the ATEC 8000 sampler and DNPH cartridge to eliminate or reduce ozone which interferes with carbonyl determination. The sampling cartridges are coated with a minimum of 300 mg of DNPH on Waters Sep-Pak silica cartridges. A volume of air is pulled through the cartridge at approximately 0.7 lpm for 24-hour sampling (1008 liters). Before and after sampling, each cartridge is kept capped and refrigerated at  $\leq 4^{\circ}\text{C}$  in a foil envelope to prevent loss of captured carbonyls or contamination.

**Laboratory Analysis** - The laboratory currently uses a Thermo Vanquish ultra high-performance liquid chromatograph (UHPLC) with autosampler. After elution of the Sep-Pak cartridge with three milliliters of acetonitrile, the samples are placed in an autosampler. Samples are analyzed using a gradient mode starting with 42% acetonitrile and 58% water at a flow rate of 0.6 ml per minute on an Acclaim Carbonyl RSLC 2.2  $\mu\text{m}$ , 2.1 mm by 150 mm column. One microliter of each sample is injected onto the column by the autosampler.

MATES V carbonyl samples from 2018 were analyzed using a Waters Millennium HPLC with autosampler and Waters C-18, 5  $\mu\text{m}$ , 4.6 mm by 250 mm column. A Thermo Vanquish UHPLC was used starting with 2019 carbonyl samples.

**Quantification** - A six-point calibration curve is created from triplicate injections of standards from 0.4 ug/ml to 10.0 ug/ml range. A second set of standards is obtained from a separate source and used to verify the calibration. PAMS/NATTS compounds, acetaldehyde, formaldehyde, and acetone (along with methyl ethyl ketone, propionaldehyde, and benzaldehyde) are quantified by comparison to the calibration curve. The concentrations are reported as ug/m<sup>3</sup> based on approximately 1000 L of air volume collected.

**QA/QC** – The Method Detection Limit (MDL) is determined according to EPA Appendix B to Part 136, 40CFR Ch.1 and Technical Assistance Document for the National Air Toxics Trends Stations Program, Revision 3, Chapter 4.0 Collection and Analysis Methods. A mid-level and a low-level control standard are added every 10 samples within each set, or batch, of analyses. For each set, or batch of 20 or less samples, an extraction solvent blank, a cartridge method blank, and a sample replicate injection are added. A duplicate sample from a second sampler is collected and analyzed every other month. For MATES V, duplicates were collected at Central Los Angeles and Rubidoux. A field blank is analyzed each month.

### **APPENDIX III-G Method Description for Sampling and Analysis of Elements by Energy Dispersive X-ray Fluorescence (ED-XRF) Spectrometry at the South Coast AQMD Laboratory**

**Sampling** - Ambient air is drawn through a 47-mm Teflon filter loaded in a PM<sub>2.5</sub> sampler. Typically, 24-hour sampling at about 20 liters per minute provides sufficient sample mass on the filter for analysis. The sampler must collect a homogeneous sample across the surface of the filter.

**Laboratory Analysis** - The Panalytical Epsilon 5 ED-XRF spectrometer is used to analyze 44 elements collected on a filter sample. Sample preparation involves bringing the filters to room temperature. Each filter is loaded onto an autosampler, placed in a sample chamber kept under vacuum and a small cross section of the filter near the center is scanned under eight different analytic conditions. Each condition is optimized for certain groups of elements. After spectral acquisition, an identification and deconvolution process extracts the net contributions to the counts for each of the 44 elements.

**Speciation and Quantification** - Each element has a unique spectral pattern. After accounting for overlaps, each of the elements is identified qualitatively. By using previously calibrated standard values, the net counts for each element are converted to actual concentrations in  $\mu\text{g}/\text{cm}^2$ . Using air volume data gathered during sampling, the  $\mu\text{g}/\text{filter}$  concentrations of the elements are converted to  $\text{ng}/\text{m}^3$ .

**QA/QC** - The X-ray instrument is calibrated using 46 single and dual element standards. These calibration standards are verified using an NIST multi-element thin film standard. The NIST is run at the beginning and end of each sequence. Filter blanks are analyzed and used to subtract background from subsequent runs using the Epsilon 5 software. Field blanks are taken at specified times depending on the frequency of sampling. Field blank results are reported in accordance with data reporting and analysis requirements. Finally, all runs are checked in duplicate for precision. Collocated samples are collected at specified sites and times to verify sampling and analytical precision.

**APPENDIX III-H Method Description for Sampling and Analysis of Elements by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) at the South Coast AQMD Laboratory**

**Sampling** - Ambient air is drawn through a 37-mm Cellulose filter loaded in a TSP sampler. Typically, 24-hour sampling at about 12 liters per minute provides sufficient sample mass on the filter for analysis.

**Laboratory Analysis** - A Perkin Elmer ICP-MS is used to analyze 38 elements collected on a filter sample. Sample preparation procedures include digesting the whole filter in 11% nitric acid in a microwave oven, centrifuging the digested solution and diluting 10 times with 2% nitric acid. The diluted solution is then analyzed by ICP-MS.

**Speciation and Quantification** - The ICP-MS is calibrated daily using a certified calibration standard mixture containing all elements of interest. The standard is diluted to eight concentrations and a 9 point calibration curve is generated and used to determine the concentration of elements in samples. The elements in the sample solutions are ionized with inductively coupled plasma and are separated in the mass spectrometer based on their mass to charge ratio and then their concentrations are determined by the detector based on the intensities of ion counts. Using air volume data gathered during sampling, the  $\mu\text{g/L}$  concentrations of the elements are converted to  $\text{ng/m}^3$ .

**QA/QC** - MDLs are performed annually to determine the analytical method sensitivity for the ICP-MS. A calibration check and blank analysis are required at the beginning and end of each analysis period and at intervals of ten samples to verify the calibration and check for contamination. Filter/ reagent blanks and filter/reagent spiked samples are digested and analyzed in each batch to examine the extraction efficiency and any matrix effects. Sample duplicates are performed for determining extraction and analysis precision. Interference check standards and serial dilutions are analyzed to insure matrix and instrument interferences are not present. Field blanks are taken at specified times depending on the frequency of sampling and reported in accordance with the data reporting and analytic requirements. Collocated samples are collected at specified sites and times to verify sampling and analytic precision.

### **APPENDIX III-I Method Description for Sampling and Analysis of Organic and Elemental Carbon by Thermal/Optical Carbon Analyzer at the South Coast AQMD Laboratory**

**Sampling** - Ambient air is drawn through a 47-mm quartz filter loaded in a PM<sub>2.5</sub> sampler. Typically, 24-hour sampling provides sufficient sample mass on a filter for analysis. The sampler must collect a homogeneous sample across the surface of the filter. A one-centimeter diameter punch from any sample portion of the filter is used in the instrument.

**Laboratory Analysis** - A Desert Research Institute (Reno, Nevada) thermal/optical carbon analyzer is used to determine the total carbon content of aerosol deposited on quartz filters. The analyzer is able to distinguish and characterize organic and inorganic carbon by a thermal/optical method with flame ionization detection. Sample preparation involves bringing the filters to room temperature. A small circular filter area is punched out from the quartz filter and loaded onto the carrier quartz tube. The filter is pushed into an oven whose temperature is raised in steps from ambient temperature to approximately 840 degrees Celsius. Helium is continuously passed over the filter until 480 degrees Celsius is attained, at which time a Helium/Oxygen mixture is then continuously passed over the punch until 840 degrees Celsius is reached to burn off elemental carbon. At the same time the surface of the filter is monitored with a laser beam to determine the point at which all the elemental carbon (soot) is burned off. The combusted carbon forms carbon dioxide that is carried over to a methanizer. The methanizer (active nickel with the addition of hydrogen gas) converts the carbon dioxide to methane. The methane flows to a flame ionization detector. The detector output is integrated and converted to  $\mu\text{g}$  of carbon per filter using previously calibrated standards.

**Speciation and Quantification** - The light organic fraction is driven off the filter at the early stages of heating. The elemental carbon fraction is then oxidized at a higher temperature with an oxygen enriched carrier gas. A laser beam constantly scans the filter surface to identify the point at which the organic and elemental carbon fractions are removed from the filter. The two fractions are summed to give the total carbon concentration of the sample. The analysis results in determination of the elemental, organic, and total carbon content of the sample. Using air volume data gathered during sampling, the  $\mu\text{gC}/\text{filter}$  concentrations are converted to  $\mu\text{gC}/\text{m}^3$  of air.

**QA/QC** - The optical-thermal carbon analyzer is calibrated using two types of standards. One consists of carbon containing gases (methane and carbon dioxide) in an inert gas. These are passed through the entire system to calibrate the instrument. In addition, filters impregnated with solution containing a known concentration of carbon are run as external standards. Field blanks are taken at specified times depending on the frequency of sampling. Field blank results are reported in accordance with the data reporting and analysis requirements. Finally, all samples are checked in duplicate and collocated runs are analyzed as a check of precision.

**APPENDIX III-J Method Description for Sampling and Analysis of VOCs by GC/MS at the South Coast AQMD**

**Sampling** - Ambient air is pumped through a properly sited probe and manifold into an evacuated Summa® polished and/or a silonite coated (Entech™) 6 liter canister using a Xontech 910A air sampler at the sample location. The sample is integrated over 24 hours to fill the canister to approximately 12 PSI, according to SOP00080 “Xontech 910 Canister Sampler/Multichannel Controller.” The canister is returned to the laboratory for analysis by Gas Chromatography with a Mass Spectrometer (GC/MS).

**Laboratory Analysis** - The Laboratory uses an Agilent 6890 Gas Chromatograph with an Agilent 5973 Mass Selective Detector. The sample is concentrated using an Entech 7200 cryo-concentrator then injected into a GC/MS. The sample canister is attached to the cryo-concentrator and a 600-milliliter aliquot is chilled in a trap to minus 150 degrees centigrade. For removal of the ambient humidity (water), the trap is heated to 10 degrees centigrade and transferred to a second trap cooled to -45 C for removal of CO<sub>2</sub> collected with the sample. The concentrator loop is then heated and the contents cryo-focused at the head of a GC column for subsequent separation of the VOCs. The mass selective detector records the mass spectrum of each peak (compound) and the analyst uses certified standards to compare selected ions for each compound to determine its concentration according to SOP0008B “Standard Operating Procedure for TO15 (VOC).”

**Quantitation** - A calibration curve is derived by injection of a gas standard containing the compounds of interest at ppb levels. Every sample run is preceded and ended with a calibration check. Every analysis day is begun with a system blank run. Selected quantitation ions for each compound are compared to those for injected gas standards to determine concentration in parts per billion.

**QA/QC** - The Method Detection Limit (MDL) is determined for the GC/MS according to the method outlined in the EPA NATTS TAD (October 2016). Collocated samples may be collected on a scheduled frequency, depending on the program. All canisters from the canister cleaning system are batch verified by analysis of purified humidified nitrogen contained in the canisters for the presence of the compounds of interest. Presence of analytes of interest above 0.2 ppb is cause for corrective action.

**APPENDIX III-K Method Description for Sampling and Analysis of PAH Compounds**

**Sampling** - Ambient air is drawn through an Andersen Instruments Poly-Urethane Foam (PUF) sampler. The method uses a high volume (Hi-Vol) air sampler equipped with a quartz fiber filter and PUF/Tenax glass adsorbent module for sampling between 325 and 400 cubic meters of air in a 24-hour sampling period. The laboratory is responsible for receipt of the quartz fiber filter and PUF/Tenax sorbent collection module, pre-cleaned and blanked, from Eastern Research Group (ERG) which is received by the Laboratory in a cold pack. The received modules are refrigerated at  $\leq 4^{\circ}\text{C}$  until needed and then constructed for sampling by a Laboratory Technician for use by the field Instrument Technician. The Instrument Technician installs the filter with PUF/Tenax collection module onto the Hi-Vol sampling unit and collects the sample after sampling completion. The Instrument Technician returns the sample immediately after sampling and places it in the laboratory refrigerator which is at  $\leq 4^{\circ}\text{C}$ . The Laboratory Technician then deconstructs the sampling module for shipment to ERG in a cooler with blue ice. Turnaround time for the sample to reach ERG from the sampling date is approximately 7 days.

**Laboratory Analysis**- Analysis of the collected sample (in accordance with the chain of custody) is performed by ERG, Morrisville, North Carolina. The protocol used is EPA Compendium Method TO-13. The results are reported to the South Coast AQMD Project Manager and U.S. EPA Air Quality System (AQS). Per ERG, “The test results are in compliance with NELAC accreditation requirements for certified parameters. All analyses are performed as described in the U.S. EPA approved QAPP, under the contract for NATTS.”

**QA/QC**- The South Coast AQMD portion of Quality Assurance/Quality Control is limited to the sampling process. The Thermo Andersen PUF sampler is calibrated using an orifice transfer standard that has been standardized against a primary standard Roots meter. The orifice transfer standard is referenced to 25 degrees centigrade and 760 millimeters of mercury (Hg). In the field leak checks and sampling flow rate checks are performed each run. Field blanks are run at the prescribed frequency as found in the National Air Toxics Trends study work plan. Non-contaminating and cold transfer of all materials is maintained up through the shipment under cold conditions to ERG.

### **APPENDIX III-L Method Description for Sampling and Analysis of Hexavalent Chromium by Ion Chromatography at the South Coast AQMD Laboratory**

**Sampling** - Ambient air is drawn through a 37-mm sodium bicarbonate treated cellulose filter loaded in a Xontech 924 sampler. Ambient air is pulled through the filter at a rate of approximately 12.0 liters per minute for 24-hours with an aggregate total air volume of approximately 17.2 m<sup>3</sup>. Samples are refrigerated at  $\leq 4^{\circ}\text{C}$  to minimize the reduction of hexavalent chromium to trivalent chromium.

**Laboratory Analysis** – Thermo Fischer Scientific ICS-5000 ion chromatograph (IC) is utilized to determine the hexavalent chromium concentration in ambient air samples. The entire filter sample is extracted in 10 mL of 20 mM sodium bicarbonate solution via ice bath sonication for one hour. The extract is then filtered to remove solids/particles and analyzed by IC. This system is comprised of an autosampler, guard column, analytical column, post-column derivatization module, a UV-Vis detector, and Chromeleon software. Hexavalent chromium is detected using a visible light lamp emitting at a wavelength of 530 nm after forming a complex with diphenylcarbazide in a post-column reaction.

**Quantification** – A five-point calibration curve is generated from prepared standards ranging from 50 to 2000 part per trillion (ppt). The hexavalent chromium sample concentrations are quantified by area comparisons to the area obtained for the calibration standards. Chromeleon software calculates the concentrations for each sample based on the calibration curve. The ppt concentrations are then converted to ng/m<sup>3</sup> by multiplying the ppt by the extraction volume (Liters) and dividing by the air volume (m<sup>3</sup>).

**QA/QC** – MDLs are performed annually to determine the analytical method sensitivity for the IC. The IC is calibrated weekly to achieve a minimum correlation coefficient of 0.9990. Blank and check standard analyses are performed every 10 samples to verify the precision of the analytical data. An external standard is prepared for every batch of samples to verify the accuracy of the calibration standard. Blank and spike QCs are extracted with every sample batch. Spike QCs are spiked with known hexavalent chromium and trivalent chromium concentrations to verify the accuracy of the method. A duplicate (DUP) injection of the first sample is analyzed at the end of the sequence to check for instrument drift and Cr<sup>III</sup>/ Cr<sup>VI</sup> conversion. Field blanks are taken at specified times depending on the frequency of sampling and reported in accordance with the data reporting and analysis requirements. Collocated samples are collected at specified sites and times to verify sampling and analytical precision. Detailed procedures are described in SOP00046, *The Analysis of Hexavalent Chromium in Ambient Air by Ion Chromatography*.

### **APPENDIX III-M Method Description for Sampling and Analysis of Levoglucosan and Related Monosaccharide Anhydrides at the South Coast AQMD Laboratory**

**Sampling** - Fine particulate matter (PM<sub>2.5</sub>) is collected by ambient air filtration onto 47 mm quartz fiber filters using Met One Instruments SASS™ samplers. Each sampler is programmed to sample approximately 9.8 m<sup>3</sup> of air over 24 hours. Levoglucosan and associated monosaccharide anhydrides (mannosan, galactosan) are analyzed by extraction of whole filters.

**Laboratory Analysis** – Monosaccharide anhydride concentrations in filter samples are determined with a Thermo Trace 1310 Gas Chromatograph (GC) coupled to an ISQ LT single quadrupole mass spectrometer (MS). Filters are spiked with an isotopically labeled internal standard (<sup>13</sup>C<sub>6</sub>-levoglucosan) and extracted by ultrasonication in acetonitrile. An aliquot of each extract is derivatized by a silanizing reagent to convert monosaccharide anhydrides to trimethylsilyl (TMS) derivatives suitable for GC/MS analysis. Samples are analyzed by GC/MS within 24 hours of derivization.

**Speciation and Quantification** – Samples are analyzed by GC/MS using a simultaneous selective ion monitoring (SIM)/full scan method. Each compound is positively identified by three characteristic mass fragments and quantified using the response of a primary fragment relative to the isotopically labeled internal standard. Using air volume data gathered during sampling, instrument concentrations (µg/filter) are converted to µg/m<sup>3</sup> of air.

**QA/QC** - Calibration curves for all compounds of interest are constructed with authenticated standards referenced to the isotopically labelled internal standard. The levoglucosan calibration curve is confirmed with a secondary authenticated standard. Instrument stability is verified by injection of low- and mid-level calibration standards following every 10 sample injections and at the close of each sequence. Due to the instability of TMS-derivatives, all calibration and secondary standards are prepared and derivatized in parallel to each sample batch. Blank contributions are assessed with instrument blanks run at the beginning of each sequence and after every 10 sample injections, a filter blank extracted as part of each sample batch, and monthly field blanks. Extraction efficiency is assessed with one filter blank spike sample per sample batch. Results from replicate injections and collocated samples are used to characterize instrument and sampling variability, respectively.

**APPENDIX IV**  
**MATES V**  
**FINAL REPORT**

**Summaries for the MATES II-V Fixed Monitoring Sites**

## Appendix IV

### Summaries for the MATES II-V Fixed Monitoring Sites

#### IV.1 Method Detection Limit (MDL) and Data Reporting

The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from the analysis of samples in a given sample matrix containing the analyte (EPA, 2017) <sup>1</sup>. Guidance for determination of the method detection limit (MDL) and data reporting was taken from the U. S. EPA's National Air Toxics Pilot City Monitoring Program. The MDL, as defined in 40 CFR Appendix B, Part 136, "Definition and Procedure for Determination of the Method Detection Limit" was used.

The South Coast AQMD Laboratory used this MDL determination method for the analyses conducted. It consists of performing seven replicate analyses of samples containing the analyte of interest at a level not to exceed five times the projected MDL. A standard deviation is determined using results of the analysis. The standard deviation multiplied by 3.14 (from the Tables of Student's t Values at the 99% confidence level) is the reported MDL.

In the tables below, the average generally represents the Kaplan-Meier (KM) mean, and the 95% confidence intervals (CI) are taken from bootstrapping the KM mean. The KM mean cannot be reliably calculated if more than 80% of the data points are below the MDL. In this situation, two average calculations are provided. The first average is found by substituting zero for all data below the MDL and calculating the average. The 95% confidence intervals are calculated for the zero-substituted mean using bootstrapping, which is a method of randomly sampling data and re-calculating the mean. The second average is found by substituting the MDL for all data below the MDL and calculating the average. The 95% confidence intervals are calculated for the MDL-substituted mean using bootstrapping. In the tables below, the reported lower-bound of the 95% confidence interval is taken from the zero-substituted mean calculations and the upper-bound of the 95% confidence interval is taken from the MDL-substituted mean calculations. Data for which more than 80% of the sample are below the MDL are denoted with a footnote ("a"). See Appendix XI for more information about the statistical methods used in this report.

Fine particulate matter (PM<sub>2.5</sub>) is a component of the total suspended particle (TSP) mass. Metals in the PM<sub>2.5</sub> size fraction often have more than 80% of the data below the MDL, e.g., arsenic, antimony, and cadmium due to limitations in measurement techniques. The upper bound estimate of the average using MDL substitution is sometimes higher than the KM mean from the TSP analysis for the same metal. Since PM<sub>2.5</sub> is a subset of TSP, an upper bound estimate higher than the TSP KM mean is unrealistic. In this situation, the KM mean and upper bound of the 95% confidence interval from the TSP analysis are used instead of MDL substitution. The data for PM<sub>2.5</sub> metals is more uncertain than other analytes in the MATES report, and staff urge caution in the

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<sup>1</sup> Reference: Environmental Protection Agency, 40 CFR Part 136, Clean Water Act Methods Update Rule for the Analysis of Effluent. <https://www.govinfo.gov/content/pkg/FR-2017-08-28/pdf/2017-17271.pdf>

interpretation of the PM<sub>2.5</sub> metal data, especially for older MATES data. In some cases (antimony for MATES III, tin and uranium for MATES IV), the KM mean from the TSP analysis is lower than the zero-substituted mean from the PM<sub>2.5</sub> analysis, indicating that these data should be interpreted with caution. Data for which the TSP KM mean is used in place of MDL-substituted mean are denoted with a footnote (“b”). The station names, abbreviations, latitude (Lat.) and longitude (Lon.) 1 for MATES II-V are in Table IV-1 below.

Table IV-2 shows the MDLs. Some data sets have multiple MDLs for a given MATES project, pollutant, and station, in which case the minimum and maximum MDLs are provided separated by a comma. Not all pollutants were monitored during all of the MATES projects, leading to empty spaces in Table IV-2. In a few instances, MDLs were not available for certain pollutants from previous MATES projects, also resulting in empty spaces in Table IV-2. Data with missing MDL values could not be analyzed with the methods used for this report and no statistics were calculated. These are denoted as “Unk MDL” for unknown MDL in later tables in this appendix. Table IV-3 through Table IV-157 present statistical summaries for all pollutants for all MATES projects by station.

Figure IV-1 through Figure IV-297 present the MATES data as bar graphs and geographic plots to visualize all of the data for a single species both temporally and spatially. For the geographic plots, both the heights of the bars and the color scale represent the pollutant concentration. The bars that consist of a solid color represent KM mean concentrations. As described above, the KM mean is not calculated if more than 80% of the data were below detection limit, and upper and lower-bound estimates are provided using MDL and zero substitution for the data below detection limit. For this situation, the bar has a color gradient from the lower to upper bound estimates. Additionally, when upper and lower bound estimates are used, the bottom of the bar may not extend all the way to the axis, but instead the height of the bottom of the bar represents the lower bound estimate of the concentration. The location of each station is represented by a blue dot, usually at the intersection of the horizontal and vertical axes for the bar plot. To avoid overlapping bar plots, some of the bar plots are moved away from the location of the station and an arrow points to the blue dot representing the station location. The “x” in the bar graphs indicate that either no measurements were conducted, or the MDL is not available.

The bar charts show the concentration on the left vertical axis. Cancer risk and/or chronic hazard quotient (HQ) estimates are shown on the right vertical axis or axes. If there is no cancer risk and/or chronic HQ axis on the right side of the bar graph, then cancer potency values and/or chronic Reference Exposure Levels (REs) have not been defined by OEHHA for that analyte and a health risk calculation could not be completed.

Section IV.2 describes multiple methods that were used for handling missing analytes in the aggregate risk calculations. The results from each of these methods are shown in Figure IV-298 through Figure IV-301.

**Table IV-1** Station names, abbreviations, latitude (Lat.) and longitude (Lon.) I for MATES II-V.

Station	MATES II Name (Lat., Lon.)	MATES III Name (Lat., Lon.)	MATES IV Name (Lat., Lon.)	MATES V Name (Lat., Lon.)
AN	Anaheim (33.8199, -117.9144)	Anaheim (33.8199, -117.9144)	Anaheim (33.8307, -117.9406)	Anaheim (33.8307, -117.9403)
BU	Burbank (34.176, -118.317)	Burbank (34.176, -118.317)	Burbank (34.176, -118.317)	Burbank Area (34.2616, -118.4123)
CP	Compton (33.9015, -118.2065)	Compton (33.9015, -118.2065)	Compton (33.9015, -118.2065)	Compton (33.9014, -118.2069)
SB	Fontana (34.0996, -117.4919)	Inland Valley San Bernardino (34.0996, -117.4919)	Inland Valley San Bernardino (34.0996, -117.4919)	Inland Valley San Bernardino (34.0996, -117.4919)
HP	Huntington Park (33.9833, -118.2306)	Huntington Park (33.9833, -118.2306)	Huntington Park (33.9833, -118.2306)	Huntington Park (33.9798, -118.2159)
LB	Long Beach (34.176, -118.317)	North Long Beach (34.176, -118.317)	North Long Beach (34.176, -118.317)	Long Beach (34.2616, -118.4123)
LA	Los Angeles (34.0665, -118.2276)	Central Los Angeles (34.0665, -118.2276)	Central Los Angeles (34.0665, -118.2276)	Central L.A. (34.0665, -118.2276)
PR	Pico Rivera (34.0135, -118.0604)	Pico Rivera (34.0135, -118.0604)	Pico Rivera (34.0135, -118.0604)	Pico Rivera (34.0135, -118.0604)
RU	Rubidoux (34.0006, -117.4151)	Rubidoux (34.0006, -117.4151)	Rubidoux (34.0006, -117.4151)	Rubidoux (34.0006, -117.4151)
WLB	Wilmington (33.7993, -118.2584)	West Long Beach (33.7924, -118.2158)	West Long Beach (33.8015, -118.2203)	West Long Beach (33.8015, -118.2203)

**Table IV-2.** Method detection limits (MDLs) for MATES II-V

<b>Analysis</b>	<b>Analyte</b>	<b>MATES II MDL</b>	<b>MATES III MDL</b>	<b>MATES IV MDL</b>	<b>MATES V MDL</b>
Carbonyls	Acetaldehyde	0.1 ppb	0.1 ppb	0.00785 ppb	0.0189, 0.0211 ppb
Carbonyls	Acetone	0.1 ppb	0.1 ppb	0.00455 ppb	0.0838, 0.12 ppb
Carbonyls	Benzaldehyde				0.00346, 0.0205 ppb
Carbonyls	Formaldehyde	0.1 ppb	0.1 ppb	0.0137 ppb	0.0195, 0.0236 ppb
Carbonyls	Methyl Ethyl Ketone	0.1 ppb	0.1 ppb	0.00125 ppb	0.00882, 0.0207 ppb
Carbonyls	Propionaldehyde				0.00463, 0.00842 ppb
VOCs	Acrolein			0.079 ppb	0.03, 0.05 ppb
VOCs	Benzene	0.1, 0.2 ppb	0.1 ppb	0.026 ppb	0.01, 0.04 ppb
VOCs	Bromomethane				0.01, 0.1 ppb
VOCs	1,3 Butadiene	0.04, 1.9 ppb	0.2 ppb	0.028 ppb	0.02, 0.03 ppb
VOCs	Carbon Tetrachloride	0.02, 0.2 ppb	0.05 ppb	0.046 ppb	0.01, 0.05 ppb
VOCs	Chloroform	0.02, 0.1 ppb	0.1 ppb	0.054 ppb	0.01, 0.05 ppb
VOCs	Chloromethane	0.1 ppb			
VOCs	1,2-Dibromoethane	0.1 ppb	0.2 ppb	0.07 ppb	0.03, 0.07 ppb
VOCs	1,2-Dichlorobenzene	0.01, 0.1 ppb	0.3 ppb	0.095 ppb	0.04, 0.07 ppb
VOCs	1,4-Dichlorobenzene	0.02, 0.1 ppb	0.3 ppb	0.057 ppb	0.04, 0.06 ppb
VOCs	Dichloroethane [1,1]	0.1 ppb			
VOCs	1,2-Dichloroethane	0.1 ppb	0.1 ppb	0.044 ppb	0.01, 0.04 ppb
VOCs	1,1-Dichloroethene (VDC)	0.1, 0.5 ppb			
VOCs	1,2-Dichloropropane		0.2 ppb	0.022 ppb	0.02, 0.03 ppb
VOCs	Ethyl Benzene	0.1, 0.6 ppb	0.1 ppb	0.05 ppb	0.02, 0.06 ppb
VOCs	Methylene Chloride	0.1, 1 ppb	0.1 ppb	0.076 ppb	0.02, 0.08 ppb
VOCs	Methyl tertiary-butyl ether (MTBE)		0.3 ppb	0.051 ppb	0.01, 0.05 ppb
VOCs	Non Methane Organic Carbon			0.3 ppbC	
VOCs	Perchloroethylene	0.01, 0.1 ppb	0.1 ppb	0.065 ppb	0.03, 0.04 ppb
VOCs	Styrene	0.1 ppb	0.1 ppb	0.069 ppb	0.04, 0.07 ppb
VOCs	Toluene	0.1, 0.2 ppb	0.1 ppb	0.024 ppb	0.02, 0.09 ppb
VOCs	Trichloroethylene	0.02, 0.1 ppb	0.1 ppb	0.072 ppb	0.008, 0.04 ppb
VOCs	Vinyl Chloride	0.2, 0.7 ppb	0.2 ppb	0.051 ppb	0.01, 0.04 ppb

<b>Analysis</b>	<b>Analyte</b>	<b>MATES II MDL</b>	<b>MATES III MDL</b>	<b>MATES IV MDL</b>	<b>MATES V MDL</b>
VOCs	Vinyl Chloride	0.2, 0.7 ppb	0.2 ppb	0.051 ppb	0.01, 0.04 ppb
VOCs	Xylene (m-, p-)	0.1, 0.6 ppb	0.1 ppb	0.072 ppb	0.05, 0.09 ppb
VOCs	Xylene (o-)	0.1 ppb	0.2 ppb	0.065 ppb	0.02, 0.05 ppb
TSP Hexavalent Chromium	Hexavalent Chromium	0.06, 0.4 ng/m <sup>3</sup>	0.06 ng/m <sup>3</sup>	0.0032 ng/m <sup>3</sup>	0.002, 0.003 ng/m <sup>3</sup>
TSP Metals	Aluminum	6, 60 ng/m <sup>3</sup>	150 ng/m <sup>3</sup>		
TSP Metals	Antimony	6, 19 ng/m <sup>3</sup>	2 ng/m <sup>3</sup>	0.077 ng/m <sup>3</sup>	0.08, 0.43 ng/m <sup>3</sup>
TSP Metals	Arsenic	3, 4 ng/m <sup>3</sup>	1 ng/m <sup>3</sup>	0.091 ng/m <sup>3</sup>	0.07 ng/m <sup>3</sup>
TSP Metals	Barium	19, 25 ng/m <sup>3</sup>	17 ng/m <sup>3</sup>	2.4 ng/m <sup>3</sup>	1.4, 7.24 ng/m <sup>3</sup>
TSP Metals	Beryllium			0.087 ng/m <sup>3</sup>	0.04, 0.22 ng/m <sup>3</sup>
TSP Metals	Bromine	1, 2 ng/m <sup>3</sup>			
TSP Metals	Cadmium	10 ng/m <sup>3</sup>	2 ng/m <sup>3</sup>	0.0785 ng/m <sup>3</sup>	0.02, 0.09 ng/m <sup>3</sup>
TSP Metals	Calcium	3, 12 ng/m <sup>3</sup>	5 ng/m <sup>3</sup>	0.291 ng/m <sup>3</sup>	337, 1740 ng/m <sup>3</sup>
TSP Metals	Cesium			0.291 ng/m <sup>3</sup>	0.01, 0.07 ng/m <sup>3</sup>
TSP Metals	Chlorine	7, 13 ng/m <sup>3</sup>			
TSP Metals	Chromium	2 ng/m <sup>3</sup>	2 ng/m <sup>3</sup>	1.05 ng/m <sup>3</sup>	0.7, 0.74 ng/m <sup>3</sup>
TSP Metals	Cobalt	16, 35 ng/m <sup>3</sup>	1 ng/m <sup>3</sup>	0.122 ng/m <sup>3</sup>	0.05, 0.25 ng/m <sup>3</sup>
TSP Metals	Copper	1, 2 ng/m <sup>3</sup>	1 ng/m <sup>3</sup>	0.933 ng/m <sup>3</sup>	0.73, 3.76 ng/m <sup>3</sup>
TSP Metals	Gallium	3 ng/m <sup>3</sup>			
TSP Metals	Indium	11 ng/m <sup>3</sup>	2 ng/m <sup>3</sup>		
TSP Metals	Iron	2, 8 ng/m <sup>3</sup>	1 ng/m <sup>3</sup>	0.291 ng/m <sup>3</sup>	14, 145 ng/m <sup>3</sup>
TSP Metals	Lanthanum	67 ng/m <sup>3</sup>			
TSP Metals	Lead	1, 3 ng/m <sup>3</sup>	5 ng/m <sup>3</sup>	0.49 ng/m <sup>3</sup>	0.2, 1.01 ng/m <sup>3</sup>
TSP Metals	Magnesium	67 ng/m <sup>3</sup>			
TSP Metals	Manganese	2 ng/m <sup>3</sup>	1 ng/m <sup>3</sup>	0.37 ng/m <sup>3</sup>	0.28, 1.45 ng/m <sup>3</sup>
TSP Metals	Mercury	3 ng/m <sup>3</sup>			
TSP Metals	Molybdenum	1, 3 ng/m <sup>3</sup>	2 ng/m <sup>3</sup>	0.12 ng/m <sup>3</sup>	0.04, 0.22 ng/m <sup>3</sup>
TSP Metals	Nickel	1, 2 ng/m <sup>3</sup>	1 ng/m <sup>3</sup>	0.719 ng/m <sup>3</sup>	0.21, 0.22 ng/m <sup>3</sup>
TSP Metals	Palladium	11 ng/m <sup>3</sup>	3 ng/m <sup>3</sup>		
TSP Metals	Phosphorus	13, 20 ng/m <sup>3</sup>	21 ng/m <sup>3</sup>		
TSP Metals	Potassium	5, 11 ng/m <sup>3</sup>	2 ng/m <sup>3</sup>	0.291 ng/m <sup>3</sup>	56.1, 58.3 ng/m <sup>3</sup>
TSP Metals	Rubidium	2 ng/m <sup>3</sup>	1 ng/m <sup>3</sup>	0.291 ng/m <sup>3</sup>	0.04, 0.22 ng/m <sup>3</sup>
TSP Metals	Selenium	1, 2 ng/m <sup>3</sup>	2 ng/m <sup>3</sup>	0.868 ng/m <sup>3</sup>	0.56, 0.59 ng/m <sup>3</sup>

Analysis	Analyte	MATES II MDL	MATES III MDL	MATES IV MDL	MATES V MDL
TSP Metals	Silicon	5, 64 ng/m <sup>3</sup>	275 ng/m <sup>3</sup>		
TSP Metals	Silver	5 ng/m <sup>3</sup>	2 ng/m <sup>3</sup>		
TSP Metals	Strontium	2, 3 ng/m <sup>3</sup>	2 ng/m <sup>3</sup>	0.211 ng/m <sup>3</sup>	0.7, 3.62 ng/m <sup>3</sup>
TSP Metals	Sulfur	4, 32 ng/m <sup>3</sup>	21 ng/m <sup>3</sup>		
TSP Metals	Tin	5 ng/m <sup>3</sup>	3 ng/m <sup>3</sup>	0.442 ng/m <sup>3</sup>	0.15, 0.8 ng/m <sup>3</sup>
TSP Metals	Titanium	4, 14 ng/m <sup>3</sup>	5 ng/m <sup>3</sup>	0.882 ng/m <sup>3</sup>	1.74, 8.97 ng/m <sup>3</sup>
TSP Metals	Uranium	3, 6 ng/m <sup>3</sup>		0.0813 ng/m <sup>3</sup>	0.01, 0.07 ng/m <sup>3</sup>
TSP Metals	Vanadium	3, 6 ng/m <sup>3</sup>	2 ng/m <sup>3</sup>	0.197 ng/m <sup>3</sup>	0.04 ng/m <sup>3</sup>
TSP Metals	Yttrium	1, 2 ng/m <sup>3</sup>	1 ng/m <sup>3</sup>		
TSP Metals	Zinc	1, 2 ng/m <sup>3</sup>	1 ng/m <sup>3</sup>	0.291 ng/m <sup>3</sup>	8.42, 8.74 ng/m <sup>3</sup>
TSP Metals	Zirconium	2 ng/m <sup>3</sup>			
PM10 Mass	PM10 Mass	22 µg/m <sup>3</sup>		0.0613 µg/m <sup>3</sup>	
PM10 Carbon	Elemental Carbon	947 ng/m <sup>3</sup>		7.47 ng/m <sup>3</sup>	
PM10 Carbon	Organic Carbon	3320 ng/m <sup>3</sup>		99.6 ng/m <sup>3</sup>	
PM10 Carbon	Total Carbon	5010 ng/m <sup>3</sup>		99.6 ng/m <sup>3</sup>	
PAH	Acenaphthene		0.037 ng/m <sup>3</sup>	0.0302, 0.346 ng/m <sup>3</sup>	0.0689, 0.69 ng/m <sup>3</sup>
PAH	Acenaphthylene		0.037 ng/m <sup>3</sup>	0.0212, 0.229 ng/m <sup>3</sup>	0.00807, 0.0444 ng/m <sup>3</sup>
PAH	Anthracene		0.037 ng/m <sup>3</sup>	0.0219, 0.306 ng/m <sup>3</sup>	0.0124, 0.0321 ng/m <sup>3</sup>
PAH	Benzo(a)anthracene		0.0018 ng/m <sup>3</sup>	0.0349, 0.377 ng/m <sup>3</sup>	0.00863, 0.00965 ng/m <sup>3</sup>
PAH	Benzo(a)pyrene	0.05 ng/m <sup>3</sup>	0.0018 ng/m <sup>3</sup>	0.0407, 0.47 ng/m <sup>3</sup>	0.00984, 0.0133 ng/m <sup>3</sup>
PAH	Benzo(b)fluoranthene	0.05 ng/m <sup>3</sup>		0.032, 0.352 ng/m <sup>3</sup>	0.0077, 0.0198 ng/m <sup>3</sup>
PAH	Benzo(b+j+k)Fluoranthene		0.0018 ng/m <sup>3</sup>		
PAH	Benzo(e)pyrene			0.0389, 0.42 ng/m <sup>3</sup>	0.0051, 0.00975 ng/m <sup>3</sup>
PAH	Benzo(g,h,i)perylene	0.05 ng/m <sup>3</sup>	0.0018 ng/m <sup>3</sup>	0.0288, 0.396 ng/m <sup>3</sup>	0.00538, 0.0538 ng/m <sup>3</sup>
PAH	Benzo(k)fluoranthene	0.05 ng/m <sup>3</sup>		0.0404, 0.459 ng/m <sup>3</sup>	0.0039, 0.0108 ng/m <sup>3</sup>

Analysis	Analyte	MATES II MDL	MATES III MDL	MATES IV MDL	MATES V MDL
PAH	Chrysene		0.0018 ng/m3	0.0186, 0.347 ng/m3	0.00633, 0.00747 ng/m3
PAH	Coronene			0.0394, 0.438 ng/m3	0.00278, 0.0278 ng/m3
PAH	Cyclopenta(c,d)pyrene			0.0304, 0.582 ng/m3	0.00386, 0.0066 ng/m3
PAH	Dibenz(a,h)anthracene	0.05 ng/m3	0.0018 ng/m3	0.0293, 0.393 ng/m3	0.0121, 0.121 ng/m3
PAH	Fluoranthene		0.037 ng/m3	0.0355, 0.612 ng/m3	0.023, 0.23 ng/m3
PAH	Fluorene		0.037 ng/m3	0.0301, 0.325 ng/m3	0.0643, 0.688 ng/m3
PAH	9-Fluorenone			0.0364, 0.393 ng/m3	0.0375, 0.563 ng/m3
PAH	Indeno(1,2,3-c,d)pyrene	0.05 ng/m3	0.0018 ng/m3	0.0264, 0.455 ng/m3	0.0123, 0.132 ng/m3
PAH	Naphthalene		0.037 ng/m3	0.118, 1.71 ng/m3	1.07, 16.9 ng/m3
PAH	Perylene			0.0291, 0.469 ng/m3	0.0084, 0.0841 ng/m3
PAH	Phenanthrene		0.037 ng/m3	0.0297, 0.321 ng/m3	0.116, 0.207 ng/m3
PAH	Pyrene		0.037 ng/m3	0.0376, 0.601 ng/m3	0.0117, 0.155 ng/m3
PAH	Retene			0.0762, 1.1 ng/m3	0.0572, 1.77 ng/m3
PM2.5 Mass (SASS)	PM2.5 Mass		0.104 µg/m3	0.104 µg/m3	0.0001 µg/m3
PM2.5 Carbon	EC1				40 ng/m3
PM2.5 Carbon	EC2				40 ng/m3
PM2.5 Carbon	EC3				40 ng/m3
PM2.5 Carbon	Elemental Carbon		74.2 ng/m3	37.5 ng/m3	40 ng/m3
PM2.5 Carbon	OC1				490, 500 ng/m3
PM2.5 Carbon	OC2				490, 500 ng/m3
PM2.5 Carbon	OC3				490, 500 ng/m3
PM2.5 Carbon	OC4				490, 500 ng/m3
PM2.5 Carbon	Organic Carbon		557 ng/m3	500 ng/m3	490, 500 ng/m3
PM2.5 Carbon	Total Carbon		557 ng/m3	500 ng/m3	490, 500 ng/m3
PM2.5 Ions	Ammonium Ion		43.8 ng/m3	43.8 ng/m3	40 ng/m3
PM2.5 Ions	Chloride		150 ng/m3	150 ng/m3	150, 160 ng/m3
PM2.5 Ions	Nitrate		150 ng/m3	150 ng/m3	154, 156 ng/m3
PM2.5 Ions	Potassium Ion				80 ng/m3
PM2.5 Ions	Sodium		15.6 ng/m3	15.6 ng/m3	20 ng/m3

Analysis	Analyte	MATES II MDL	MATES III MDL	MATES IV MDL	MATES V MDL
PM2.5 Ions	Sulfate		150 ng/m3	150 ng/m3	154, 156 ng/m3
PM2.5 Metals	Aluminum		1.2 ng/m3	42.2 ng/m3	42 ng/m3
PM2.5 Metals	Antimony		1.4 ng/m3	59.8 ng/m3	42 ng/m3
PM2.5 Metals	Arsenic		0.2 ng/m3	13.1 ng/m3	12 ng/m3
PM2.5 Metals	Barium		10 ng/m3	123 ng/m3	68 ng/m3
PM2.5 Metals	Cadmium		1 ng/m3	42.7 ng/m3	25 ng/m3
PM2.5 Metals	Calcium		1 ng/m3	13.9 ng/m3	17 ng/m3
PM2.5 Metals	Cesium			154 ng/m3	123, 124 ng/m3
PM2.5 Metals	Chlorine			12.4 ng/m3	14 ng/m3
PM2.5 Metals	Chromium		1 ng/m3	8.86 ng/m3	6 ng/m3
PM2.5 Metals	Cobalt		0.4 ng/m3	10.3 ng/m3	7 ng/m3
PM2.5 Metals	Copper		0.2 ng/m3	11.7 ng/m3	7 ng/m3
PM2.5 Metals	Indium		1 ng/m3		
PM2.5 Metals	Iron		0.4 ng/m3	15.8 ng/m3	25 ng/m3
PM2.5 Metals	Lead		3 ng/m3	22.2 ng/m3	14 ng/m3
PM2.5 Metals	Magnesium				67 ng/m3
PM2.5 Metals	Manganese		0.5 ng/m3	14.7 ng/m3	9 ng/m3
PM2.5 Metals	Molybdenum		1 ng/m3		10 ng/m3
PM2.5 Metals	Nickel		0.2 ng/m3	8.03 ng/m3	4 ng/m3
PM2.5 Metals	Palladium		1.5 ng/m3		
PM2.5 Metals	Phosphorus		12 ng/m3	15.4 ng/m3	15 ng/m3
PM2.5 Metals	Potassium		1 ng/m3	7.16 ng/m3	7 ng/m3
PM2.5 Metals	Rubidium		0.4 ng/m3	13.3 ng/m3	12 ng/m3
PM2.5 Metals	Samarium				123, 124 ng/m3
PM2.5 Metals	Selenium		1 ng/m3	25.6 ng/m3	25 ng/m3
PM2.5 Metals	Silicon		160 ng/m3	28.7 ng/m3	28, 29 ng/m3
PM2.5 Metals	Silver		1.2 ng/m3		
PM2.5 Metals	Strontium		1 ng/m3	16.4 ng/m3	9 ng/m3
PM2.5 Metals	Sulfur		12 ng/m3	31.3 ng/m3	28, 29 ng/m3
PM2.5 Metals	Thallium				25 ng/m3
PM2.5 Metals	Tin		1.5 ng/m3	49.8 ng/m3	25 ng/m3
PM2.5 Metals	Titanium		3 ng/m3	17.5 ng/m3	20 ng/m3
PM2.5 Metals	Uranium			23.4 ng/m3	25 ng/m3

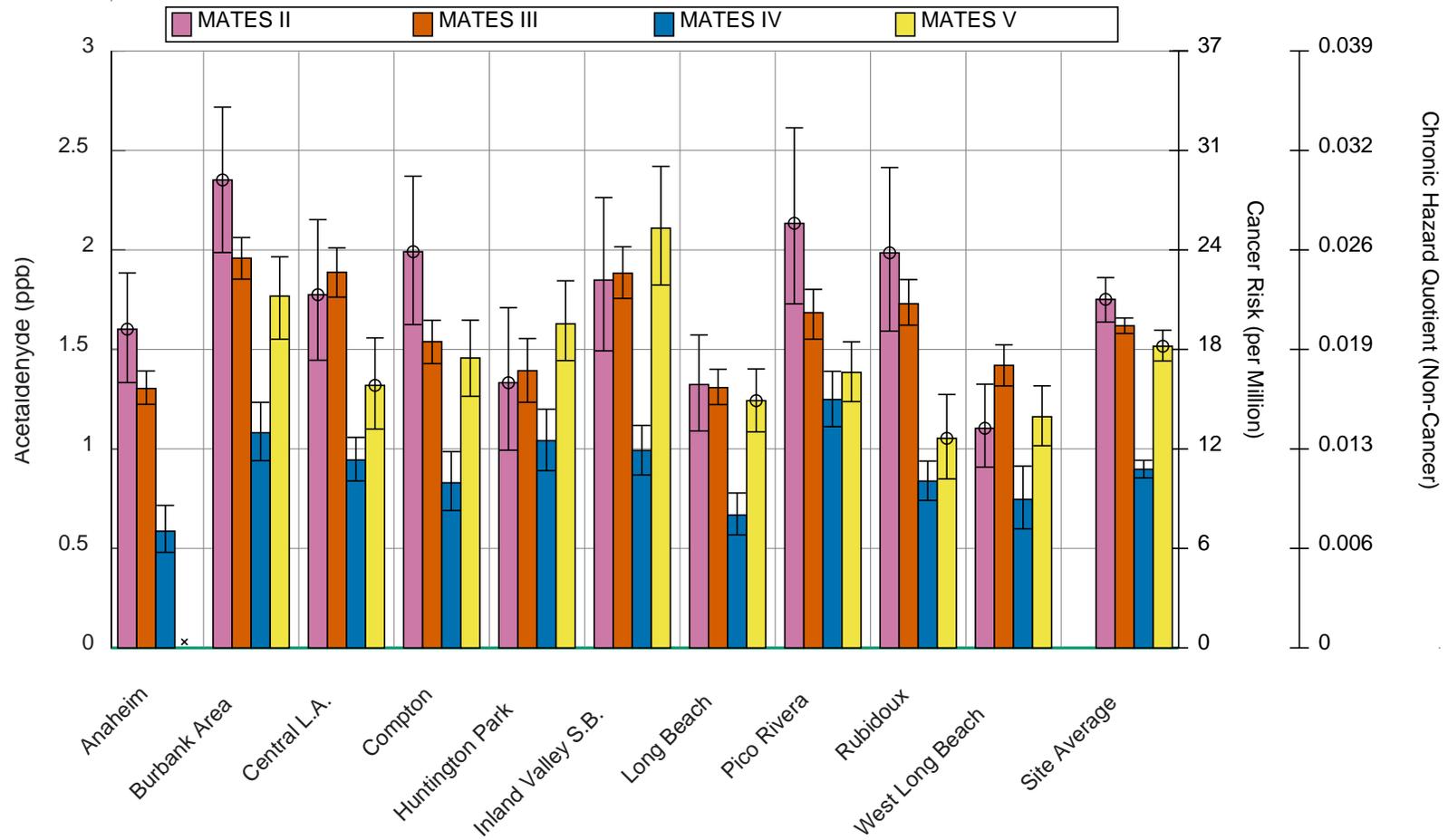
<b>Analysis</b>	<b>Analyte</b>	<b>MATES II MDL</b>	<b>MATES III MDL</b>	<b>MATES IV MDL</b>	<b>MATES V MDL</b>
PM2.5 Metals	Vanadium		1.2 ng/m3	15.5 ng/m3	11 ng/m3
PM2.5 Metals	Yttrium		0.2 ng/m3	15.7 ng/m3	12 ng/m3
PM2.5 Metals	Zinc		0.2 ng/m3	8.37 ng/m3	7 ng/m3
PM2.5 Levoglucosan	Galactosan				2 ng/m3
PM2.5 Levoglucosan	Levoglucosan				2 ng/m3
PM2.5 Levoglucosan	Mannosan				2 ng/m3
Diesel PM	Diesel PM				

Carbonyls Analysis

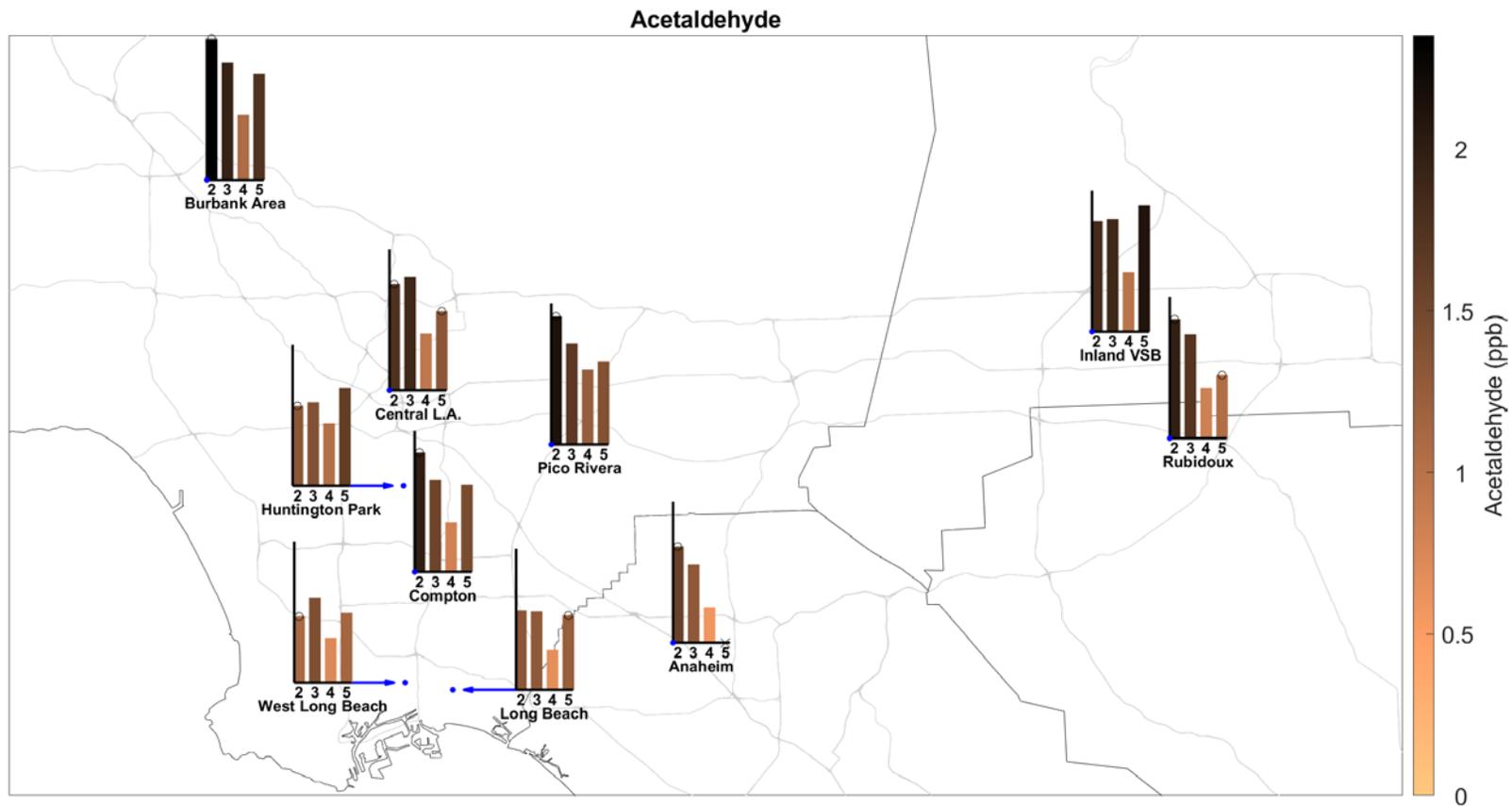
## Acetaldehyde

**Table IV-3.** Ambient Concentrations (ppb) of Acetaldehyde from the Carbonyls analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	1.6	2.35	1.99	1.85	1.33	1.32	1.77	2.13	1.99	1.1
95% CI LB	1.33	1.99	1.62	1.49	0.993	1.09	1.45	1.73	1.59	0.908
95% CI UB	1.88	2.72	2.37	2.26	1.71	1.57	2.15	2.61	2.41	1.33
N	51	55	41	59	50	62	51	52	49	40
% < MDL	2	0	0	1.7	20	0	0	0	2	2.5
Max	3.8	6.1	5.4	8.5	4.5	4.9	5.4	10.3	7.1	2.7
MATES III										
Average	1.3	1.96	1.54	1.88	1.39	1.31	1.89	1.68	1.73	1.42
95% CI LB	1.22	1.85	1.43	1.76	1.23	1.22	1.76	1.55	1.62	1.32
95% CI UB	1.39	2.06	1.65	2.02	1.55	1.4	2.01	1.8	1.85	1.52
N	243	240	228	238	117	242	241	119	239	237
% < MDL	0.4	0	0.4	0	0.9	0.8	0.4	0	0	0
Max	3.73	5	4.67	4.71	4	3.99	5.22	3.9	4.31	4.52
MATES IV										
Average	0.587	1.08	0.83	0.992	1.04	0.667	0.944	1.25	0.838	0.746
95% CI LB	0.48	0.941	0.69	0.869	0.891	0.568	0.839	1.11	0.741	0.598
95% CI UB	0.716	1.23	0.987	1.12	1.2	0.779	1.06	1.39	0.939	0.914
N	60	59	60	59	57	59	59	59	59	55
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	3.07	2.7	2.94	2.44	2.94	2.07	2	2.61	1.95	2.79
MATES V										
Average		1.77	1.46	2.11	1.63	1.24	1.32	1.38	1.05	1.16
95% CI LB		1.55	1.26	1.82	1.44	1.09	1.1	1.24	0.849	1.02
95% CI UB		1.97	1.65	2.42	1.84	1.4	1.56	1.54	1.27	1.32
N	0	59	61	59	60	55	18	58	12	60
% < MDL		0	0	1.7	0	0	0	0	0	0
Max		4	3.71	7	4.5	3.26	2.78	3.26	1.87	3.26



**Figure IV-1.** Annual Average Concentrations of Acetaldehyde in the Carbonyls Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

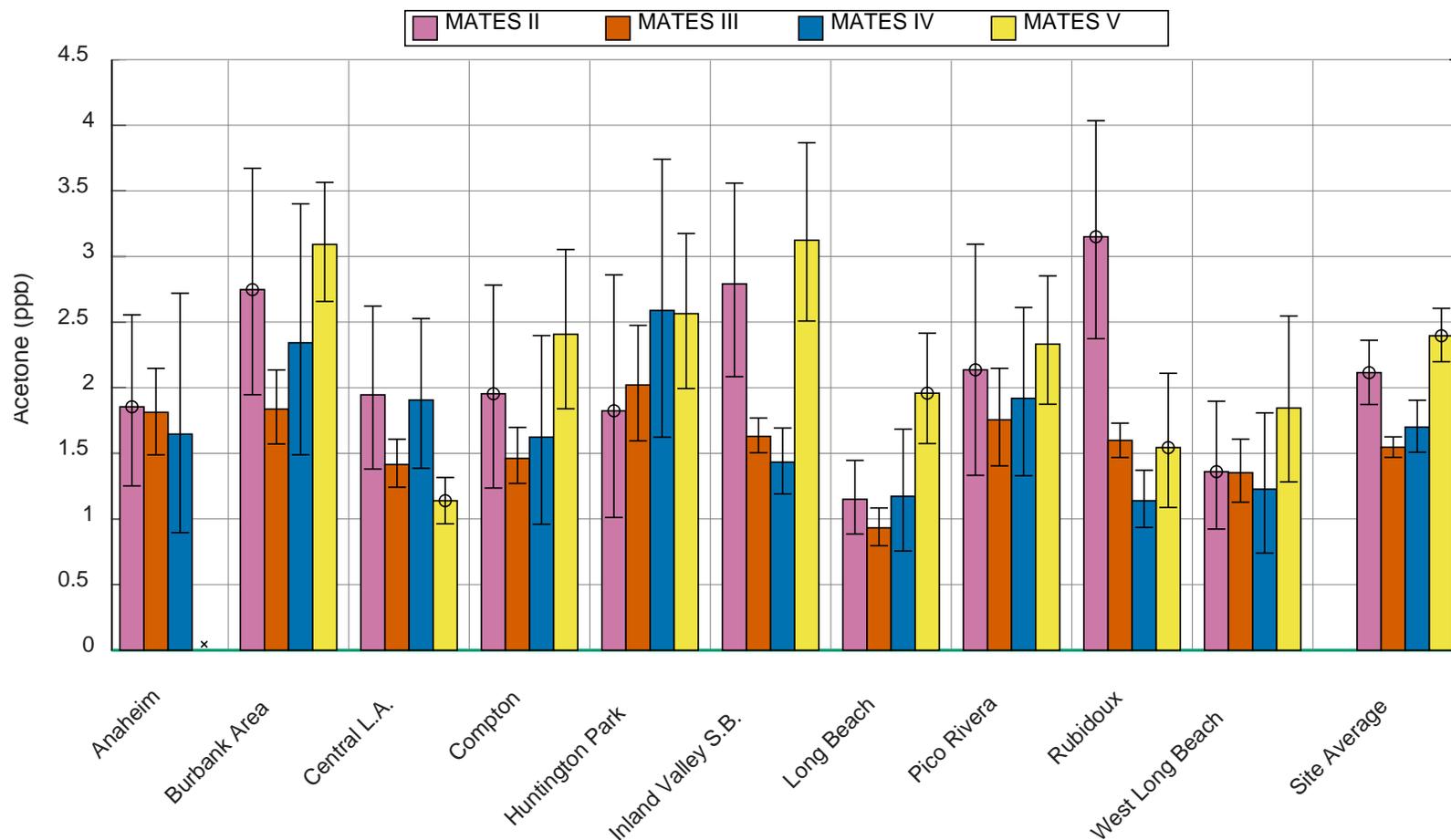


**Figure IV-2.** Geographic distribution of Acetaldehyde from the Carbonyls Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

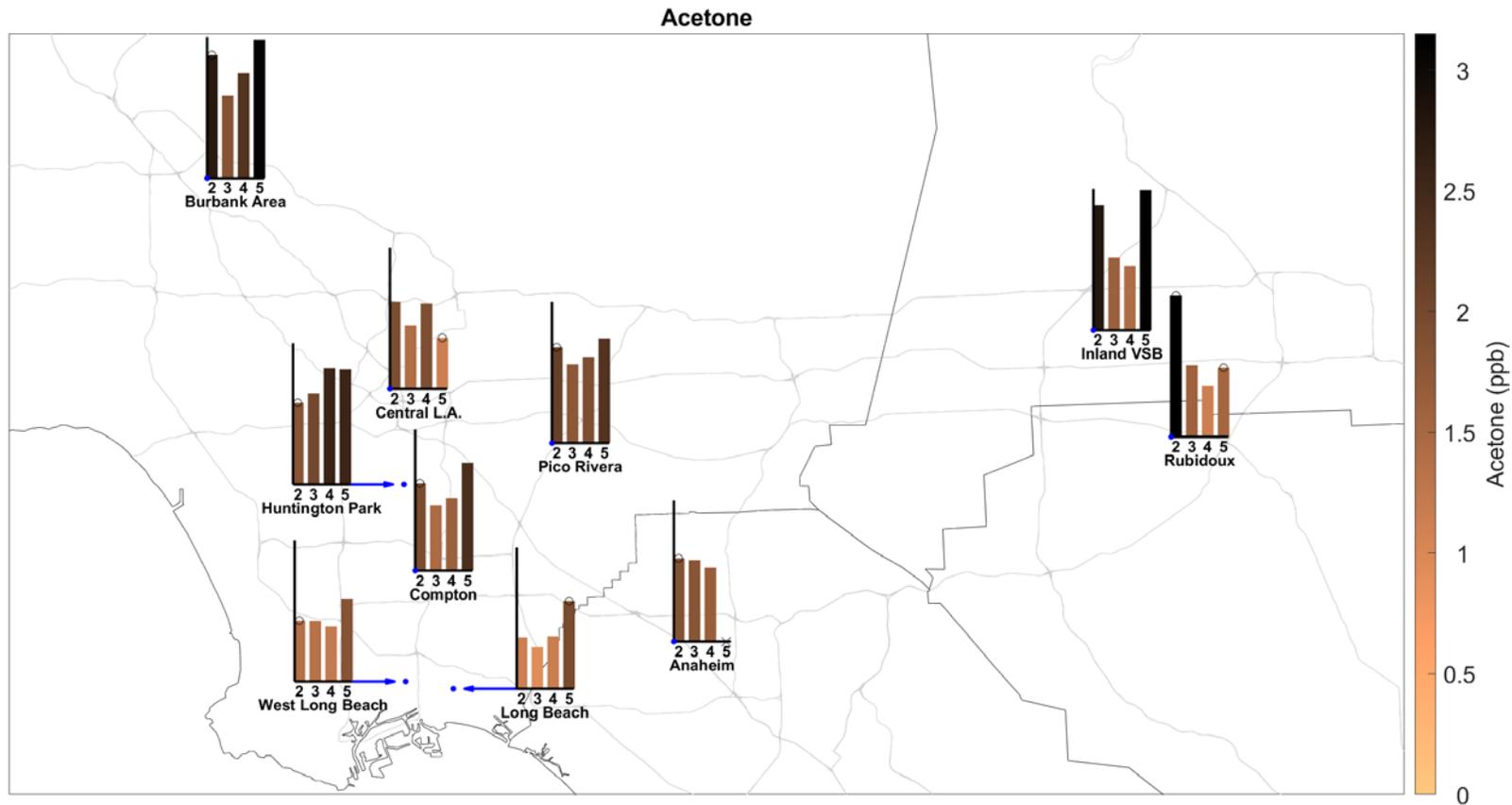
## Acetone

**Table IV-4.** Ambient Concentrations (ppb) of Acetone from the Carbonyls analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	1.85	2.75	1.95	2.79	1.82	1.15	1.95	2.14	3.15	1.36
95% CI LB	1.25	1.95	1.24	2.08	1.01	0.885	1.38	1.33	2.37	0.924
95% CI UB	2.56	3.67	2.78	3.56	2.86	1.45	2.62	3.09	4.03	1.9
N	27	26	20	30	24	28	27	28	25	19
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	8.71	9.97	7.7	7.2	9.62	3.78	5.9	8.65	8.5	5.15
MATES III										
Average	1.81	1.84	1.46	1.63	2.02	0.933	1.42	1.76	1.6	1.35
95% CI LB	1.49	1.57	1.27	1.51	1.6	0.796	1.24	1.4	1.47	1.13
95% CI UB	2.15	2.14	1.7	1.77	2.48	1.08	1.61	2.15	1.73	1.61
N	243	240	228	238	117	242	241	119	239	237
% < MDL	0.4	0	1.8	0.4	2.6	2.1	2.1	0.8	0	0.8
Max	21.4	14.1	9.68	5.34	11.2	8.04	9.23	11.5	5.9	12.4
MATES IV										
Average	1.65	2.34	1.62	1.43	2.59	1.17	1.91	1.92	1.14	1.23
95% CI LB	0.896	1.49	0.96	1.19	1.62	0.756	1.39	1.33	0.936	0.74
95% CI UB	2.72	3.4	2.4	1.69	3.74	1.68	2.53	2.61	1.37	1.81
N	59	59	60	59	57	59	59	60	59	55
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	21.8	19.5	12.4	4.77	19.7	8.95	9.97	11.4	5.05	9.93
MATES V										
Average		3.09	2.41	3.12	2.56	1.96	1.14	2.33	1.54	1.85
95% CI LB		2.66	1.84	2.51	1.99	1.58	0.963	1.87	1.09	1.28
95% CI UB		3.56	3.05	3.87	3.18	2.42	1.32	2.85	2.11	2.55
N	0	58	61	59	60	56	18	58	12	60
% < MDL		0	1.6	1.7	0	1.8	0	0	0	0
Max		8.54	10.5	16.3	9.99	6.7	1.75	8.57	3.89	15.7



**Figure IV-3.** Annual Average Concentrations of Acetone in the Carbonyls Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

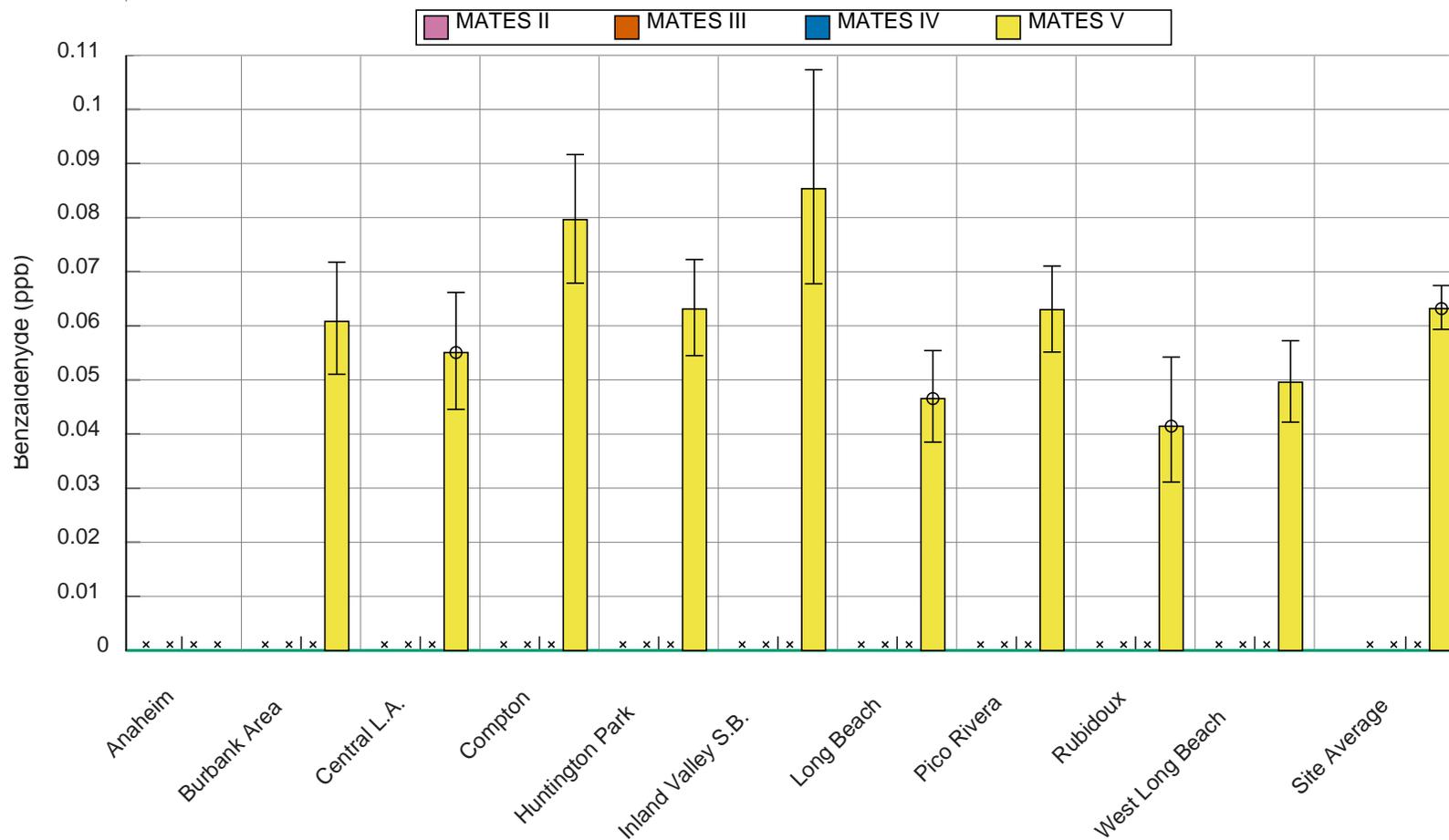


**Figure IV-4.** Geographic distribution of Acetone from the Carbonyls Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

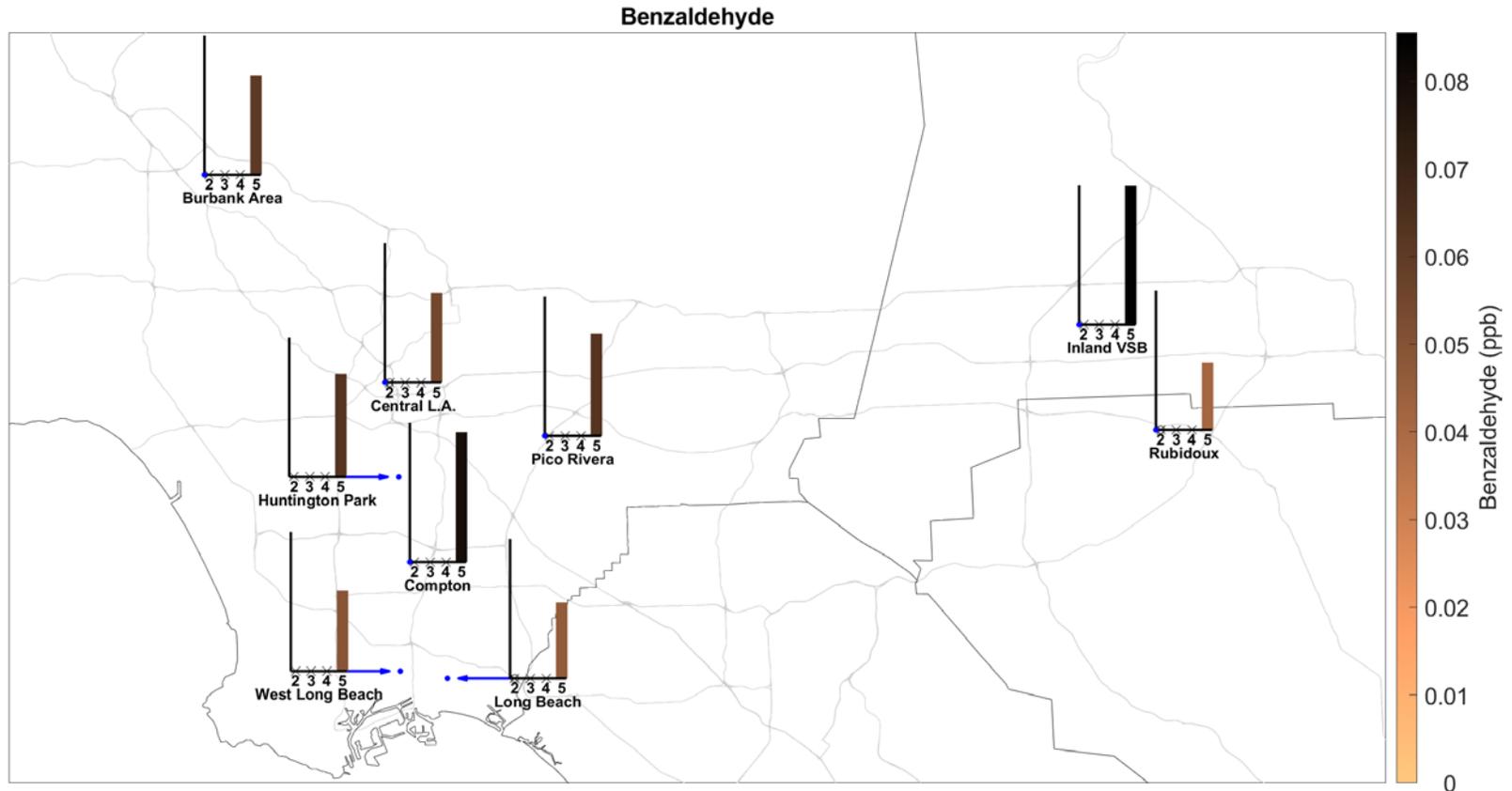
Benzaldehyde

**Table IV-5.** Ambient Concentrations (ppb) of Benzaldehyde from the Carbonyls analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average		0.0608	0.0796	0.0853	0.0631	0.0466	0.0551	0.063	0.0415	0.0496
95% CI LB		0.051	0.0679	0.0678	0.0545	0.0385	0.0446	0.0552	0.0311	0.0422
95% CI UB		0.0718	0.0917	0.107	0.0723	0.0554	0.0662	0.071	0.0542	0.0572
N	0	58	61	59	60	56	18	58	12	60
% < MDL		1.7	1.6	5.1	0	1.8	0	0	0	1.7
Max		0.259	0.182	0.57	0.191	0.13	0.108	0.137	0.0871	0.138



**Figure IV-5.** Annual Average Concentrations of Benzaldehyde in the Carbonyls Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

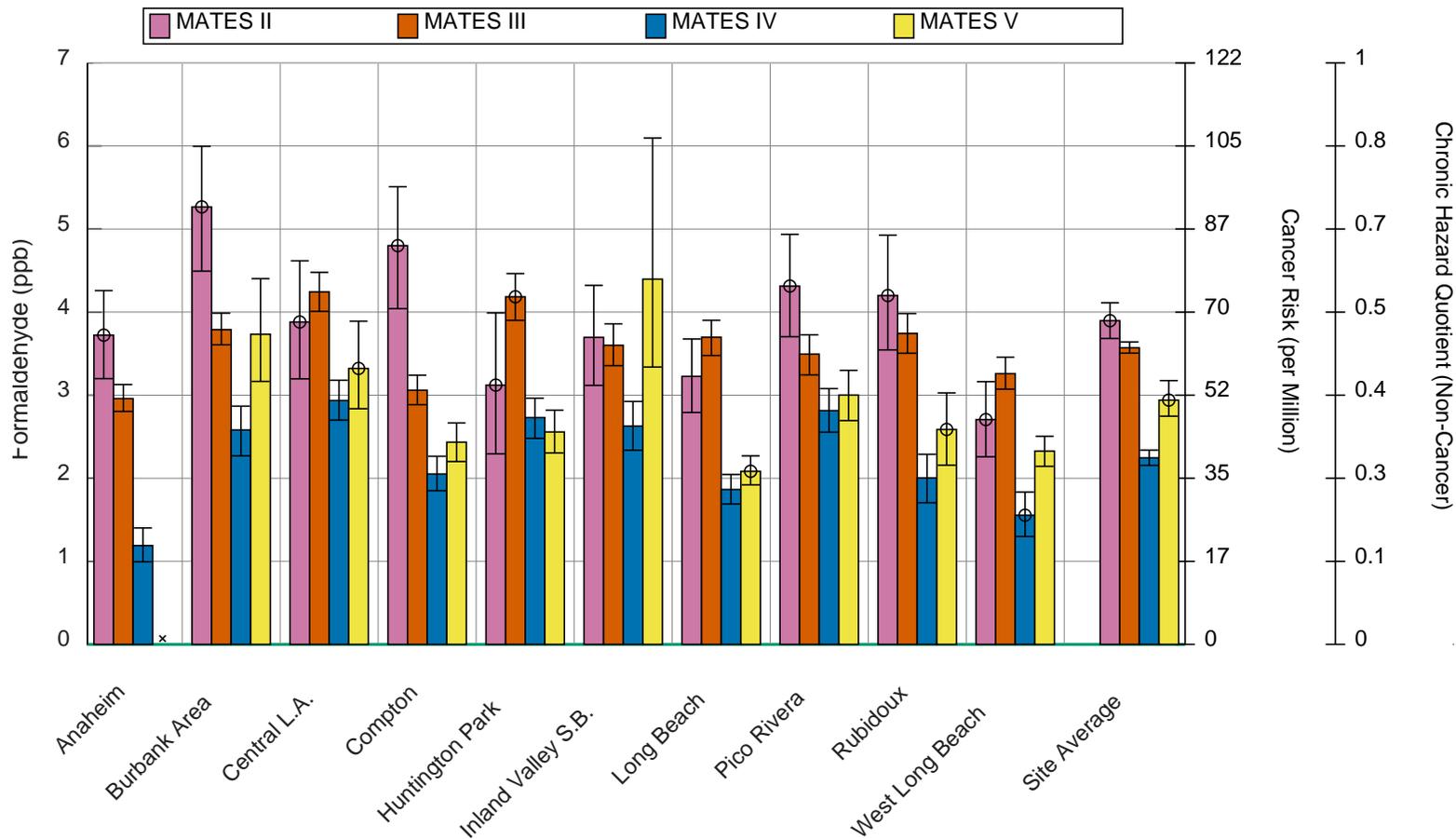


**Figure IV-6.** Geographic distribution of Benzaldehyde from the Carbonyls Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

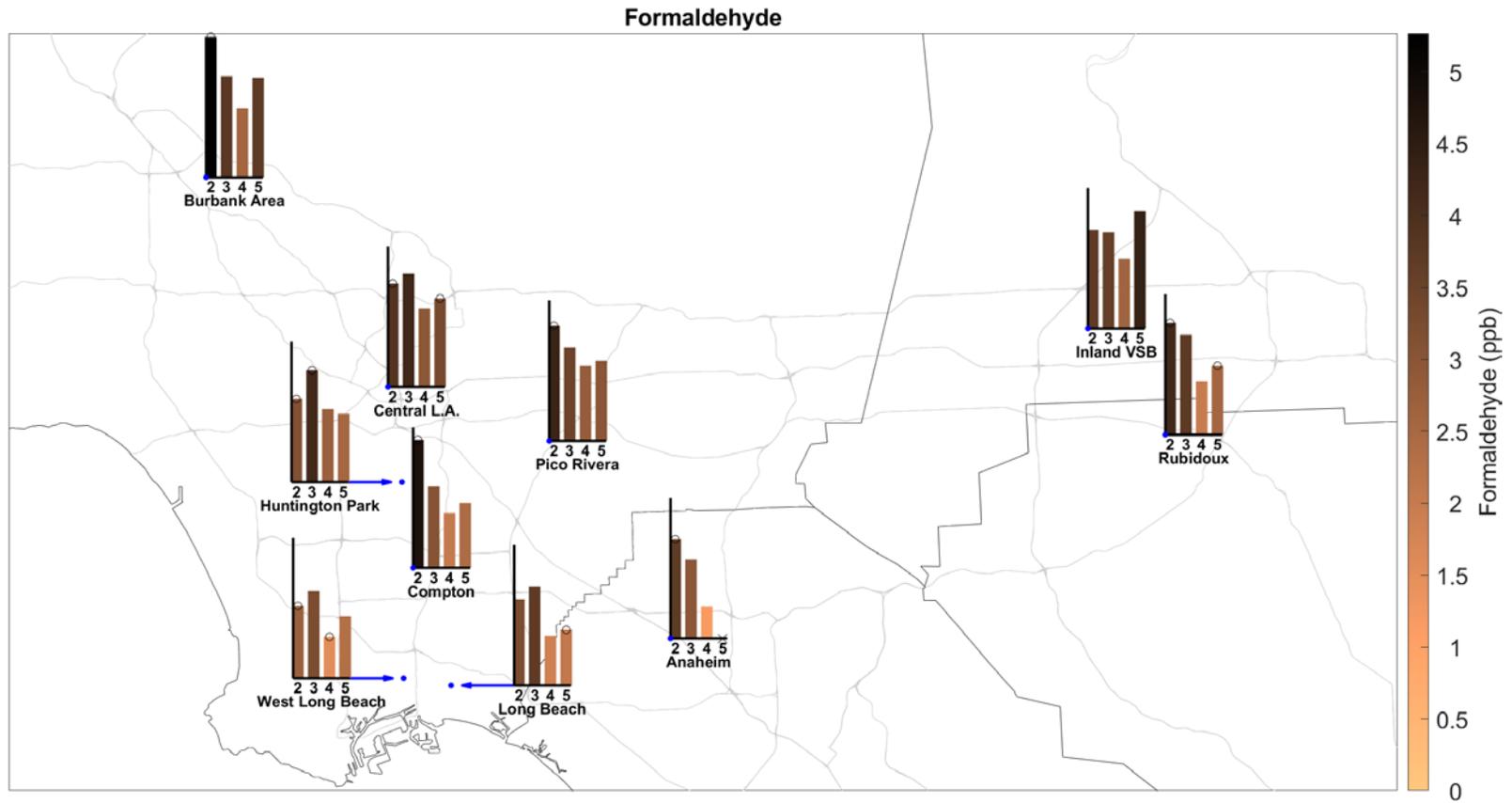
## Formaldehyde

**Table IV-6.** Ambient Concentrations (ppb) of Formaldehyde from the Carbonyls analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	3.72	5.27	4.8	3.7	3.12	3.23	3.88	4.31	4.2	2.71
95% CI LB	3.2	4.49	4.04	3.12	2.29	2.79	3.2	3.7	3.54	2.26
95% CI UB	4.26	6	5.51	4.32	3.99	3.68	4.62	4.94	4.93	3.16
N	52	55	41	59	50	62	51	53	50	40
% < MDL	1.9	0	0	0	18	0	0	1.9	0	2.5
Max	7.6	13.6	10	9.5	10.9	7.32	12	10	11.4	5.8
MATES III										
Average	2.96	3.79	3.06	3.6	4.18	3.7	4.24	3.49	3.74	3.26
95% CI LB	2.8	3.61	2.89	3.36	3.9	3.48	4.01	3.24	3.5	3.07
95% CI UB	3.13	3.99	3.24	3.86	4.46	3.9	4.48	3.73	3.98	3.46
N	243	240	228	238	88	242	241	119	239	237
% < MDL	0	0	0	0	0	0	0.4	0	0	0
Max	7.74	7.71	8.43	8.96	8.49	11.5	10.6	6.85	8.95	12.8
MATES IV										
Average	1.19	2.58	2.05	2.63	2.73	1.86	2.94	2.81	2	1.55
95% CI LB	0.994	2.27	1.85	2.34	2.48	1.69	2.7	2.55	1.71	1.3
95% CI UB	1.4	2.87	2.26	2.92	2.96	2.05	3.18	3.08	2.29	1.83
N	58	59	60	59	57	59	59	59	57	51
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	3.73	4.72	4.18	5.15	5.4	3.79	5.06	6.32	4.4	4.06
MATES V										
Average		3.73	2.43	4.4	2.56	2.08	3.32	3	2.59	2.33
95% CI LB		3.17	2.2	3.34	2.3	1.92	2.84	2.69	2.16	2.14
95% CI UB		4.4	2.67	6.1	2.82	2.27	3.89	3.3	3.03	2.51
N	0	59	61	59	60	56	18	58	12	60
% < MDL		0	0	1.7	0	0	0	0	0	0
Max		19.3	4.55	46.3	5.63	3.95	6.35	5.73	3.89	4.49



**Figure IV-7.** Annual Average Concentrations of Formaldehyde in the Carbonyls Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

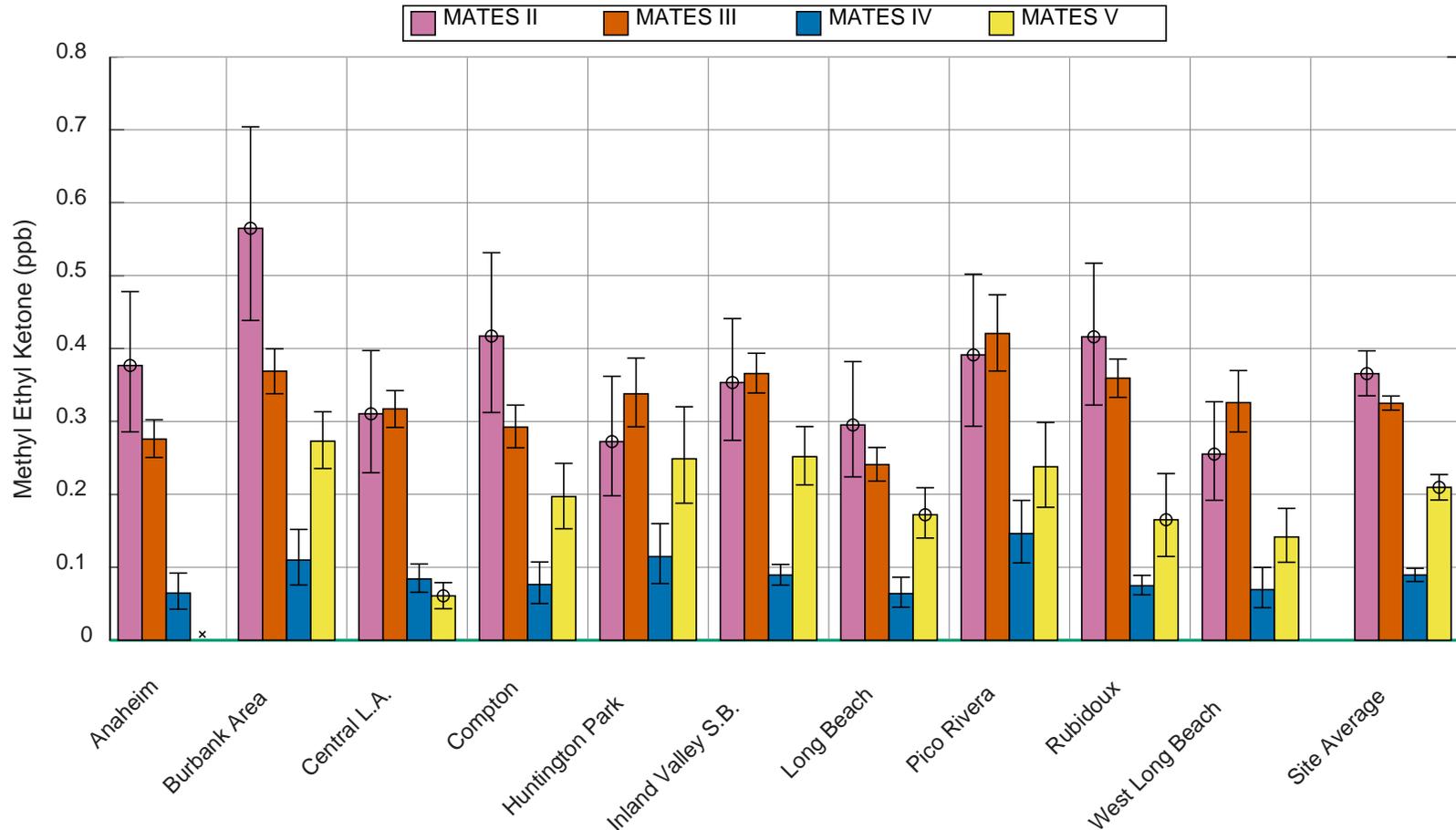


**Figure IV-8.** Geographic distribution of Formaldehyde from the Carbonyls Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

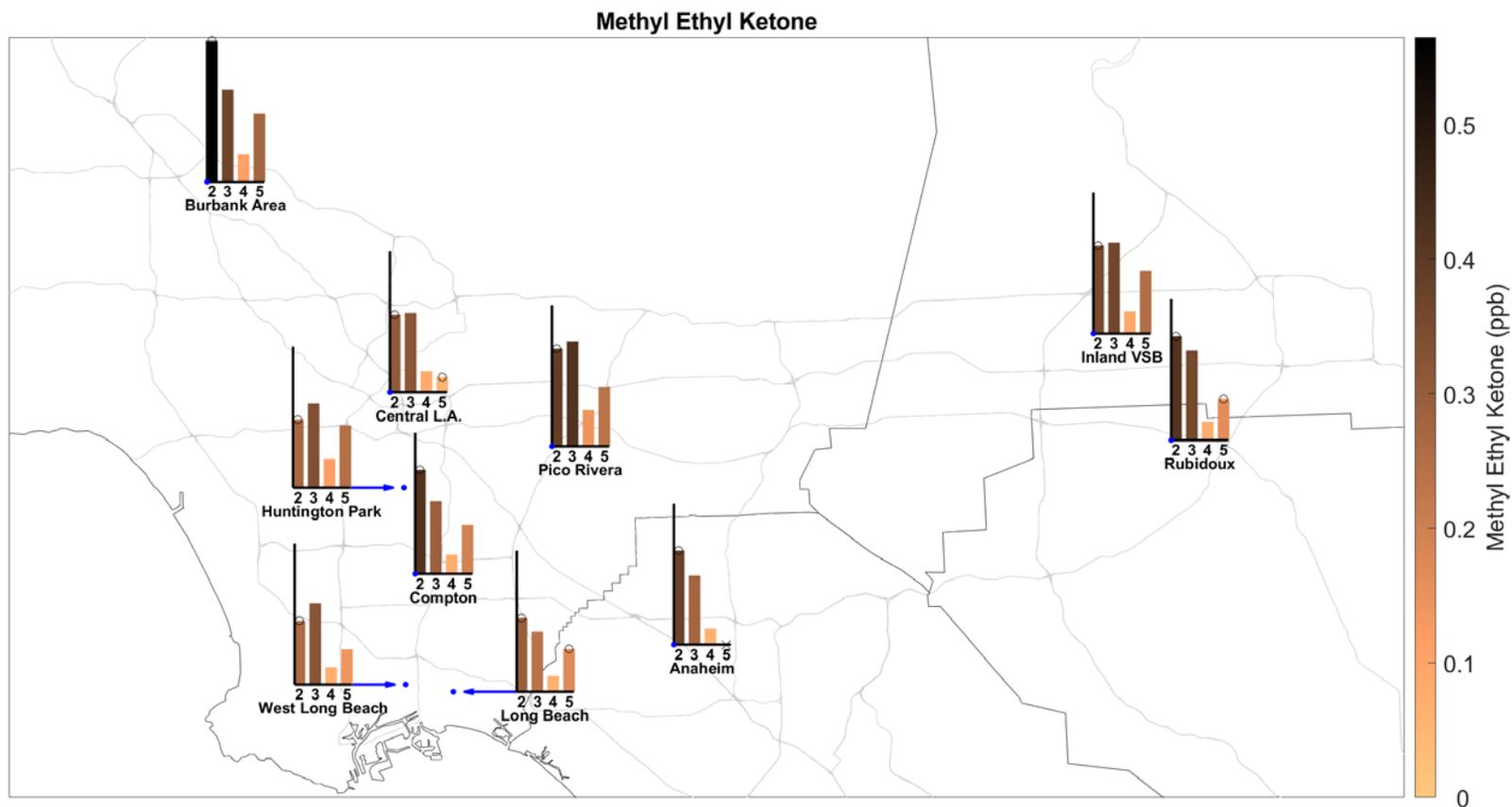
## Methyl Ethyl Ketone

**Table IV-7.** Ambient Concentrations (ppb) of Methyl Ethyl Ketone from the Carbonyls analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.377	0.565	0.417	0.353	0.272	0.295	0.31	0.391	0.416	0.255
95% CI LB	0.286	0.439	0.312	0.274	0.198	0.224	0.23	0.293	0.323	0.192
95% CI UB	0.478	0.704	0.531	0.441	0.362	0.382	0.397	0.502	0.517	0.327
N	46	47	41	50	46	54	43	46	46	40
% < MDL	19.6	2.1	26.8	16	39.1	25.9	34.9	19.6	13	32.5
Max	1.42	2.19	1.35	1.35	1.53	1.83	1.15	1.72	1.22	1.03
MATES III										
Average	0.276	0.369	0.292	0.366	0.338	0.241	0.317	0.421	0.359	0.326
95% CI LB	0.251	0.338	0.264	0.339	0.293	0.218	0.292	0.369	0.333	0.286
95% CI UB	0.302	0.4	0.322	0.394	0.387	0.264	0.342	0.474	0.386	0.37
N	243	240	228	238	117	242	241	119	239	237
% < MDL	20.6	6.7	15.8	5.5	12.8	23.1	9.5	10.1	6.3	16.9
Max	1.07	1.2	1.22	1.06	1.39	0.88	1.07	1.32	1.11	2.4
MATES IV										
Average	0.0646	0.11	0.0764	0.0895	0.115	0.0639	0.084	0.146	0.0748	0.0695
95% CI LB	0.0425	0.0757	0.0503	0.0756	0.0776	0.0453	0.0657	0.106	0.0623	0.0447
95% CI UB	0.0921	0.152	0.107	0.104	0.16	0.0864	0.105	0.192	0.089	0.0999
N	58	59	60	58	57	59	59	60	59	54
% < MDL	1.7	0	3.3	0	0	0	0	0	0	3.7
Max	0.568	0.619	0.547	0.227	0.768	0.39	0.345	0.758	0.288	0.472
MATES V										
Average		0.273	0.197	0.252	0.249	0.172	0.0609	0.238	0.165	0.142
95% CI LB		0.235	0.153	0.213	0.188	0.14	0.0432	0.182	0.115	0.107
95% CI UB		0.313	0.243	0.293	0.32	0.209	0.079	0.299	0.229	0.181
N	0	58	60	59	60	56	17	57	12	59
% < MDL		1.7	11.7	1.7	3.3	1.8	17.6	3.5	0	5.1
Max		0.615	0.711	0.669	1.21	0.648	0.172	0.888	0.433	0.623



**Figure IV-9.** Annual Average Concentrations of Methyl Ethyl Ketone in the Carbonyls Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

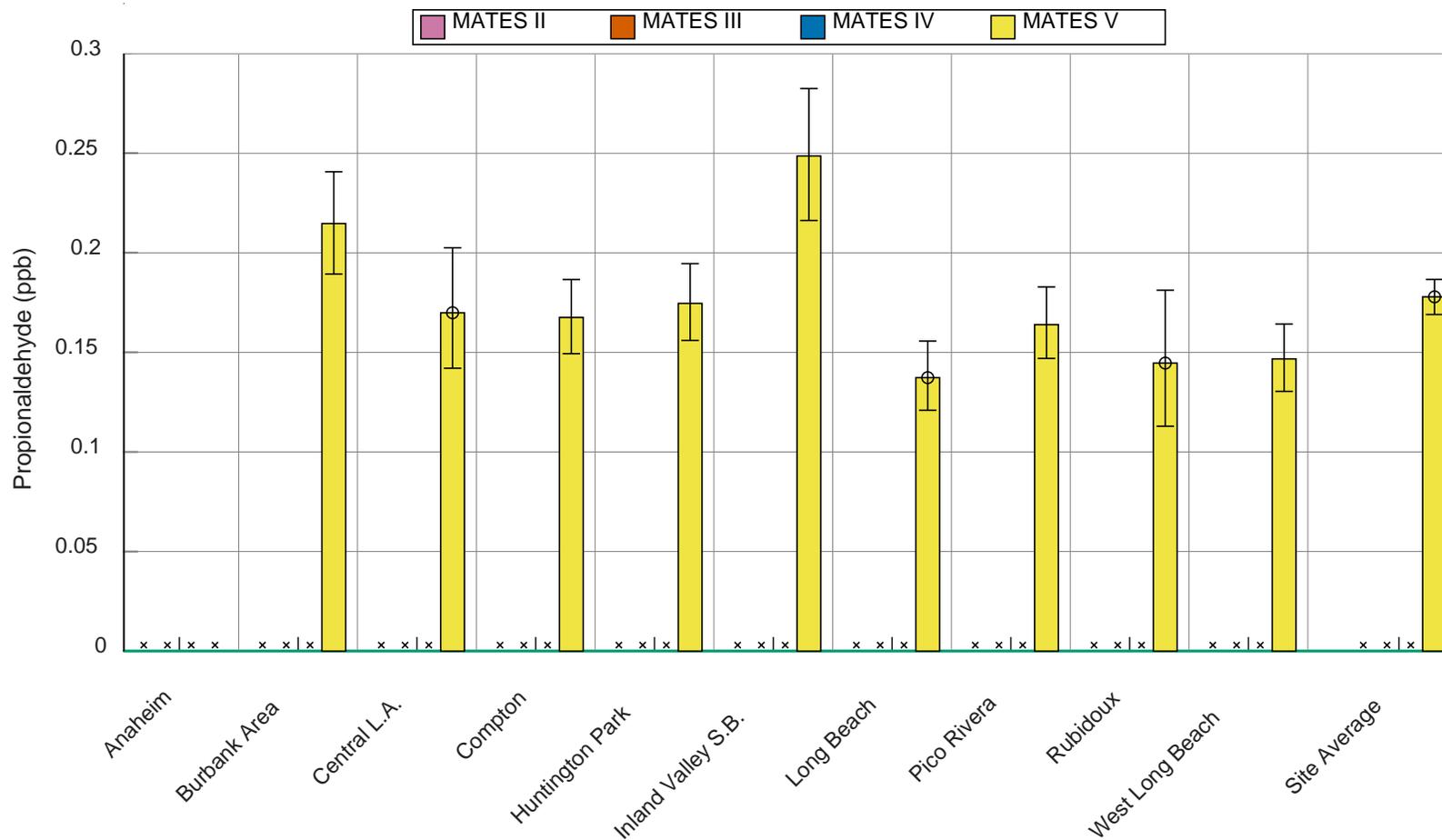


**Figure IV-10.** Geographic distribution of Methyl Ethyl Ketone from the Carbonyls Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

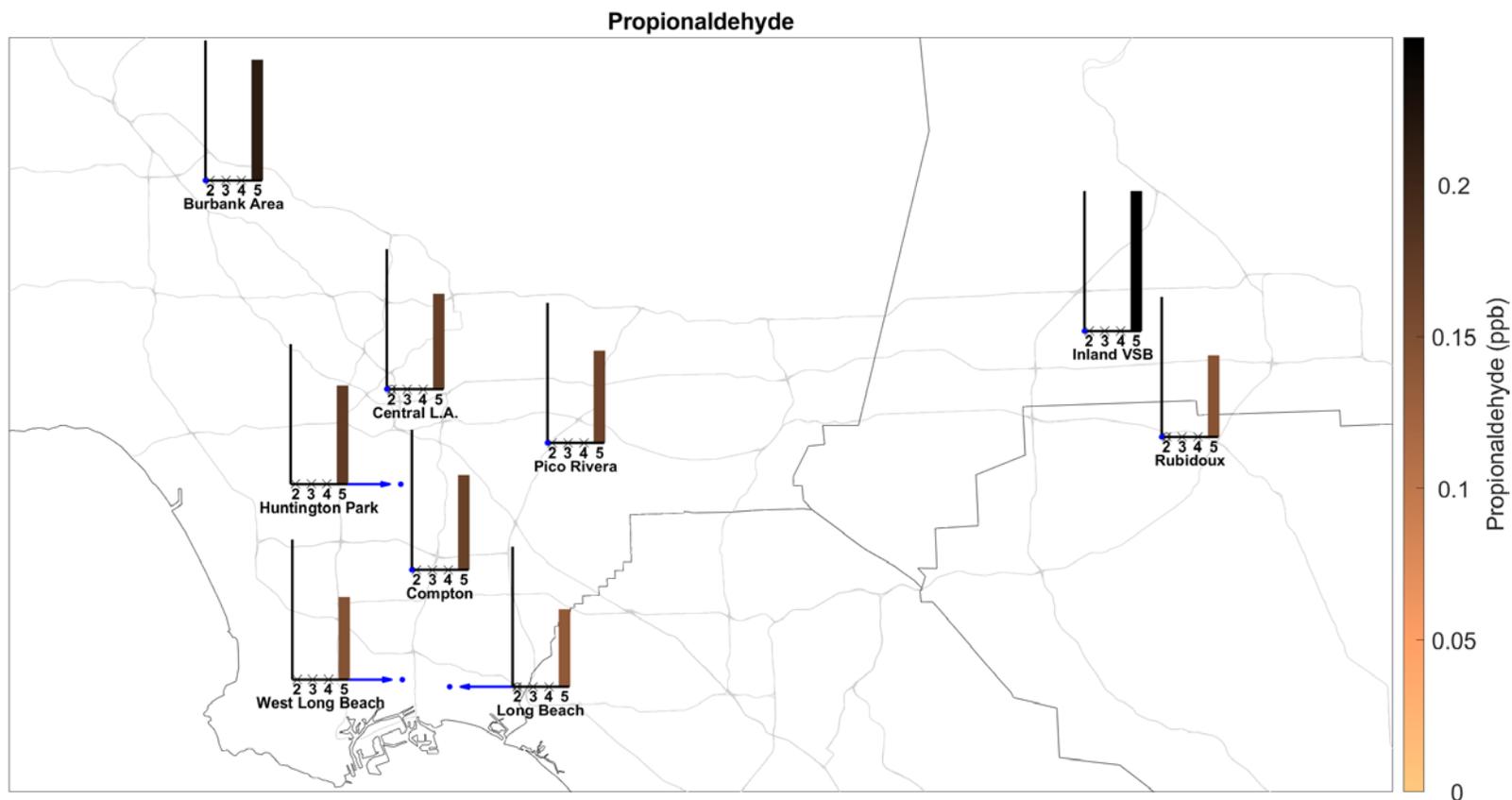
Propionaldehyde

**Table IV-8.** Ambient Concentrations (ppb) of Propionaldehyde from the Carbonyls analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average		0.215	0.168	0.249	0.175	0.137	0.17	0.164	0.145	0.147
95% CI LB		0.189	0.149	0.216	0.156	0.121	0.142	0.147	0.113	0.13
95% CI UB		0.241	0.187	0.283	0.195	0.156	0.203	0.183	0.181	0.164
N	0	58	61	59	59	56	18	57	12	60
% < MDL		0	1.6	1.7	0	0	0	0	0	0
Max		0.574	0.36	0.636	0.427	0.324	0.353	0.382	0.282	0.364



**Figure IV-11.** Annual Average Concentrations of Propionaldehyde in the Carbonyls Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



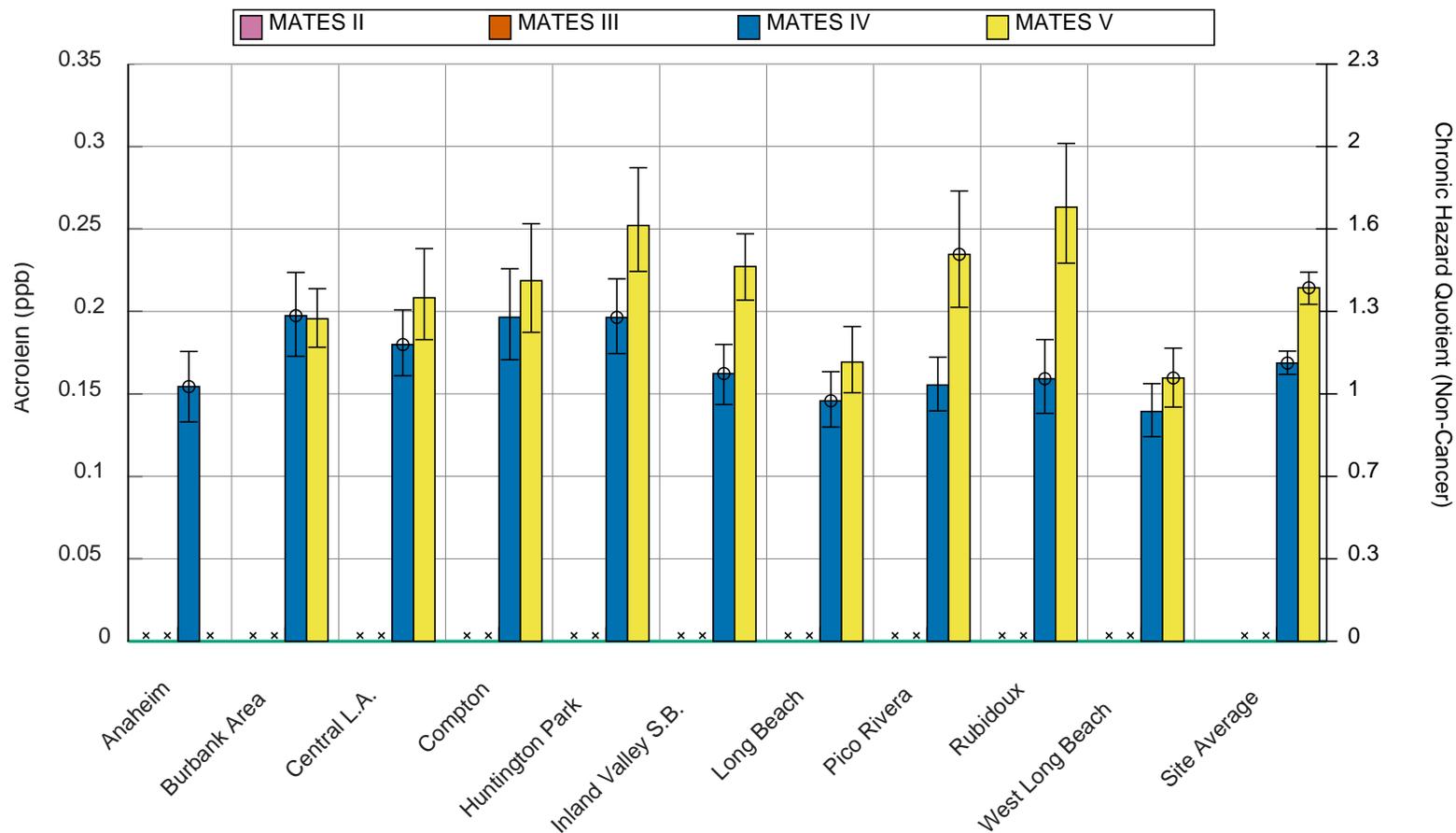
**Figure IV-12.** Geographic distribution of Propionaldehyde from the Carbonyls Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

VOCs Analysis

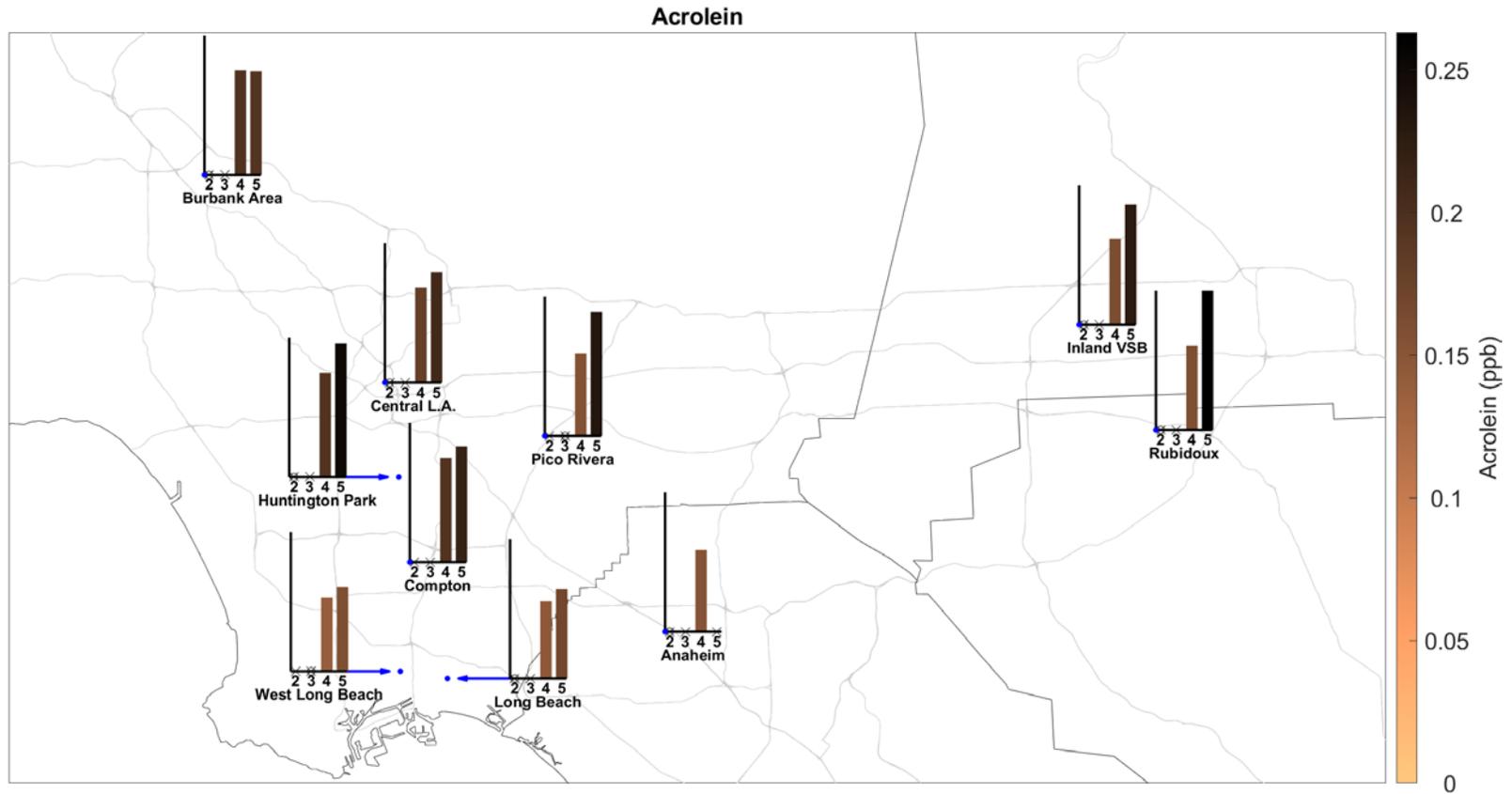
Acrolein

**Table IV-9.** Ambient Concentrations (ppb) of Acrolein from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average	0.154	0.197	0.196	0.162	0.196	0.146	0.18	0.155	0.159	0.139
95% CI LB	0.133	0.173	0.171	0.144	0.174	0.13	0.161	0.14	0.138	0.124
95% CI UB	0.176	0.224	0.226	0.18	0.22	0.163	0.201	0.172	0.183	0.156
N	51	55	57	53	53	54	53	57	52	57
% < MDL	9.8	5.5	3.5	15.1	5.7	14.8	11.3	7	3.8	15.8
Max	0.43	0.51	0.56	0.36	0.48	0.41	0.41	0.38	0.52	0.37
MATES V										
Average		0.196	0.219	0.227	0.252	0.169	0.208	0.235	0.263	0.16
95% CI LB		0.178	0.187	0.207	0.224	0.151	0.183	0.203	0.229	0.142
95% CI UB		0.214	0.253	0.247	0.287	0.191	0.238	0.273	0.302	0.178
N	0	58	58	58	57	57	55	50	58	55
% < MDL		0	0	0	0	0	0	0	0	0
Max		0.42	0.65	0.41	0.61	0.55	0.71	0.87	0.77	0.4



**Figure IV-13.** Annual Average Concentrations of Acrolein in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

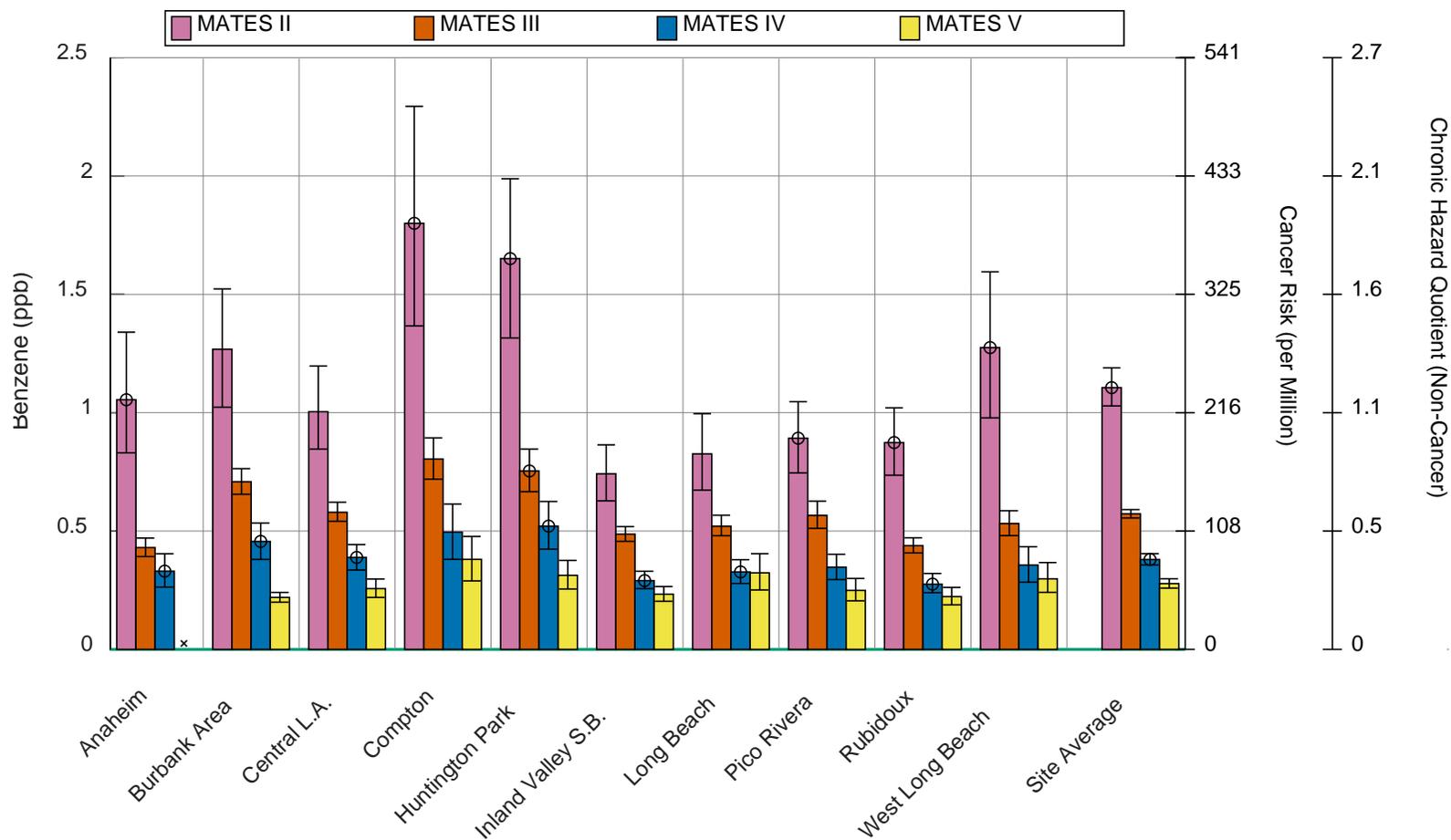


**Figure IV-14.** Geographic distribution of Acrolein from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

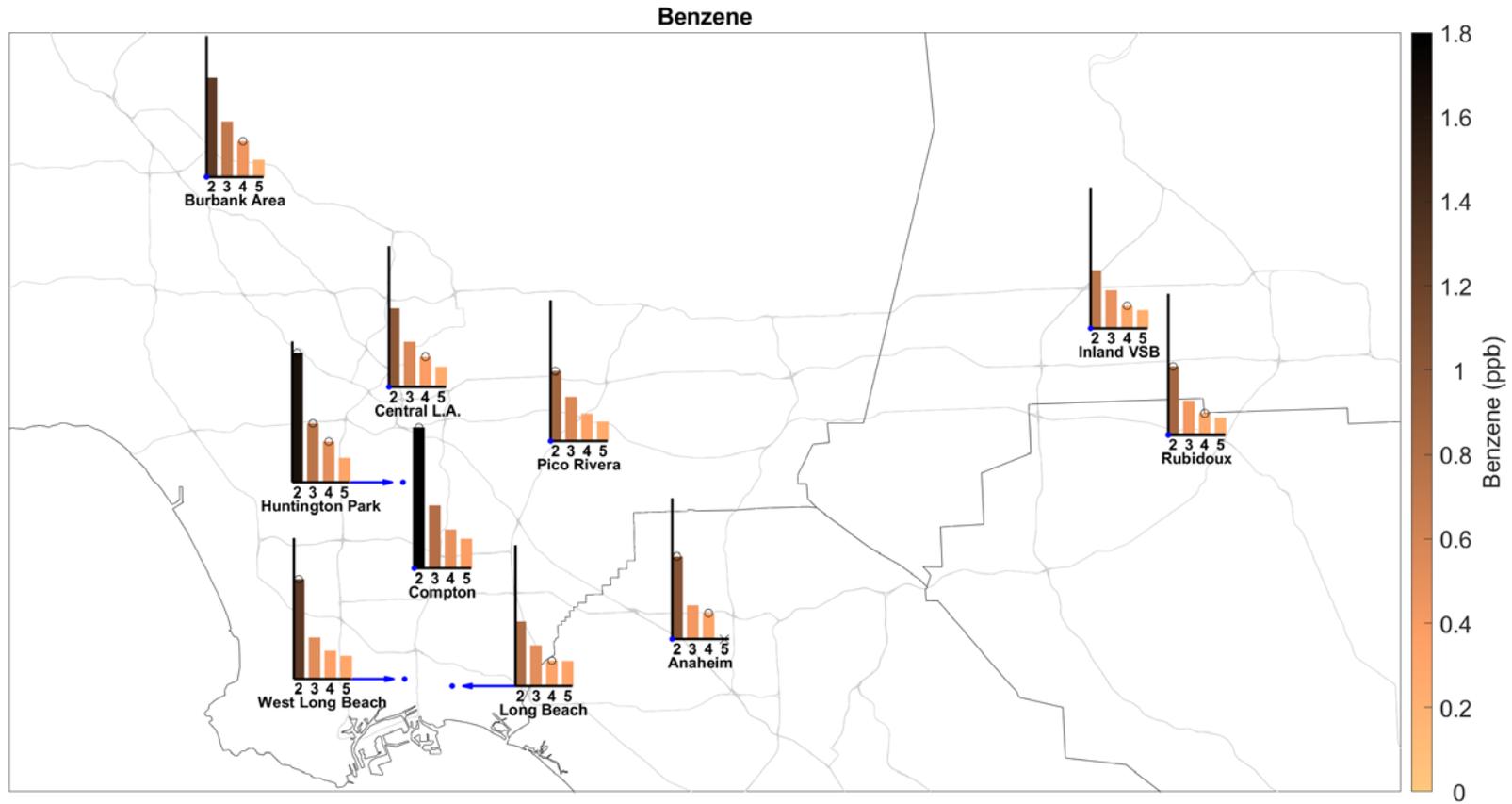
## Benzene

**Table IV-10.** Ambient Concentrations (ppb) of Benzene from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	1.05	1.27	1.8	0.742	1.65	0.826	1	0.892	0.874	1.27
95% CI LB	0.83	1.02	1.37	0.628	1.32	0.673	0.846	0.746	0.736	0.978
95% CI UB	1.34	1.52	2.29	0.864	1.99	0.996	1.2	1.05	1.02	1.6
N	51	58	42	60	46	60	59	54	45	35
% < MDL	5.9	1.7	2.4	3.3	0	1.7	0	1.9	4.4	5.7
Max	5.2	4.1	6.9	2.2	5.1	3.4	3.6	2.2	2.5	3.9
MATES III										
Average	0.43	0.708	0.804	0.487	0.754	0.52	0.579	0.566	0.438	0.532
95% CI LB	0.392	0.655	0.719	0.456	0.666	0.48	0.541	0.511	0.407	0.481
95% CI UB	0.47	0.763	0.893	0.519	0.846	0.567	0.621	0.626	0.471	0.586
N	233	241	237	232	100	238	238	121	234	235
% < MDL	0	0	0	0.9	0	0	0	0	0	0.4
Max	2.06	2.16	3.53	1.26	2.2	1.7	1.83	1.85	1.32	1.95
MATES IV										
Average	0.33	0.456	0.495	0.291	0.521	0.327	0.388	0.347	0.276	0.356
95% CI LB	0.263	0.38	0.38	0.257	0.423	0.279	0.335	0.295	0.239	0.284
95% CI UB	0.404	0.534	0.614	0.33	0.625	0.379	0.443	0.402	0.321	0.434
N	51	55	57	53	53	54	53	57	52	57
% < MDL	0	0	0	0	1.9	0	1.9	0	0	0
Max	1.33	1.23	1.77	0.91	1.72	0.84	1.15	0.91	0.91	1.17
MATES V										
Average		0.22	0.38	0.233	0.313	0.323	0.257	0.249	0.223	0.298
95% CI LB		0.199	0.289	0.203	0.255	0.251	0.219	0.205	0.188	0.241
95% CI UB		0.241	0.477	0.265	0.376	0.404	0.297	0.3	0.262	0.367
N	0	60	61	61	60	59	56	53	60	58
% < MDL		0	0	0	0	0	0	0	0	0
Max		0.45	1.55	0.69	0.94	1.57	0.69	0.85	0.78	1.12



**Figure IV-15.** Annual Average Concentrations of Benzene in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

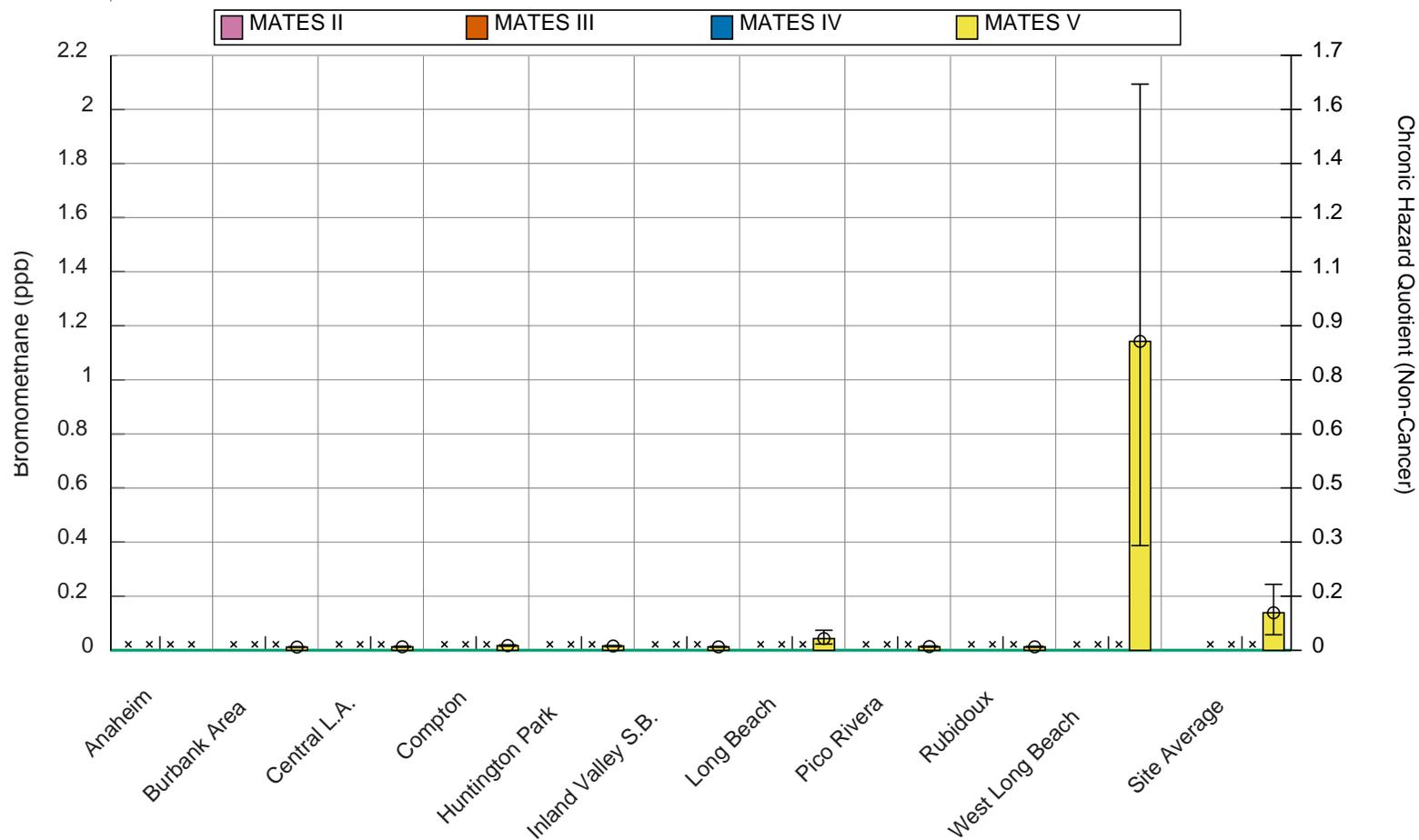


**Figure IV-16.** Geographic distribution of Benzene from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

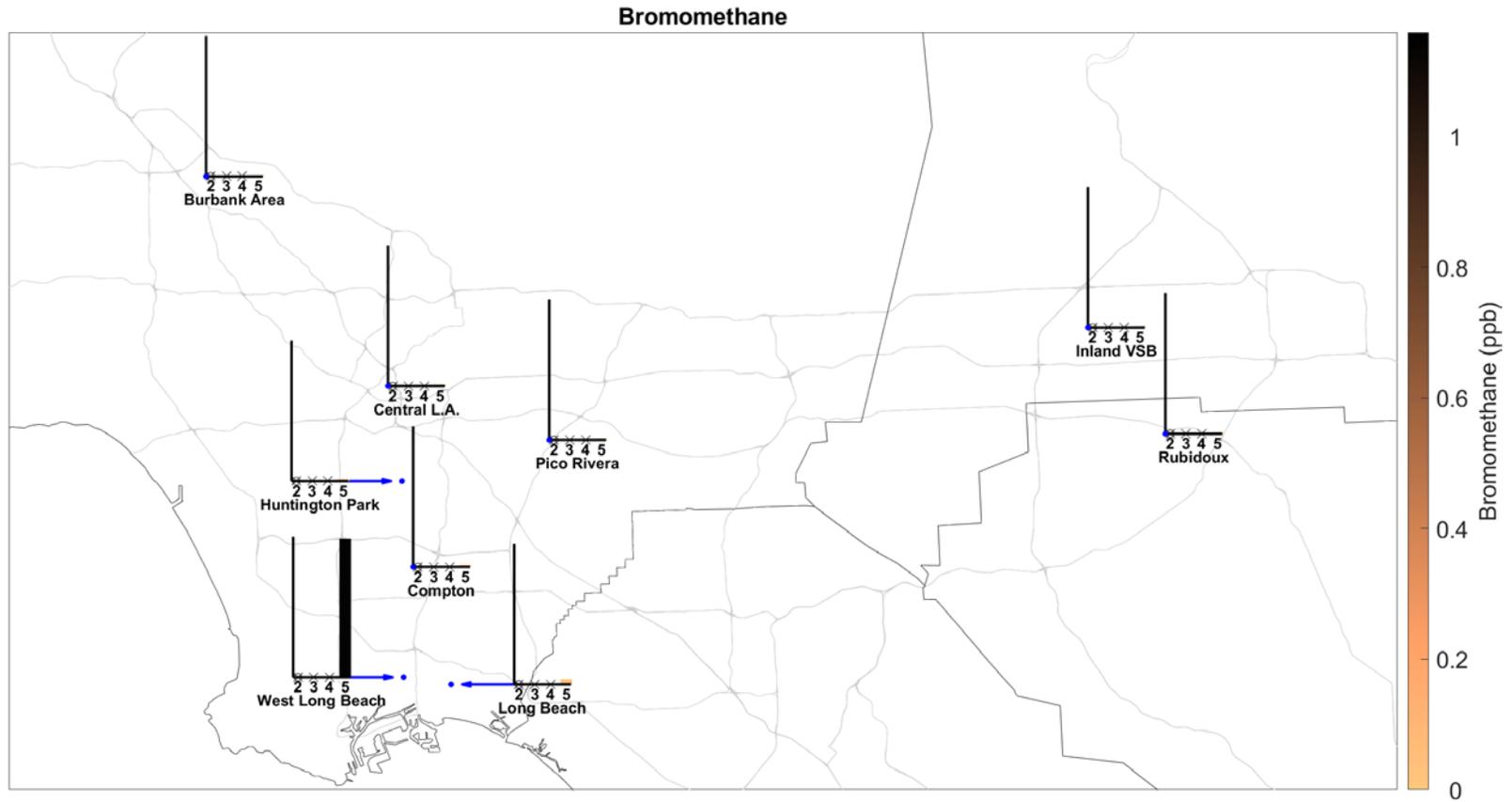
Bromomethane

**Table IV-11.** Ambient Concentrations (ppb) of Bromomethane from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average		0.0119	0.0174	0.0126	0.0158	0.0433	0.0129	0.0136	0.0127	1.14
95% CI LB		0.0104	0.0149	0.0108	0.0136	0.0232	0.0109	0.0116	0.0109	0.387
95% CI UB		0.0138	0.0204	0.0147	0.0179	0.0742	0.0152	0.0156	0.015	2.09
N	0	43	43	43	42	41	40	37	42	40
% < MDL		48.8	44.2	48.8	47.6	46.3	52.5	54.1	52.4	30
Max		0.03	0.03	0.03	0.03	0.54	0.03	0.02	0.03	12.2



**Figure IV-17.** Annual Average Concentrations of Bromomethane in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



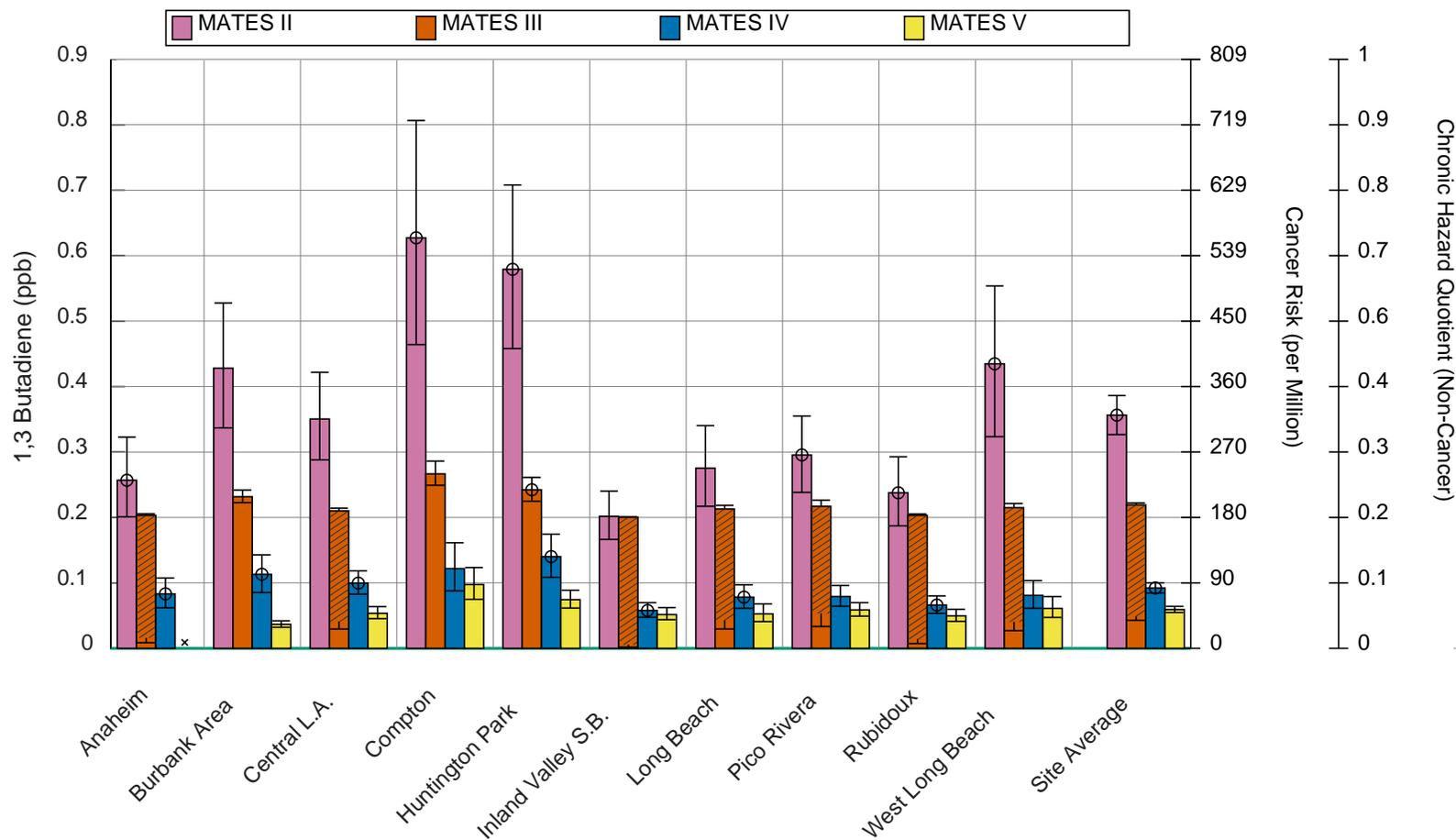
**Figure IV-18.** Geographic distribution of Bromomethane from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

## 1,3 Butadiene

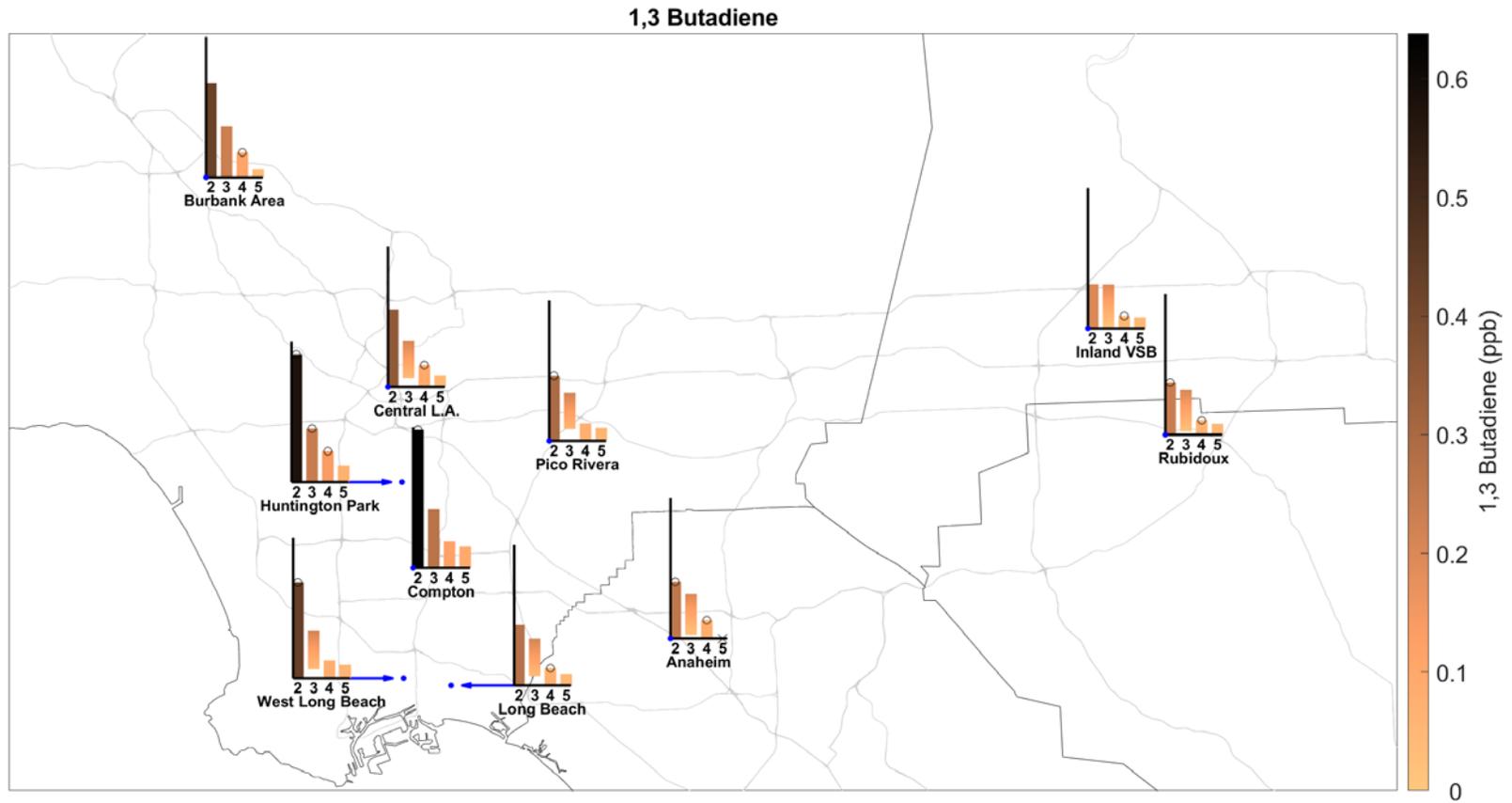
**Table IV-12.** Ambient Concentrations (ppb) of 1,3 Butadiene from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.257	0.428	0.627	0.202	0.579	0.275	0.35	0.295	0.238	0.435
95% CI LB	0.201	0.337	0.464	0.166	0.458	0.217	0.288	0.238	0.187	0.323
95% CI UB	0.323	0.528	0.807	0.24	0.708	0.34	0.422	0.355	0.293	0.554
N	51	58	42	60	46	60	59	54	45	35
% < MDL	13.7	13.8	2.4	16.7	4.3	10	10.2	11.1	13.3	8.6
Max	1	1.5	2.4	0.66	1.9	1.2	1.3	0.972	0.828	1.3
MATES III										
Average	0.0161, 0.203 <sup>a</sup>	0.232	0.267	0.0056, 0.2 <sup>a</sup>	0.242	0.0424, 0.213 <sup>a</sup>	0.0412, 0.21 <sup>a</sup>	0.0534, 0.217 <sup>a</sup>	0.0143, 0.203 <sup>a</sup>	0.0404, 0.215 <sup>a</sup>
95% CI LB	0.00854 <sup>a</sup>	0.223	0.249	0.00181 <sup>a</sup>	0.225	0.0295 <sup>a</sup>	0.0295 <sup>a</sup>	0.0334 <sup>a</sup>	0.00718 <sup>a</sup>	0.027 <sup>a</sup>
95% CI UB	0.206 <sup>a</sup>	0.242	0.286	0.201 <sup>a</sup>	0.261	0.218 <sup>a</sup>	0.214 <sup>a</sup>	0.226 <sup>a</sup>	0.205 <sup>a</sup>	0.221 <sup>a</sup>
N	233 <sup>a</sup>	241	237	232 <sup>a</sup>	100	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	235 <sup>a</sup>
% < MDL	93.6 <sup>a</sup>	78.8	70.9	97.4 <sup>a</sup>	69	85.3 <sup>a</sup>	84.5 <sup>a</sup>	81.8 <sup>a</sup>	94.4 <sup>a</sup>	87.2 <sup>a</sup>
Max	0.34 <sup>a</sup>	0.62	1.02	0.24 <sup>a</sup>	0.71	0.48 <sup>a</sup>	0.42 <sup>a</sup>	0.47 <sup>a</sup>	0.33 <sup>a</sup>	0.5 <sup>a</sup>
MATES IV										
Average	0.0833	0.113	0.122	0.0578	0.14	0.0782	0.0996	0.0792	0.0661	0.081
95% CI LB	0.062	0.0852	0.0878	0.0475	0.108	0.0612	0.0828	0.0643	0.0534	0.0612
95% CI UB	0.107	0.143	0.161	0.0698	0.174	0.0971	0.118	0.0961	0.0801	0.103
N	51	55	57	53	53	54	53	57	52	57
% < MDL	23.5	9.1	15.8	24.5	5.7	14.8	9.4	24.6	30.8	38.6
Max	0.41	0.39	0.58	0.22	0.53	0.28	0.36	0.3	0.21	0.32
MATES V										
Average		0.0367	0.0975	0.0516	0.0743	0.0527	0.0535	0.0587	0.0497	0.061
95% CI LB		0.0322	0.0749	0.0438	0.0615	0.0408	0.0454	0.0492	0.0413	0.0472
95% CI UB		0.042	0.123	0.0623	0.0888	0.068	0.0638	0.0698	0.0597	0.0791
N	0	60	61	61	60	59	56	53	60	58
% < MDL		16.7	16.4	16.4	8.3	35.6	17.9	24.5	28.3	29.3
Max		0.14	0.49	0.25	0.25	0.32	0.19	0.21	0.18	0.33

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-19.** Annual Average Concentrations of 1,3 Butadiene in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

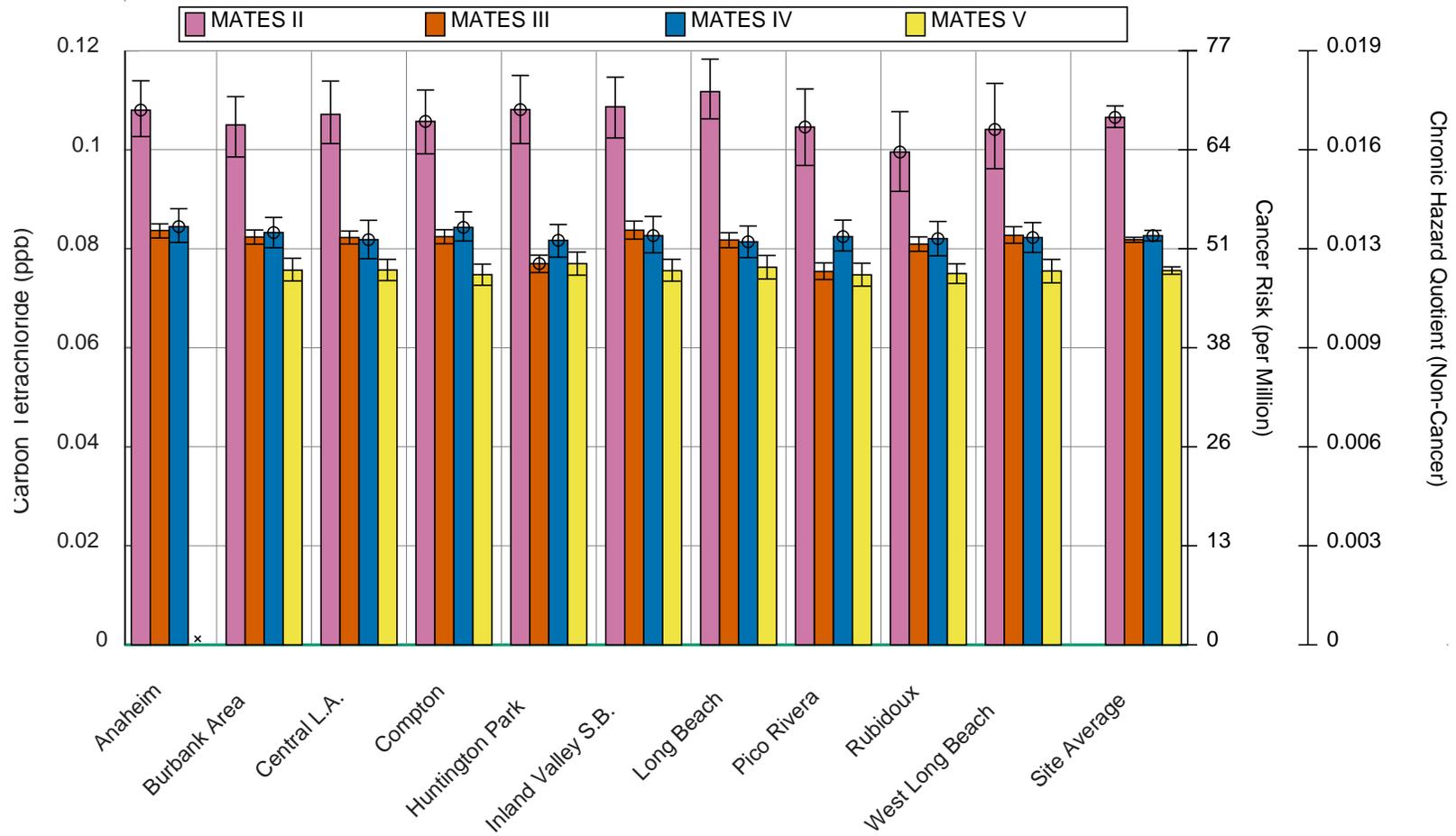


**Figure IV-20.** Geographic distribution of 1,3 Butadiene from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

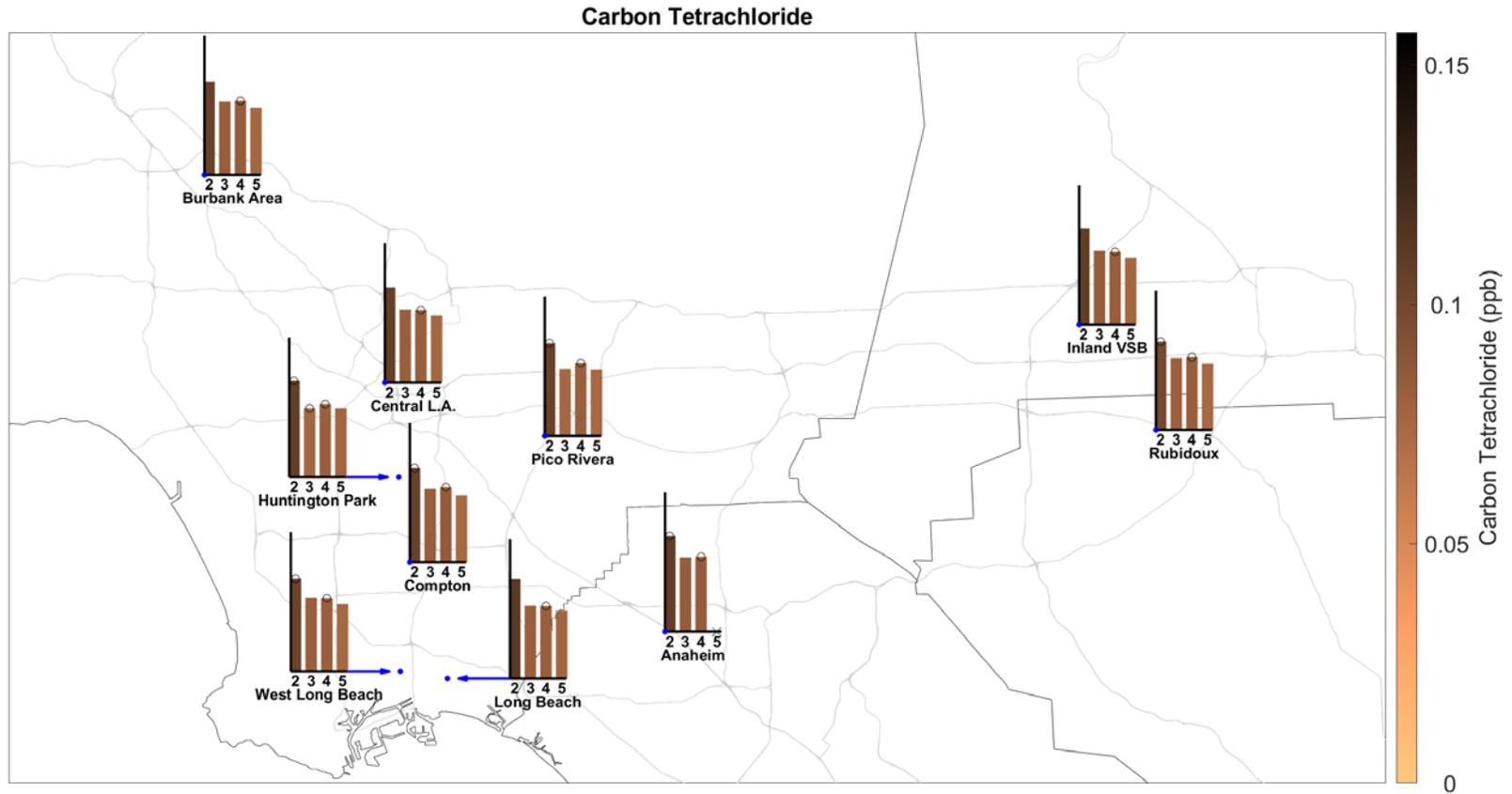
## Carbon Tetrachloride

**Table IV-13.** Ambient Concentrations (ppb) of Carbon Tetrachloride from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.108	0.105	0.106	0.109	0.108	0.112	0.107	0.105	0.0995	0.104
95% CI LB	0.103	0.0985	0.0992	0.102	0.101	0.106	0.101	0.0968	0.0916	0.0962
95% CI UB	0.114	0.111	0.112	0.115	0.115	0.118	0.114	0.112	0.108	0.113
N	51	56	42	60	44	59	57	53	45	34
% < MDL	51	50	50	50	52.3	50.8	50.9	54.7	53.3	47.1
Max	0.13	0.14	0.13	0.15	0.13	0.17	0.14	0.14	0.13	0.2
MATES III										
Average	0.0837	0.0824	0.0824	0.0837	0.077	0.0818	0.0823	0.0754	0.0809	0.0827
95% CI LB	0.0822	0.0809	0.081	0.0819	0.0752	0.0802	0.081	0.0738	0.0795	0.0811
95% CI UB	0.085	0.0838	0.0838	0.0856	0.0787	0.0832	0.0836	0.0771	0.0824	0.0845
N	233	241	237	232	100	238	238	121	234	235
% < MDL	0.9	1.2	0.8	0.9	2	1.3	0.4	2.5	0.4	1.7
Max	0.12	0.11	0.11	0.13	0.09	0.11	0.11	0.09	0.11	0.12
MATES IV										
Average	0.0845	0.0833	0.0843	0.0827	0.0817	0.0814	0.0818	0.0825	0.082	0.0823
95% CI LB	0.0813	0.0802	0.0816	0.0792	0.0783	0.0782	0.078	0.0796	0.0786	0.0792
95% CI UB	0.0881	0.0863	0.0875	0.0865	0.0849	0.0846	0.0857	0.0858	0.0855	0.0853
N	47	49	51	49	47	50	47	51	49	53
% < MDL	0	0	0	0	0	0	2.1	0	0	0
Max	0.12	0.11	0.11	0.11	0.1	0.11	0.11	0.11	0.11	0.11
MATES V										
Average		0.0757	0.0748	0.0756	0.077	0.0763	0.0757	0.0747	0.075	0.0755
95% CI LB		0.0735	0.0726	0.0734	0.0747	0.0739	0.0736	0.0725	0.073	0.0731
95% CI UB		0.0781	0.0769	0.0779	0.0793	0.0786	0.0779	0.0771	0.077	0.0778
N	0	60	61	61	60	59	56	53	60	58
% < MDL		0	0	0	0	0	0	0	0	0
Max		0.1	0.1	0.1	0.1	0.1	0.1	0.11	0.1	0.11



**Figure IV-21.** Annual Average Concentrations of Carbon Tetrachloride in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



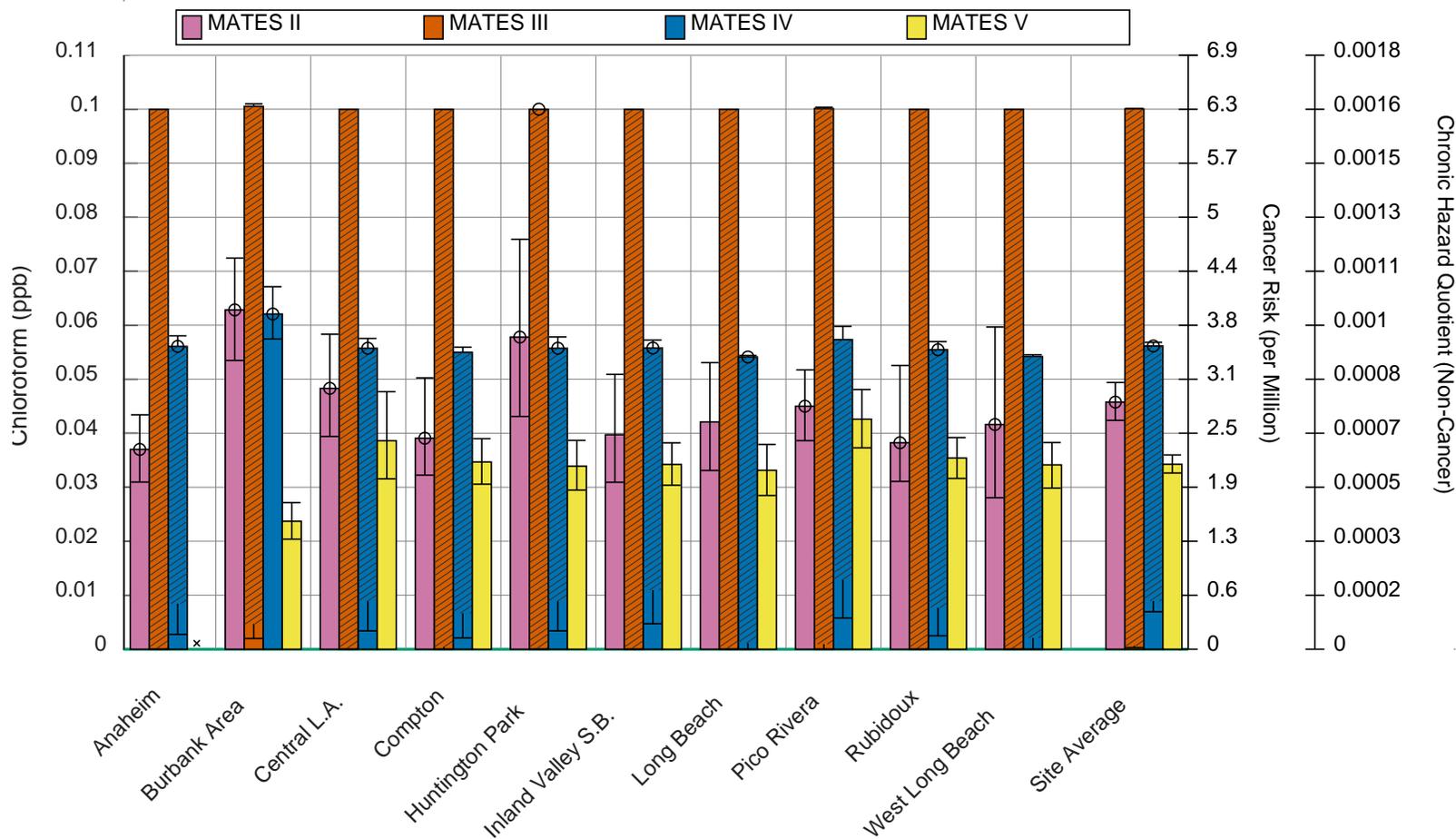
**Figure IV-22.** Geographic distribution of Carbon Tetrachloride from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Chloroform

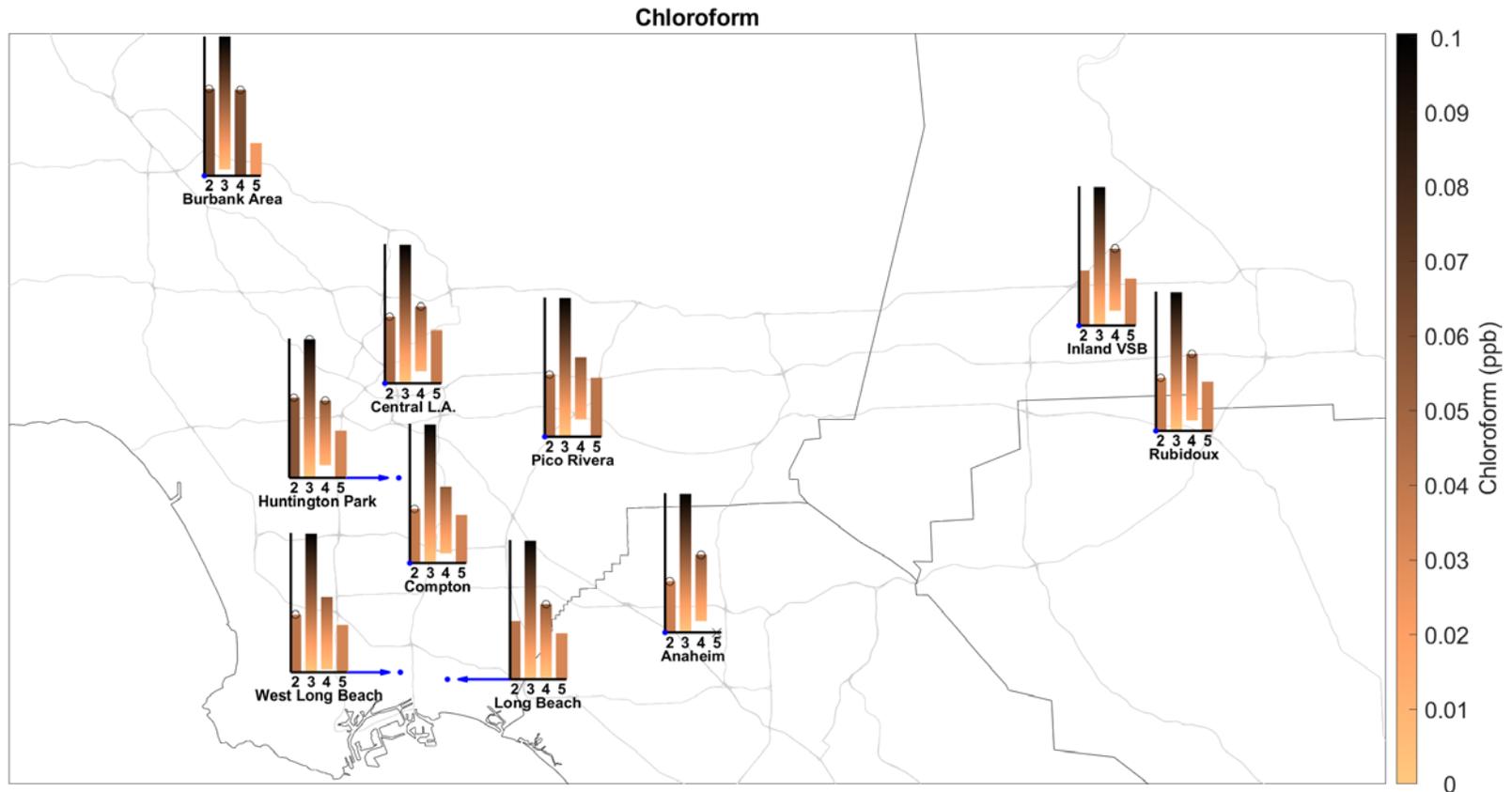
**Table IV-14.** Ambient Concentrations (ppb) of Chloroform from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0.037	0.0628	0.0391	0.0397	0.0578	0.0421	0.0483	0.045	0.0382	0.0416
95% CI LB	0.031	0.0535	0.0322	0.0309	0.0431	0.0331	0.0394	0.0386	0.0311	0.0281
95% CI UB	0.0434	0.0724	0.0502	0.0509	0.0759	0.0531	0.0583	0.0517	0.0525	0.0597
N	46	55	36	57	39	56	54	50	41	30
% < MDL	63	41.8	63.9	61.4	56.4	58.9	55.6	60	65.9	63.3
Max	0.06	0.18	0.1	0.24	0.3	0.22	0.2	0.11	0.08	0.2
<b>MATES III</b>										
Average	0, 0.1 <sup>a</sup>	0.00469, 0.101 <sup>a</sup>	0.000422, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0.00095, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0.00199 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.1 <sup>a</sup>	0.101 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>
N	233 <sup>a</sup>	241 <sup>a</sup>	237 <sup>a</sup>	232 <sup>a</sup>	100 <sup>a</sup>	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	235 <sup>a</sup>
% < MDL	100 <sup>a</sup>	95.9 <sup>a</sup>	99.6 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	99.2 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	0.13 <sup>a</sup>	0.1 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.115 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES IV</b>										
Average	0.00843, 0.0561 <sup>a</sup>	0.0621	0.00667, 0.055 <sup>a</sup>	0.0109, 0.0558 <sup>a</sup>	0.00887, 0.0557 <sup>a</sup>	0.00111, 0.0541 <sup>a</sup>	0.00887, 0.0557 <sup>a</sup>	0.0128, 0.0573 <sup>a</sup>	0.00769, 0.0555 <sup>a</sup>	0.00211, 0.0542 <sup>a</sup>
95% CI LB	0.00275 <sup>a</sup>	0.0574	0.00211 <sup>a</sup>	0.00472 <sup>a</sup>	0.0034 <sup>a</sup>	0 <sup>a</sup>	0.0034 <sup>a</sup>	0.00579 <sup>a</sup>	0.0025 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.058 <sup>a</sup>	0.0671	0.0559 <sup>a</sup>	0.0572 <sup>a</sup>	0.0578 <sup>a</sup>	0.0544 <sup>a</sup>	0.0575 <sup>a</sup>	0.0598 <sup>a</sup>	0.057 <sup>a</sup>	0.0545 <sup>a</sup>
N	51 <sup>a</sup>	55	57 <sup>a</sup>	53 <sup>a</sup>	53 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52 <sup>a</sup>	57 <sup>a</sup>
% < MDL	88.2 <sup>a</sup>	74.5	89.5 <sup>a</sup>	83 <sup>a</sup>	86.8 <sup>a</sup>	98.1 <sup>a</sup>	86.8 <sup>a</sup>	82.5 <sup>a</sup>	88.5 <sup>a</sup>	96.5 <sup>a</sup>
Max	0.08 <sup>a</sup>	0.14	0.07 <sup>a</sup>	0.08 <sup>a</sup>	0.1 <sup>a</sup>	0.06 <sup>a</sup>	0.09 <sup>a</sup>	0.1 <sup>a</sup>	0.08 <sup>a</sup>	0.06 <sup>a</sup>
<b>MATES V</b>										
Average		0.0237	0.0347	0.0342	0.0339	0.0331	0.0386	0.0426	0.0354	0.0341
95% CI LB		0.0204	0.0306	0.0304	0.0295	0.0285	0.0316	0.0373	0.0316	0.0298
95% CI UB		0.0271	0.039	0.0382	0.0387	0.0379	0.0477	0.0481	0.0392	0.0383
N	0	60	61	61	60	59	56	53	60	58
% < MDL		55	49.2	34.4	53.3	54.2	46.4	43.4	41.7	51.7
Max		0.04	0.07	0.08	0.07	0.08	0.23	0.09	0.07	0.07

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-23.** Annual Average Concentrations of Chloroform in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

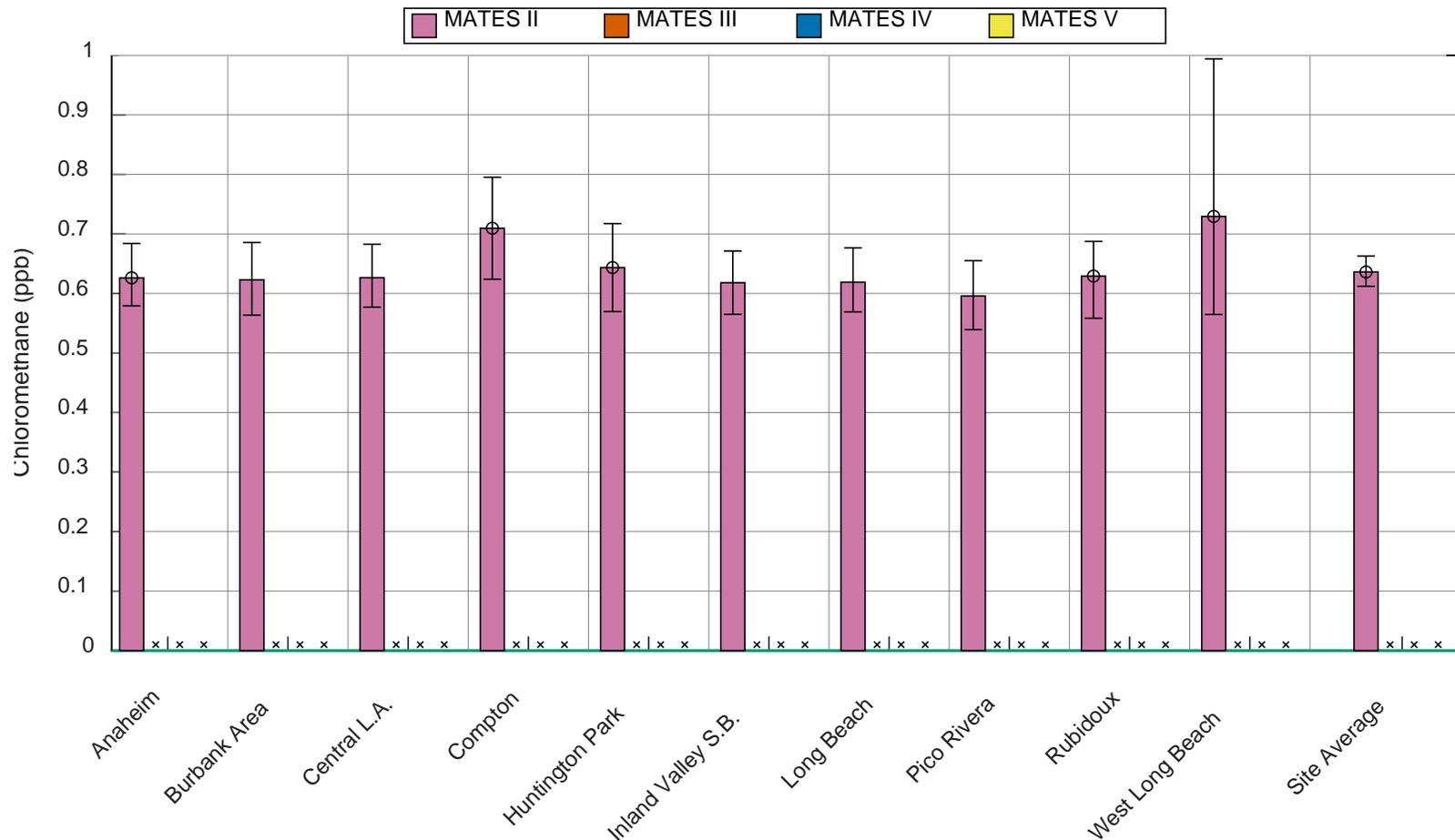


**Figure IV-24.** Geographic distribution of Chloroform from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

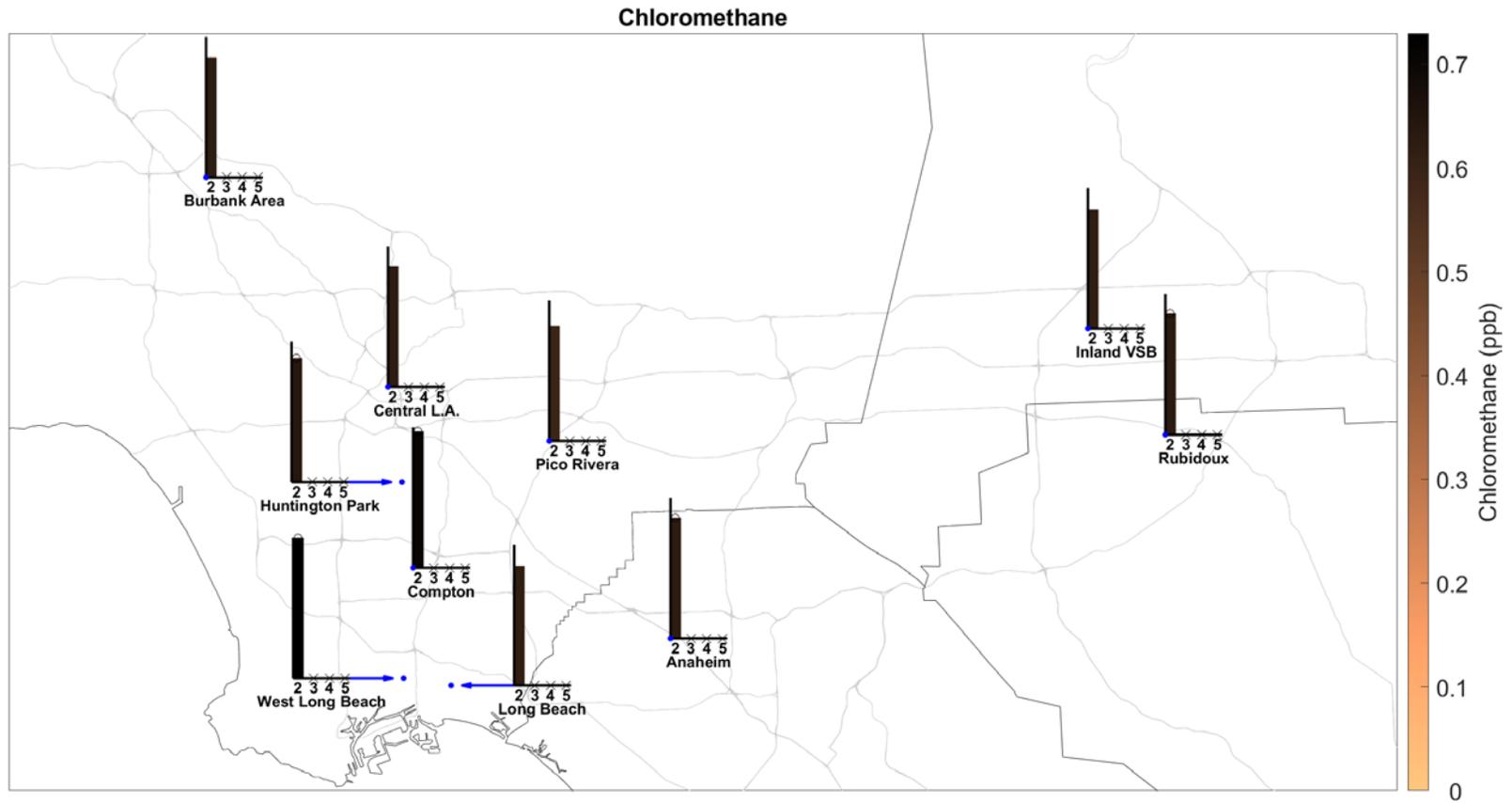
Chloromethane

**Table IV-15.** Ambient Concentrations (ppb) of Chloromethane from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.626	0.623	0.71	0.618	0.643	0.619	0.627	0.596	0.629	0.729
95% CI LB	0.579	0.564	0.624	0.565	0.57	0.569	0.577	0.539	0.558	0.565
95% CI UB	0.684	0.686	0.795	0.671	0.717	0.677	0.683	0.655	0.688	0.994
N	26	28	21	30	23	30	29	29	24	17
% < MDL	0	0	0	0	0	0	0	0	4.2	0
Max	1	1.1	1.2	1	1	1.1	1.1	1	0.9	2.5
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-25.** Annual Average Concentrations of Chloromethane in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



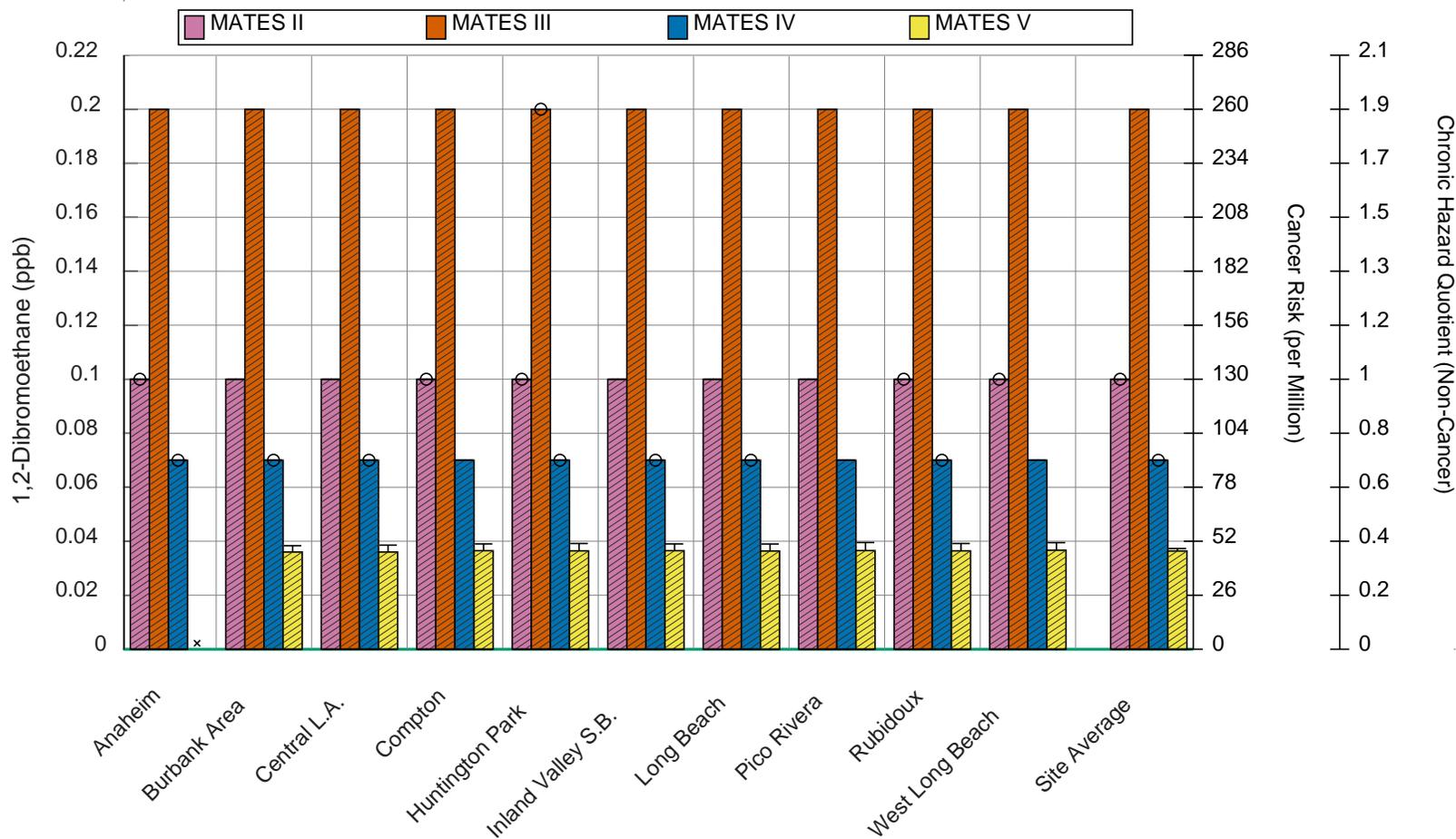
**Figure IV-26.** Geographic distribution of Chloromethane from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

## 1,2-Dibromoethane

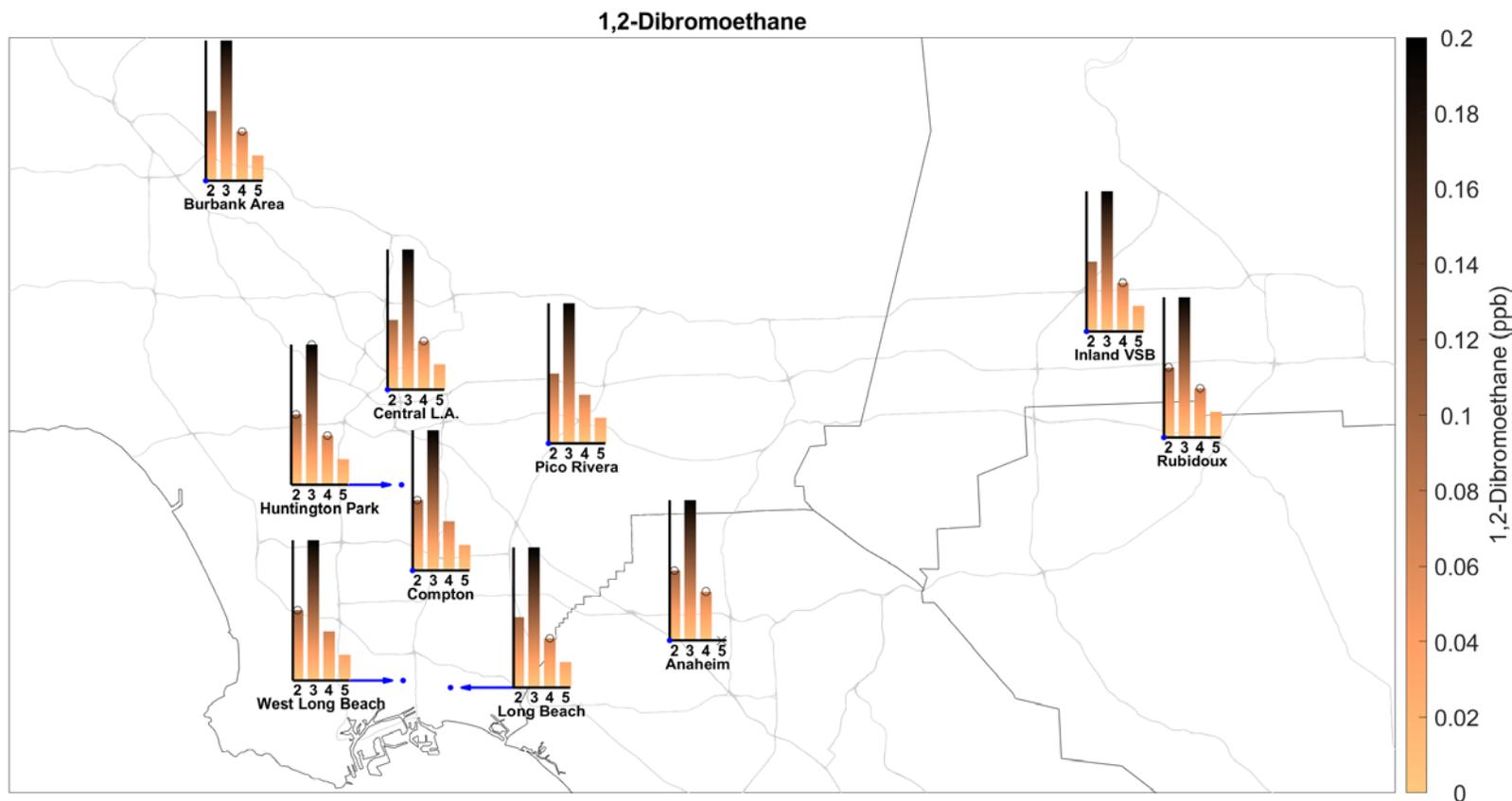
**Table IV-16.** Ambient Concentrations (ppb) of 1,2-Dibromoethane from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>
N	26 <sup>a</sup>	28 <sup>a</sup>	21 <sup>a</sup>	30 <sup>a</sup>	23 <sup>a</sup>	30 <sup>a</sup>	29 <sup>a</sup>	29 <sup>a</sup>	24 <sup>a</sup>	17 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES III</b>										
Average	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>
N	233 <sup>a</sup>	241 <sup>a</sup>	237 <sup>a</sup>	232 <sup>a</sup>	100 <sup>a</sup>	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	235 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES IV</b>										
Average	0, 0.07 <sup>a</sup>	0, 0.07 <sup>a</sup>	0, 0.07 <sup>a</sup>	0, 0.07 <sup>a</sup>	0, 0.07 <sup>a</sup>	0, 0.07 <sup>a</sup>	0, 0.07 <sup>a</sup>	0, 0.07 <sup>a</sup>	0, 0.07 <sup>a</sup>	0, 0.07 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.07 <sup>a</sup>	0.07 <sup>a</sup>	0.07 <sup>a</sup>	0.07 <sup>a</sup>	0.07 <sup>a</sup>	0.07 <sup>a</sup>	0.07 <sup>a</sup>	0.07 <sup>a</sup>	0.07 <sup>a</sup>	0.07 <sup>a</sup>
N	51 <sup>a</sup>	55 <sup>a</sup>	57 <sup>a</sup>	53 <sup>a</sup>	53 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52 <sup>a</sup>	57 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES V</b>										
Average		0, 0.036 <sup>a</sup>	0, 0.0365 <sup>a</sup>	0, 0.0365 <sup>a</sup>	0, 0.0364 <sup>a</sup>	0, 0.0364 <sup>a</sup>	0, 0.036 <sup>a</sup>	0, 0.0365 <sup>a</sup>	0, 0.0364 <sup>a</sup>	0, 0.0367 <sup>a</sup>
95% CI LB		0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB		0.0383 <sup>a</sup>	0.039 <sup>a</sup>	0.039 <sup>a</sup>	0.0392 <sup>a</sup>	0.039 <sup>a</sup>	0.0385 <sup>a</sup>	0.0395 <sup>a</sup>	0.0392 <sup>a</sup>	0.0395 <sup>a</sup>
N	0	60 <sup>a</sup>	60 <sup>a</sup>	60 <sup>a</sup>	59 <sup>a</sup>	58 <sup>a</sup>	55 <sup>a</sup>	52 <sup>a</sup>	59 <sup>a</sup>	57 <sup>a</sup>
% < MDL		100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max		< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-27.** Annual Average Concentrations of 1,2-Dibromoethane in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



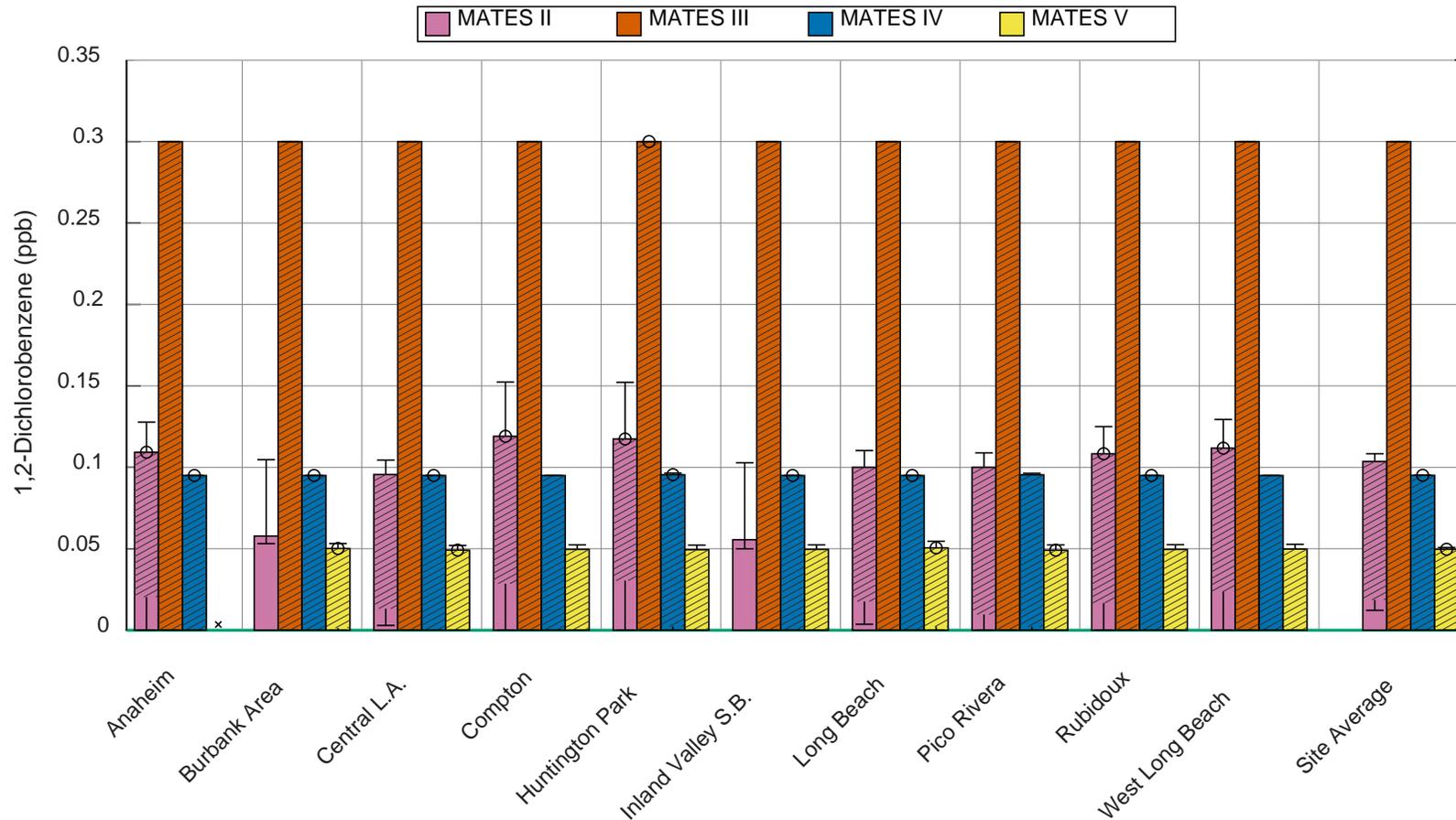
**Figure IV-28.** Geographic distribution of 1,2-Dibromoethane from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

1,2-Dichlorobenzene

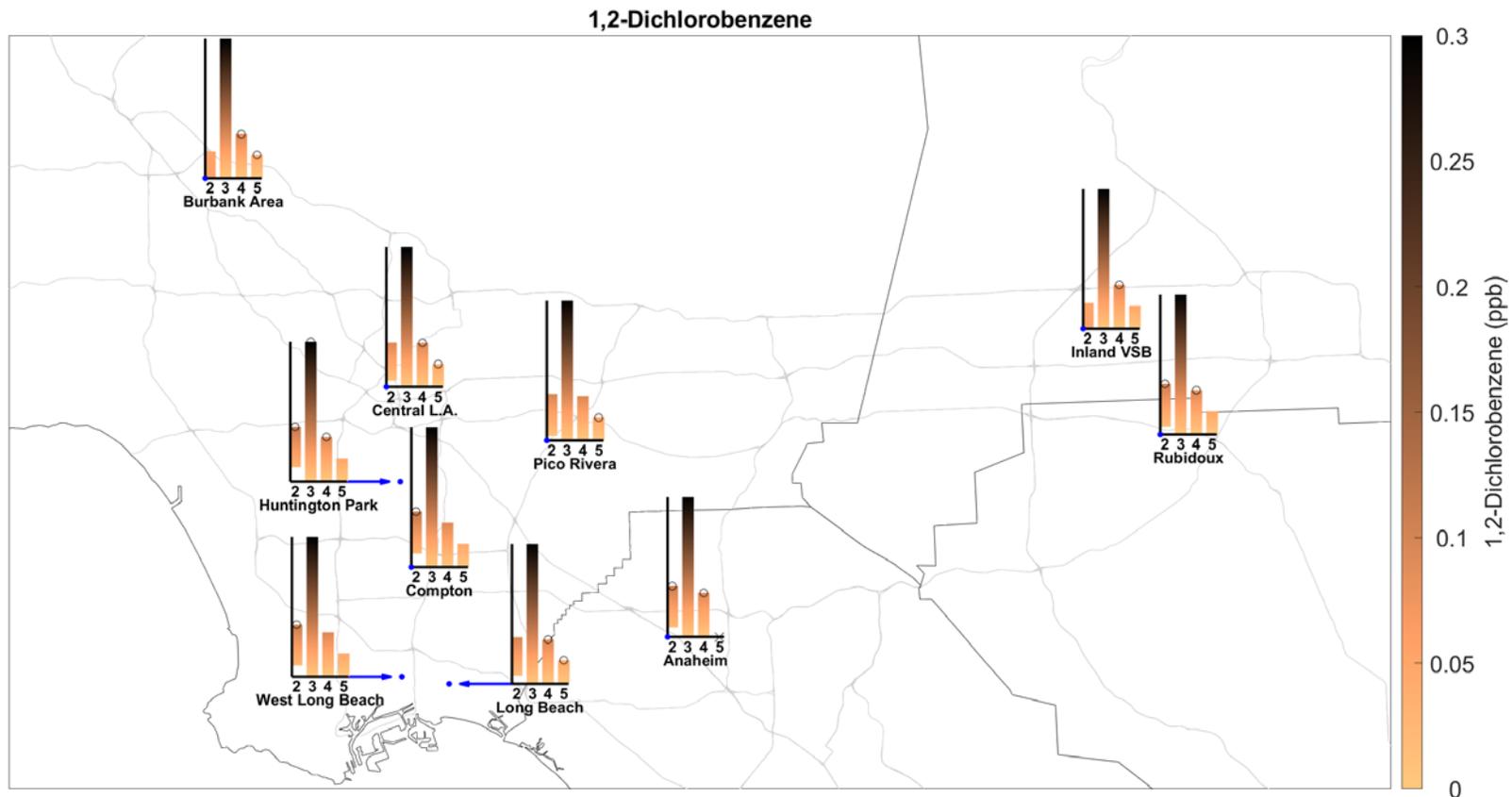
**Table IV-17.** Ambient Concentrations (ppb) of 1,2-Dichlorobenzene from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0.0204, 0.109 <sup>a</sup>	0.0578	0.0286, 0.119 <sup>a</sup>	0.0556	0.0304, 0.117 <sup>a</sup>	0.0176, 0.1 <sup>a</sup>	0.0132, 0.0956 <sup>a</sup>	0.00968, 0.1 <sup>a</sup>	0.0167, 0.108 <sup>a</sup>	0.0235, 0.112 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0.0531	0 <sup>a</sup>	0.05	0 <sup>a</sup>	0.00368 <sup>a</sup>	0.00294 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.128 <sup>a</sup>	0.105	0.152 <sup>a</sup>	0.103	0.152 <sup>a</sup>	0.11 <sup>a</sup>	0.104 <sup>a</sup>	0.109 <sup>a</sup>	0.125 <sup>a</sup>	0.129 <sup>a</sup>
N	27 <sup>a</sup>	32	21 <sup>a</sup>	36	23 <sup>a</sup>	34 <sup>a</sup>	34 <sup>a</sup>	31 <sup>a</sup>	24 <sup>a</sup>	17 <sup>a</sup>
% < MDL	88.9 <sup>a</sup>	78.1	90.5 <sup>a</sup>	77.8	87 <sup>a</sup>	82.4 <sup>a</sup>	82.4 <sup>a</sup>	90.3 <sup>a</sup>	91.7 <sup>a</sup>	88.2 <sup>a</sup>
Max	0.3 <sup>a</sup>	0.2	0.4 <sup>a</sup>	0.2	0.4 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.3 <sup>a</sup>	0.2 <sup>a</sup>
<b>MATES III</b>										
Average	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>
N	233 <sup>a</sup>	241 <sup>a</sup>	237 <sup>a</sup>	232 <sup>a</sup>	100 <sup>a</sup>	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	235 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES IV</b>										
Average	0, 0.095 <sup>a</sup>	0, 0.095 <sup>a</sup>	0, 0.095 <sup>a</sup>	0, 0.095 <sup>a</sup>	0.00226, 0.0955 <sup>a</sup>	0, 0.095 <sup>a</sup>	0, 0.095 <sup>a</sup>	0.00211, 0.0954 <sup>a</sup>	0, 0.095 <sup>a</sup>	0, 0.095 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.095 <sup>a</sup>	0.095 <sup>a</sup>	0.095 <sup>a</sup>	0.095 <sup>a</sup>	0.0964 <sup>a</sup>	0.095 <sup>a</sup>	0.095 <sup>a</sup>	0.0963 <sup>a</sup>	0.095 <sup>a</sup>	0.095 <sup>a</sup>
N	51 <sup>a</sup>	55 <sup>a</sup>	57 <sup>a</sup>	53 <sup>a</sup>	53 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52 <sup>a</sup>	57 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	98.1 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	98.2 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.12 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.12 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES V</b>										
Average		0.00132, 0.0502 <sup>a</sup>	0, 0.0496 <sup>a</sup>	0, 0.0496 <sup>a</sup>	0, 0.0494 <sup>a</sup>	0.00212, 0.0506 <sup>a</sup>	0, 0.0492 <sup>a</sup>	0, 0.0491 <sup>a</sup>	0.000769, 0.0496 <sup>a</sup>	0, 0.0498 <sup>a</sup>
95% CI LB		0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB		0.0532 <sup>a</sup>	0.0524 <sup>a</sup>	0.0524 <sup>a</sup>	0.0523 <sup>a</sup>	0.0546 <sup>a</sup>	0.052 <sup>a</sup>	0.0524 <sup>a</sup>	0.0525 <sup>a</sup>	0.0527 <sup>a</sup>
N	0	53 <sup>a</sup>	54 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	52 <sup>a</sup>	49 <sup>a</sup>	46 <sup>a</sup>	52 <sup>a</sup>	51 <sup>a</sup>
% < MDL		98.1 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	98.1 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	98.1 <sup>a</sup>	100 <sup>a</sup>
Max		0.07 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.11 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.04 <sup>a</sup>	< MDL <sup>a</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-29.** Annual Average Concentrations of 1,2-Dichlorobenzene in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



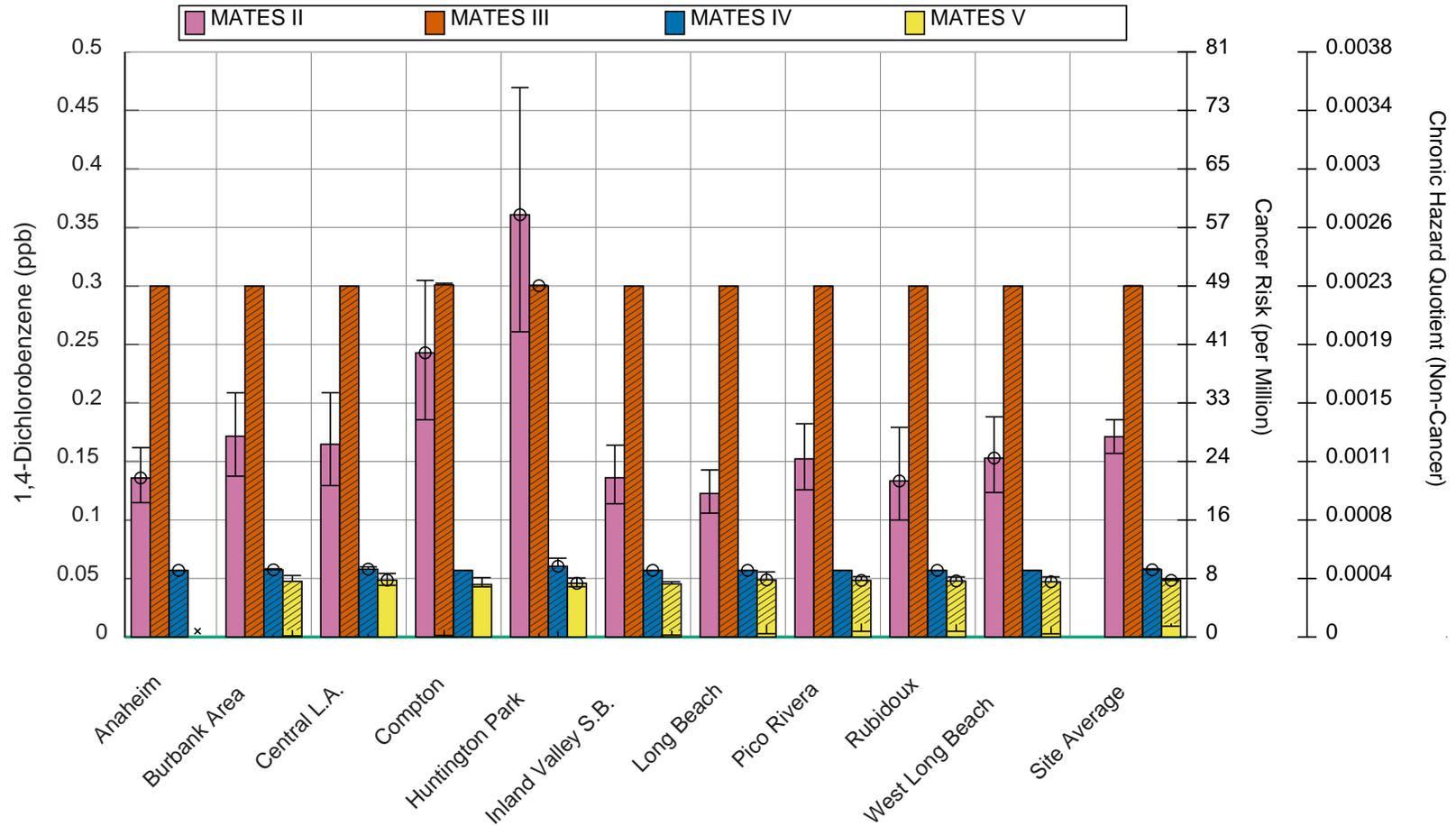
**Figure IV-30.** Geographic distribution of 1,2-Dichlorobenzene from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

1,4-Dichlorobenzene

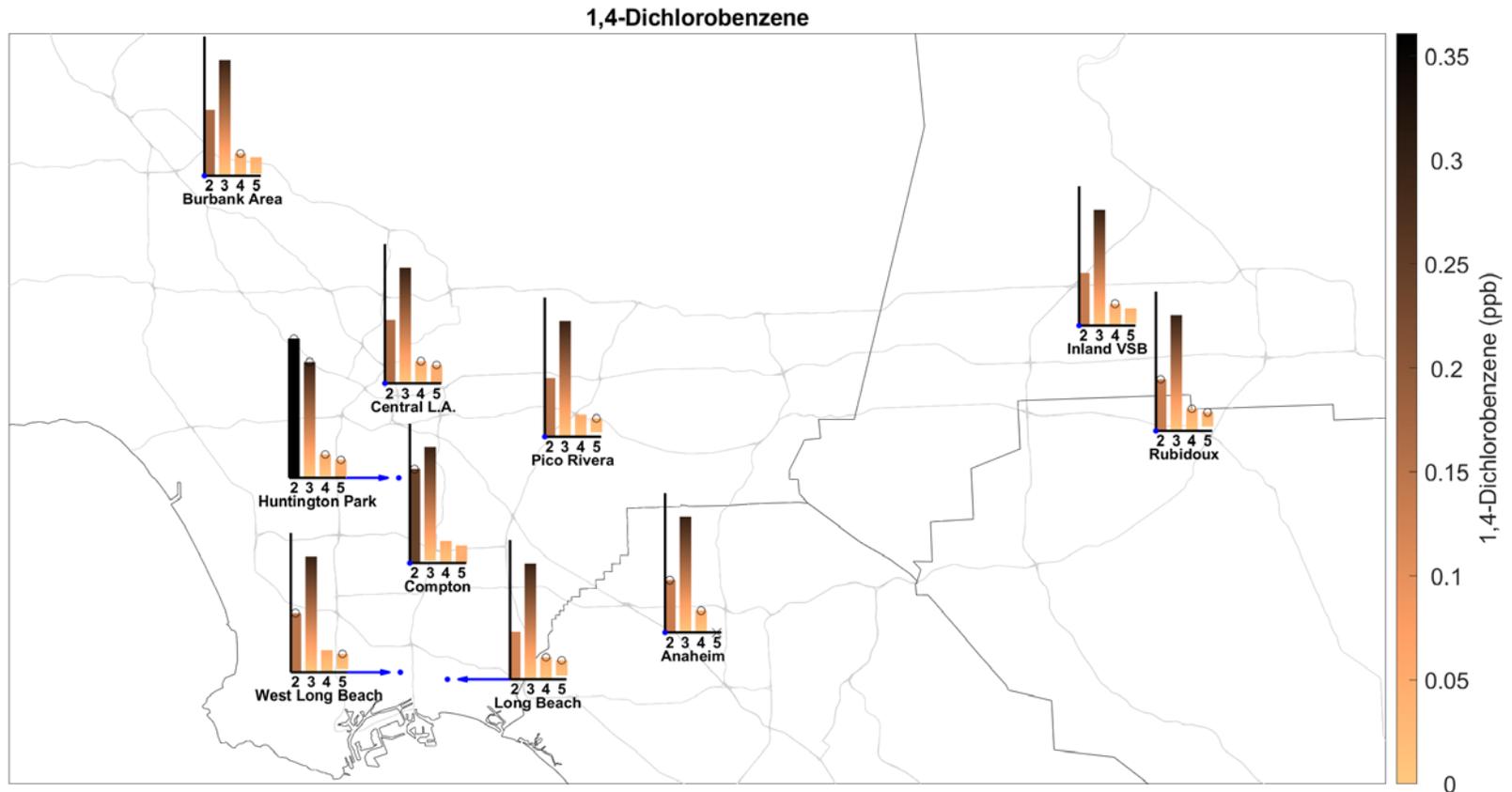
**Table IV-18.** Ambient Concentrations (ppb) of 1,4-Dichlorobenzene from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0.136	0.172	0.243	0.136	0.361	0.123	0.165	0.152	0.133	0.153
95% CI LB	0.115	0.138	0.186	0.114	0.261	0.106	0.129	0.126	0.1	0.124
95% CI UB	0.162	0.209	0.305	0.164	0.47	0.143	0.209	0.182	0.179	0.188
N	27	32	21	36	23	34	34	31	24	17
% < MDL	55.6	37.5	14.3	47.2	8.7	52.9	38.2	51.6	70.8	52.9
Max	0.3	0.5	0.5	0.4	1.1	0.3	0.5	0.4	0.5	0.3
<b>MATES III</b>										
Average	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0.00595, 0.301 <sup>a</sup>	0, 0.3 <sup>a</sup>	0.0032, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0.00131 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.302 <sup>a</sup>	0.3 <sup>a</sup>	0.301 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>
N	233 <sup>a</sup>	241 <sup>a</sup>	237 <sup>a</sup>	232 <sup>a</sup>	100 <sup>a</sup>	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	235 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	98.3 <sup>a</sup>	100 <sup>a</sup>	99 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.42 <sup>a</sup>	< MDL <sup>a</sup>	0.32 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES IV</b>										
Average	0, 0.057 <sup>a</sup>	0.00145, 0.0574 <sup>a</sup>	0, 0.057 <sup>a</sup>	0, 0.057 <sup>a</sup>	0.00453, 0.0605 <sup>a</sup>	0, 0.057 <sup>a</sup>	0.00208, 0.058 <sup>a</sup>	0, 0.057 <sup>a</sup>	0, 0.057 <sup>a</sup>	0, 0.057 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.057 <sup>a</sup>	0.0583 <sup>a</sup>	0.057 <sup>a</sup>	0.057 <sup>a</sup>	0.0674 <sup>a</sup>	0.057 <sup>a</sup>	0.06 <sup>a</sup>	0.057 <sup>a</sup>	0.057 <sup>a</sup>	0.057 <sup>a</sup>
N	51 <sup>a</sup>	55 <sup>a</sup>	57 <sup>a</sup>	53 <sup>a</sup>	53 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52 <sup>a</sup>	57 <sup>a</sup>
% < MDL	100 <sup>a</sup>	98.2 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	98.1 <sup>a</sup>	100 <sup>a</sup>	98.1 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	0.08 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.24 <sup>a</sup>	< MDL <sup>a</sup>	0.11 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES V</b>										
Average		0.00593, 0.0476 <sup>a</sup>	0.0449	0.00545, 0.0455 <sup>a</sup>	0.046	0.01, 0.0489 <sup>a</sup>	0.0487	0.0116, 0.0484 <sup>a</sup>	0.011, 0.0479 <sup>a</sup>	0.00824, 0.0473 <sup>a</sup>
95% CI LB		0.000926 <sup>a</sup>	0.0429	0.00164 <sup>a</sup>	0.043	0.00283 <sup>a</sup>	0.0442	0.0049 <sup>a</sup>	0.00491 <sup>a</sup>	0.00275 <sup>a</sup>
95% CI UB		0.0526 <sup>a</sup>	0.0507	0.0473 <sup>a</sup>	0.0504	0.0557 <sup>a</sup>	0.0543	0.0516 <sup>a</sup>	0.0513 <sup>a</sup>	0.0514 <sup>a</sup>
N	0	54 <sup>a</sup>	55	55 <sup>a</sup>	54	53 <sup>a</sup>	51	49 <sup>a</sup>	56 <sup>a</sup>	51 <sup>a</sup>
% < MDL		92.6 <sup>a</sup>	80	89.1 <sup>a</sup>	72.2	86.8 <sup>a</sup>	64.7	81.6 <sup>a</sup>	82.1 <sup>a</sup>	86.3 <sup>a</sup>
Max		0.15 <sup>a</sup>	0.12	0.07 <sup>a</sup>	0.11	0.2 <sup>a</sup>	0.14	0.09 <sup>a</sup>	0.1 <sup>a</sup>	0.13 <sup>a</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-31.** Annual Average Concentrations of 1,4-Dichlorobenzene in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



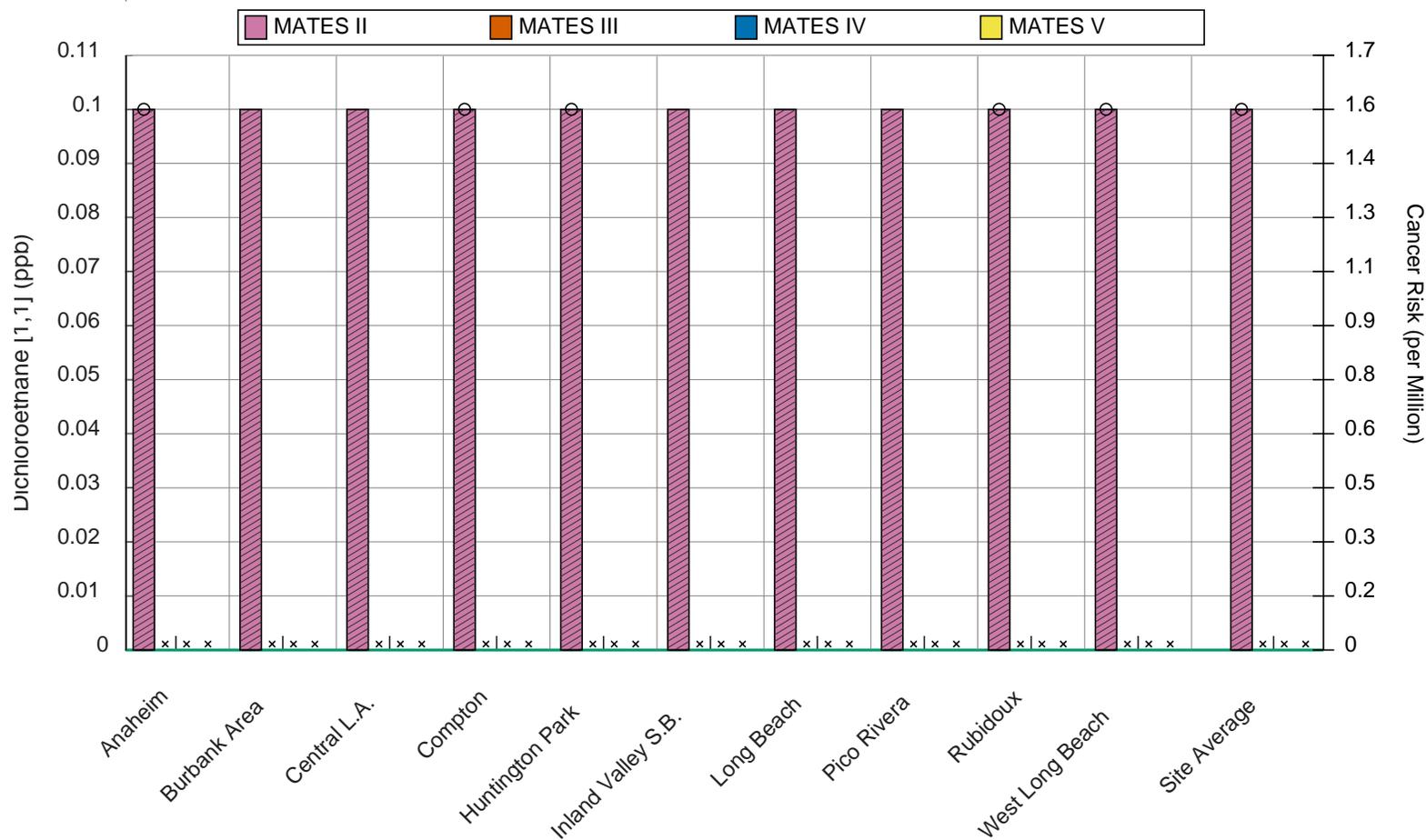
**Figure IV-32.** Geographic distribution of 1,4-Dichlorobenzene from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Dichloroethane [1,1]

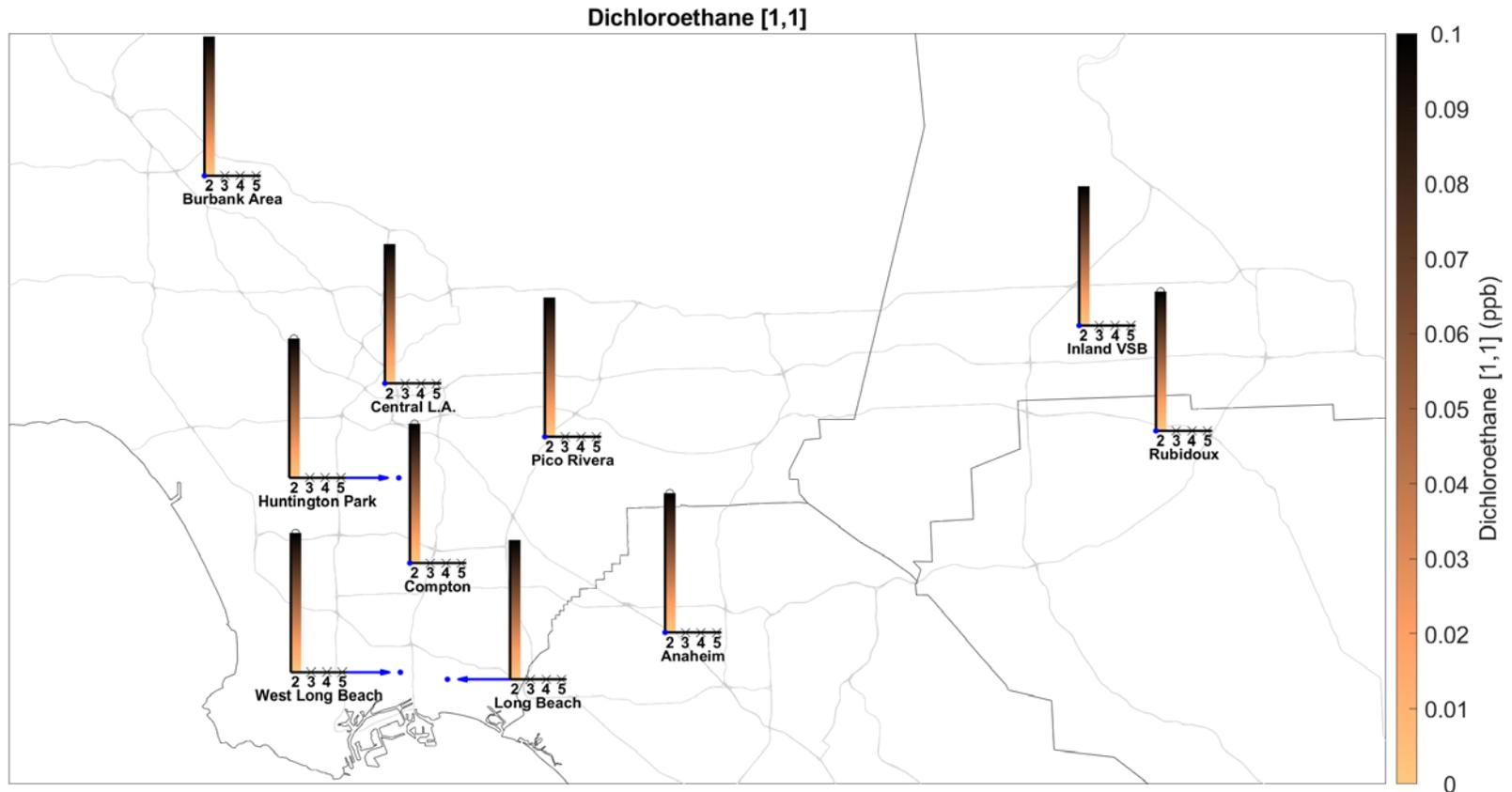
**Table IV-19.** Ambient Concentrations (ppb) of Dichloroethane [1,1] from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0, 0.1 <sup>a</sup>									
95% CI LB	0 <sup>a</sup>									
95% CI UB	0.1 <sup>a</sup>									
N	26 <sup>a</sup>	28 <sup>a</sup>	21 <sup>a</sup>	30 <sup>a</sup>	23 <sup>a</sup>	30 <sup>a</sup>	29 <sup>a</sup>	29 <sup>a</sup>	24 <sup>a</sup>	17 <sup>a</sup>
% < MDL	100 <sup>a</sup>									
Max	< MDL <sup>a</sup>									
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-33.** Annual Average Concentrations of Dichloroethane [1,1] in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



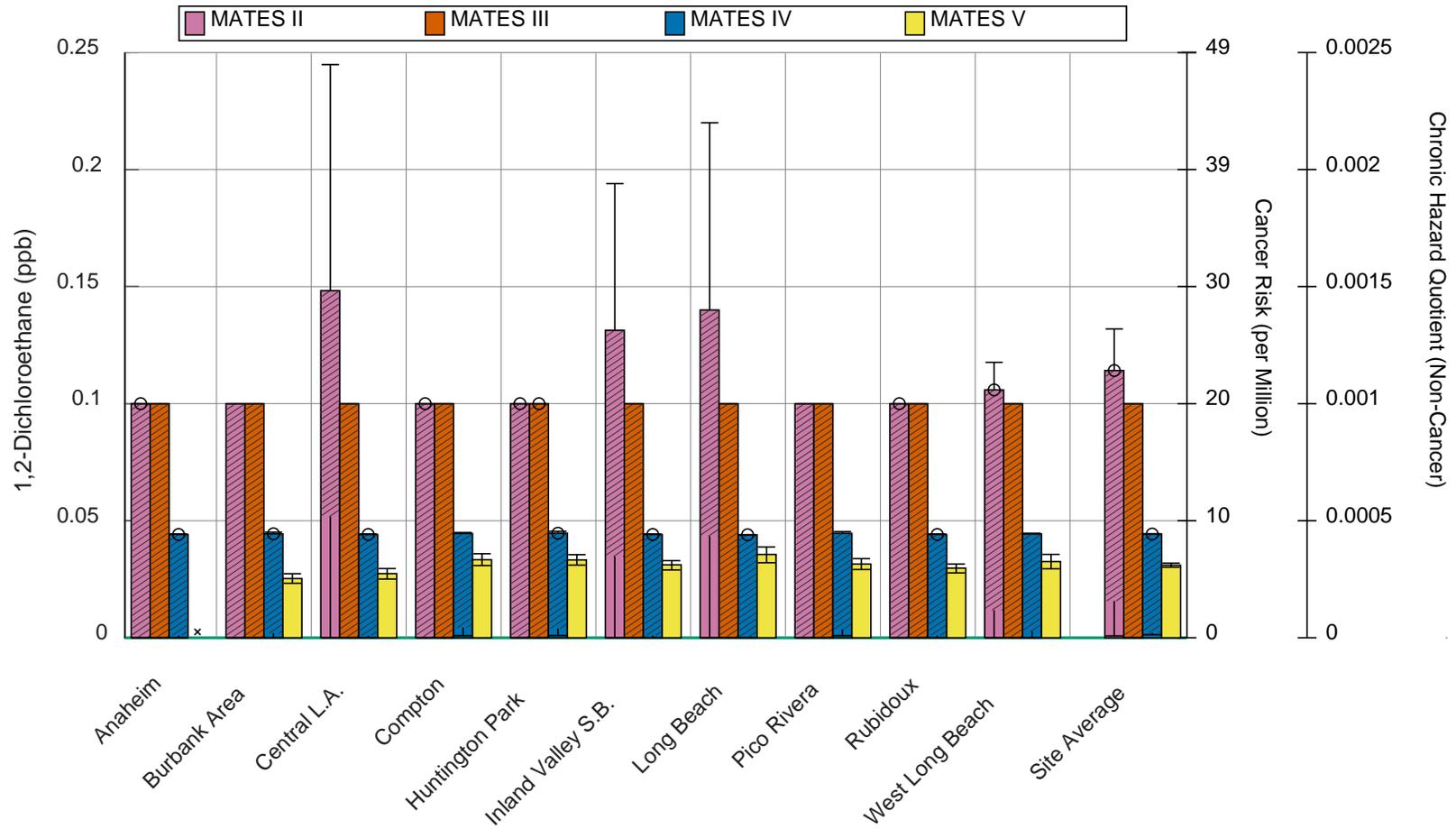
**Figure IV-34.** Geographic distribution of Dichloroethane [1,1] from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

1,2-Dichloroethane

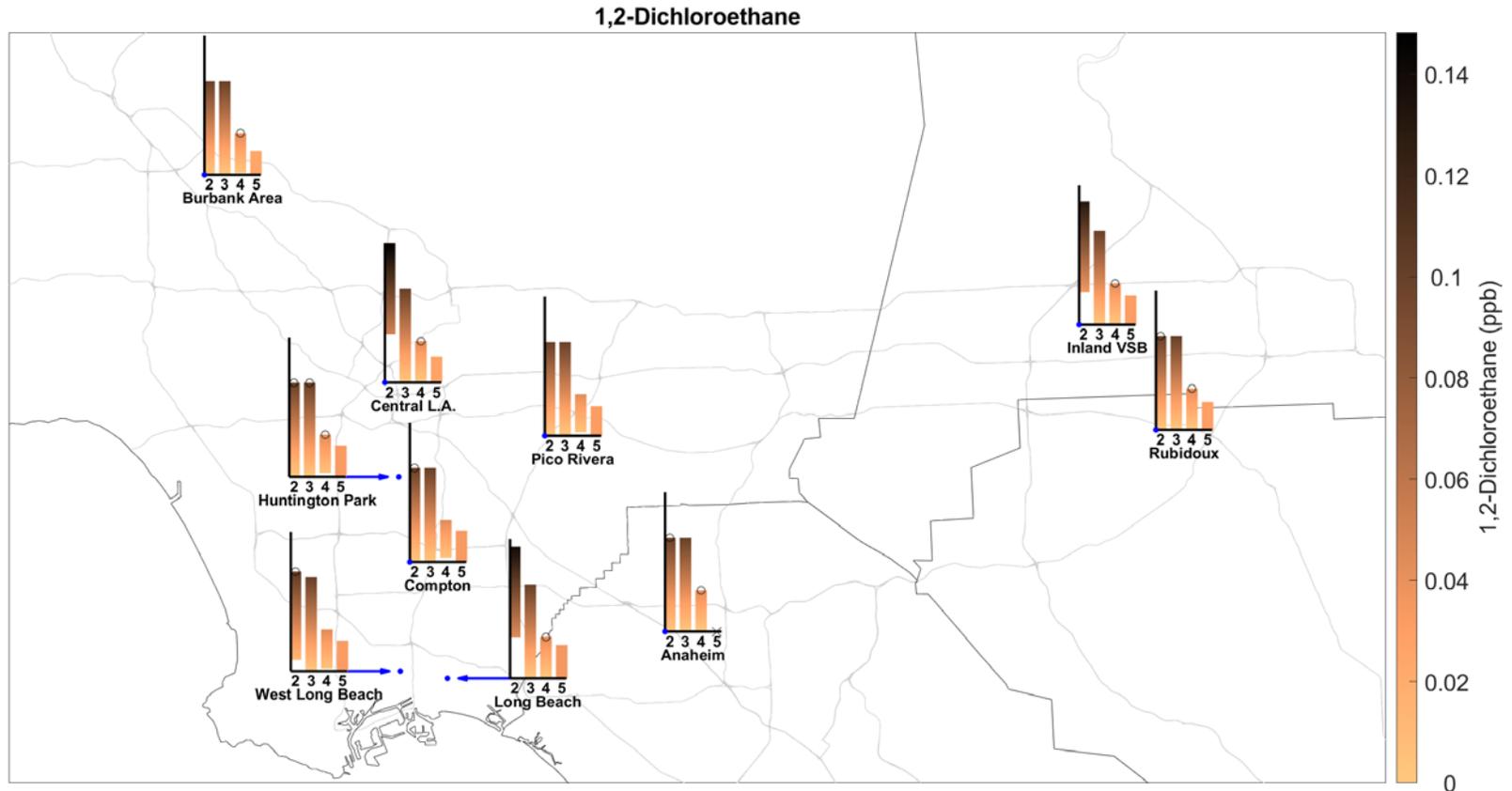
**Table IV-20.** Ambient Concentrations (ppb) of 1,2-Dichloroethane from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0.0347, 0.131 <sup>a</sup>	0, 0.1 <sup>a</sup>	0.0433, 0.14 <sup>a</sup>	0.0517, 0.148 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0.0118, 0.106 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.194 <sup>a</sup>	0.1 <sup>a</sup>	0.22 <sup>a</sup>	0.245 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.118 <sup>a</sup>
N	26 <sup>a</sup>	28 <sup>a</sup>	21 <sup>a</sup>	30 <sup>a</sup>	23 <sup>a</sup>	30 <sup>a</sup>	29 <sup>a</sup>	29 <sup>a</sup>	24 <sup>a</sup>	17 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	96.7 <sup>a</sup>	100 <sup>a</sup>	96.7 <sup>a</sup>	96.6 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	94.1 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	1.04 <sup>a</sup>	< MDL <sup>a</sup>	1.3 <sup>a</sup>	1.5 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.2 <sup>a</sup>
<b>MATES III</b>										
Average	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>
N	233 <sup>a</sup>	241 <sup>a</sup>	237 <sup>a</sup>	232 <sup>a</sup>	100 <sup>a</sup>	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	235 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES IV</b>										
Average	0.00098, 0.0441 <sup>a</sup>	0.002, 0.0444 <sup>a</sup>	0.00439, 0.0445 <sup>a</sup>	0.000943, 0.0441 <sup>a</sup>	0.00396, 0.0446 <sup>a</sup>	0, 0.044 <sup>a</sup>	0.000943, 0.0441 <sup>a</sup>	0.00368, 0.0446 <sup>a</sup>	0.000962, 0.0441 <sup>a</sup>	0.00263, 0.0443 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0.000877 <sup>a</sup>	0 <sup>a</sup>	0.000943 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0.000877 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.0444 <sup>a</sup>	0.0451 <sup>a</sup>	0.0449 <sup>a</sup>	0.0443 <sup>a</sup>	0.0455 <sup>a</sup>	0.044 <sup>a</sup>	0.0443 <sup>a</sup>	0.0453 <sup>a</sup>	0.0443 <sup>a</sup>	0.0446 <sup>a</sup>
N	51 <sup>a</sup>	55 <sup>a</sup>	57 <sup>a</sup>	53 <sup>a</sup>	53 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52 <sup>a</sup>	57 <sup>a</sup>
% < MDL	98 <sup>a</sup>	96.4 <sup>a</sup>	91.2 <sup>a</sup>	98.1 <sup>a</sup>	92.5 <sup>a</sup>	100 <sup>a</sup>	98.1 <sup>a</sup>	93 <sup>a</sup>	98.1 <sup>a</sup>	94.7 <sup>a</sup>
Max	0.05 <sup>a</sup>	0.06 <sup>a</sup>	0.05 <sup>a</sup>	0.05 <sup>a</sup>	0.06 <sup>a</sup>	< MDL <sup>a</sup>	0.05 <sup>a</sup>	0.06 <sup>a</sup>	0.05 <sup>a</sup>	0.05 <sup>a</sup>
<b>MATES V</b>										
Average		0.0253	0.0333	0.0311	0.0333	0.0356	0.0274	0.0315	0.0298	0.0326
95% CI LB		0.0233	0.0308	0.029	0.031	0.032	0.0251	0.0292	0.0277	0.0295
95% CI UB		0.0274	0.0359	0.033	0.0355	0.0388	0.0296	0.0338	0.0315	0.0356
N	0	60	61	61	60	59	56	53	60	58
% < MDL		55	49.2	49.2	53.3	47.5	55.4	54.7	51.7	51.7
Max		0.04	0.06	0.05	0.06	0.07	0.04	0.05	0.04	0.06

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-35.** Annual Average Concentrations of 1,2-Dichloroethane in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



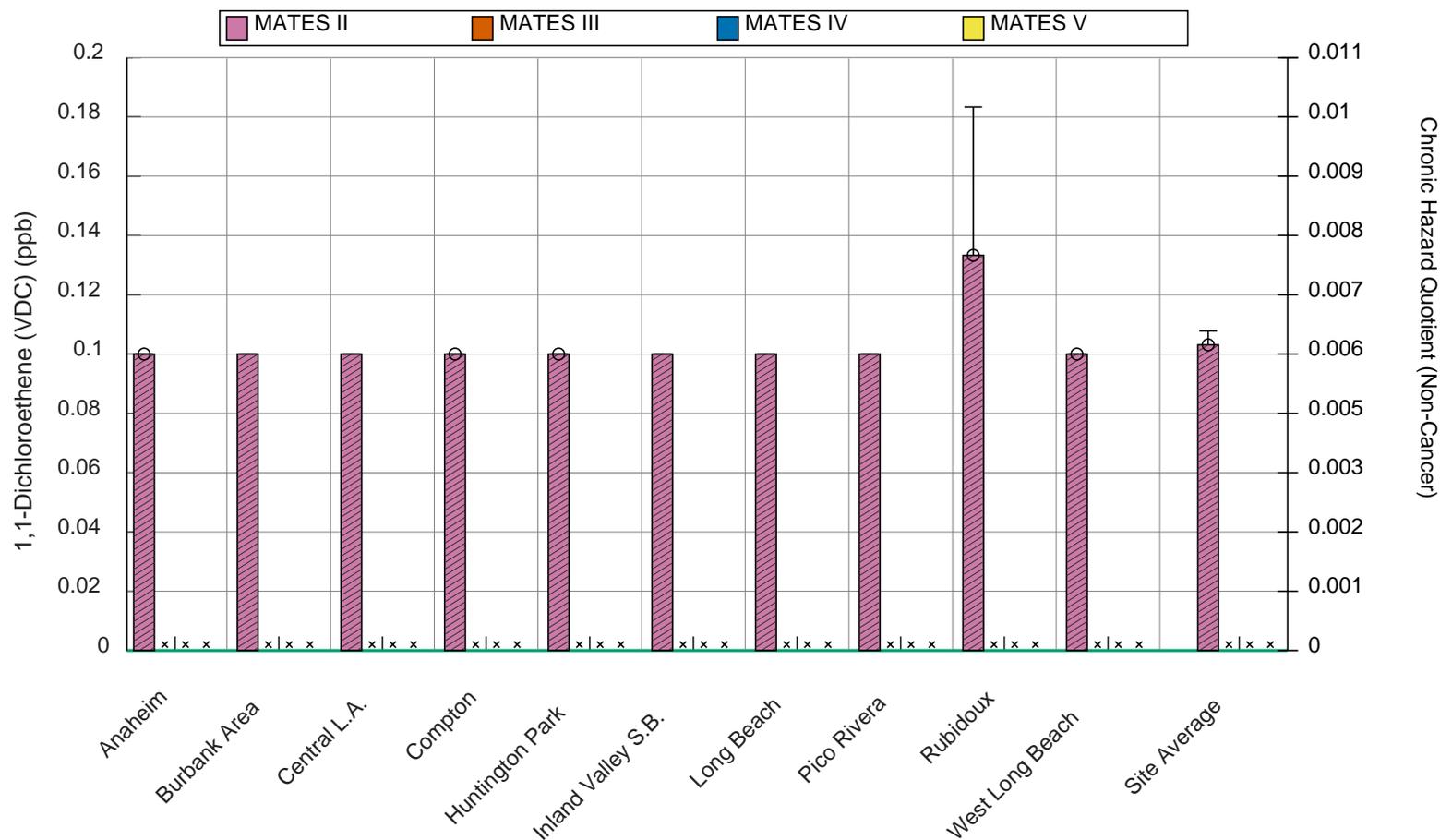
**Figure IV-36.** Geographic distribution of 1,2-Dichloroethane from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

1,1-Dichloroethene (VDC)

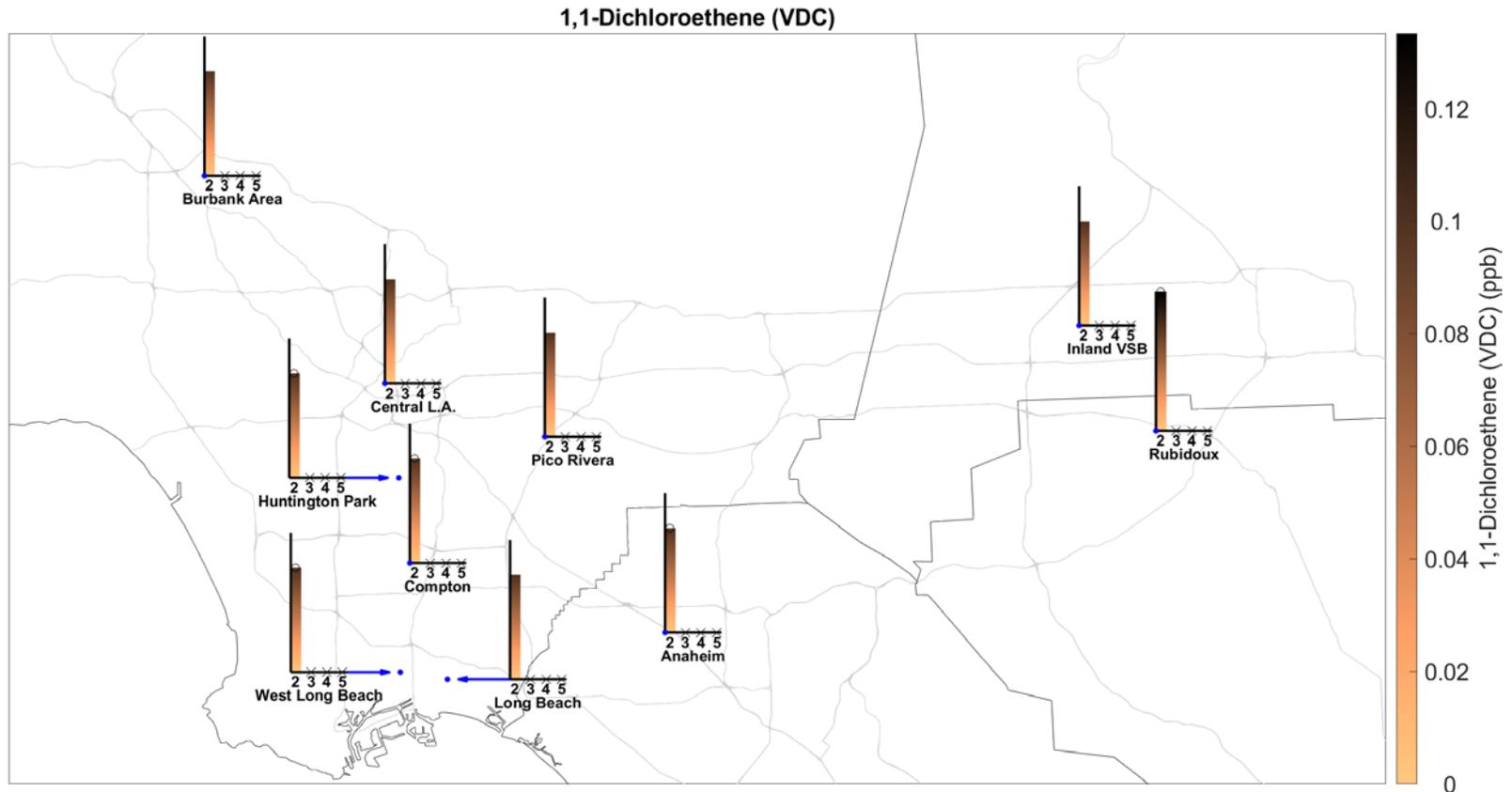
**Table IV-21.** Ambient Concentrations (ppb) of 1,1-Dichloroethene (VDC) from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0, 0.1 <sup>a</sup>	0, 0.133 <sup>a</sup>	0, 0.1 <sup>a</sup>							
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>								
95% CI UB	0.1 <sup>a</sup>	0.183 <sup>a</sup>	0.1 <sup>a</sup>							
N	26 <sup>a</sup>	28 <sup>a</sup>	21 <sup>a</sup>	30 <sup>a</sup>	23 <sup>a</sup>	30 <sup>a</sup>	29 <sup>a</sup>	29 <sup>a</sup>	24 <sup>a</sup>	17 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>								
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>								
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-37.** Annual Average Concentrations of 1,1-Dichloroethene (VDC) in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



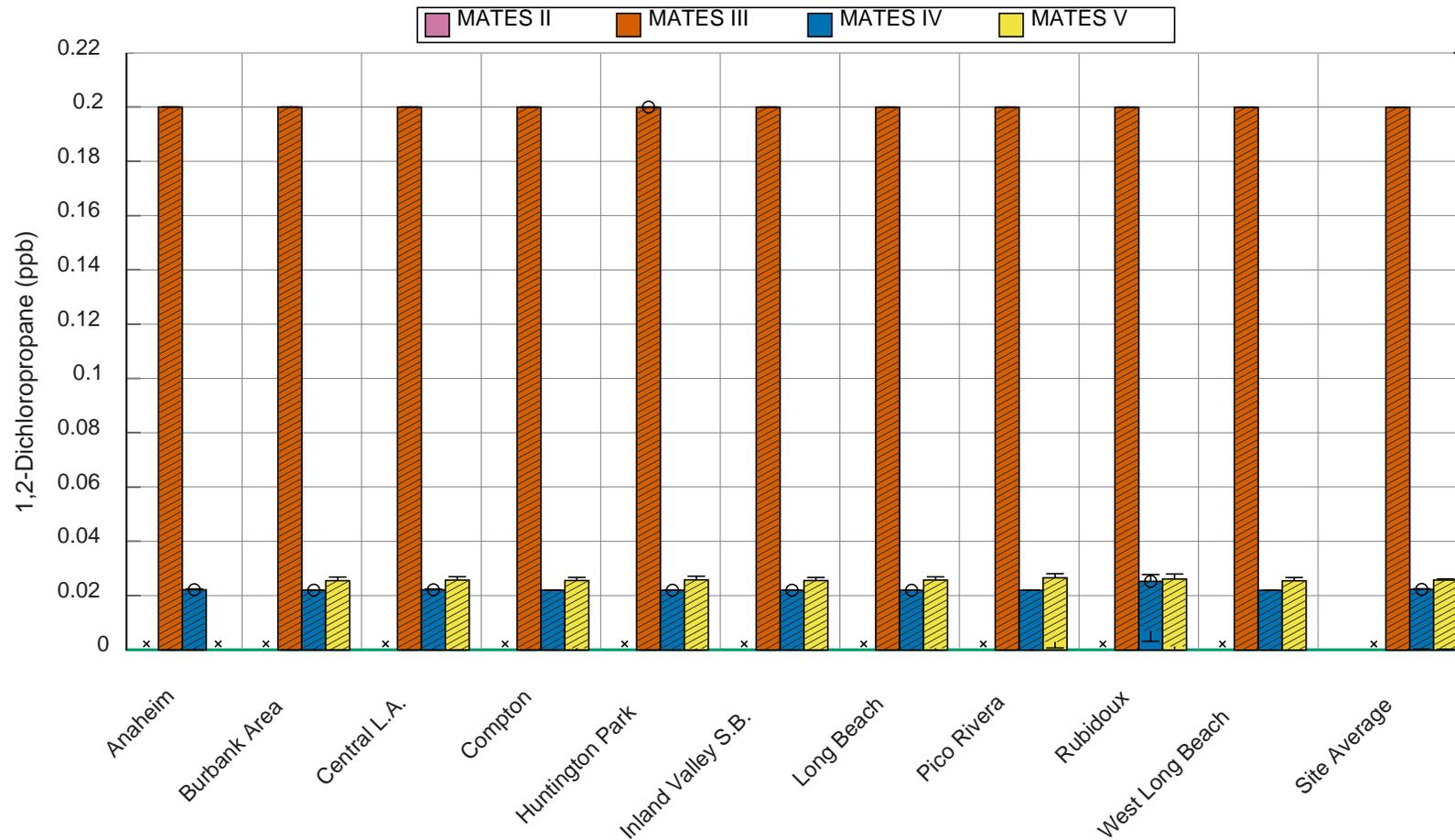
**Figure IV-38.** Geographic distribution of 1,1-Dichloroethene (VDC) from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

1,2-Dichloropropane

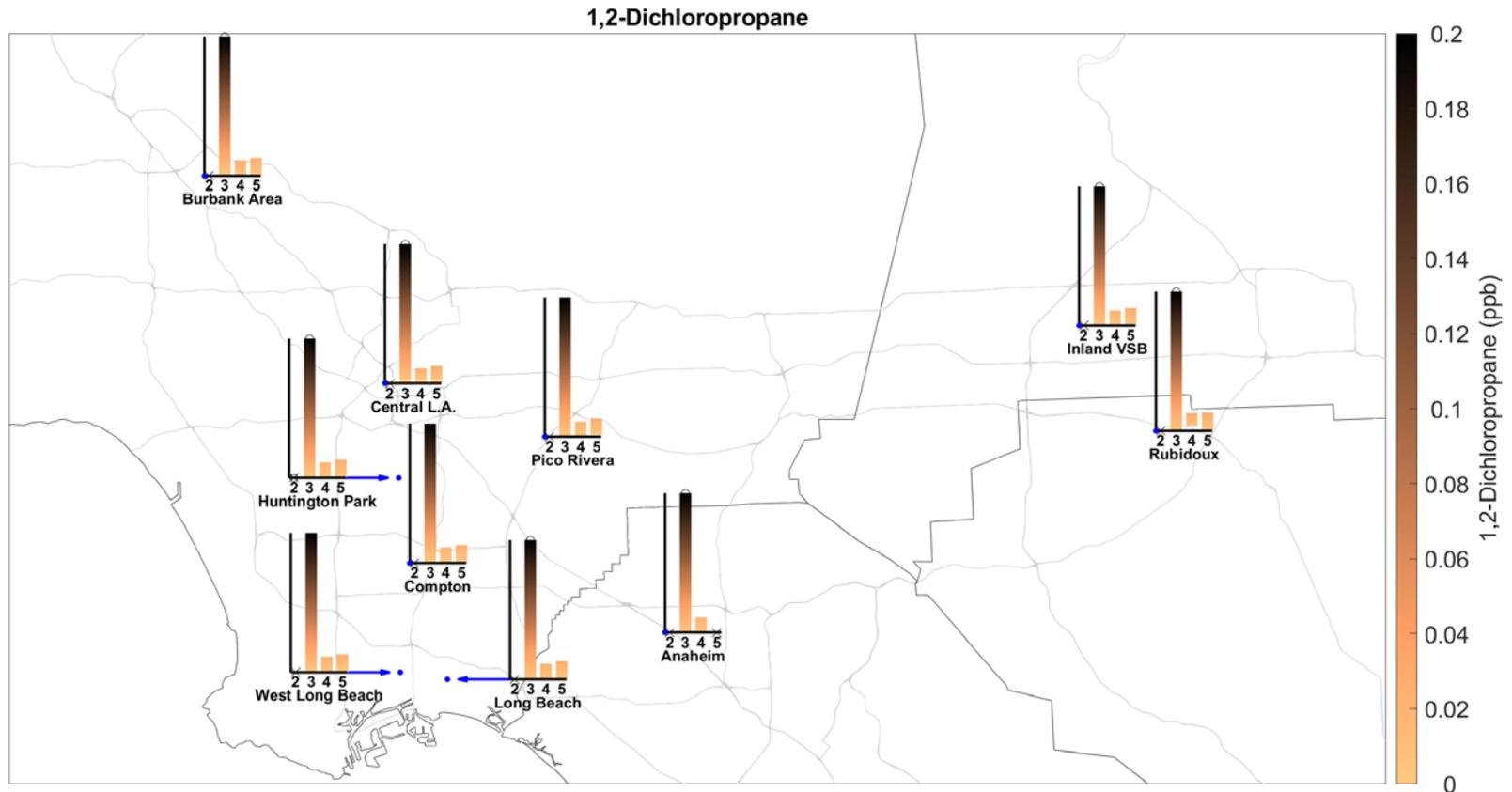
**Table IV-22.** Ambient Concentrations (ppb) of 1,2-Dichloropropane from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>
N	233 <sup>a</sup>	241 <sup>a</sup>	237 <sup>a</sup>	232 <sup>a</sup>	100 <sup>a</sup>	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	235 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
MATES IV										
Average	0.000588, 0.0222 <sup>a</sup>	0, 0.022 <sup>a</sup>	0, 0.022 <sup>a</sup>	0, 0.022 <sup>a</sup>	0, 0.022 <sup>a</sup>	0, 0.022 <sup>a</sup>	0.000566, 0.0222 <sup>a</sup>	0, 0.022 <sup>a</sup>	0.00712, 0.0253 <sup>a</sup>	0, 0.022 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0.00317 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.0225 <sup>a</sup>	0.022 <sup>a</sup>	0.022 <sup>a</sup>	0.022 <sup>a</sup>	0.022 <sup>a</sup>	0.022 <sup>a</sup>	0.0225 <sup>a</sup>	0.022 <sup>a</sup>	0.0278 <sup>a</sup>	0.022 <sup>a</sup>
N	51 <sup>a</sup>	55 <sup>a</sup>	57 <sup>a</sup>	53 <sup>a</sup>	53 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52 <sup>a</sup>	57 <sup>a</sup>
% < MDL	98 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	98.1 <sup>a</sup>	100 <sup>a</sup>	82.7 <sup>a</sup>	100 <sup>a</sup>
Max	0.03 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.03 <sup>a</sup>	< MDL <sup>a</sup>	0.06 <sup>a</sup>	< MDL <sup>a</sup>
MATES V										
Average		0, 0.0255 <sup>a</sup>	0.000656, 0.0256 <sup>a</sup>	0, 0.0256 <sup>a</sup>	0.0005, 0.0258 <sup>a</sup>	0.000678, 0.0258 <sup>a</sup>	0, 0.0257 <sup>a</sup>	0.00302, 0.0266 <sup>a</sup>	0.00133, 0.0262 <sup>a</sup>	0, 0.0255 <sup>a</sup>
95% CI LB		0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0.000755 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB		0.0268 <sup>a</sup>	0.0267 <sup>a</sup>	0.0267 <sup>a</sup>	0.0272 <sup>a</sup>	0.0269 <sup>a</sup>	0.027 <sup>a</sup>	0.0281 <sup>a</sup>	0.028 <sup>a</sup>	0.0267 <sup>a</sup>
N	0	60 <sup>a</sup>	61 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	59 <sup>a</sup>	56 <sup>a</sup>	53 <sup>a</sup>	60 <sup>a</sup>	58 <sup>a</sup>
% < MDL		100 <sup>a</sup>	96.7 <sup>a</sup>	100 <sup>a</sup>	98.3 <sup>a</sup>	96.6 <sup>a</sup>	100 <sup>a</sup>	88.7 <sup>a</sup>	96.7 <sup>a</sup>	100 <sup>a</sup>
Max		< MDL <sup>a</sup>	0.02 <sup>a</sup>	< MDL <sup>a</sup>	0.03 <sup>a</sup>	0.02 <sup>a</sup>	< MDL <sup>a</sup>	0.05 <sup>a</sup>	0.06 <sup>a</sup>	< MDL <sup>a</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-39.** Annual Average Concentrations of 1,2-Dichloropropane in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

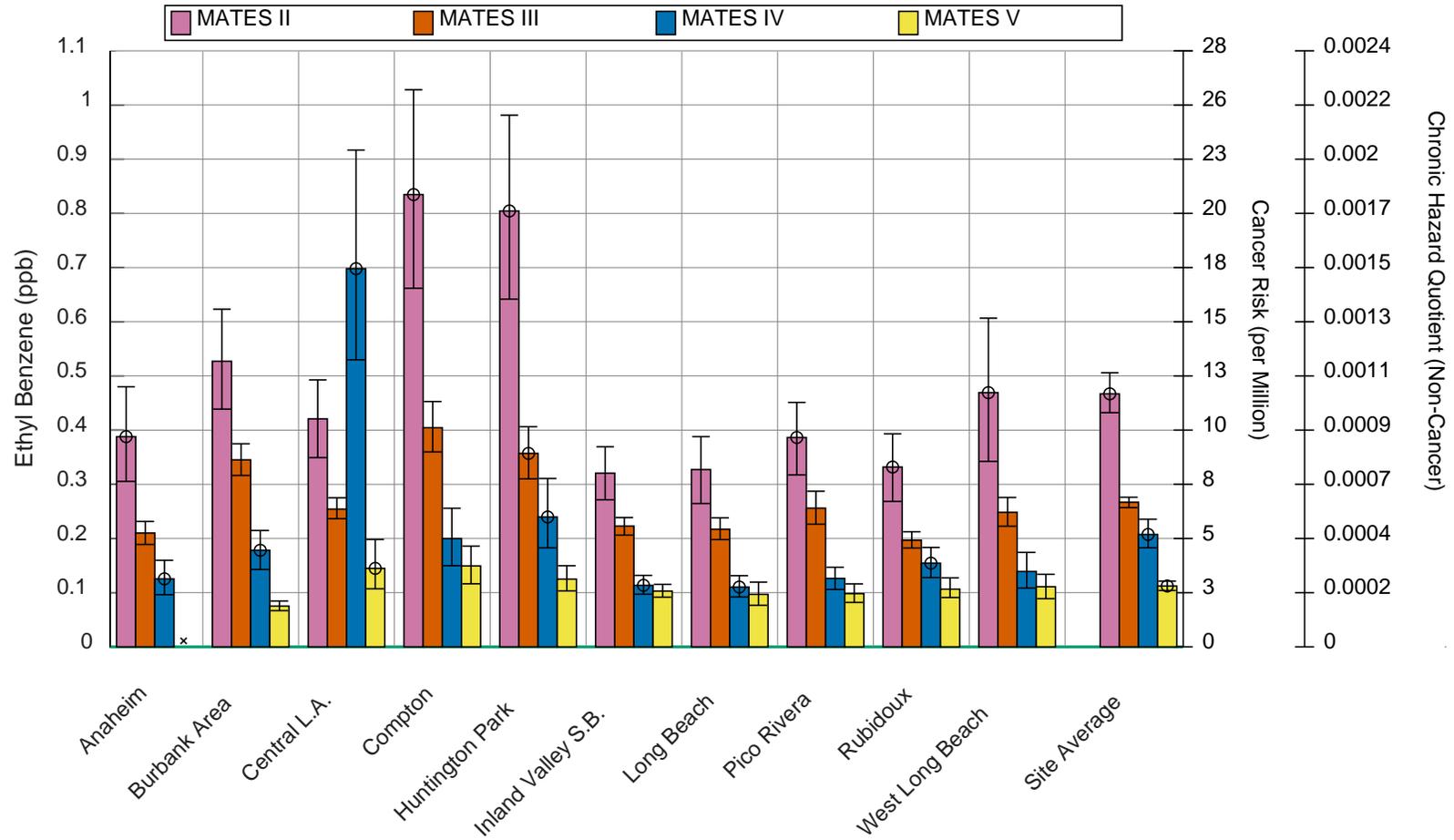


**Figure IV-40.** Geographic distribution of 1,2-Dichloropropane from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

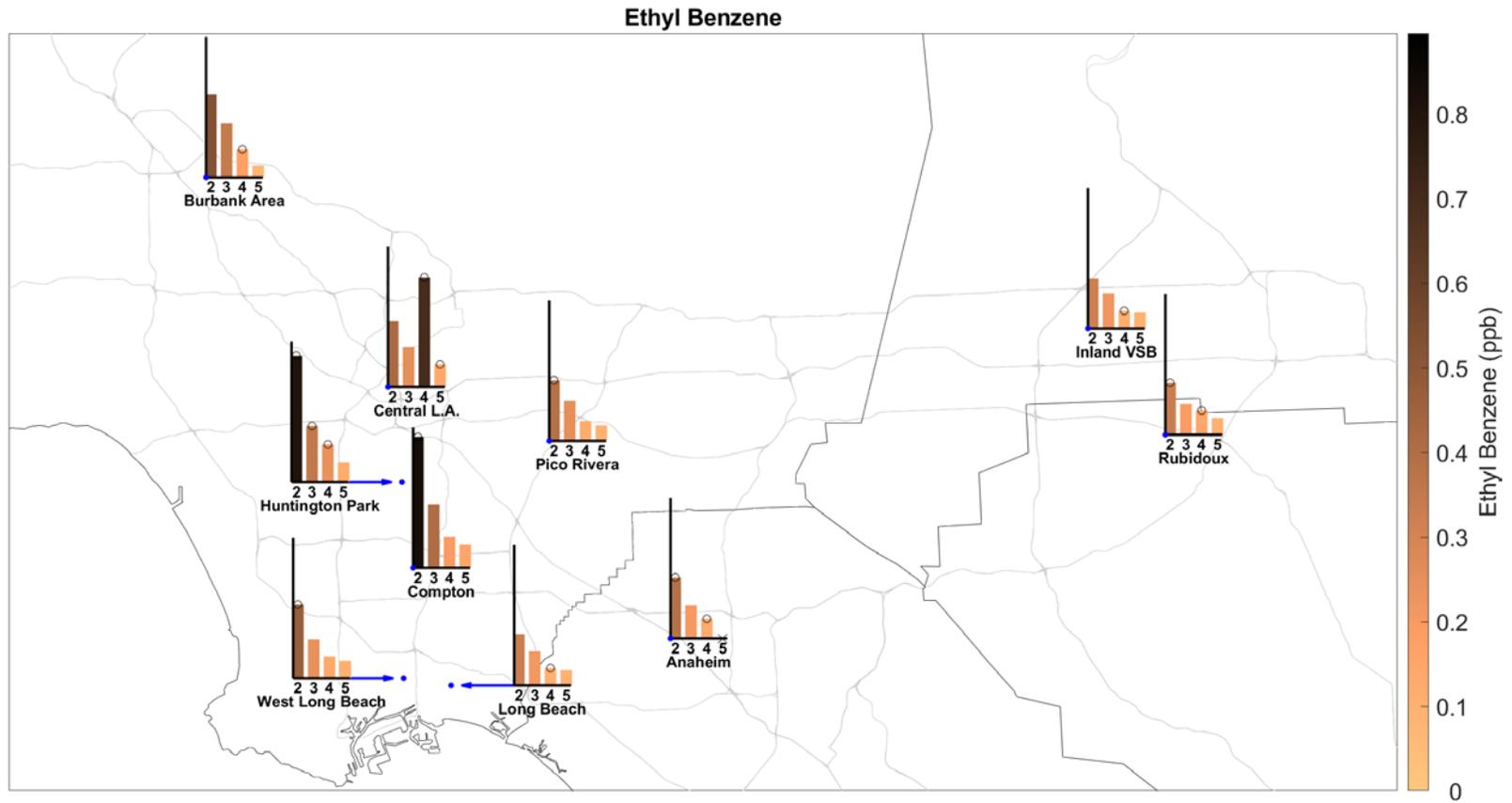
## Ethyl Benzene

**Table IV-23.** Ambient Concentrations (ppb) of Ethyl Benzene from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.388	0.527	0.835	0.321	0.804	0.327	0.421	0.386	0.332	0.469
95% CI LB	0.305	0.439	0.662	0.271	0.642	0.264	0.349	0.317	0.268	0.342
95% CI UB	0.48	0.623	1.03	0.369	0.981	0.388	0.493	0.451	0.393	0.607
N	51	57	42	59	45	58	56	54	44	35
% < MDL	47.1	38.6	28.6	52.5	26.7	46.6	42.9	44.4	47.7	40
Max	1.5	1.6	3.1	0.6	2.7	1.2	1.3	1.1	0.8	1.7
MATES III										
Average	0.21	0.345	0.405	0.223	0.357	0.217	0.254	0.256	0.197	0.248
95% CI LB	0.189	0.316	0.36	0.206	0.31	0.198	0.237	0.226	0.182	0.223
95% CI UB	0.231	0.375	0.453	0.239	0.406	0.238	0.275	0.287	0.212	0.276
N	233	241	237	232	100	238	238	121	234	235
% < MDL	30.5	3.3	6.8	18.5	0	23.1	6.7	9.1	26.1	23.4
Max	1.25	1.16	1.97	0.69	1.22	0.85	0.85	0.92	0.8	1.13
MATES IV										
Average	0.125	0.178	0.2	0.114	0.24	0.11	0.698	0.126	0.154	0.139
95% CI LB	0.0963	0.143	0.15	0.0972	0.183	0.092	0.53	0.106	0.128	0.109
95% CI UB	0.16	0.215	0.256	0.132	0.311	0.131	0.917	0.147	0.183	0.174
N	51	55	57	53	53	54	53	57	52	57
% < MDL	17.6	3.6	15.8	9.4	1.9	9.3	1.9	12.3	1.9	28.1
Max	0.63	0.58	0.81	0.42	1.43	0.32	4.75	0.35	0.43	0.73
MATES V										
Average		0.0753	0.149	0.103	0.125	0.0969	0.145	0.0982	0.107	0.111
95% CI LB		0.0668	0.116	0.0917	0.103	0.0767	0.107	0.082	0.0911	0.0889
95% CI UB		0.0846	0.186	0.115	0.15	0.119	0.198	0.116	0.127	0.134
N	0	57	58	58	57	55	54	50	57	54
% < MDL		5.3	0	1.7	0	0	1.9	0	1.8	0
Max		0.2	0.57	0.27	0.38	0.38	1.29	0.3	0.51	0.43



**Figure IV-41.** Annual Average Concentrations of Ethyl Benzene in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

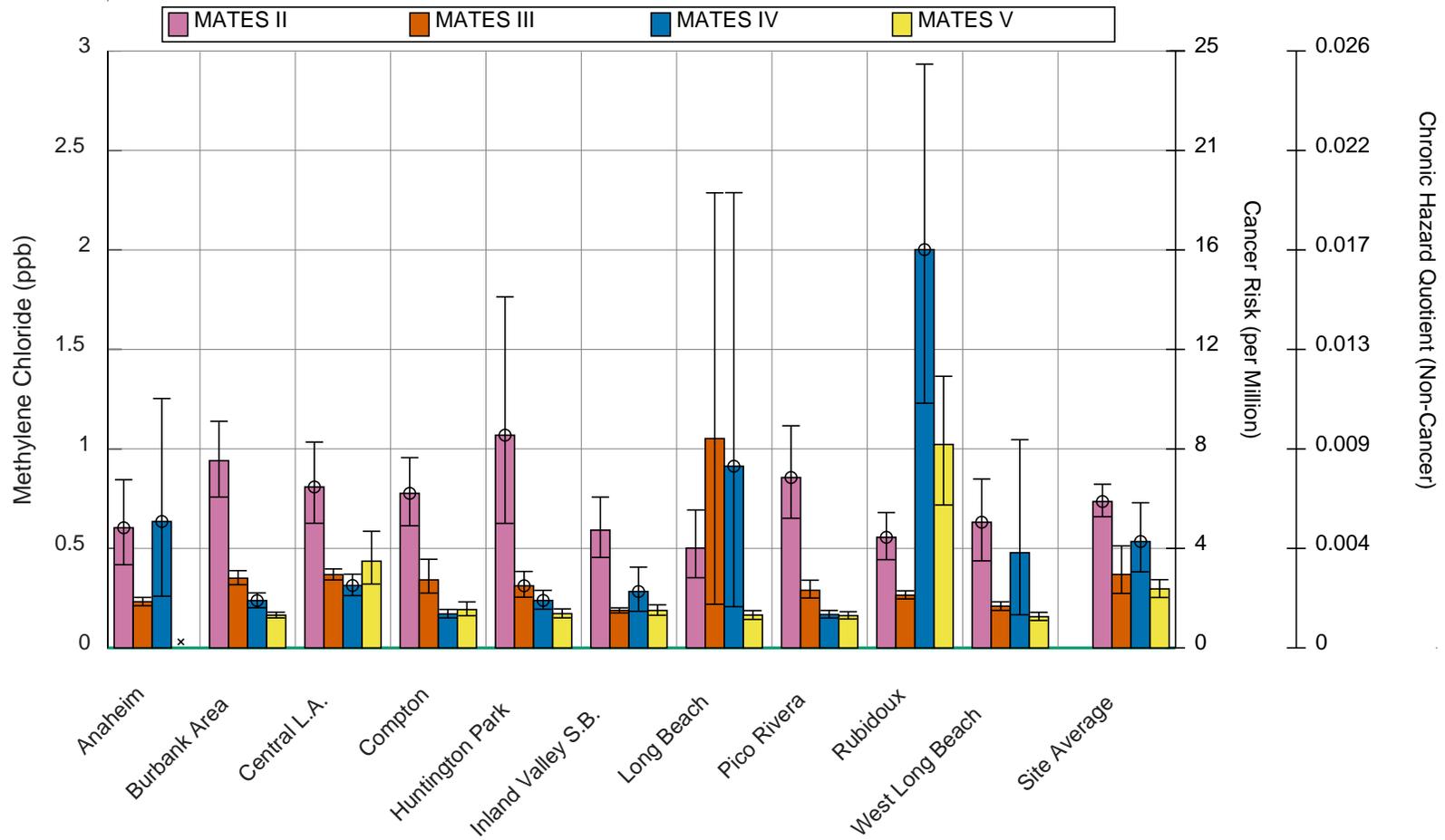


**Figure IV-42.** Geographic distribution of Ethyl Benzene from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

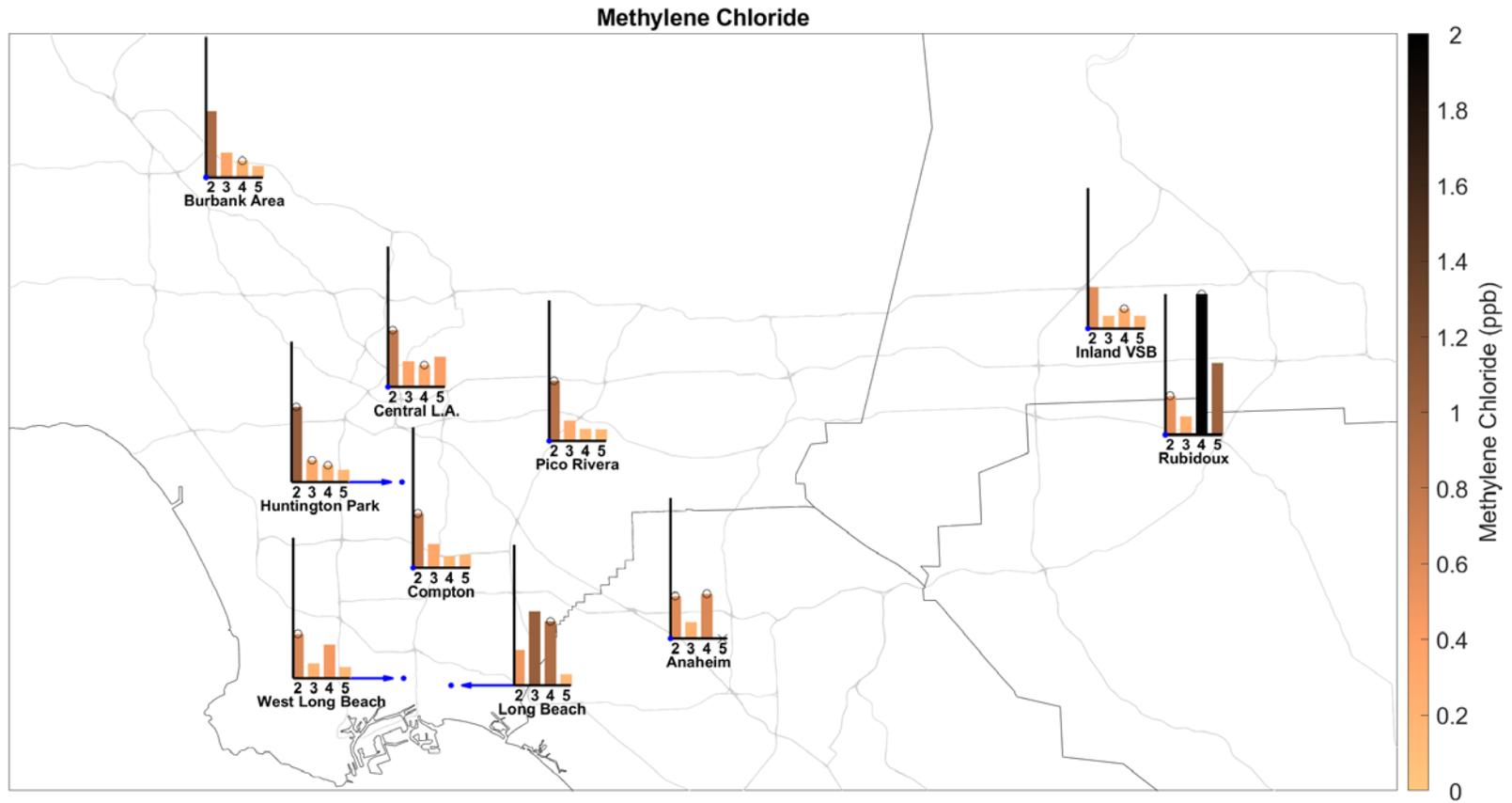
## Methylene Chloride

**Table IV-24.** Ambient Concentrations (ppb) of Methylene Chloride from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.604	0.941	0.777	0.592	1.07	0.501	0.809	0.856	0.556	0.631
95% CI LB	0.418	0.758	0.614	0.455	0.625	0.353	0.626	0.652	0.443	0.437
95% CI UB	0.845	1.14	0.956	0.758	1.76	0.693	1.03	1.12	0.68	0.849
N	51	57	42	59	45	57	56	54	44	35
% < MDL	47.1	24.6	35.7	42.4	37.8	49.1	32.1	27.8	38.6	40
Max	5	3.3	3	3.6	13	4.6	5.2	5.8	2.1	2.7
MATES III										
Average	0.232	0.35	0.342	0.189	0.312	1.05	0.368	0.29	0.265	0.21
95% CI LB	0.212	0.317	0.276	0.176	0.255	0.219	0.341	0.251	0.246	0.188
95% CI UB	0.254	0.388	0.445	0.201	0.384	2.29	0.397	0.34	0.287	0.232
N	233	241	237	232	100	238	238	121	234	235
% < MDL	14.6	3.3	5.1	20.3	4	21	1.3	5	8.1	33.2
Max	0.99	2.81	10.3	0.59	2.97	110	1.37	2.47	0.91	1.42
MATES IV										
Average	0.635	0.238	0.171	0.283	0.238	0.913	0.313	0.168	2	0.478
95% CI LB	0.26	0.202	0.15	0.184	0.195	0.207	0.263	0.15	1.23	0.167
95% CI UB	1.25	0.276	0.193	0.406	0.289	2.29	0.371	0.188	2.93	1.05
N	51	55	57	53	53	54	53	57	52	57
% < MDL	0	0	0	1.9	1.9	1.9	3.8	0	0	7
Max	13.8	0.86	0.44	2.56	1.05	36.8	1.16	0.45	17.1	13.6
MATES V										
Average		0.164	0.193	0.188	0.172	0.165	0.436	0.162	1.02	0.157
95% CI LB		0.151	0.162	0.164	0.151	0.143	0.321	0.145	0.718	0.138
95% CI UB		0.179	0.231	0.217	0.196	0.187	0.586	0.182	1.37	0.179
N	0	59	60	60	59	58	54	52	59	57
% < MDL		0	0	0	0	0	0	0	0	0
Max		0.33	0.97	0.67	0.47	0.43	2.24	0.41	5.92	0.39



**Figure IV-43.** Annual Average Concentrations of Methylene Chloride in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



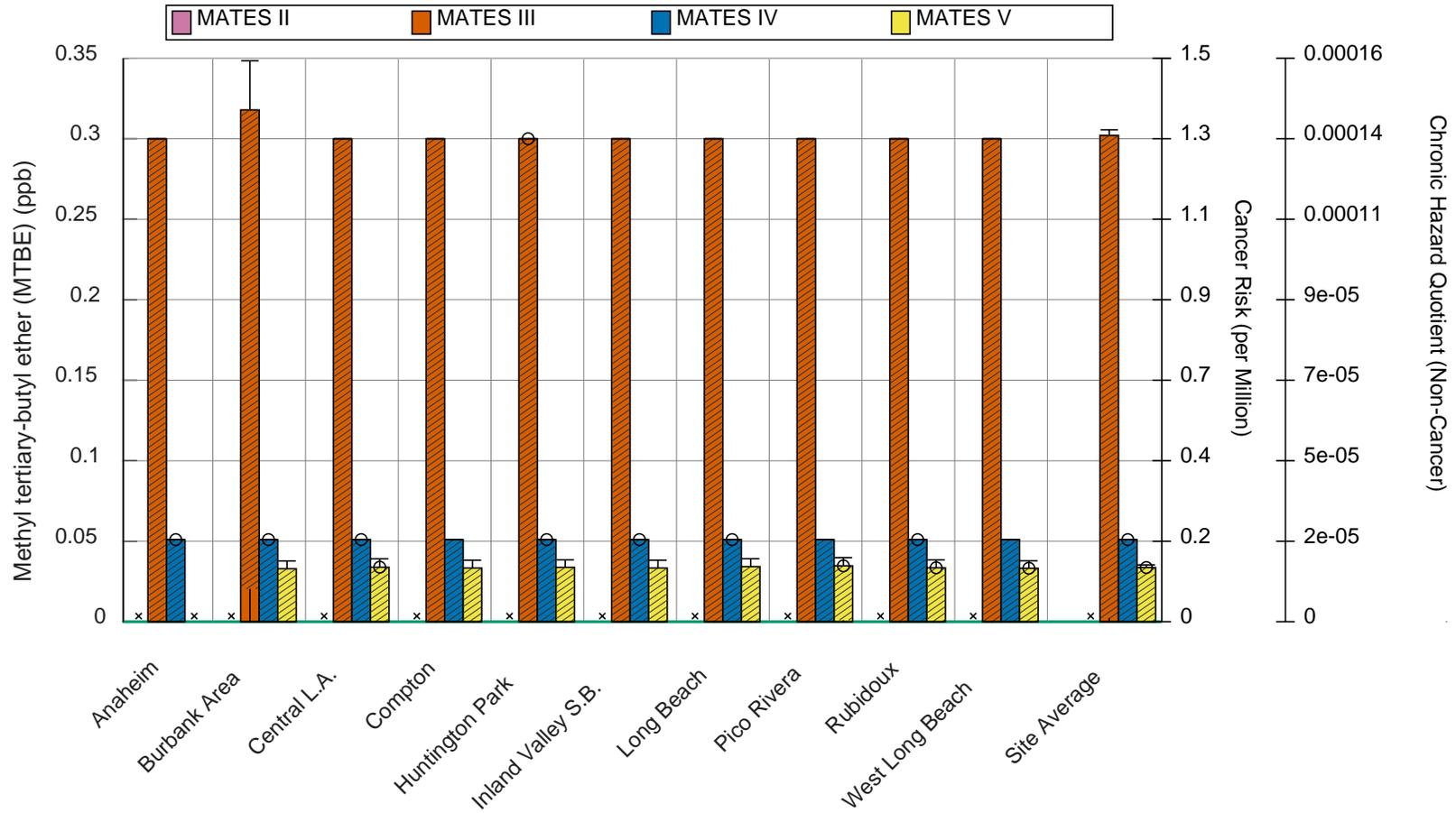
**Figure IV-44.** Geographic distribution of Methylene Chloride from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Methyl tertiary-butyl ether (MTBE)

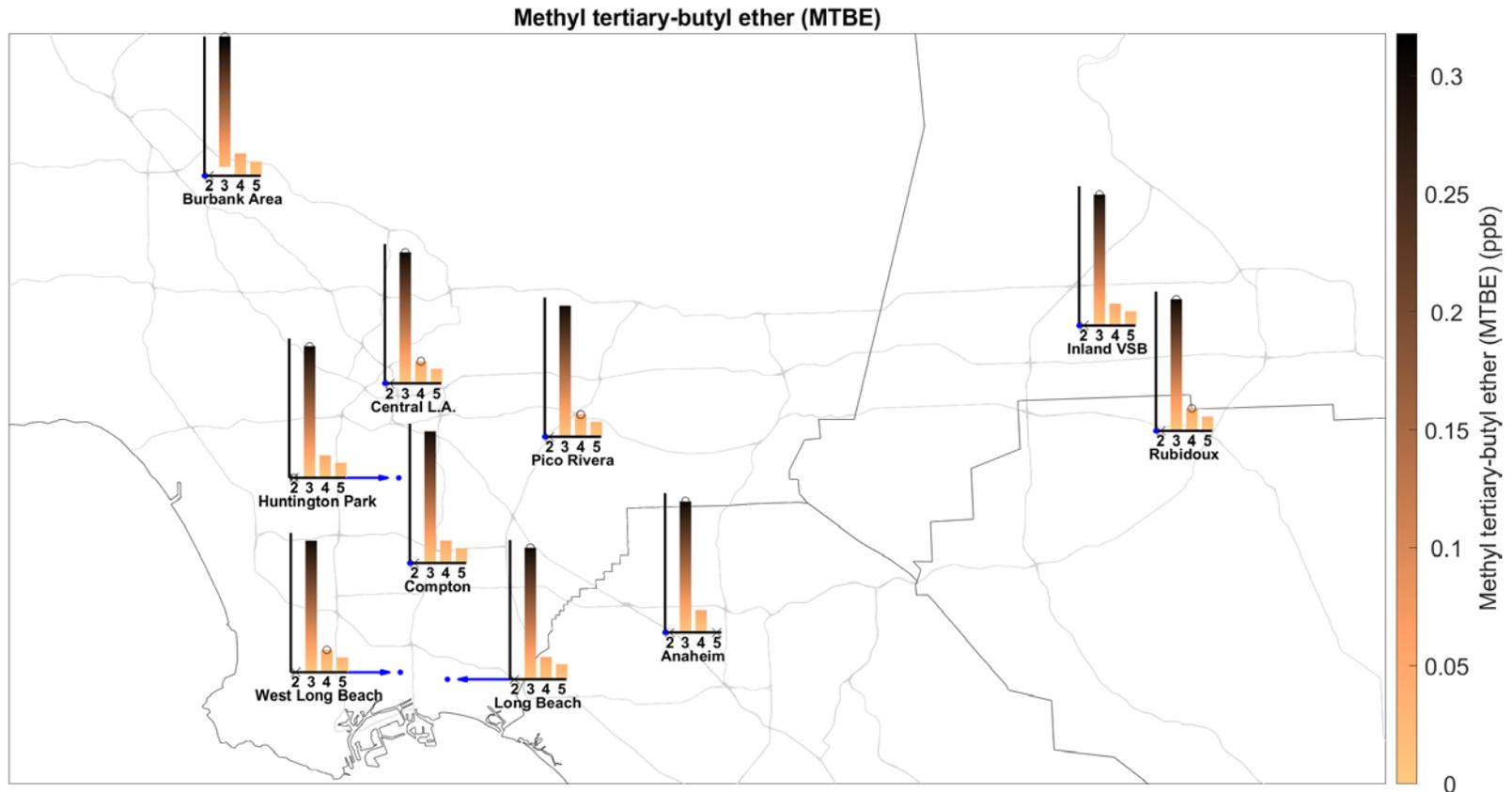
**Table IV-25.** Ambient Concentrations (ppb) of Methyl tertiary-butyl ether (MTBE) from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	0, 0.3 <sup>a</sup>	0.0204, 0.318 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>	0, 0.3 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.3 <sup>a</sup>	0.348 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>	0.3 <sup>a</sup>
N	233 <sup>a</sup>	241 <sup>a</sup>	237 <sup>a</sup>	232 <sup>a</sup>	100 <sup>a</sup>	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	235 <sup>a</sup>
% < MDL	100 <sup>a</sup>	99.2 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	3.35 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
MATES IV										
Average	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>
N	51 <sup>a</sup>	55 <sup>a</sup>	57 <sup>a</sup>	53 <sup>a</sup>	53 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52 <sup>a</sup>	57 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
MATES V										
Average		0, 0.0329 <sup>a</sup>	0, 0.0334 <sup>a</sup>	0, 0.0334 <sup>a</sup>	0, 0.0338 <sup>a</sup>	0, 0.0342 <sup>a</sup>	0, 0.0339 <sup>a</sup>	0.00098, 0.0347 <sup>a</sup>	0.000175, 0.0335 <sup>a</sup>	0.000179, 0.0332 <sup>a</sup>
95% CI LB		0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB		0.0378 <sup>a</sup>	0.0382 <sup>a</sup>	0.0382 <sup>a</sup>	0.0384 <sup>a</sup>	0.0391 <sup>a</sup>	0.0391 <sup>a</sup>	0.0398 <sup>a</sup>	0.0384 <sup>a</sup>	0.0379 <sup>a</sup>
N	0	58 <sup>a</sup>	59 <sup>a</sup>	59 <sup>a</sup>	58 <sup>a</sup>	57 <sup>a</sup>	54 <sup>a</sup>	51 <sup>a</sup>	57 <sup>a</sup>	56 <sup>a</sup>
% < MDL		100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	98 <sup>a</sup>	98.2 <sup>a</sup>	98.2 <sup>a</sup>
Max		< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.05 <sup>a</sup>	0.01 <sup>a</sup>	0.01 <sup>a</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-45.** Annual Average Concentrations of Methyl tertiary-butyl ether (MTBE) in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

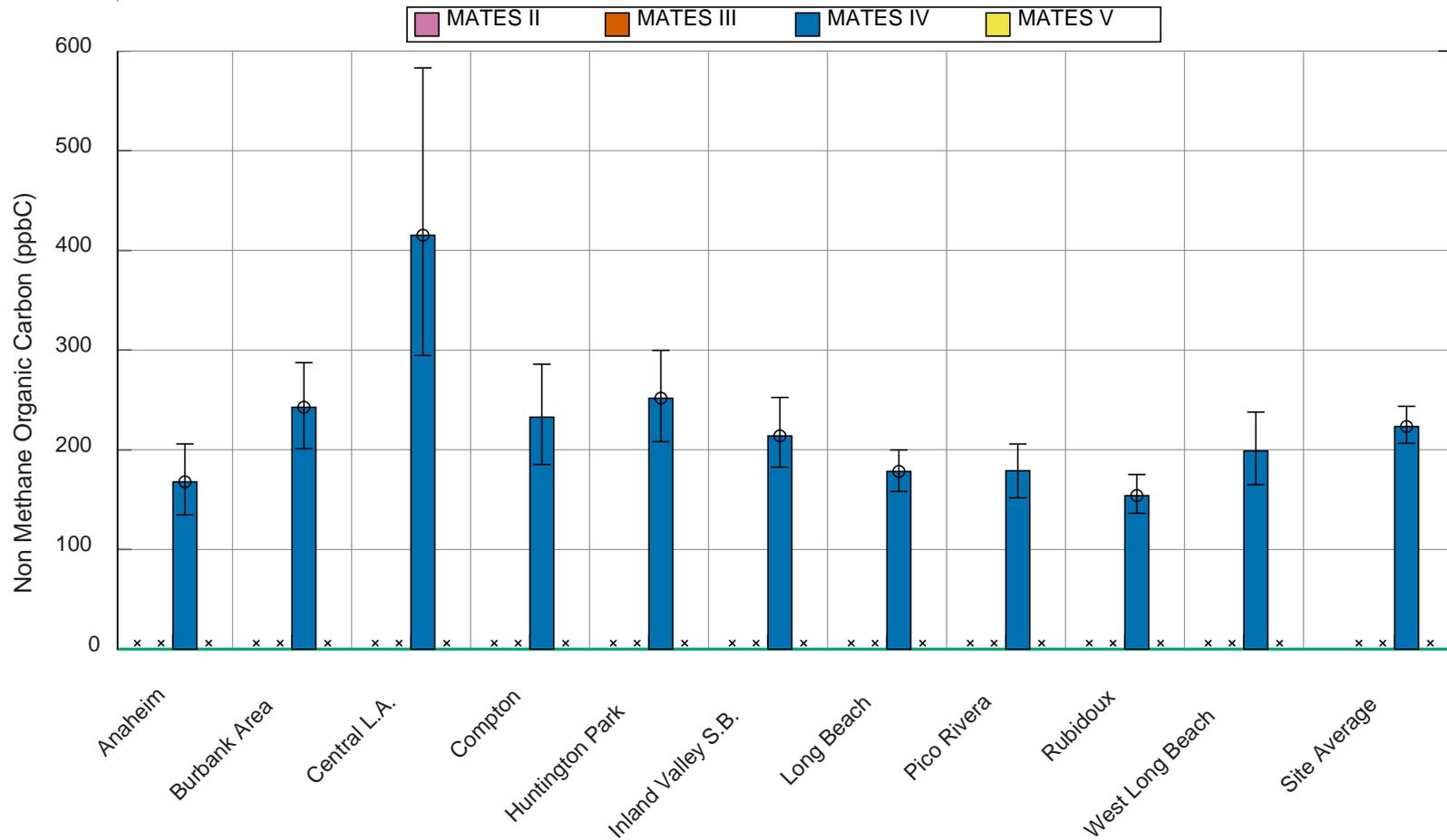


**Figure IV-46.** Geographic distribution of Methyl tertiary-butyl ether (MTBE) from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

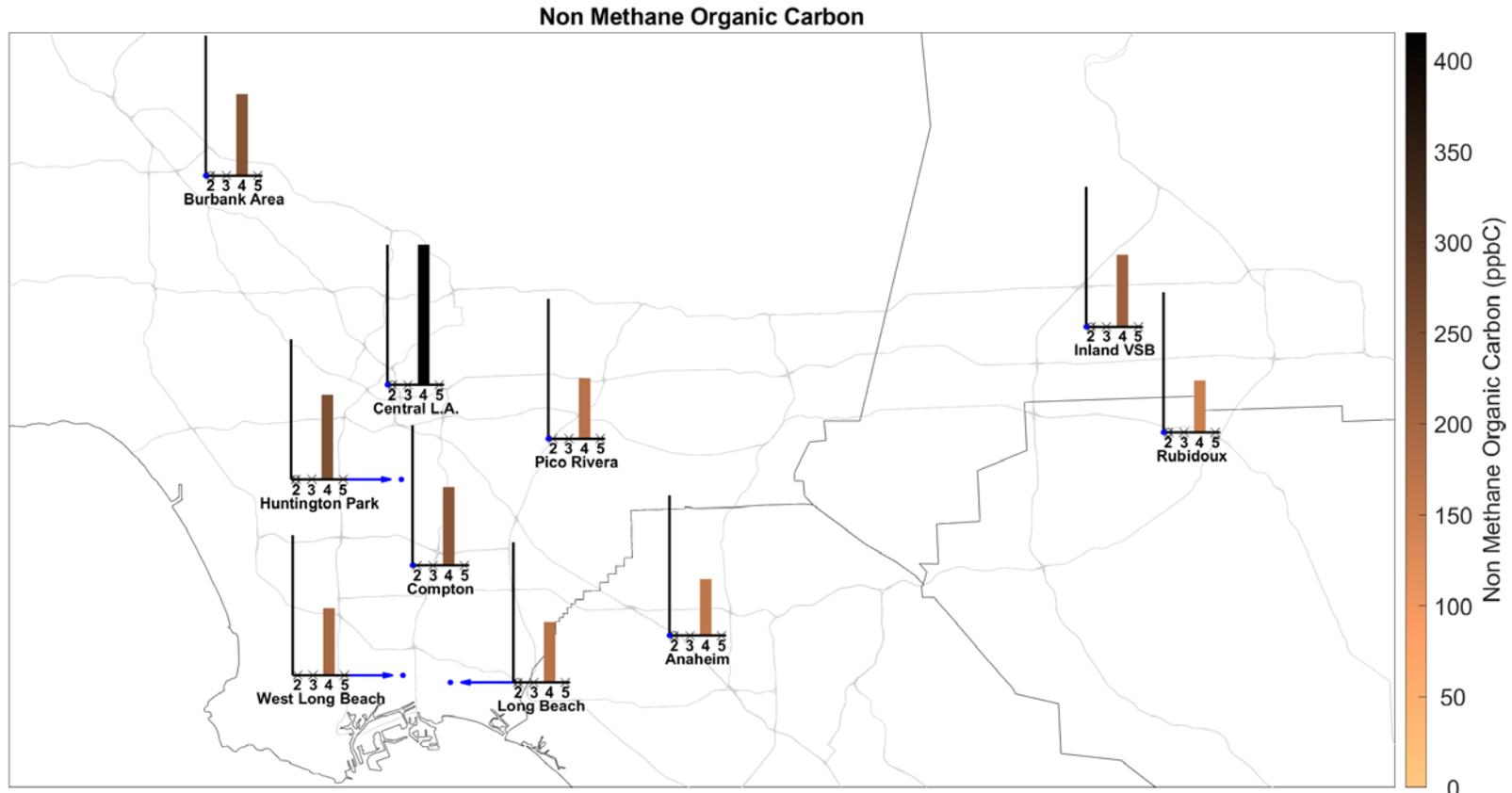
Non Methane Organic Carbon

**Table IV-26.** Ambient Concentrations (ppbC) of Non Methane Organic Carbon from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average	168	243	233	214	252	178	415	179	154	199
95% CI LB	135	201	185	183	208	158	295	152	136	165
95% CI UB	206	287	286	253	300	200	583	206	175	238
N	51	55	57	53	53	54	53	57	52	57
% < MDL	0	0	0	0	1.9	0	1.9	0	0	0
Max	715	733	810	940	836	417	3730	447	361	596
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-47.** Annual Average Concentrations of Non Methane Organic Carbon in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



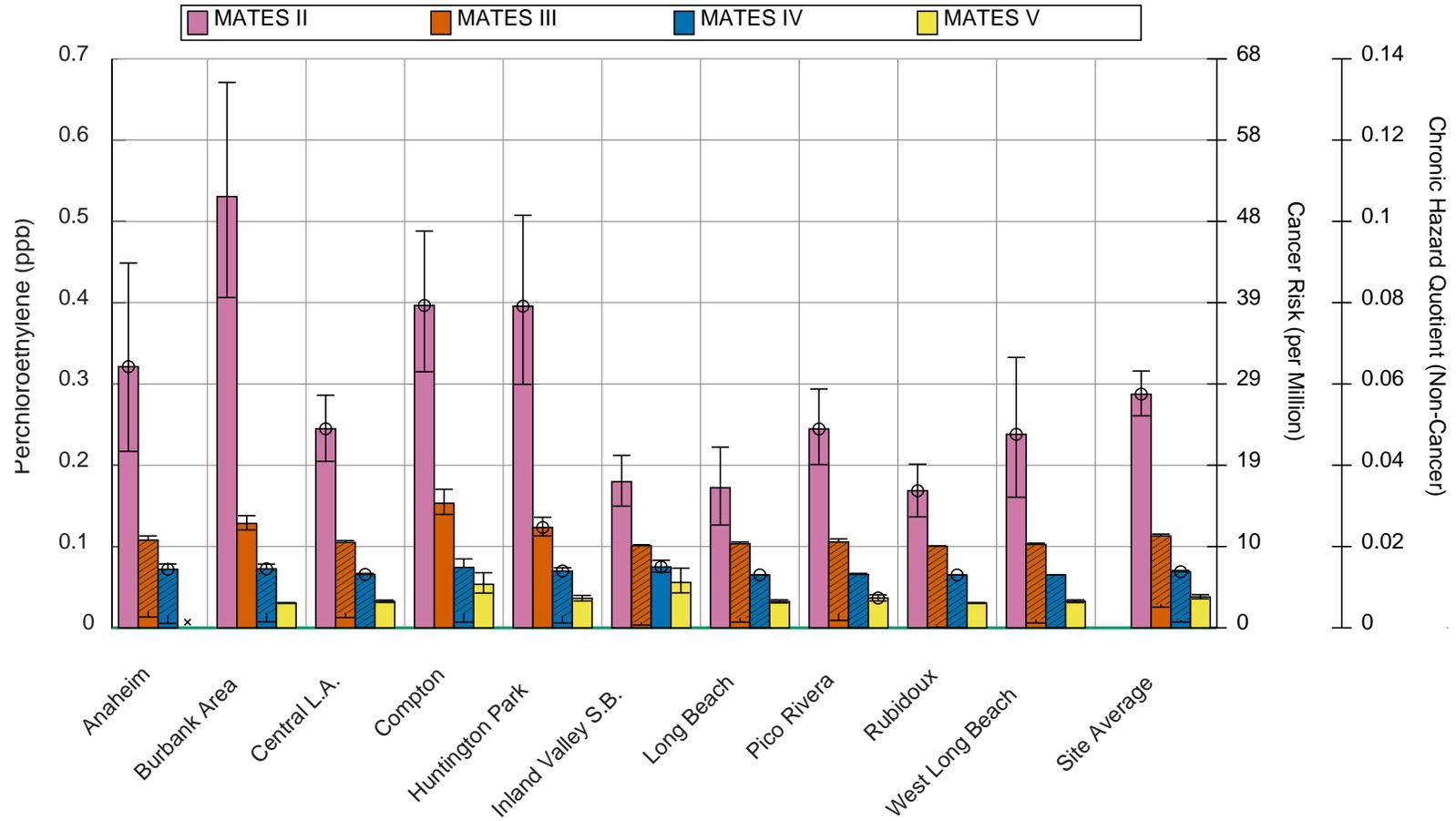
**Figure IV-48.** Geographic distribution of Non Methane Organic Carbon from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Perchloroethylene

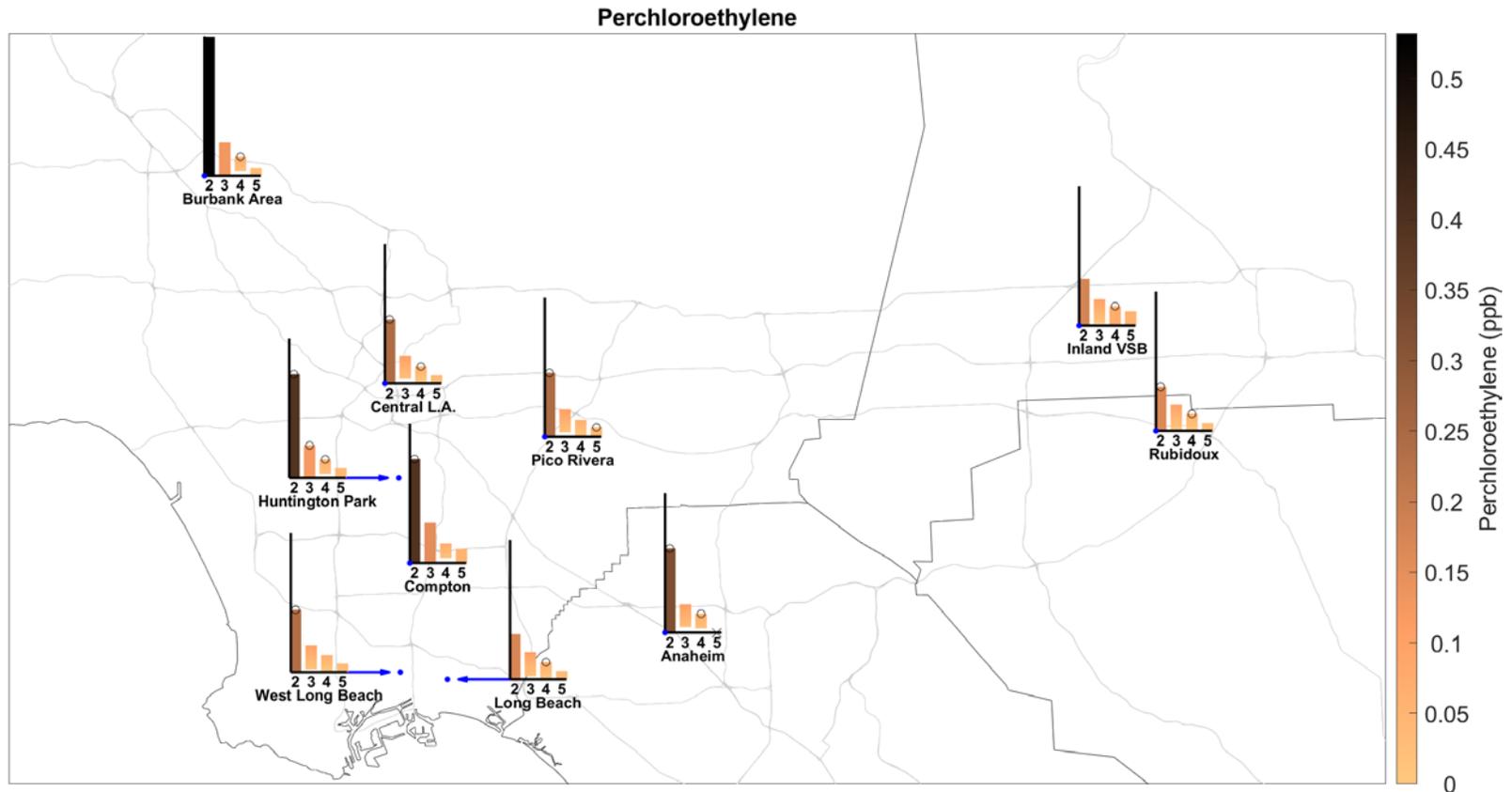
**Table IV-27.** Ambient Concentrations (ppb) of Perchloroethylene from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0.321	0.53	0.397	0.18	0.396	0.172	0.245	0.245	0.169	0.238
95% CI LB	0.217	0.406	0.315	0.15	0.3	0.126	0.205	0.201	0.136	0.161
95% CI UB	0.449	0.671	0.488	0.212	0.507	0.222	0.286	0.294	0.201	0.333
N	49	56	40	59	44	57	55	50	45	33
% < MDL	14.3	5.4	0	8.5	2.3	21.1	7.3	12	11.1	18.2
Max	2.6	2	1.3	0.6	1.9	0.79	0.8	0.9	0.5	1.3
<b>MATES III</b>										
Average	0.0209, 0.108 <sup>a</sup>	0.128	0.153	0.00672, 0.101 <sup>a</sup>	0.123	0.0119, 0.103 <sup>a</sup>	0.0185, 0.105 <sup>a</sup>	0.0172, 0.106 <sup>a</sup>	0.00244, 0.1 <sup>a</sup>	0.0103, 0.103 <sup>a</sup>
95% CI LB	0.0133 <sup>a</sup>	0.12	0.139	0.00336 <sup>a</sup>	0.113	0.00702 <sup>a</sup>	0.0126 <sup>a</sup>	0.00905 <sup>a</sup>	0.00047 <sup>a</sup>	0.00596 <sup>a</sup>
95% CI UB	0.113 <sup>a</sup>	0.138	0.17	0.102 <sup>a</sup>	0.136	0.106 <sup>a</sup>	0.107 <sup>a</sup>	0.109 <sup>a</sup>	0.101 <sup>a</sup>	0.104 <sup>a</sup>
N	233 <sup>a</sup>	241	237	232 <sup>a</sup>	100	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	235 <sup>a</sup>
% < MDL	87.1 <sup>a</sup>	66	60.3	94.4 <sup>a</sup>	73	91.6 <sup>a</sup>	86.6 <sup>a</sup>	88.4 <sup>a</sup>	97.9 <sup>a</sup>	92.3 <sup>a</sup>
Max	0.46 <sup>a</sup>	0.79	1.21	0.17 <sup>a</sup>	0.5	0.22 <sup>a</sup>	0.21 <sup>a</sup>	0.22 <sup>a</sup>	0.15 <sup>a</sup>	0.19 <sup>a</sup>
<b>MATES IV</b>										
Average	0.0159, 0.072 <sup>a</sup>	0.0182, 0.0725 <sup>a</sup>	0.0184, 0.0743 <sup>a</sup>	0.0749	0.0147, 0.0699 <sup>a</sup>	0.0013, 0.0651 <sup>a</sup>	0.00189, 0.0657 <sup>a</sup>	0.00298, 0.0657 <sup>a</sup>	0, 0.065 <sup>a</sup>	0.00123, 0.0651 <sup>a</sup>
95% CI LB	0.00549 <sup>a</sup>	0.00745 <sup>a</sup>	0.00693 <sup>a</sup>	0.0683	0.00585 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.0785 <sup>a</sup>	0.0783 <sup>a</sup>	0.0848 <sup>a</sup>	0.0831	0.0739 <sup>a</sup>	0.0653 <sup>a</sup>	0.067 <sup>a</sup>	0.067 <sup>a</sup>	0.065 <sup>a</sup>	0.0653 <sup>a</sup>
N	51 <sup>a</sup>	55 <sup>a</sup>	57 <sup>a</sup>	53	53 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52 <sup>a</sup>	57 <sup>a</sup>
% < MDL	86.3 <sup>a</sup>	83.6 <sup>a</sup>	86 <sup>a</sup>	79.2	84.9 <sup>a</sup>	98.1 <sup>a</sup>	98.1 <sup>a</sup>	96.5 <sup>a</sup>	100 <sup>a</sup>	98.2 <sup>a</sup>
Max	0.17 <sup>a</sup>	0.15 <sup>a</sup>	0.26 <sup>a</sup>	0.23	0.12 <sup>a</sup>	0.07 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	< MDL <sup>a</sup>	0.07 <sup>a</sup>
<b>MATES V</b>										
Average		0.0305	0.0536	0.0558	0.0364	0.0324	0.0325	0.0367	0.0305	0.0326
95% CI LB		0.03	0.0427	0.043	0.0331	0.0307	0.0312	0.0331	0.03	0.0311
95% CI UB		0.0312	0.0678	0.0734	0.0398	0.0345	0.0342	0.0406	0.0312	0.0344
N	0	60	59	60	58	58	54	51	58	57
% < MDL		73.3	33.9	25	36.2	70.7	55.6	49	69	64.9
Max		0.04	0.34	0.46	0.09	0.07	0.05	0.07	0.04	0.06

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-49.** Annual Average Concentrations of Perchloroethylene in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



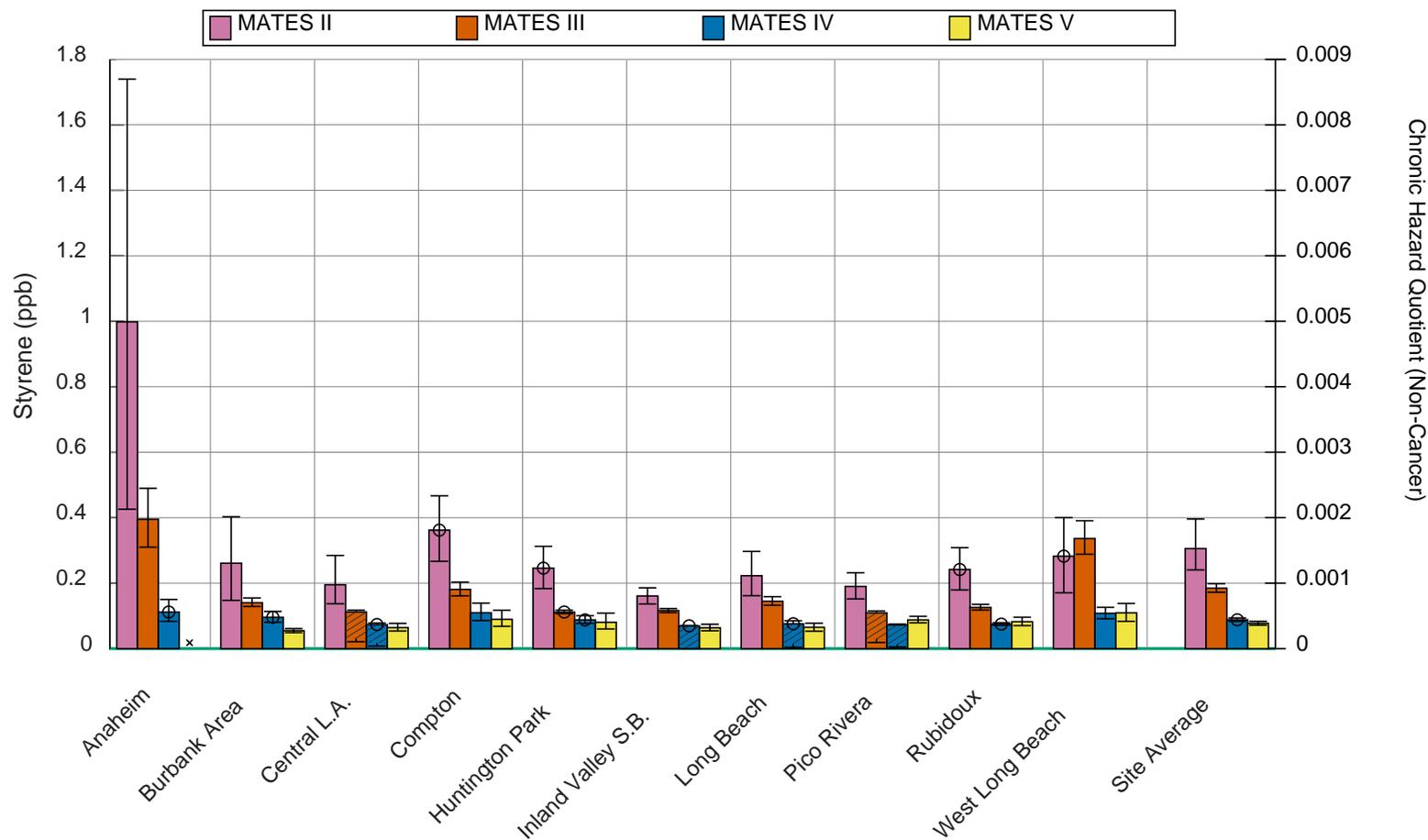
**Figure IV-50.** Geographic distribution of Perchloroethylene from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Styrene

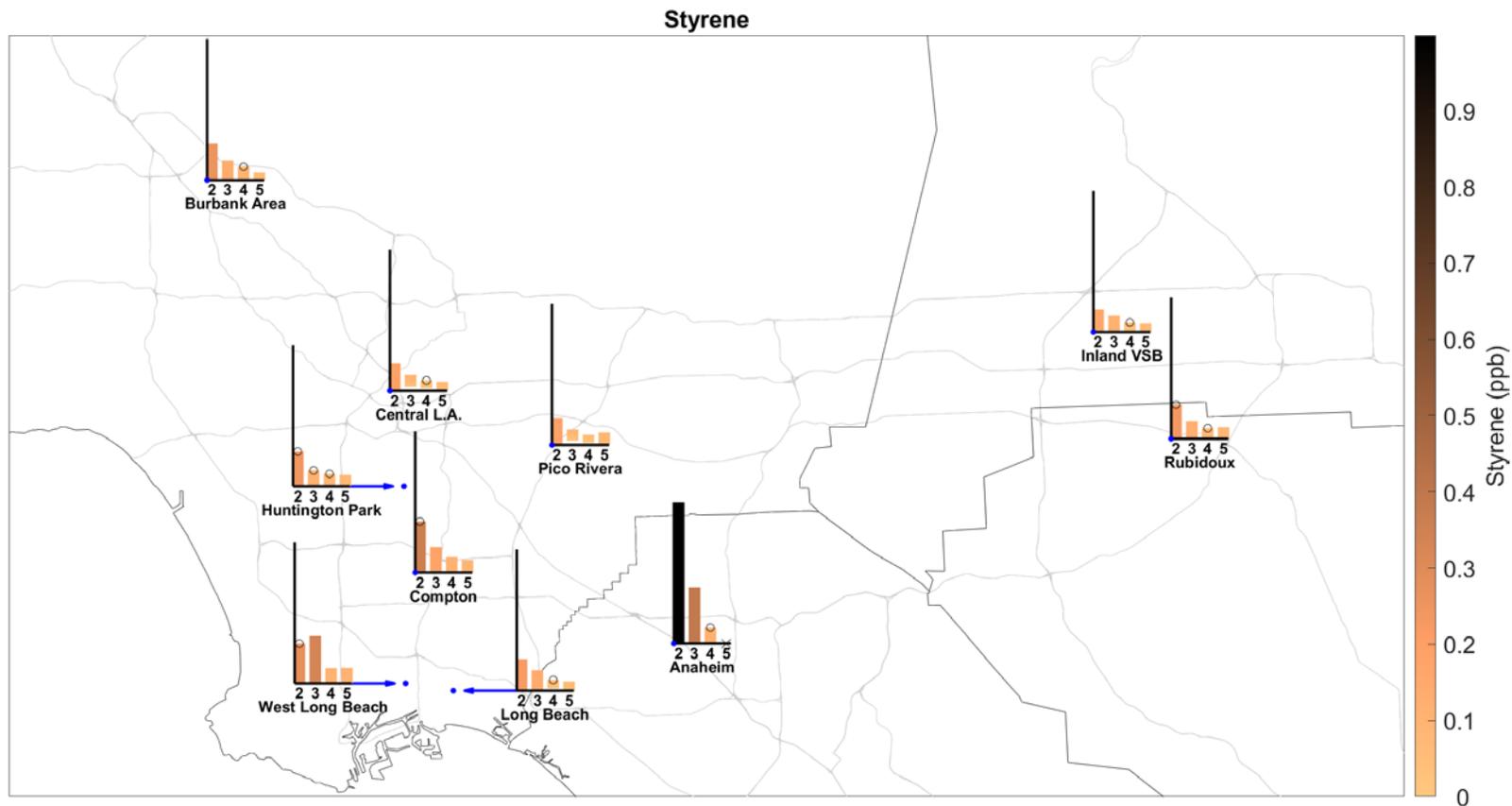
**Table IV-28.** Ambient Concentrations (ppb) of Styrene from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0.998	0.261	0.362	0.161	0.246	0.223	0.195	0.19	0.242	0.282
95% CI LB	0.426	0.147	0.267	0.137	0.183	0.162	0.137	0.152	0.179	0.171
95% CI UB	1.74	0.403	0.467	0.186	0.313	0.297	0.285	0.232	0.308	0.4
N	29	35	21	38	24	37	35	34	24	17
% < MDL	34.5	42.9	0	39.5	8.3	35.1	40	38.2	20.8	35.3
Max	8	1.8	1	0.4	0.6	1	1.4	0.5	0.6	0.9
<b>MATES III</b>										
Average	0.395	0.14	0.181	0.116	0.112	0.145	0.0294, 0.112 <sup>a</sup>	0.0291, 0.109 <sup>a</sup>	0.126	0.336
95% CI LB	0.31	0.129	0.161	0.11	0.107	0.132	0.0209 <sup>a</sup>	0.0186 <sup>a</sup>	0.118	0.288
95% CI UB	0.49	0.155	0.203	0.123	0.118	0.159	0.118 <sup>a</sup>	0.115 <sup>a</sup>	0.135	0.391
N	233	241	237	232	100	238	238 <sup>a</sup>	121 <sup>a</sup>	234	235
% < MDL	63.9	74.7	53.6	72.8	73	71.4	82.8 <sup>a</sup>	80.2 <sup>a</sup>	74.8	37.4
Max	3.78	0.805	1.33	0.39	0.27	0.78	0.41 <sup>a</sup>	0.265 <sup>a</sup>	0.62	3.69
<b>MATES IV</b>										
Average	0.112	0.0958	0.11	0.00189, 0.0696 <sup>a</sup>	0.0877	0.0146, 0.076 <sup>a</sup>	0.0175, 0.0735 <sup>a</sup>	0.0131, 0.0724 <sup>a</sup>	0.0748	0.108
95% CI LB	0.0835	0.0805	0.0858	0 <sup>a</sup>	0.0771	0.00407 <sup>a</sup>	0.00802 <sup>a</sup>	0.00504 <sup>a</sup>	0.0711	0.0911
95% CI UB	0.15	0.114	0.139	0.0708 <sup>a</sup>	0.101	0.085 <sup>a</sup>	0.0783 <sup>a</sup>	0.0751 <sup>a</sup>	0.0792	0.126
N	51	55	57	53 <sup>a</sup>	53	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52	57
% < MDL	74.5	74.5	71.9	98.1 <sup>a</sup>	77.4	88.9 <sup>a</sup>	81.1 <sup>a</sup>	86 <sup>a</sup>	78.8	64.9
Max	0.85	0.33	0.49	0.1 <sup>a</sup>	0.25	0.26 <sup>a</sup>	0.16 <sup>a</sup>	0.105 <sup>a</sup>	0.14	0.32
<b>MATES V</b>										
Average		0.0547	0.0896	0.0636	0.0805	0.0652	0.0643	0.0876	0.0822	0.109
95% CI LB		0.0488	0.0681	0.0544	0.0599	0.0533	0.0537	0.0788	0.0704	0.0834
95% CI UB		0.0614	0.117	0.0745	0.109	0.0777	0.0772	0.0987	0.0959	0.138
N	0	59	60	60	59	58	55	52	60	57
% < MDL		54.2	40	43.3	49.2	60.3	54.5	13.5	28.3	38.6
Max		0.15	0.68	0.31	0.68	0.3	0.28	0.25	0.32	0.62

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-51.** Annual Average Concentrations of Styrene in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

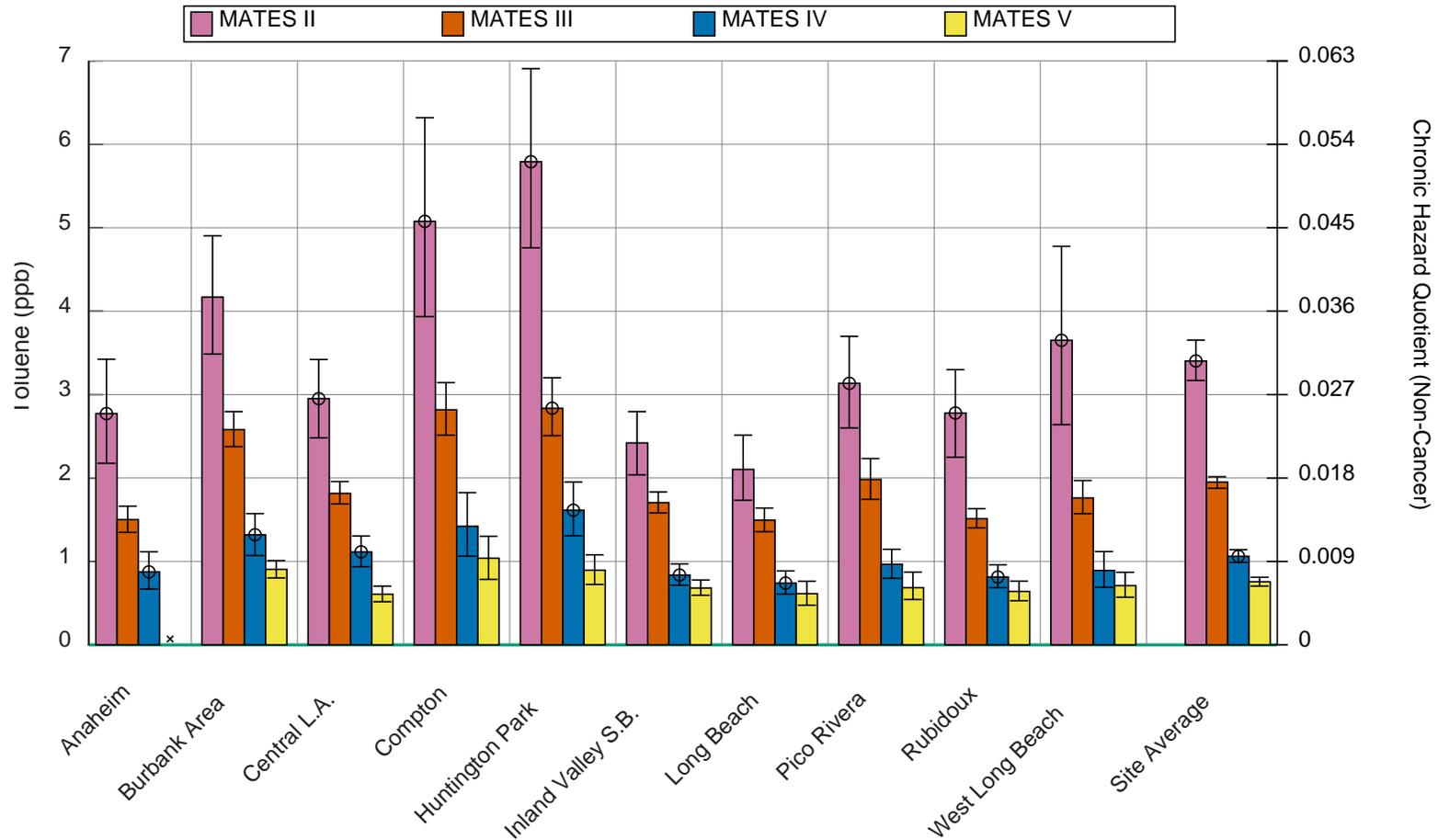


**Figure IV-52.** Geographic distribution of Styrene from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

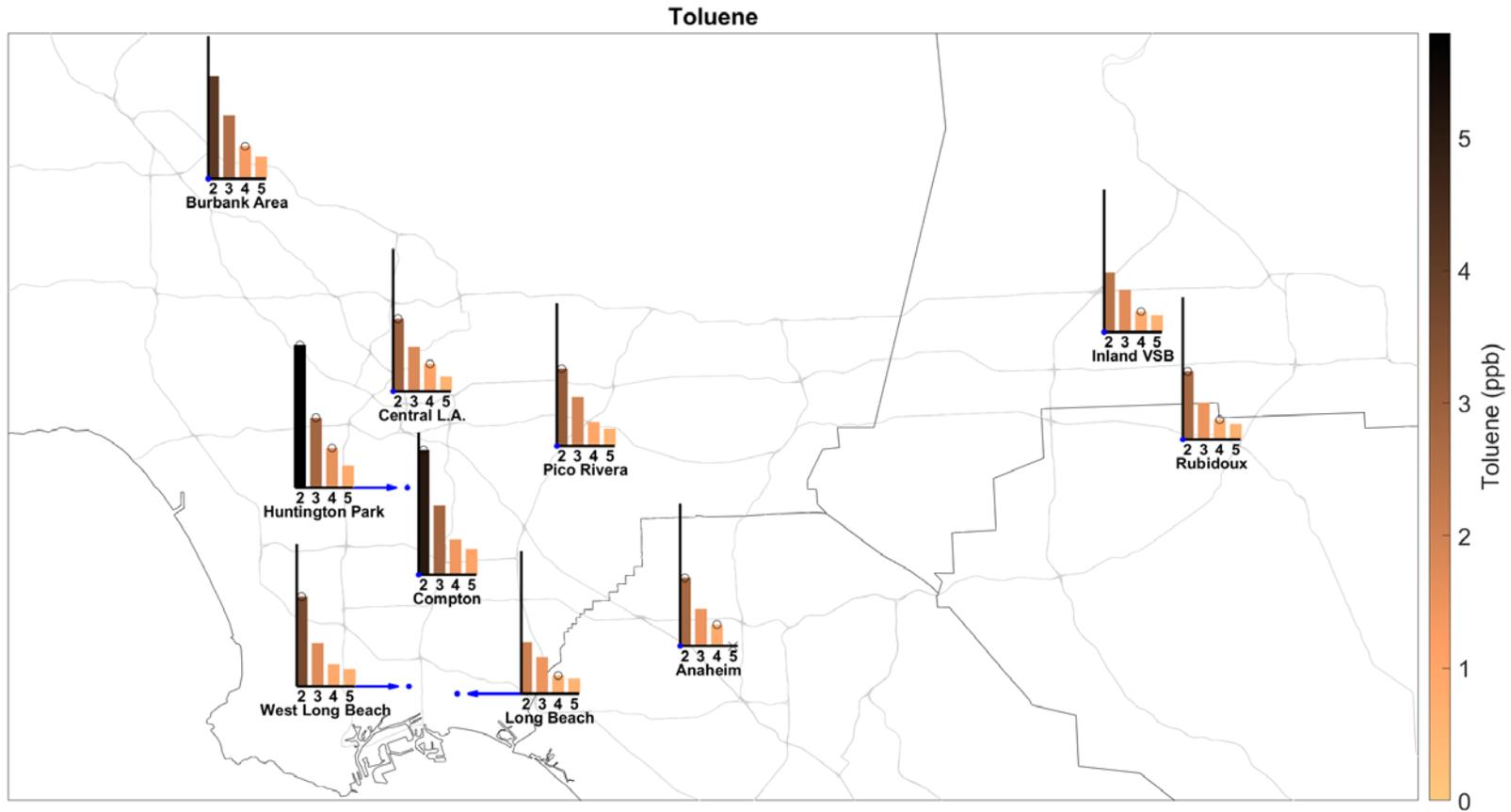
## Toluene

**Table IV-29.** Ambient Concentrations (ppb) of Toluene from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	2.77	4.17	5.08	2.42	5.79	2.1	2.95	3.13	2.78	3.65
95% CI LB	2.18	3.49	3.93	2.04	4.76	1.73	2.48	2.6	2.25	2.64
95% CI UB	3.42	4.9	6.32	2.8	6.91	2.51	3.42	3.7	3.3	4.78
N	49	56	40	56	44	56	53	53	42	34
% < MDL	2	1.8	0	1.8	2.3	1.8	1.9	3.8	2.4	2.9
Max	8.8	11.6	20	7.6	15.1	6.1	7.4	8.8	7.5	15
MATES III										
Average	1.5	2.58	2.82	1.71	2.84	1.5	1.82	1.98	1.51	1.76
95% CI LB	1.35	2.38	2.51	1.58	2.51	1.36	1.69	1.74	1.4	1.57
95% CI UB	1.66	2.8	3.14	1.83	3.2	1.64	1.96	2.23	1.63	1.97
N	233	241	237	232	100	238	238	121	234	235
% < MDL	0	0	0	0.4	0	0	0	0	0	0
Max	8.42	8.94	13.2	5.55	8.68	5.58	6.11	6.95	5.5	8.44
MATES IV										
Average	0.875	1.32	1.42	0.837	1.61	0.741	1.11	0.966	0.813	0.892
95% CI LB	0.669	1.07	1.06	0.715	1.31	0.61	0.937	0.798	0.685	0.689
95% CI UB	1.12	1.57	1.82	0.97	1.95	0.886	1.3	1.15	0.96	1.12
N	51	55	57	53	53	54	53	57	52	57
% < MDL	0	0	0	0	0	0	1.9	0	0	0
Max	4.6	3.78	6.15	2.92	5.67	2.33	3.76	2.81	2.71	3.58
MATES V										
Average		0.905	1.04	0.681	0.895	0.613	0.607	0.686	0.641	0.71
95% CI LB		0.802	0.785	0.595	0.724	0.476	0.517	0.544	0.529	0.57
95% CI UB		1.01	1.3	0.777	1.08	0.763	0.704	0.872	0.764	0.87
N	0	60	61	61	60	59	56	53	60	58
% < MDL		0	0	0	0	0	0	0	0	0
Max		1.85	4.2	1.78	2.88	2.27	1.62	3.64	2.4	2.37



**Figure IV-53.** Annual Average Concentrations of Toluene in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



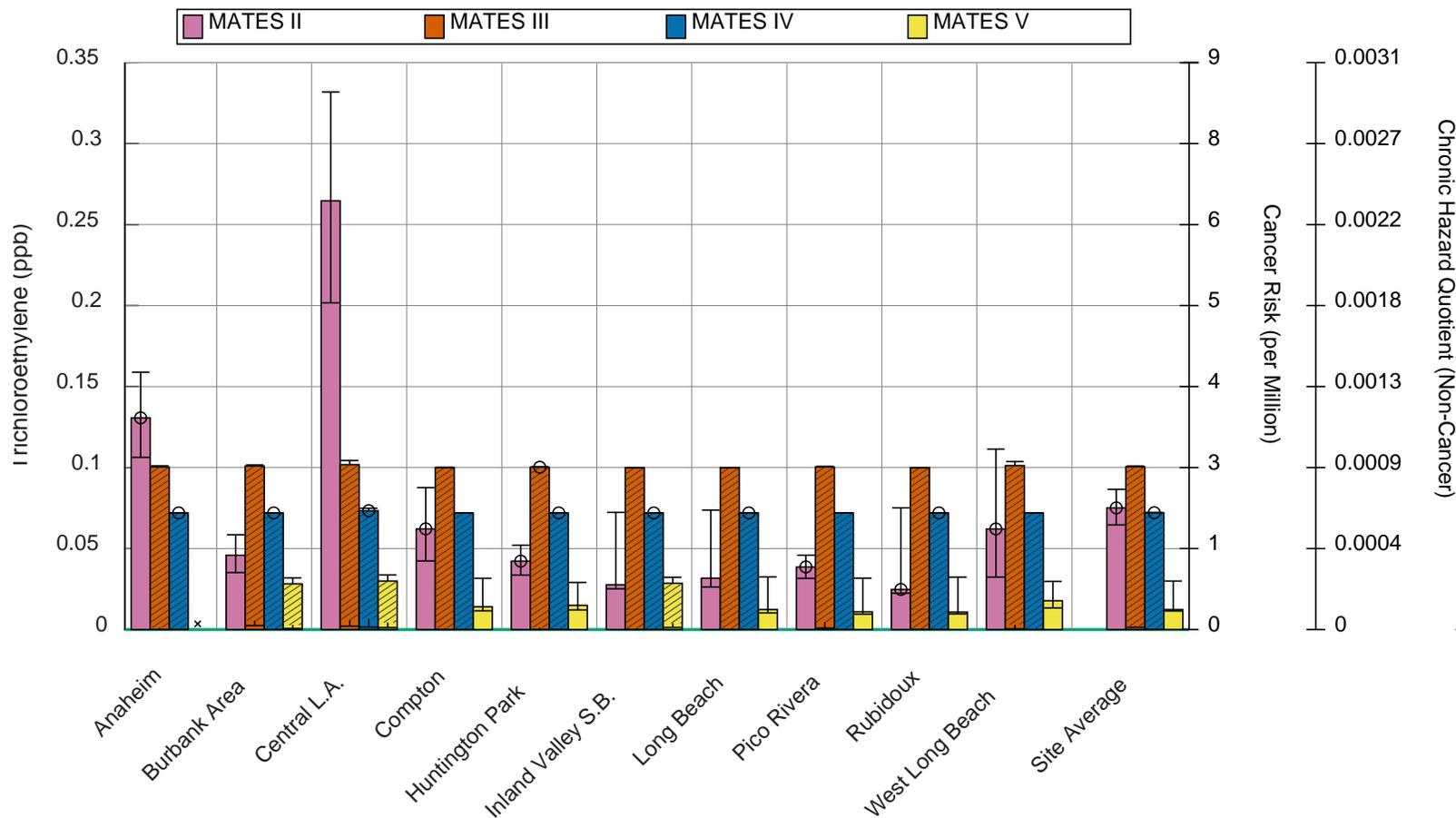
**Figure IV-54.** Geographic distribution of Toluene from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

## Trichloroethylene

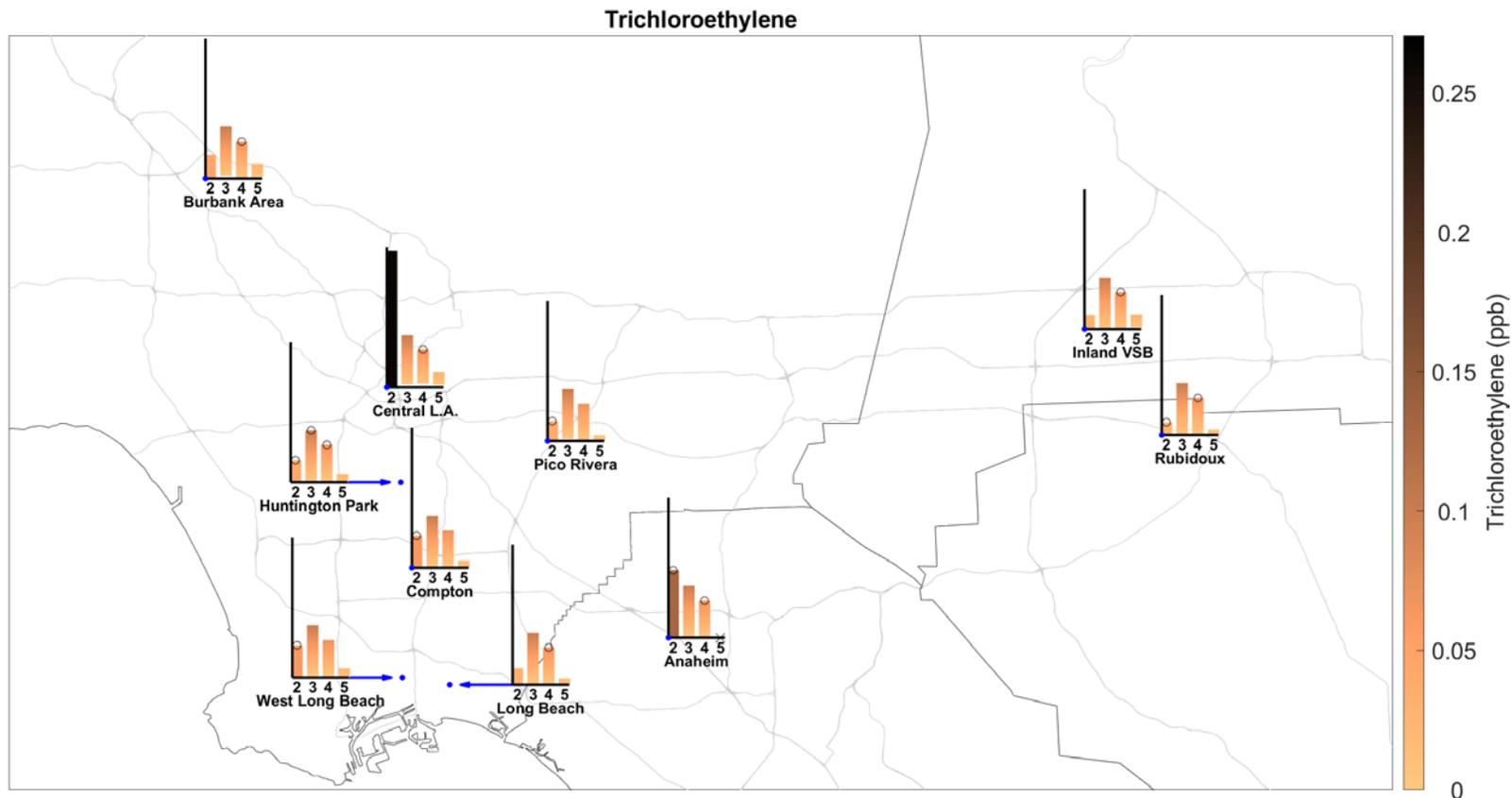
**Table IV-30.** Ambient Concentrations (ppb) of Trichloroethylene from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.131	0.0459	0.0621	0.0277	0.0422	0.0317	0.265	0.0387	0.0248	0.0621
95% CI LB	0.106	0.0352	0.0423	0.0252	0.0336	0.0263	0.202	0.0316	0.0224	0.0324
95% CI UB	0.159	0.0585	0.0876	0.0723	0.0521	0.0737	0.332	0.0459	0.0751	0.111
N	51	57	42	60	45	59	57	54	45	35
% < MDL	23.5	52.6	57.1	80	53.3	74.6	14	59.3	80	54.3
Max	0.57	0.29	0.36	0.07	0.13	0.15	1.3	0.1	0.06	0.8
MATES III										
Average	0.0012, 0.1 <sup>a</sup>	0.00546, 0.101 <sup>a</sup>	0.000886, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0.0012, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0.00559, 0.102 <sup>a</sup>	0.00446, 0.1 <sup>a</sup>	0, 0.1 <sup>a</sup>	0.00294, 0.101 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0.00249 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0.00206 <sup>a</sup>	0.000909 <sup>a</sup>	0 <sup>a</sup>	0.000426 <sup>a</sup>
95% CI UB	0.101 <sup>a</sup>	0.102 <sup>a</sup>	0.1 <sup>a</sup>	0.1 <sup>a</sup>	0.101 <sup>a</sup>	0.1 <sup>a</sup>	0.104 <sup>a</sup>	0.101 <sup>a</sup>	0.1 <sup>a</sup>	0.104 <sup>a</sup>
N	233 <sup>a</sup>	241 <sup>a</sup>	237 <sup>a</sup>	232 <sup>a</sup>	100 <sup>a</sup>	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	235 <sup>a</sup>
% < MDL	99.1 <sup>a</sup>	95.4 <sup>a</sup>	99.2 <sup>a</sup>	100 <sup>a</sup>	99 <sup>a</sup>	100 <sup>a</sup>	96.2 <sup>a</sup>	95.9 <sup>a</sup>	100 <sup>a</sup>	98.3 <sup>a</sup>
Max	0.18 <sup>a</sup>	0.15 <sup>a</sup>	0.11 <sup>a</sup>	< MDL <sup>a</sup>	0.12 <sup>a</sup>	< MDL <sup>a</sup>	0.33 <sup>a</sup>	0.115 <sup>a</sup>	< MDL <sup>a</sup>	0.36 <sup>a</sup>
MATES IV										
Average	0, 0.072 <sup>a</sup>	0, 0.072 <sup>a</sup>	0, 0.072 <sup>a</sup>	0, 0.072 <sup>a</sup>	0, 0.072 <sup>a</sup>	0, 0.072 <sup>a</sup>	0.00679, 0.0734 <sup>a</sup>	0, 0.072 <sup>a</sup>	0, 0.072 <sup>a</sup>	0, 0.072 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0.00151 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.072 <sup>a</sup>	0.072 <sup>a</sup>	0.072 <sup>a</sup>	0.072 <sup>a</sup>	0.072 <sup>a</sup>	0.072 <sup>a</sup>	0.0749 <sup>a</sup>	0.072 <sup>a</sup>	0.072 <sup>a</sup>	0.072 <sup>a</sup>
N	51 <sup>a</sup>	55 <sup>a</sup>	57 <sup>a</sup>	53 <sup>a</sup>	53 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52 <sup>a</sup>	57 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	92.5 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.1 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
MATES V										
Average		0.00283, 0.0282 <sup>a</sup>	0.0141	0.00377, 0.0286 <sup>a</sup>	0.0149	0.0124	0.00429, 0.0299 <sup>a</sup>	0.0109	0.0108	0.0178
95% CI LB		0.000667 <sup>a</sup>	0.0115	0.00131 <sup>a</sup>	0.0121	0.0103	0.00125 <sup>a</sup>	0.0095	0.00965	0.0133
95% CI UB		0.0319 <sup>a</sup>	0.0316	0.0323 <sup>a</sup>	0.0291	0.0325	0.0338 <sup>a</sup>	0.0317	0.0324	0.0297
N	0	60 <sup>a</sup>	61	61 <sup>a</sup>	60	59	56 <sup>a</sup>	53	60	58
% < MDL		90 <sup>a</sup>	70.5	82 <sup>a</sup>	70	72.9	85.7 <sup>a</sup>	73.6	80	69
Max		0.05 <sup>a</sup>	0.06	0.05 <sup>a</sup>	0.07	0.05	0.05 <sup>a</sup>	0.05	0.05	0.14

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-55.** Annual Average Concentrations of Trichloroethylene in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



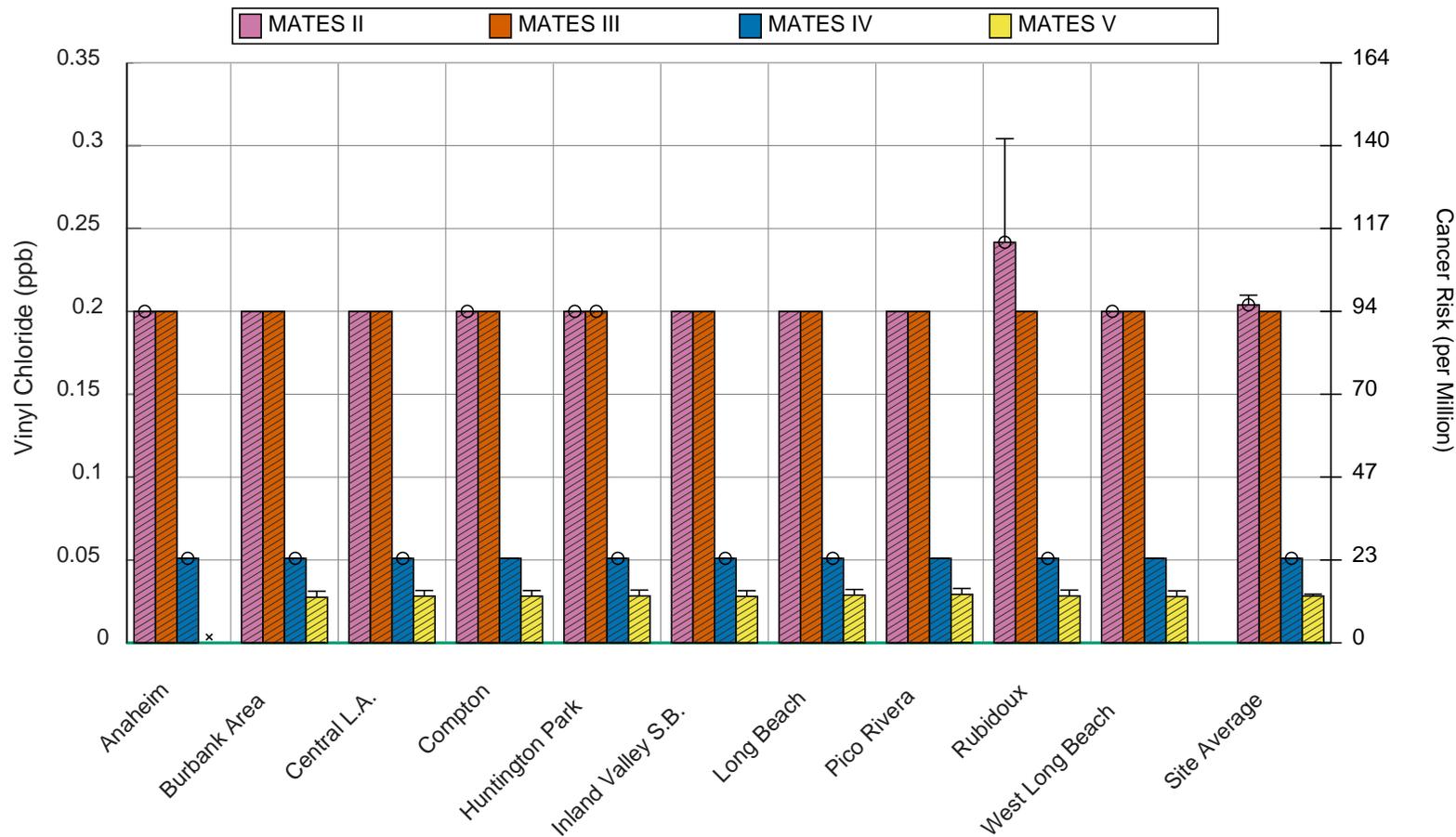
**Figure IV-56.** Geographic distribution of Trichloroethylene from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Vinyl Chloride

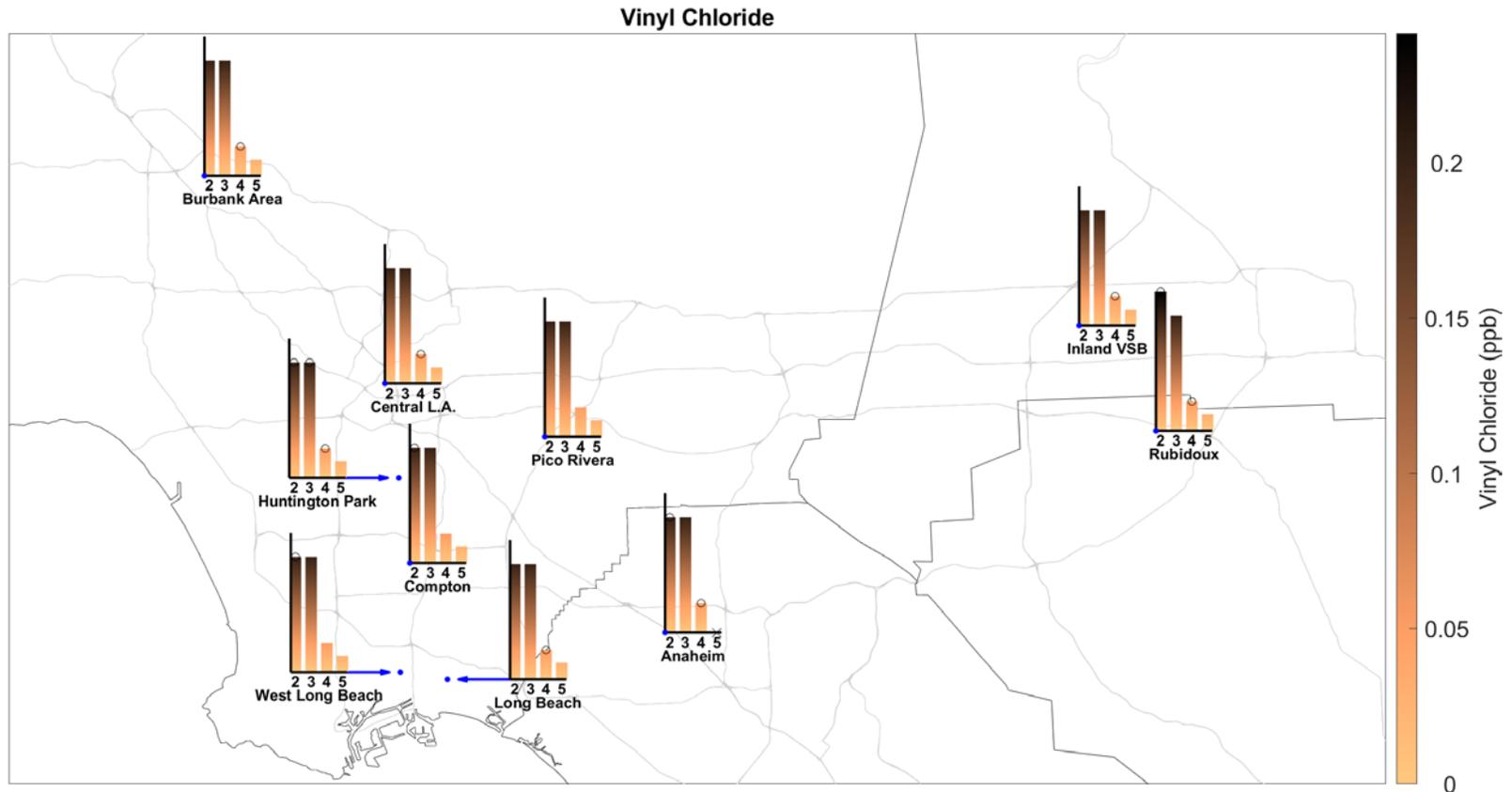
**Table IV-31.** Ambient Concentrations (ppb) of Vinyl Chloride from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.242 <sup>a</sup>	0, 0.2 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.304 <sup>a</sup>	0.2 <sup>a</sup>
N	26 <sup>a</sup>	28 <sup>a</sup>	21 <sup>a</sup>	30 <sup>a</sup>	23 <sup>a</sup>	30 <sup>a</sup>	29 <sup>a</sup>	29 <sup>a</sup>	24 <sup>a</sup>	17 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES III</b>										
Average	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>	0, 0.2 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>	0.2 <sup>a</sup>
N	233 <sup>a</sup>	241 <sup>a</sup>	237 <sup>a</sup>	232 <sup>a</sup>	100 <sup>a</sup>	238 <sup>a</sup>	238 <sup>a</sup>	121 <sup>a</sup>	234 <sup>a</sup>	234 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES IV</b>										
Average	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>	0, 0.051 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>	0.051 <sup>a</sup>
N	51 <sup>a</sup>	55 <sup>a</sup>	57 <sup>a</sup>	53 <sup>a</sup>	53 <sup>a</sup>	54 <sup>a</sup>	53 <sup>a</sup>	57 <sup>a</sup>	52 <sup>a</sup>	57 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES V</b>										
Average		0.000667, 0.0275 <sup>a</sup>	0.00082, 0.0282 <sup>a</sup>	0.000328, 0.028 <sup>a</sup>	0.000167, 0.0283 <sup>a</sup>	0.00119, 0.0288 <sup>a</sup>	0.000357, 0.0282 <sup>a</sup>	0.000943, 0.0292 <sup>a</sup>	0.000167, 0.0283 <sup>a</sup>	0.00069, 0.0279 <sup>a</sup>
95% CI LB		0.000167 <sup>a</sup>	0.000164 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0.000339 <sup>a</sup>	0 <sup>a</sup>	0.000189 <sup>a</sup>	0 <sup>a</sup>	0.000172 <sup>a</sup>
95% CI UB		0.0312 <sup>a</sup>	0.0316 <sup>a</sup>	0.0315 <sup>a</sup>	0.0318 <sup>a</sup>	0.0322 <sup>a</sup>	0.0316 <sup>a</sup>	0.0328 <sup>a</sup>	0.0318 <sup>a</sup>	0.0314 <sup>a</sup>
N	0	60 <sup>a</sup>	61 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	59 <sup>a</sup>	56 <sup>a</sup>	53 <sup>a</sup>	60 <sup>a</sup>	58 <sup>a</sup>
% < MDL		93.3 <sup>a</sup>	93.4 <sup>a</sup>	96.7 <sup>a</sup>	98.3 <sup>a</sup>	89.8 <sup>a</sup>	96.4 <sup>a</sup>	92.5 <sup>a</sup>	98.3 <sup>a</sup>	93.1 <sup>a</sup>
Max		0.01 <sup>a</sup>	0.02 <sup>a</sup>	0.01 <sup>a</sup>	0.01 <sup>a</sup>	0.02 <sup>a</sup>	0.01 <sup>a</sup>	0.02 <sup>a</sup>	0.01 <sup>a</sup>	0.01 <sup>a</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-57.** Annual Average Concentrations of Vinyl Chloride in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

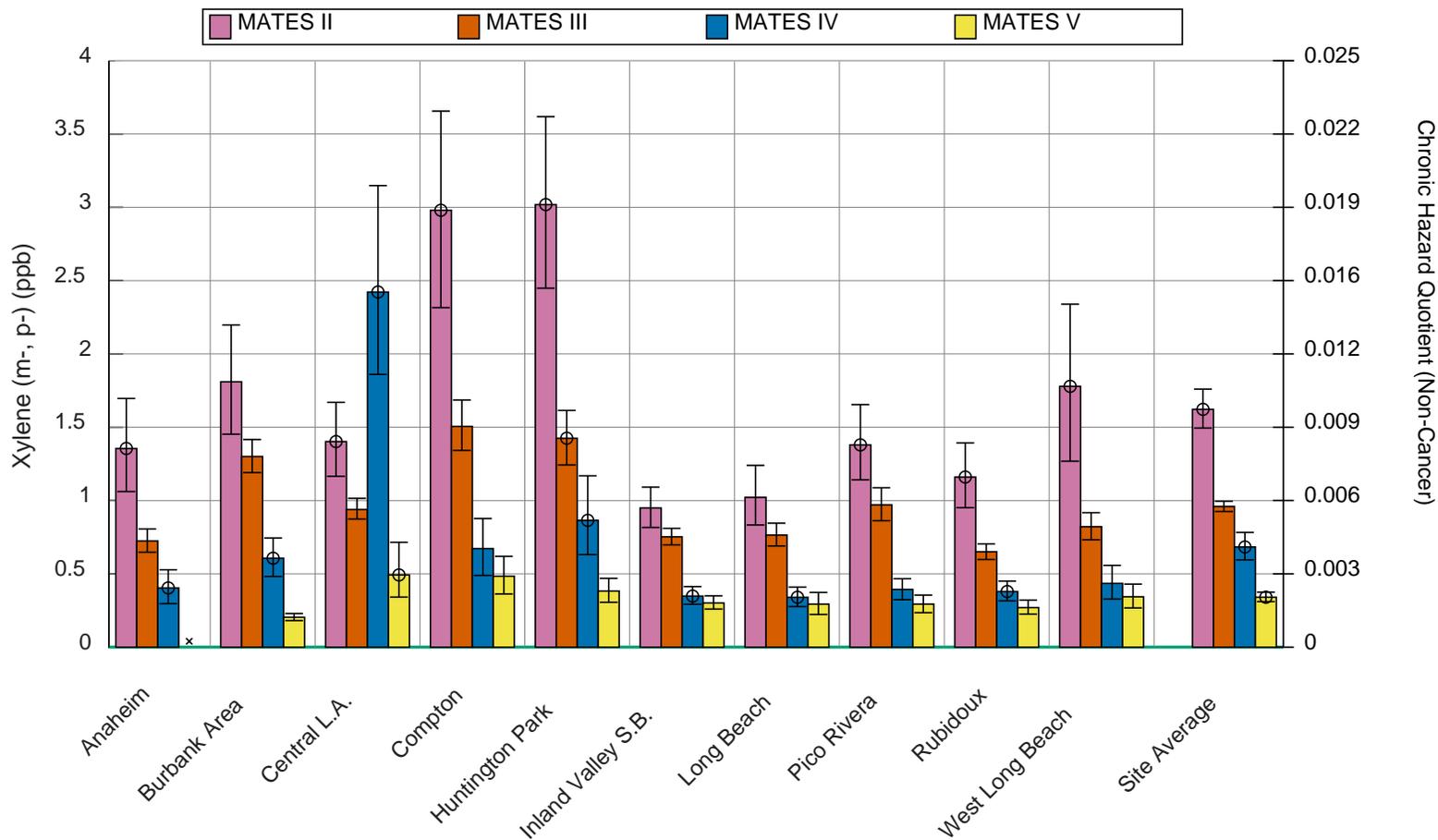


**Figure IV-58.** Geographic distribution of Vinyl Chloride from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

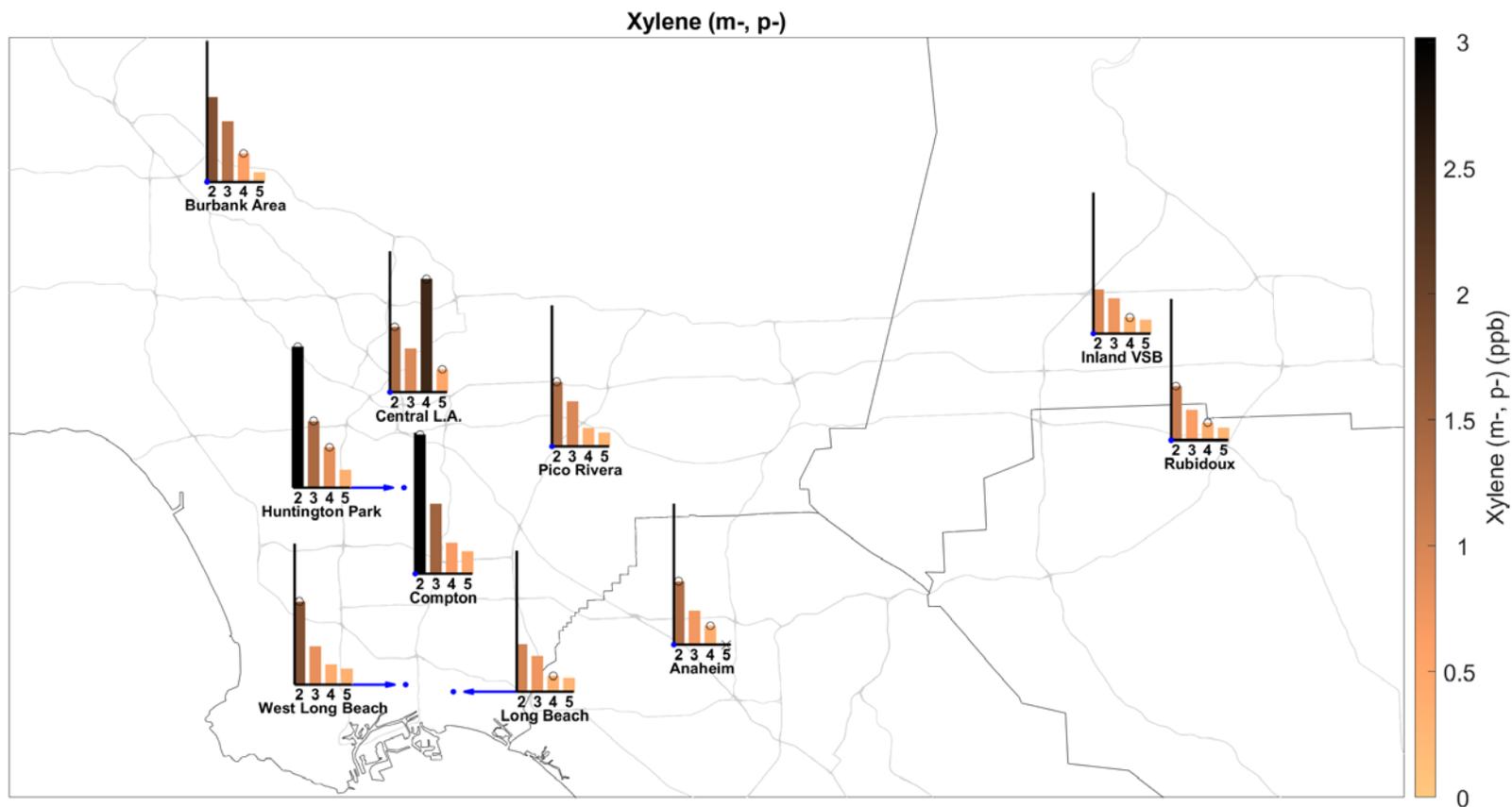
## Xylene (m-, p-)

**Table IV-32.** Ambient Concentrations (ppb) of Xylene (m-, p-) from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	1.36	1.81	2.98	0.949	3.02	1.02	1.4	1.38	1.16	1.78
95% CI LB	1.06	1.45	2.32	0.816	2.45	0.833	1.17	1.14	0.951	1.27
95% CI UB	1.7	2.2	3.66	1.09	3.62	1.24	1.67	1.65	1.39	2.34
N	50	56	41	58	44	57	55	54	42	35
% < MDL	22	16.1	17.1	31	2.3	31.6	20	18.5	21.4	20
Max	6.1	6	8.8	2.5	8.9	3.2	3.8	4.3	3.3	7.2
MATES III										
Average	0.724	1.3	1.51	0.753	1.42	0.764	0.939	0.97	0.65	0.822
95% CI LB	0.647	1.19	1.34	0.697	1.24	0.69	0.874	0.862	0.598	0.732
95% CI UB	0.806	1.42	1.69	0.81	1.61	0.846	1.01	1.09	0.704	0.917
N	233	241	237	232	100	238	238	121	234	235
% < MDL	0	0	0	2.6	0	0	0	0	0.4	0.4
Max	4.03	4.91	7.85	2.4	4.58	3.03	3.04	3.74	2.5	4.53
MATES IV										
Average	0.404	0.606	0.672	0.348	0.865	0.34	2.42	0.394	0.379	0.435
95% CI LB	0.297	0.482	0.49	0.292	0.631	0.277	1.86	0.324	0.316	0.328
95% CI UB	0.528	0.744	0.877	0.413	1.17	0.41	3.15	0.467	0.451	0.558
N	51	55	57	53	53	54	53	57	52	57
% < MDL	3.9	0	1.8	3.8	1.9	0	1.9	1.8	0	5.3
Max	2.31	2.19	3.06	1.42	6.62	1.09	16.2	1.08	1.03	2.53
MATES V										
Average		0.204	0.484	0.302	0.383	0.293	0.492	0.294	0.27	0.343
95% CI LB		0.181	0.363	0.26	0.306	0.223	0.341	0.235	0.226	0.267
95% CI UB		0.229	0.619	0.35	0.469	0.373	0.715	0.355	0.321	0.43
N	0	57	58	58	57	56	54	50	57	55
% < MDL		1.8	1.7	1.7	0	1.8	0	0	1.8	0
Max		0.48	2.01	1.04	1.26	1.39	5.1	0.98	0.84	1.52



**Figure IV-59.** Annual Average Concentrations of Xylene (m-, p-) in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

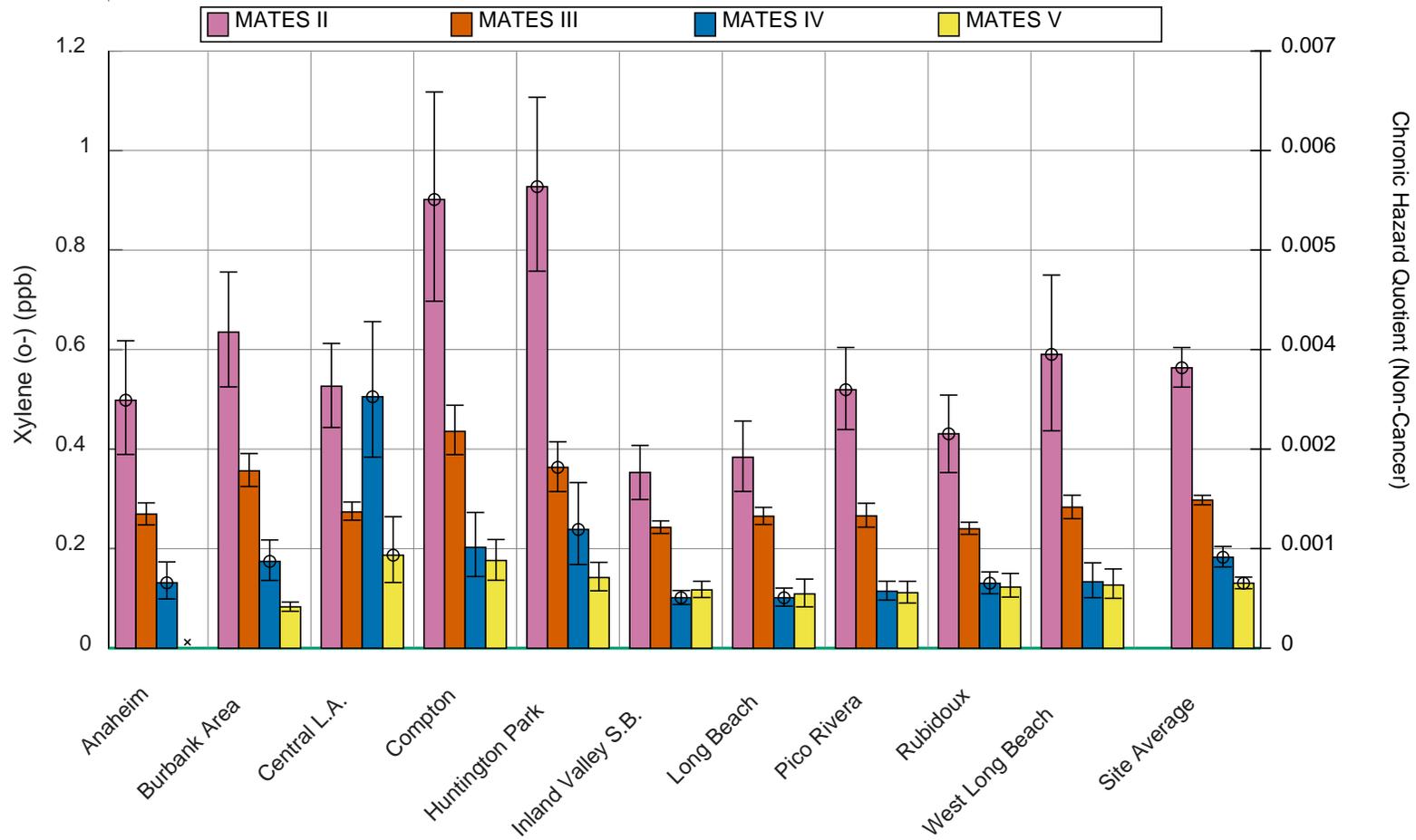


**Figure IV-60.** Geographic distribution of Xylene (m-, p-) from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

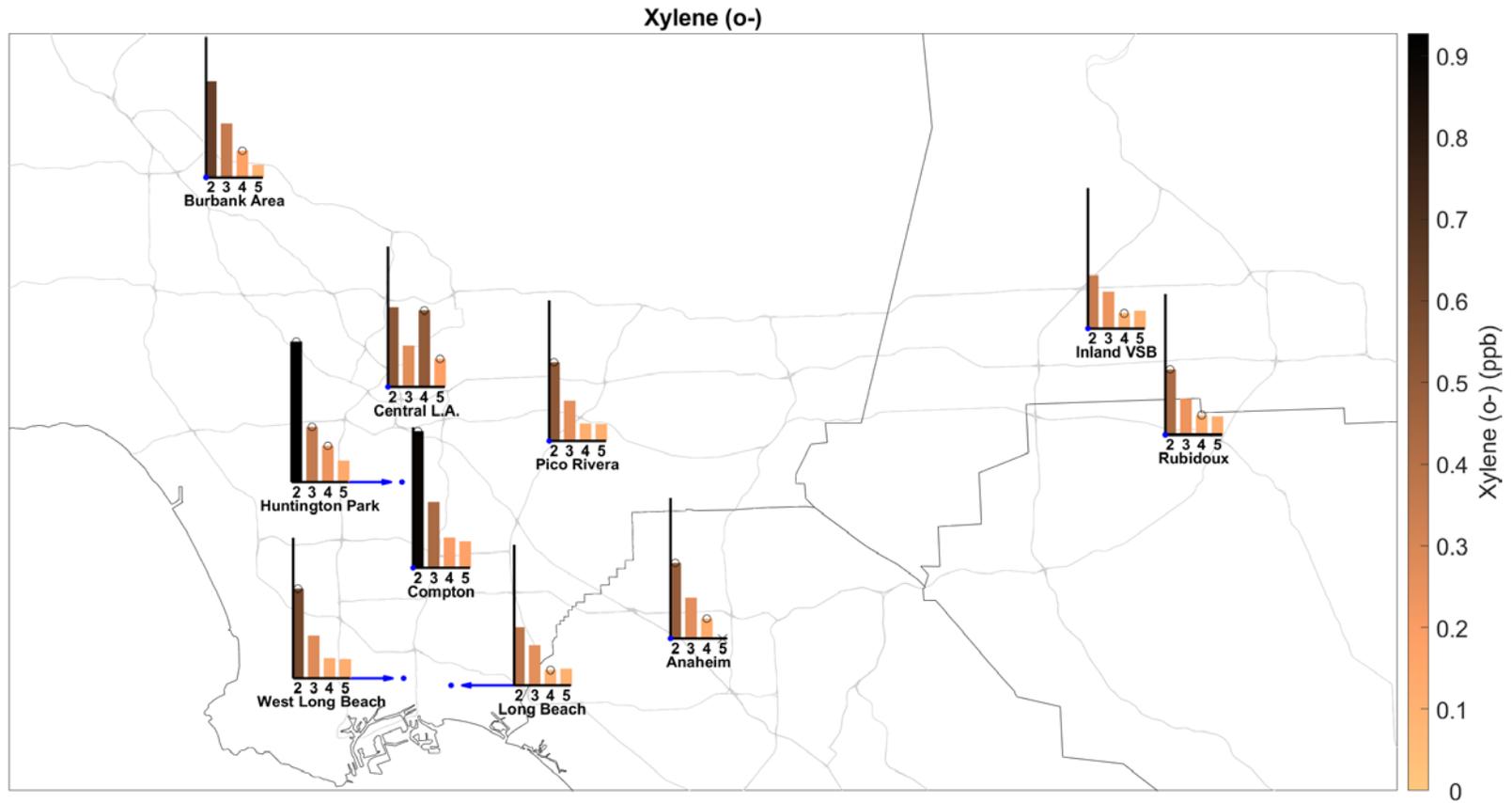
## Xylene (o-)

**Table IV-33.** Ambient Concentrations (ppb) of Xylene (o-) from the VOCs analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.498	0.635	0.901	0.353	0.927	0.384	0.526	0.519	0.431	0.59
95% CI LB	0.389	0.525	0.697	0.299	0.758	0.315	0.443	0.439	0.353	0.437
95% CI UB	0.618	0.756	1.12	0.407	1.11	0.456	0.612	0.604	0.509	0.75
N	51	56	42	56	44	56	55	54	42	35
% < MDL	19.6	7.1	11.9	16.1	0	19.6	10.9	9.3	16.7	22.9
Max	1.7	2.1	2.9	0.9	2.3	1.1	1.3	1.5	1	1.7
MATES III										
Average	0.269	0.356	0.436	0.243	0.363	0.265	0.274	0.266	0.24	0.283
95% CI LB	0.248	0.325	0.389	0.23	0.315	0.249	0.257	0.243	0.229	0.26
95% CI UB	0.292	0.391	0.488	0.256	0.415	0.283	0.294	0.291	0.253	0.307
N	233	241	237	232	100	238	238	121	234	235
% < MDL	73	49	45.6	65.9	40	69.7	58	60.3	72.6	68.1
Max	1.69	1.45	2.26	0.82	1.32	0.83	0.94	0.965	1.1	1.28
MATES IV										
Average	0.131	0.174	0.203	0.101	0.238	0.101	0.505	0.114	0.13	0.133
95% CI LB	0.0989	0.136	0.144	0.0877	0.168	0.0844	0.384	0.0966	0.109	0.101
95% CI UB	0.173	0.217	0.273	0.116	0.333	0.121	0.656	0.135	0.153	0.171
N	51	55	57	53	53	54	53	57	52	57
% < MDL	51	18.2	36.8	35.8	15.1	48.1	1.9	33.3	28.8	49.1
Max	0.79	0.72	1.01	0.3	2.03	0.34	3.17	0.34	0.35	0.86
MATES V										
Average		0.083	0.176	0.117	0.142	0.109	0.187	0.111	0.123	0.127
95% CI LB		0.0742	0.136	0.102	0.115	0.083	0.132	0.0908	0.103	0.1
95% CI UB		0.0927	0.218	0.134	0.172	0.139	0.264	0.134	0.15	0.159
N	0	57	58	58	57	56	54	50	57	55
% < MDL		1.8	0	0	0	0	0	0	0	0
Max		0.2	0.81	0.43	0.5	0.55	1.81	0.38	0.63	0.62



**Figure IV-61.** Annual Average Concentrations of Xylene (o-) in the VOCs Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



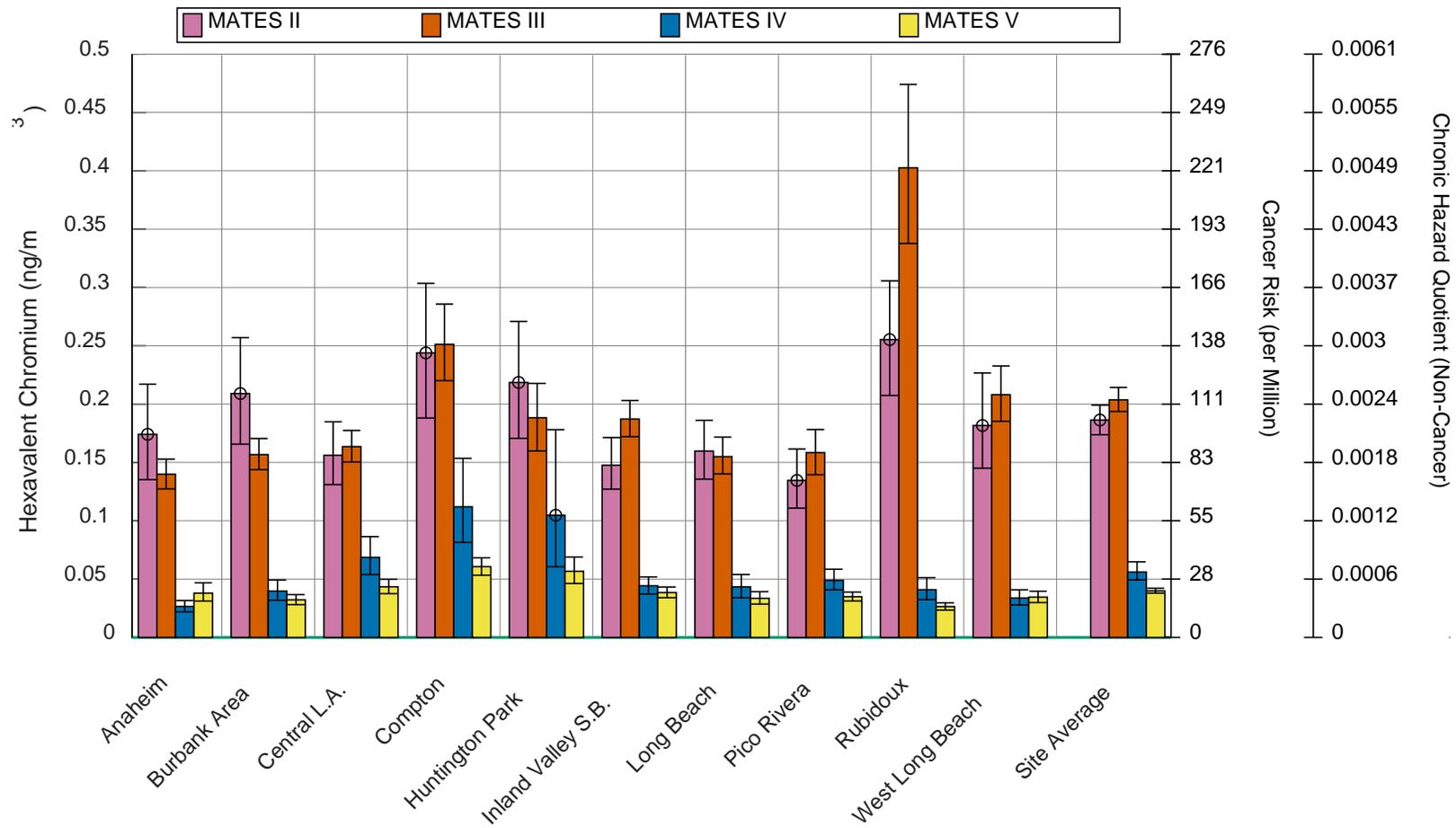
**Figure IV-62.** Geographic distribution of Xylene (o-) from the VOCs Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

TSP Hexavalent Chromium Analysis

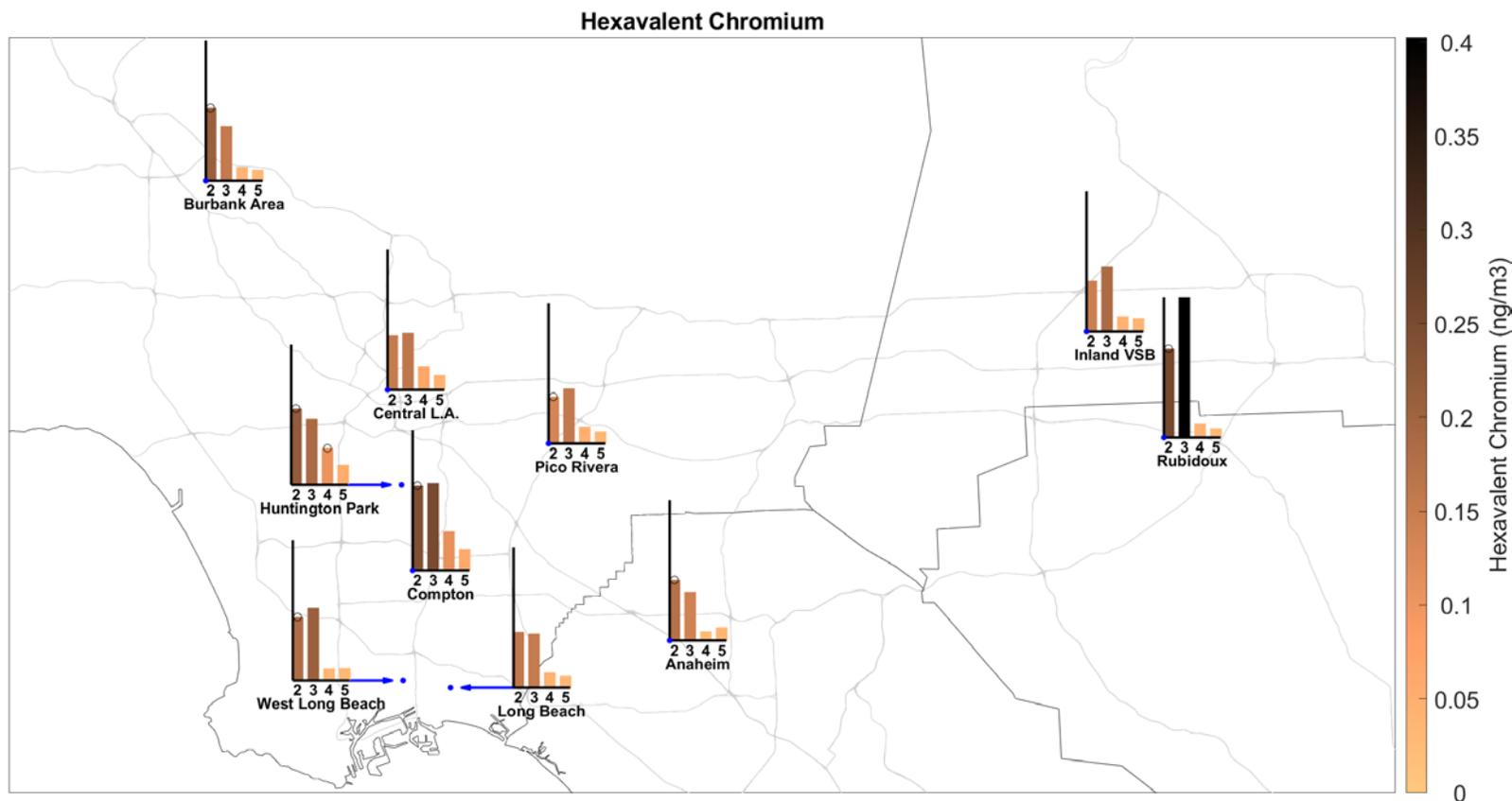
## Hexavalent Chromium

**Table IV-34.** Ambient Concentrations (ng/m<sup>3</sup>) of Hexavalent Chromium from the TSP Hexavalent Chromium analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.174	0.209	0.244	0.148	0.219	0.16	0.156	0.135	0.255	0.182
95% CI LB	0.135	0.166	0.188	0.127	0.171	0.136	0.131	0.111	0.207	0.145
95% CI UB	0.217	0.257	0.304	0.171	0.271	0.186	0.185	0.162	0.306	0.227
N	51	52	40	53	48	58	55	51	48	41
% < MDL	54.9	51.9	42.5	66	52.1	63.8	67.3	64.7	39.6	43.9
Max	0.7	0.6	1.1	0.44	0.82	0.39	0.41	0.41	0.8	0.71
MATES III										
Average	0.14	0.157	0.251	0.187	0.188	0.155	0.164	0.158	0.403	0.208
95% CI LB	0.127	0.144	0.22	0.172	0.16	0.14	0.15	0.14	0.338	0.185
95% CI UB	0.153	0.171	0.286	0.203	0.218	0.172	0.177	0.178	0.474	0.233
N	238	237	231	230	118	237	240	121	234	232
% < MDL	17.2	15.6	9.1	7	8.5	13.5	10	7.4	13.2	14.2
Max	0.68	0.75	1.77	0.69	0.91	1.07	0.79	0.69	3.55	1.16
MATES IV										
Average	0.0266	0.0398	0.112	0.0443	0.105	0.0434	0.0686	0.049	0.0409	0.0338
95% CI LB	0.022	0.0319	0.0814	0.0373	0.0606	0.034	0.0538	0.0408	0.0324	0.0278
95% CI UB	0.0316	0.0492	0.154	0.0519	0.178	0.054	0.0864	0.0585	0.0513	0.0408
N	60	57	60	58	55	60	59	61	59	58
% < MDL	1.7	0	0	1.7	0	1.7	0	0	1.7	1.7
Max	0.09	0.19	0.85	0.12	1.8	0.2	0.39	0.17	0.25	0.14
MATES V										
Average	0.038	0.0322	0.0607	0.0385	0.0567	0.0336	0.0434	0.0349	0.0264	0.0346
95% CI LB	0.0312	0.0281	0.0533	0.0341	0.0462	0.0286	0.0375	0.0313	0.0235	0.0299
95% CI UB	0.0468	0.0367	0.0683	0.0432	0.0689	0.0392	0.0499	0.0389	0.0297	0.0397
N	60	58	60	59	61	59	59	61	59	59
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	0.24	0.1	0.16	0.1	0.24	0.13	0.16	0.09	0.06	0.11



**Figure IV-63.** Annual Average Concentrations of Hexavalent Chromium in the TSP Hexavalent Chromium Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



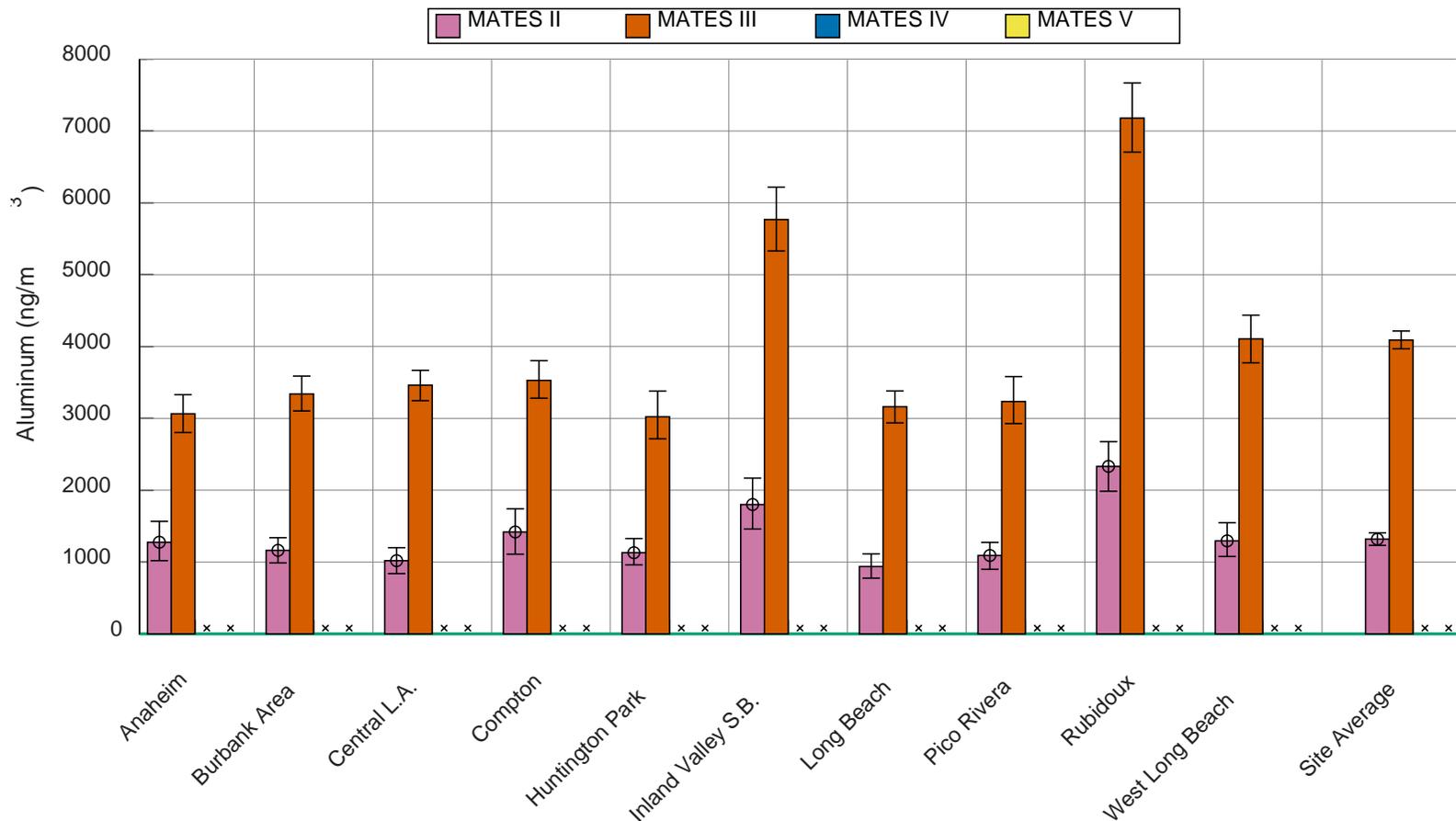
**Figure IV-64.** Geographic distribution of Hexavalent Chromium from the TSP Hexavalent Chromium Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

TSP Metals Analysis

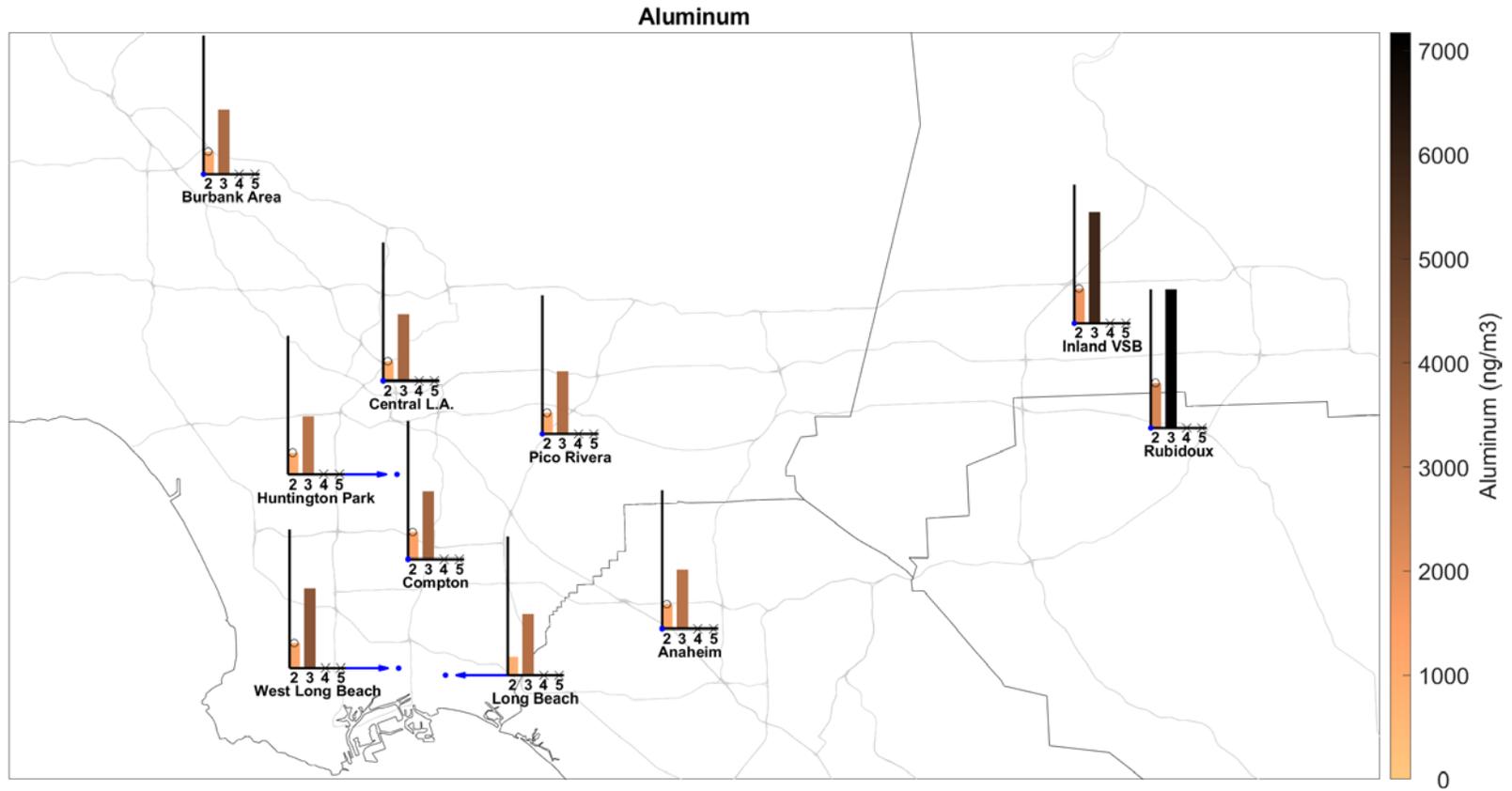
Aluminum

**Table IV-35.** Ambient Concentrations (ng/m<sup>3</sup>) of Aluminum from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	1280	1160	1420	1800	1130	937	1020	1090	2330	1290
95% CI LB	1020	988	1110	1460	961	776	839	899	1990	1080
95% CI UB	1570	1340	1740	2170	1330	1110	1200	1270	2680	1550
N	45	47	39	41	42	56	51	41	41	39
% < MDL	4.4	4.3	7.7	7.3	4.8	7.1	9.8	9.8	2.4	2.6
Max	4160	2960	4480	4930	3170	2840	3030	2620	5670	3580
MATES III										
Average	3060	3340	3530	5770	3020	3160	3460	3230	7180	4110
95% CI LB	2800	3100	3280	5330	2720	2940	3250	2930	6710	3770
95% CI UB	3330	3590	3800	6220	3380	3380	3670	3580	7670	4440
N	232	218	228	224	116	230	229	118	237	227
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	11800	13100	10700	17200	13700	11600	8210	14900	18000	14600
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-65.** Annual Average Concentrations of Aluminum in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



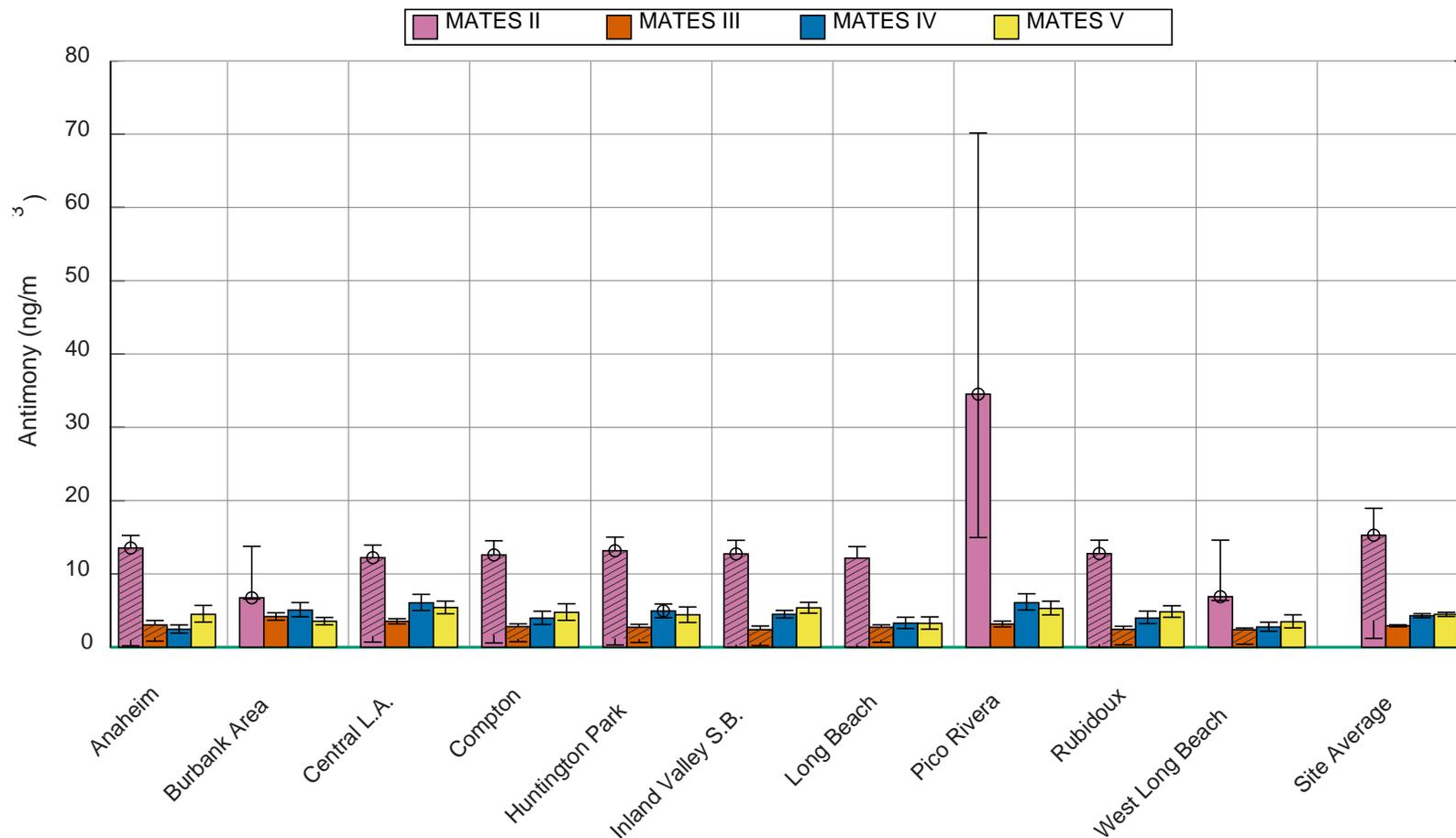
**Figure IV-66.** Geographic distribution of Aluminum from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

## Antimony

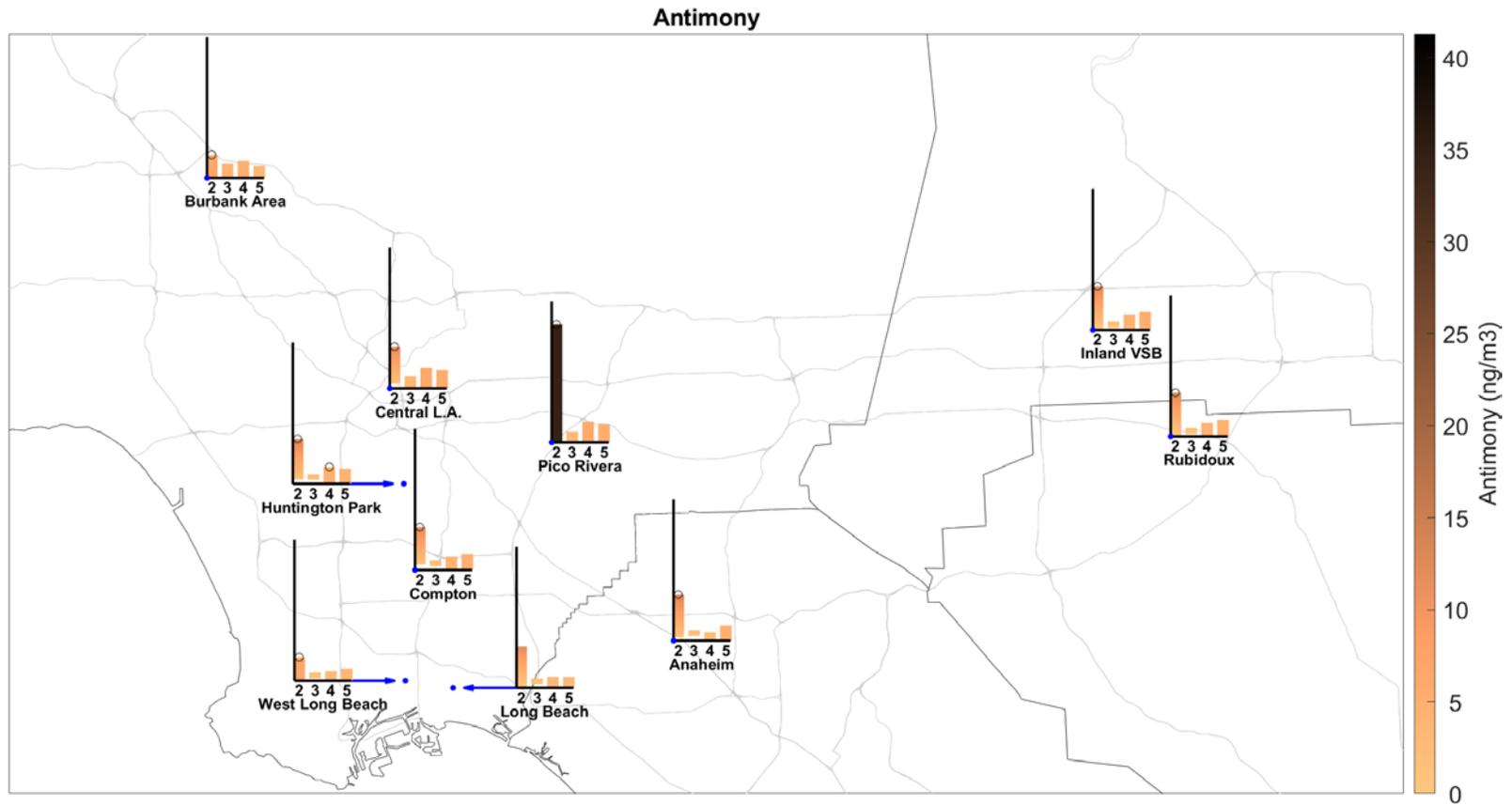
**Table IV-36.** Ambient Concentrations (ng/m<sup>3</sup>) of Antimony from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.978, 13.5 <sup>a</sup>	6.74	1.67, 12.6 <sup>a</sup>	0.366, 12.7 <sup>a</sup>	1.21, 13.2 <sup>a</sup>	0.339, 12.2 <sup>a</sup>	1.53, 12.2 <sup>a</sup>	34.5	0.415, 12.8 <sup>a</sup>	6.9
95% CI LB	0.2 <sup>a</sup>	6.58	0.59 <sup>a</sup>	0 <sup>a</sup>	0.31 <sup>a</sup>	0 <sup>a</sup>	0.706 <sup>a</sup>	15	0 <sup>a</sup>	6.38
95% CI UB	15.2 <sup>a</sup>	13.8	14.5 <sup>a</sup>	14.6 <sup>a</sup>	15 <sup>a</sup>	13.7 <sup>a</sup>	13.9 <sup>a</sup>	70.2	14.6 <sup>a</sup>	14.6
N	45 <sup>a</sup>	47	39 <sup>a</sup>	41 <sup>a</sup>	42 <sup>a</sup>	56 <sup>a</sup>	51 <sup>a</sup>	41	41 <sup>a</sup>	39
% < MDL	88.9 <sup>a</sup>	78.7	82.1 <sup>a</sup>	95.1 <sup>a</sup>	85.7 <sup>a</sup>	96.4 <sup>a</sup>	80.4 <sup>a</sup>	78	95.1 <sup>a</sup>	79.5
Max	15 <sup>a</sup>	10	16 <sup>a</sup>	8 <sup>a</sup>	13 <sup>a</sup>	10 <sup>a</sup>	13 <sup>a</sup>	547	11 <sup>a</sup>	12
MATES III										
Average	1.35, 3.03 <sup>a</sup>	4.18	1.14, 2.82 <sup>a</sup>	0.58, 2.39 <sup>a</sup>	1.1, 2.72 <sup>a</sup>	1.05, 2.74 <sup>a</sup>	3.54	3.16	0.687, 2.44 <sup>a</sup>	0.653, 2.4 <sup>a</sup>
95% CI LB	0.835 <sup>a</sup>	3.69	0.752 <sup>a</sup>	0.23 <sup>a</sup>	0.646 <sup>a</sup>	0.686 <sup>a</sup>	3.19	2.77	0.336 <sup>a</sup>	0.411 <sup>a</sup>
95% CI UB	3.64 <sup>a</sup>	4.7	3.19 <sup>a</sup>	2.9 <sup>a</sup>	3.12 <sup>a</sup>	3.07 <sup>a</sup>	3.88	3.57	2.87 <sup>a</sup>	2.63 <sup>a</sup>
N	232 <sup>a</sup>	218	228 <sup>a</sup>	224 <sup>a</sup>	116 <sup>a</sup>	230 <sup>a</sup>	229	118	237 <sup>a</sup>	227 <sup>a</sup>
% < MDL	84.1 <sup>a</sup>	59.6	83.8 <sup>a</sup>	90.6 <sup>a</sup>	81 <sup>a</sup>	84.3 <sup>a</sup>	67.2	66.9	87.8 <sup>a</sup>	87.2 <sup>a</sup>
Max	53.7 <sup>a</sup>	20.4	31.9 <sup>a</sup>	53 <sup>a</sup>	15.2 <sup>a</sup>	16.8 <sup>a</sup>	17.7	11.5	46.5 <sup>a</sup>	17.2 <sup>a</sup>
MATES IV										
Average	2.45	5.07	3.97	4.5	4.95	3.28	6.06	6.09	3.98	2.76
95% CI LB	1.92	4.16	3.11	3.99	4.01	2.55	5	5.08	3.24	2.19
95% CI UB	3.04	6.09	4.92	5.03	5.9	4.1	7.22	7.3	4.94	3.43
N	60	58	59	56	55	59	59	60	58	58
% < MDL	1.7	0	0	0	0	1.7	0	0	0	0
Max	11.4	21.4	13.9	9.01	16.6	11.8	19	30.4	23.7	11.4
MATES V										
Average	4.49	3.54	4.76	5.37	4.43	3.26	5.41	5.3	4.84	3.48
95% CI LB	3.43	3.06	3.67	4.65	3.38	2.47	4.57	4.42	4.09	2.64
95% CI UB	5.71	4.06	5.93	6.13	5.5	4.14	6.29	6.29	5.66	4.43
N	61	58	61	59	61	60	60	60	60	59
% < MDL	0	0	0	0	11.5	0	1.7	0	0	0
Max	23.1	7.95	20.2	15.4	16.7	13	15.5	16.9	14.2	16.4

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-67.** Annual Average Concentrations of Antimony in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



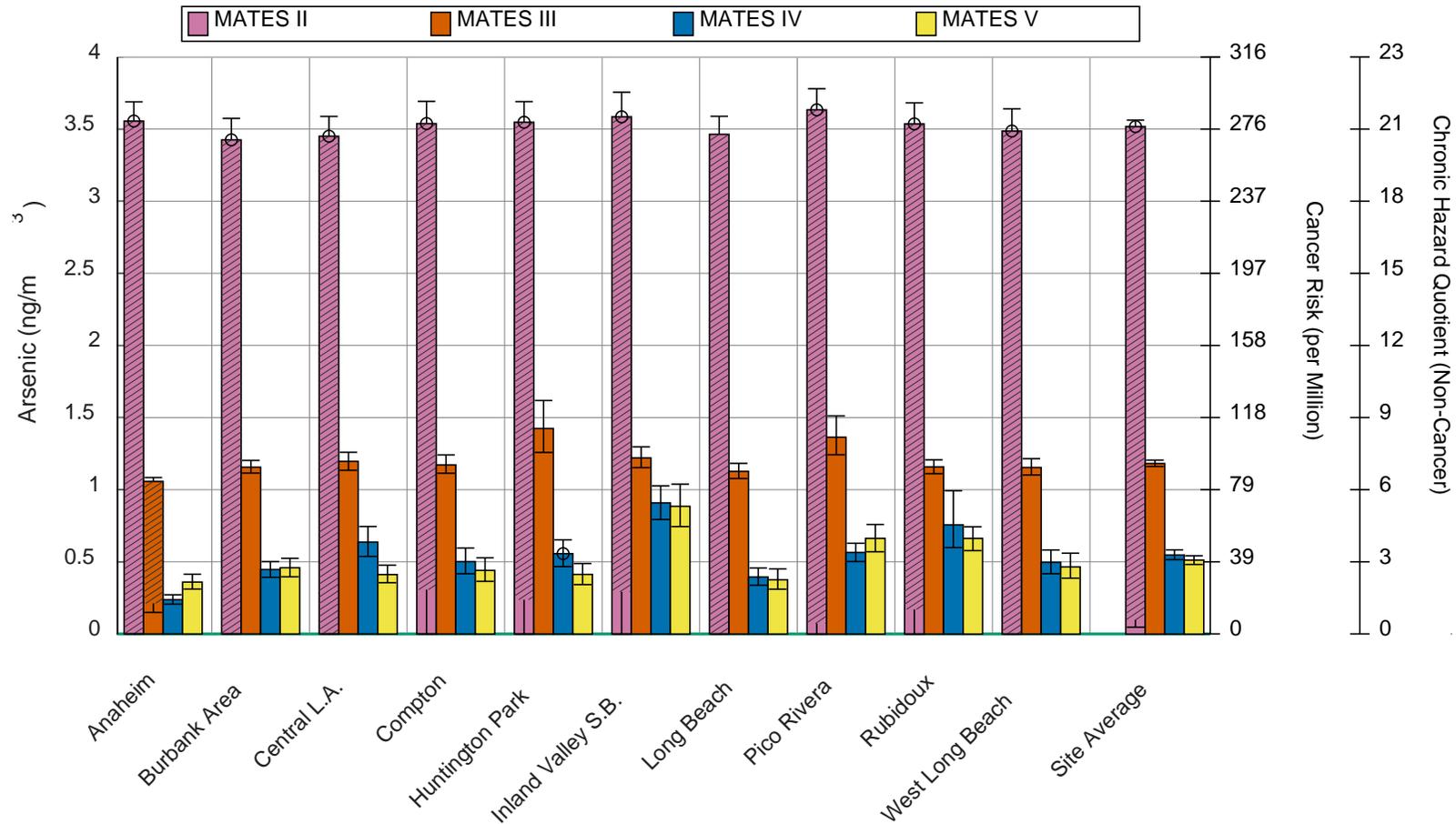
**Figure IV-68.** Geographic distribution of Antimony from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

## Arsenic

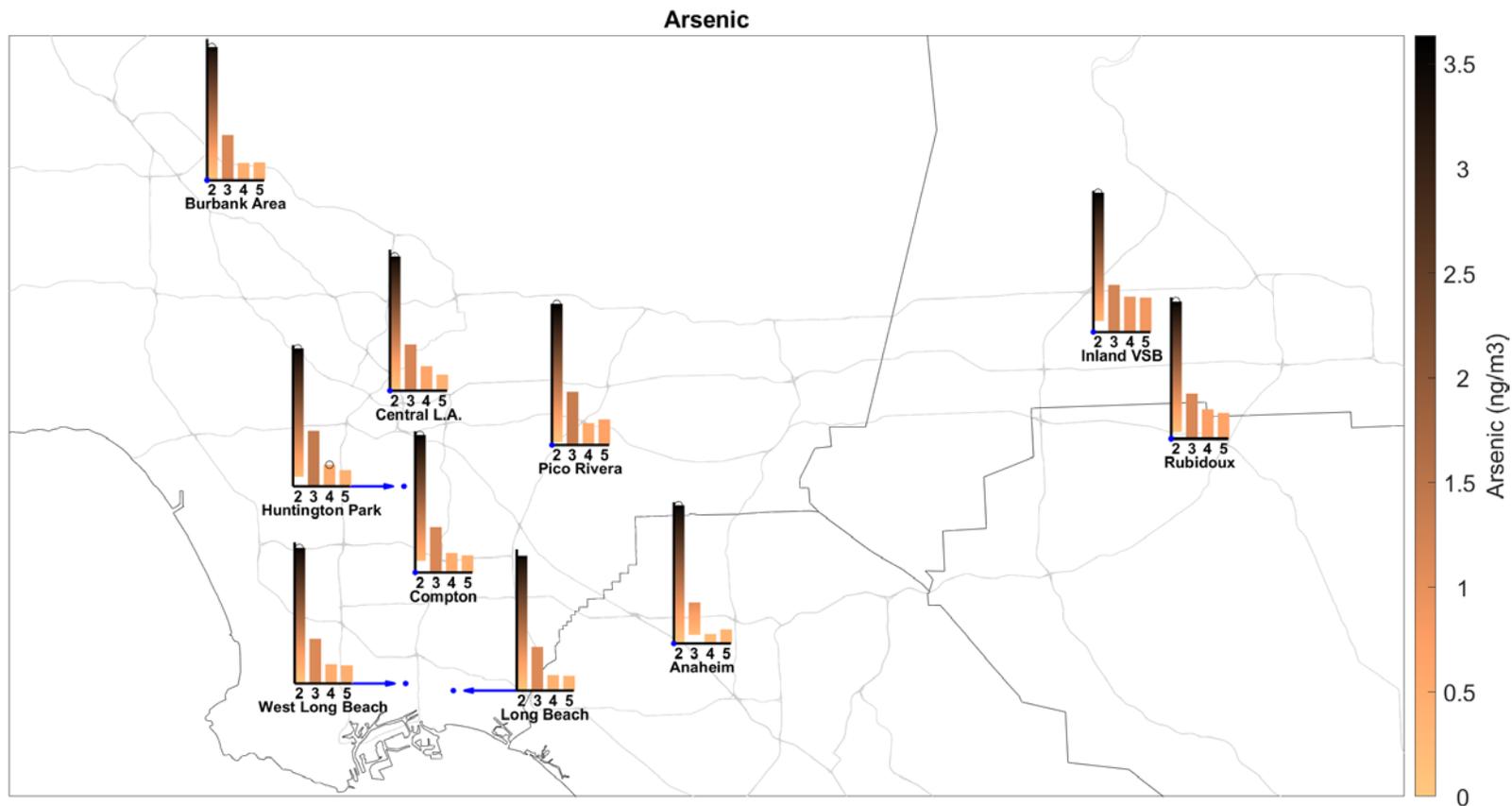
**Table IV-37.** Ambient Concentrations (ng/m<sup>3</sup>) of Arsenic from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0, 3.56 <sup>a</sup>	0, 3.43 <sup>a</sup>	0.308, 3.54 <sup>a</sup>	0.293, 3.59 <sup>a</sup>	0.238, 3.55 <sup>a</sup>	0, 3.46 <sup>a</sup>	0, 3.45 <sup>a</sup>	0.0732, 3.63 <sup>a</sup>	0.171, 3.54 <sup>a</sup>	0, 3.49 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	3.69 <sup>a</sup>	3.57 <sup>a</sup>	3.69 <sup>a</sup>	3.76 <sup>a</sup>	3.69 <sup>a</sup>	3.59 <sup>a</sup>	3.59 <sup>a</sup>	3.78 <sup>a</sup>	3.68 <sup>a</sup>	3.64 <sup>a</sup>
N	45 <sup>a</sup>	47 <sup>a</sup>	39 <sup>a</sup>	41 <sup>a</sup>	42 <sup>a</sup>	56 <sup>a</sup>	51 <sup>a</sup>	41 <sup>a</sup>	41 <sup>a</sup>	39 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	92.3 <sup>a</sup>	92.7 <sup>a</sup>	92.9 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	97.6 <sup>a</sup>	95.1 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	4 <sup>a</sup>	5 <sup>a</sup>	4 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	3 <sup>a</sup>	4 <sup>a</sup>	< MDL <sup>a</sup>
MATES III										
Average	0.212, 1.06 <sup>a</sup>	1.16	1.17	1.22	1.42	1.13	1.2	1.36	1.16	1.15
95% CI LB	0.149 <sup>a</sup>	1.12	1.11	1.15	1.26	1.08	1.13	1.24	1.11	1.1
95% CI UB	1.08 <sup>a</sup>	1.2	1.24	1.3	1.62	1.18	1.26	1.51	1.21	1.22
N	232 <sup>a</sup>	218	228	224	116	230	229	118	237	227
% < MDL	84.5 <sup>a</sup>	68.8	73.7	67.9	61.2	77	71.2	66.1	71.3	72.7
Max	2.31 <sup>a</sup>	3.43	5.77	7.23	6.47	4.2	4.95	4.97	4.3	4.98
MATES IV										
Average	0.238	0.447	0.502	0.909	0.557	0.396	0.637	0.566	0.757	0.497
95% CI LB	0.207	0.393	0.418	0.794	0.467	0.338	0.538	0.503	0.6	0.418
95% CI UB	0.271	0.502	0.596	1.03	0.653	0.458	0.745	0.629	0.993	0.583
N	60	58	59	56	55	59	59	60	58	58
% < MDL	16.7	3.4	5.1	0	0	5.1	0	3.3	0	3.4
Max	0.52	0.96	2.08	2.35	1.67	1.02	2.1	1.19	6.33	1.46
MATES V										
Average	0.36	0.459	0.441	0.885	0.413	0.376	0.412	0.663	0.663	0.466
95% CI LB	0.311	0.396	0.365	0.745	0.342	0.311	0.356	0.571	0.578	0.388
95% CI UB	0.414	0.524	0.528	1.04	0.489	0.452	0.477	0.759	0.743	0.561
N	61	58	61	59	61	60	60	60	60	59
% < MDL	1.6	0	0	0	14.8	0	1.7	0	0	0
Max	1.03	1.13	1.58	3.16	1.12	1.64	1.58	1.51	1.46	2.12

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.

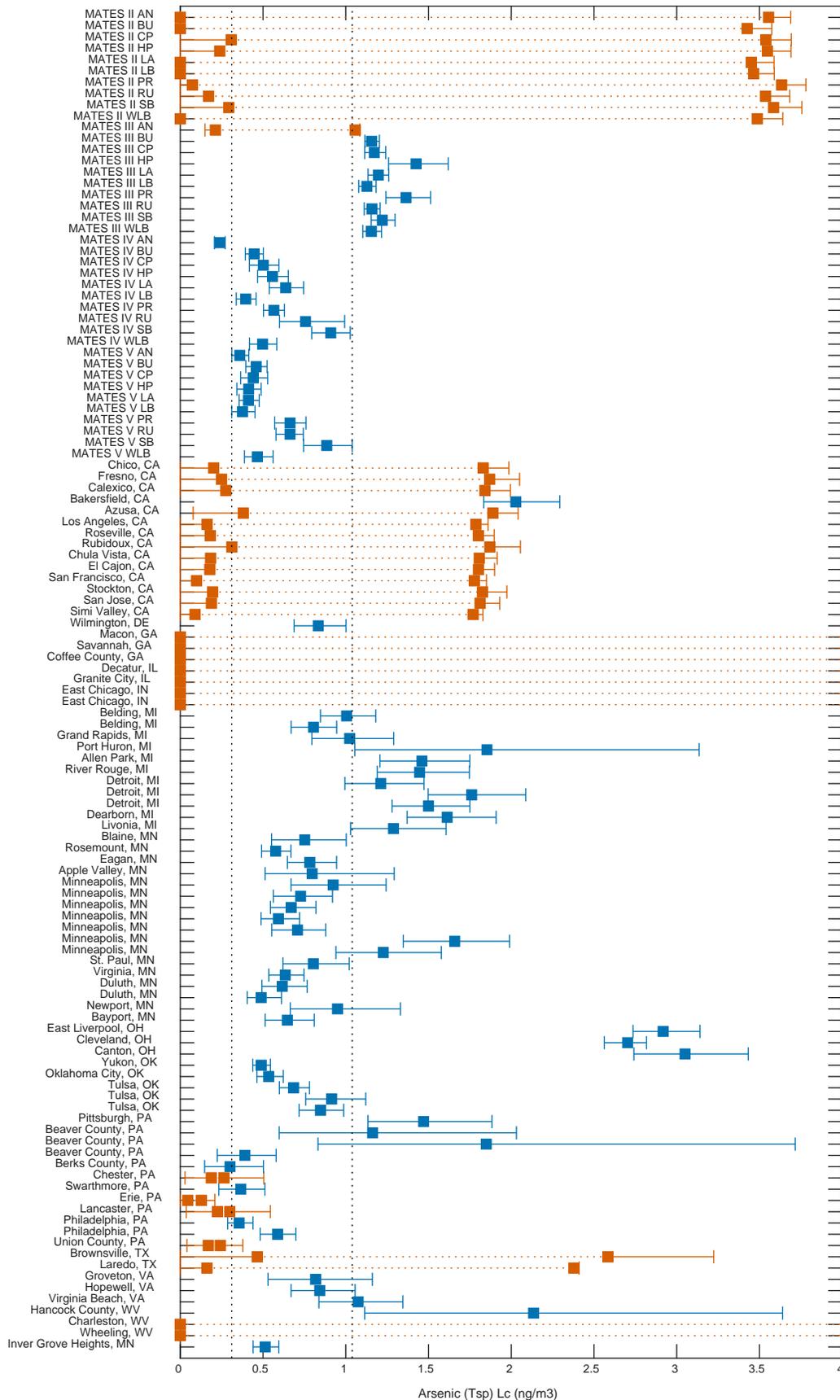


**Figure IV-69.** Annual Average Concentrations of Arsenic in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



**Figure IV-70.** Geographic distribution of Arsenic from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

The TSP arsenic concentrations from MATES V are consistent with or lower than those measured at most of the 79 sites in 13 states around the U.S. in the Ambient Monitoring Archive (AMA) for 2017 (<https://www3.epa.gov/ttn/amtic/toxdat.html#data>), see Figure IV-71. South Coast AQMD staff analyzed the 2017 AMA data using the same methods used for the MATES data (see Appendix XI). One site in Pennsylvania has a 95% confidence interval entirely lower than the 95% confidence intervals observed for the SoCAB for MATES V. Several sites around the nation have 95% confidence intervals that are entirely above the 95% confidence intervals seen in MATES V.



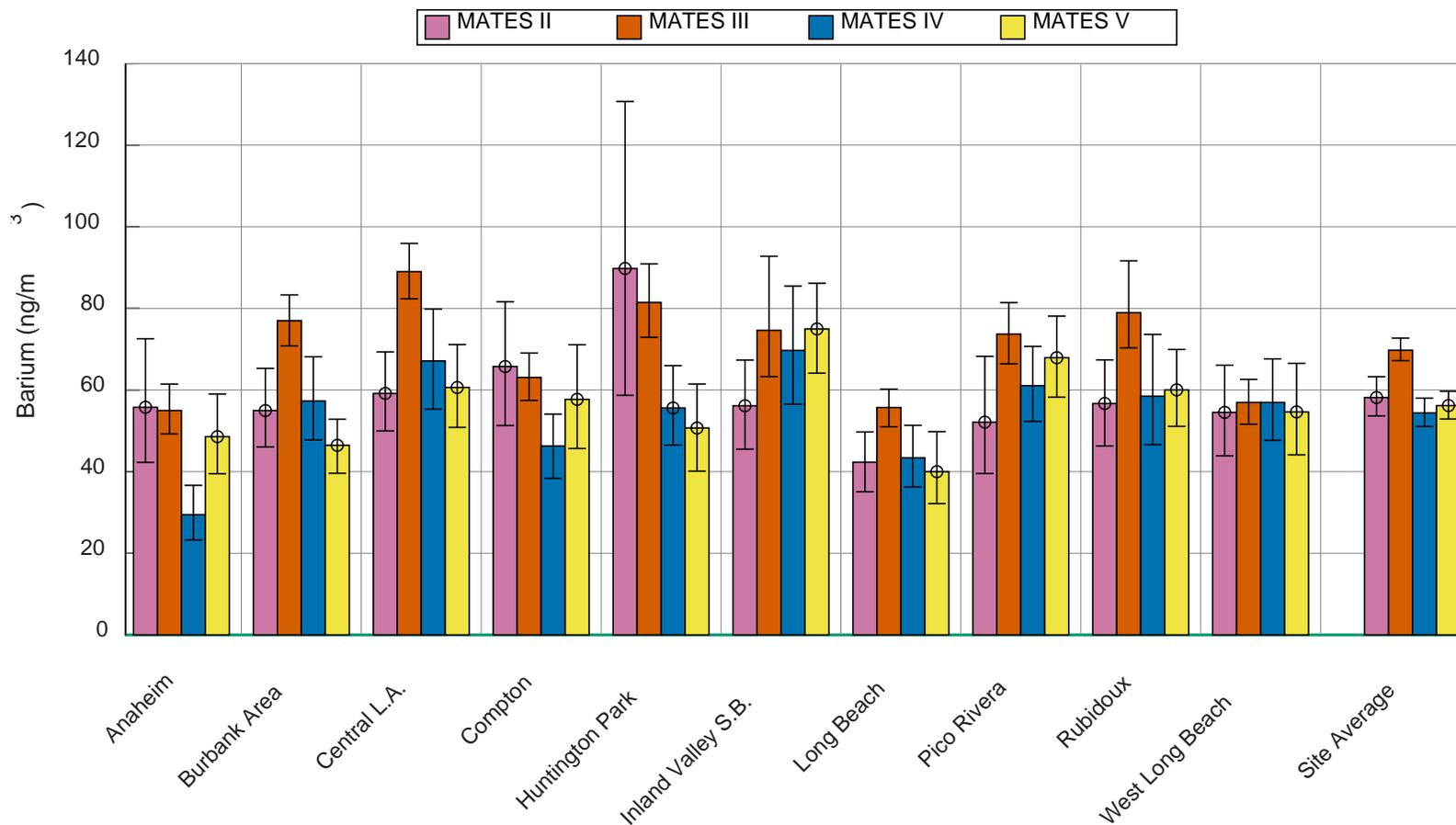
**Figure IV-71.** Comparison of MATES TSP Arsenic data with TSP Arsenic data from the Ambient Monitoring Archive (AMA) for 2017 (<https://www3.epa.gov/ttn/amtic/toxdat.html#data>). The 2-letter abbreviations for the MATES stations

are the same as those shown in Table IV-1. For the AMA data, the city or county is followed by the 2-letter state abbreviation. Blue data are the KM mean and corresponding error bars. The red-orange data have more than 80% below detection limit. For these data, the zero-substituted mean with its lower bound bootstrap 95% confidence interval, a dotted line between the zero-substituted mean and the MDL-substituted mean, and then the upper 95% confidence interval corresponding to the MDL substituted mean are shown. Note that some of the upper-bound estimates go well off the right-side of the plot. Vertical dotted lines mark the minimum and maximum 95% confidence intervals for TSP arsenic KM means from MATES V.

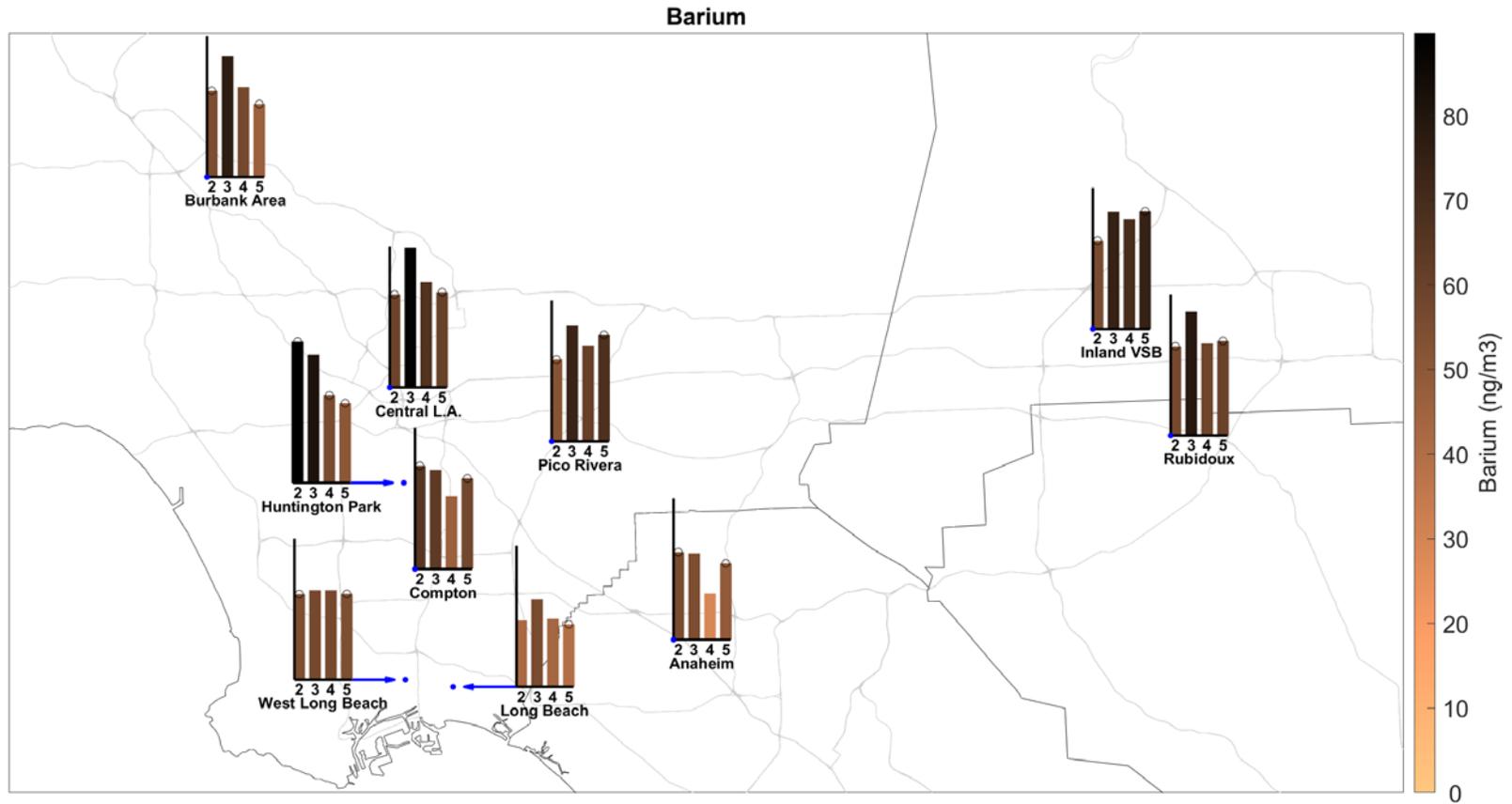
## Barium

**Table IV-38.** Ambient Concentrations (ng/m<sup>3</sup>) of Barium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	55.8	55	65.8	56.1	89.8	42.3	59.2	52.1	56.7	54.5
95% CI LB	42.3	46.1	51.3	45.5	58.7	35.1	50	39.5	46.3	43.9
95% CI UB	72.6	65.3	81.6	67.3	131	49.7	69.3	68.3	67.4	66.1
N	45	47	39	41	42	56	51	41	41	39
% < MDL	42.2	27.7	23.1	29.3	19	41.1	25.5	41.5	29.3	30.8
Max	237	161	212	176	602	127	197	286	152	170
MATES III										
Average	55	77	63.1	74.6	81.4	55.7	89	73.7	78.9	56.9
95% CI LB	49.3	70.8	57.4	63.3	72.9	51	82.4	66.4	70.3	51.6
95% CI UB	61.5	83.3	69.1	92.8	90.9	60.2	95.9	81.4	91.6	62.6
N	232	218	228	224	116	230	229	118	237	227
% < MDL	10.3	3.2	4.4	5.4	0.9	5.7	2.6	0.8	5.1	11
Max	457	366	268	1830	300	214	353	210	1280	218
MATES IV										
Average	29.4	57.3	46.3	69.7	55.6	43.4	67.1	61.1	58.5	57
95% CI LB	23.3	47.8	38.3	56.5	46.5	36.3	55.3	52.3	46.6	47.7
95% CI UB	36.6	68.1	54.1	85.5	66	51.3	79.8	70.7	73.6	67.6
N	60	58	59	56	55	59	59	60	58	58
% < MDL	1.7	0	0	0	0	0	0	0	0	0
Max	159	216	139	306	158	115	216	162	371	159
MATES V										
Average	48.6	46.4	57.7	75	50.7	40	60.6	67.9	60	54.6
95% CI LB	39.5	39.6	45.7	64.1	40.1	32.2	50.8	58.3	51.1	44.1
95% CI UB	59	52.9	71.1	86.2	61.5	49.8	71.1	78.1	69.9	66.5
N	55	51	54	55	56	55	53	55	53	54
% < MDL	0	0	0	0	1.8	0	1.9	0	0	0
Max	218	109	215	189	171	154	185	179	160	225



**Figure IV-72.** Annual Average Concentrations of Barium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



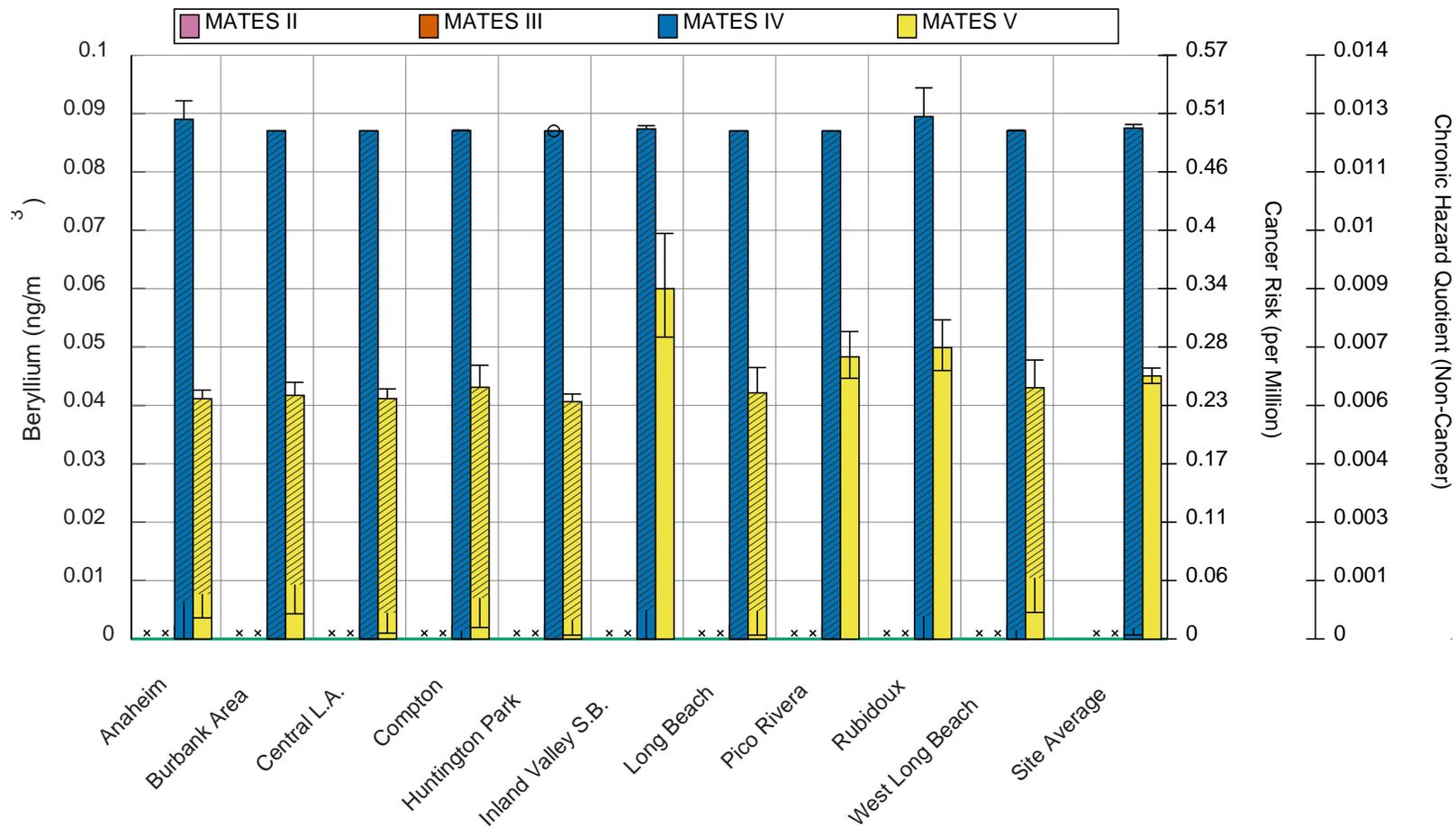
**Figure IV-73.** Geographic distribution of Barium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Beryllium

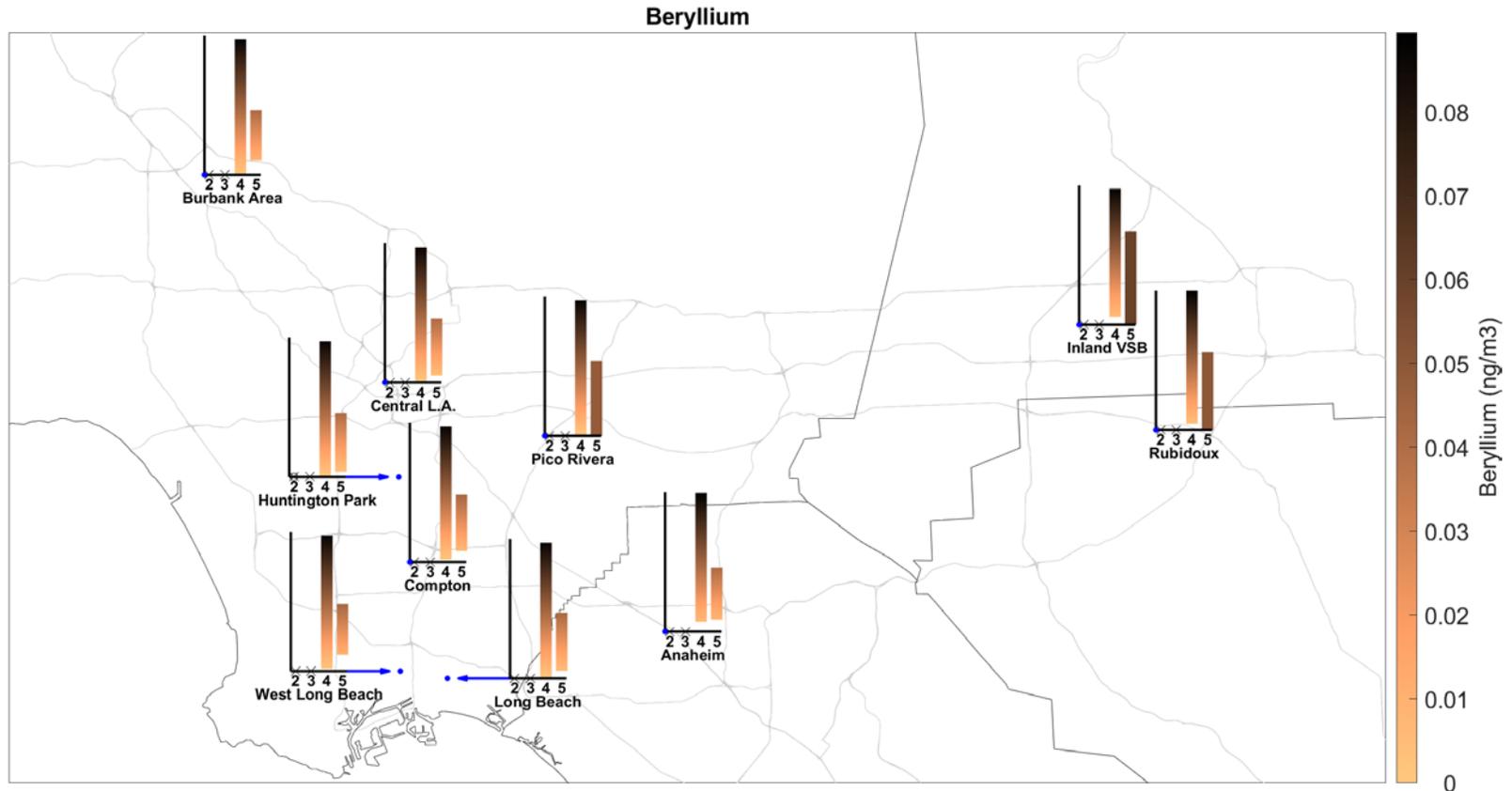
**Table IV-39.** Ambient Concentrations (ng/m<sup>3</sup>) of Beryllium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average	0.00633, 0.089 <sup>a</sup>	0, 0.087 <sup>a</sup>	0.00153, 0.0871 <sup>a</sup>	0.005, 0.0874 <sup>a</sup>	0, 0.087 <sup>a</sup>	0, 0.087 <sup>a</sup>	0, 0.087 <sup>a</sup>	0, 0.087 <sup>a</sup>	0.00397, 0.0895 <sup>a</sup>	0.00155, 0.0871 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.0922 <sup>a</sup>	0.087 <sup>a</sup>	0.0872 <sup>a</sup>	0.0879 <sup>a</sup>	0.087 <sup>a</sup>	0.087 <sup>a</sup>	0.087 <sup>a</sup>	0.087 <sup>a</sup>	0.0944 <sup>a</sup>	0.0872 <sup>a</sup>
N	60 <sup>a</sup>	58 <sup>a</sup>	59 <sup>a</sup>	56 <sup>a</sup>	55 <sup>a</sup>	59 <sup>a</sup>	59 <sup>a</sup>	60 <sup>a</sup>	58 <sup>a</sup>	58 <sup>a</sup>
% < MDL	95 <sup>a</sup>	100 <sup>a</sup>	98.3 <sup>a</sup>	94.6 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	98.3 <sup>a</sup>	98.3 <sup>a</sup>
Max	0.15 <sup>a</sup>	< MDL <sup>a</sup>	0.09 <sup>a</sup>	0.1 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.23 <sup>a</sup>	0.09 <sup>a</sup>
MATES V										
Average	0.0077, 0.0411 <sup>a</sup>	0.00931, 0.0417 <sup>a</sup>	0.00705, 0.0431 <sup>a</sup>	0.06	0.00328, 0.0407 <sup>a</sup>	0.00483, 0.0422 <sup>a</sup>	0.0045, 0.0412 <sup>a</sup>	0.0483	0.0499	0.0105, 0.0431 <sup>a</sup>
95% CI LB	0.00361 <sup>a</sup>	0.00431 <sup>a</sup>	0.00197 <sup>a</sup>	0.0517	0.000656 <sup>a</sup>	0.000667 <sup>a</sup>	0.001 <sup>a</sup>	0.0447	0.046	0.00458 <sup>a</sup>
95% CI UB	0.0426 <sup>a</sup>	0.044 <sup>a</sup>	0.0469 <sup>a</sup>	0.0695	0.042 <sup>a</sup>	0.0465 <sup>a</sup>	0.0428 <sup>a</sup>	0.0527	0.0547	0.0478 <sup>a</sup>
N	61 <sup>a</sup>	58 <sup>a</sup>	61 <sup>a</sup>	59	61 <sup>a</sup>	60 <sup>a</sup>	60 <sup>a</sup>	60	60	59 <sup>a</sup>
% < MDL	83.6 <sup>a</sup>	81 <sup>a</sup>	90.2 <sup>a</sup>	40.7	93.4 <sup>a</sup>	93.3 <sup>a</sup>	91.7 <sup>a</sup>	58.3	46.7	81.4 <sup>a</sup>
Max	0.07 <sup>a</sup>	0.09 <sup>a</sup>	0.13 <sup>a</sup>	0.18	0.07 <sup>a</sup>	0.15 <sup>a</sup>	0.08 <sup>a</sup>	0.11	0.14	0.15 <sup>a</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-74.** Annual Average Concentrations of Beryllium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

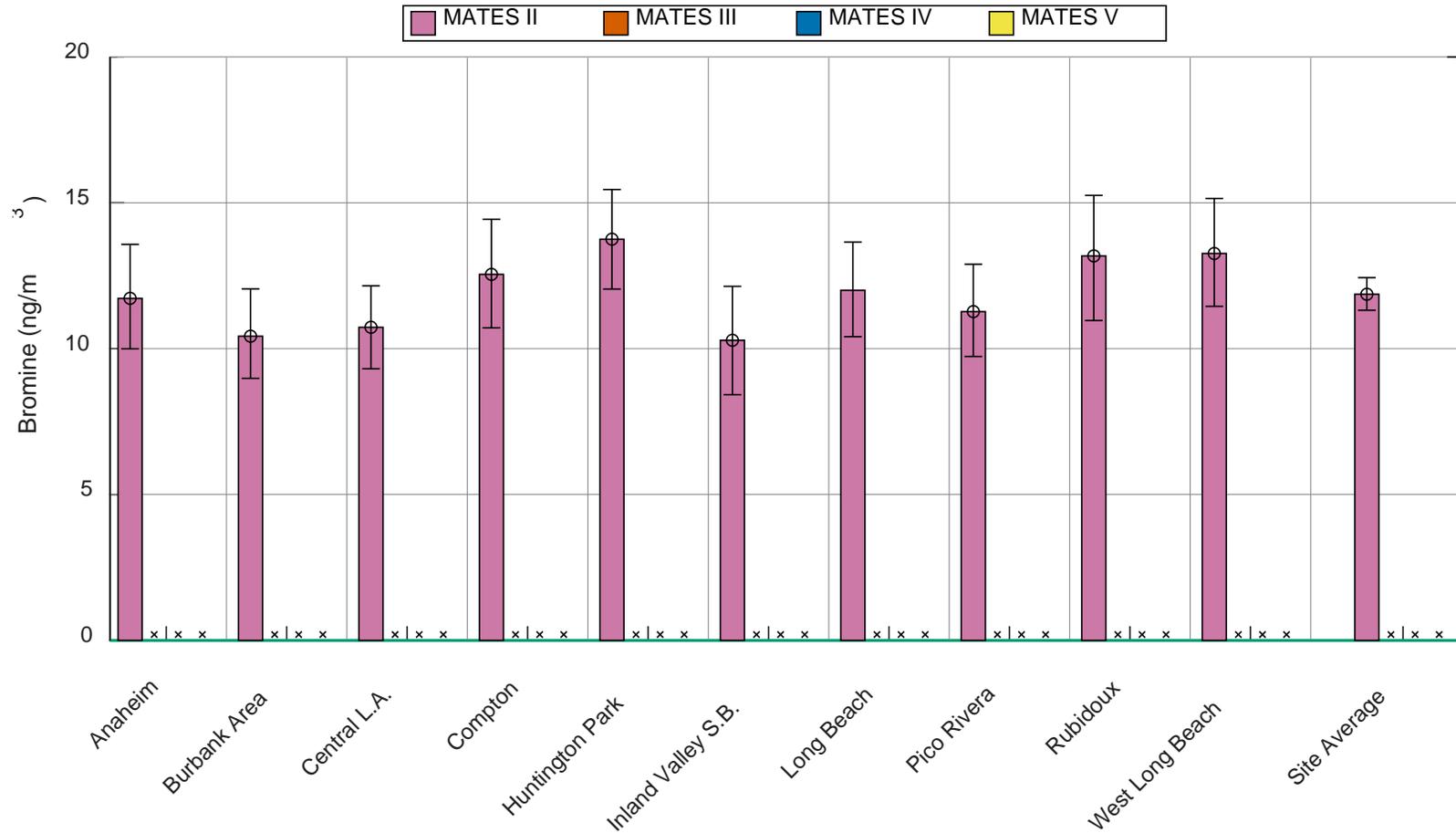


**Figure IV-75.** Geographic distribution of Beryllium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

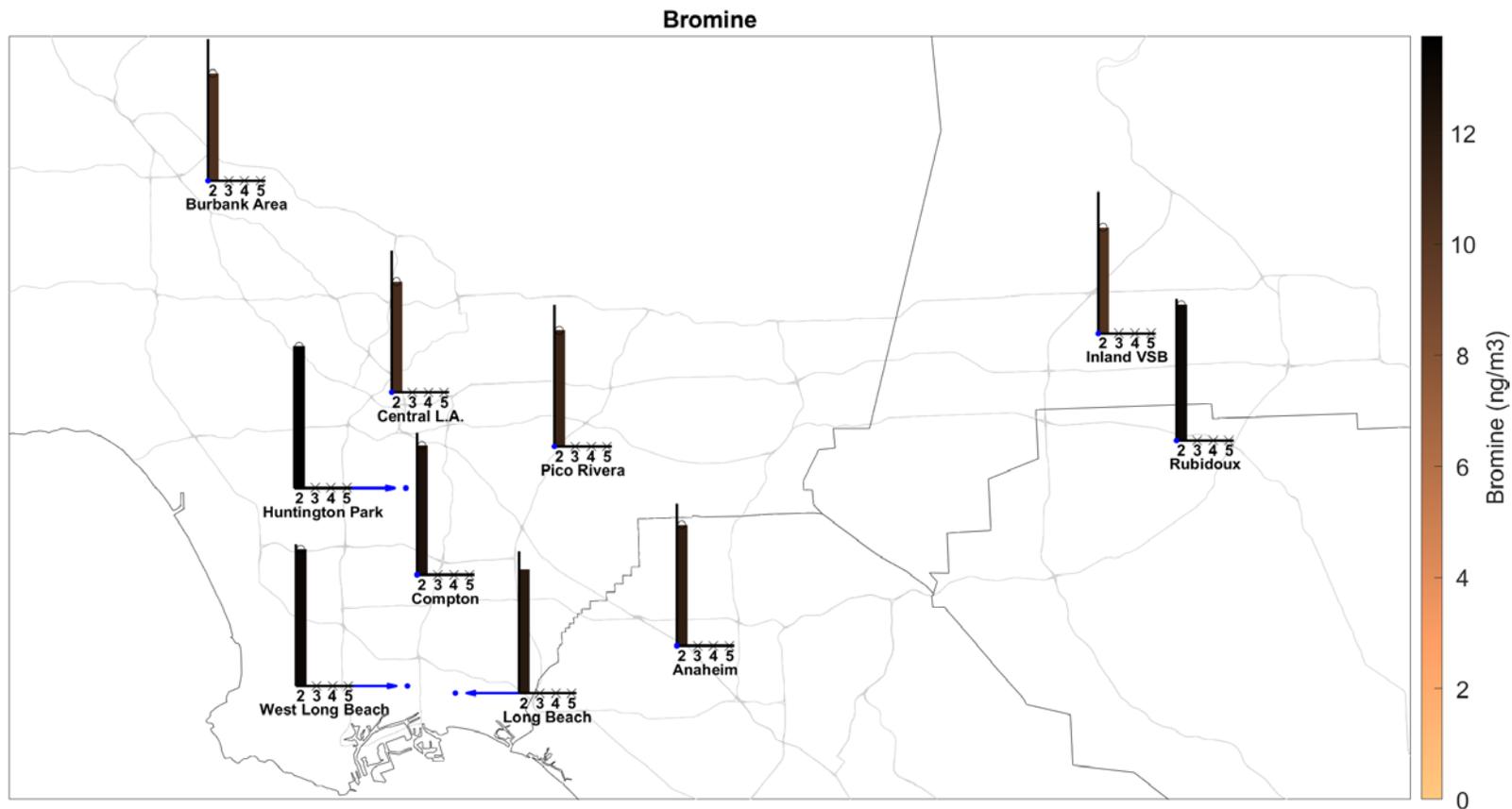
Bromine

**Table IV-40.** Ambient Concentrations (ng/m<sup>3</sup>) of Bromine from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	11.7	10.4	12.5	10.3	13.8	12	10.7	11.3	13.2	13.3
95% CI LB	9.99	8.98	10.7	8.42	12	10.4	9.31	9.73	11	11.4
95% CI UB	13.6	12	14.4	12.1	15.5	13.7	12.2	12.9	15.3	15.1
N	45	47	39	41	42	56	51	41	41	39
% < MDL	2.2	0	0	4.9	0	0	3.9	2.4	4.9	0
Max	28	30.1	35.1	28.4	29	37.5	22.4	23.9	29.1	28.8
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-76.** Annual Average Concentrations of Bromine in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



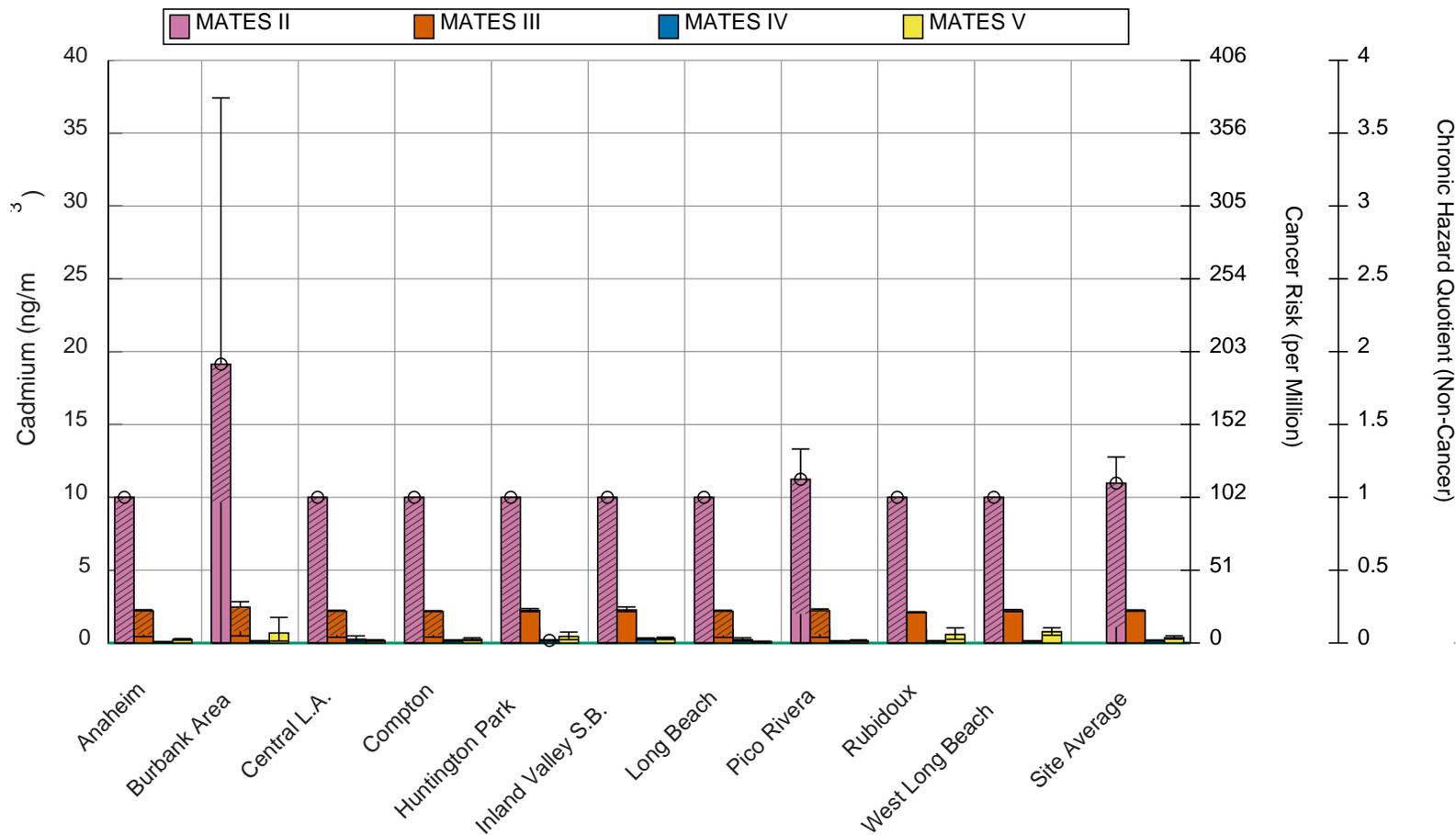
**Figure IV-77.** Geographic distribution of Bromine from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Cadmium

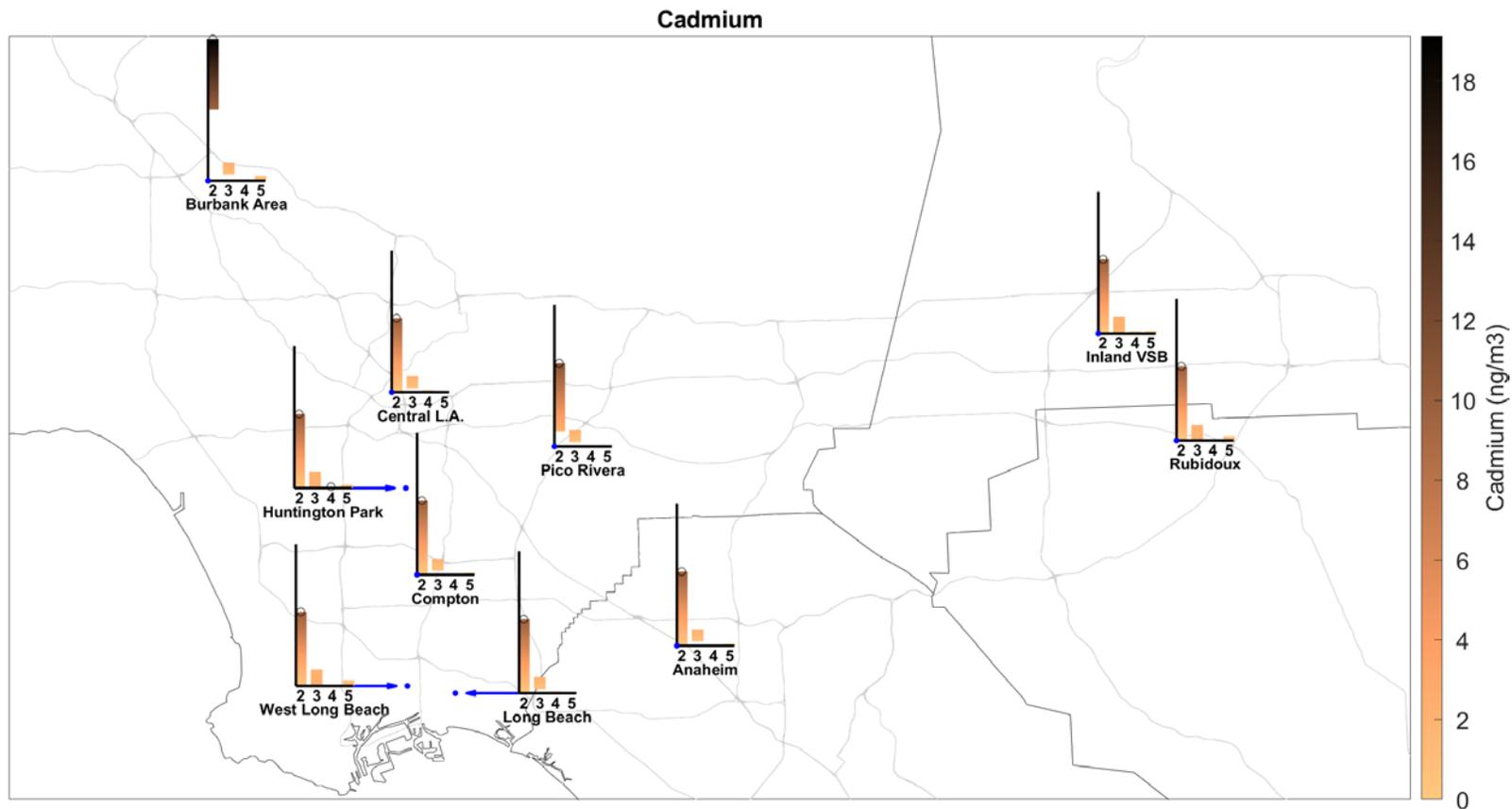
**Table IV-41.** Ambient Concentrations (ng/m<sup>3</sup>) of Cadmium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0, 10 <sup>a</sup>	9.64, 19.1 <sup>a</sup>	0, 10 <sup>a</sup>	0, 10 <sup>a</sup>	0, 10 <sup>a</sup>	0, 10 <sup>a</sup>	0, 10 <sup>a</sup>	2.01, 11.2 <sup>a</sup>	0, 10 <sup>a</sup>	0, 10 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	10 <sup>a</sup>	37.4 <sup>a</sup>	10 <sup>a</sup>	10 <sup>a</sup>	10 <sup>a</sup>	10 <sup>a</sup>	10 <sup>a</sup>	13.3 <sup>a</sup>	10 <sup>a</sup>	10 <sup>a</sup>
N	25 <sup>a</sup>	20 <sup>a</sup>	18 <sup>a</sup>	21 <sup>a</sup>	22 <sup>a</sup>	26 <sup>a</sup>	23 <sup>a</sup>	26 <sup>a</sup>	21 <sup>a</sup>	19 <sup>a</sup>
% < MDL	100 <sup>a</sup>	95 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	92.3 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	193 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	31.7 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES III</b>										
Average	0.595, 2.21 <sup>a</sup>	0.821, 2.46 <sup>a</sup>	0.555, 2.16 <sup>a</sup>	2.27	2.24	0.531, 2.18 <sup>a</sup>	0.542, 2.18 <sup>a</sup>	0.614, 2.22 <sup>a</sup>	2.11	2.22
95% CI LB	0.437 <sup>a</sup>	0.49 <sup>a</sup>	0.409 <sup>a</sup>	2.15	2.15	0.384 <sup>a</sup>	0.391 <sup>a</sup>	0.387 <sup>a</sup>	2.08	2.15
95% CI UB	2.28 <sup>a</sup>	2.84 <sup>a</sup>	2.22 <sup>a</sup>	2.47	2.36	2.25 <sup>a</sup>	2.25 <sup>a</sup>	2.34 <sup>a</sup>	2.15	2.3
N	232 <sup>a</sup>	218 <sup>a</sup>	228 <sup>a</sup>	224	116	230 <sup>a</sup>	229 <sup>a</sup>	118 <sup>a</sup>	237	227
% < MDL	80.6 <sup>a</sup>	82.1 <sup>a</sup>	80.3 <sup>a</sup>	76.8	74.1	82.6 <sup>a</sup>	82.1 <sup>a</sup>	80.5 <sup>a</sup>	78.9	77.5
Max	6.58 <sup>a</sup>	28.1 <sup>a</sup>	4.6 <sup>a</sup>	17.5	5.71	5.45 <sup>a</sup>	5.34 <sup>a</sup>	6.53 <sup>a</sup>	3.83	6.94
<b>MATES IV</b>										
Average	0.0876	0.134	0.168	0.283	0.181	0.227	0.26	0.124	0.131	0.127
95% CI LB	0.0817	0.109	0.13	0.232	0.144	0.14	0.134	0.106	0.108	0.107
95% CI UB	0.0947	0.164	0.211	0.346	0.222	0.36	0.491	0.148	0.164	0.152
N	60	58	59	56	55	59	59	60	58	58
% < MDL	80	41.4	40.7	7.1	27.3	35.6	30.5	35	39.7	44.8
Max	0.2	0.65	0.7	1.45	0.76	3.19	6.5	0.59	0.84	0.42
<b>MATES V</b>										
Average	0.244	0.69	0.249	0.311	0.449	0.088	0.15	0.144	0.588	0.771
95% CI LB	0.193	0.136	0.166	0.239	0.234	0.0646	0.107	0.1	0.251	0.531
95% CI UB	0.306	1.76	0.359	0.394	0.751	0.129	0.219	0.214	1.04	1.05
N	61	58	61	59	61	60	60	60	60	59
% < MDL	0	0	0	0	3.3	0	1.7	0	0	0
Max	1.42	30	2.62	1.72	7.13	1.01	1.85	1.77	9.18	4.43

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-78.** Annual Average Concentrations of Cadmium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

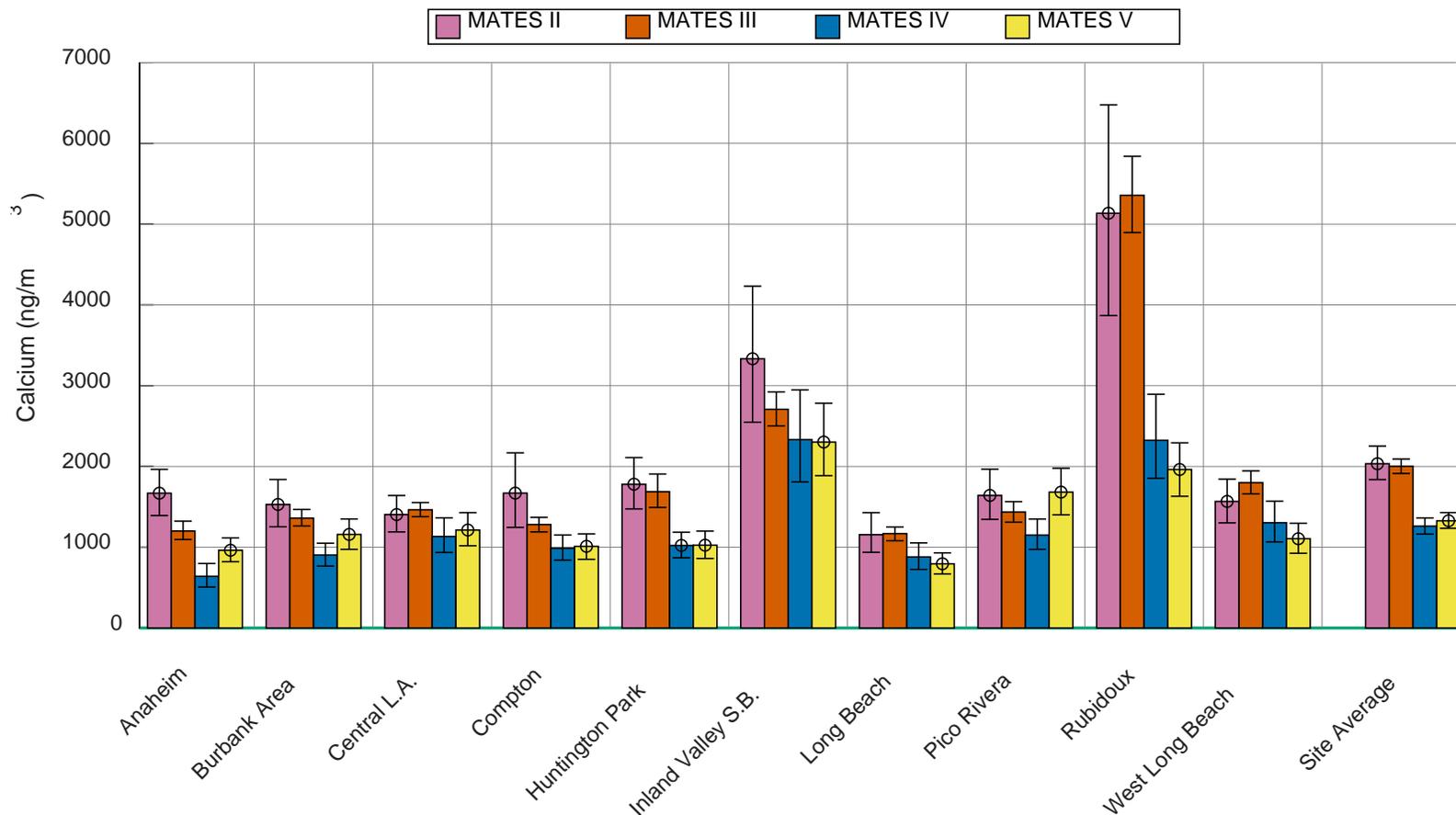


**Figure IV-79.** Geographic distribution of Cadmium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

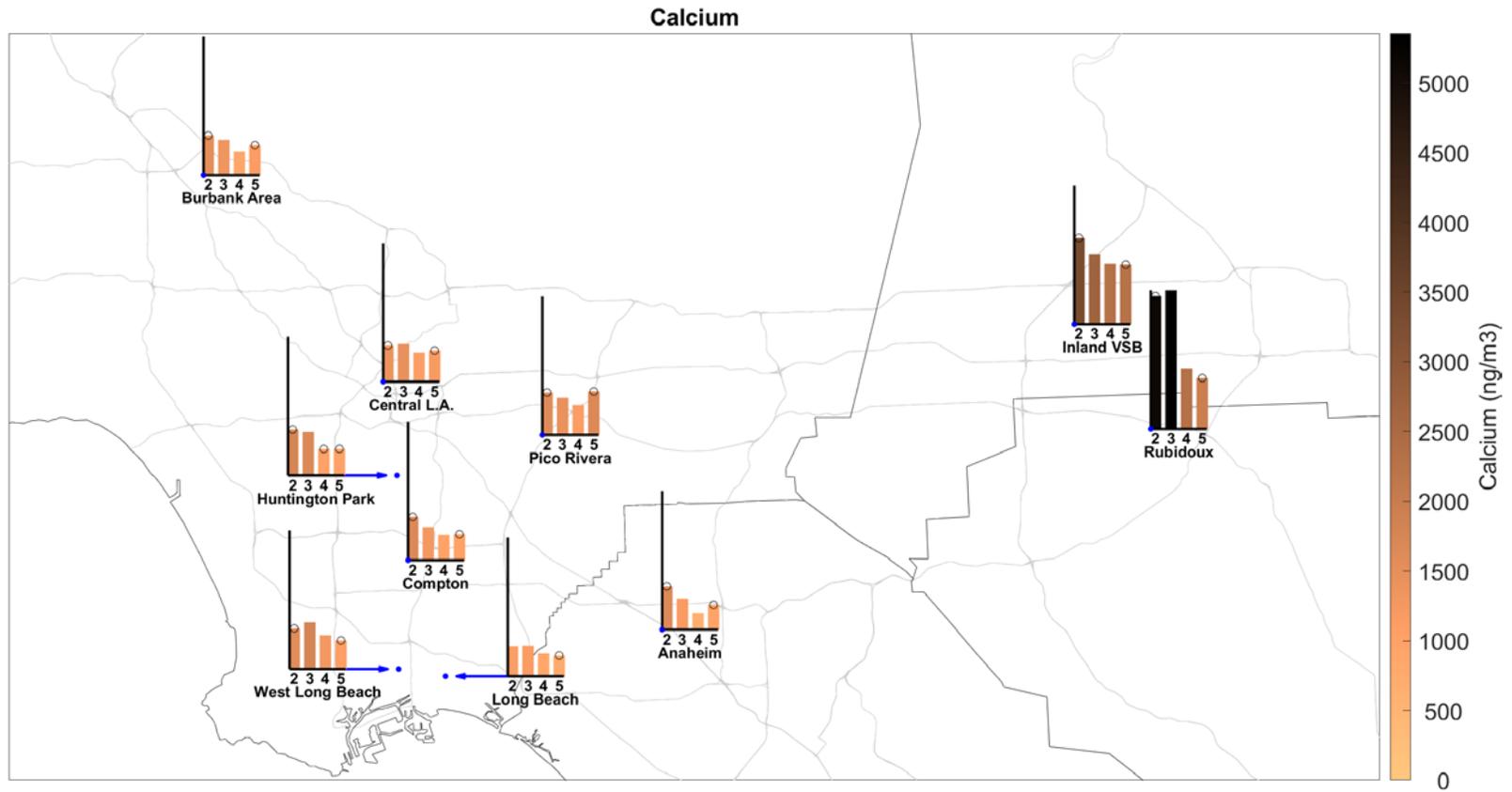
## Calcium

**Table IV-42.** Ambient Concentrations (ng/m<sup>3</sup>) of Calcium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	1670	1530	1670	3330	1780	1160	1400	1640	5130	1570
95% CI LB	1390	1250	1250	2550	1470	937	1190	1340	3870	1300
95% CI UB	1960	1840	2170	4230	2110	1430	1640	1970	6480	1840
N	45	47	39	41	42	56	51	41	41	39
% < MDL	0	2.1	0	0	0	0	0	2.4	4.9	0
Max	3840	5920	9710	14600	4750	6070	4320	4930	16100	3810
MATES III										
Average	1200	1360	1280	2710	1690	1170	1460	1440	5360	1800
95% CI LB	1100	1260	1190	2500	1490	1080	1380	1310	4900	1660
95% CI UB	1320	1470	1370	2920	1910	1250	1550	1560	5840	1950
N	232	218	228	224	116	230	229	118	237	227
% < MDL	0	0	0	0.4	0	0	0	0	0	0
Max	5750	5920	3720	9080	10300	4630	3330	3660	20600	7020
MATES IV										
Average	640	903	987	2330	1020	879	1130	1150	2320	1300
95% CI LB	507	767	840	1810	869	725	935	974	1850	1070
95% CI UB	799	1050	1150	2950	1190	1050	1360	1350	2890	1570
N	60	58	59	56	55	59	59	60	58	58
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	3540	2880	3090	11200	3420	3340	4610	3800	9220	4640
MATES V										
Average	962	1160	1010	2300	1020	795	1210	1680	1960	1110
95% CI LB	821	974	851	1890	861	669	1020	1400	1630	925
95% CI UB	1110	1350	1160	2780	1200	930	1430	1980	2290	1300
N	41	39	40	42	41	38	37	39	39	38
% < MDL	7.3	5.1	7.5	4.8	14.6	7.9	5.4	5.1	7.7	5.3
Max	2430	2530	2500	7320	2490	1860	3540	4280	4320	2660



**Figure IV-80.** Annual Average Concentrations of Calcium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



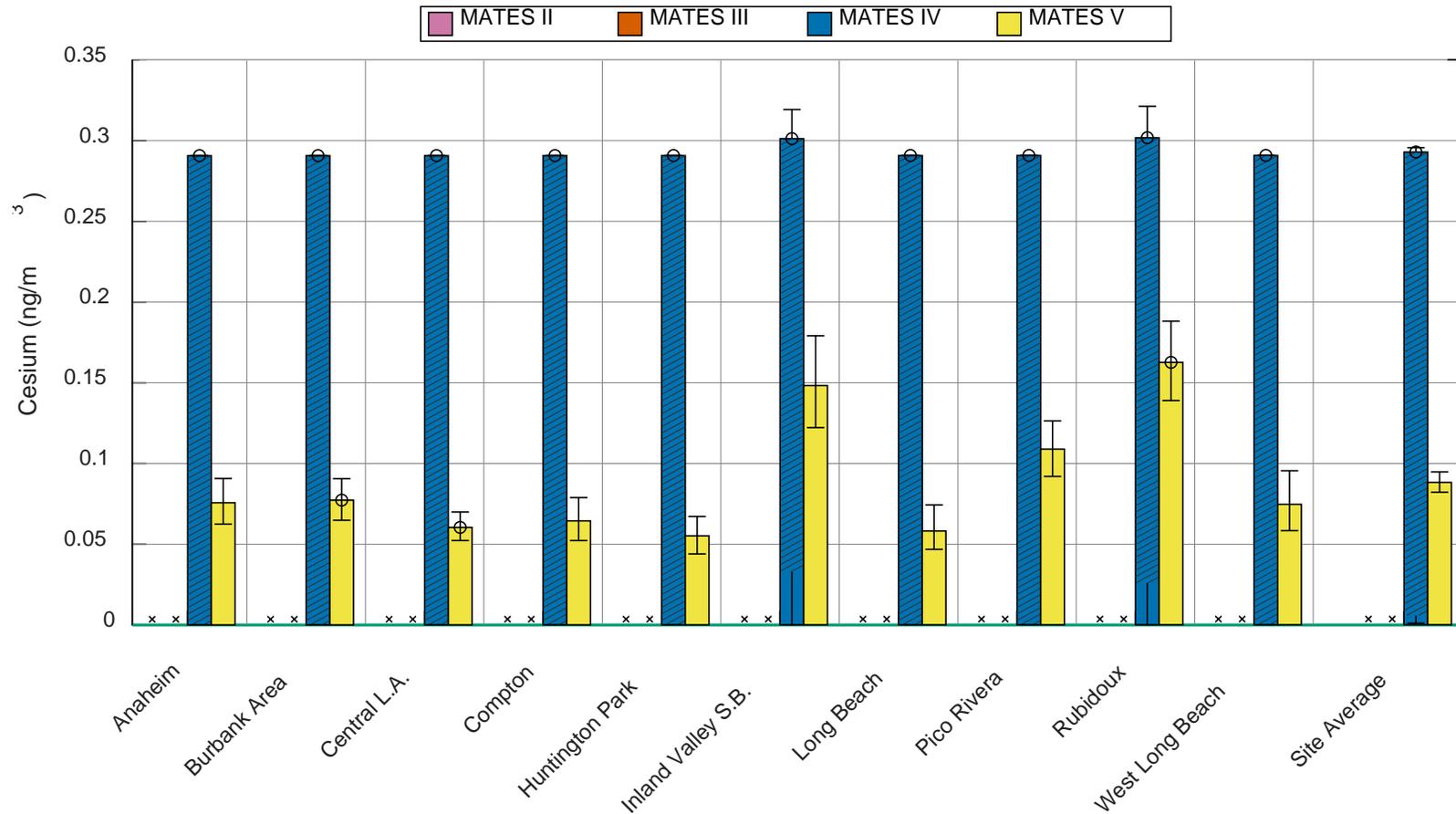
**Figure IV-81.** Geographic distribution of Calcium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Cesium

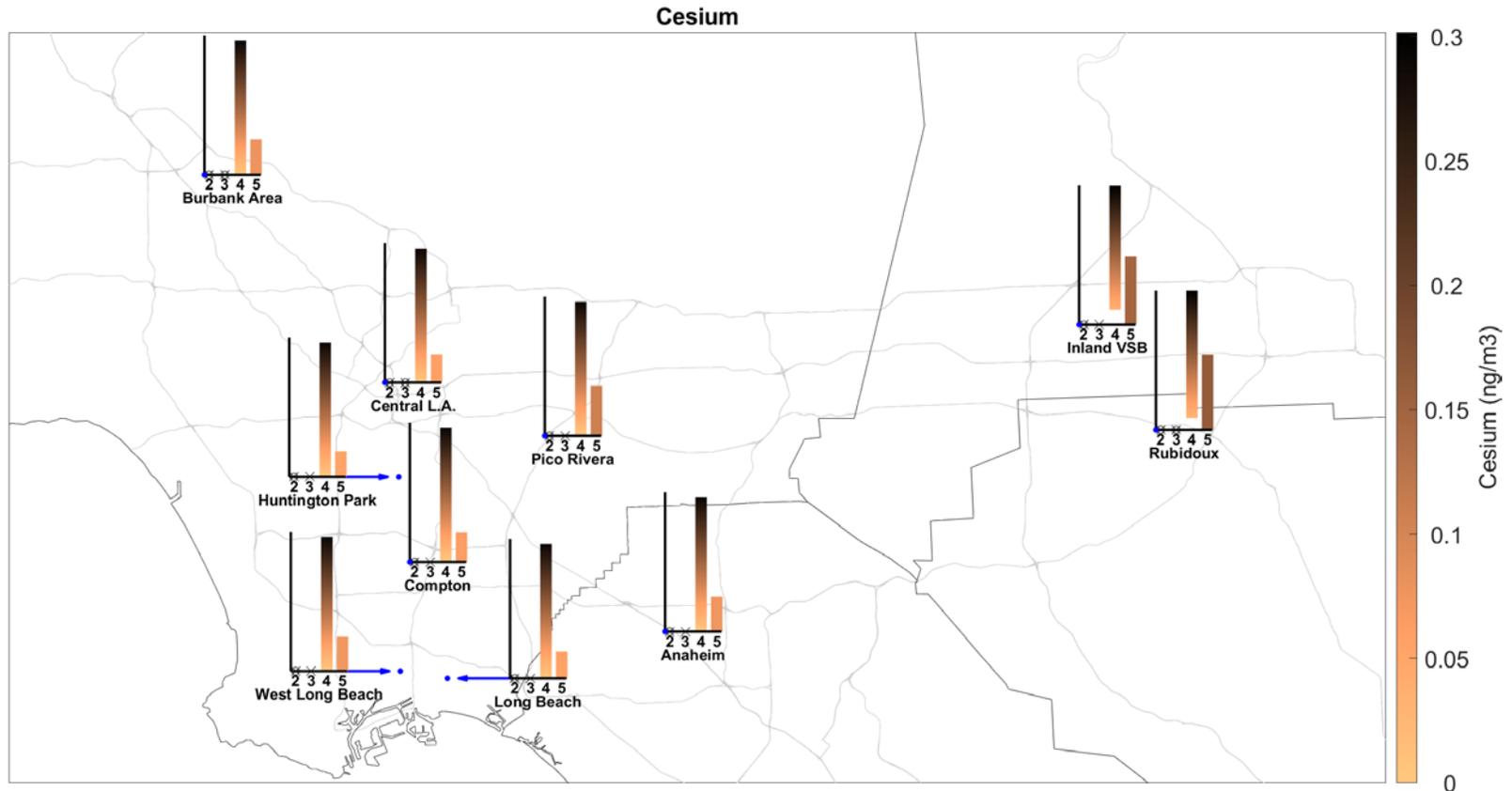
**Table IV-43.** Ambient Concentrations (ng/m<sup>3</sup>) of Cesium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average	0, 0.291 <sup>a</sup>	0, 0.291 <sup>a</sup>	0, 0.291 <sup>a</sup>	0.0328, 0.301 <sup>a</sup>	0, 0.291 <sup>a</sup>	0, 0.291 <sup>a</sup>	0, 0.291 <sup>a</sup>	0, 0.291 <sup>a</sup>	0.0259, 0.302 <sup>a</sup>	0, 0.291 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	0.291 <sup>a</sup>	0.291 <sup>a</sup>	0.291 <sup>a</sup>	0.319 <sup>a</sup>	0.291 <sup>a</sup>	0.291 <sup>a</sup>	0.291 <sup>a</sup>	0.291 <sup>a</sup>	0.321 <sup>a</sup>	0.291 <sup>a</sup>
N	41 <sup>a</sup>	39 <sup>a</sup>	40 <sup>a</sup>	39 <sup>a</sup>	40 <sup>a</sup>	41 <sup>a</sup>	40 <sup>a</sup>	42 <sup>a</sup>	39 <sup>a</sup>	41 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	92.3 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	94.9 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.63 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	0.67 <sup>a</sup>	< MDL <sup>a</sup>
MATES V										
Average	0.0757	0.0773	0.0644	0.148	0.0551	0.0581	0.0604	0.109	0.162	0.0746
95% CI LB	0.0624	0.0648	0.0522	0.122	0.0439	0.0467	0.0522	0.0919	0.139	0.0582
95% CI UB	0.0907	0.0905	0.0788	0.179	0.0671	0.0742	0.0699	0.126	0.188	0.0954
N	58	55	59	56	59	58	56	58	56	57
% < MDL	1.7	3.6	3.4	3.6	20.3	5.2	5.4	5.2	0	3.5
Max	0.28	0.27	0.3	0.6	0.2	0.38	0.19	0.33	0.53	0.5

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-82.** Annual Average Concentrations of Cesium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

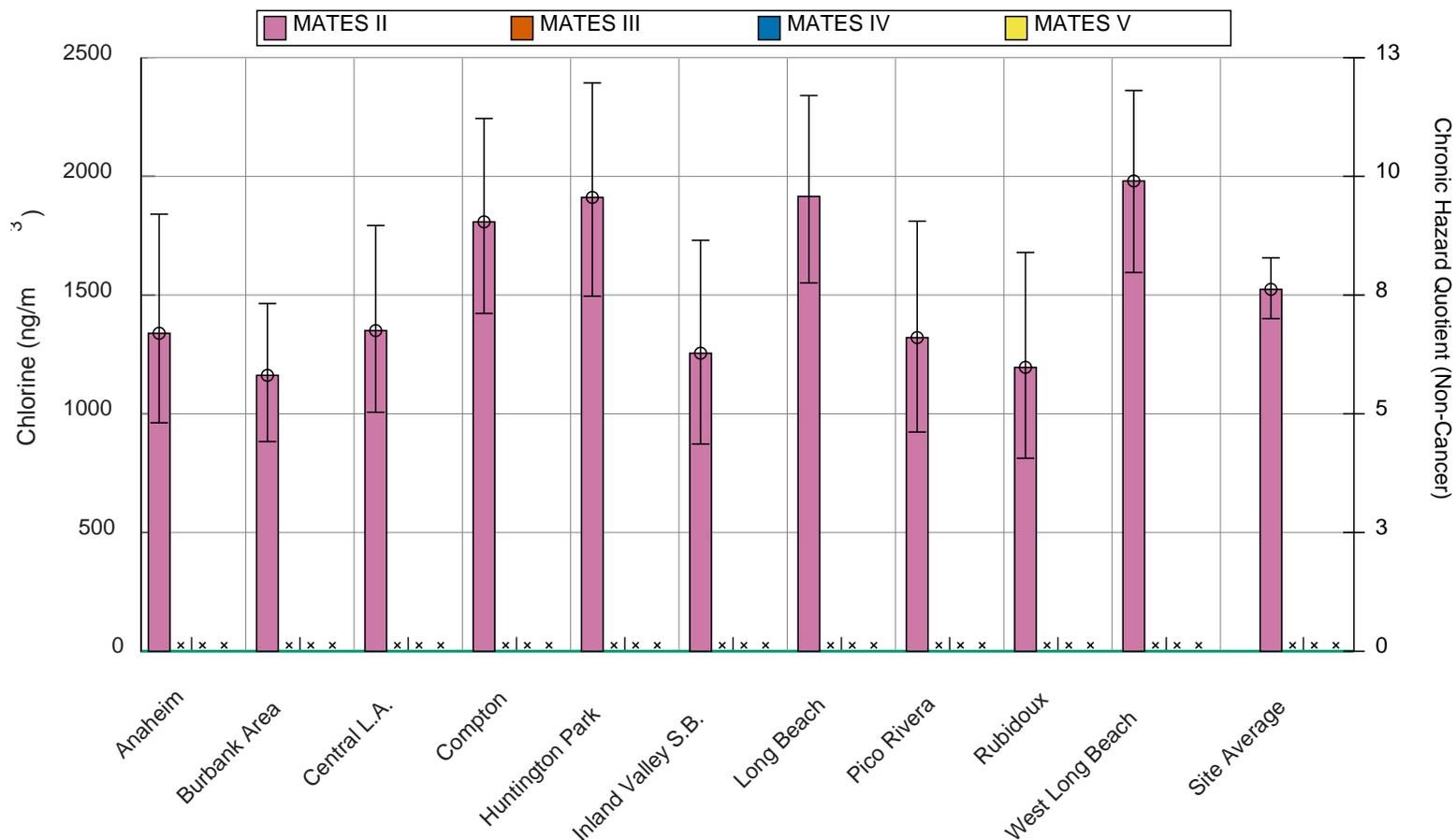


**Figure IV-83.** Geographic distribution of Cesium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

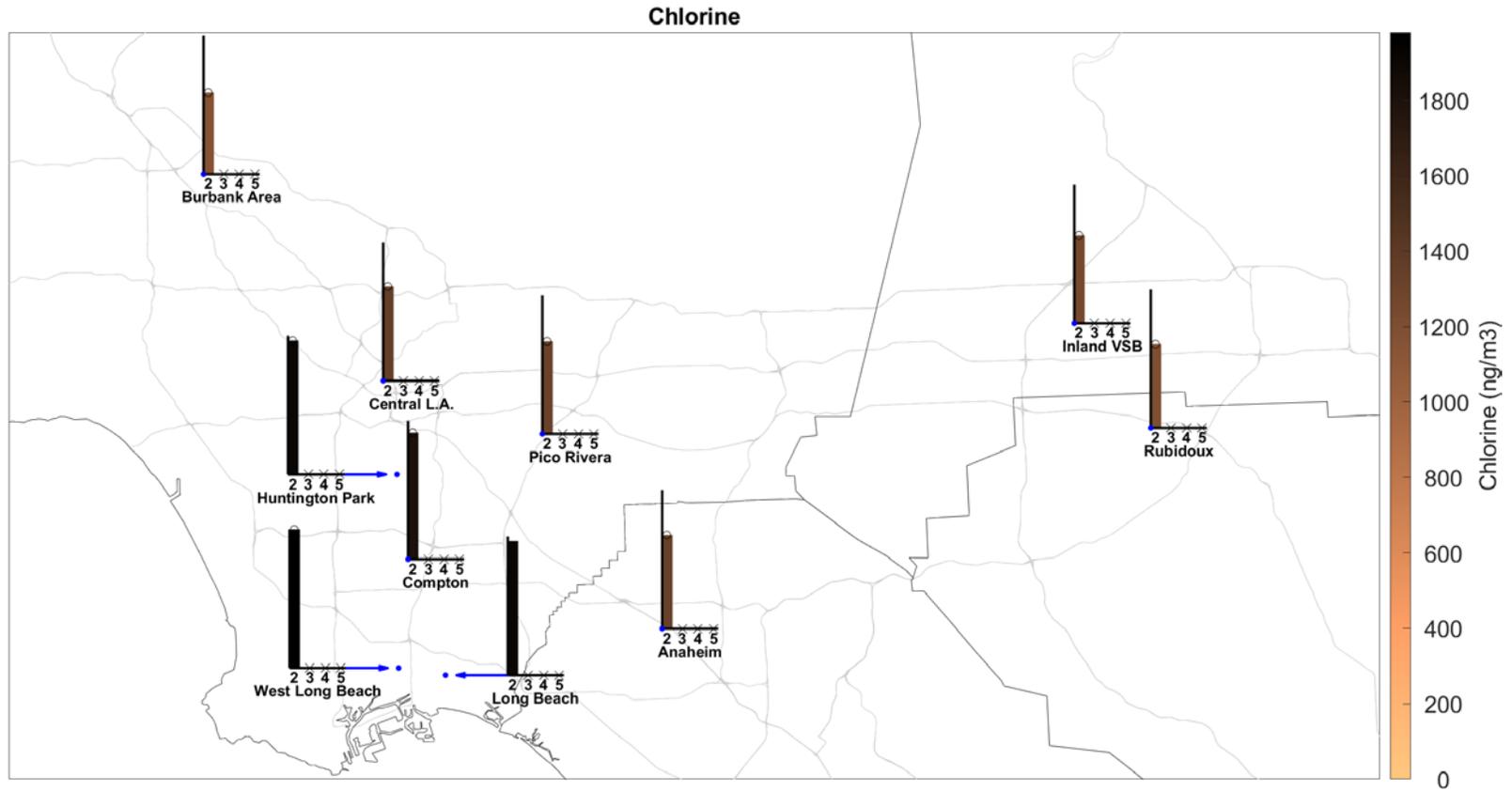
Chlorine

**Table IV-44.** Ambient Concentrations (ng/m<sup>3</sup>) of Chlorine from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	1340	1160	1810	1260	1910	1920	1350	1320	1200	1980
95% CI LB	962	883	1420	873	1500	1550	1010	923	813	1600
95% CI UB	1840	1460	2240	1730	2390	2340	1790	1810	1680	2360
N	45	47	39	41	42	56	51	41	41	39
% < MDL	0	0	0	0	0	0	2	2.4	2.4	0
Max	9700	5180	7040	7950	7730	8320	7920	8760	7890	5140
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-84.** Annual Average Concentrations of Chlorine in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

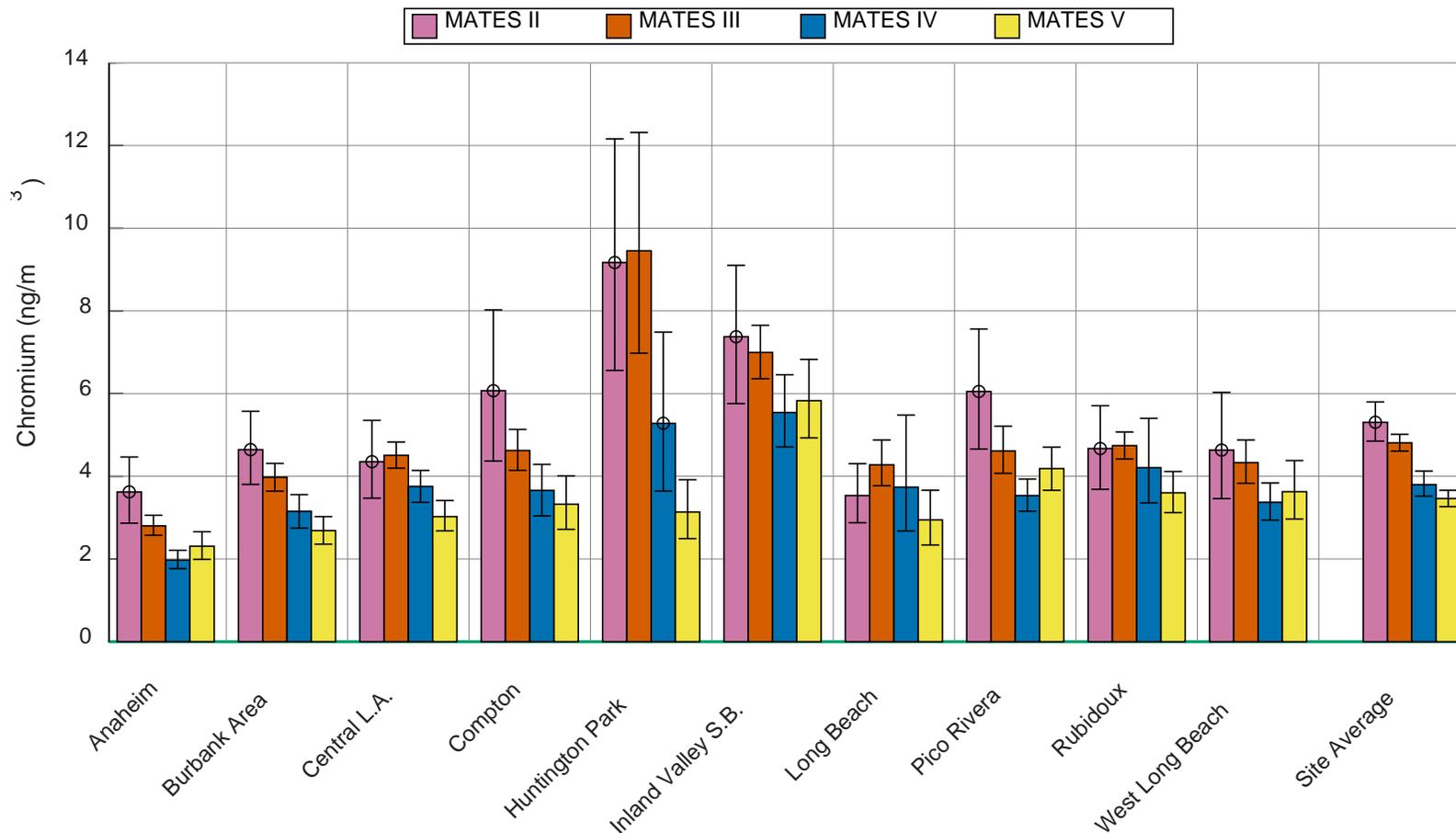


**Figure IV-85.** Geographic distribution of Chlorine from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

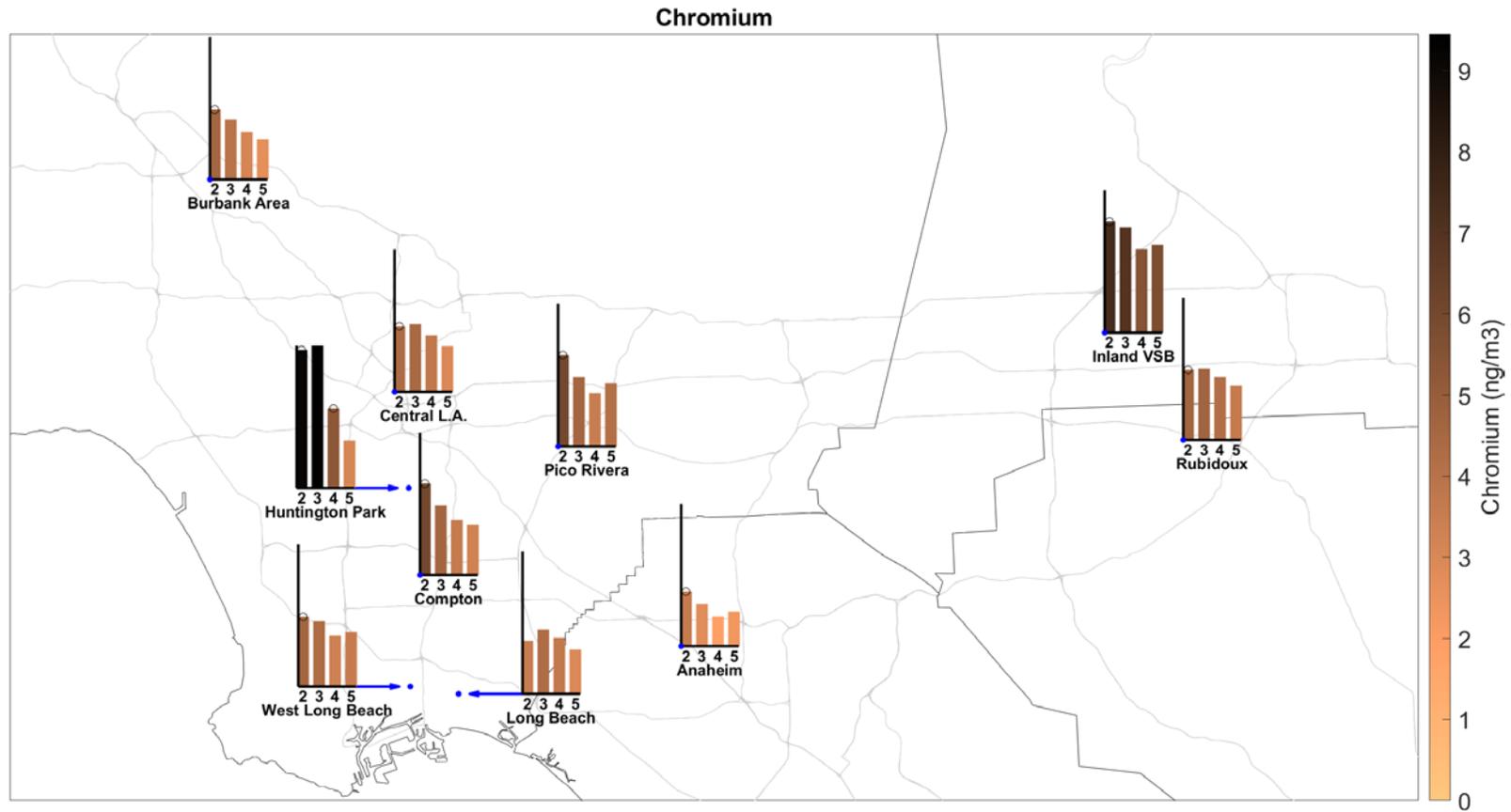
## Chromium

**Table IV-45.** Ambient Concentrations (ng/m<sup>3</sup>) of Chromium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	3.62	4.64	6.07	7.38	9.17	3.54	4.35	6.05	4.67	4.63
95% CI LB	2.87	3.8	4.37	5.76	6.56	2.88	3.47	4.66	3.69	3.46
95% CI UB	4.47	5.57	8.03	9.1	12.2	4.31	5.35	7.56	5.71	6.03
N	45	47	39	41	42	56	51	41	41	39
% < MDL	57.8	38.3	43.6	36.6	38.1	51.8	49	41.5	46.3	46.2
Max	14	14	27	20	38	15	20	19	13	20
MATES III										
Average	2.8	3.98	4.62	7	9.45	4.28	4.51	4.61	4.74	4.33
95% CI LB	2.57	3.64	4.14	6.36	6.98	3.77	4.2	4.07	4.42	3.83
95% CI UB	3.06	4.31	5.13	7.65	12.3	4.88	4.83	5.21	5.07	4.88
N	232	218	228	224	116	230	229	118	237	227
% < MDL	68.1	36.7	36.8	21	19	51.3	23.6	27.1	22.8	48
Max	15	20.3	22.5	21.9	83.3	34.1	18	20.1	15	24.5
MATES IV										
Average	1.97	3.15	3.66	5.54	5.28	3.74	3.76	3.53	4.21	3.37
95% CI LB	1.77	2.75	3.04	4.71	3.64	2.68	3.37	3.16	3.36	2.94
95% CI UB	2.21	3.56	4.29	6.46	7.49	5.48	4.14	3.93	5.4	3.84
N	60	58	59	56	55	59	59	60	58	58
% < MDL	20	3.4	0	1.8	0	6.8	5.1	0	5.2	3.4
Max	4.6	7.94	13.1	19.9	49.5	47.7	6.92	8.17	31.5	8.83
MATES V										
Average	2.31	2.69	3.32	5.83	3.14	2.95	3.03	4.19	3.6	3.63
95% CI LB	1.99	2.36	2.72	4.93	2.49	2.34	2.68	3.66	3.12	2.97
95% CI UB	2.66	3.03	4.01	6.83	3.92	3.66	3.41	4.71	4.12	4.38
N	61	58	61	59	61	60	60	60	60	59
% < MDL	1.6	5.2	0	1.7	9.8	8.3	3.3	3.3	0	3.4
Max	8.49	5.66	13.7	17.3	17.5	12.9	7.6	9.66	8.61	14.5



**Figure IV-86.** Annual Average Concentrations of Chromium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



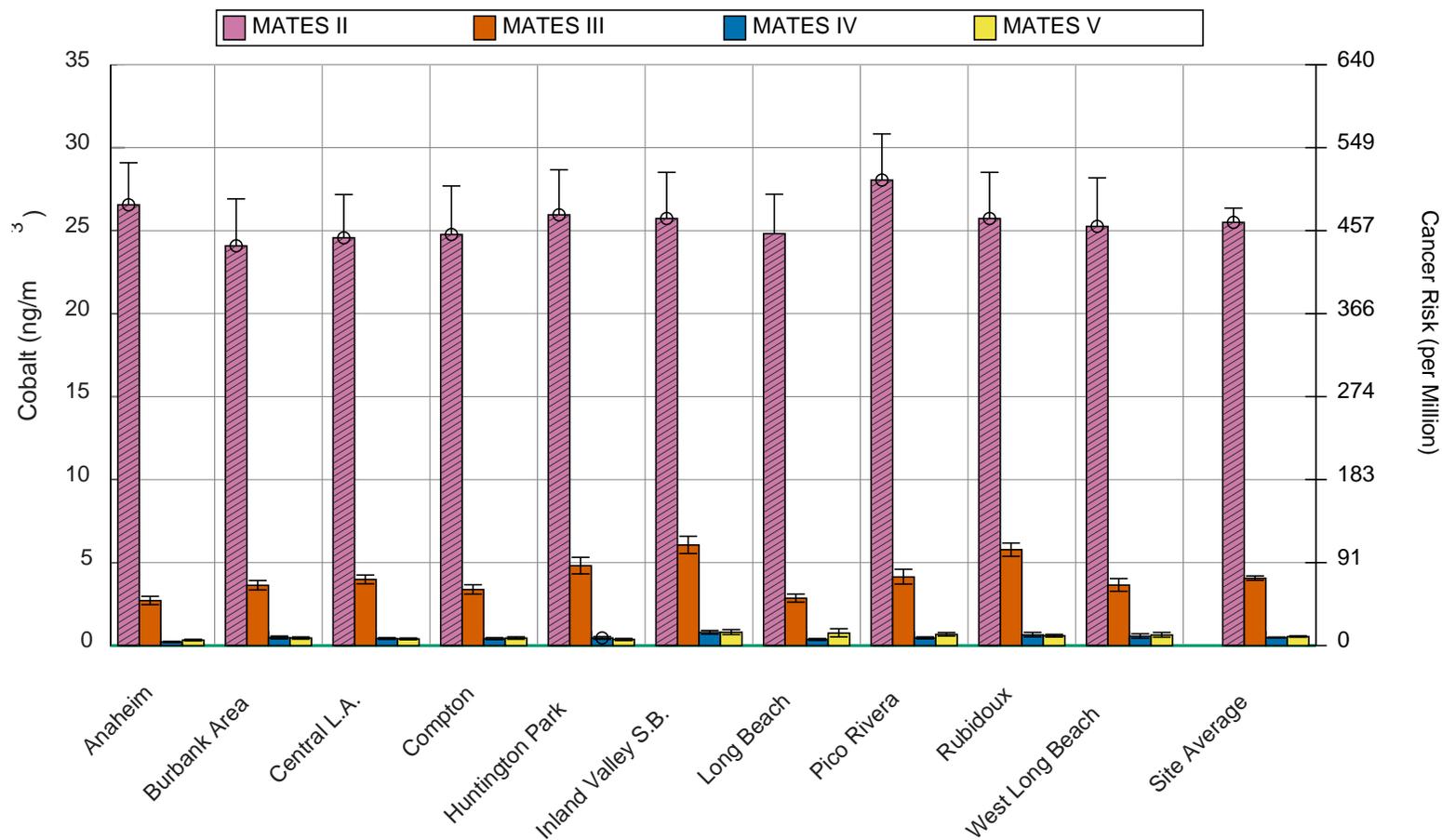
**Figure IV-87.** Geographic distribution of Chromium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

## Cobalt

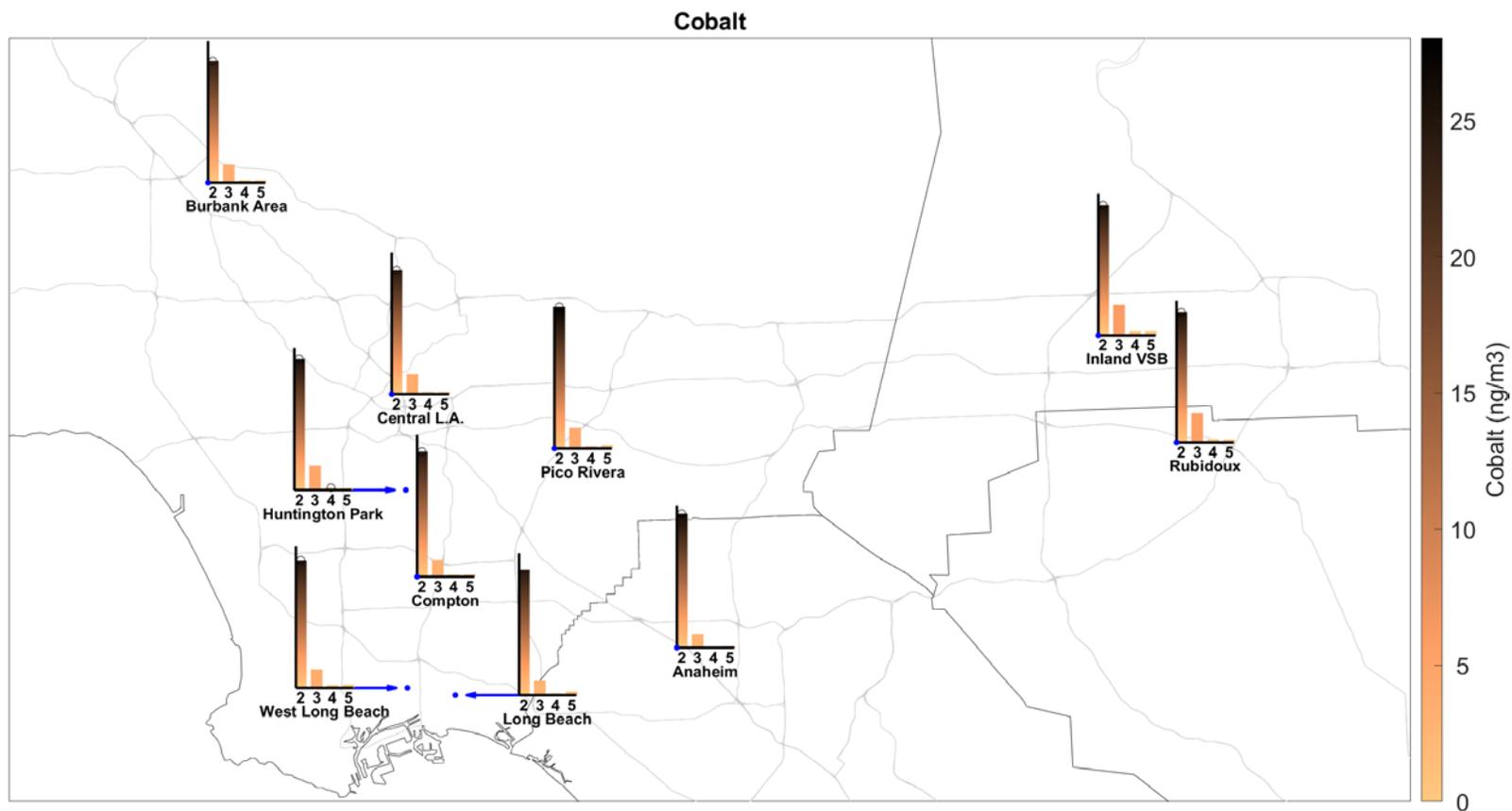
**Table IV-46.** Ambient Concentrations (ng/m<sup>3</sup>) of Cobalt from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0, 26.6 <sup>a</sup>	0, 24.1 <sup>a</sup>	0, 24.8 <sup>a</sup>	0, 25.7 <sup>a</sup>	0, 26 <sup>a</sup>	0, 24.8 <sup>a</sup>	0, 24.6 <sup>a</sup>	0, 28 <sup>a</sup>	0, 25.7 <sup>a</sup>	0, 25.3 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	29.1 <sup>a</sup>	26.9 <sup>a</sup>	27.7 <sup>a</sup>	28.5 <sup>a</sup>	28.7 <sup>a</sup>	27.2 <sup>a</sup>	27.2 <sup>a</sup>	30.8 <sup>a</sup>	28.5 <sup>a</sup>	28.2 <sup>a</sup>
N	45 <sup>a</sup>	47 <sup>a</sup>	39 <sup>a</sup>	41 <sup>a</sup>	42 <sup>a</sup>	56 <sup>a</sup>	51 <sup>a</sup>	41 <sup>a</sup>	41 <sup>a</sup>	39 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES III</b>										
Average	2.71	3.63	3.38	6.06	4.81	2.85	3.98	4.13	5.78	3.64
95% CI LB	2.46	3.35	3.11	5.55	4.32	2.62	3.72	3.7	5.38	3.27
95% CI UB	2.97	3.92	3.67	6.58	5.32	3.11	4.25	4.6	6.18	4.04
N	232	218	228	224	116	230	229	118	237	227
% < MDL	26.7	8.7	14.9	8.5	4.3	21.3	8.3	5.9	7.2	15
Max	10.7	11	12.7	18.5	14.5	9.6	11.4	17	15.4	16.7
<b>MATES IV</b>										
Average	0.217	0.482	0.414	0.792	0.458	0.367	0.426	0.461	0.646	0.562
95% CI LB	0.187	0.401	0.356	0.682	0.382	0.312	0.375	0.403	0.526	0.442
95% CI UB	0.252	0.572	0.477	0.904	0.543	0.425	0.478	0.522	0.791	0.716
N	60	58	59	56	55	59	59	60	58	58
% < MDL	35	10.3	8.5	0	0	10.2	8.5	8.3	5.2	8.6
Max	0.66	1.92	1.04	1.96	1.74	0.98	1	1.26	3.57	3.7
<b>MATES V</b>										
Average	0.329	0.454	0.452	0.804	0.366	0.751	0.4	0.674	0.594	0.636
95% CI LB	0.284	0.388	0.383	0.666	0.304	0.523	0.349	0.576	0.514	0.504
95% CI UB	0.38	0.519	0.527	0.96	0.431	1.01	0.455	0.784	0.675	0.79
N	60	58	60	58	60	59	59	59	60	58
% < MDL	1.7	1.7	1.7	1.7	10	1.7	3.4	1.7	1.7	0
Max	1.04	1.01	1.52	3.47	1.02	4.48	1.27	2.54	1.54	2.73

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-88.** Annual Average Concentrations of Cobalt in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

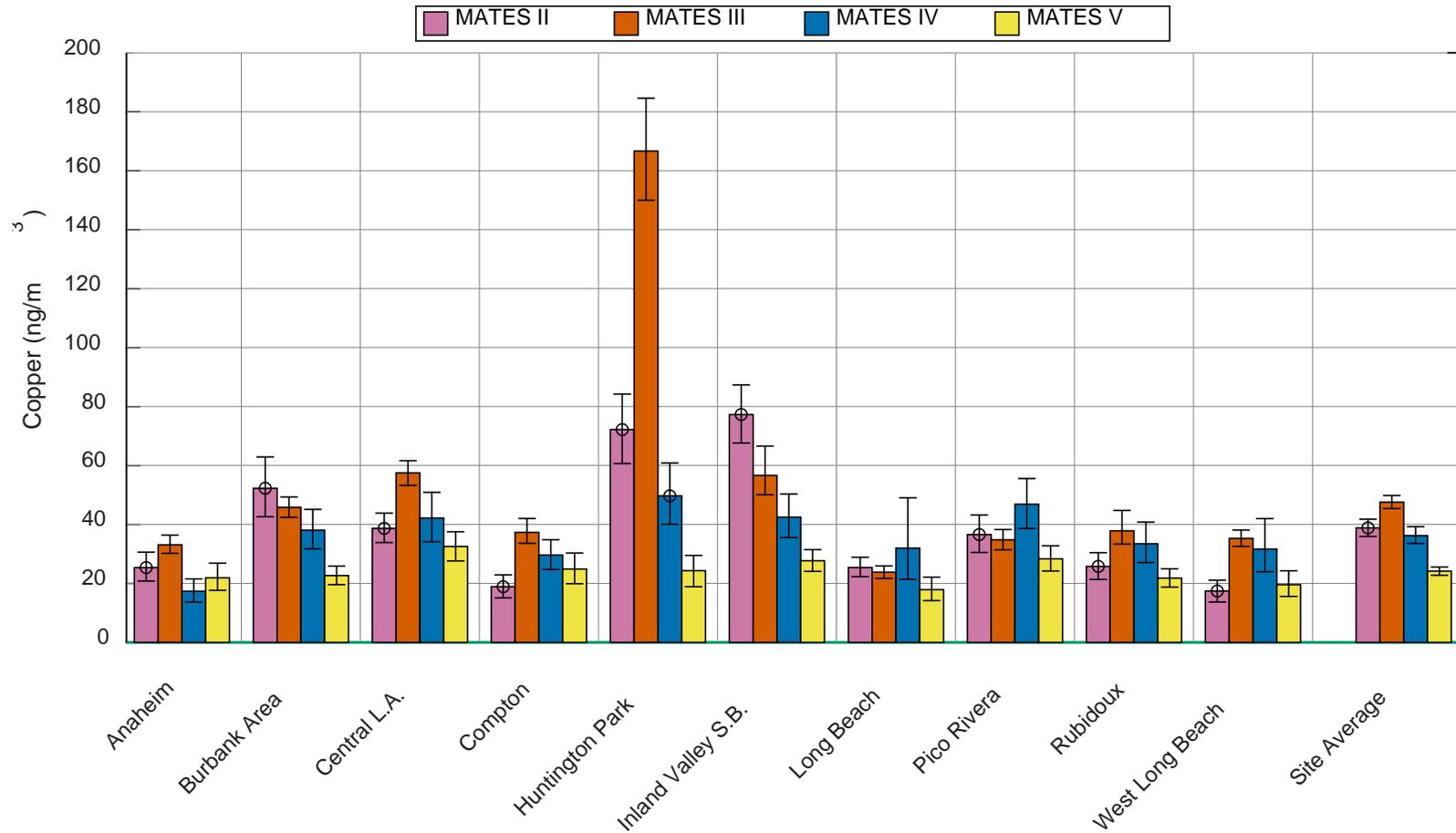


**Figure IV-89.** Geographic distribution of Cobalt from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

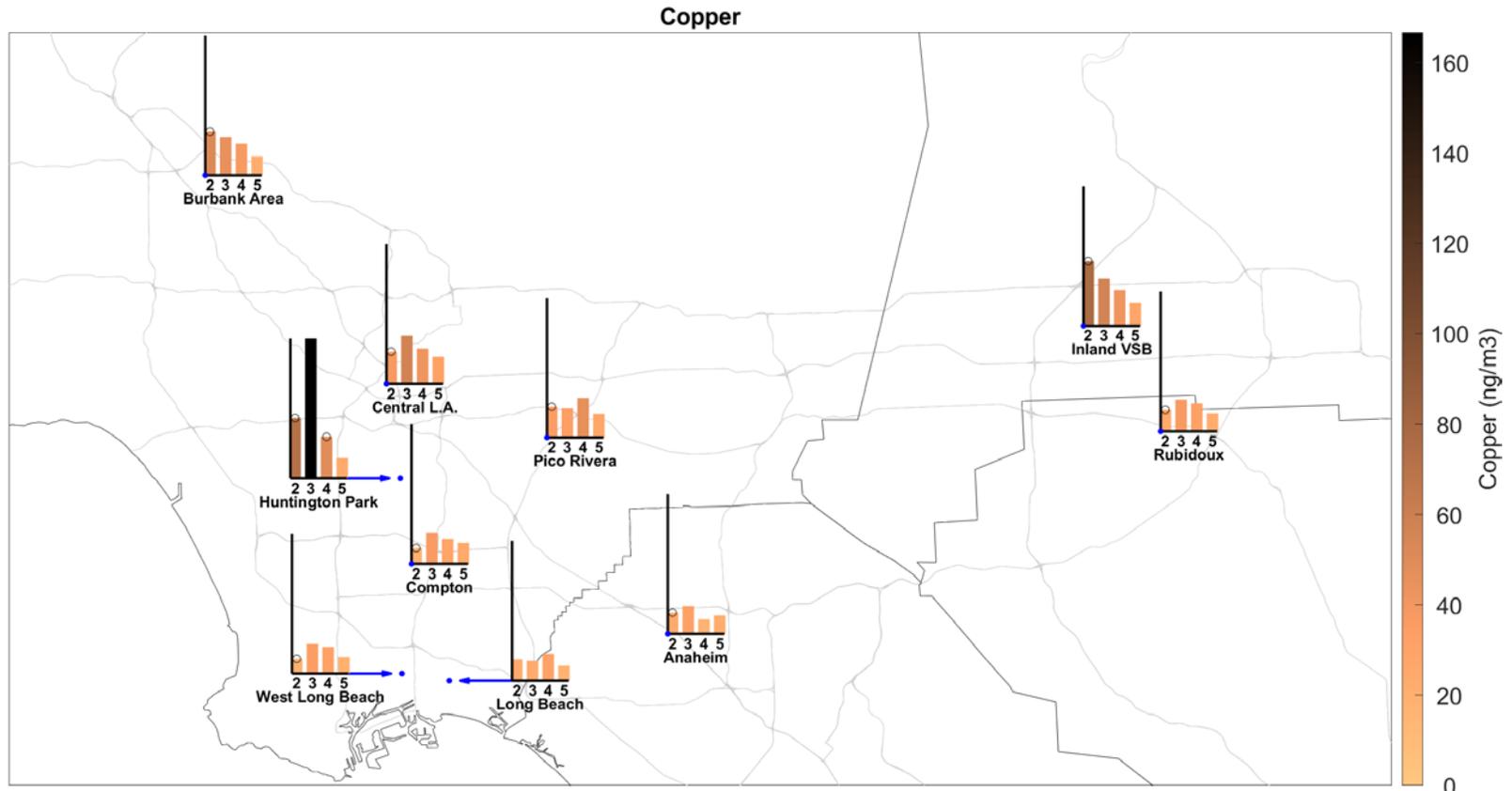
## Copper

**Table IV-47.** Ambient Concentrations (ng/m<sup>3</sup>) of Copper from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	25.4	52.3	18.9	77.3	72.2	25.4	38.7	36.6	25.8	17.4
95% CI LB	20.8	42.6	15.1	67.6	60.7	22.3	33.9	30.5	21.3	13.7
95% CI UB	30.6	62.9	22.9	87.3	84.2	28.9	43.8	43.2	30.4	21.1
N	45	47	39	41	42	56	51	41	41	39
% < MDL	2.2	0	2.6	0	0	0	3.9	0	2.4	7.7
Max	72	173	72	171	162	77	89	114	71	53
MATES III										
Average	33.1	45.8	37.3	56.6	167	23.8	57.5	34.8	37.8	35.3
95% CI LB	30.2	42.4	33.6	50.1	150	21.7	53.3	31.4	33.3	32.6
95% CI UB	36.4	49.3	42	66.6	185	25.9	61.6	38.3	44.8	38.1
N	232	218	228	224	116	230	229	118	237	227
% < MDL	0	0	0.4	0.4	0	0	0	0	0	0
Max	265	199	417	959	496	79.9	198	101	697	110
MATES IV										
Average	17.3	38	29.6	42.5	49.7	32	42.2	46.9	33.4	31.6
95% CI LB	13.6	31.7	24.7	35.5	40.1	21.4	34.1	38.6	27.1	24
95% CI UB	21.5	45.1	34.8	50.3	60.8	49	50.9	55.6	40.8	42
N	60	58	59	56	55	59	59	60	58	58
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	74.1	127	87.4	147	261	459	160	140	162	251
MATES V										
Average	21.9	22.7	24.9	27.7	24.3	17.9	32.5	28.3	21.8	19.6
95% CI LB	17.6	19.6	19.9	24.1	18.9	14.2	27.6	24.2	18.8	15.6
95% CI UB	26.9	25.9	30.3	31.5	29.5	22.1	37.5	32.7	25	24.3
N	61	58	61	59	61	60	60	60	60	59
% < MDL	0	0	0	0	4.9	0	1.7	0	0	0
Max	111	52.4	94	73.3	79.1	72.4	91.1	78.4	60.2	84.1



**Figure IV-90.** Annual Average Concentrations of Copper in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



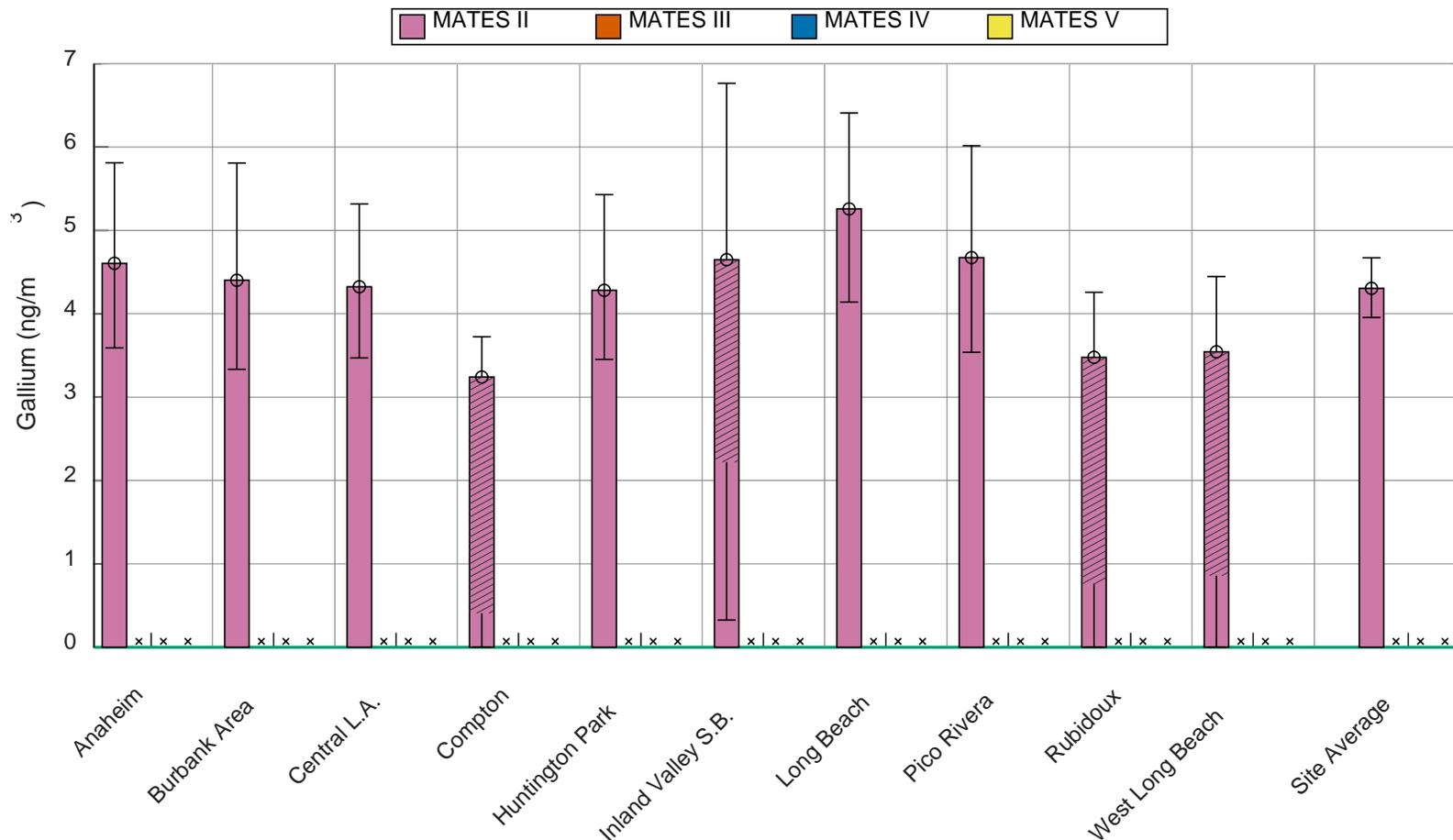
**Figure IV-91.** Geographic distribution of Copper from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Gallium

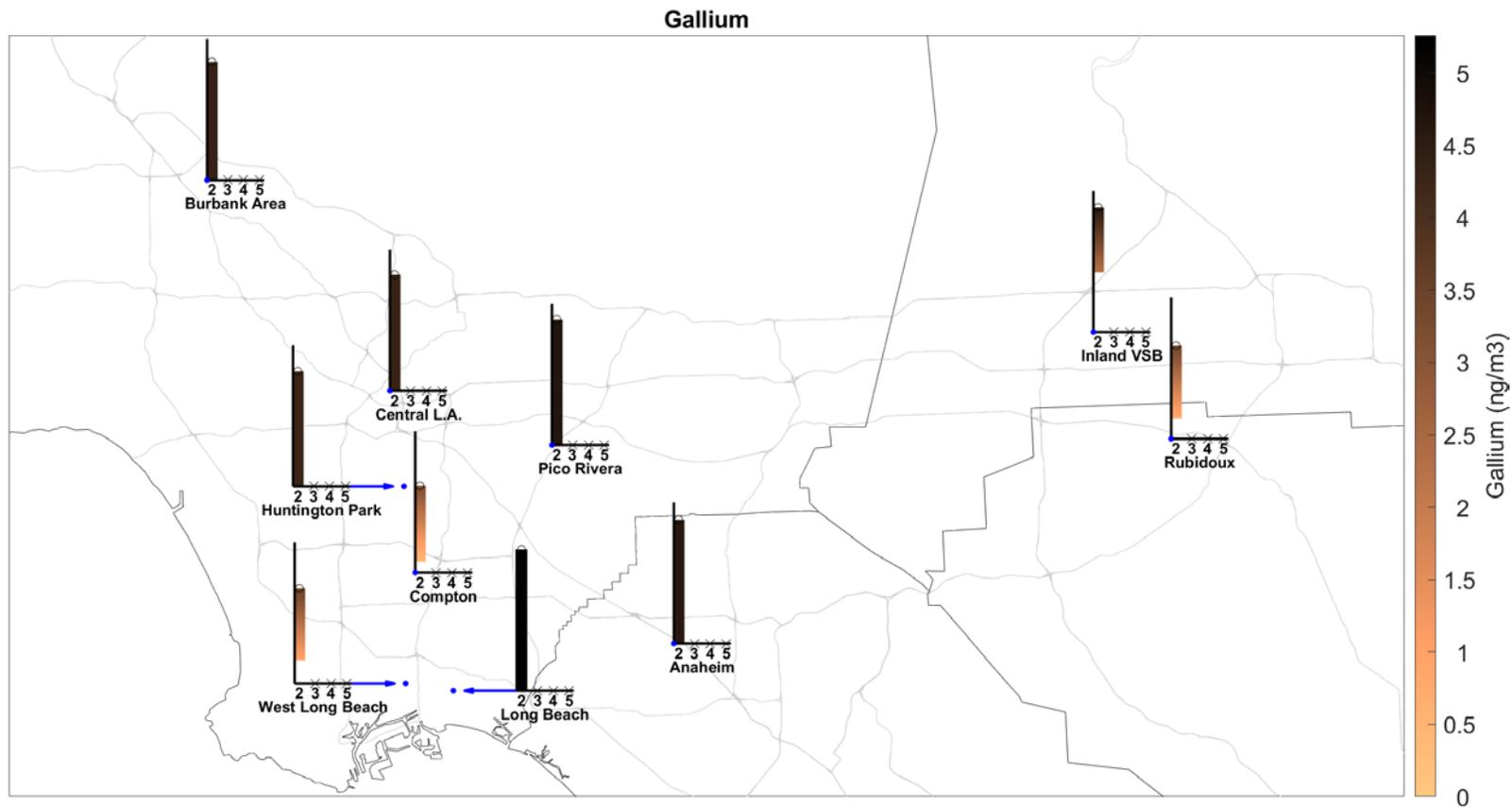
**Table IV-48.** Ambient Concentrations (ng/m<sup>3</sup>) of Gallium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	4.6	4.4	0.408, 3.24 <sup>a</sup>	2.22, 4.65 <sup>a</sup>	4.28	5.26	4.32	4.67	0.763, 3.48 <sup>a</sup>	0.859, 3.54 <sup>a</sup>
95% CI LB	3.59	3.33	0 <sup>a</sup>	0.326 <sup>a</sup>	3.45	4.14	3.47	3.54	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	5.81	5.81	3.72 <sup>a</sup>	6.76 <sup>a</sup>	5.43	6.41	5.32	6.02	4.26 <sup>a</sup>	4.45 <sup>a</sup>
N	25	20	18 <sup>a</sup>	21 <sup>a</sup>	22	26	23	26	21 <sup>a</sup>	19 <sup>a</sup>
% < MDL	72	80	94.4 <sup>a</sup>	81 <sup>a</sup>	77.3	61.5	73.9	73.1	90.5 <sup>a</sup>	89.5 <sup>a</sup>
Max	11.6	13.1	7.34 <sup>a</sup>	20.3 <sup>a</sup>	10	11.6	10.6	14.1	9.33 <sup>a</sup>	9.83 <sup>a</sup>
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-92.** Annual Average Concentrations of Gallium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



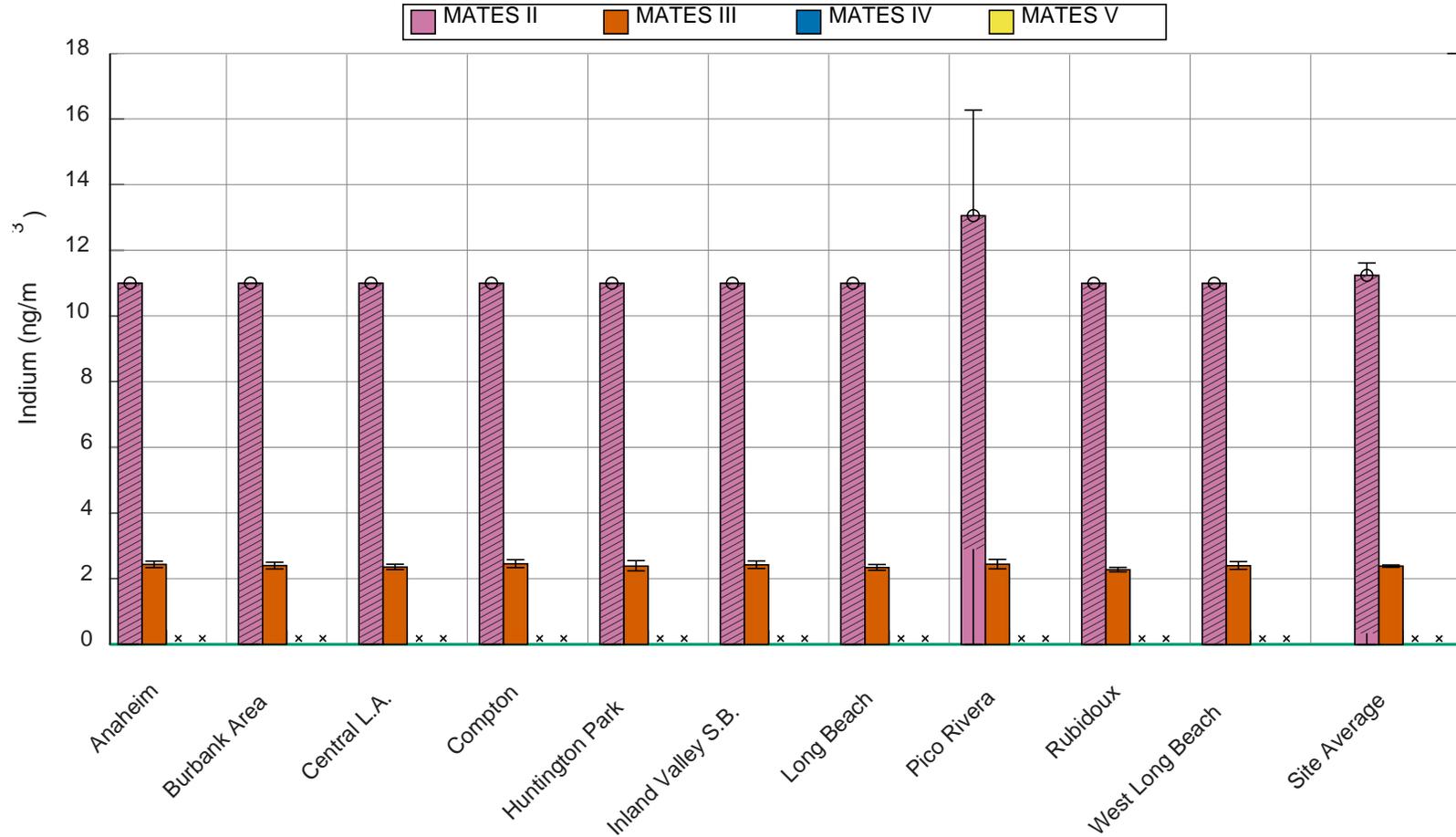
**Figure IV-93.** Geographic distribution of Gallium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Indium

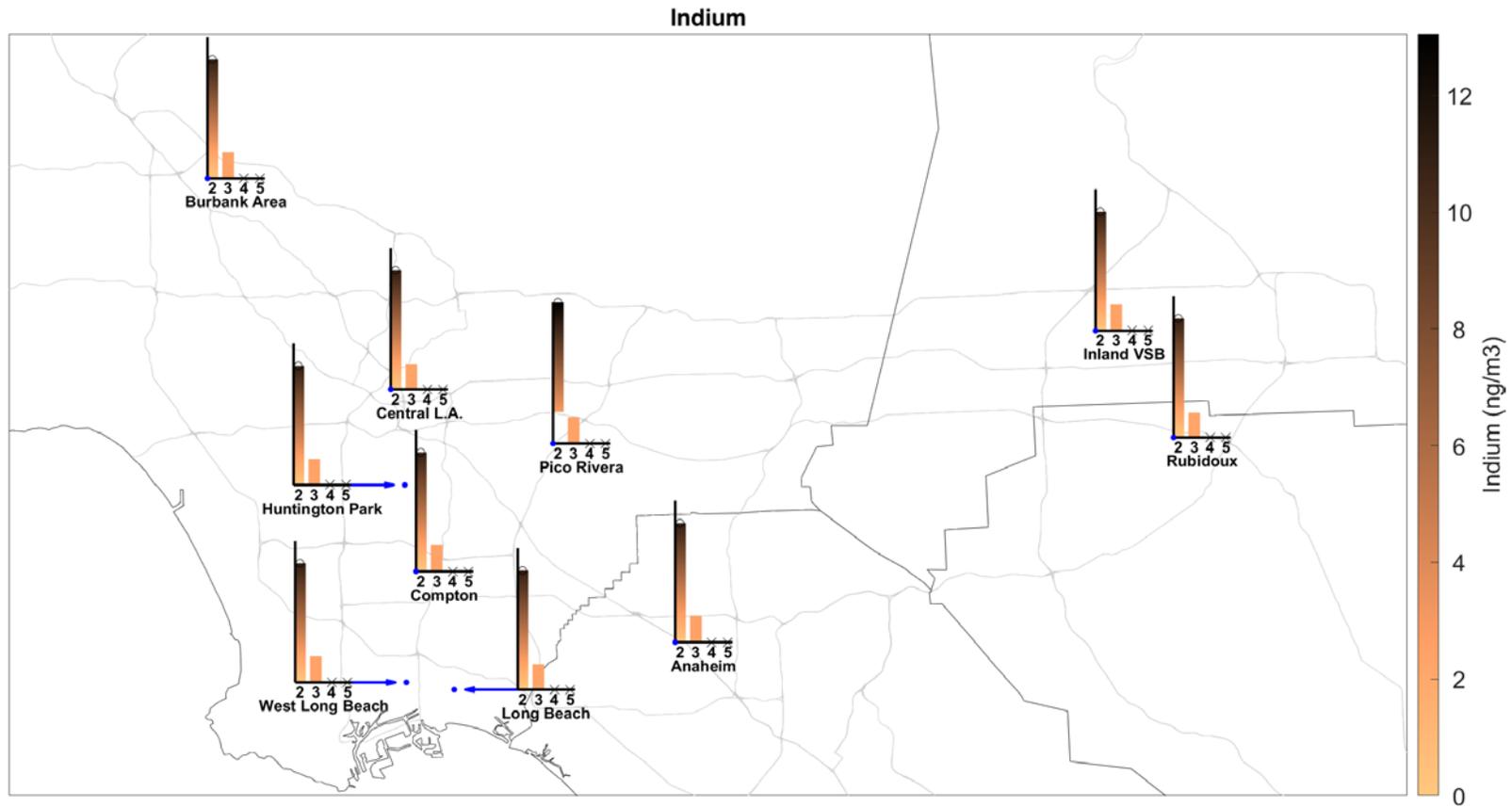
**Table IV-49.** Ambient Concentrations (ng/m<sup>3</sup>) of Indium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0, 11 <sup>a</sup>	2.91, 13.1 <sup>a</sup>	0, 11 <sup>a</sup>	0, 11 <sup>a</sup>						
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>							
95% CI UB	11 <sup>a</sup>	16.3 <sup>a</sup>	11 <sup>a</sup>	11 <sup>a</sup>						
N	25 <sup>a</sup>	20 <sup>a</sup>	18 <sup>a</sup>	21 <sup>a</sup>	22 <sup>a</sup>	26 <sup>a</sup>	23 <sup>a</sup>	26 <sup>a</sup>	21 <sup>a</sup>	19 <sup>a</sup>
% < MDL	100 <sup>a</sup>	92.3 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>						
Max	< MDL <sup>a</sup>	41 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>						
<b>MATES III</b>										
Average	2.43	2.4	2.45	2.42	2.38	2.34	2.35	2.44	2.28	2.4
95% CI LB	2.34	2.3	2.34	2.32	2.24	2.26	2.28	2.3	2.21	2.29
95% CI UB	2.53	2.5	2.58	2.54	2.55	2.44	2.44	2.59	2.35	2.53
N	232	218	228	224	116	230	229	118	237	227
% < MDL	64.2	70.2	68.4	64.7	74.1	68.7	68.6	63.6	67.9	66.5
Max	7.32	6.15	7.28	6.83	6.47	7.18	5	6.15	4.91	9.96
<b>MATES IV</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES V</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-94.** Annual Average Concentrations of Indium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

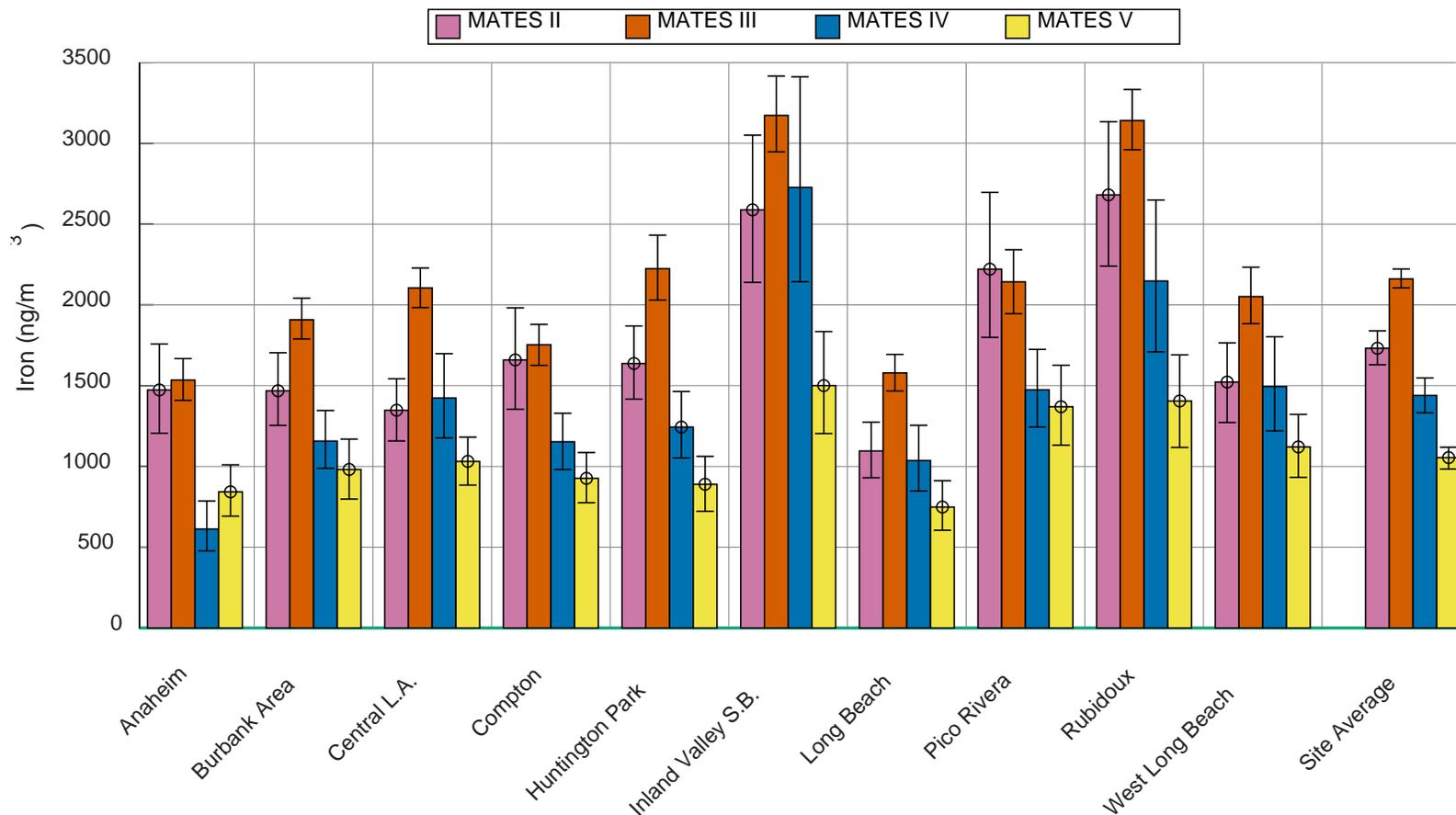


**Figure IV-95.** Geographic distribution of Indium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

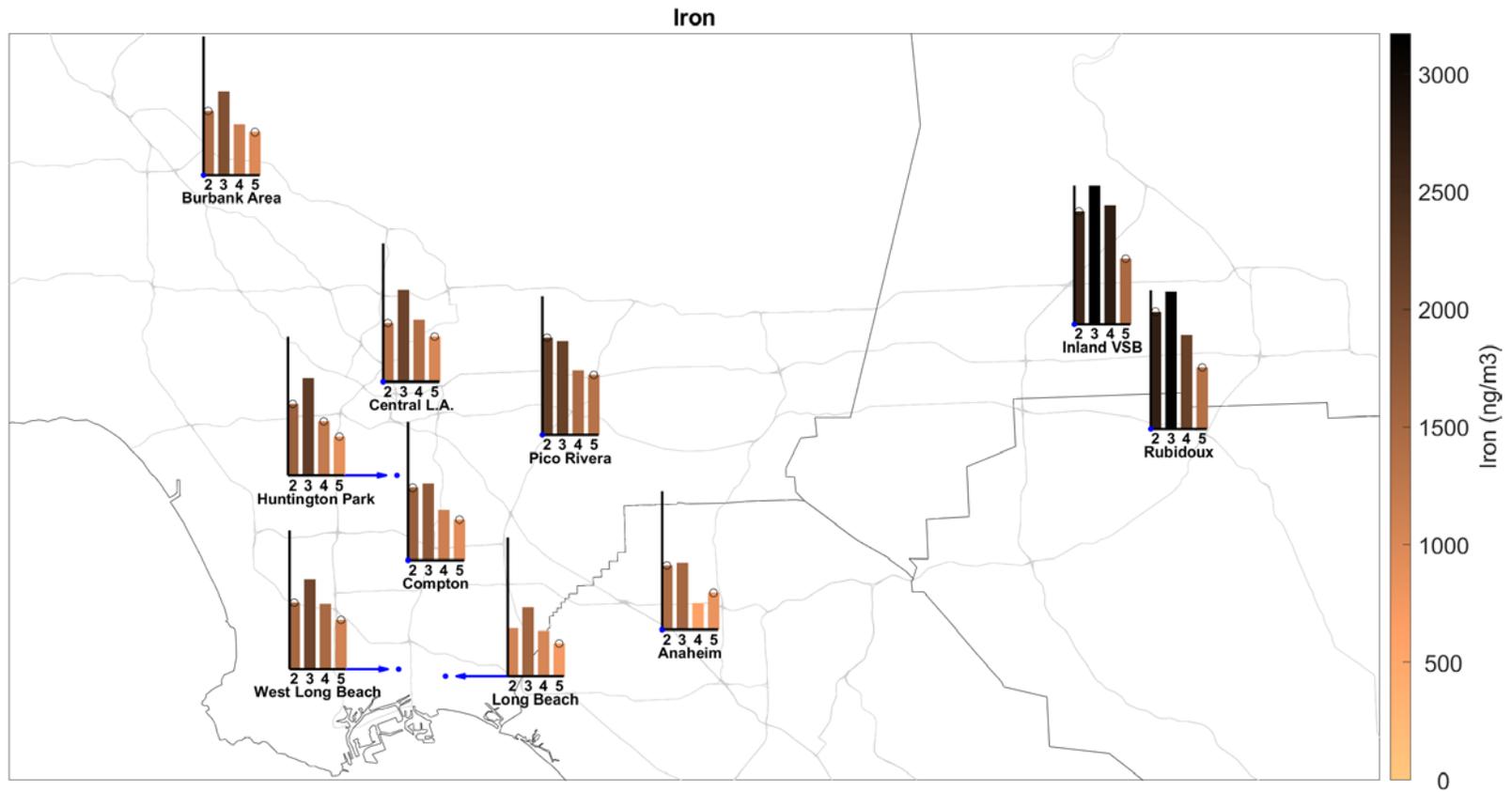
## Iron

**Table IV-50.** Ambient Concentrations (ng/m<sup>3</sup>) of Iron from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	1470	1470	1660	2590	1640	1100	1350	2220	2680	1520
95% CI LB	1210	1250	1350	2140	1420	930	1160	1800	2240	1270
95% CI UB	1760	1700	1980	3050	1870	1270	1540	2700	3130	1760
N	45	47	39	41	42	56	51	41	41	39
% < MDL	0	0	0	0	0	0	2	2.4	2.4	0
Max	3870	3910	4380	5630	3890	3630	3680	8550	5870	3710
MATES III										
Average	1540	1910	1750	3170	2220	1580	2100	2140	3140	2050
95% CI LB	1410	1790	1630	2950	2030	1470	1980	1950	2960	1880
95% CI UB	1670	2040	1880	3420	2430	1690	2230	2340	3330	2230
N	232	218	228	224	116	230	229	118	237	227
% < MDL	0	0	0	0.4	0	0	0	0	0	0
Max	5800	7570	5260	8470	5700	4950	5330	6240	7180	9820
MATES IV										
Average	613	1160	1150	2730	1240	1040	1420	1470	2150	1490
95% CI LB	477	988	981	2140	1050	848	1180	1240	1710	1220
95% CI UB	786	1350	1330	3410	1460	1250	1700	1720	2650	1800
N	60	58	59	56	55	59	59	60	58	58
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	4050	3310	3000	11600	3660	3920	5560	4470	9440	5730
MATES V										
Average	843	981	926	1500	890	749	1030	1370	1410	1120
95% CI LB	692	798	776	1200	722	605	885	1130	1120	932
95% CI UB	1010	1170	1090	1830	1060	912	1180	1630	1690	1320
N	44	37	42	31	46	43	43	33	35	41
% < MDL	0	0	0	0	0	0	2.3	0	0	0
Max	2520	2230	2020	3380	2580	2300	2650	3240	3260	2570



**Figure IV-96.** Annual Average Concentrations of Iron in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



**Figure IV-97.** Geographic distribution of Iron from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Lanthanum

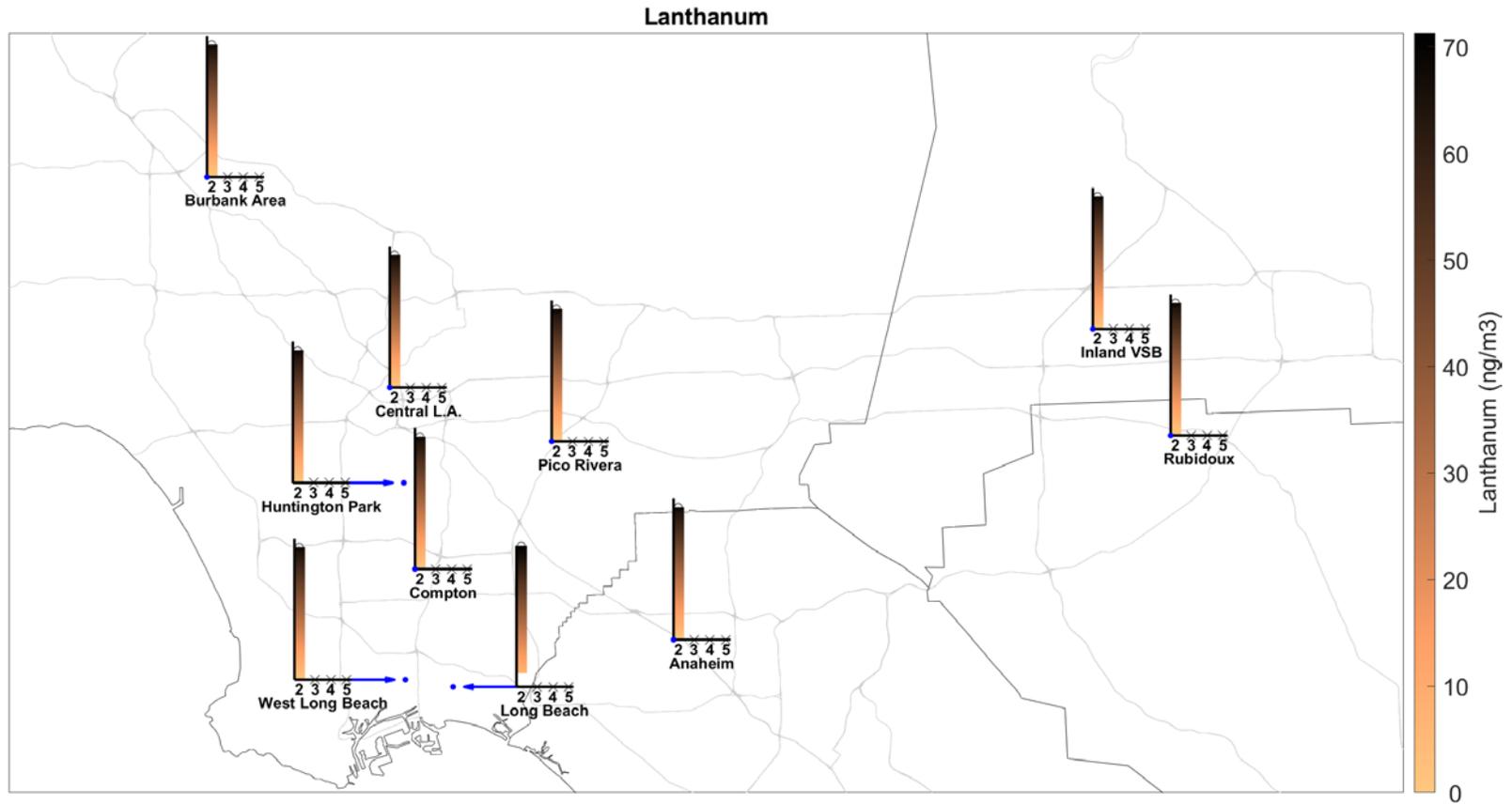
**Table IV-51.** Ambient Concentrations (ng/m<sup>3</sup>) of Lanthanum from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0, 67 <sup>a</sup>	6.91, 71.3 <sup>a</sup>	0, 67 <sup>a</sup>	0, 67 <sup>a</sup>	0, 67 <sup>a</sup>	0, 67 <sup>a</sup>				
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>					
95% CI UB	67 <sup>a</sup>	80 <sup>a</sup>	67 <sup>a</sup>	67 <sup>a</sup>	67 <sup>a</sup>	67 <sup>a</sup>				
N	25 <sup>a</sup>	20 <sup>a</sup>	18 <sup>a</sup>	21 <sup>a</sup>	22 <sup>a</sup>	26 <sup>a</sup>	23 <sup>a</sup>	26 <sup>a</sup>	21 <sup>a</sup>	19 <sup>a</sup>
% < MDL	100 <sup>a</sup>	96.2 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>				
Max	< MDL <sup>a</sup>	180 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>				
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-98.** Annual Average Concentrations of Lanthanum in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

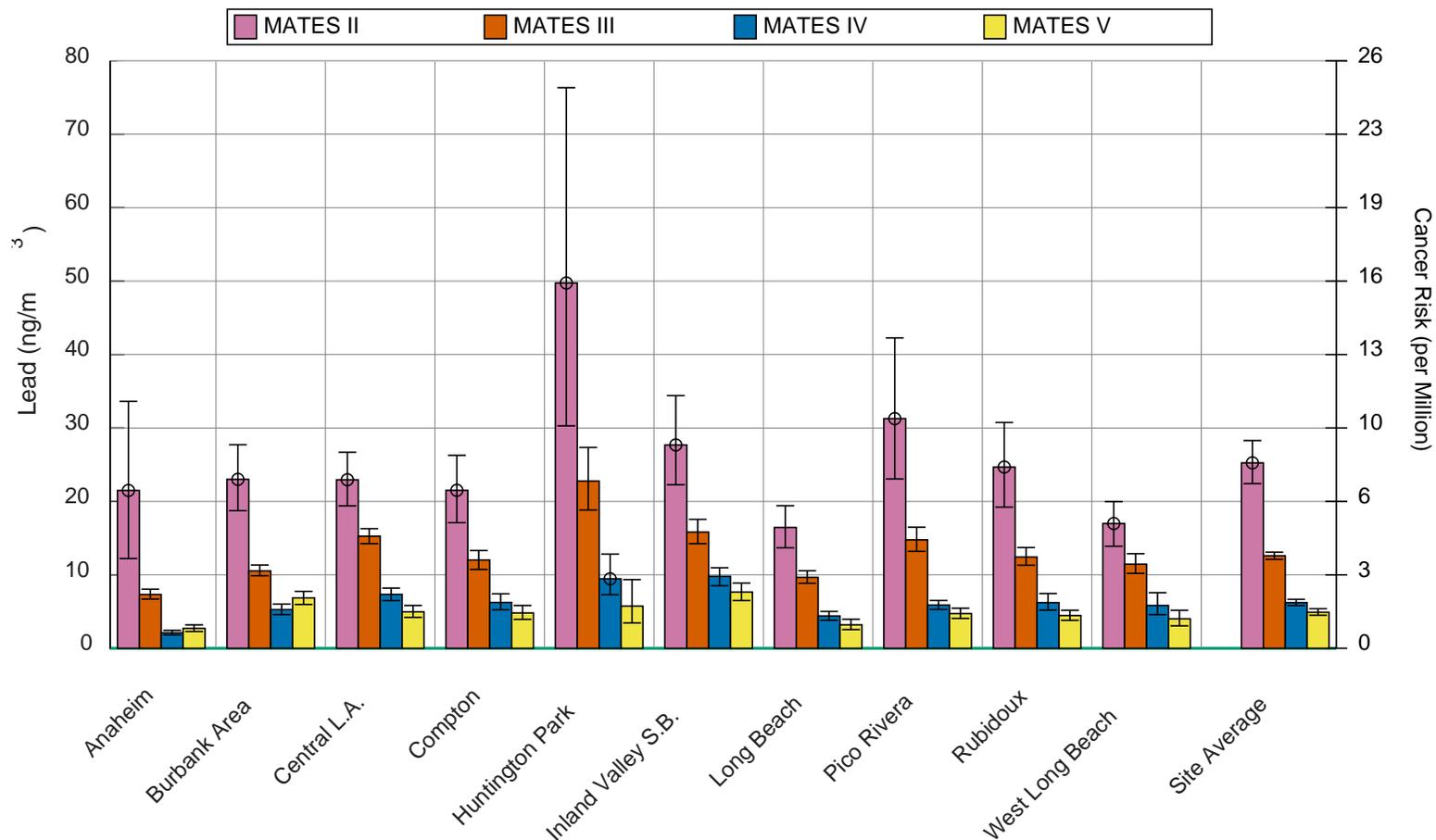


**Figure IV-99.** Geographic distribution of Lanthanum from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

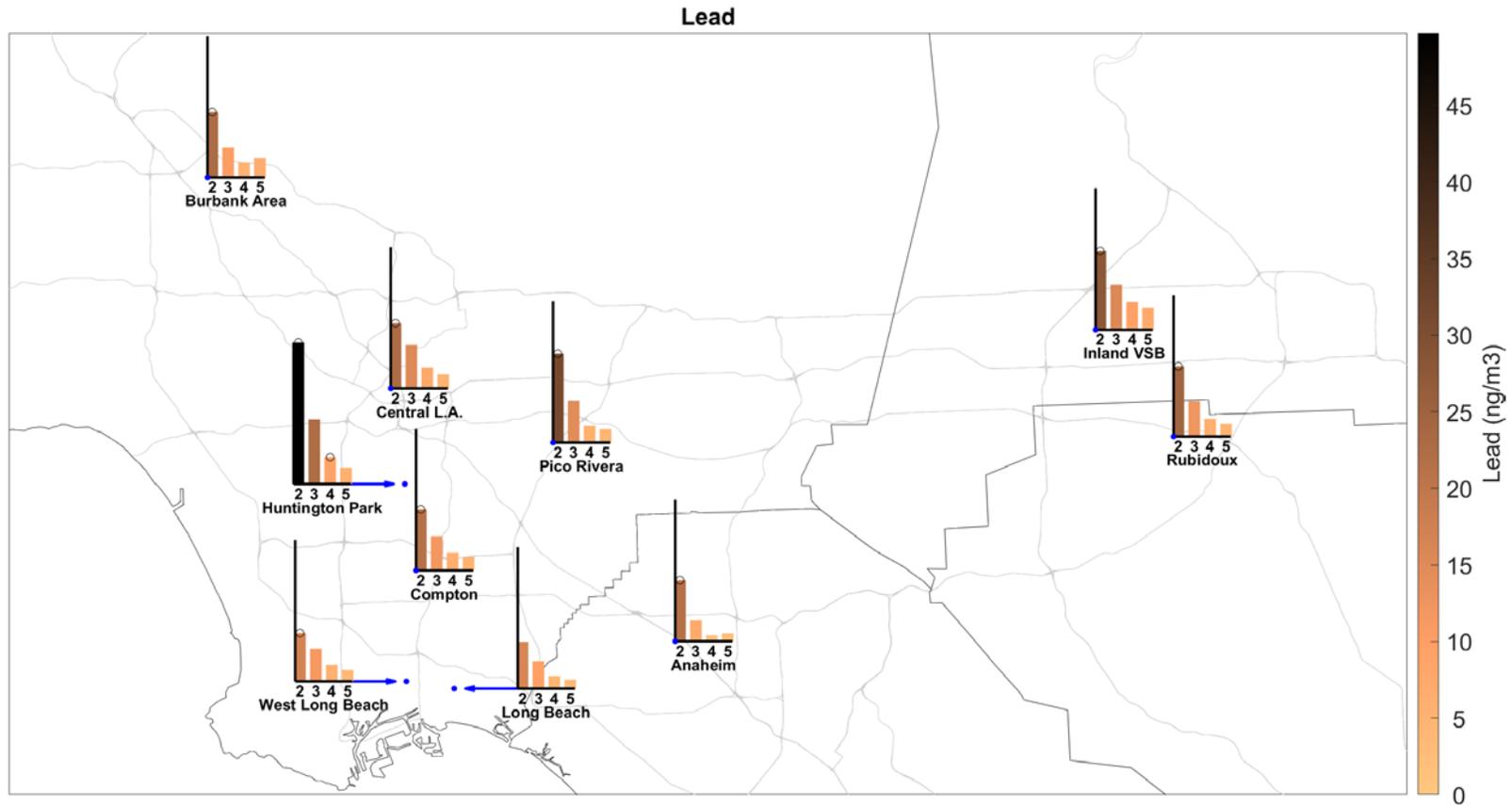
## Lead

**Table IV-52.** Ambient Concentrations (ng/m<sup>3</sup>) of Lead from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	21.5	23	21.5	27.7	49.7	16.4	22.9	31.3	24.7	17
95% CI LB	12.2	18.7	17.1	22.3	30.3	13.7	19.4	23.1	19.2	13.9
95% CI UB	33.6	27.7	26.3	34.4	76.3	19.4	26.7	42.3	30.7	20
N	45	47	39	41	42	56	51	41	41	39
% < MDL	11.1	0	2.6	0	0	3.6	3.9	4.9	7.3	5.1
Max	181	93.2	62	124	391	57.1	60.2	189	96.5	41.6
MATES III										
Average	7.32	10.5	12	15.8	22.8	9.66	15.3	14.8	12.4	11.4
95% CI LB	6.7	9.88	10.7	14.2	18.8	8.86	14.3	13.2	11.3	10.2
95% CI UB	8.05	11.3	13.3	17.6	27.3	10.6	16.3	16.5	13.7	12.9
N	232	218	228	224	116	230	229	118	237	227
% < MDL	51.7	17.4	27.2	15.2	5.2	30	11.4	5.9	15.6	26
Max	51.4	37.8	75.9	146	156	37.6	54.9	48.4	93.3	111
MATES IV										
Average	2.12	5.27	6.24	9.8	9.46	4.4	7.34	5.89	6.21	5.83
95% CI LB	1.82	4.59	5.25	8.52	7.29	3.8	6.5	5.28	5.19	4.58
95% CI UB	2.44	6.02	7.42	11	12.8	5.02	8.19	6.51	7.46	7.57
N	60	58	59	56	55	59	59	60	58	58
% < MDL	5	0	0	0	0	1.7	0	0	0	0
Max	6.84	16.8	20.1	19.3	81.7	13	15.6	12.6	32.3	43.3
MATES V										
Average	2.72	6.87	4.81	7.66	5.75	3.19	4.97	4.73	4.46	4.02
95% CI LB	2.28	5.97	3.94	6.51	3.46	2.54	4.21	4.06	3.8	3.05
95% CI UB	3.19	7.75	5.83	8.89	9.35	3.96	5.83	5.46	5.17	5.17
N	61	58	61	59	61	60	60	60	60	59
% < MDL	0	0	0	0	3.3	0	1.7	0	0	0
Max	9.53	19.7	16.9	24	106	15.2	20	18.2	11.3	20.4



**Figure IV-100.** Annual Average Concentrations of Lead in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

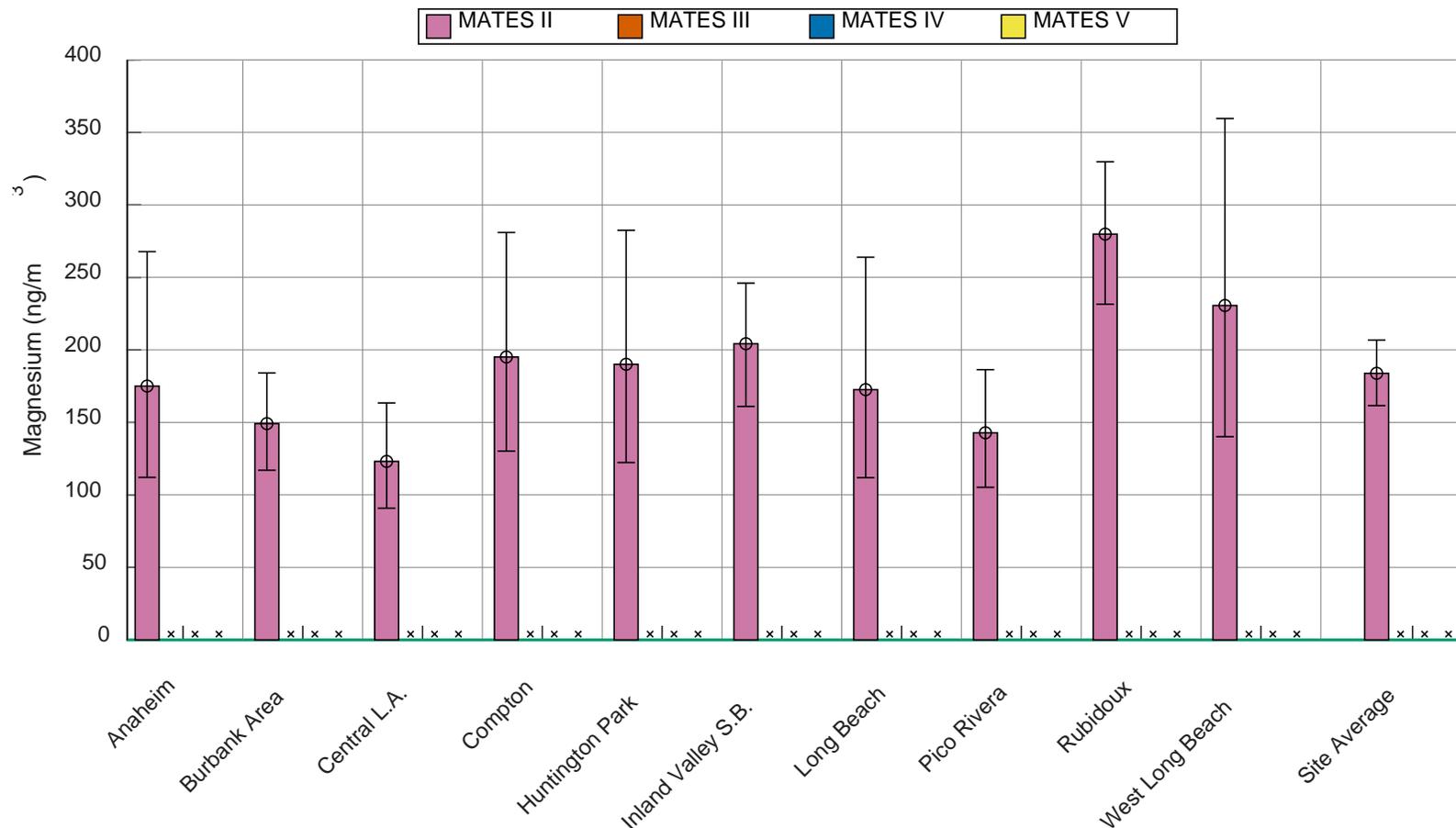


**Figure IV-101.** Geographic distribution of Lead from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

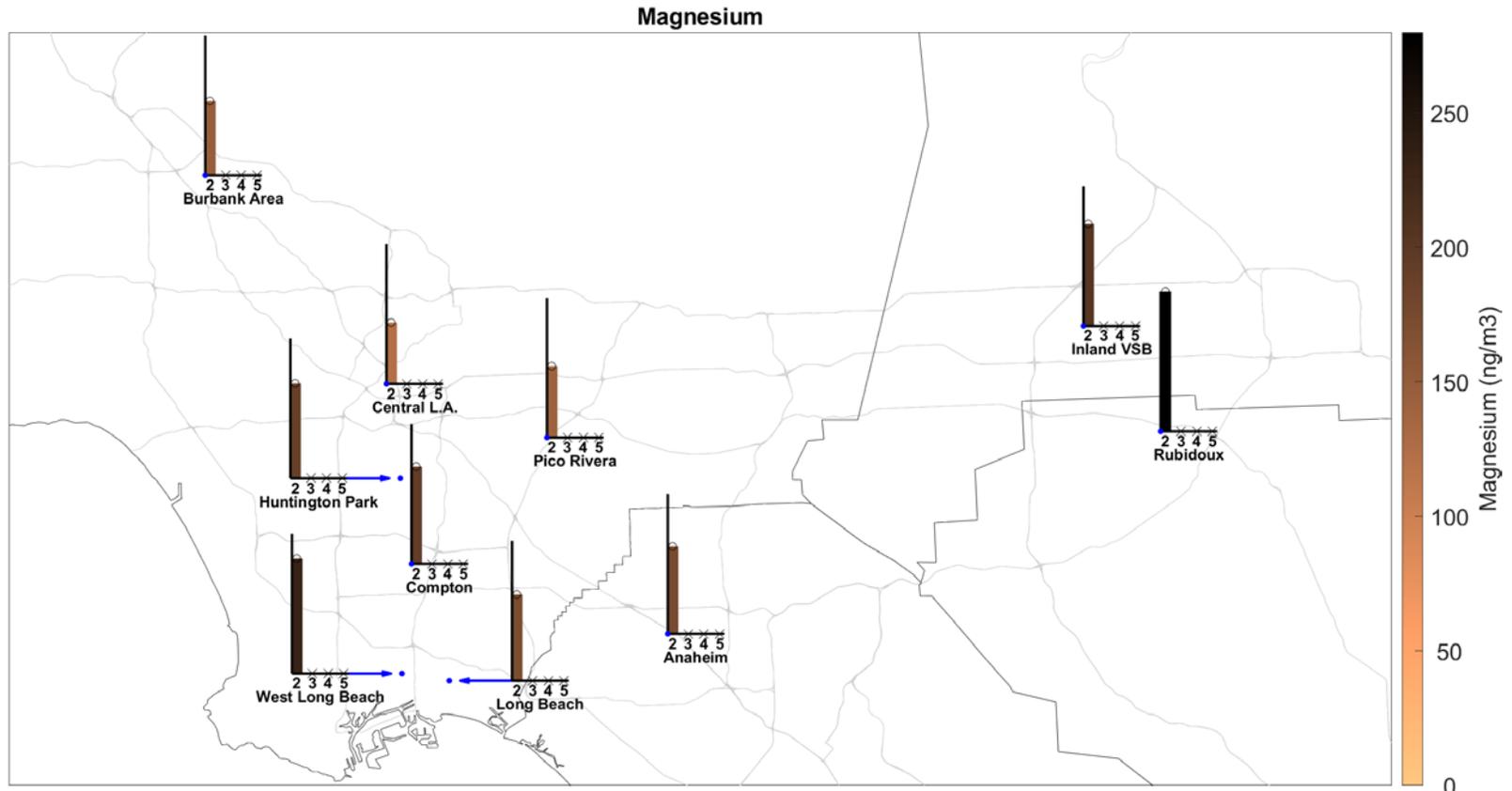
Magnesium

**Table IV-53.** Ambient Concentrations (ng/m<sup>3</sup>) of Magnesium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	175	149	195	204	190	173	123	143	280	231
95% CI LB	112	117	130	161	122	112	90.8	105	231	140
95% CI UB	268	184	281	246	282	264	163	186	330	360
N	25	20	18	21	22	26	23	26	21	19
% < MDL	48	35	33.3	23.8	40.9	46.2	65.2	53.8	9.5	26.3
Max	1170	331	762	357	999	1130	422	498	543	1160
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-102.** Annual Average Concentrations of Magnesium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

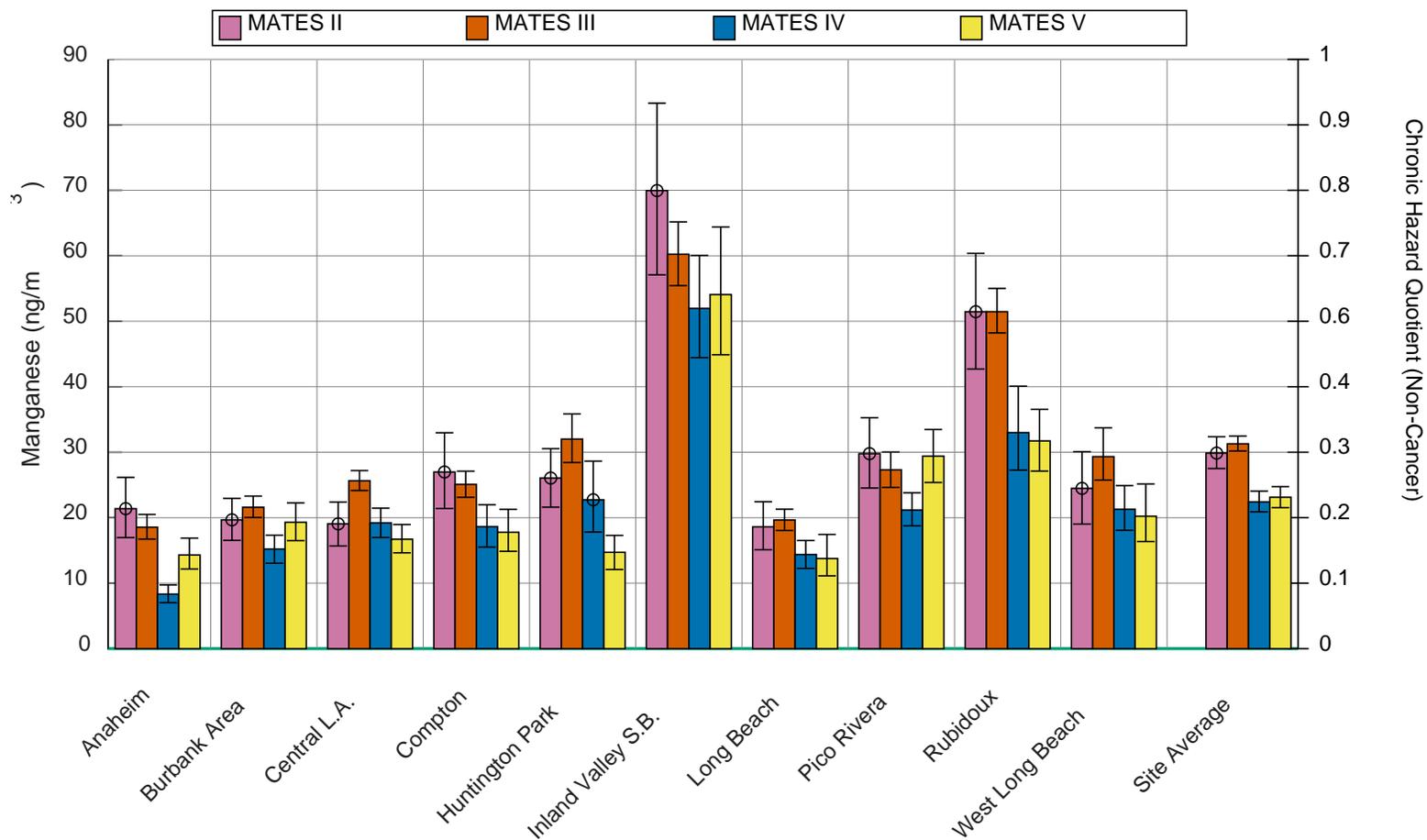


**Figure IV-103.** Geographic distribution of Magnesium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

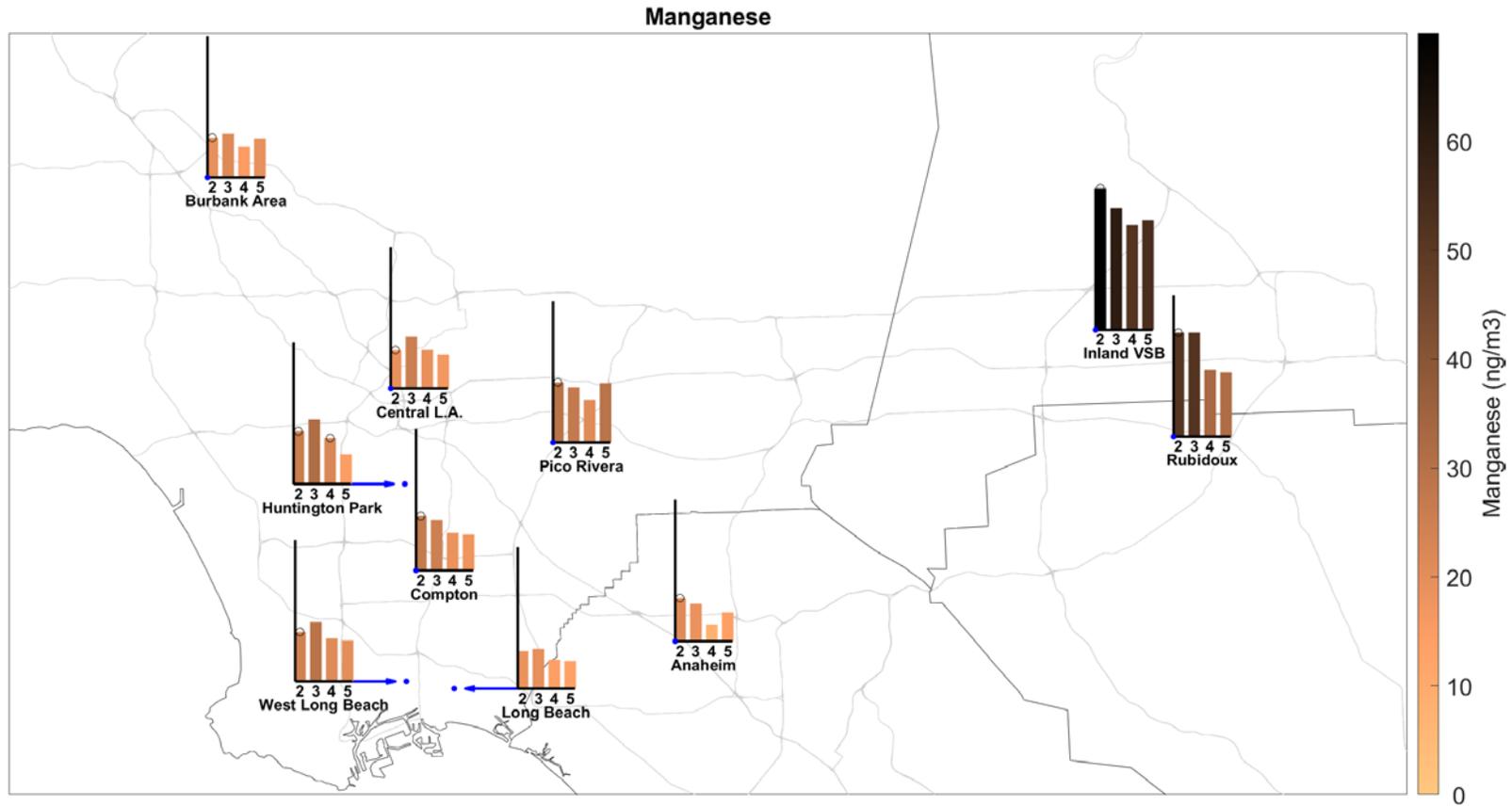
## Manganese

**Table IV-54.** Ambient Concentrations (ng/m<sup>3</sup>) of Manganese from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	21.4	19.7	27	70	26.1	18.6	19.1	29.8	51.5	24.5
95% CI LB	17	16.5	21.4	57.1	21.6	15.1	15.7	24.5	42.7	19
95% CI UB	26.1	22.9	33	83.3	30.5	22.4	22.4	35.3	60.4	30.1
N	45	47	39	41	42	56	51	41	41	39
% < MDL	17.8	8.5	10.3	2.4	7.1	12.5	11.8	4.9	2.4	10.3
Max	66	55.3	76	158	71	72.7	55	68	110	85.1
MATES III										
Average	18.6	21.6	25.1	60.2	32	19.7	25.6	27.3	51.5	29.3
95% CI LB	16.7	20	23.1	55.4	28.4	18	24.1	24.6	48.2	25.7
95% CI UB	20.5	23.3	27.1	65.2	35.9	21.3	27.2	30	55	33.7
N	232	218	228	224	116	230	229	118	237	227
% < MDL	0.4	0.5	0	0.4	0	0.4	0	0	0	0.4
Max	110	128	102	192	99.6	72.5	56.5	86.7	158	357
MATES IV										
Average	8.32	15.2	18.6	52	22.7	14.4	19.2	21.2	33	21.3
95% CI LB	7.01	13	15.5	44.4	17.8	12.3	17	18.7	27.3	18.1
95% CI UB	9.73	17.3	22	60.1	28.6	16.5	21.5	23.8	40.1	24.9
N	60	58	59	56	55	59	59	60	58	58
% < MDL	0	0	0	0	0	1.7	0	0	0	0
Max	28.3	40.2	77.5	120	103	42.6	38.8	40.3	178	61.7
MATES V										
Average	14.3	19.3	17.8	54.1	14.7	13.8	16.7	29.4	31.7	20.2
95% CI LB	12.2	16.5	14.9	44.9	12.1	11.1	14.6	25.4	27.1	16.4
95% CI UB	16.9	22.3	21.3	64.4	17.3	17.4	19	33.5	36.5	25.1
N	61	58	61	59	61	60	60	60	60	59
% < MDL	0	0	0	0	0	0	1.7	0	0	0
Max	43.6	51.2	68.7	194	43.1	86.8	40.6	75.5	99	122



**Figure IV-104.** Annual Average Concentrations of Manganese in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



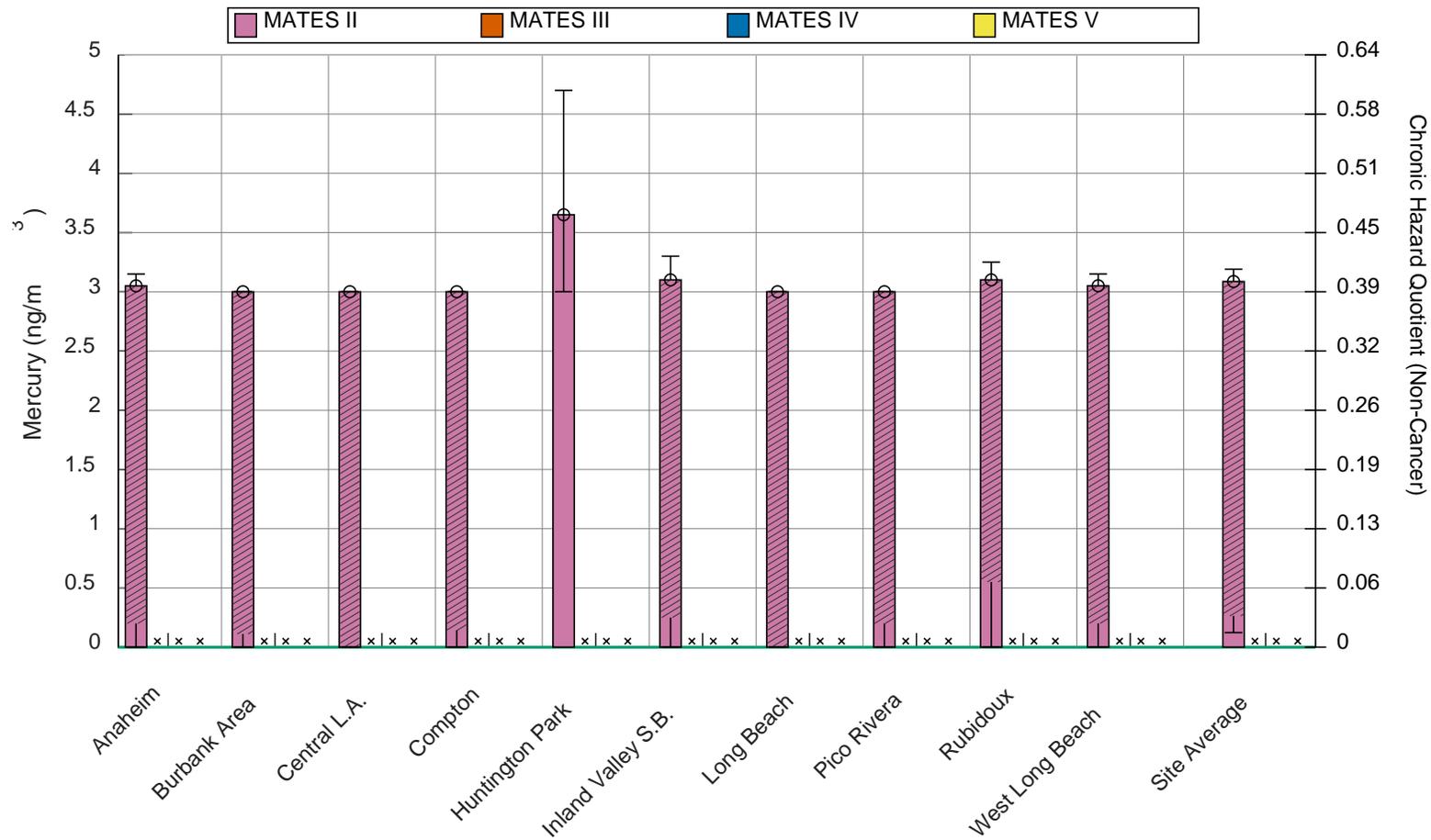
**Figure IV-105.** Geographic distribution of Manganese from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Mercury

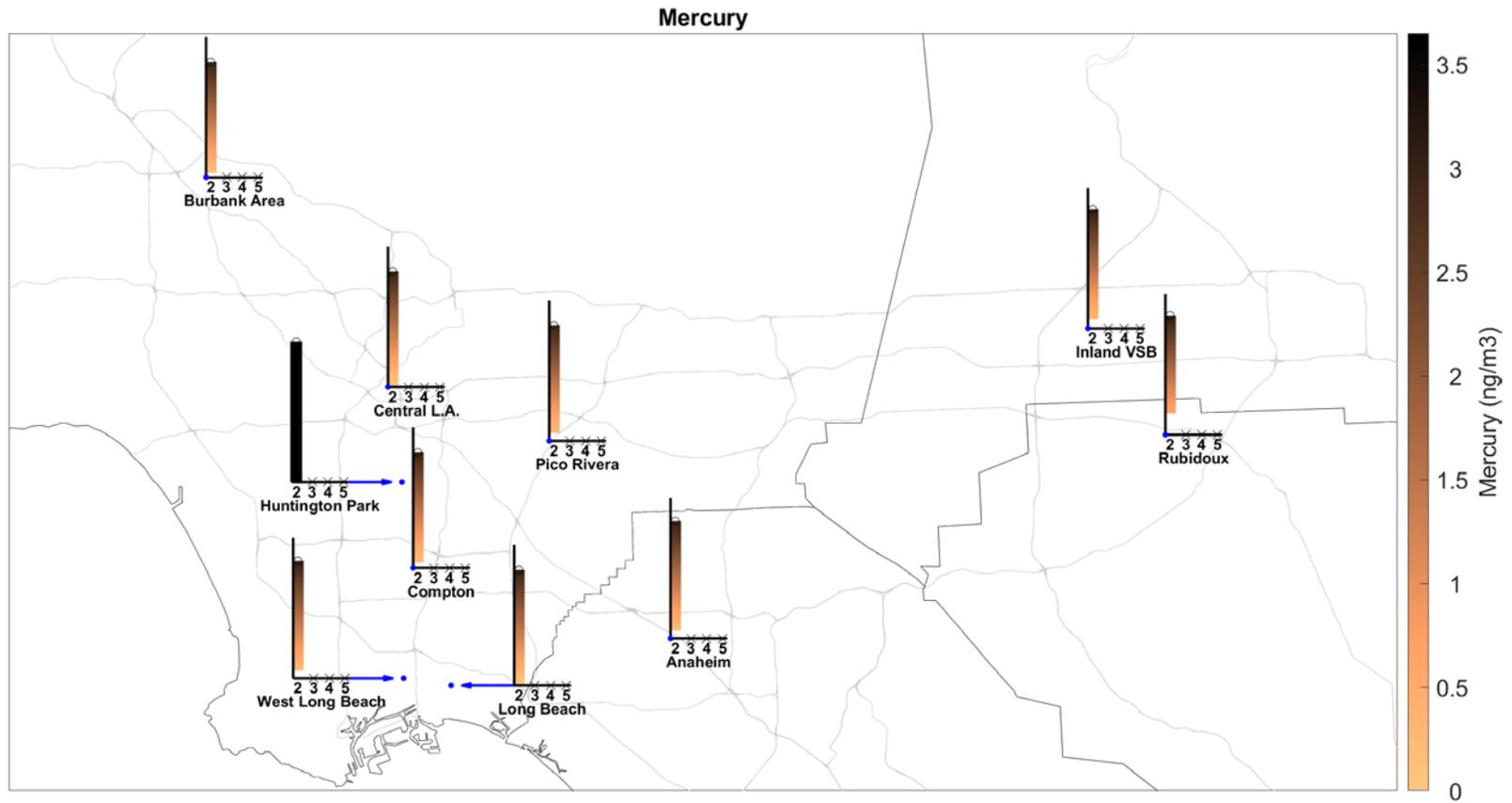
**Table IV-55.** Ambient Concentrations (ng/m<sup>3</sup>) of Mercury from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.2, 3.05 <sup>a</sup>	0.111, 3 <sup>a</sup>	0.143, 3 <sup>a</sup>	0.25, 3.1 <sup>a</sup>	3.65	0, 3 <sup>a</sup>	0, 3 <sup>a</sup>	0.2, 3 <sup>a</sup>	0.55, 3.1 <sup>a</sup>	0.2, 3.05 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	3	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	3.15 <sup>a</sup>	3 <sup>a</sup>	3 <sup>a</sup>	3.3 <sup>a</sup>	4.7	3 <sup>a</sup>	3 <sup>a</sup>	3 <sup>a</sup>	3.25 <sup>a</sup>	3.15 <sup>a</sup>
N	20 <sup>a</sup>	27 <sup>a</sup>	21 <sup>a</sup>	20 <sup>a</sup>	20	30 <sup>a</sup>	28 <sup>a</sup>	15 <sup>a</sup>	20 <sup>a</sup>	20 <sup>a</sup>
% < MDL	95 <sup>a</sup>	96.3 <sup>a</sup>	95.2 <sup>a</sup>	95 <sup>a</sup>	80	100 <sup>a</sup>	100 <sup>a</sup>	93.3 <sup>a</sup>	85 <sup>a</sup>	95 <sup>a</sup>
Max	4 <sup>a</sup>	3 <sup>a</sup>	3 <sup>a</sup>	5 <sup>a</sup>	12	< MDL <sup>a</sup>	< MDL <sup>a</sup>	3 <sup>a</sup>	4 <sup>a</sup>	4 <sup>a</sup>
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-106.** Annual Average Concentrations of Mercury in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

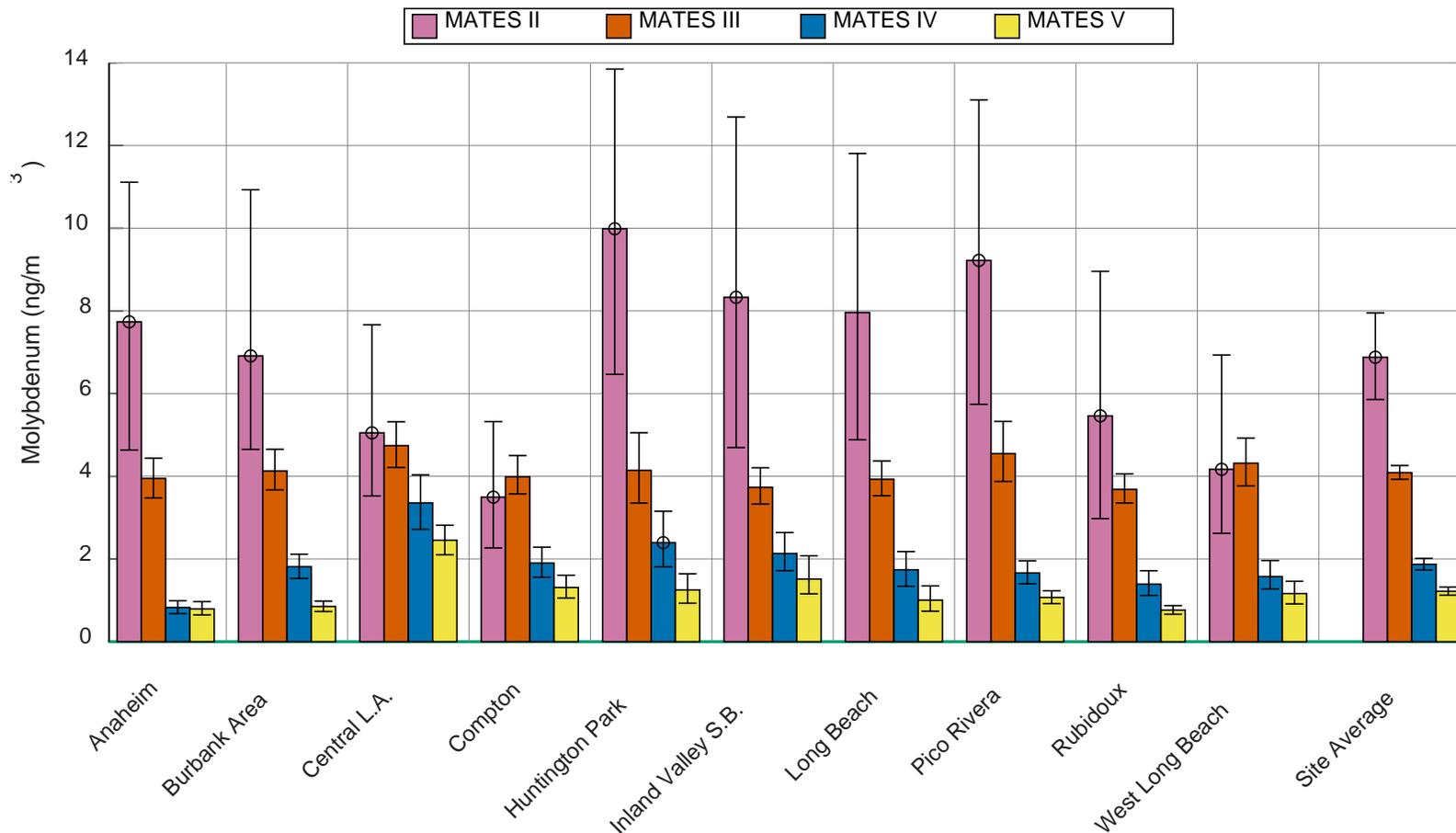


**Figure IV-107.** Geographic distribution of Mercury from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

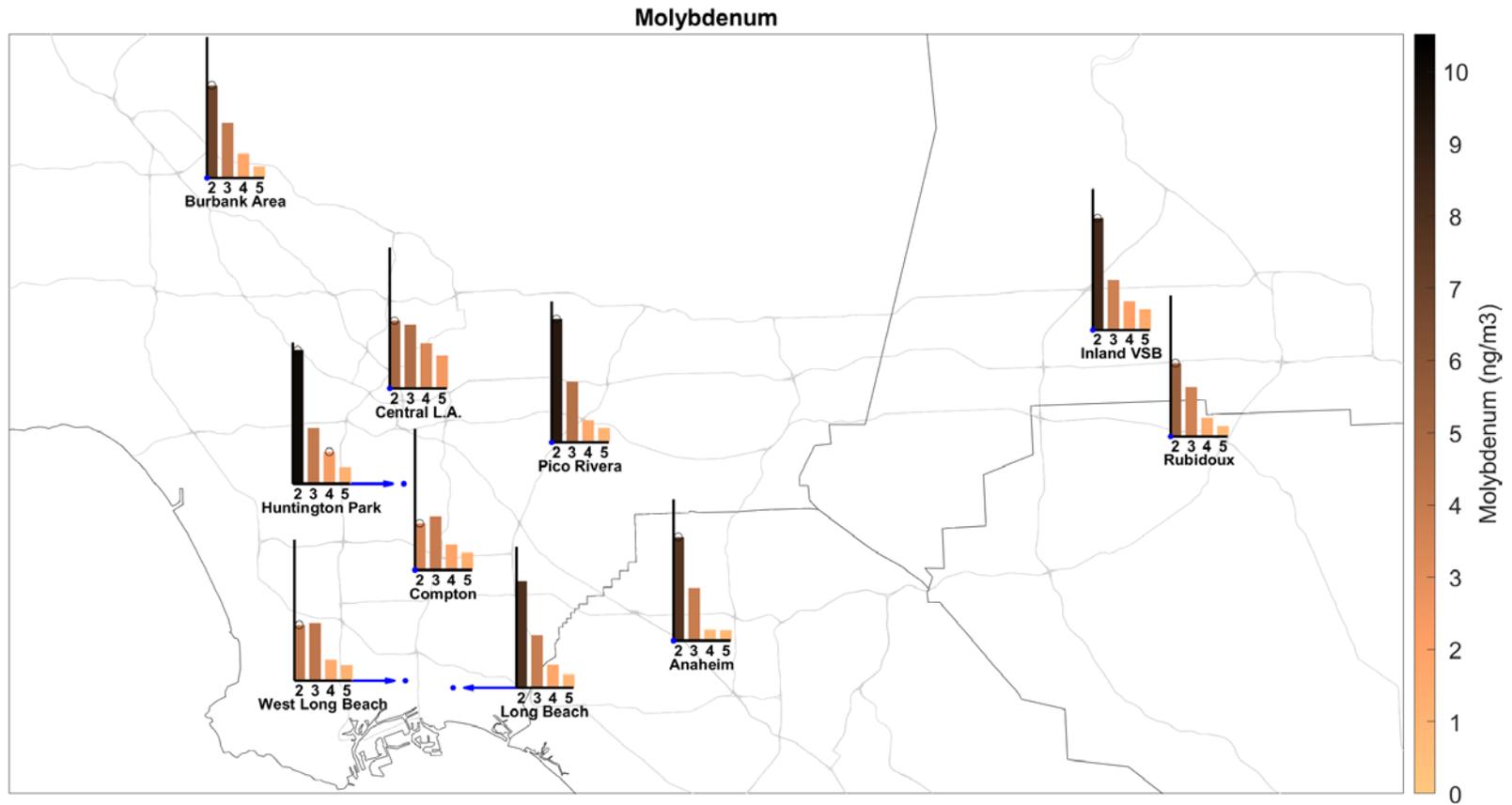
## Molybdenum

**Table IV-56.** Ambient Concentrations (ng/m<sup>3</sup>) of Molybdenum from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	7.73	6.91	3.5	8.33	9.99	7.96	5.05	9.22	5.46	4.17
95% CI LB	4.63	4.65	2.27	4.69	6.47	4.89	3.52	5.74	2.98	2.62
95% CI UB	11.1	10.9	5.32	12.7	13.8	11.8	7.66	13.1	8.96	6.93
N	45	47	39	41	42	56	51	41	41	39
% < MDL	60	74.5	71.8	56.1	45.2	67.9	74.5	48.8	70.7	76.9
Max	32.7	63.6	27.7	57.7	38.4	59.8	35	44.2	39.5	36.7
MATES III										
Average	3.95	4.13	3.99	3.73	4.14	3.93	4.74	4.55	3.68	4.32
95% CI LB	3.48	3.67	3.57	3.33	3.35	3.53	4.21	3.87	3.36	3.77
95% CI UB	4.44	4.65	4.5	4.21	5.05	4.37	5.32	5.33	4.06	4.93
N	232	218	228	224	116	230	229	118	237	227
% < MDL	34.1	26.1	31.6	29.5	33.6	27	21	20.3	23.2	32.2
Max	26.3	24.7	29.6	23.6	28.1	23.4	25.3	22.3	22.6	28.2
MATES IV										
Average	0.826	1.81	1.9	2.13	2.39	1.74	3.36	1.66	1.39	1.58
95% CI LB	0.678	1.53	1.56	1.72	1.81	1.34	2.72	1.4	1.12	1.28
95% CI UB	0.991	2.12	2.29	2.64	3.15	2.18	4.03	1.96	1.72	1.96
N	60	58	59	56	55	59	59	60	58	58
% < MDL	0	0	0	0	0	1.7	0	0	0	0
Max	2.84	5.27	6.62	9.78	17	7.25	12.6	5.88	8.48	7.35
MATES V										
Average	0.793	0.852	1.31	1.52	1.25	1	2.45	1.07	0.766	1.17
95% CI LB	0.647	0.729	1.06	1.16	0.931	0.737	2.1	0.922	0.664	0.915
95% CI UB	0.97	0.981	1.61	2.08	1.64	1.35	2.82	1.23	0.873	1.46
N	60	57	60	59	59	59	60	60	60	58
% < MDL	0	0	0	0	3.4	0	0	0	0	0
Max	4.16	2.09	5.01	14.7	9.48	8	6.52	2.84	1.87	5.56



**Figure IV-108.** Annual Average Concentrations of Molybdenum in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

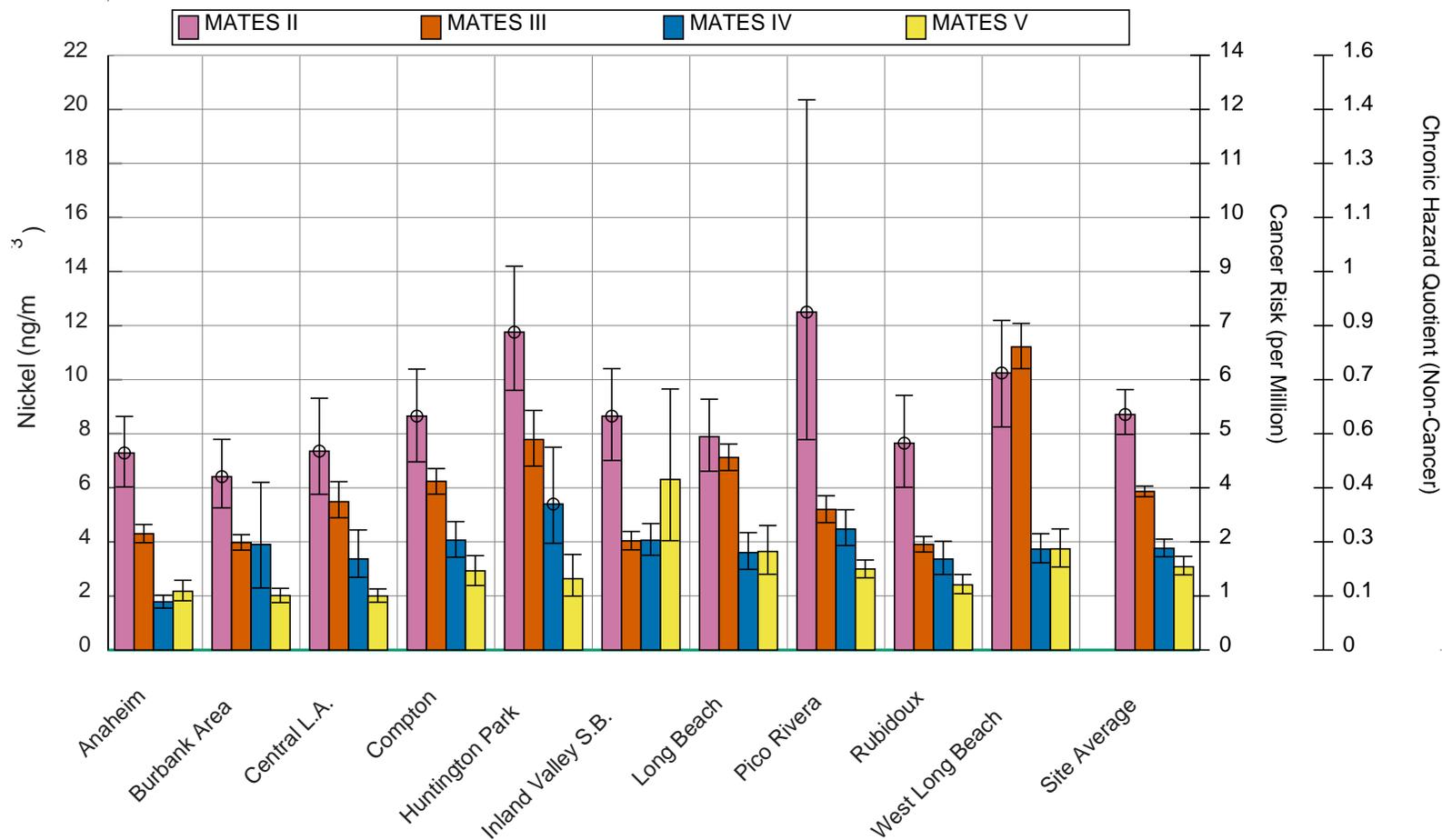


**Figure IV-109.** Geographic distribution of Molybdenum from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

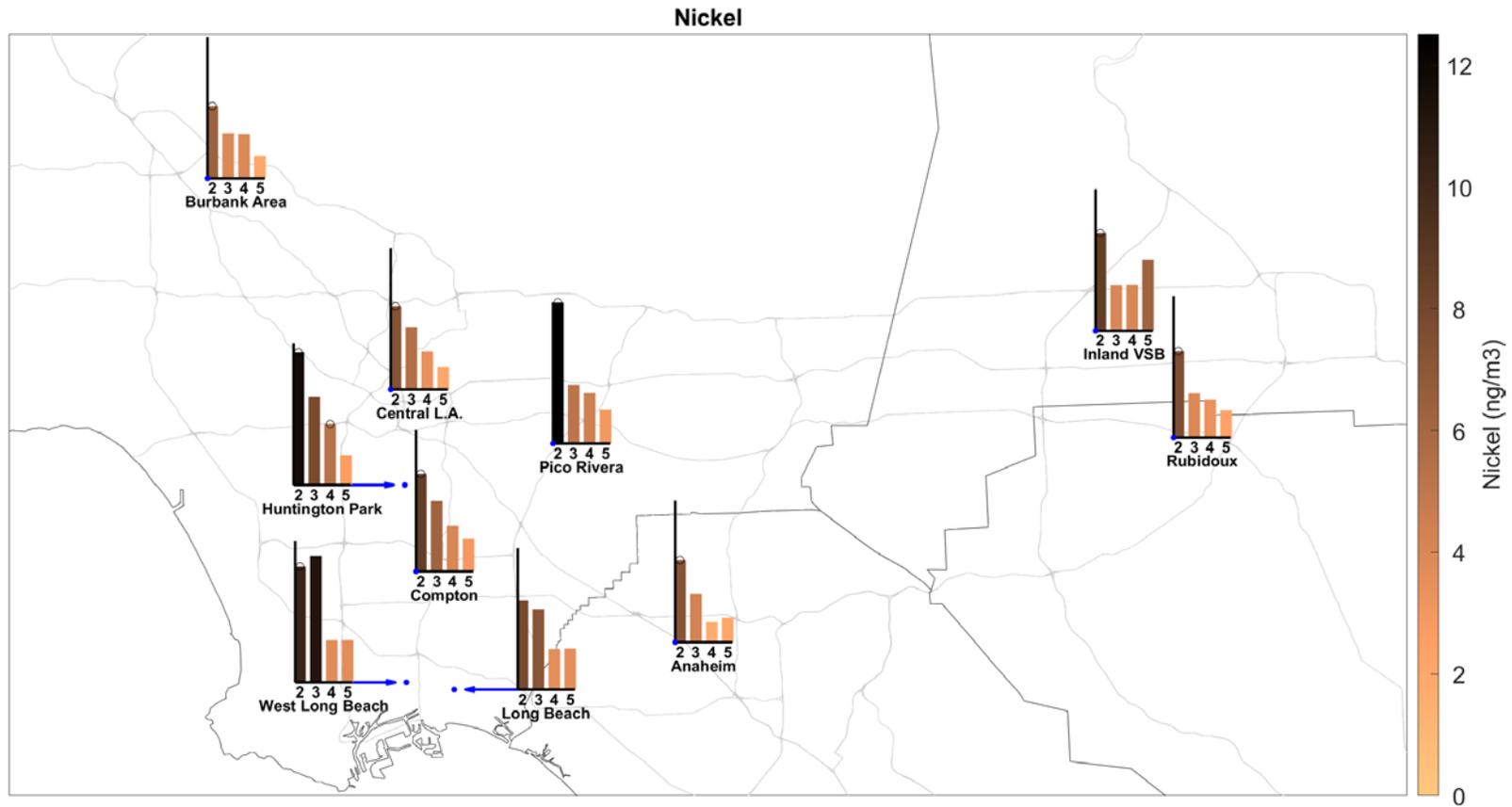
## Nickel

**Table IV-57.** Ambient Concentrations (ng/m<sup>3</sup>) of Nickel from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	7.29	6.41	8.65	8.65	11.8	7.89	7.36	12.5	7.65	10.2
95% CI LB	6.03	5.26	6.96	7.01	9.61	6.61	5.76	7.78	6.02	8.25
95% CI UB	8.64	7.79	10.4	10.4	14.2	9.28	9.31	20.4	9.42	12.2
N	45	47	39	41	42	56	51	41	41	39
% < MDL	6.7	8.5	0	4.9	2.4	5.4	9.8	4.9	9.8	2.6
Max	18.7	24.9	30.2	21.4	38.8	21.8	38	153	21.6	25.7
MATES III										
Average	4.3	3.97	6.24	4.04	7.79	7.12	5.49	5.2	3.91	11.2
95% CI LB	3.97	3.69	5.76	3.71	6.8	6.64	4.89	4.71	3.62	10.4
95% CI UB	4.64	4.27	6.71	4.38	8.86	7.62	6.23	5.71	4.2	12.1
N	232	218	228	224	116	230	229	118	237	227
% < MDL	4.3	5	3.1	11.2	1.7	2.6	3.5	0.8	11	1.8
Max	15	17.1	21.4	13.2	29.7	19.2	69.8	17.4	15	34.5
MATES IV										
Average	1.78	3.9	4.06	4.06	5.4	3.6	3.37	4.47	3.36	3.73
95% CI LB	1.55	2.3	3.44	3.51	3.95	2.98	2.69	3.87	2.79	3.23
95% CI UB	2.03	6.2	4.75	4.68	7.5	4.34	4.44	5.19	4.02	4.3
N	60	58	59	56	55	59	59	60	58	58
% < MDL	15	5.2	0	1.8	0	5.1	0	0	6.9	1.7
Max	5.8	44.5	13.7	13.4	50	14.8	29.4	17.5	14.6	13
MATES V										
Average	2.17	2.01	2.93	6.31	2.64	3.64	2	3	2.41	3.74
95% CI LB	1.82	1.75	2.38	4.04	2	2.8	1.77	2.67	2.08	3.07
95% CI UB	2.58	2.28	3.49	9.66	3.53	4.6	2.26	3.33	2.79	4.48
N	61	58	61	59	61	60	60	60	60	59
% < MDL	0	0	0	0	3.3	0	1.7	0	0	0
Max	8.32	4.24	8.85	83.5	23.2	18.3	5.24	7.55	9.23	12.2



**Figure IV-110.** Annual Average Concentrations of Nickel in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



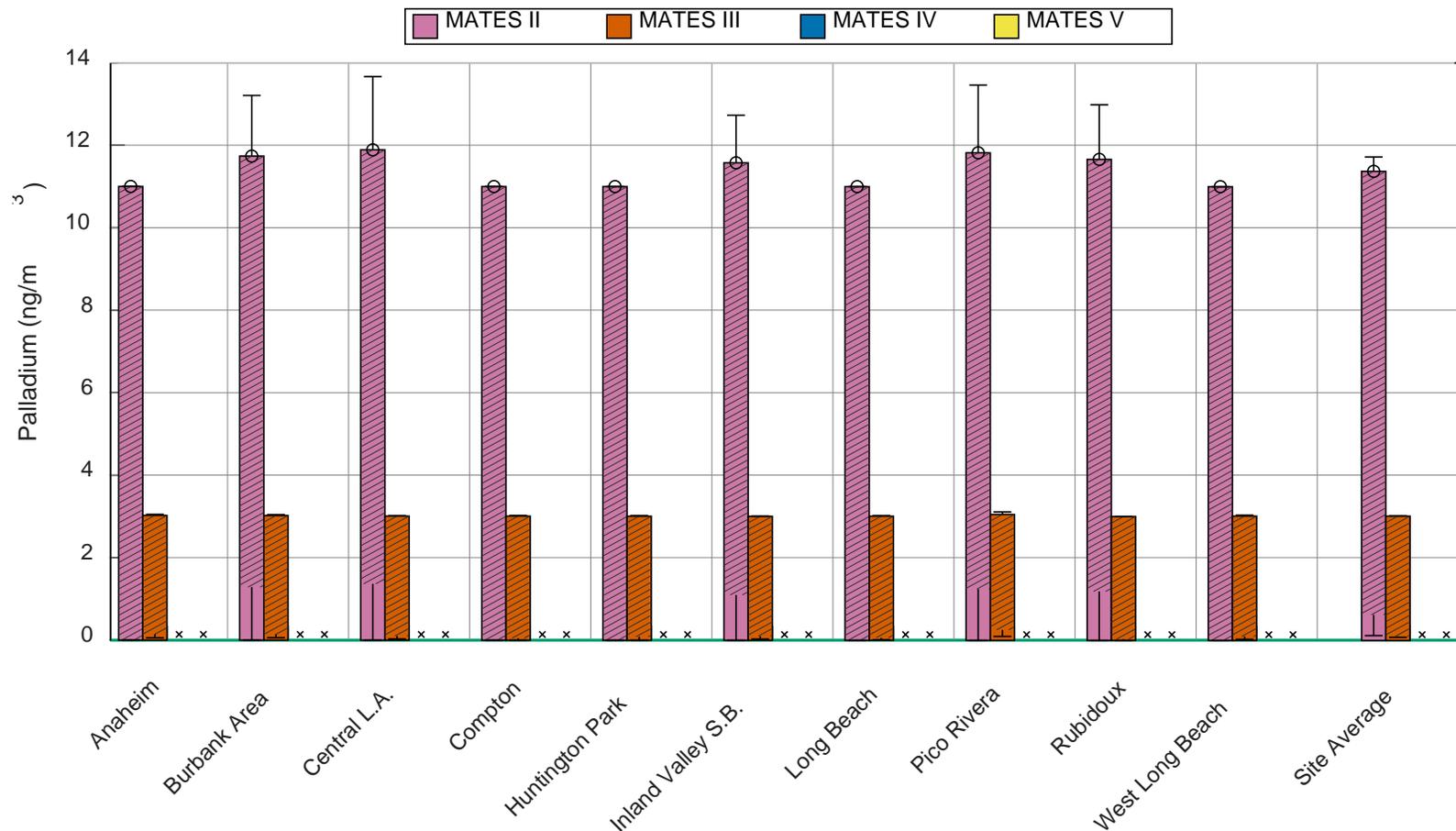
**Figure IV-111.** Geographic distribution of Nickel from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Palladium

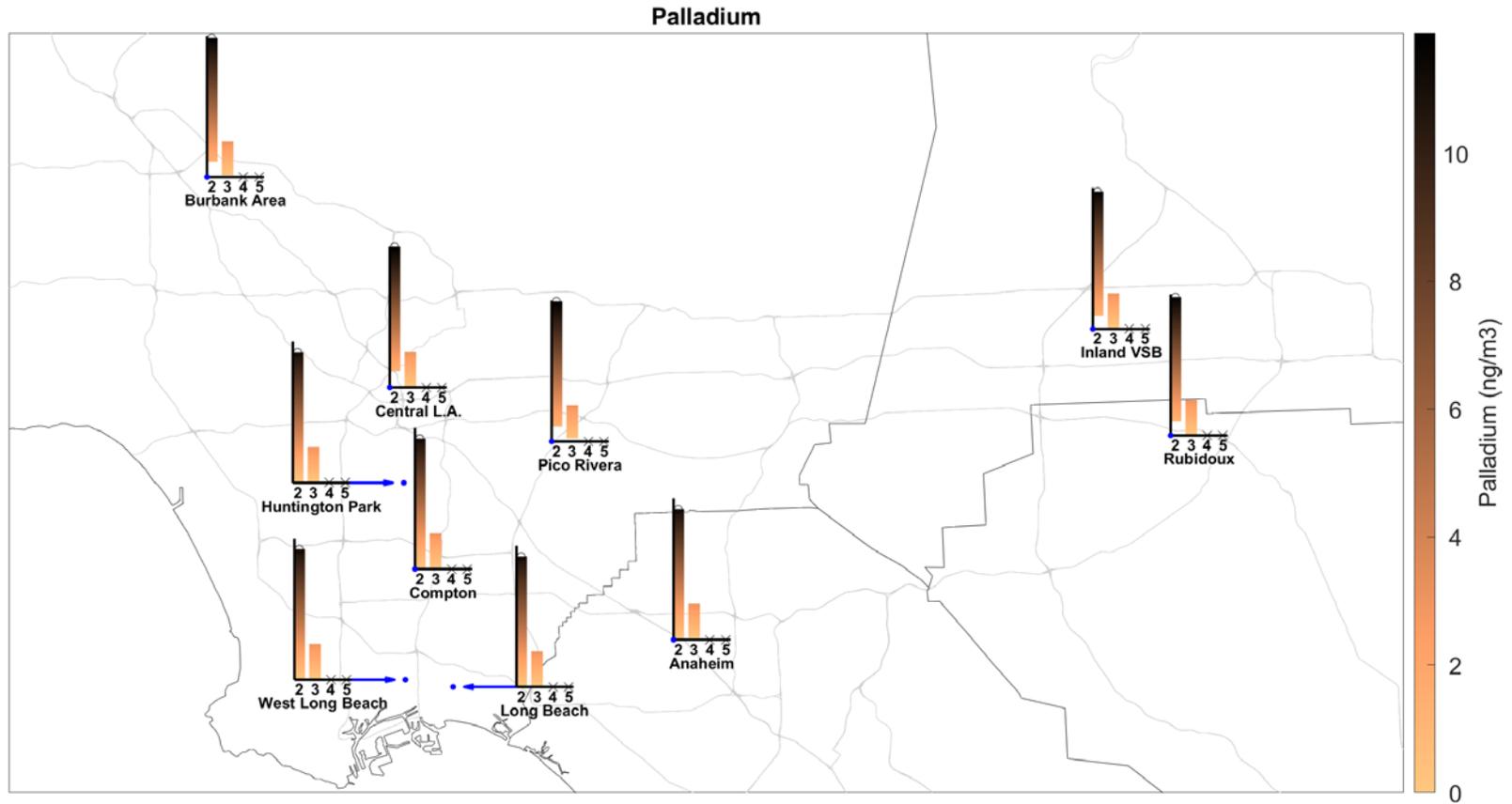
**Table IV-58.** Ambient Concentrations (ng/m<sup>3</sup>) of Palladium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0, 11 <sup>a</sup>	1.29, 11.7 <sup>a</sup>	0, 11 <sup>a</sup>	1.1, 11.6 <sup>a</sup>	0, 11 <sup>a</sup>	0, 11 <sup>a</sup>	1.37, 11.9 <sup>a</sup>	1.24, 11.8 <sup>a</sup>	1.19, 11.7 <sup>a</sup>	0, 11 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	11 <sup>a</sup>	13.2 <sup>a</sup>	11 <sup>a</sup>	12.7 <sup>a</sup>	11 <sup>a</sup>	11 <sup>a</sup>	13.7 <sup>a</sup>	13.5 <sup>a</sup>	13 <sup>a</sup>	11 <sup>a</sup>
N	25 <sup>a</sup>	20 <sup>a</sup>	18 <sup>a</sup>	21 <sup>a</sup>	22 <sup>a</sup>	26 <sup>a</sup>	23 <sup>a</sup>	26 <sup>a</sup>	21 <sup>a</sup>	19 <sup>a</sup>
% < MDL	100 <sup>a</sup>	95 <sup>a</sup>	100 <sup>a</sup>	95.2 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	95.7 <sup>a</sup>	96.2 <sup>a</sup>	95.2 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	25.7 <sup>a</sup>	< MDL <sup>a</sup>	23.1 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	31.4 <sup>a</sup>	32.3 <sup>a</sup>	24.9 <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES III</b>										
Average	0.142, 3.03 <sup>a</sup>	0.145, 3.02 <sup>a</sup>	0.0487, 3.01 <sup>a</sup>	0.0997, 3.01 <sup>a</sup>	0.0852, 3.01 <sup>a</sup>	0.0621, 3.01 <sup>a</sup>	0.101, 3.01 <sup>a</sup>	0.256, 3.05 <sup>a</sup>	0.0267, 3 <sup>a</sup>	0.093, 3.01 <sup>a</sup>
95% CI LB	0.0583 <sup>a</sup>	0.0613 <sup>a</sup>	0 <sup>a</sup>	0.0297 <sup>a</sup>	0 <sup>a</sup>	0.0136 <sup>a</sup>	0.0304 <sup>a</sup>	0.0939 <sup>a</sup>	0 <sup>a</sup>	0.027 <sup>a</sup>
95% CI UB	3.05 <sup>a</sup>	3.04 <sup>a</sup>	3.03 <sup>a</sup>	3.01 <sup>a</sup>	3.02 <sup>a</sup>	3.02 <sup>a</sup>	3.02 <sup>a</sup>	3.11 <sup>a</sup>	3 <sup>a</sup>	3.04 <sup>a</sup>
N	232 <sup>a</sup>	218 <sup>a</sup>	228 <sup>a</sup>	224 <sup>a</sup>	116 <sup>a</sup>	230 <sup>a</sup>	229 <sup>a</sup>	118 <sup>a</sup>	237 <sup>a</sup>	227 <sup>a</sup>
% < MDL	96.1 <sup>a</sup>	95.9 <sup>a</sup>	98.7 <sup>a</sup>	96.9 <sup>a</sup>	97.4 <sup>a</sup>	98.3 <sup>a</sup>	96.9 <sup>a</sup>	93.2 <sup>a</sup>	99.2 <sup>a</sup>	97.4 <sup>a</sup>
Max	4.64 <sup>a</sup>	4.55 <sup>a</sup>	4.61 <sup>a</sup>	3.52 <sup>a</sup>	3.8 <sup>a</sup>	4.28 <sup>a</sup>	3.8 <sup>a</sup>	5.63 <sup>a</sup>	3.26 <sup>a</sup>	5.4 <sup>a</sup>
<b>MATES IV</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES V</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-112.** Annual Average Concentrations of Palladium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

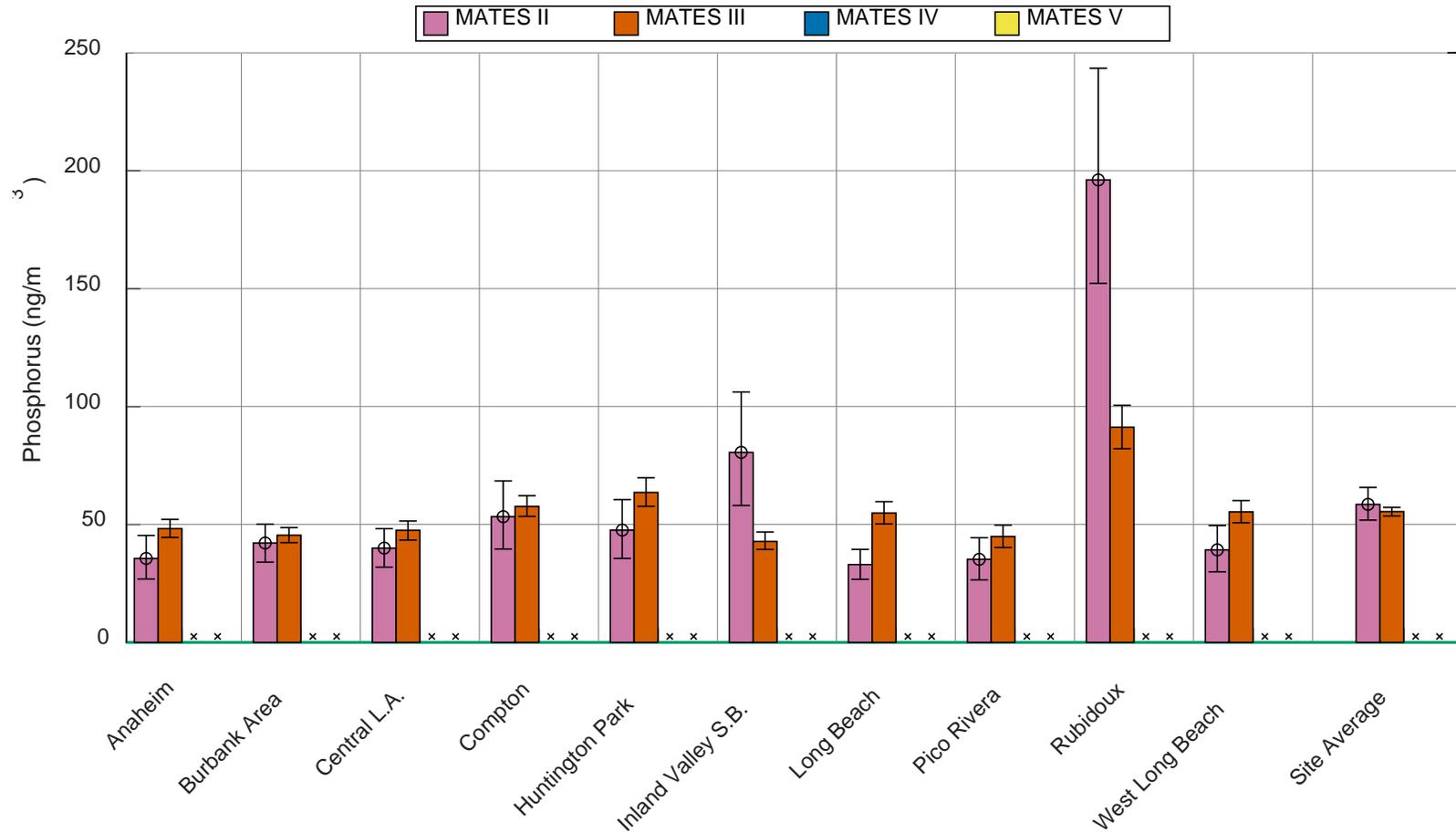


**Figure IV-113.** Geographic distribution of Palladium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

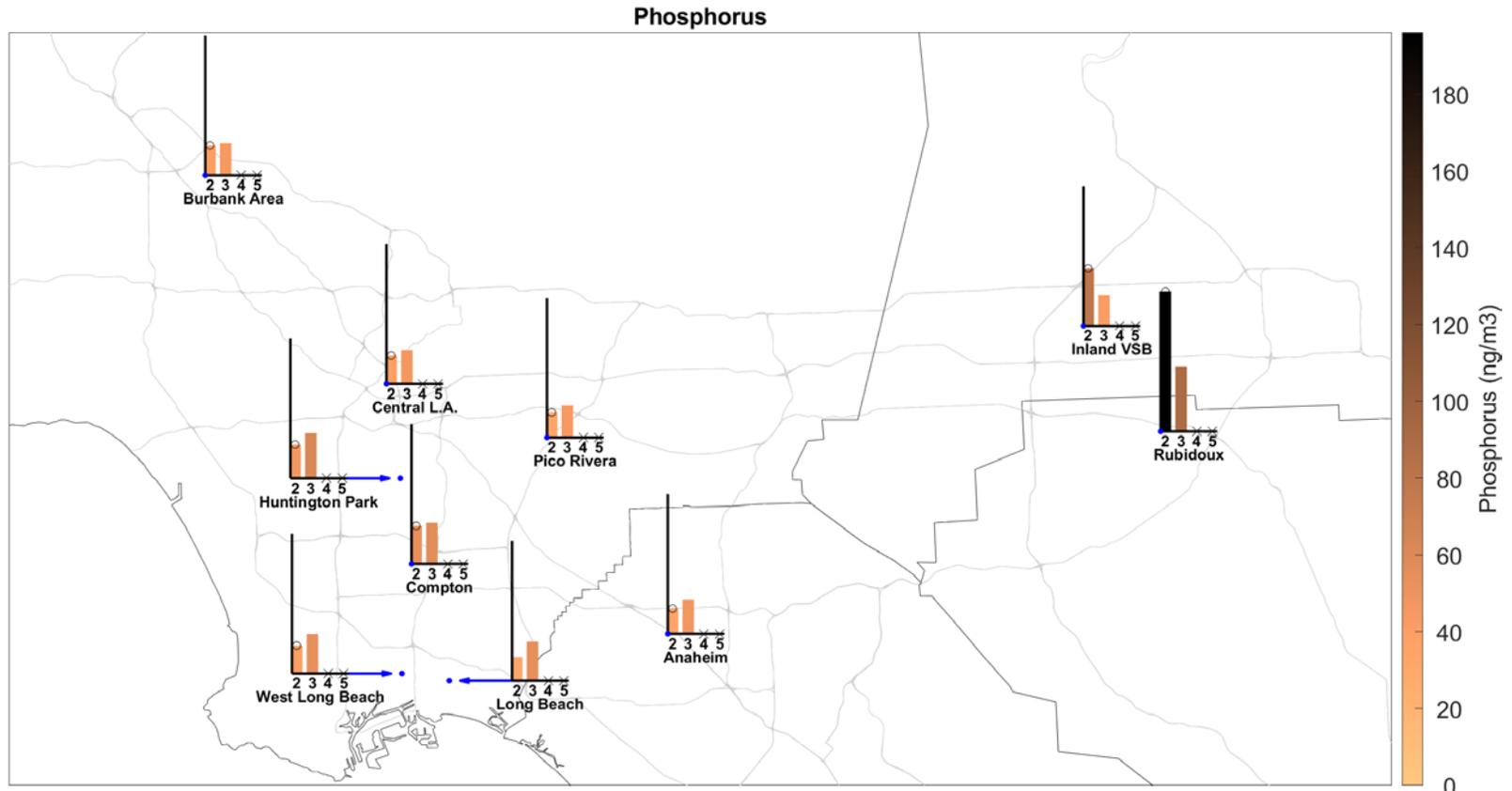
Phosphorus

**Table IV-59.** Ambient Concentrations (ng/m<sup>3</sup>) of Phosphorus from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	35.6	42.1	53.3	80.6	47.6	33	40	35.2	196	39.2
95% CI LB	26.9	34	39.6	58.1	35.6	26.7	31.9	26.5	152	29.9
95% CI UB	45.3	50.1	68.5	106	60.5	39.4	48.2	44.4	243	49.5
N	45	47	39	41	42	56	51	41	41	39
% < MDL	55.6	42.6	41	36.6	50	48.2	45.1	63.4	17.1	48.7
Max	151	101	187	372	186	121	140	109	471	143
MATES III										
Average	48.2	45.5	57.7	42.8	63.6	54.8	47.5	44.9	91.2	55.4
95% CI LB	44.5	42.3	53.4	39.4	57.7	50.2	43.4	40.2	82.1	50.7
95% CI UB	52.2	48.7	62.2	46.8	69.8	59.7	51.5	49.7	101	60.1
N	232	218	228	224	116	230	229	118	237	227
% < MDL	25	23.9	10.1	37.9	6	18.7	31	23.7	24.5	18.1
Max	152	126	160	147	159	200	182	143	264	197
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-114.** Annual Average Concentrations of Phosphorus in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

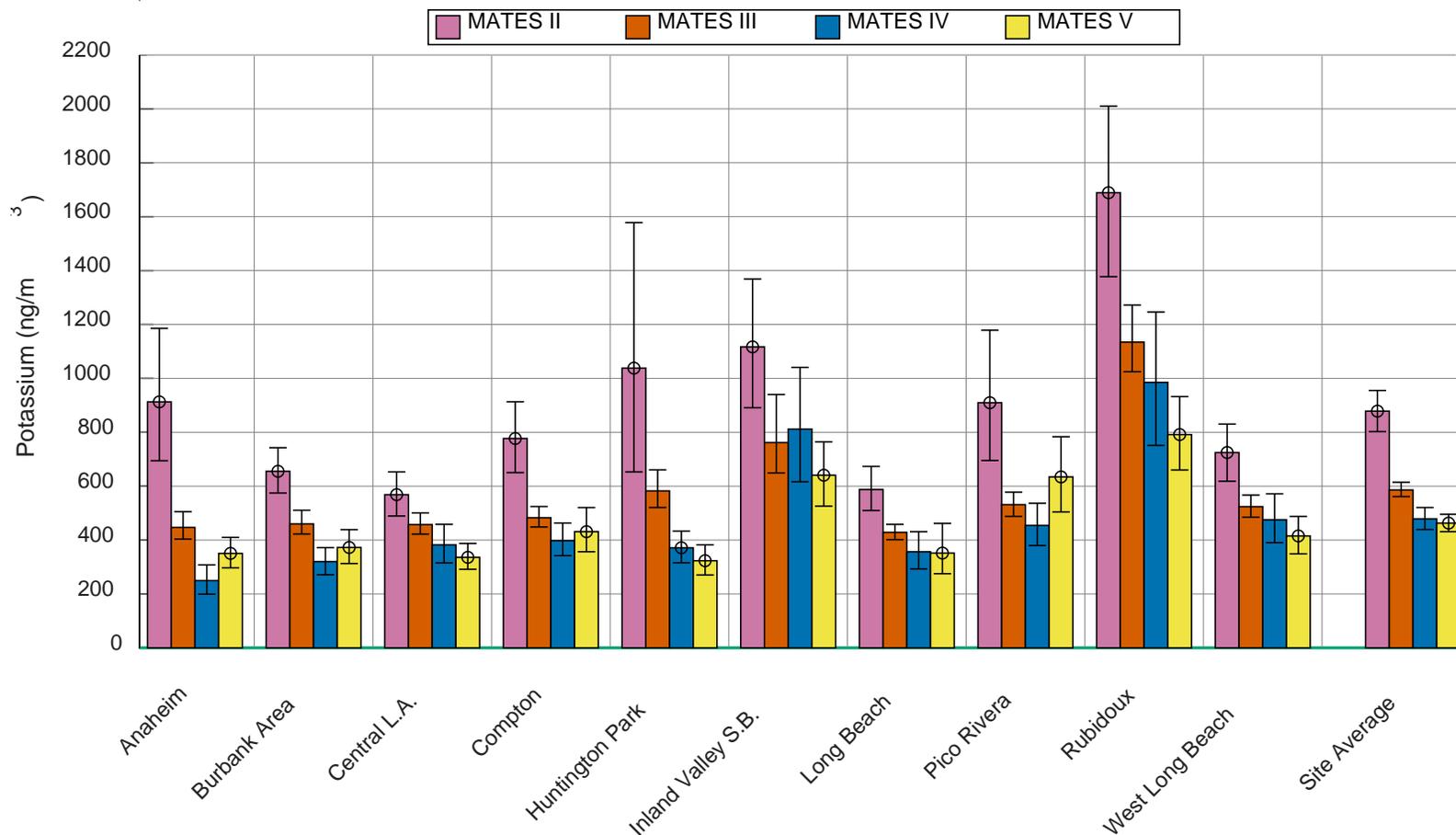


**Figure IV-115.** Geographic distribution of Phosphorus from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

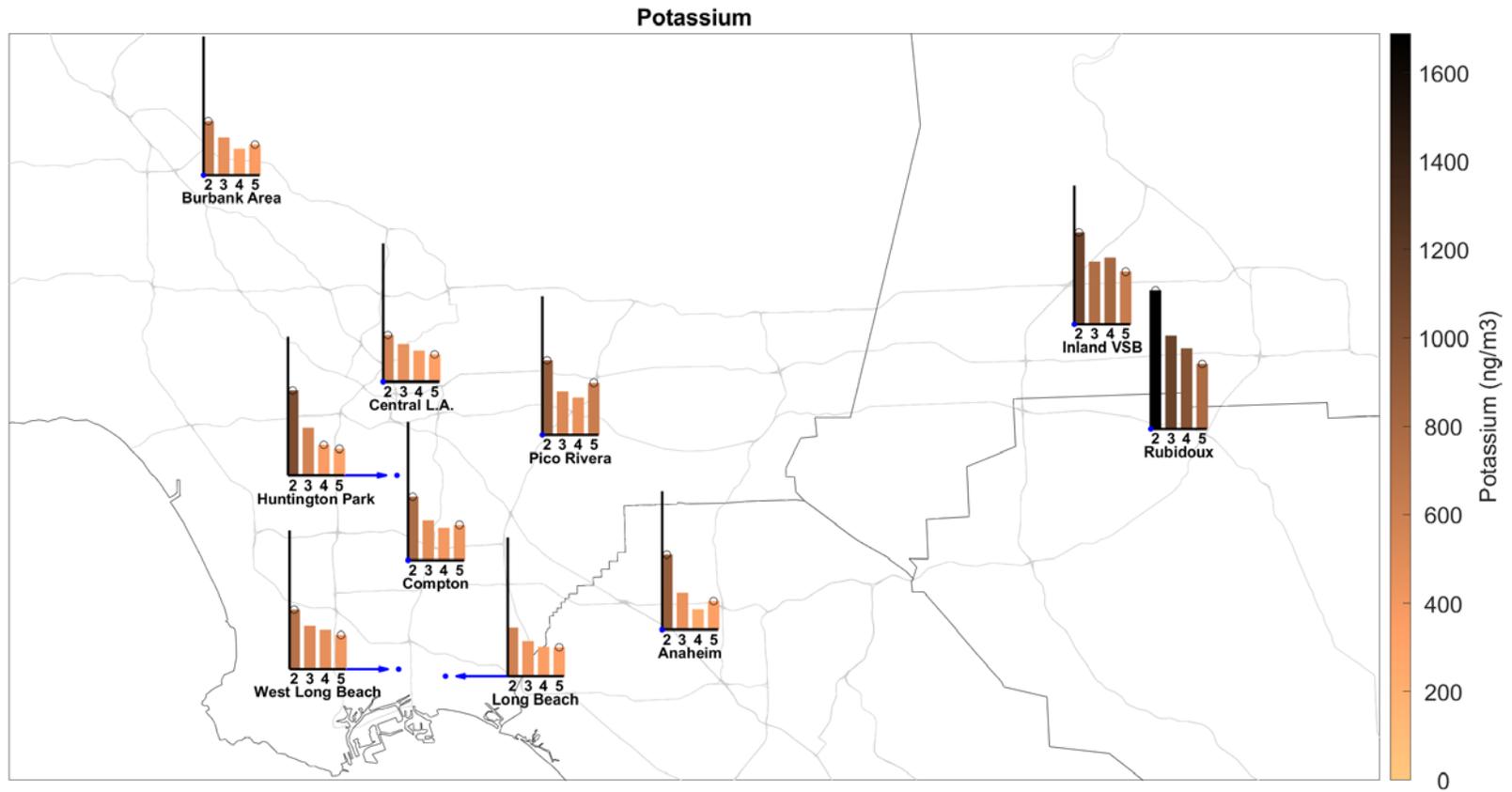
## Potassium

**Table IV-60.** Ambient Concentrations (ng/m<sup>3</sup>) of Potassium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	913	655	777	1120	1040	588	568	910	1690	725
95% CI LB	694	575	650	891	653	510	489	695	1380	618
95% CI UB	1190	743	913	1370	1580	673	653	1180	2010	830
N	45	47	39	41	42	56	51	41	41	39
% < MDL	0	0	0	0	0	0	2	2.4	2.4	0
Max	4380	1760	1810	3390	7950	1740	1640	4550	4100	1760
MATES III										
Average	447	460	483	762	582	429	457	531	1130	524
95% CI LB	404	422	449	649	521	401	422	488	1020	485
95% CI UB	505	511	524	940	660	458	501	578	1270	567
N	232	218	228	224	116	230	229	118	237	227
% < MDL	0	0	0	0.4	0	0	0	0	0	0
Max	5650	4540	3040	17500	3720	1740	4190	1910	13100	2380
MATES IV										
Average	250	320	398	812	371	357	382	454	985	475
95% CI LB	199	271	342	616	316	293	315	380	751	390
95% CI UB	308	372	463	1040	433	431	458	537	1250	572
N	60	58	59	56	55	59	59	60	58	58
% < MDL	0	0	0	0	0	1.7	0	0	0	0
Max	1150	998	1240	4420	1350	1350	1490	1470	4170	1920
MATES V										
Average	350	372	431	641	323	352	336	634	791	415
95% CI LB	297	313	357	526	270	275	291	504	660	349
95% CI UB	410	439	521	765	382	462	387	783	932	488
N	46	44	47	45	47	45	45	44	44	44
% < MDL	0	2.3	0	0	12.8	0	4.4	2.3	0	0
Max	1260	950	1760	1880	911	2290	850	2390	1710	1190



**Figure IV-116.** Annual Average Concentrations of Potassium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

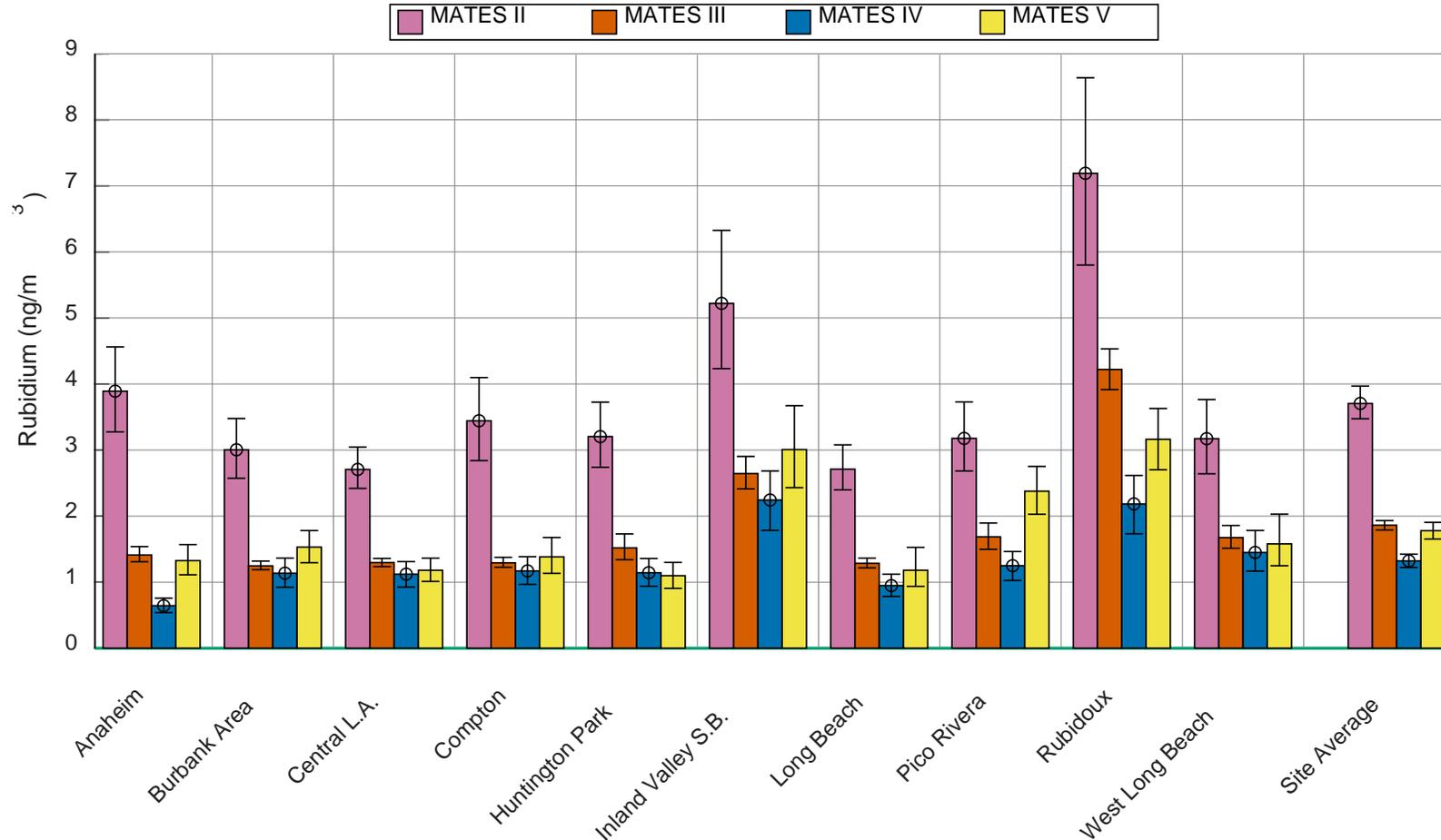


**Figure IV-117.** Geographic distribution of Potassium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

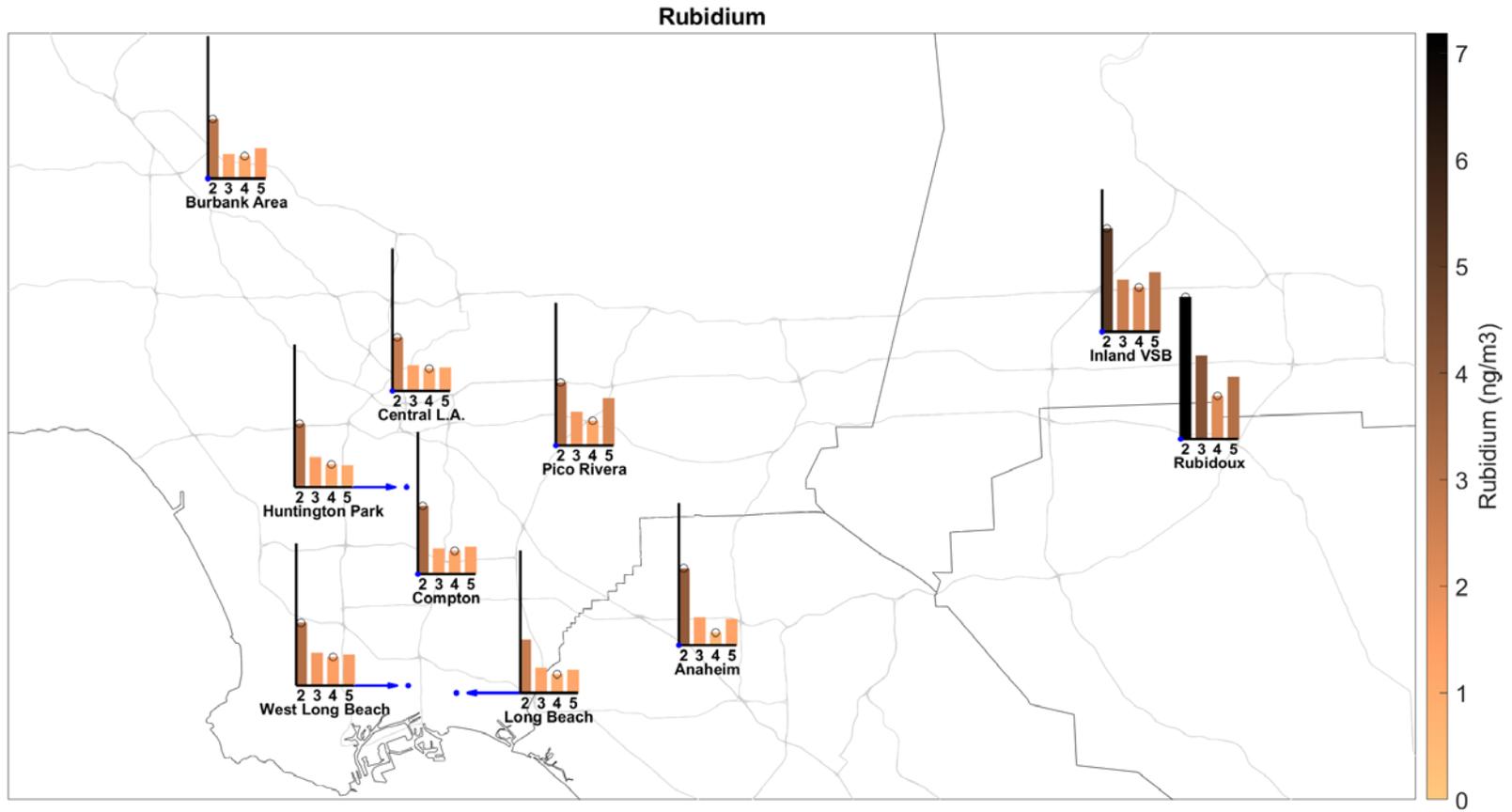
## Rubidium

**Table IV-61.** Ambient Concentrations (ng/m<sup>3</sup>) of Rubidium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	3.89	3	3.44	5.22	3.2	2.71	2.71	3.18	7.19	3.17
95% CI LB	3.28	2.57	2.84	4.23	2.74	2.4	2.42	2.68	5.8	2.64
95% CI UB	4.56	3.48	4.1	6.33	3.73	3.08	3.05	3.73	8.64	3.76
N	45	47	39	41	42	56	51	41	41	39
% < MDL	35.6	48.9	43.6	24.4	42.9	62.5	58.8	48.8	19.5	51.3
Max	10	8.81	9.94	16.6	8.29	8.84	6.55	7.87	18.1	9.01
MATES III										
Average	1.41	1.25	1.29	2.64	1.52	1.29	1.3	1.69	4.22	1.67
95% CI LB	1.31	1.19	1.23	2.41	1.34	1.22	1.23	1.5	3.91	1.51
95% CI UB	1.54	1.32	1.38	2.9	1.73	1.36	1.36	1.9	4.53	1.86
N	232	218	228	224	116	230	229	118	237	227
% < MDL	62.9	64.2	61.4	30.8	50.9	64.8	58.1	44.9	16.5	53.7
Max	6.9	4.57	5.36	12	9.13	5.29	3.51	8.13	11.6	13.6
MATES IV										
Average	0.643	1.14	1.17	2.24	1.14	0.948	1.12	1.25	2.18	1.45
95% CI LB	0.539	0.924	0.966	1.78	0.938	0.783	0.926	1.02	1.73	1.17
95% CI UB	0.758	1.36	1.39	2.68	1.36	1.12	1.31	1.46	2.61	1.78
N	41	39	40	39	40	41	40	42	39	41
% < MDL	19.5	7.7	7.5	0	5	7.3	12.5	7.1	5.1	7.3
Max	1.63	3.24	2.77	5.77	3.39	2.07	3.41	3.18	5.57	4.48
MATES V										
Average	1.33	1.53	1.38	3.01	1.1	1.18	1.18	2.38	3.16	1.58
95% CI LB	1.11	1.29	1.13	2.43	0.905	0.937	1.01	2.03	2.7	1.25
95% CI UB	1.57	1.78	1.68	3.67	1.3	1.53	1.36	2.75	3.63	2.03
N	61	58	61	59	61	60	60	60	60	59
% < MDL	0	0	0	0	0	0	1.7	0	0	0
Max	5.17	4.41	6.85	14.7	3.68	8.84	3.54	7.26	9.39	11.3



**Figure IV-118.** Annual Average Concentrations of Rubidium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



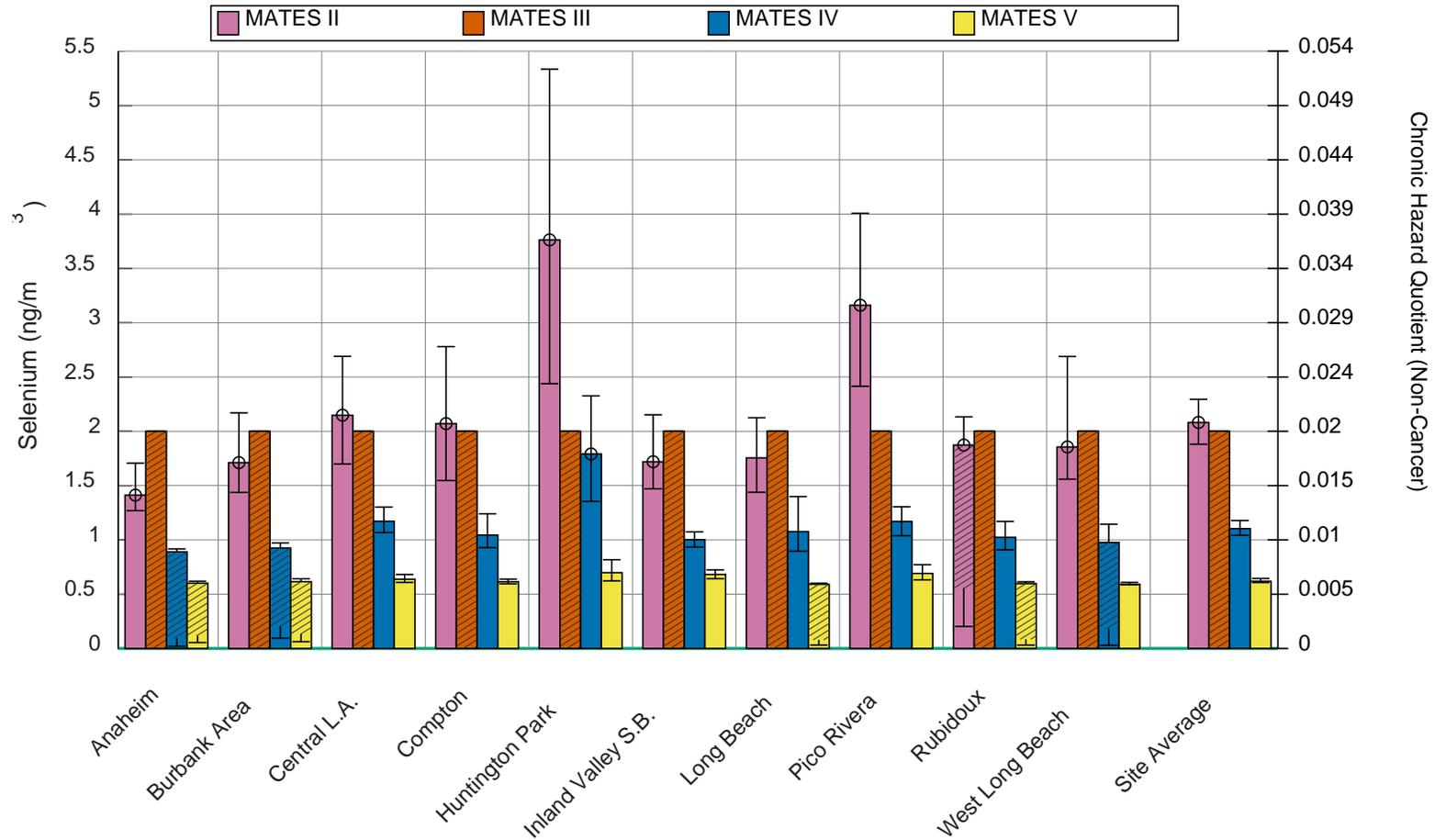
**Figure IV-119.** Geographic distribution of Rubidium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Selenium

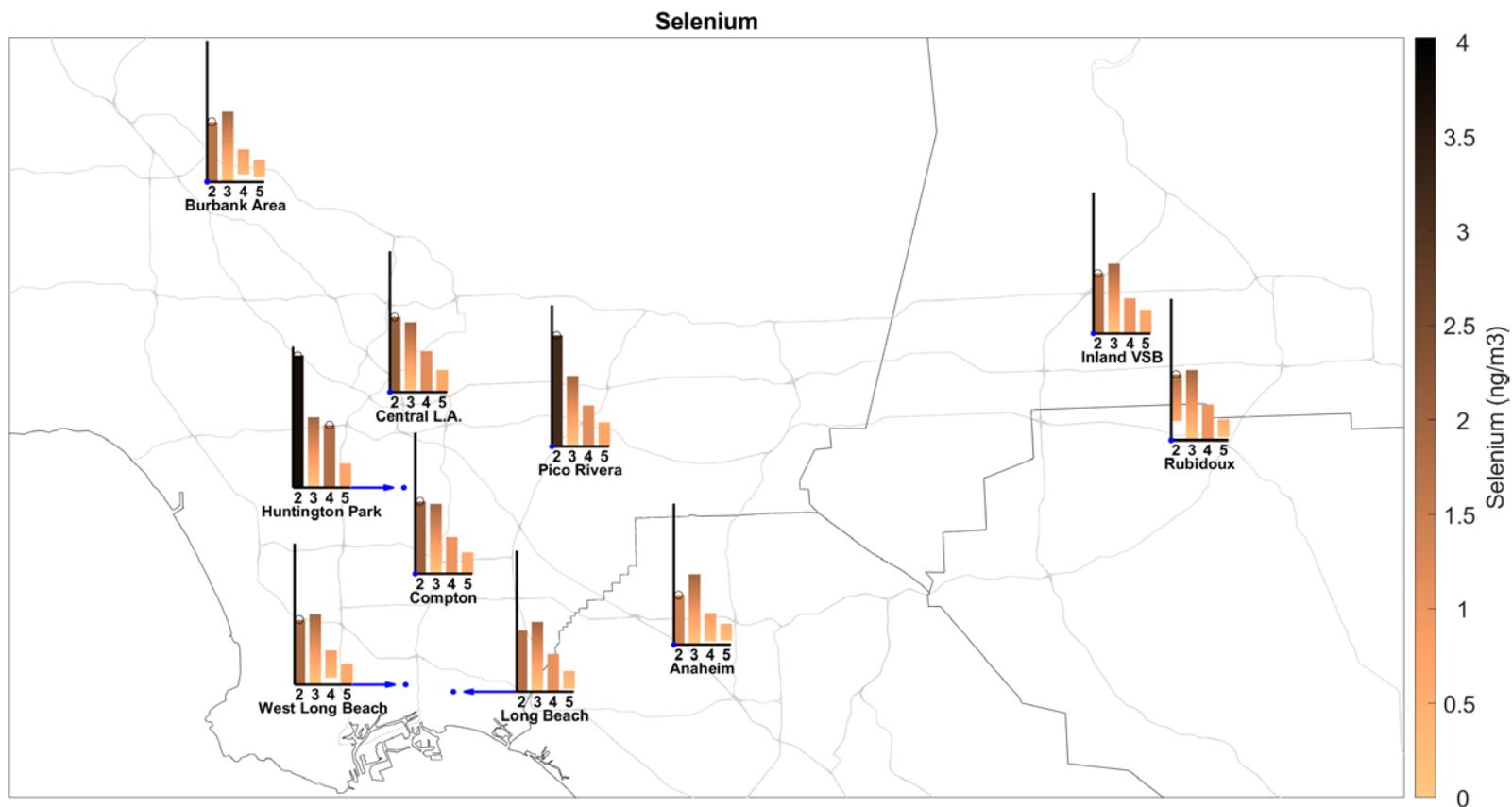
**Table IV-62.** Ambient Concentrations (ng/m<sup>3</sup>) of Selenium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	1.41	1.71	2.07	1.72	3.76	1.75	2.15	3.16	0.556, 1.87 <sup>a</sup>	1.85
95% CI LB	1.27	1.44	1.55	1.47	2.44	1.44	1.7	2.41	0.202 <sup>a</sup>	1.56
95% CI UB	1.71	2.17	2.78	2.15	5.33	2.12	2.69	4.01	2.13 <sup>a</sup>	2.69
N	45	47	39	41	42	56	51	41	41 <sup>a</sup>	39
% < MDL	68.9	70.2	69.2	70.7	50	66.1	58.8	39	82.9 <sup>a</sup>	79.5
Max	2.96	7	11.2	5.41	20.7	7.17	11.4	12.1	4.29 <sup>a</sup>	13
<b>MATES III</b>										
Average	0, 2 <sup>a</sup>	0, 2 <sup>a</sup>	0, 2 <sup>a</sup>	0, 2 <sup>a</sup>	0, 2 <sup>a</sup>	0, 2 <sup>a</sup>	0, 2 <sup>a</sup>	0, 2 <sup>a</sup>	0, 2 <sup>a</sup>	0, 2 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	2 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>
N	232 <sup>a</sup>	218 <sup>a</sup>	228 <sup>a</sup>	224 <sup>a</sup>	116 <sup>a</sup>	230 <sup>a</sup>	229 <sup>a</sup>	118 <sup>a</sup>	237 <sup>a</sup>	227 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES IV</b>										
Average	0.0942, 0.889 <sup>a</sup>	0.207, 0.925 <sup>a</sup>	1.04	1	1.79	1.08	1.17	1.17	1.02	0.182, 0.975 <sup>a</sup>
95% CI LB	0.0207 <sup>a</sup>	0.0947 <sup>a</sup>	0.929	0.933	1.35	0.895	1.07	1.04	0.908	0.0283 <sup>a</sup>
95% CI UB	0.917 <sup>a</sup>	0.972 <sup>a</sup>	1.24	1.07	2.33	1.4	1.3	1.3	1.17	1.14 <sup>a</sup>
N	60 <sup>a</sup>	58 <sup>a</sup>	59	56	55	59	59	60	58	58 <sup>a</sup>
% < MDL	91.7 <sup>a</sup>	82.8 <sup>a</sup>	72.9	62.5	36.4	78	50.8	65	75.9	91.4 <sup>a</sup>
Max	1.46 <sup>a</sup>	1.73 <sup>a</sup>	5.21	2.14	12.6	9.26	2.52	3.32	4.06	5.19 <sup>a</sup>
<b>MATES V</b>										
Average	0.117, 0.601 <sup>a</sup>	0.135, 0.615 <sup>a</sup>	0.614	0.681	0.697	0.0785, 0.591 <sup>a</sup>	0.637	0.691	0.0842, 0.597 <sup>a</sup>	0.591
95% CI LB	0.0543 <sup>a</sup>	0.0624 <sup>a</sup>	0.595	0.642	0.622	0.0305 <sup>a</sup>	0.608	0.631	0.0299 <sup>a</sup>	0.585
95% CI UB	0.619 <sup>a</sup>	0.642 <sup>a</sup>	0.638	0.723	0.817	0.601 <sup>a</sup>	0.681	0.771	0.613 <sup>a</sup>	0.608
N	61 <sup>a</sup>	58 <sup>a</sup>	61	59	61	60 <sup>a</sup>	60	60	60 <sup>a</sup>	59
% < MDL	83.6 <sup>a</sup>	82.8 <sup>a</sup>	75.4	61	73.8	88.3 <sup>a</sup>	71.7	63.3	88.3 <sup>a</sup>	78
Max	0.89 <sup>a</sup>	0.99 <sup>a</sup>	0.96	1.12	3.68	0.79 <sup>a</sup>	1.23	2.37	0.88 <sup>a</sup>	0.82

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-120.** Annual Average Concentrations of Selenium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

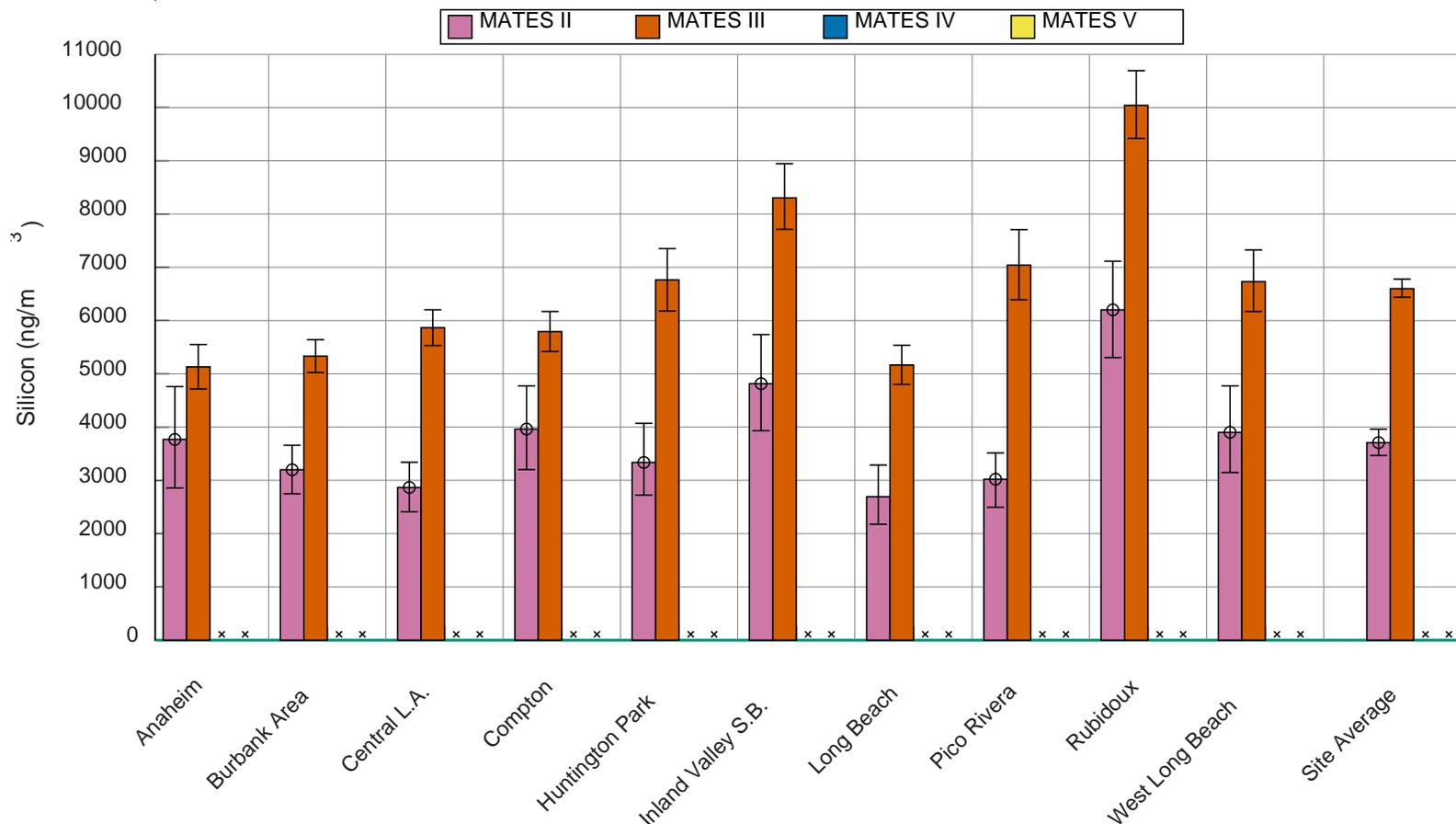


**Figure IV-121.** Geographic distribution of Selenium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

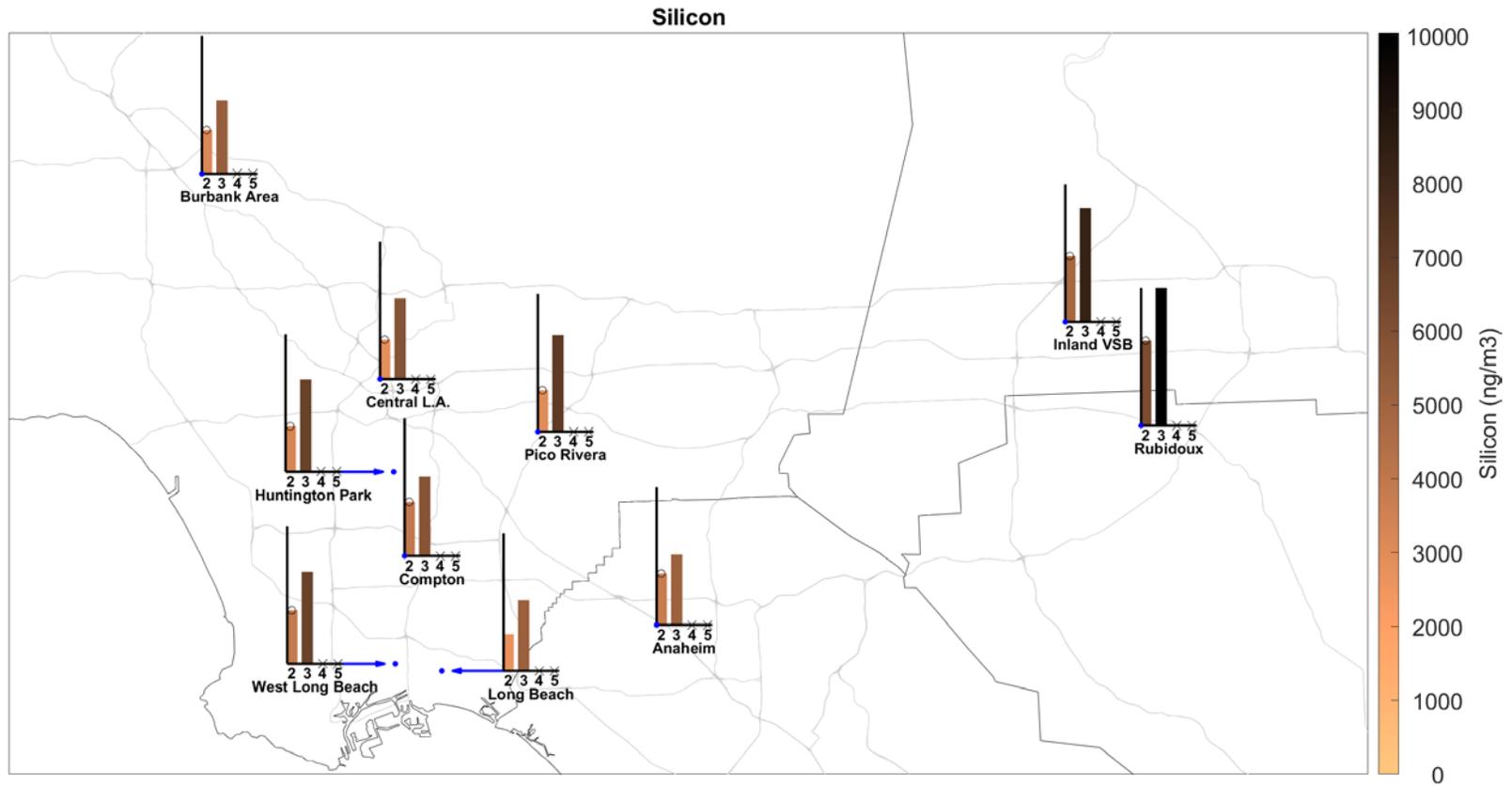
Silicon

**Table IV-63.** Ambient Concentrations (ng/m<sup>3</sup>) of Silicon from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	3770	3200	3960	4810	3340	2690	2870	3020	6200	3900
95% CI LB	2860	2750	3200	3930	2720	2180	2410	2490	5310	3150
95% CI UB	4760	3660	4770	5740	4070	3290	3340	3520	7110	4770
N	45	47	39	41	42	56	51	41	41	39
% < MDL	2.2	0	0	2.4	2.4	0	2	2.4	2.4	0
Max	17200	7520	11500	12000	13000	12800	8210	7860	13600	14900
MATES III										
Average	5130	5330	5790	8300	6760	5170	5870	7040	10000	6730
95% CI LB	4720	5030	5420	7710	6180	4800	5530	6390	9420	6170
95% CI UB	5550	5640	6170	8950	7350	5540	6200	7710	10700	7330
N	232	218	228	224	116	230	229	118	237	227
% < MDL	3	1.4	1.3	1.8	0.9	3	0.9	0	0	0.9
Max	19000	13900	17100	24300	17200	13400	12100	28000	25900	31900
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-122.** Annual Average Concentrations of Silicon in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



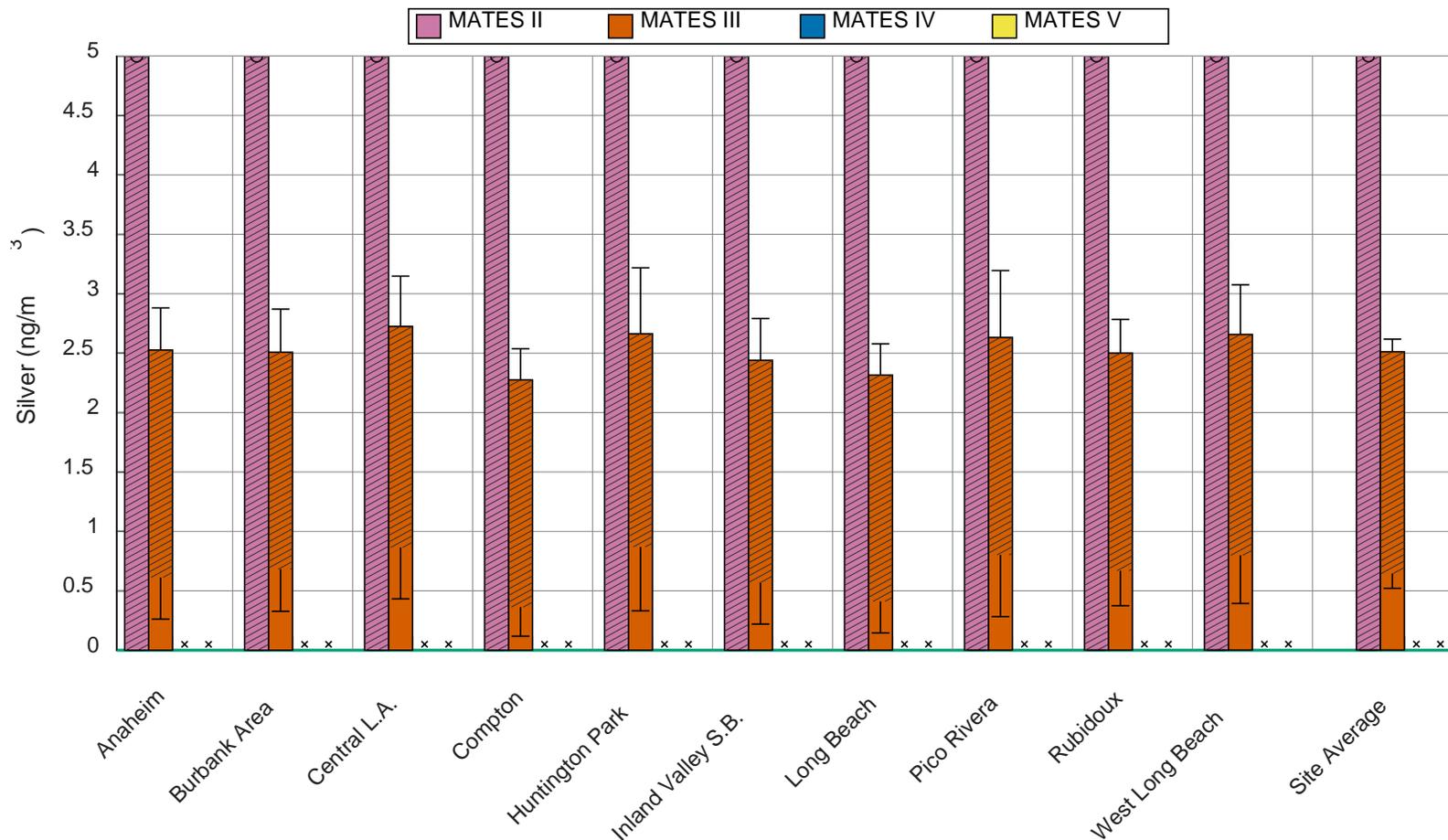
**Figure IV-123.** Geographic distribution of Silicon from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. "x" indicates that there is no data for a given station/MATES iteration.

Silver

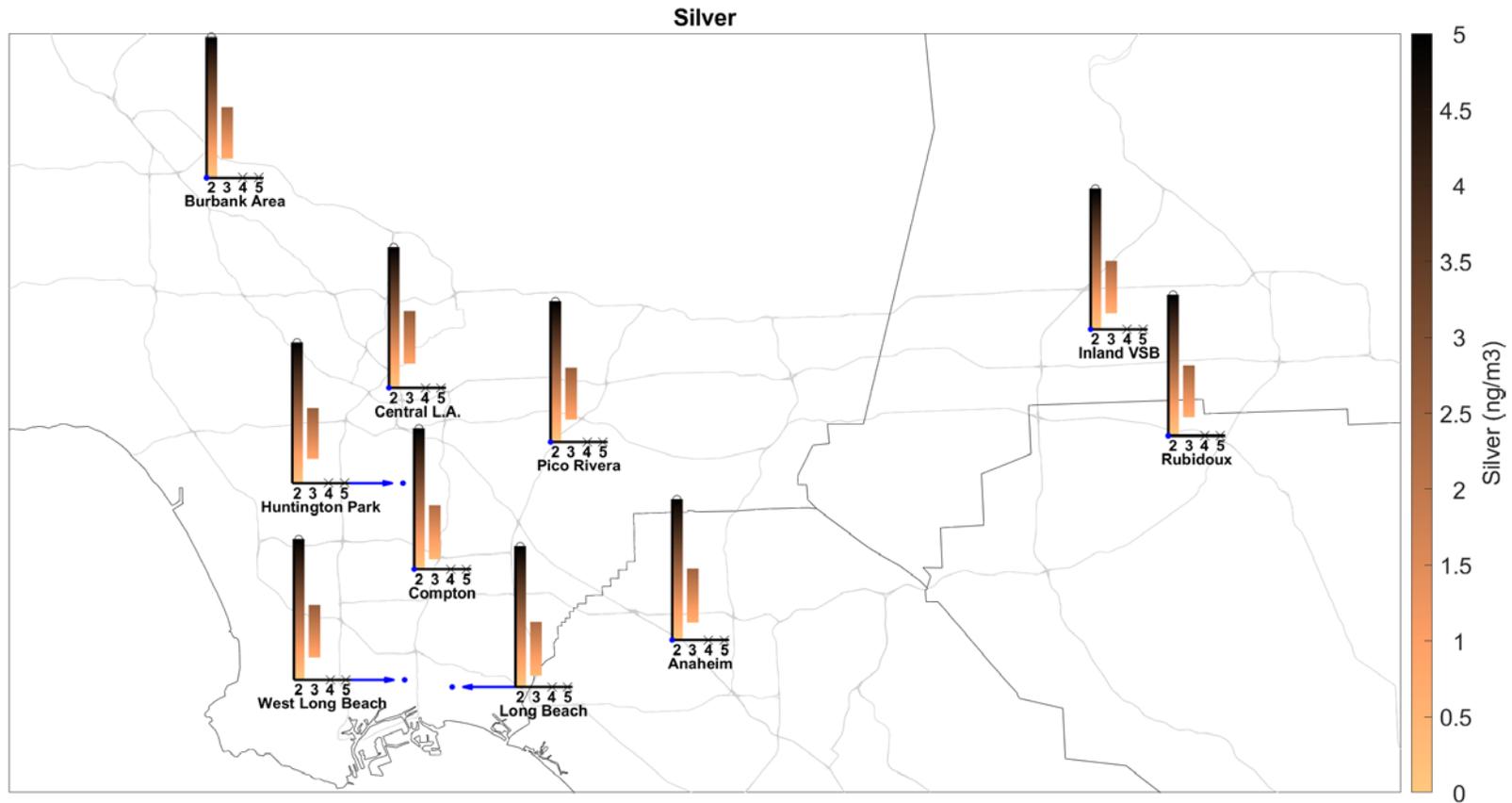
**Table IV-64.** Ambient Concentrations (ng/m<sup>3</sup>) of Silver from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0, 5 <sup>a</sup>	0, 5 <sup>a</sup>	0, 5 <sup>a</sup>	0, 5 <sup>a</sup>	0, 5 <sup>a</sup>	0, 5 <sup>a</sup>				
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>				
95% CI UB	5 <sup>a</sup>	5 <sup>a</sup>	5 <sup>a</sup>	5 <sup>a</sup>	5 <sup>a</sup>	5 <sup>a</sup>				
N	25 <sup>a</sup>	20 <sup>a</sup>	18 <sup>a</sup>	21 <sup>a</sup>	22 <sup>a</sup>	26 <sup>a</sup>	23 <sup>a</sup>	26 <sup>a</sup>	21 <sup>a</sup>	19 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>				
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>				
<b>MATES III</b>										
Average	0.613, 2.53 <sup>a</sup>	0.682, 2.51 <sup>a</sup>	0.363, 2.27 <sup>a</sup>	0.564, 2.44 <sup>a</sup>	0.869, 2.66 <sup>a</sup>	0.41, 2.31 <sup>a</sup>	0.864, 2.72 <sup>a</sup>	0.8, 2.63 <sup>a</sup>	0.667, 2.5 <sup>a</sup>	0.797, 2.66 <sup>a</sup>
95% CI LB	0.262 <sup>a</sup>	0.327 <sup>a</sup>	0.118 <sup>a</sup>	0.219 <sup>a</sup>	0.331 <sup>a</sup>	0.145 <sup>a</sup>	0.432 <sup>a</sup>	0.282 <sup>a</sup>	0.373 <sup>a</sup>	0.392 <sup>a</sup>
95% CI UB	2.88 <sup>a</sup>	2.87 <sup>a</sup>	2.54 <sup>a</sup>	2.79 <sup>a</sup>	3.22 <sup>a</sup>	2.58 <sup>a</sup>	3.15 <sup>a</sup>	3.19 <sup>a</sup>	2.78 <sup>a</sup>	3.07 <sup>a</sup>
N	232 <sup>a</sup>	218 <sup>a</sup>	228 <sup>a</sup>	224 <sup>a</sup>	116 <sup>a</sup>	230 <sup>a</sup>	229 <sup>a</sup>	118 <sup>a</sup>	237 <sup>a</sup>	227 <sup>a</sup>
% < MDL	95.7 <sup>a</sup>	91.3 <sup>a</sup>	95.6 <sup>a</sup>	93.8 <sup>a</sup>	89.7 <sup>a</sup>	95.2 <sup>a</sup>	93 <sup>a</sup>	91.5 <sup>a</sup>	91.6 <sup>a</sup>	93 <sup>a</sup>
Max	18.4 <sup>a</sup>	17.6 <sup>a</sup>	18.4 <sup>a</sup>	25.3 <sup>a</sup>	18.3 <sup>a</sup>	17.6 <sup>a</sup>	22 <sup>a</sup>	18.1 <sup>a</sup>	19.2 <sup>a</sup>	18.5 <sup>a</sup>
<b>MATES IV</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES V</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-124.** Annual Average Concentrations of Silver in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

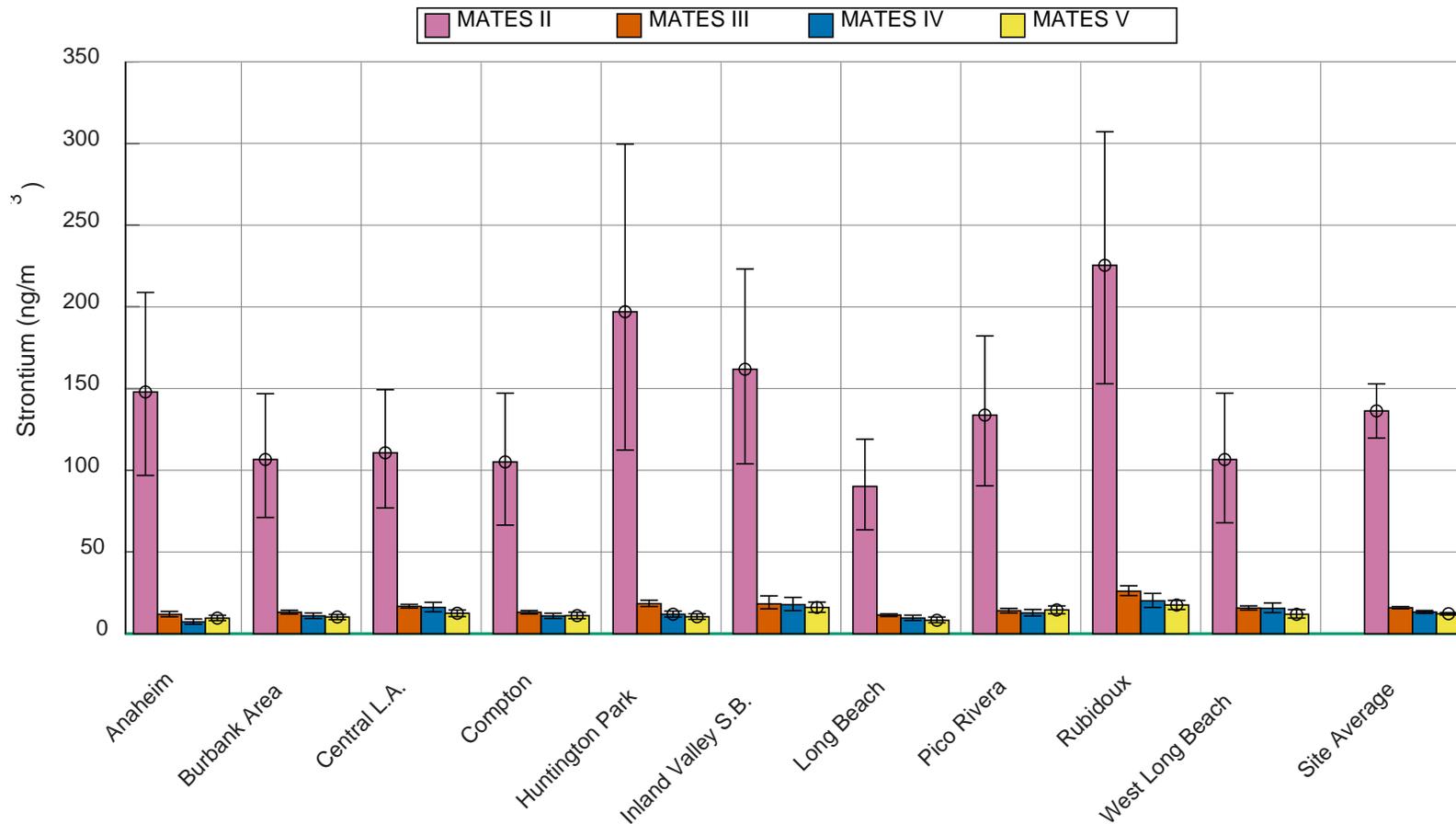


**Figure IV-125.** Geographic distribution of Silver from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

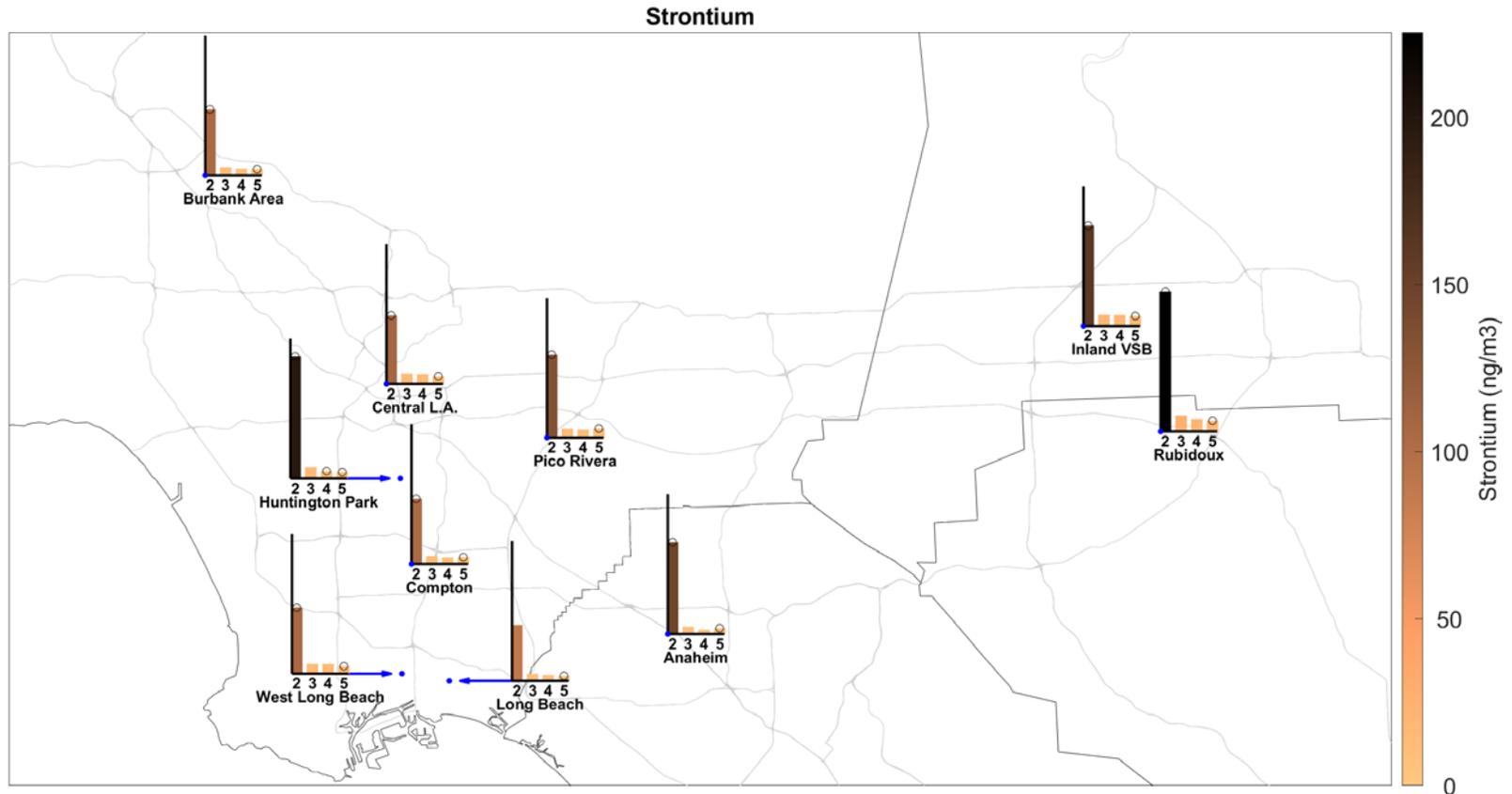
## Strontium

**Table IV-65.** Ambient Concentrations (ng/m<sup>3</sup>) of Strontium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	148	107	105	162	197	90.2	111	134	225	107
95% CI LB	96.9	71.1	66.5	104	112	63.6	76.9	90.5	153	67.8
95% CI UB	209	147	147	223	300	119	149	182	307	147
N	45	47	39	41	42	56	51	41	41	39
% < MDL	0	0	0	0	0	0	3.9	0	2.4	0
Max	770	585	474	684	1470	476	546	707	786	524
MATES III										
Average	11.9	13.1	13.1	18.2	18.4	11.4	16.8	14.1	26	15.7
95% CI LB	10.4	12	12.1	15.2	16.6	10.6	15.7	12.7	23.3	14.5
95% CI UB	13.6	14.3	14.1	23.1	20.5	12.2	18	15.5	29.3	17
N	232	218	228	224	116	230	229	118	237	227
% < MDL	4.3	4.1	3.5	5.8	1.7	3.9	1.3	5.9	1.7	1.3
Max	126	95.5	63.6	478	82.5	39.7	91.2	43.8	346	64.4
MATES IV										
Average	7.27	10.9	10.9	17.8	11.9	9.6	16.1	12.7	20.1	15.6
95% CI LB	5.8	9.32	9.37	14.1	10.2	8.09	13.4	10.8	16.1	12.9
95% CI UB	9.01	12.7	12.5	22.2	13.9	11.3	19.2	14.8	24.7	18.8
N	60	58	59	56	55	59	59	60	58	58
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	37.6	34	33	75.3	40.5	28.5	58.8	36.9	83.8	56
MATES V										
Average	9.54	10.2	11.1	16.1	10.4	8.22	12.5	14.6	17.6	11.9
95% CI LB	7.99	8.58	9.16	13.1	8.8	6.71	10.5	12.2	14.8	9.57
95% CI UB	11.3	11.8	13.2	19.3	12.2	10.2	14.5	17	20.4	14.7
N	44	43	43	44	45	42	45	44	43	42
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	31.6	24.1	33	51.3	24.9	37.8	36.8	33.8	44.5	53



**Figure IV-126.** Annual Average Concentrations of Strontium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

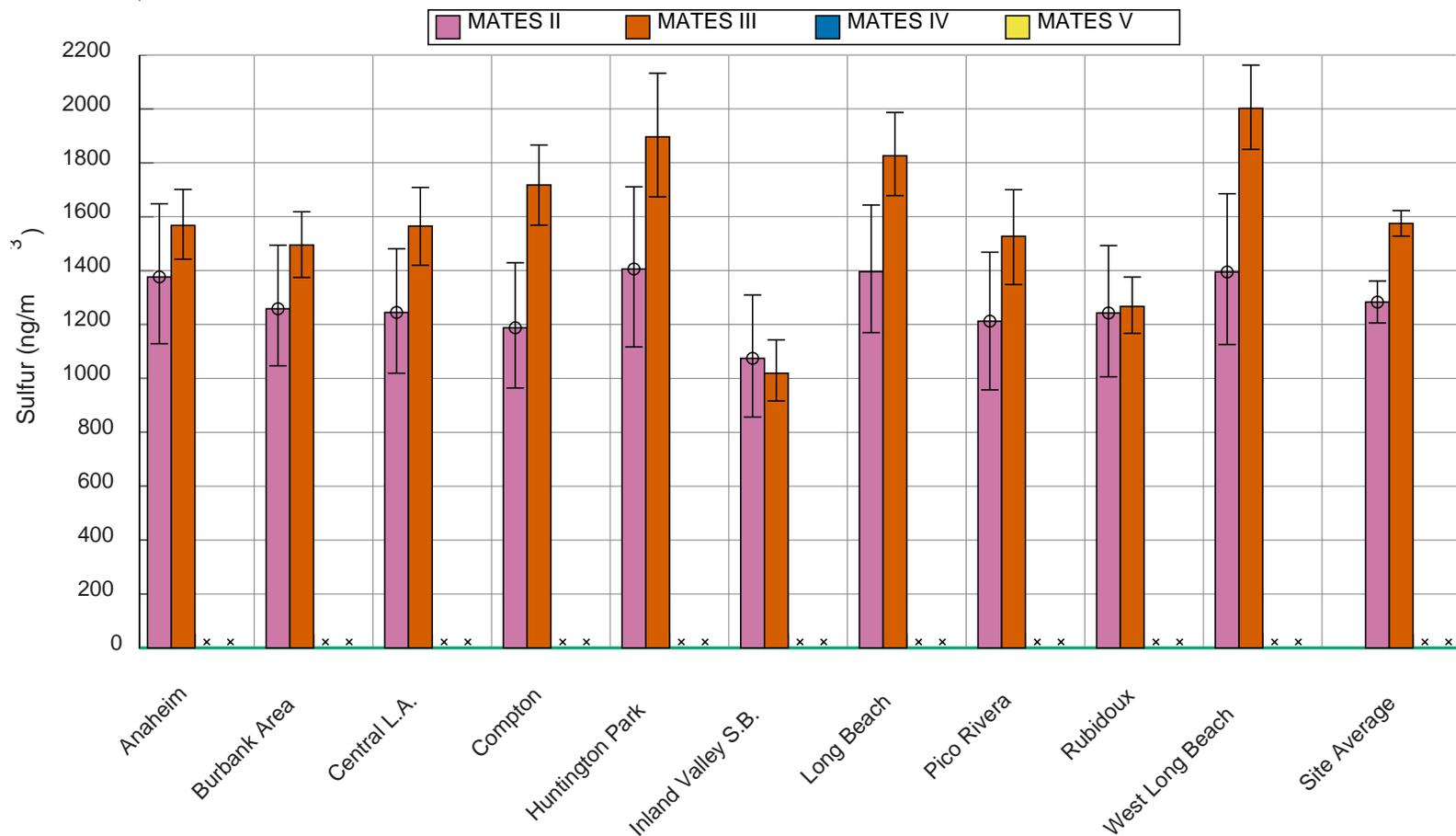


**Figure IV-127.** Geographic distribution of Strontium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

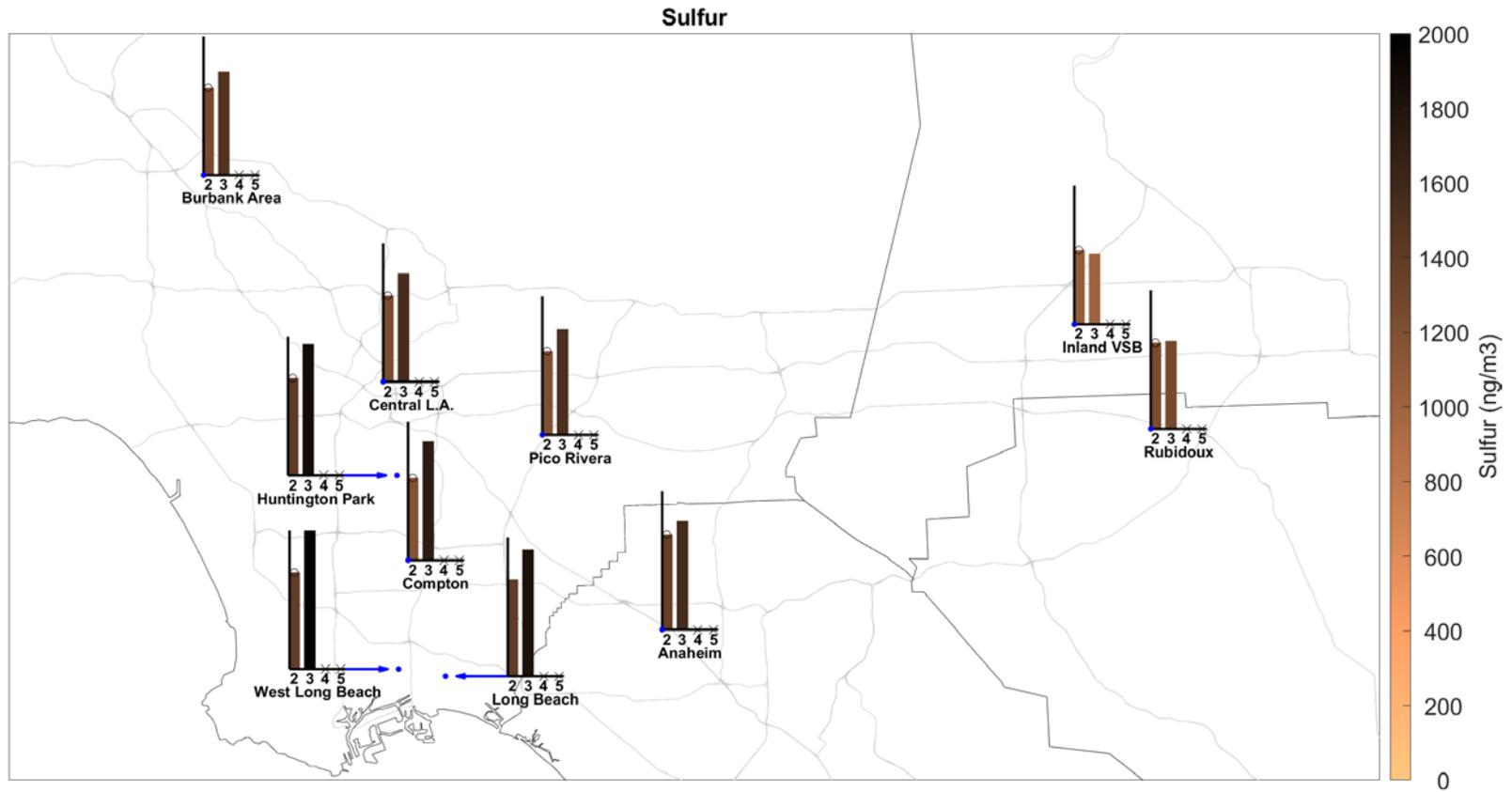
Sulfur

**Table IV-66.** Ambient Concentrations (ng/m<sup>3</sup>) of Sulfur from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	1380	1260	1190	1070	1410	1400	1240	1210	1240	1390
95% CI LB	1130	1050	964	857	1120	1170	1020	957	1010	1130
95% CI UB	1650	1490	1430	1310	1710	1640	1480	1470	1490	1690
N	45	47	39	41	42	56	51	41	41	39
% < MDL	0	0	0	2.4	0	0	2	2.4	2.4	0
Max	3430	3310	3910	2940	4350	4140	3190	2940	3320	3990
MATES III										
Average	1570	1500	1720	1020	1900	1830	1570	1530	1270	2000
95% CI LB	1440	1370	1570	916	1670	1680	1420	1350	1170	1850
95% CI UB	1700	1620	1870	1140	2130	1990	1710	1700	1380	2160
N	232	218	228	224	116	230	229	118	237	227
% < MDL	0	0	0.4	0.4	0	0	0	0	0	0
Max	5230	4270	5800	9040	5510	6420	4730	4640	7480	6740
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-128.** Annual Average Concentrations of Sulfur in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



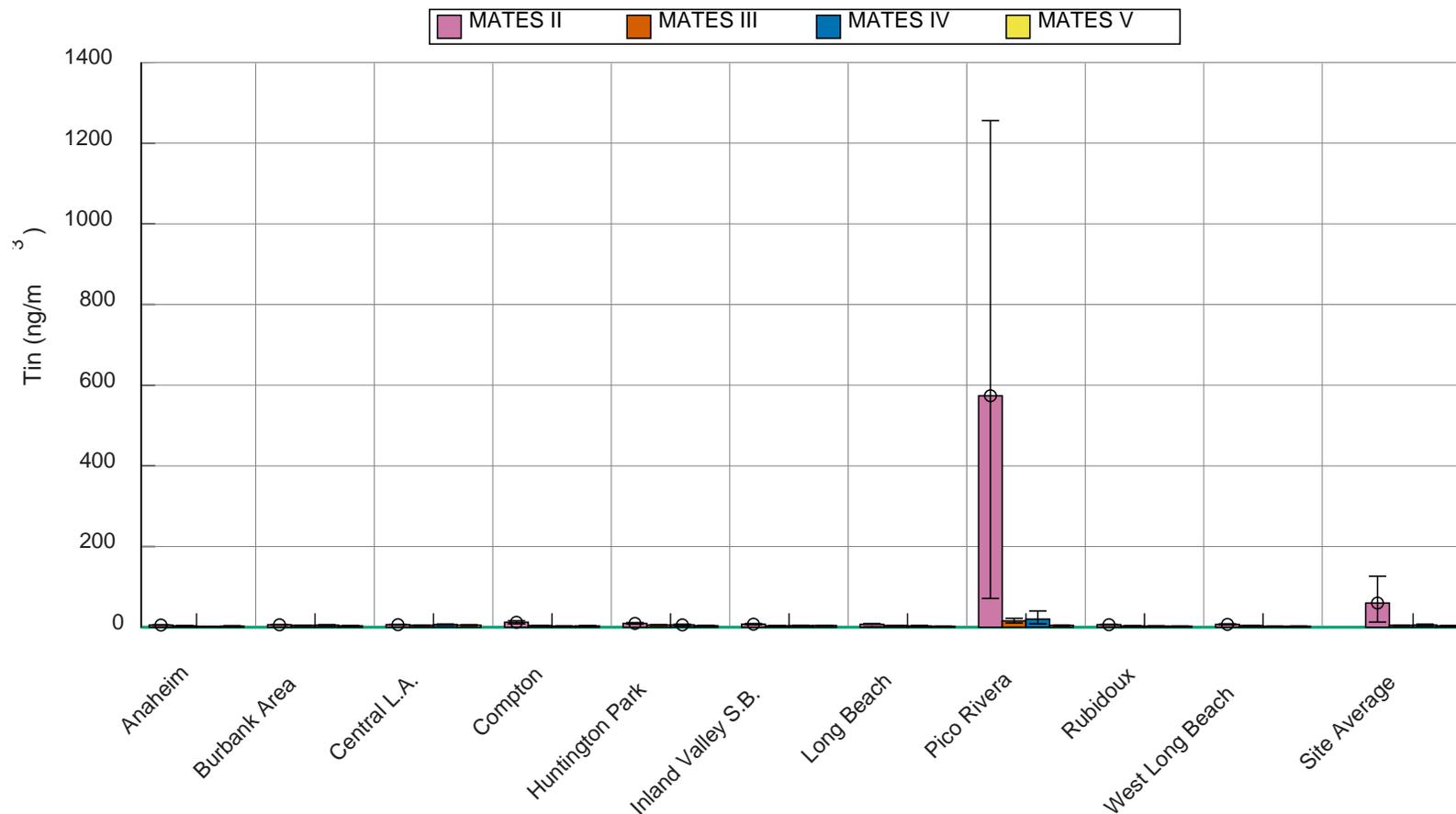
**Figure IV-129.** Geographic distribution of Sulfur from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. "x" indicates that there is no data for a given station/MATES iteration.

## Tin

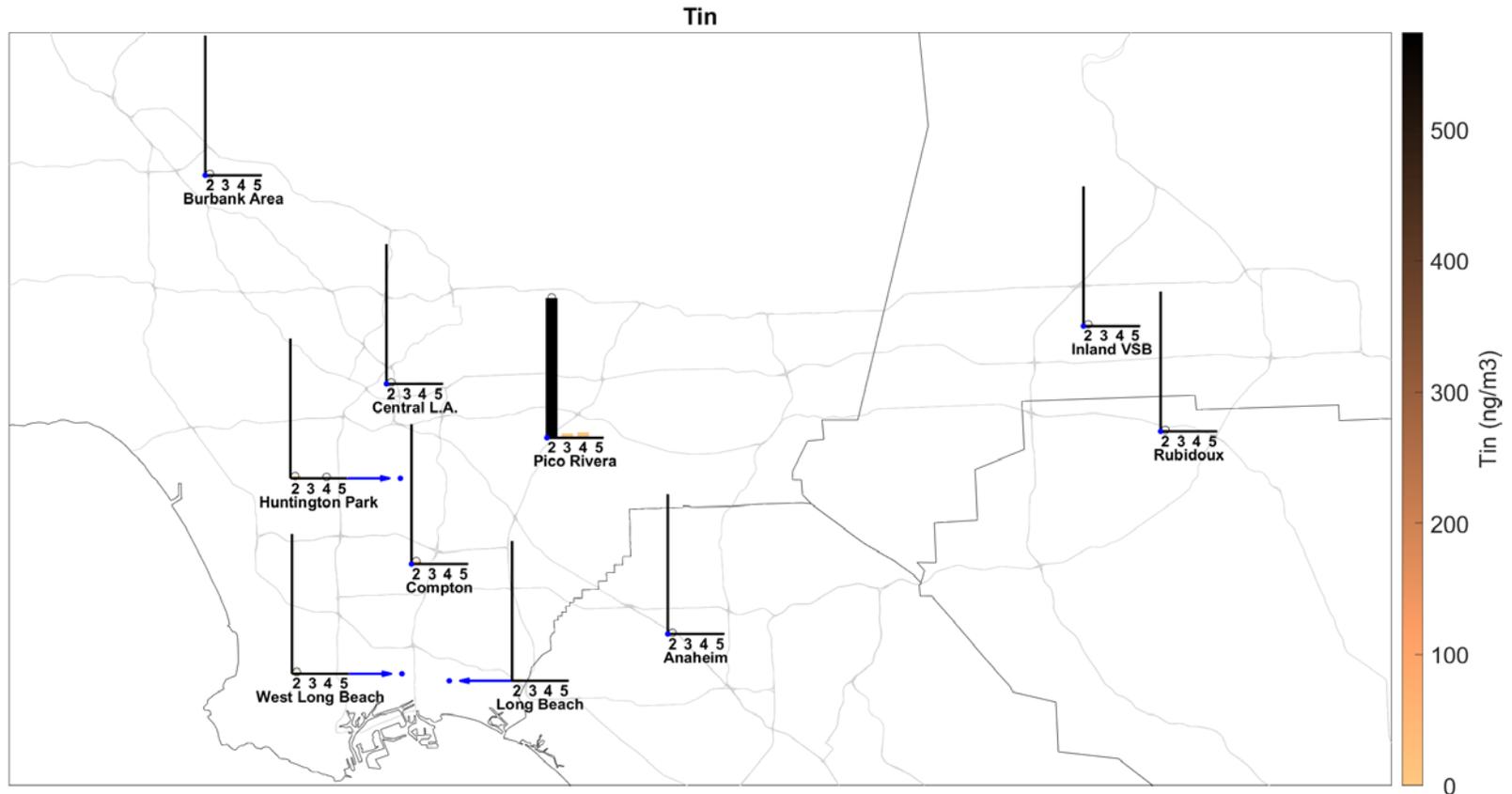
**Table IV-67.** Ambient Concentrations (ng/m<sup>3</sup>) of Tin from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	1.31, 5.42 <sup>a</sup>	6.05	12.3	7.54	9.45	3.09, 7.2 <sup>a</sup>	6.32	574	2.22, 6.24 <sup>a</sup>	7.03
95% CI LB	0.489 <sup>a</sup>	5.38	8.48	6.18	7.6	1.18 <sup>a</sup>	5.57	71.3	0.829 <sup>a</sup>	5.95
95% CI UB	5.84 <sup>a</sup>	6.91	16.2	8.98	11.5	9.12 <sup>a</sup>	7.21	1260	7.35 <sup>a</sup>	8.43
N	45 <sup>a</sup>	47	39	41	42	56 <sup>a</sup>	51	41	41 <sup>a</sup>	39
% < MDL	82.2 <sup>a</sup>	72.3	66.7	63.4	57.1	82.1 <sup>a</sup>	68.6	43.9	80.5 <sup>a</sup>	71.8
Max	11 <sup>a</sup>	20.5	45.7	24	37	43.1 <sup>a</sup>	17	9200	18.3 <sup>a</sup>	23.2
MATES III										
Average	3.51	4.75	4.18	3.58	5.47	4.31	4.91	15.8	3.31	4.16
95% CI LB	3.35	4.41	3.87	3.42	4.76	3.96	4.6	10.5	3.22	3.82
95% CI UB	3.67	5.1	4.52	3.76	6.23	4.7	5.23	22	3.41	4.56
N	232	218	228	224	116	230	229	118	237	227
% < MDL	74.6	35.3	67.1	69.2	45.7	66.1	40.6	25.4	74.7	68.3
Max	10.8	26.7	17.5	10.8	21.7	19.4	15.4	245	8.83	19.1
MATES IV										
Average	1.9	5.26	2.86	3.98	5.83	3.25	6.5	20	2.89	2.55
95% CI LB	1.53	4.43	2.37	3.19	4.28	2.32	5.23	8.27	2.36	2.07
95% CI UB	2.27	6.17	3.38	4.87	7.62	4.55	7.95	40.3	3.55	3.07
N	60	58	59	56	55	59	59	60	58	58
% < MDL	1.7	0	0	1.8	0	0	0	0	0	0
Max	7.7	18.4	8.93	17.7	33.5	32.8	31.1	549	13.2	8.63
MATES V										
Average	2.92	3.5	3.25	4.17	3.72	2.44	5.16	4.63	2.69	2.54
95% CI LB	2.26	3.04	2.51	3.62	2.77	1.87	4.34	3.83	2.25	1.92
95% CI UB	3.68	3.99	4.12	4.73	4.78	3.07	6.05	5.45	3.13	3.23
N	60	57	60	58	60	59	59	60	58	58
% < MDL	0	0	0	0	13.3	0	1.7	0	0	0
Max	15.8	9.28	13	9.47	16.6	10.1	14.5	12.8	8.16	11

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-130.** Annual Average Concentrations of Tin in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

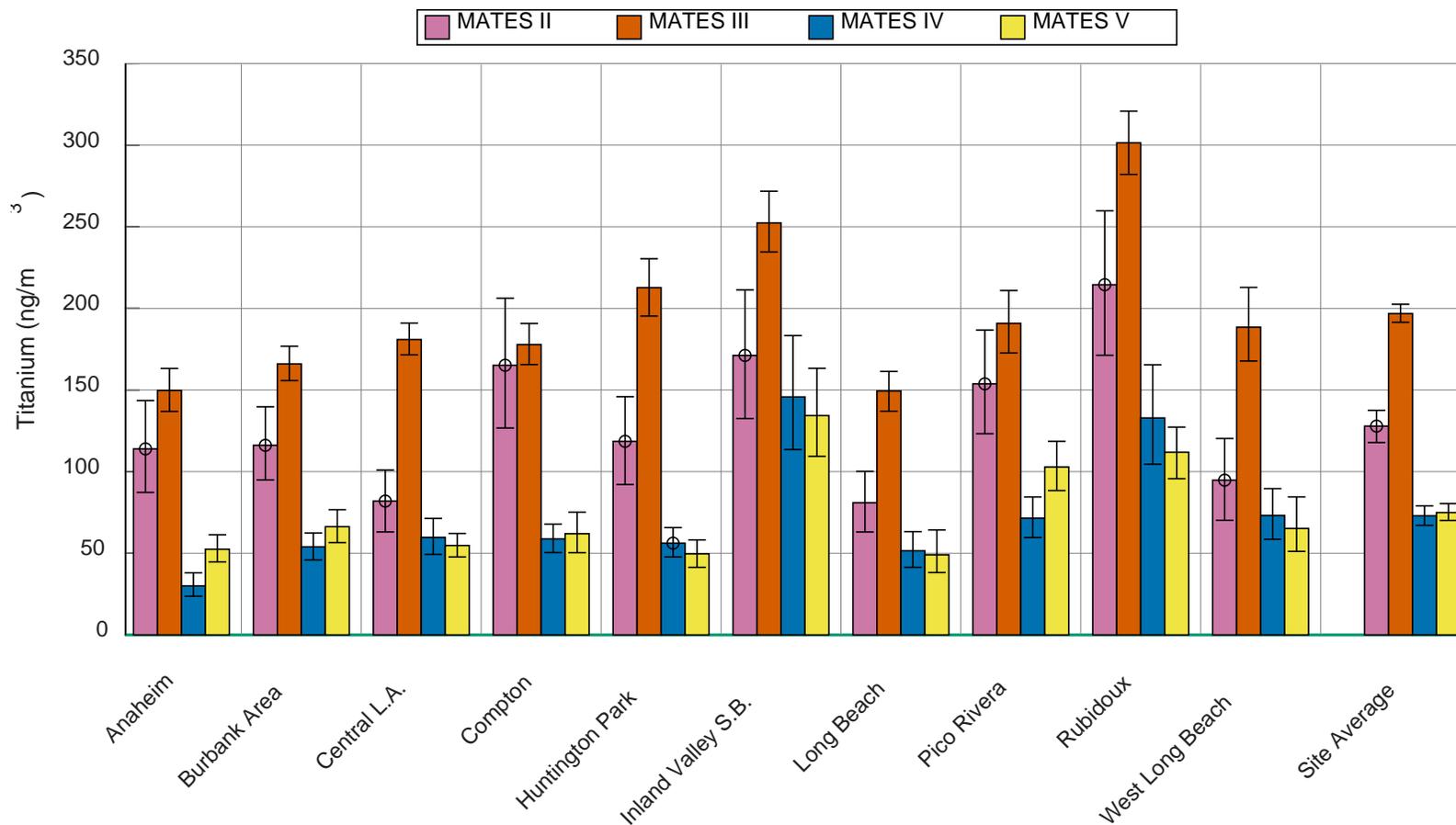


**Figure IV-131.** Geographic distribution of Tin from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

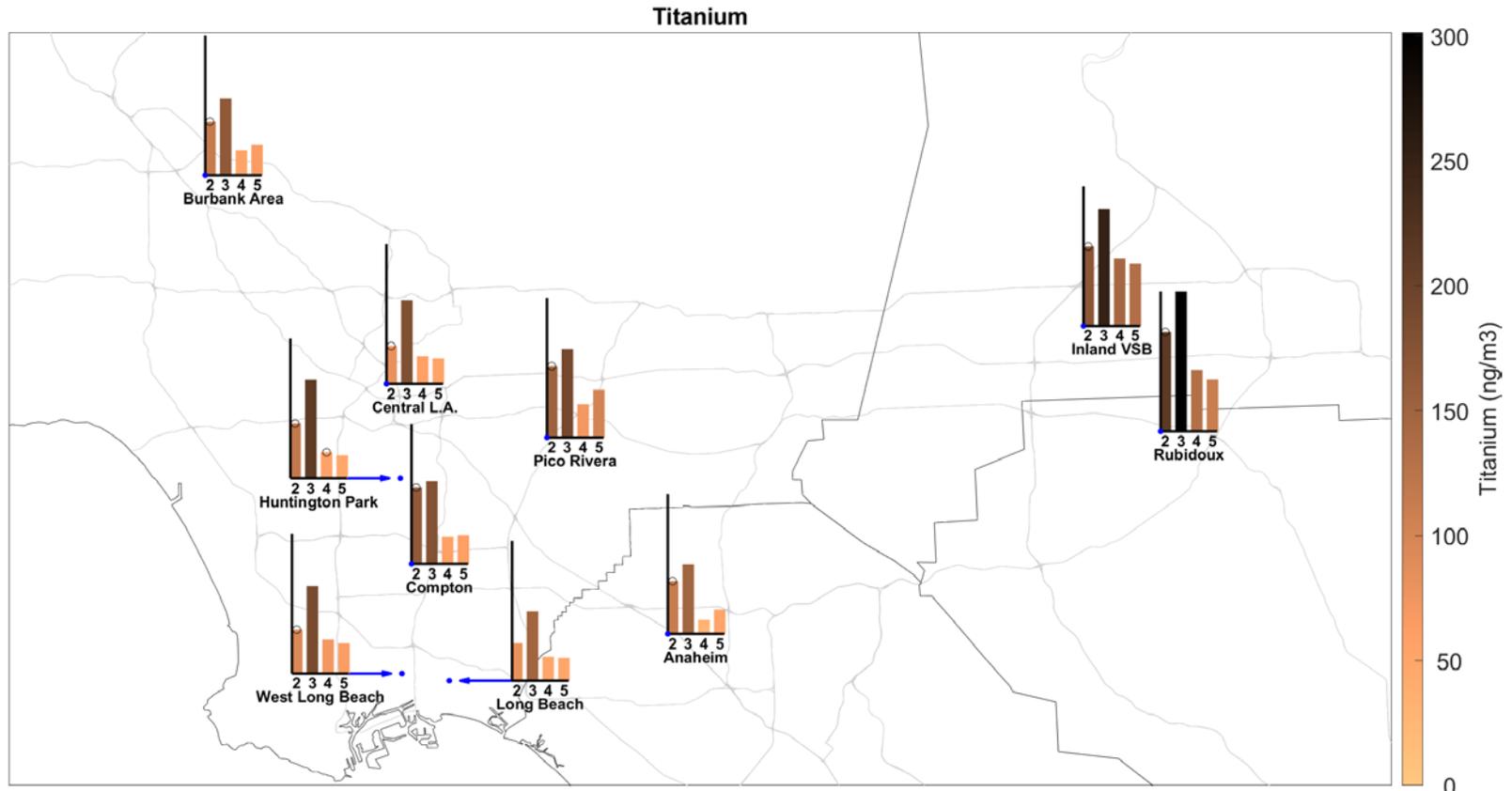
## Titanium

**Table IV-68.** Ambient Concentrations (ng/m<sup>3</sup>) of Titanium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	114	116	165	171	119	80.9	81.9	154	214	94.8
95% CI LB	87.3	94.9	127	133	92.1	63.1	63.1	123	171	70.2
95% CI UB	144	140	206	211	146	100	101	187	260	120
N	45	48	39	41	42	56	51	41	41	39
% < MDL	26.7	18.8	15.4	17.1	26.2	25	33.3	12.2	12.2	28.2
Max	388	396	445	478	334	318	285	470	530	316
MATES III										
Average	150	166	178	252	213	149	181	191	301	188
95% CI LB	137	156	166	235	195	137	172	173	282	168
95% CI UB	163	177	191	272	230	161	191	211	321	213
N	232	218	228	224	116	230	229	118	237	227
% < MDL	0.4	0	0	0.4	0	0	0	0	0	0
Max	620	476	504	786	511	500	378	788	693	1870
MATES IV										
Average	30	53.9	58.8	146	56.2	51.6	59.7	71.5	133	73.1
95% CI LB	23.7	45.9	50.4	114	47.7	41.4	49.3	59.6	105	58.6
95% CI UB	38	62.4	67.8	183	65.7	63.2	71.3	84.5	165	89.6
N	60	58	59	56	55	59	59	60	58	58
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	183	147	145	636	169	215	221	238	554	324
MATES V										
Average	52.5	66.3	62	134	49.7	49	54.8	103	112	65.2
95% CI LB	44.7	56.5	50.4	109	41.4	38.2	47.7	88.4	95.7	51.2
95% CI UB	61.3	76.7	75.2	163	58.2	64.3	62.1	119	127	84.5
N	59	57	59	58	58	58	59	59	60	57
% < MDL	0	0	0	0	0	0	1.7	0	0	0
Max	175	166	283	657	135	384	134	298	298	476



**Figure IV-132.** Annual Average Concentrations of Titanium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



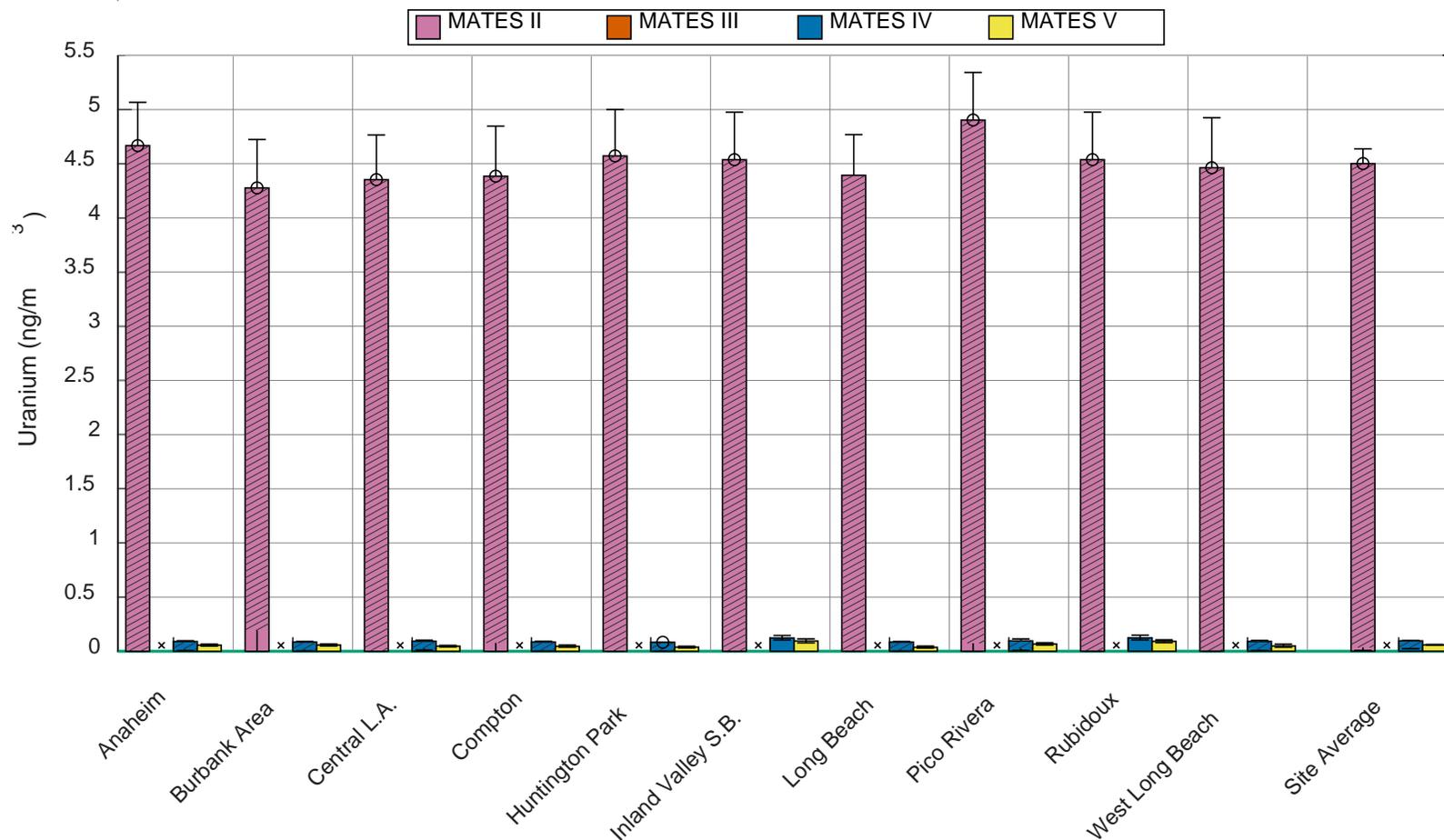
**Figure IV-133.** Geographic distribution of Titanium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Uranium

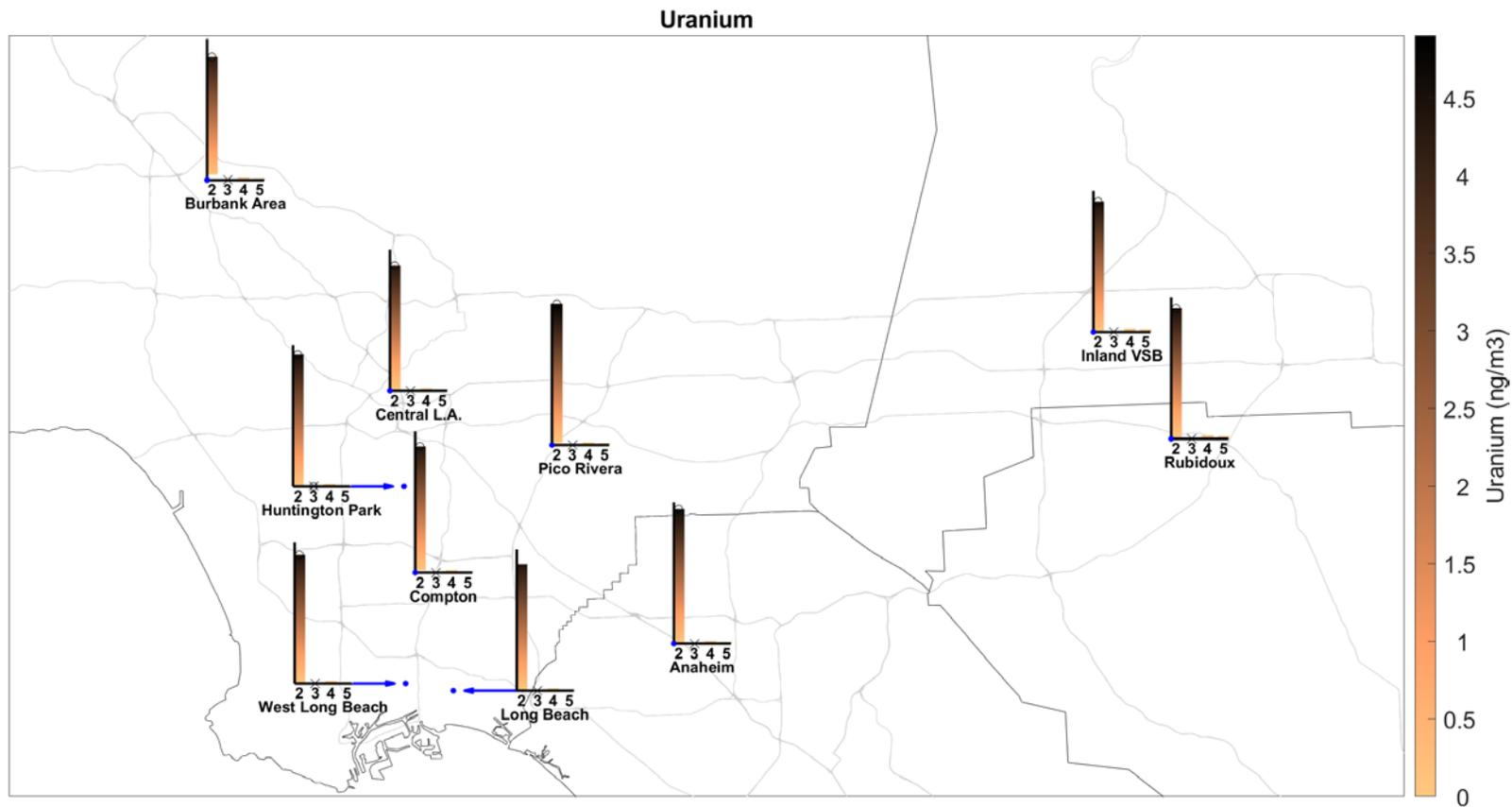
**Table IV-69.** Ambient Concentrations (ng/m<sup>3</sup>) of Uranium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0, 4.67 <sup>a</sup>	0.191, 4.28 <sup>a</sup>	0.0769, 4.38 <sup>a</sup>	0, 4.54 <sup>a</sup>	0, 4.57 <sup>a</sup>	0, 4.39 <sup>a</sup>	0, 4.35 <sup>a</sup>	0.0732, 4.9 <sup>a</sup>	0, 4.54 <sup>a</sup>	0, 4.46 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	5.07 <sup>a</sup>	4.72 <sup>a</sup>	4.85 <sup>a</sup>	4.98 <sup>a</sup>	5 <sup>a</sup>	4.77 <sup>a</sup>	4.76 <sup>a</sup>	5.34 <sup>a</sup>	4.98 <sup>a</sup>	4.92 <sup>a</sup>
N	45 <sup>a</sup>	47 <sup>a</sup>	39 <sup>a</sup>	41 <sup>a</sup>	42 <sup>a</sup>	56 <sup>a</sup>	51 <sup>a</sup>	41 <sup>a</sup>	41 <sup>a</sup>	39 <sup>a</sup>
% < MDL	100 <sup>a</sup>	93.6 <sup>a</sup>	97.4 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	97.6 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	3 <sup>a</sup>	3 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	3 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES III</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES IV</b>										
Average	0.0178, 0.0897 <sup>a</sup>	0.0128, 0.0857 <sup>a</sup>	0.0112, 0.0856 <sup>a</sup>	0.122	0.00727, 0.0827 <sup>a</sup>	0.00881, 0.0846 <sup>a</sup>	0.0254, 0.093 <sup>a</sup>	0.0248, 0.0953 <sup>a</sup>	0.123	0.0169, 0.0898 <sup>a</sup>
95% CI LB	0.00617 <sup>a</sup>	0.00379 <sup>a</sup>	0.0022 <sup>a</sup>	0.104	0.00164 <sup>a</sup>	0.00169 <sup>a</sup>	0.0112 <sup>a</sup>	0.00767 <sup>a</sup>	0.103	0.00466 <sup>a</sup>
95% CI UB	0.0972 <sup>a</sup>	0.0903 <sup>a</sup>	0.0924 <sup>a</sup>	0.145	0.0842 <sup>a</sup>	0.0891 <sup>a</sup>	0.103 <sup>a</sup>	0.113 <sup>a</sup>	0.147	0.0995 <sup>a</sup>
N	60 <sup>a</sup>	58 <sup>a</sup>	59 <sup>a</sup>	56	55 <sup>a</sup>	59 <sup>a</sup>	59 <sup>a</sup>	60 <sup>a</sup>	58	58 <sup>a</sup>
% < MDL	88.3 <sup>a</sup>	89.7 <sup>a</sup>	91.5 <sup>a</sup>	51.8	92.7 <sup>a</sup>	93.2 <sup>a</sup>	83.1 <sup>a</sup>	86.7 <sup>a</sup>	55.2	89.7 <sup>a</sup>
Max	0.24 <sup>a</sup>	0.18 <sup>a</sup>	0.24 <sup>a</sup>	0.54	0.11 <sup>a</sup>	0.19 <sup>a</sup>	0.25 <sup>a</sup>	0.46 <sup>a</sup>	0.61	0.29 <sup>a</sup>
<b>MATES V</b>										
Average	0.0561	0.0577	0.0453	0.0944	0.0376	0.036	0.0465	0.0664	0.0908	0.0475
95% CI LB	0.0476	0.0488	0.037	0.0772	0.0308	0.0284	0.04	0.0564	0.078	0.0361
95% CI UB	0.0658	0.0675	0.0571	0.114	0.0459	0.0472	0.0542	0.0781	0.105	0.0647
N	59	56	59	57	59	58	58	59	59	57
% < MDL	5.1	5.4	5.1	5.3	22	6.9	5.2	5.1	1.7	5.3
Max	0.22	0.21	0.28	0.4	0.18	0.29	0.17	0.26	0.26	0.43

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-134.** Annual Average Concentrations of Uranium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

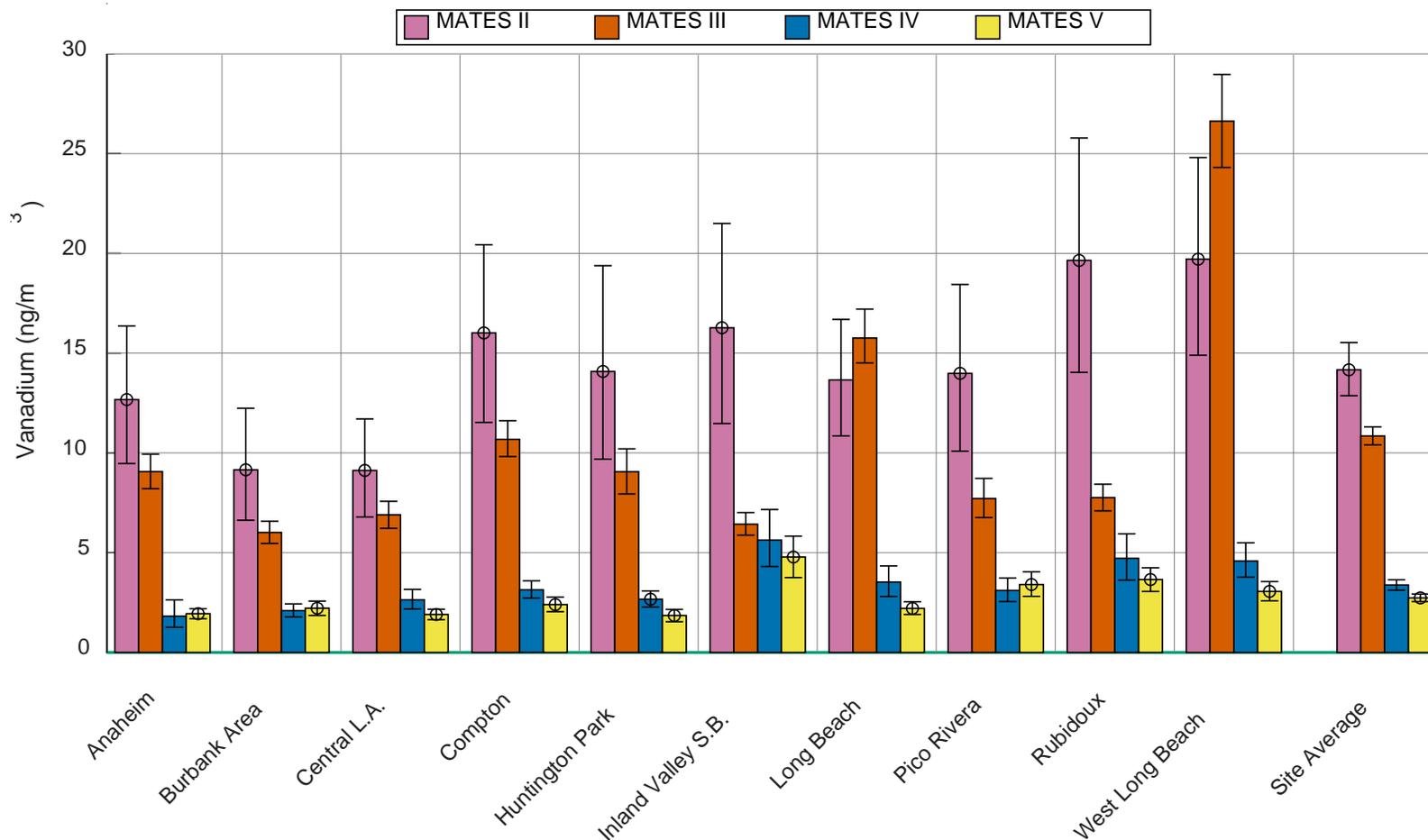


**Figure IV-135.** Geographic distribution of Uranium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

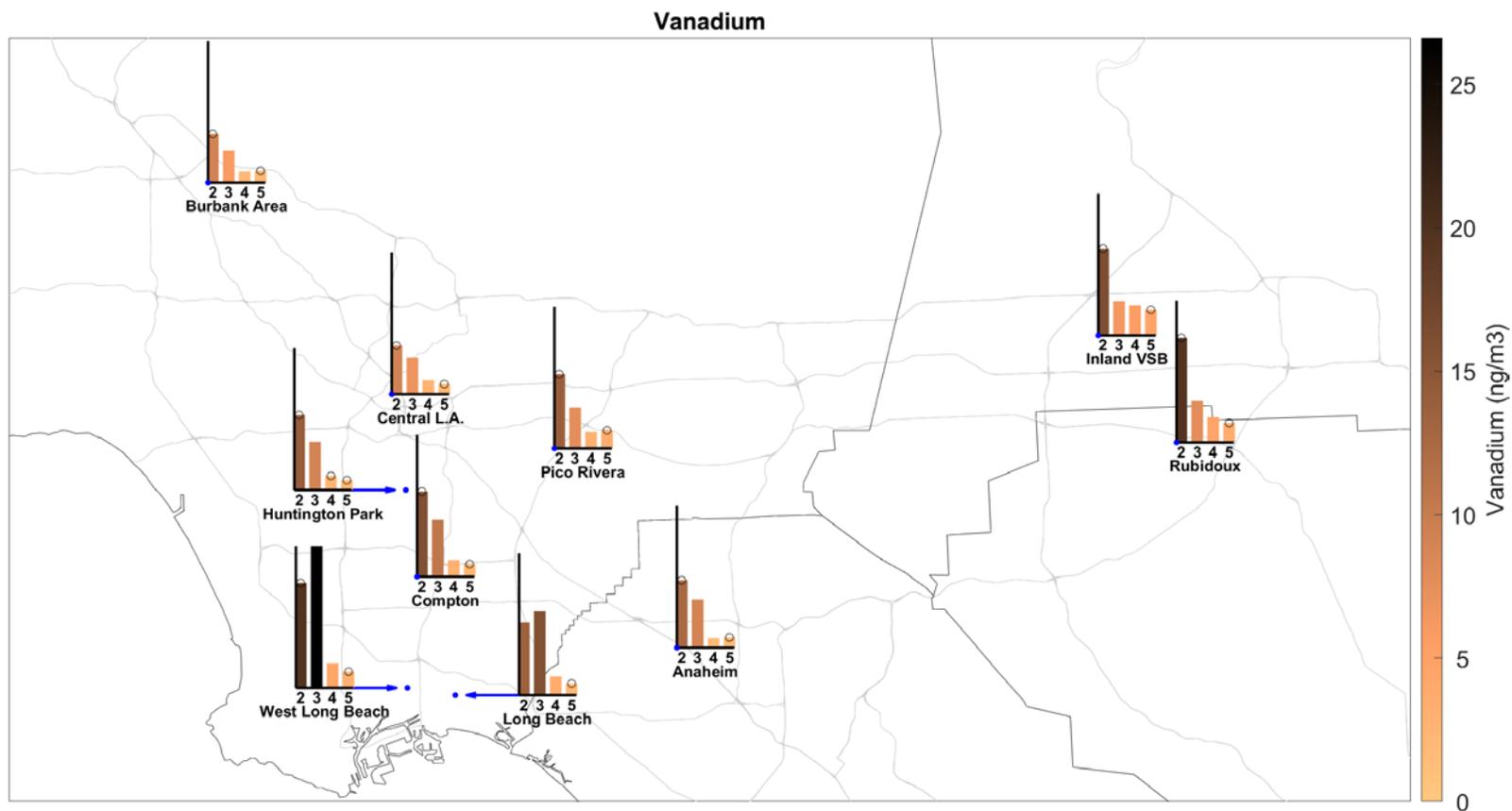
## Vanadium

**Table IV-70.** Ambient Concentrations (ng/m<sup>3</sup>) of Vanadium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	12.7	9.15	16	16.3	14.1	13.7	9.12	14	19.6	19.7
95% CI LB	9.47	6.63	11.5	11.5	9.69	10.9	6.79	10.1	14	14.9
95% CI UB	16.4	12.2	20.4	21.5	19.4	16.7	11.7	18.4	25.8	24.8
N	45	47	39	41	42	56	51	41	41	39
% < MDL	48.9	66	28.2	41.5	50	35.7	58.8	41.5	31.7	25.6
Max	44	39.3	58.8	54.7	67.7	48.2	34.7	51.8	68.8	66
MATES III										
Average	9.06	6.01	10.7	6.43	9.06	15.8	6.9	7.72	7.76	26.6
95% CI LB	8.21	5.47	9.82	5.88	7.95	14.5	6.22	6.77	7.1	24.3
95% CI UB	9.94	6.58	11.6	7.01	10.2	17.2	7.58	8.72	8.44	29
N	232	218	228	224	116	230	229	118	237	227
% < MDL	12.9	26.6	8.8	25.4	17.2	5.2	28.4	14.4	14.3	3.1
Max	34.9	24.5	40.8	22.8	36.5	59.5	26.4	30.4	31.5	99.6
MATES IV										
Average	1.82	2.1	3.14	5.63	2.67	3.53	2.64	3.11	4.72	4.58
95% CI LB	1.26	1.78	2.73	4.31	2.28	2.8	2.18	2.55	3.63	3.78
95% CI UB	2.64	2.43	3.59	7.16	3.08	4.34	3.16	3.73	5.94	5.49
N	60	58	59	56	55	59	59	60	58	58
% < MDL	5	0	0	0	0	1.7	0	0	0	0
Max	21.1	6.09	8.5	28.1	8.08	12.3	10	11.1	22.3	18
MATES V										
Average	1.94	2.22	2.4	4.78	1.85	2.21	1.9	3.41	3.66	3.06
95% CI LB	1.69	1.85	2.04	3.75	1.54	1.9	1.64	2.81	3.06	2.59
95% CI UB	2.19	2.57	2.78	5.83	2.16	2.54	2.16	4.04	4.24	3.55
N	45	44	44	41	41	42	36	40	41	42
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	4.2	5.85	6.25	15.8	3.96	6.03	3.81	10.9	7.09	8.29



**Figure IV-136.** Annual Average Concentrations of Vanadium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



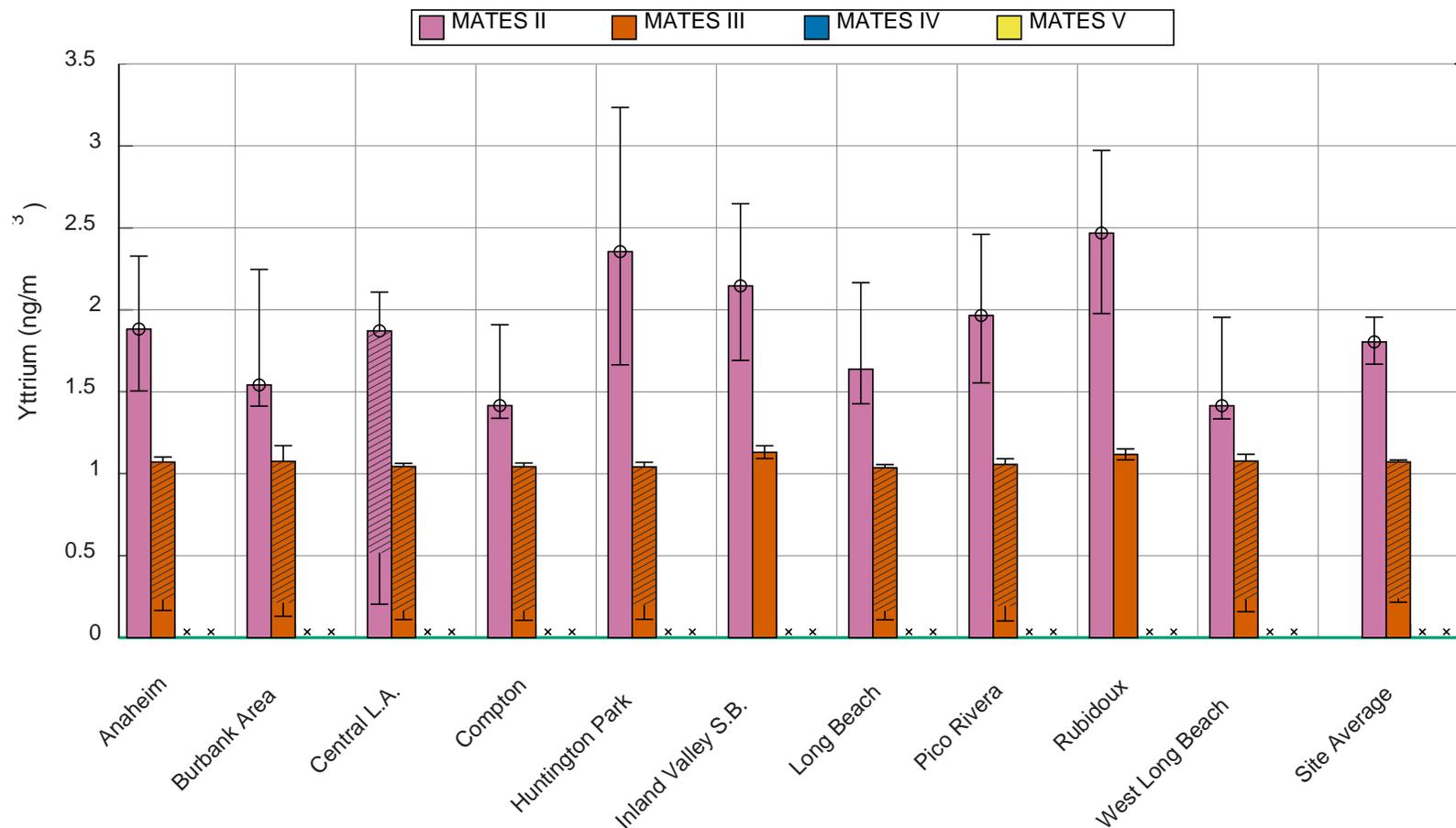
**Figure IV-137.** Geographic distribution of Vanadium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Yttrium

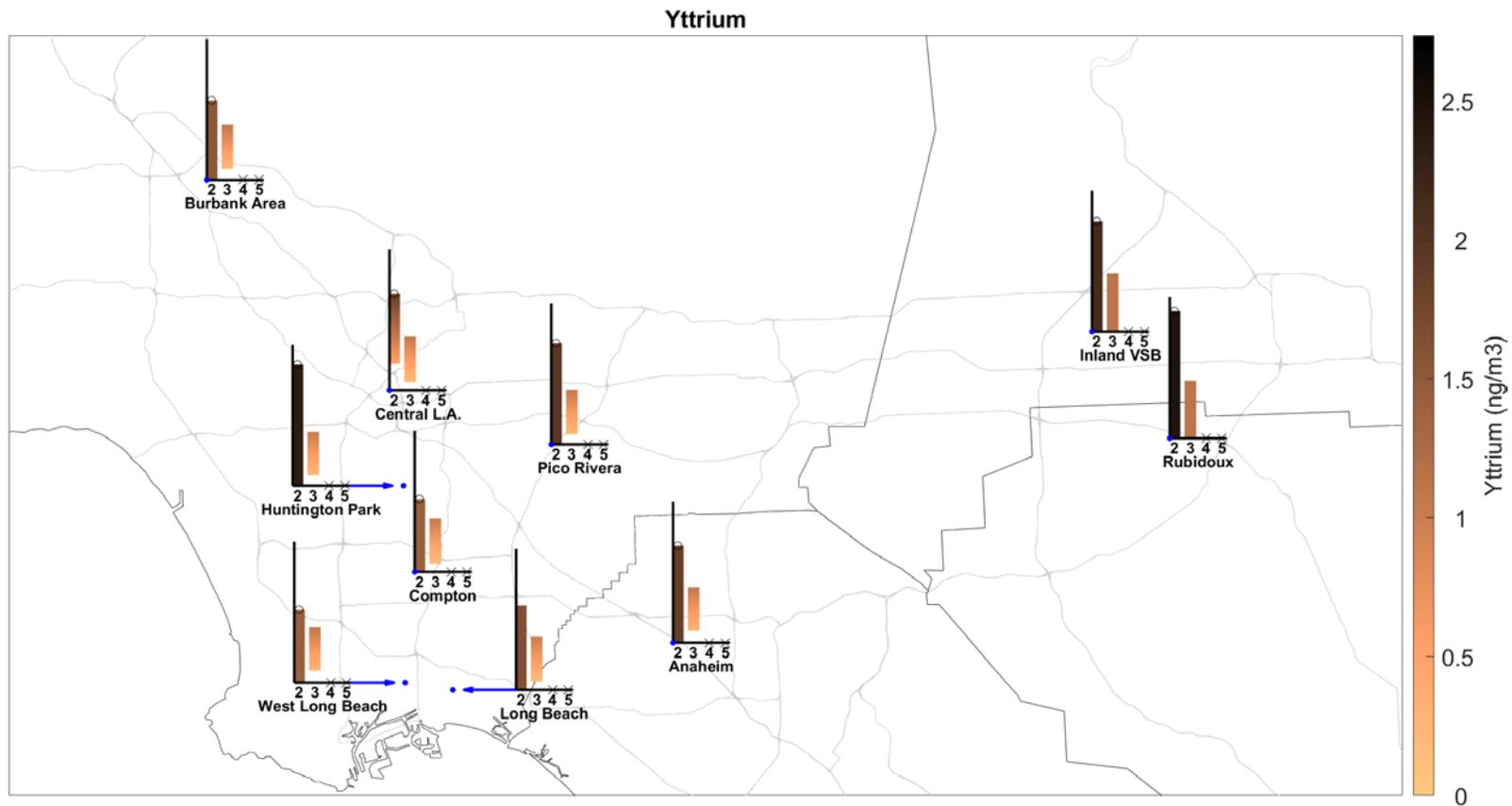
**Table IV-71.** Ambient Concentrations (ng/m<sup>3</sup>) of Yttrium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	1.88	1.54	1.42	2.15	2.35	1.64	0.519, 1.87 <sup>a</sup>	1.97	2.47	1.41
95% CI LB	1.51	1.41	1.34	1.69	1.66	1.43	0.204 <sup>a</sup>	1.55	1.98	1.33
95% CI UB	2.33	2.25	1.91	2.65	3.23	2.17	2.11 <sup>a</sup>	2.46	2.97	1.95
N	45	47	39	41	42	56	51 <sup>a</sup>	41	41	39
% < MDL	64.4	78.7	79.5	53.7	57.1	75	84.3 <sup>a</sup>	65.9	46.3	79.5
Max	7.21	8.42	5.06	6.16	12.6	8.9	4.69 <sup>a</sup>	6.35	6.69	4.45
<b>MATES III</b>										
Average	0.231, 1.07 <sup>a</sup>	0.213, 1.08 <sup>a</sup>	0.161, 1.04 <sup>a</sup>	1.13	0.197, 1.04 <sup>a</sup>	0.163, 1.04 <sup>a</sup>	0.166, 1.04 <sup>a</sup>	0.192, 1.06 <sup>a</sup>	1.12	0.231, 1.08 <sup>a</sup>
95% CI LB	0.166 <sup>a</sup>	0.13 <sup>a</sup>	0.106 <sup>a</sup>	1.09	0.111 <sup>a</sup>	0.109 <sup>a</sup>	0.11 <sup>a</sup>	0.102 <sup>a</sup>	1.08	0.158 <sup>a</sup>
95% CI UB	1.1 <sup>a</sup>	1.17 <sup>a</sup>	1.07 <sup>a</sup>	1.17	1.07 <sup>a</sup>	1.06 <sup>a</sup>	1.06 <sup>a</sup>	1.09 <sup>a</sup>	1.15	1.12 <sup>a</sup>
N	232 <sup>a</sup>	218 <sup>a</sup>	228 <sup>a</sup>	224	116 <sup>a</sup>	230 <sup>a</sup>	229 <sup>a</sup>	118 <sup>a</sup>	237	227 <sup>a</sup>
% < MDL	84.1 <sup>a</sup>	86.2 <sup>a</sup>	88.2 <sup>a</sup>	74.1	84.5 <sup>a</sup>	87.4 <sup>a</sup>	87.8 <sup>a</sup>	86.4 <sup>a</sup>	71.3	84.6 <sup>a</sup>
Max	2.69 <sup>a</sup>	8.83 <sup>a</sup>	1.92 <sup>a</sup>	2.81	1.9 <sup>a</sup>	1.96 <sup>a</sup>	1.94 <sup>a</sup>	1.93 <sup>a</sup>	2.48	3.88 <sup>a</sup>
<b>MATES IV</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES V</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-138.** Annual Average Concentrations of Yttrium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

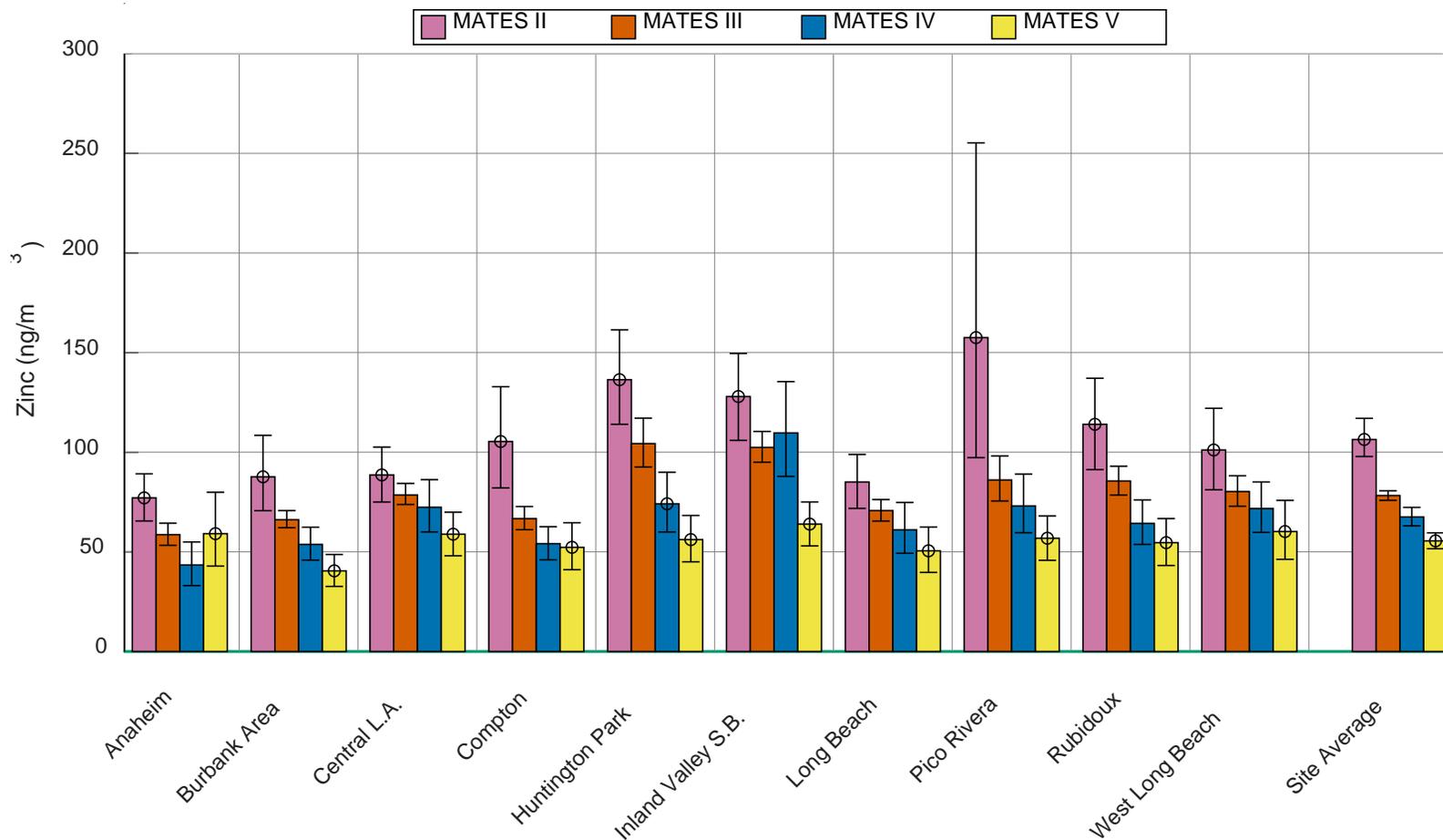


**Figure IV-139.** Geographic distribution of Yttrium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

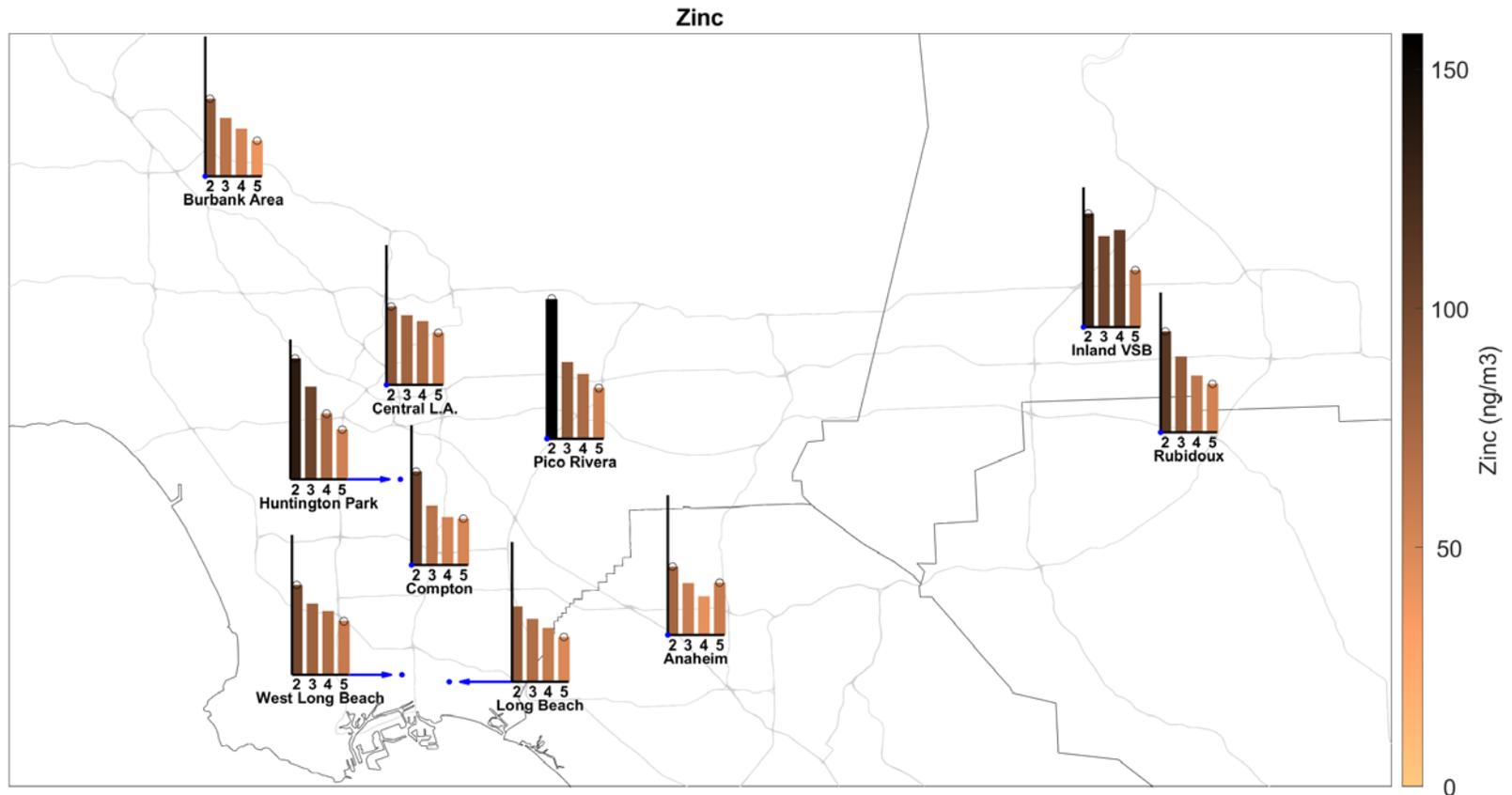
## Zinc

**Table IV-72.** Ambient Concentrations (ng/m<sup>3</sup>) of Zinc from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	77.1	87.6	105	128	136	85.1	88.6	158	114	101
95% CI LB	65.5	70.6	82.1	106	114	71.8	75	97.3	91.3	81.1
95% CI UB	89.2	108	133	150	161	98.9	103	255	137	122
N	45	47	39	41	42	56	51	41	41	39
% < MDL	0	0	0	0	0	0	3.9	2.4	2.4	0
Max	181	348	390	343	335	246	228	1830	309	325
MATES III										
Average	58.6	66.1	66.7	102	104	70.7	78.5	86.1	85.6	80.3
95% CI LB	53.3	62.1	61.1	95	92.6	65.5	73.7	75.5	78.5	72.9
95% CI UB	64.4	70.7	72.7	110	117	76.3	84.3	98.1	93	88.2
N	232	218	228	224	116	230	229	118	237	227
% < MDL	0	0	0	0.4	0	0	0	0	0	0
Max	246	181	252	312	364	207	433	362	351	352
MATES IV										
Average	43.4	53.7	54.1	110	74.1	61	72.4	73	64.3	71.7
95% CI LB	33.1	45.9	46	87.8	60	49.3	60	59.6	53.7	59.8
95% CI UB	55	62.4	62.6	135	90	74.8	86.2	89	76	85.1
N	60	58	59	56	55	59	59	60	58	58
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	219	162	138	496	305	267	264	351	250	225
MATES V										
Average	59.1	40.5	52.3	63.9	56.1	50.5	58.8	56.8	54.6	60.2
95% CI LB	42.8	32.7	41	53	45	39.7	48	45.8	43.2	46.3
95% CI UB	79.9	48.7	64.6	75	68.2	62.4	69.9	68	66.7	75.8
N	23	20	25	24	24	24	25	23	24	23
% < MDL	0	5	4	4.2	4.2	0	4	4.3	0	4.3
Max	236	84.3	141	112	121	129	119	114	121	162



**Figure IV-140.** Annual Average Concentrations of Zinc in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

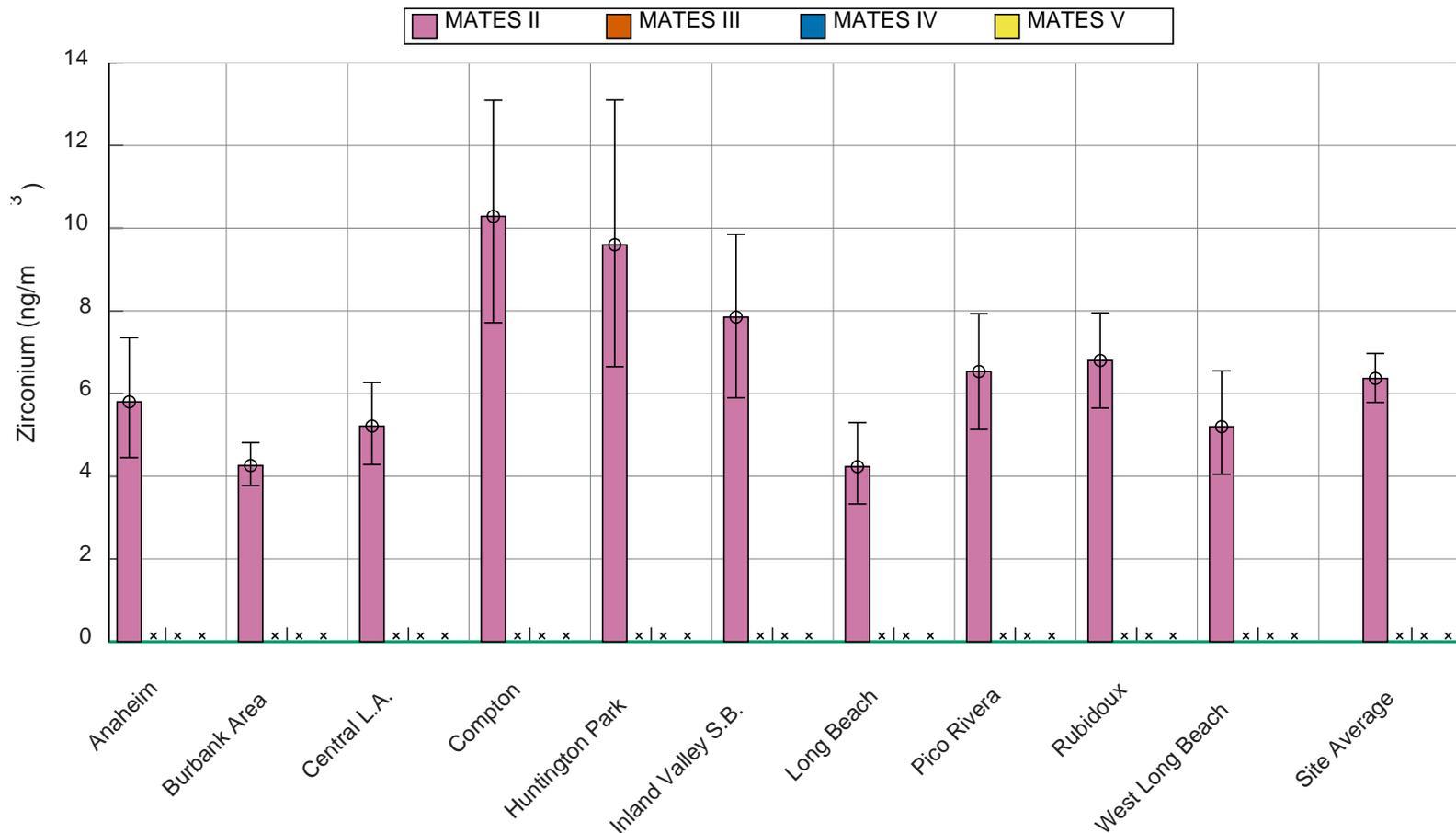


**Figure IV-141.** Geographic distribution of Zinc from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

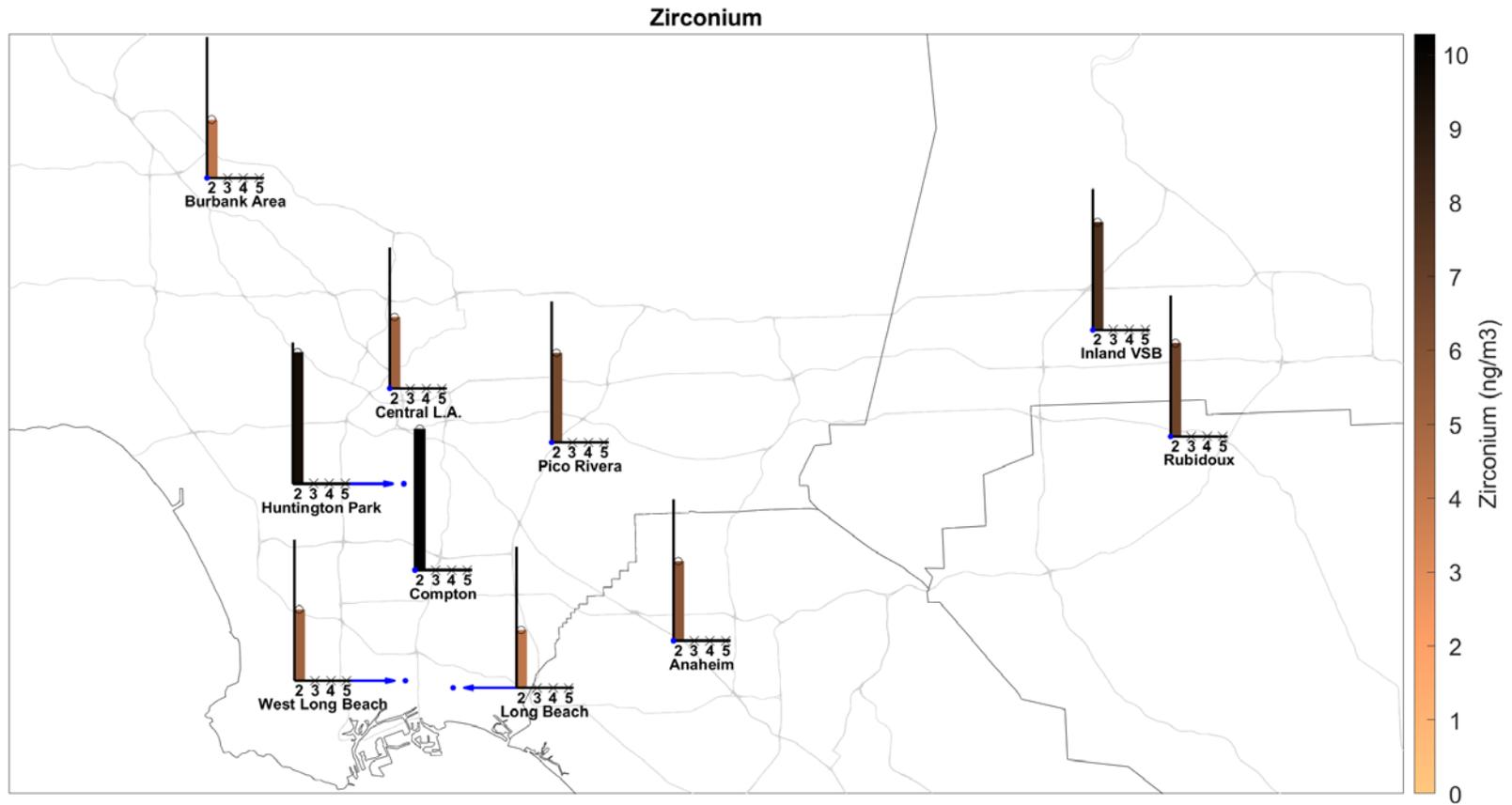
Zirconium

**Table IV-73.** Ambient Concentrations (ng/m<sup>3</sup>) of Zirconium from the TSP Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	5.8	4.26	10.3	7.85	9.6	4.23	5.21	6.53	6.8	5.2
95% CI LB	4.45	3.78	7.71	5.9	6.65	3.33	4.29	5.13	5.65	4.05
95% CI UB	7.35	4.81	13.1	9.85	13.1	5.3	6.27	7.93	7.95	6.55
N	20	27	21	20	20	30	28	15	20	20
% < MDL	5	3.7	4.8	10	0	20	7.1	13.3	5	10
Max	15	7	25	15	32	13	14	12	11	14
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-142.** Annual Average Concentrations of Zirconium in the TSP Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



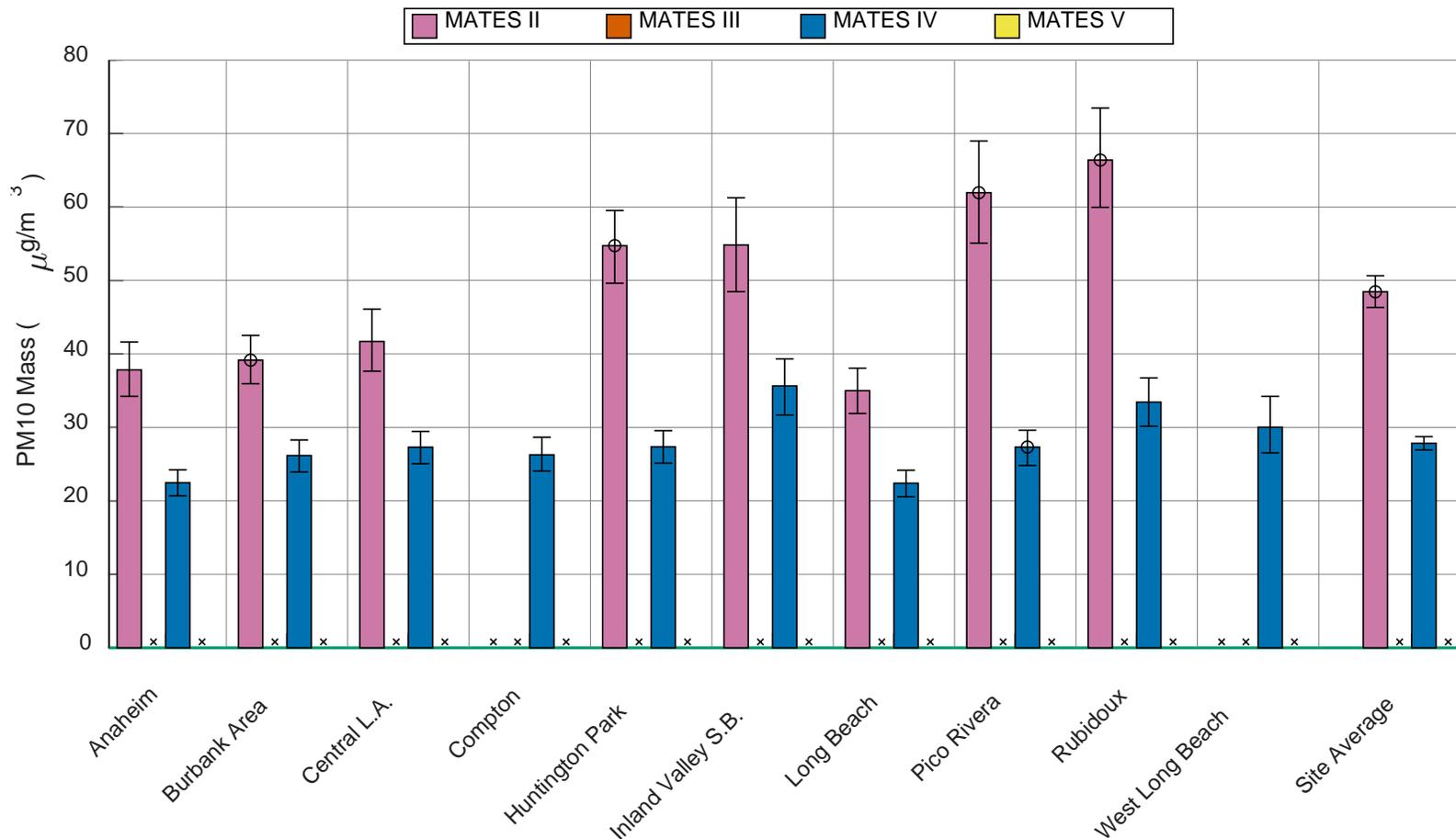
**Figure IV-143.** Geographic distribution of Zirconium from the TSP Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

PM10 Mass Analysis

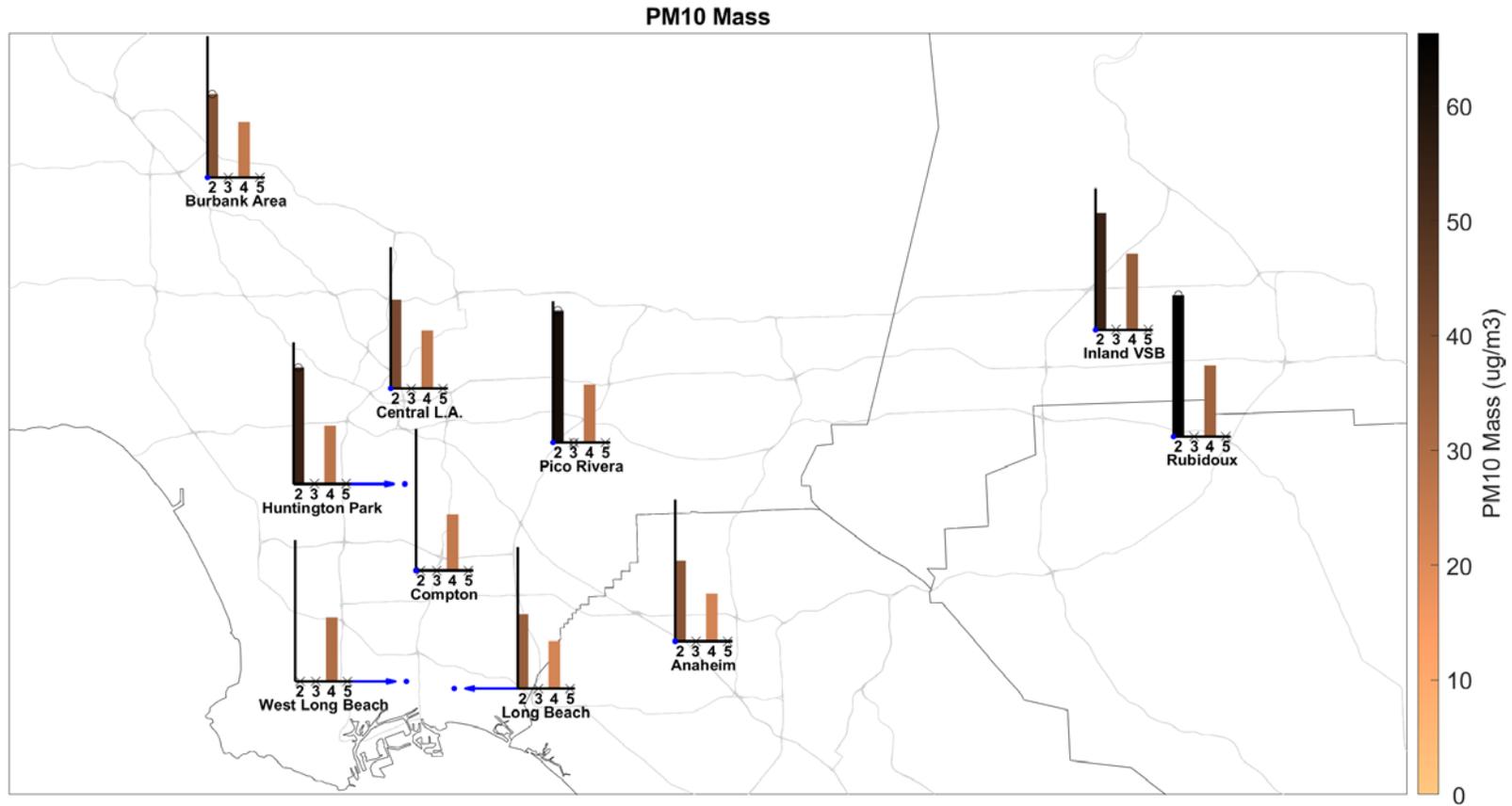
PM10 Mass

**Table IV-74.** Ambient Concentrations (µg/m) of PM10 Mass from the PM10 Mass analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	37.8	39.2		54.8	54.7	35	41.7	61.9	66.4	
95% CI LB	34.2	35.9		48.5	49.6	31.9	37.7	55.1	60	
95% CI UB	41.6	42.5		61.3	59.5	38.1	46.1	69	73.5	
N	58	53	0	59	46	58	59	38	62	0
% < MDL	15.5	15.1		10.2	2.2	20.7	11.9	0	4.8	
Max	81	69		101	104	69	88	115	119	
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average	22.5	26.2	26.3	35.6	27.4	22.4	27.3	27.3	33.5	30
95% CI LB	20.7	23.9	24.1	31.7	25.1	20.5	25	24.8	30.2	26.5
95% CI UB	24.2	28.3	28.7	39.3	29.5	24.2	29.5	29.6	36.7	34.2
N	61	57	57	61	52	60	60	50	60	51
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	43	40	52	63	41	36	45	48	66	78
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-144.** Annual Average Concentrations of PM10 Mass in the PM10 Mass Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



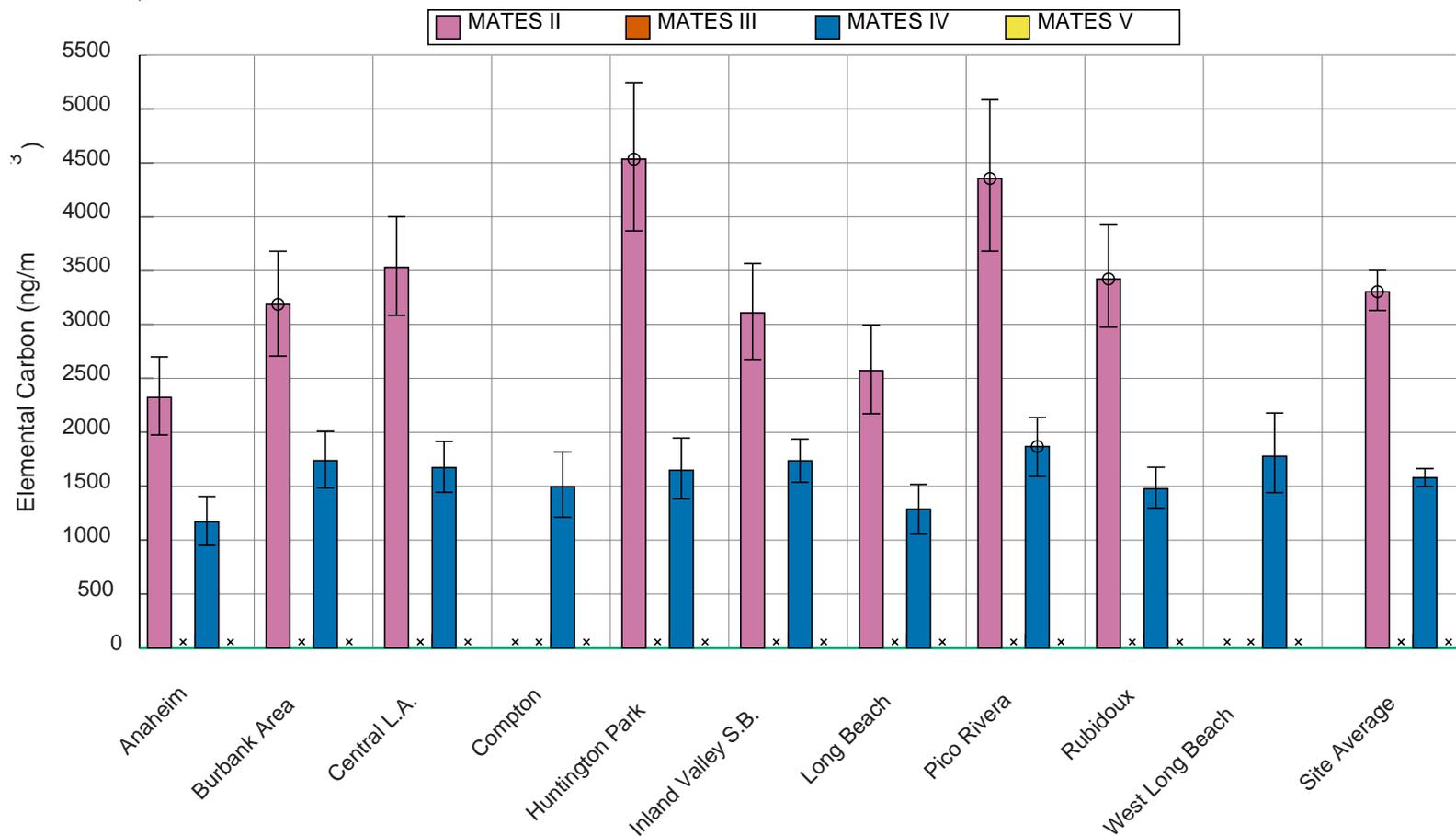
**Figure IV-145.** Geographic distribution of PM10 Mass from the PM10 Mass Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

PM10 Carbon Analysis

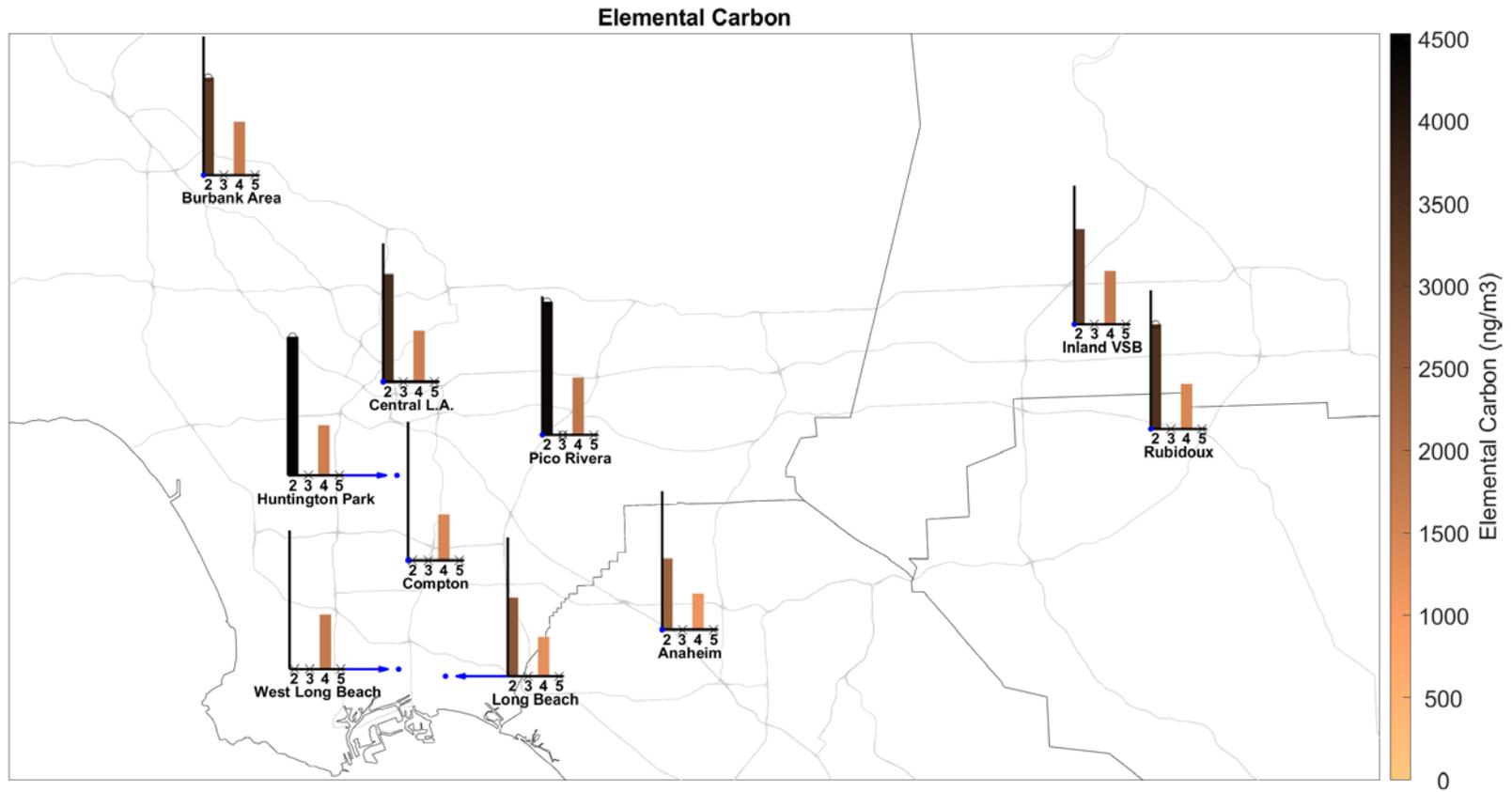
Elemental Carbon

**Table IV-75.** Ambient Concentrations (ng/m<sup>3</sup>) of Elemental Carbon from the PM10 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	2320	3190		3110	4530	2570	3530	4350	3420	
95% CI LB	1980	2710		2680	3870	2170	3080	3680	2970	
95% CI UB	2700	3680		3570	5240	3000	4000	5090	3920	
N	58	53	0	59	46	58	59	38	62	0
% < MDL	12.1	3.8		5.1	0	20.7	1.7	0	12.9	
Max	7760	8410		6860	10600	7700	8160	10200	8290	
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average	1170	1740	1500	1740	1650	1290	1670	1870	1480	1780
95% CI LB	951	1480	1210	1540	1380	1060	1440	1590	1300	1440
95% CI UB	1400	2010	1820	1940	1950	1520	1910	2140	1680	2180
N	61	57	57	61	52	58	60	50	59	51
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	4760	4540	4680	3980	5150	3690	4240	4390	3960	5980
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-146.** Annual Average Concentrations of Elemental Carbon in the PM10 Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

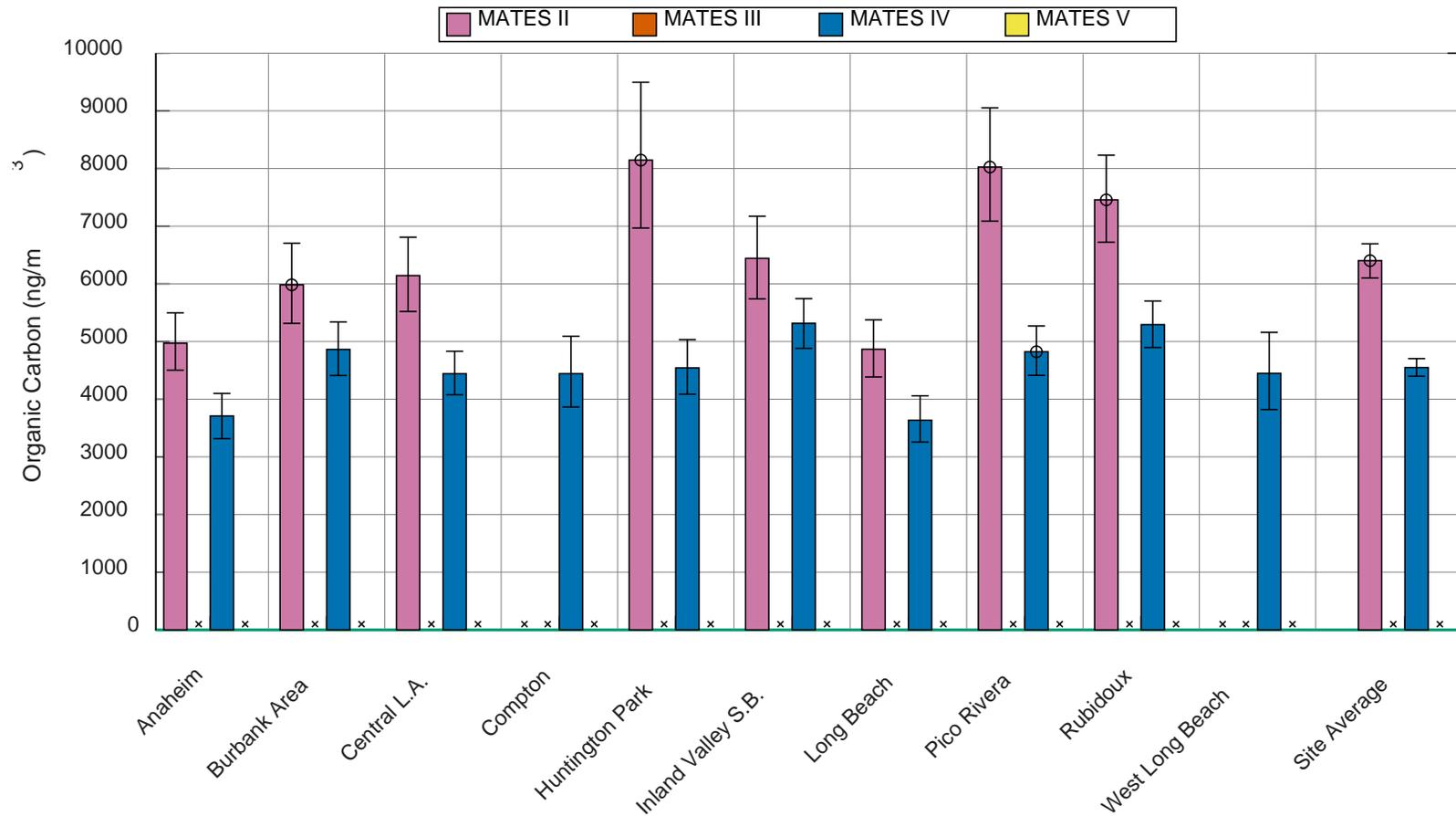


**Figure IV-147.** Geographic distribution of Elemental Carbon from the PM10 Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

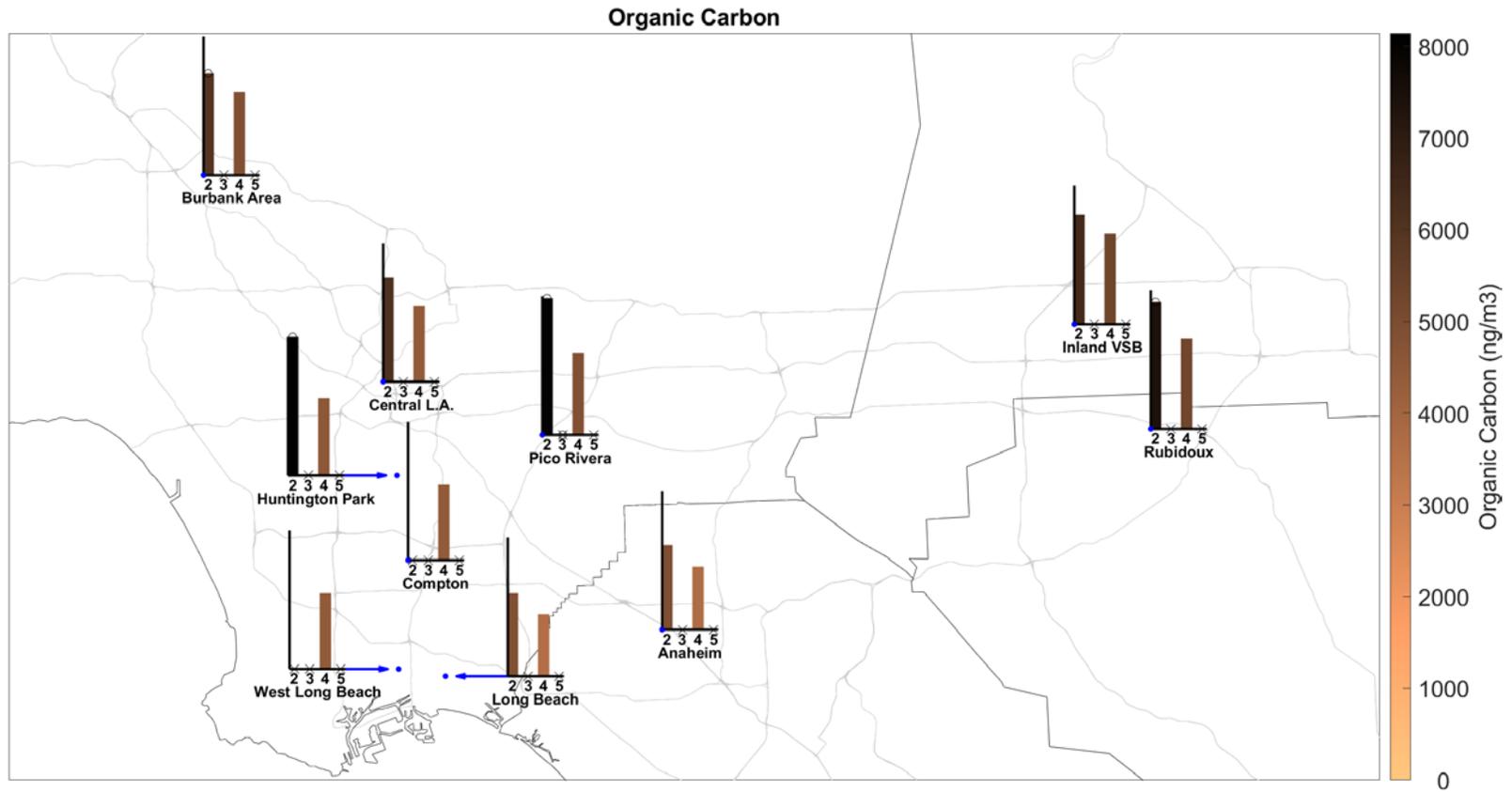
Organic Carbon

**Table IV-76.** Ambient Concentrations (ng/m<sup>3</sup>) of Organic Carbon from the PM10 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	4970	5980		6440	8150	4870	6140	8030	7460	
95% CI LB	4500	5320		5740	6970	4390	5520	7090	6720	
95% CI UB	5500	6710		7170	9500	5380	6810	9050	8230	
N	58	53	0	59	46	58	59	38	62	0
% < MDL	31	17		18.6	0	39.7	13.6	0	9.7	
Max	12600	13800		15200	26100	11600	14400	16700	14600	
<b>MATES III</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES IV</b>										
Average	3710	4860	4440	5320	4540	3640	4440	4820	5290	4450
95% CI LB	3320	4410	3860	4880	4090	3260	4080	4410	4900	3820
95% CI UB	4100	5340	5090	5740	5030	4060	4830	5270	5700	5160
N	61	57	57	61	52	58	60	50	59	51
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	9320	10300	12100	9270	9260	7960	8220	9280	9170	12200
<b>MATES V</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-148.** Annual Average Concentrations of Organic Carbon in the PM10 Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

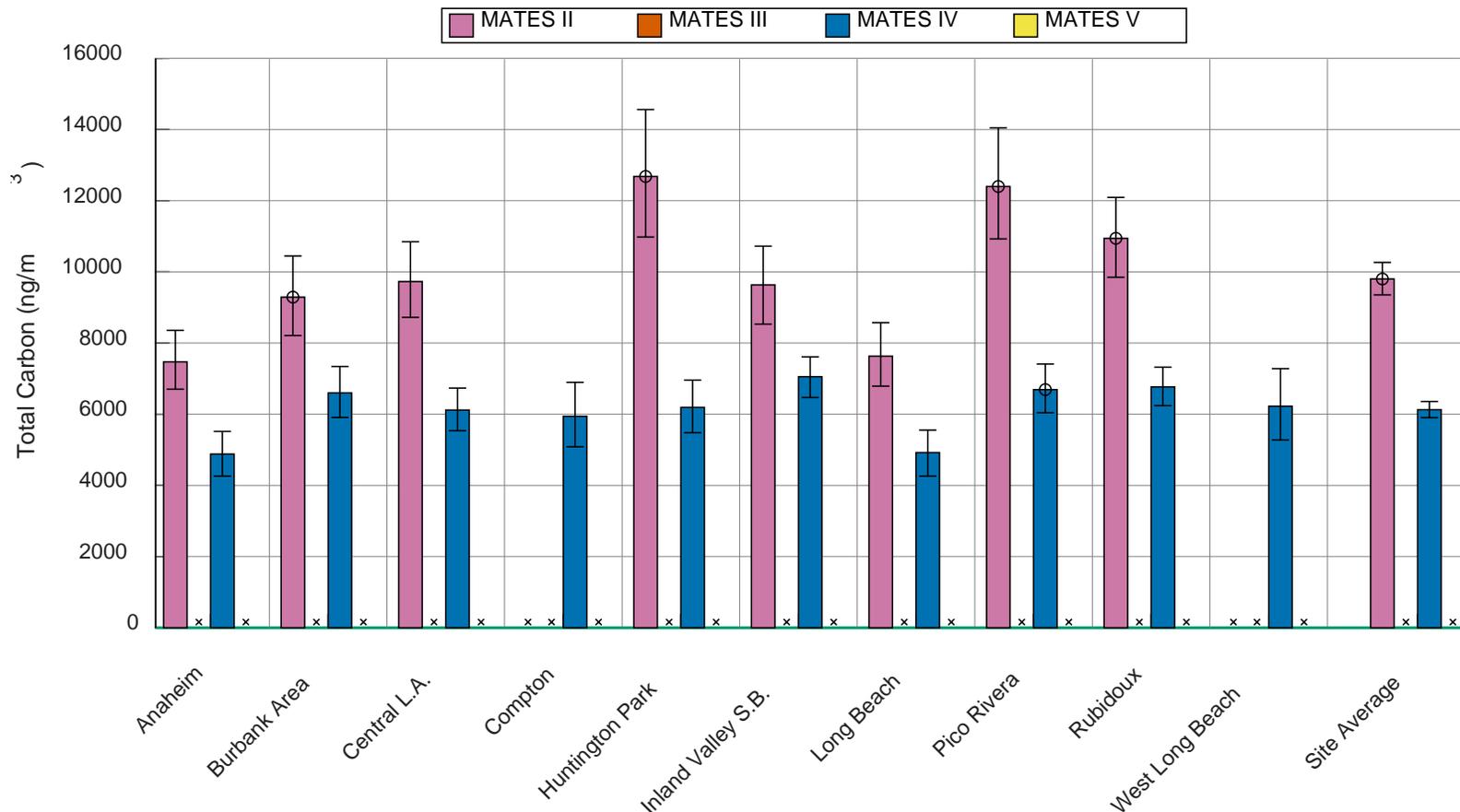


**Figure IV-149.** Geographic distribution of Organic Carbon from the PM10 Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

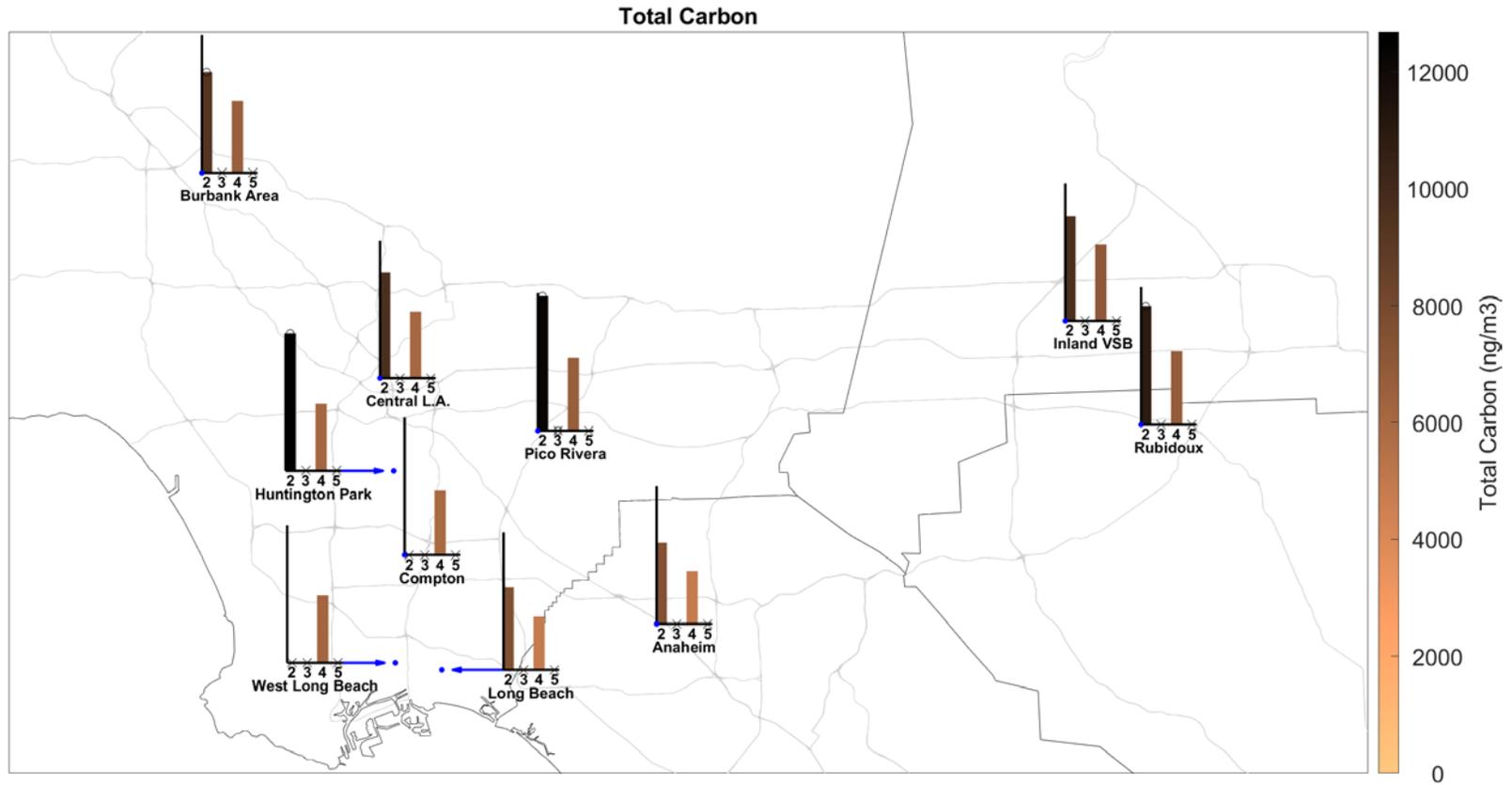
Total Carbon

**Table IV-77.** Ambient Concentrations (ng/m<sup>3</sup>) of Total Carbon from the PM10 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	7470	9290		9640	12700	7630	9730	12400	10900	
95% CI LB	6700	8210		8530	11000	6790	8720	10900	9850	
95% CI UB	8360	10400		10700	14600	8570	10800	14000	12100	
N	58	53	0	59	46	58	59	38	62	0
% < MDL	37.9	24.5		20.3	2.2	39.7	18.6	2.6	14.5	
Max	20300	22200		20300	36700	19300	22500	24100	22100	
<b>MATES III</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES IV</b>										
Average	4880	6600	5940	7050	6190	4920	6120	6690	6770	6230
95% CI LB	4260	5910	5080	6470	5480	4260	5540	6040	6240	5280
95% CI UB	5520	7340	6900	7610	6960	5550	6730	7410	7320	7280
N	61	57	57	61	52	58	60	50	59	51
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	14100	14200	16800	12900	13600	11600	12400	13700	13100	18200
<b>MATES V</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-150.** Annual Average Concentrations of Total Carbon in the PM10 Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



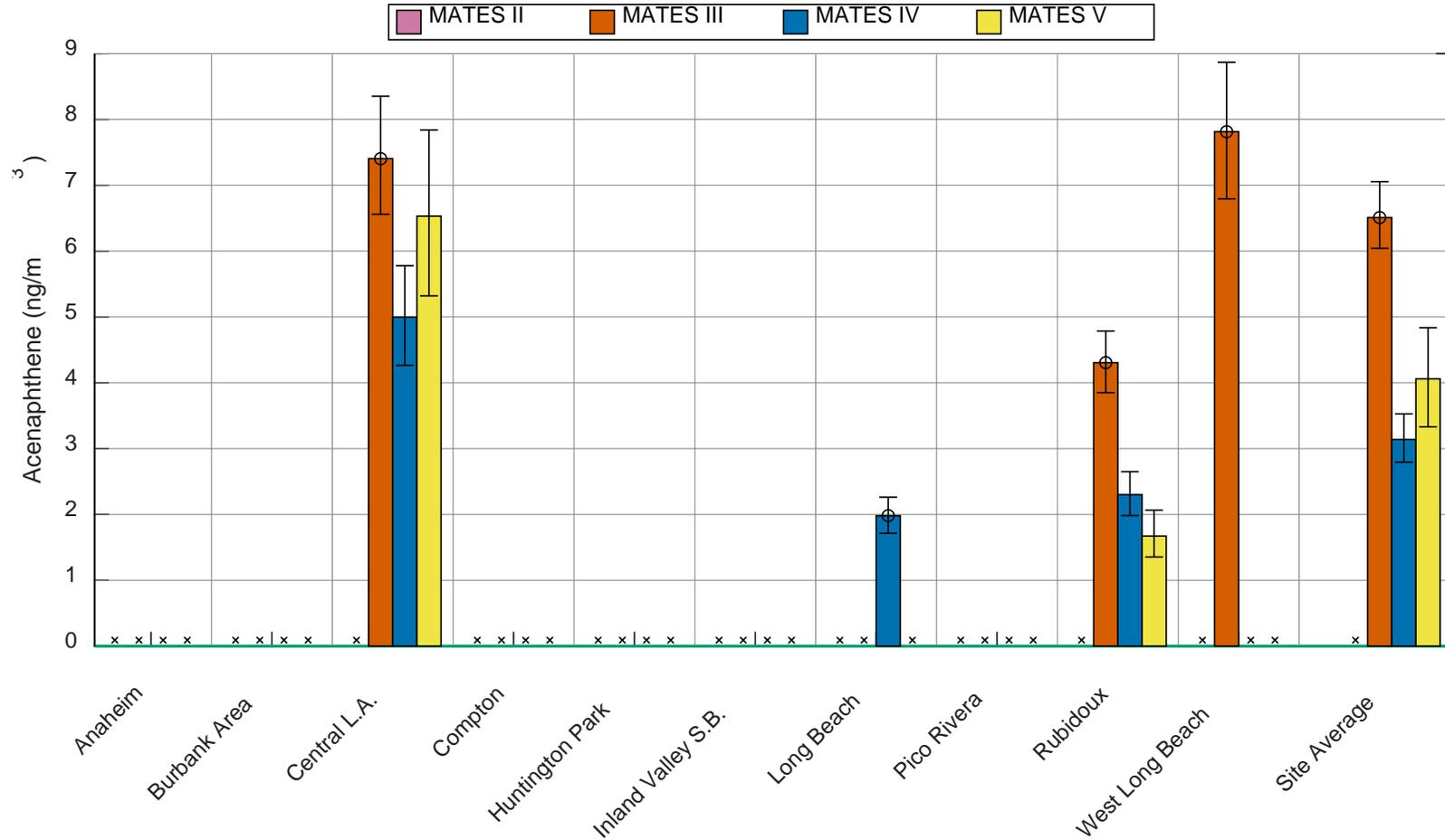
**Figure IV-151.** Geographic distribution of Total Carbon from the PM10 Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

PAH Analysis

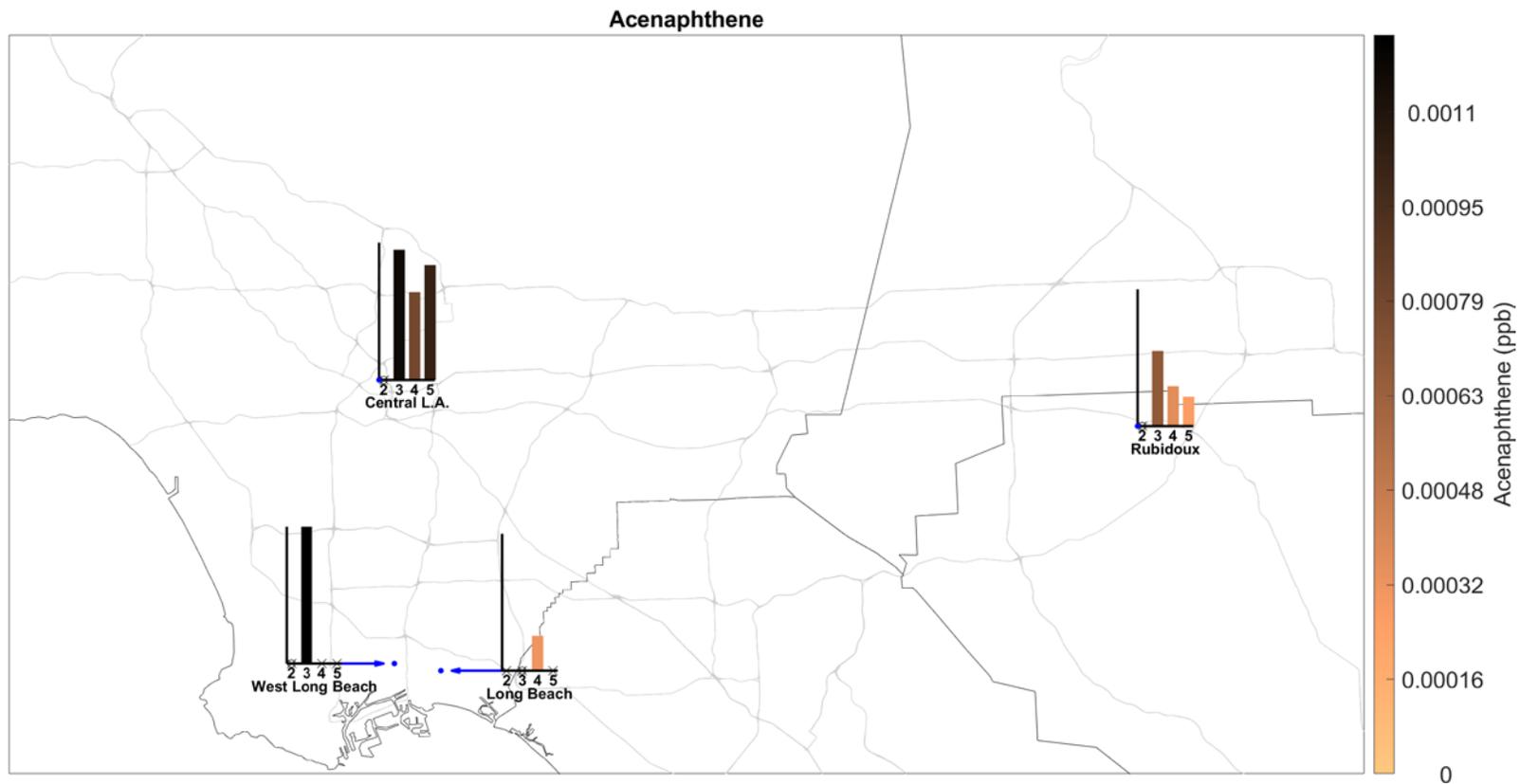
Acenaphthene

**Table IV-78.** Ambient Concentrations (ng/m<sup>3</sup>) of Acenaphthene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							7.4		4.31	7.81
95% CI LB							6.56		3.85	6.79
95% CI UB							8.35		4.79	8.87
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							38.1		13.4	34.8
MATES IV										
Average						1.98	5		2.3	
95% CI LB						1.71	4.26		1.98	
95% CI UB						2.26	5.78		2.65	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						0	0		0	
Max						4.37	12.4		6.7	
MATES V										
Average							6.53		1.67	
95% CI LB							5.32		1.35	
95% CI UB							7.84		2.06	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		3.3	
Max							27.1		9.98	



**Figure IV-152.** Annual Average Concentrations of Acenaphthene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

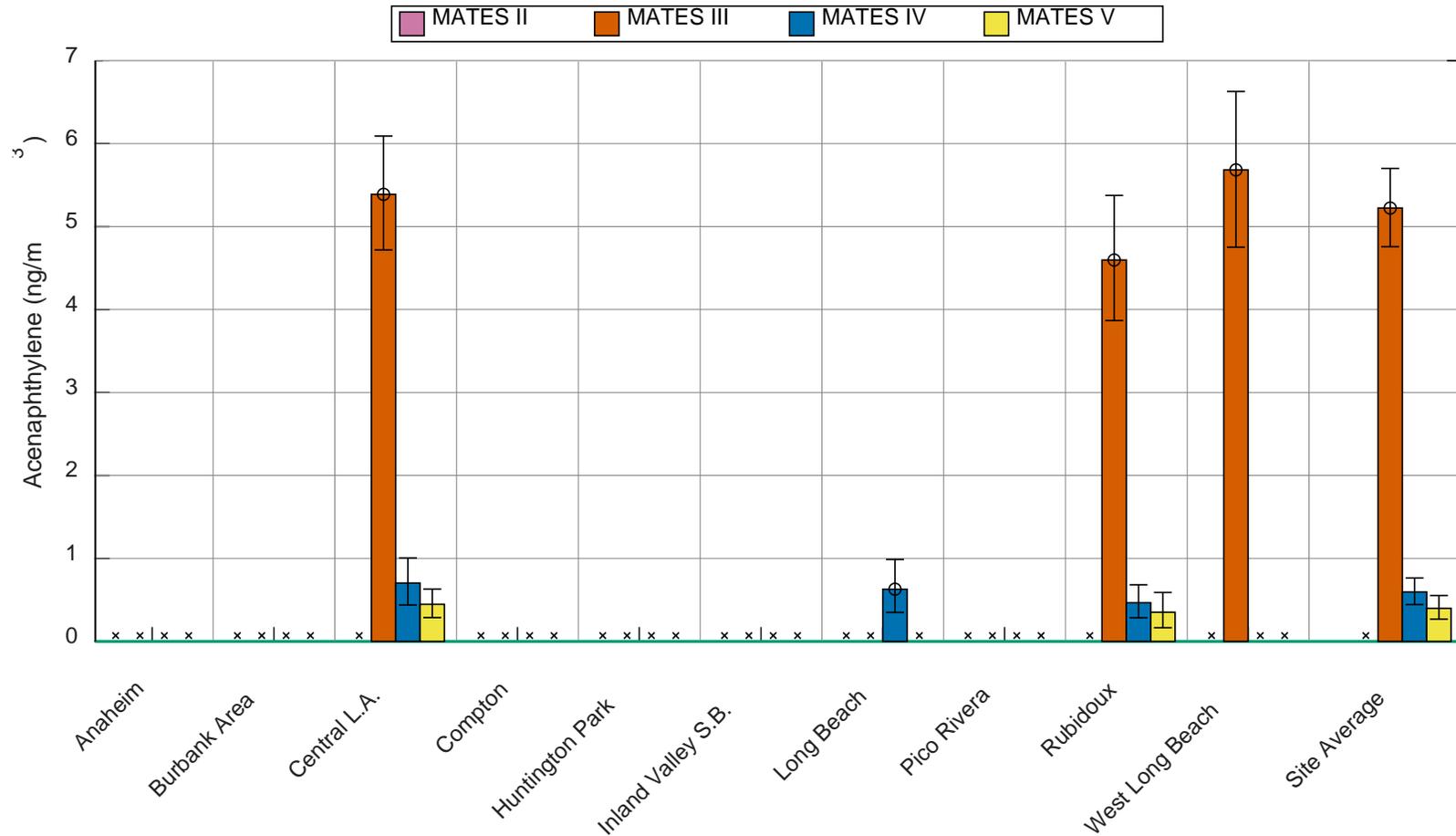


**Figure IV-153.** Geographic distribution of Acenaphthene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

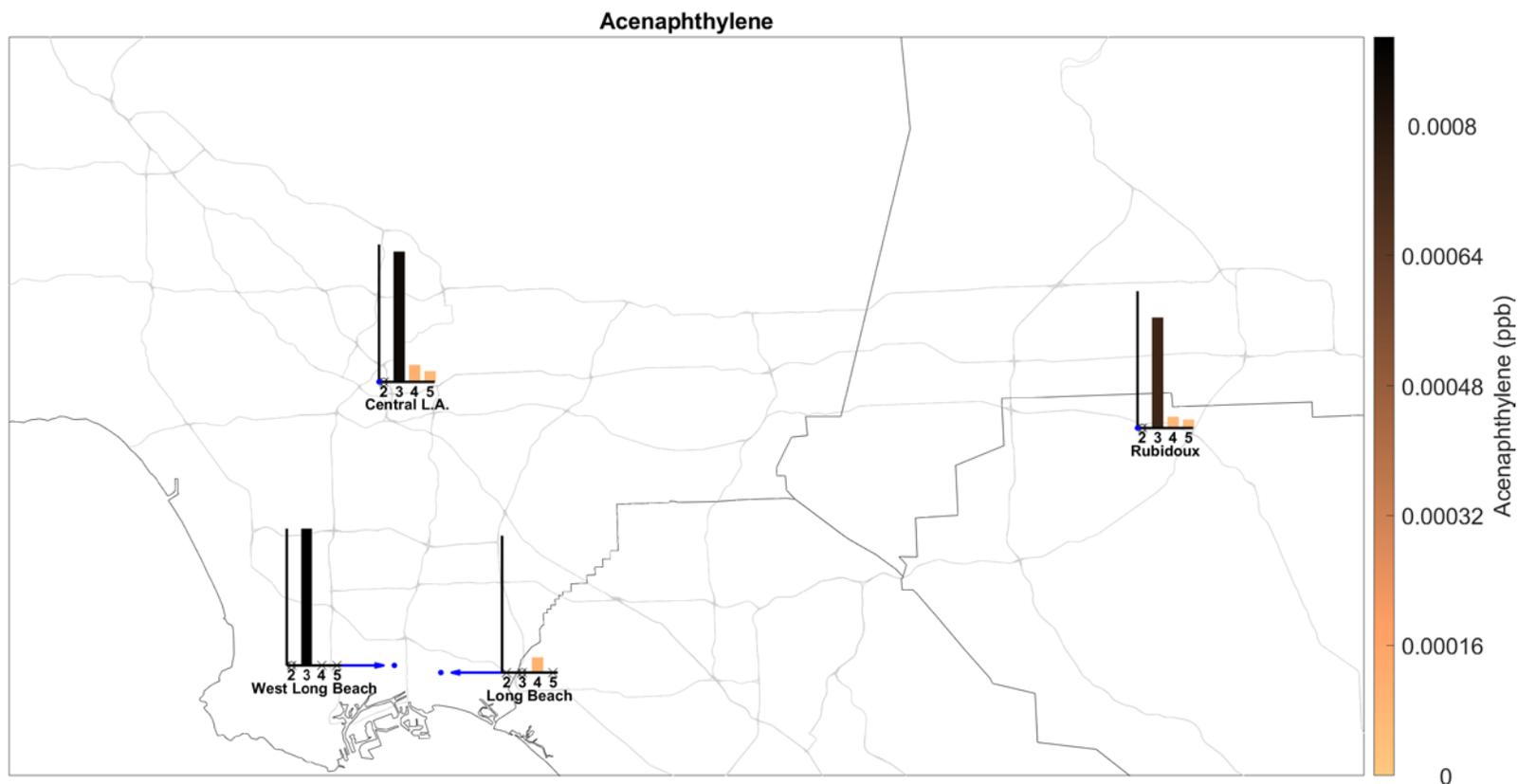
Acenaphthylene

**Table IV-79.** Ambient Concentrations (ng/m<sup>3</sup>) of Acenaphthylene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							5.39		4.6	5.68
95% CI LB							4.72		3.87	4.75
95% CI UB							6.09		5.38	6.63
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							16.6		20.9	24.7
MATES IV										
Average						0.629	0.703		0.467	
95% CI LB						0.349	0.438		0.284	
95% CI UB						0.988	1.01		0.682	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						60.8	56.9		55.2	
Max						5.36	4.64		4.05	
MATES V										
Average							0.447		0.351	
95% CI LB							0.287		0.164	
95% CI UB							0.631		0.59	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							15.5		35	
Max							3.15		5	



**Figure IV-154.** Annual Average Concentrations of Acenaphthylene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

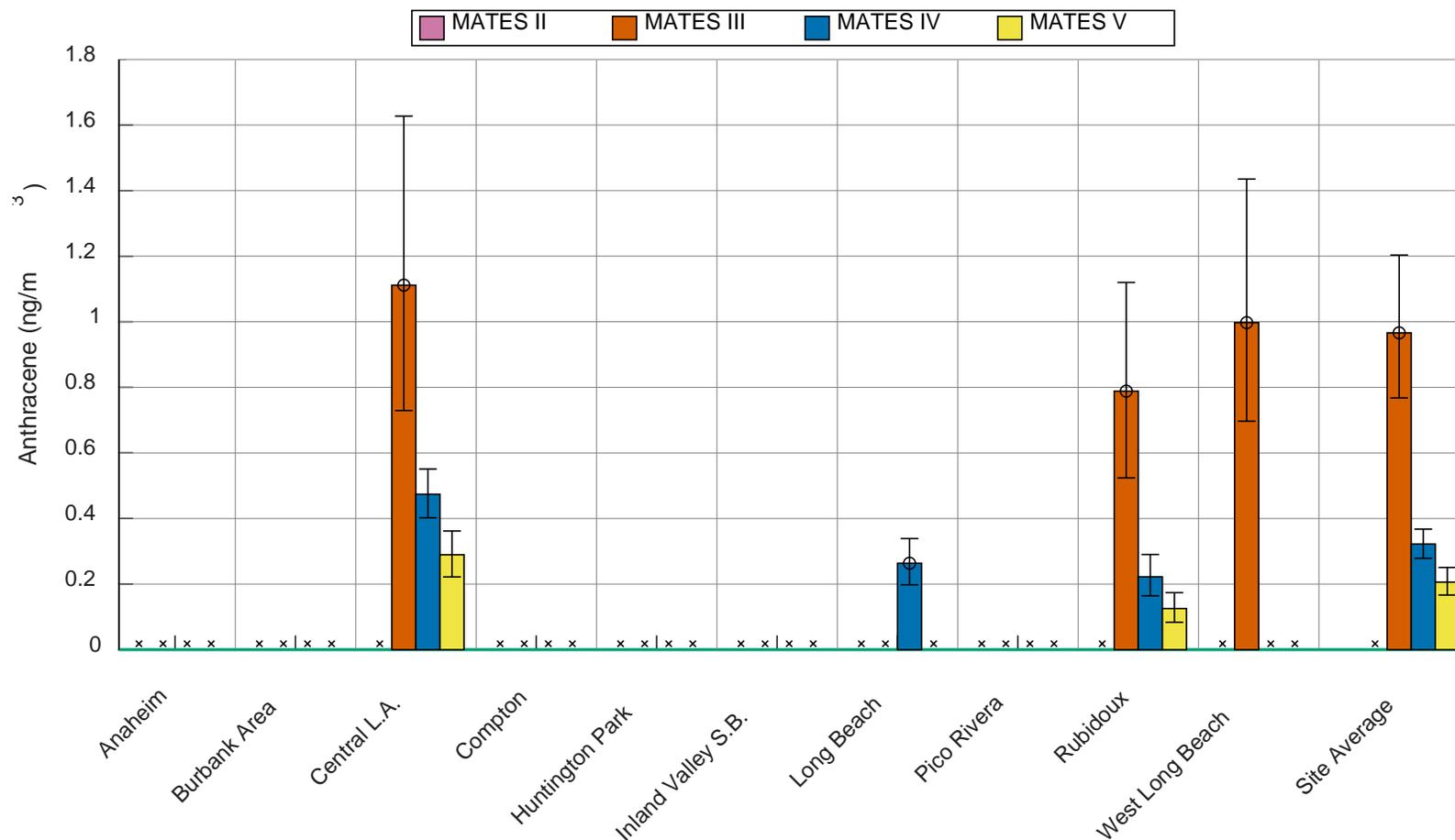


**Figure IV-155.** Geographic distribution of Acenaphthylene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

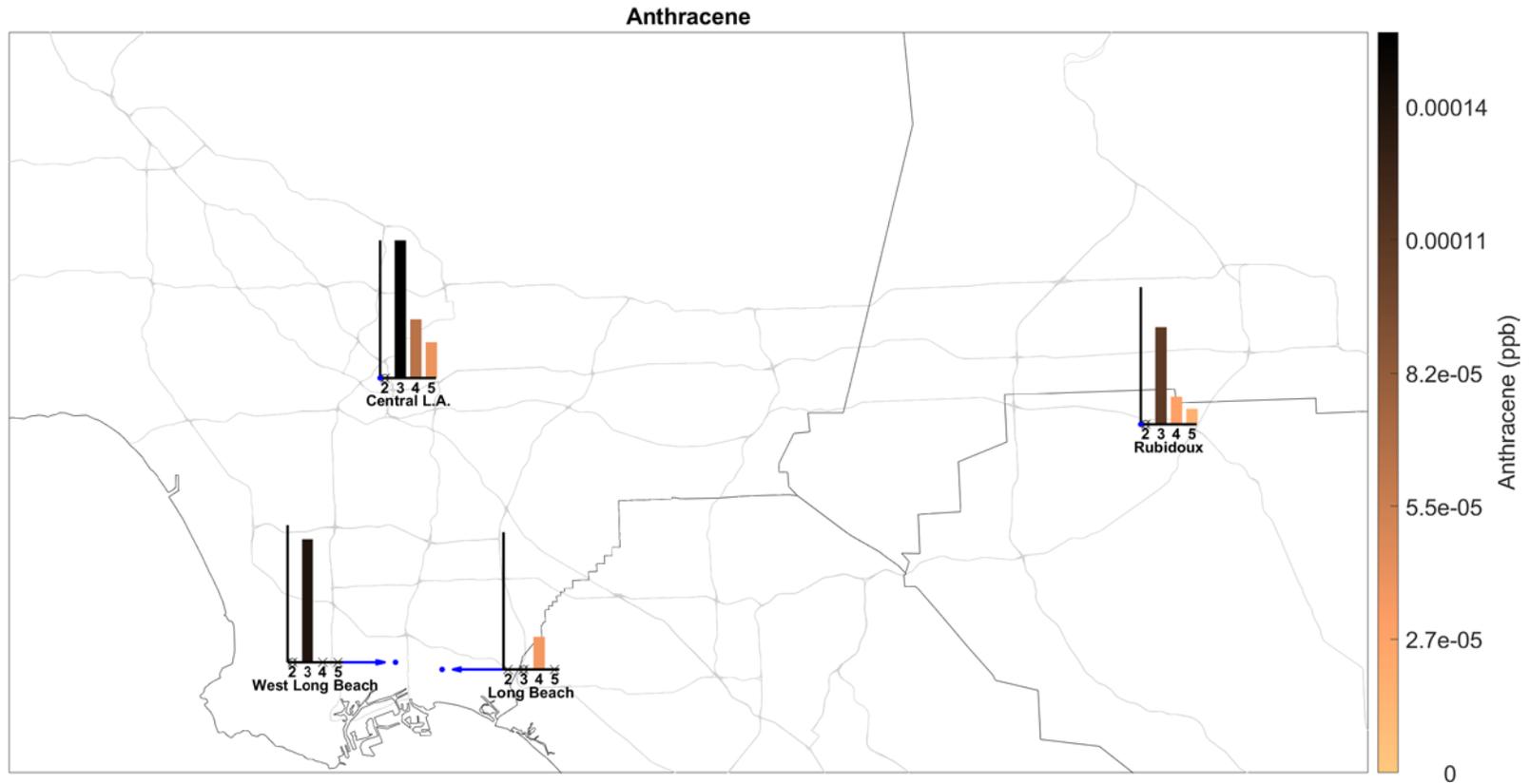
Anthracene

**Table IV-80.** Ambient Concentrations (ng/m<sup>3</sup>) of Anthracene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							1.11		0.788	0.997
95% CI LB							0.729		0.524	0.697
95% CI UB							1.63		1.12	1.44
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							21.6		11.8	22.3
MATES IV										
Average						0.263	0.474		0.222	
95% CI LB						0.198	0.402		0.164	
95% CI UB						0.339	0.551		0.29	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						19.6	5.2		36.2	
Max						1.15	1.51		1.38	
MATES V										
Average							0.289		0.125	
95% CI LB							0.222		0.0835	
95% CI UB							0.362		0.174	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							15.5		18.3	
Max							1.12		1.04	



**Figure IV-156.** Annual Average Concentrations of Anthracene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

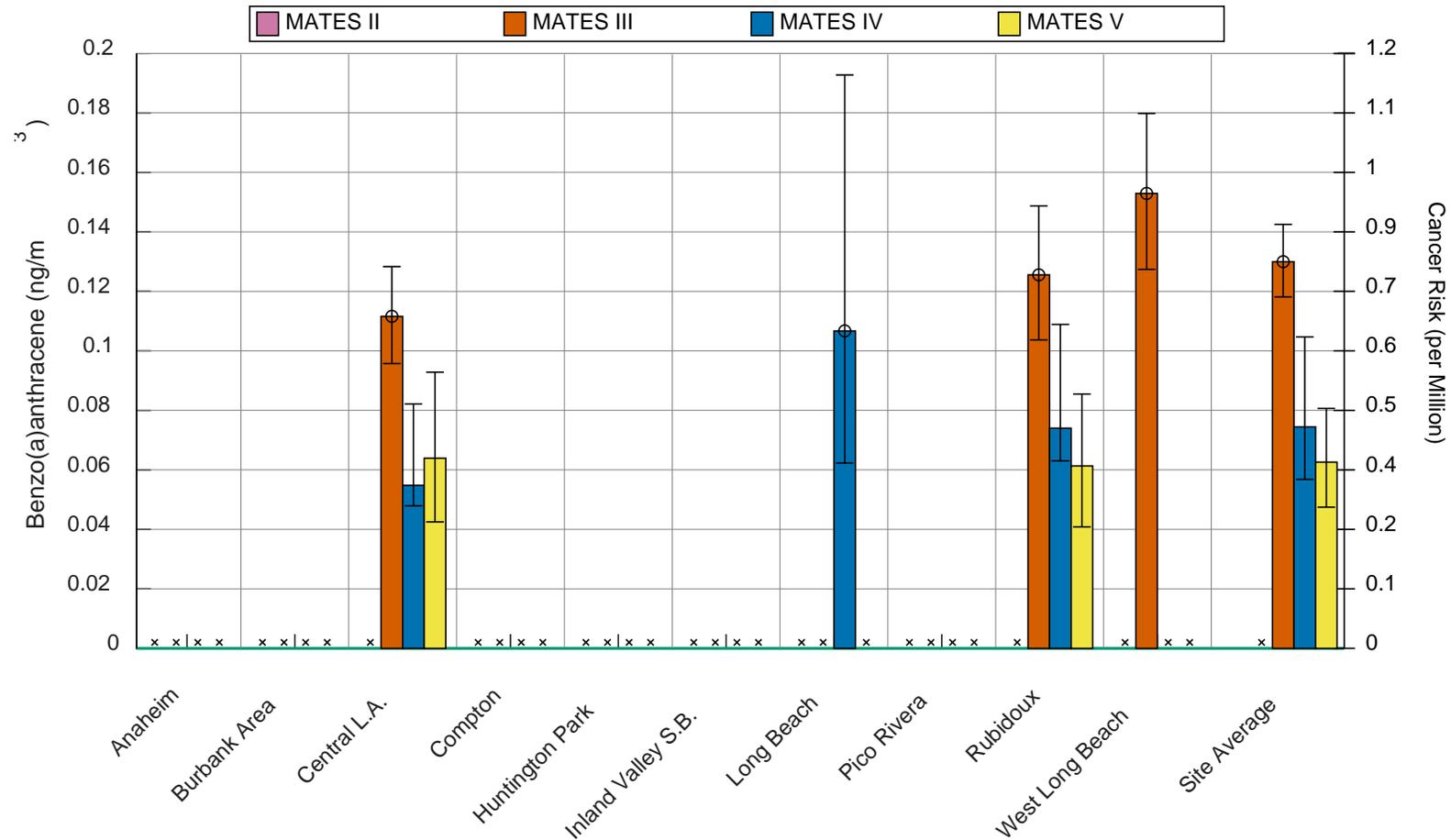


**Figure IV-157.** Geographic distribution of Anthracene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

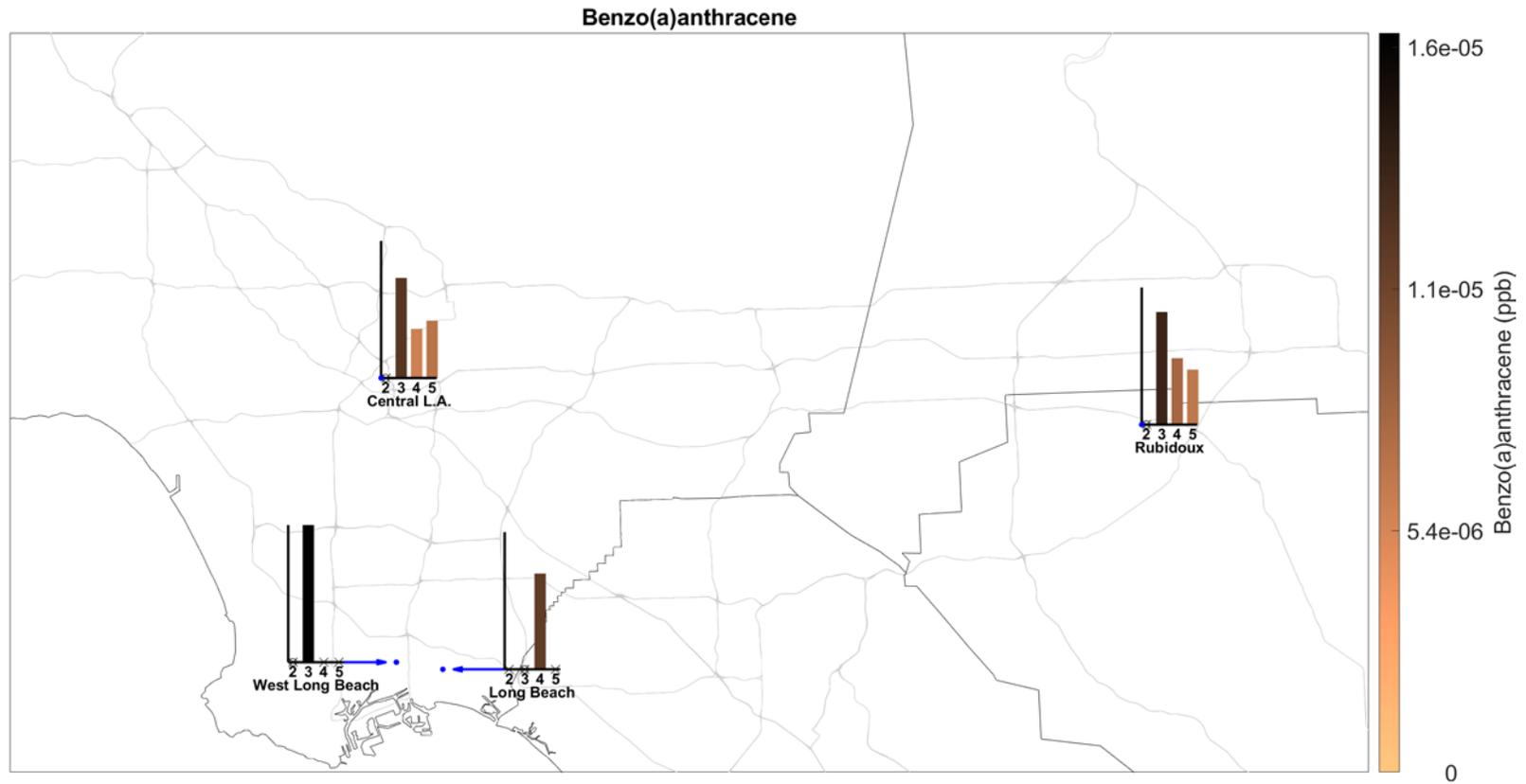
Benzo(a)anthracene

**Table IV-81.** Ambient Concentrations (ng/m<sup>3</sup>) of Benzo(a)anthracene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							0.112		0.126	0.153
95% CI LB							0.0957		0.104	0.127
95% CI UB							0.128		0.149	0.18
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							0.536		0.696	0.853
MATES IV										
Average						0.107	0.0548		0.074	
95% CI LB						0.0623	0.0479		0.063	
95% CI UB						0.193	0.0822		0.109	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						74.5	74.1		77.6	
Max						1.97	0.248		0.684	
MATES V										
Average							0.0639		0.0613	
95% CI LB							0.0425		0.0408	
95% CI UB							0.0928		0.0855	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		1.7	
Max							0.645		0.548	



**Figure IV-158.** Annual Average Concentrations of Benzo(a)anthracene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



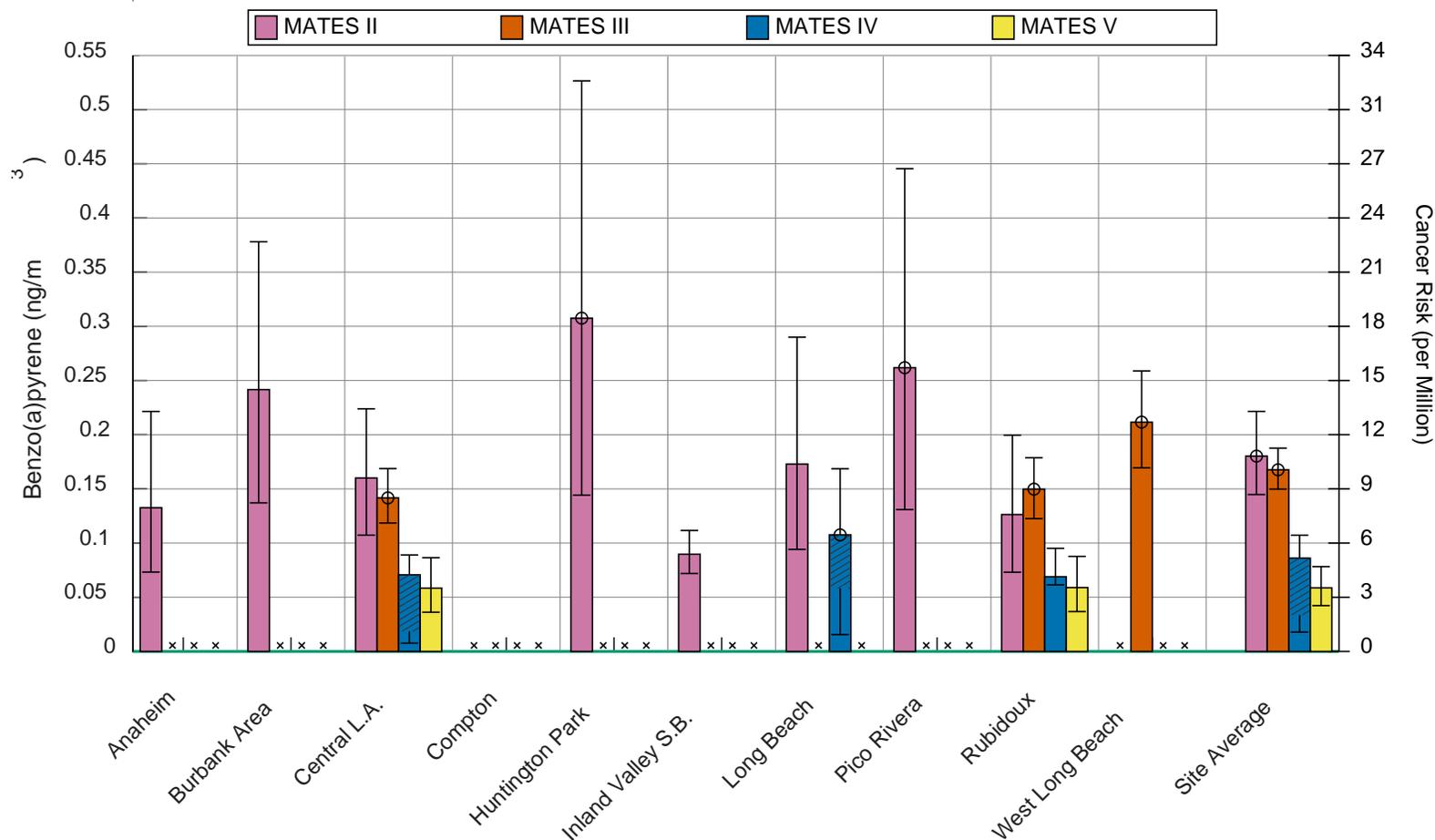
**Figure IV-159.** Geographic distribution of Benzo(a)anthracene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

## Benzo(a)pyrene

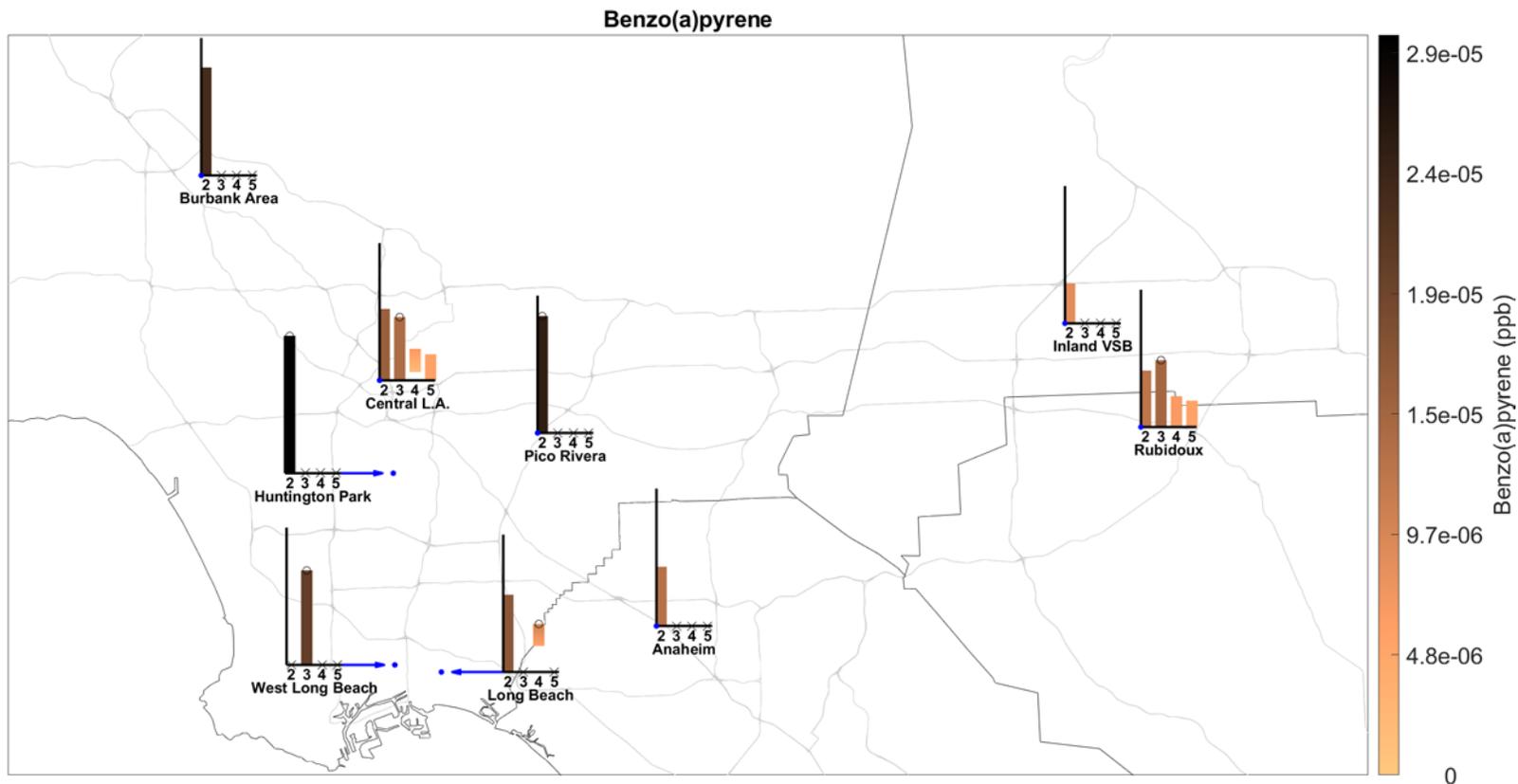
**Table IV-82.** Ambient Concentrations (ng/m<sup>3</sup>) of Benzo(a)pyrene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.133	0.242		0.0897	0.307	0.173	0.16	0.262	0.126	
95% CI LB	0.0732	0.137		0.0719	0.144	0.0942	0.107	0.131	0.0731	
95% CI UB	0.221	0.378		0.112	0.526	0.29	0.224	0.445	0.2	
N	31	31	0	31	24	31	31	22	30	0
% < MDL	58.1	35.5		45.2	20.8	41.9	32.3	36.4	53.3	
Max	1.3	1.8		0.27	2.3	1.6	0.9	1.9	1	
MATES III										
Average							0.142		0.15	0.212
95% CI LB							0.119		0.123	0.169
95% CI UB							0.169		0.179	0.259
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							1.1		0.76	1.83
MATES IV										
Average						0.0582, 0.108 <sup>a</sup>	0.0185, 0.0707 <sup>a</sup>		0.0689	
95% CI LB						0.0156 <sup>a</sup>	0.0076 <sup>a</sup>		0.0614	
95% CI UB						0.169 <sup>a</sup>	0.089 <sup>a</sup>		0.0952	
N	0	0	0	0	0	51 <sup>a</sup>	58 <sup>a</sup>	0	58	0
% < MDL						80.4 <sup>a</sup>	82.8 <sup>a</sup>		79.3	
Max						1.4 <sup>a</sup>	0.221 <sup>a</sup>		0.519	
MATES V										
Average							0.0584		0.0589	
95% CI LB							0.0362		0.0368	
95% CI UB							0.0865		0.0877	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							10.3		11.7	
Max							0.516		0.654	

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-160.** Annual Average Concentrations of Benzo(a)pyrene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

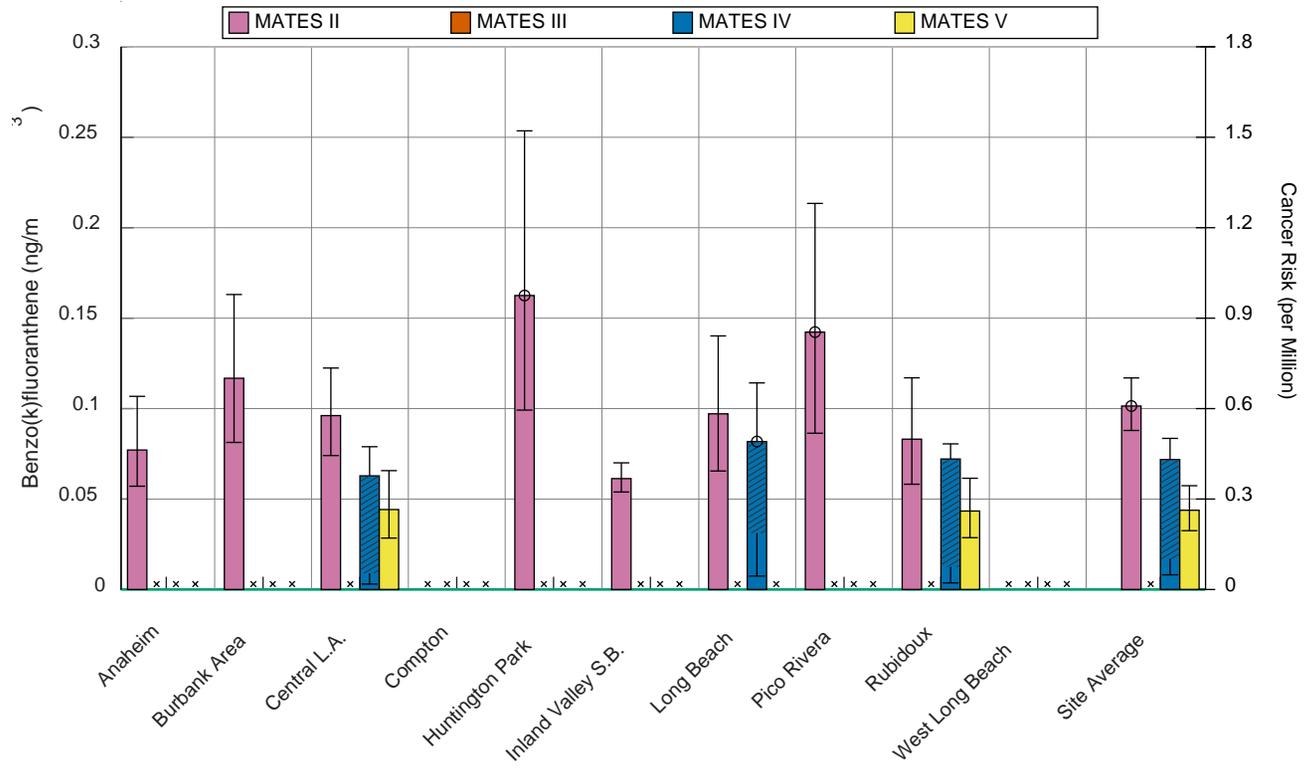


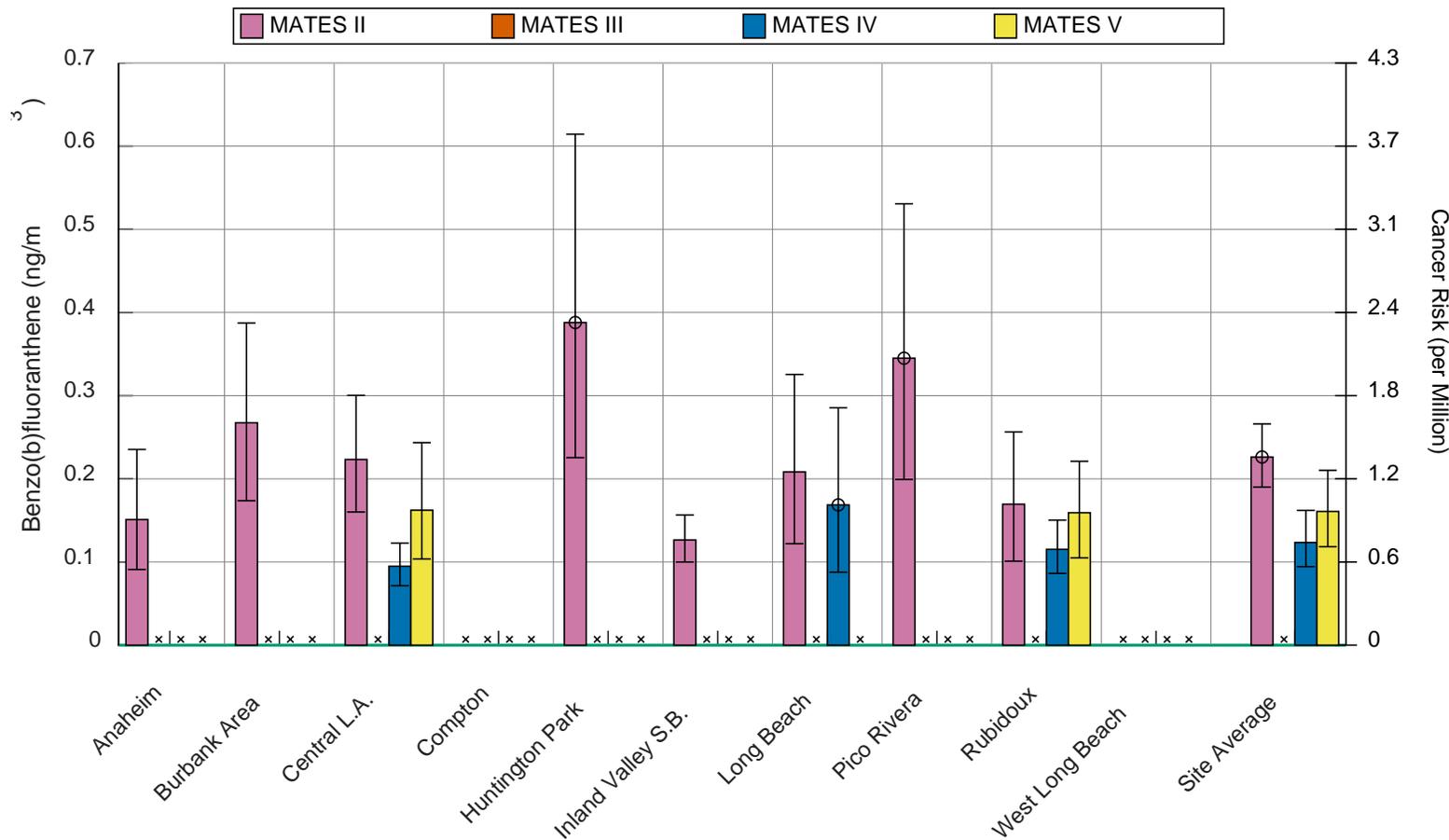
**Figure IV-161.** Geographic distribution of Benzo(a)pyrene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Benzo(b)fluoranthene

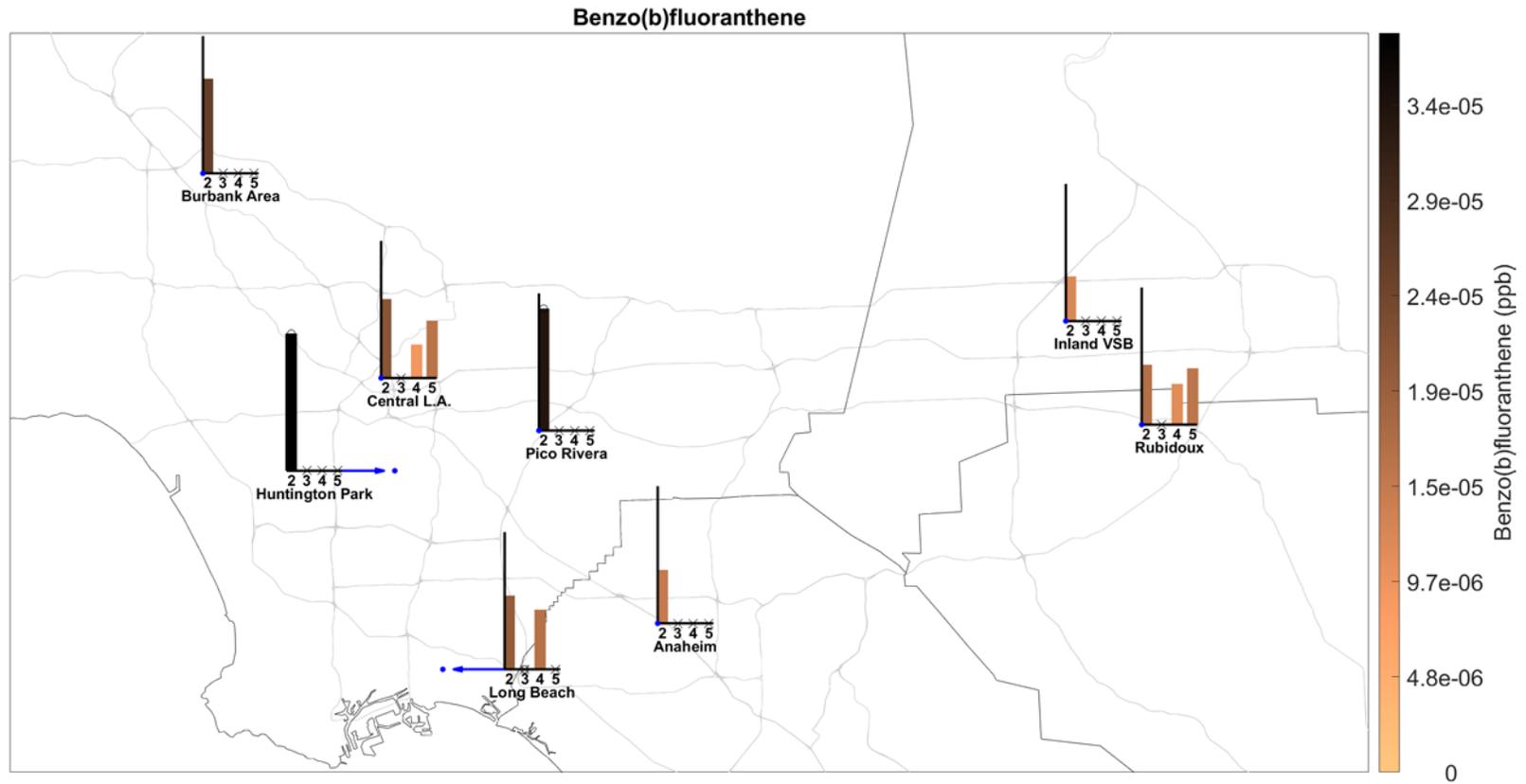
**Table IV-83.** Ambient Concentrations (ng/m<sup>3</sup>) of Benzo(b)fluoranthene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.151	0.267		0.126	0.388	0.208	0.223	0.345	0.169	
95% CI LB	0.091	0.174		0.1	0.225	0.122	0.16	0.199	0.101	
95% CI UB	0.235	0.387		0.156	0.614	0.325	0.3	0.531	0.256	
N	31	31	0	31	24	31	31	22	30	0
% < MDL	38.7	9.7		16.1	16.7	29	19.4	4.5	30	
Max	1.2	1.6		0.38	2	1.6	1	1.9	1.25	
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average						0.169	0.0949		0.115	
95% CI LB						0.0878	0.0715		0.0863	
95% CI UB						0.285	0.123		0.15	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						52.9	32.8		46.6	
Max						2.46	0.577		0.74	
MATES V										
Average							0.162		0.159	
95% CI LB							0.104		0.105	
95% CI UB							0.243		0.221	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		0	
Max							1.86		1.27	





**Figure IV-162.** Annual Average Concentrations of Benzo(b)fluoranthene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

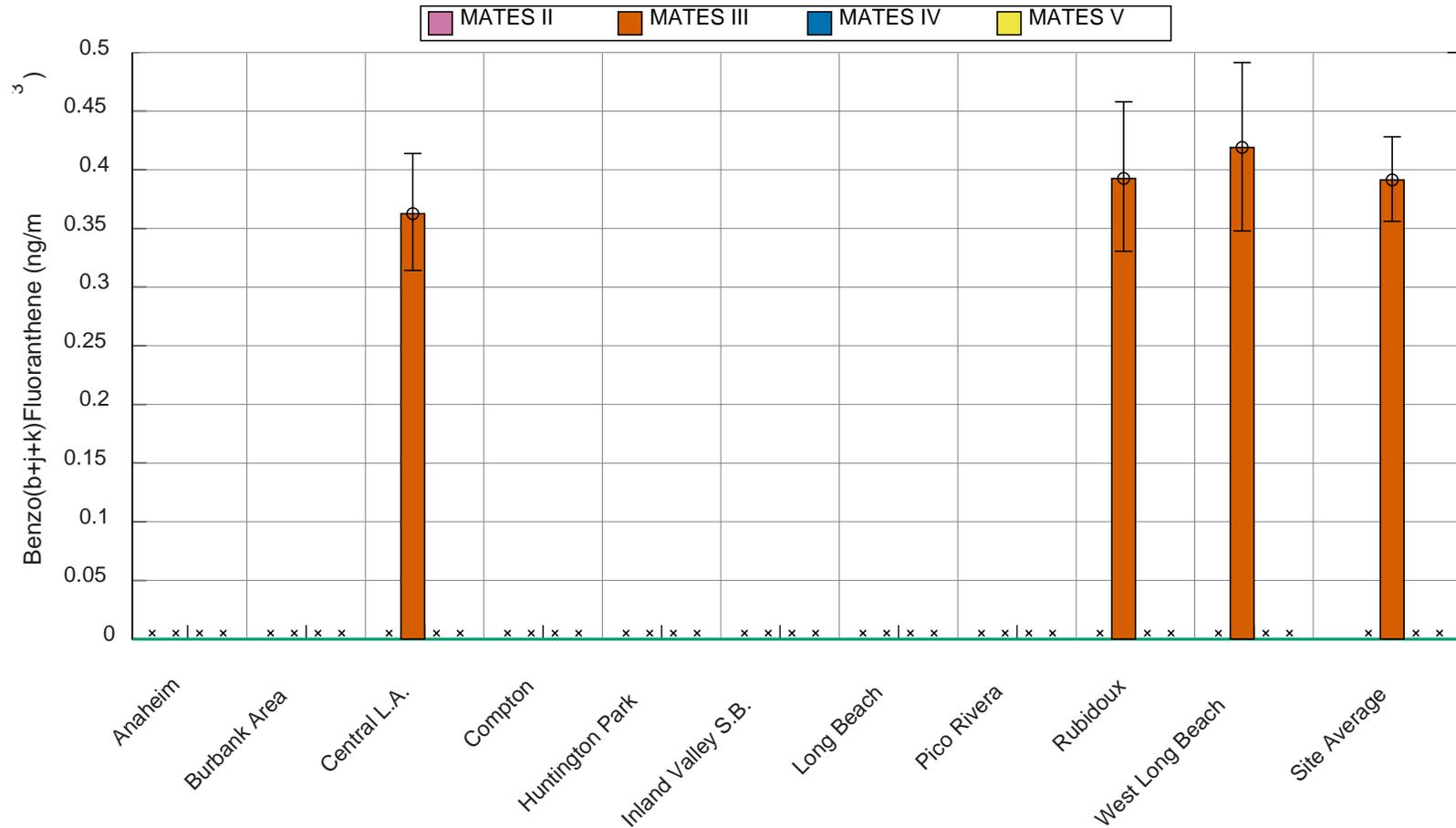


**Figure IV-163.** Geographic distribution of Benzo(b)fluoranthene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

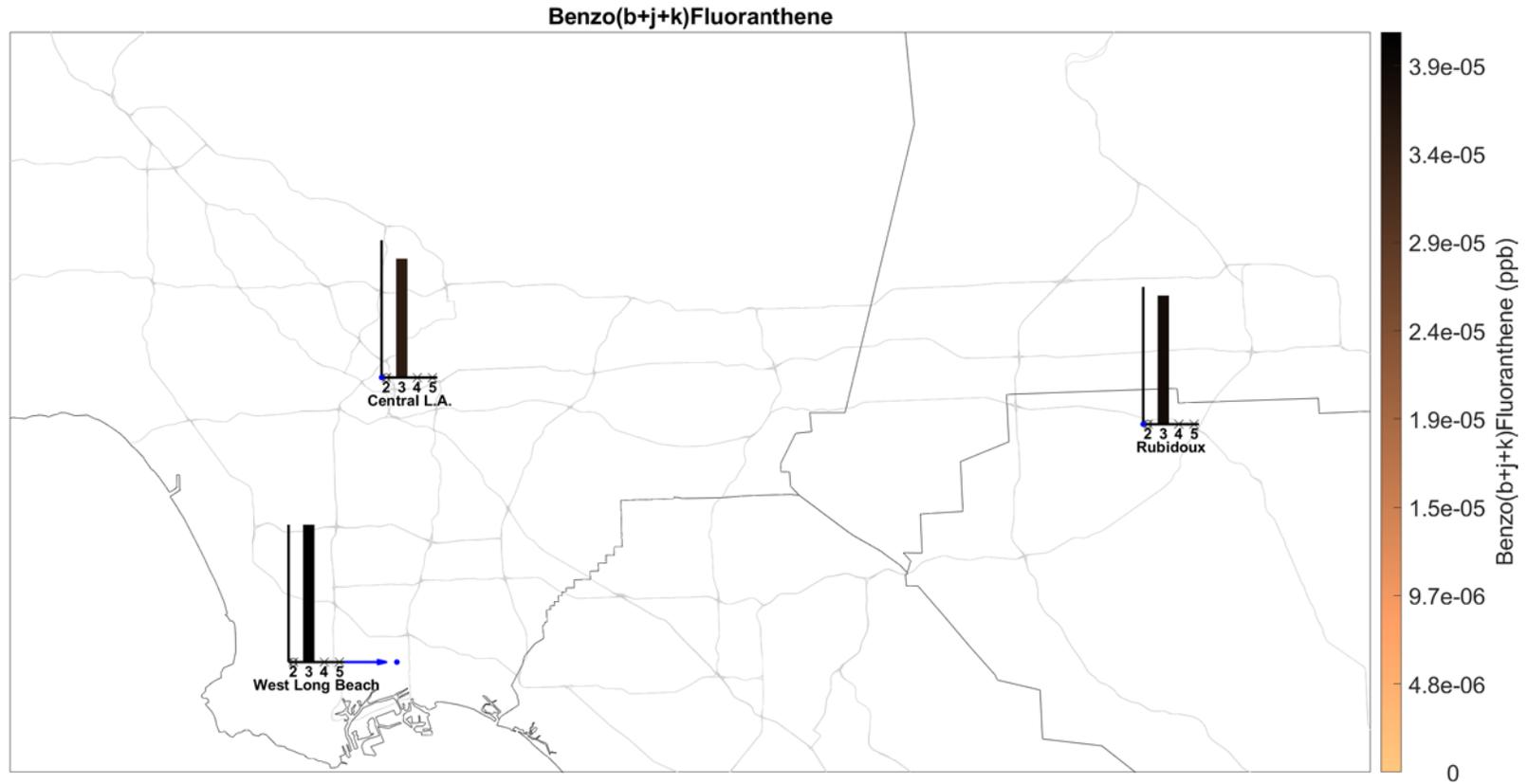
Benzo(b+j+k)Fluoranthene

**Table IV-84.** Ambient Concentrations (ng/m<sup>3</sup>) of Benzo(b+j+k)Fluoranthene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							0.363		0.393	0.419
95% CI LB							0.314		0.331	0.348
95% CI UB							0.414		0.458	0.491
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							1.75		1.58	2.09
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-164.** Annual Average Concentrations of Benzo(b+j+k)Fluoranthene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

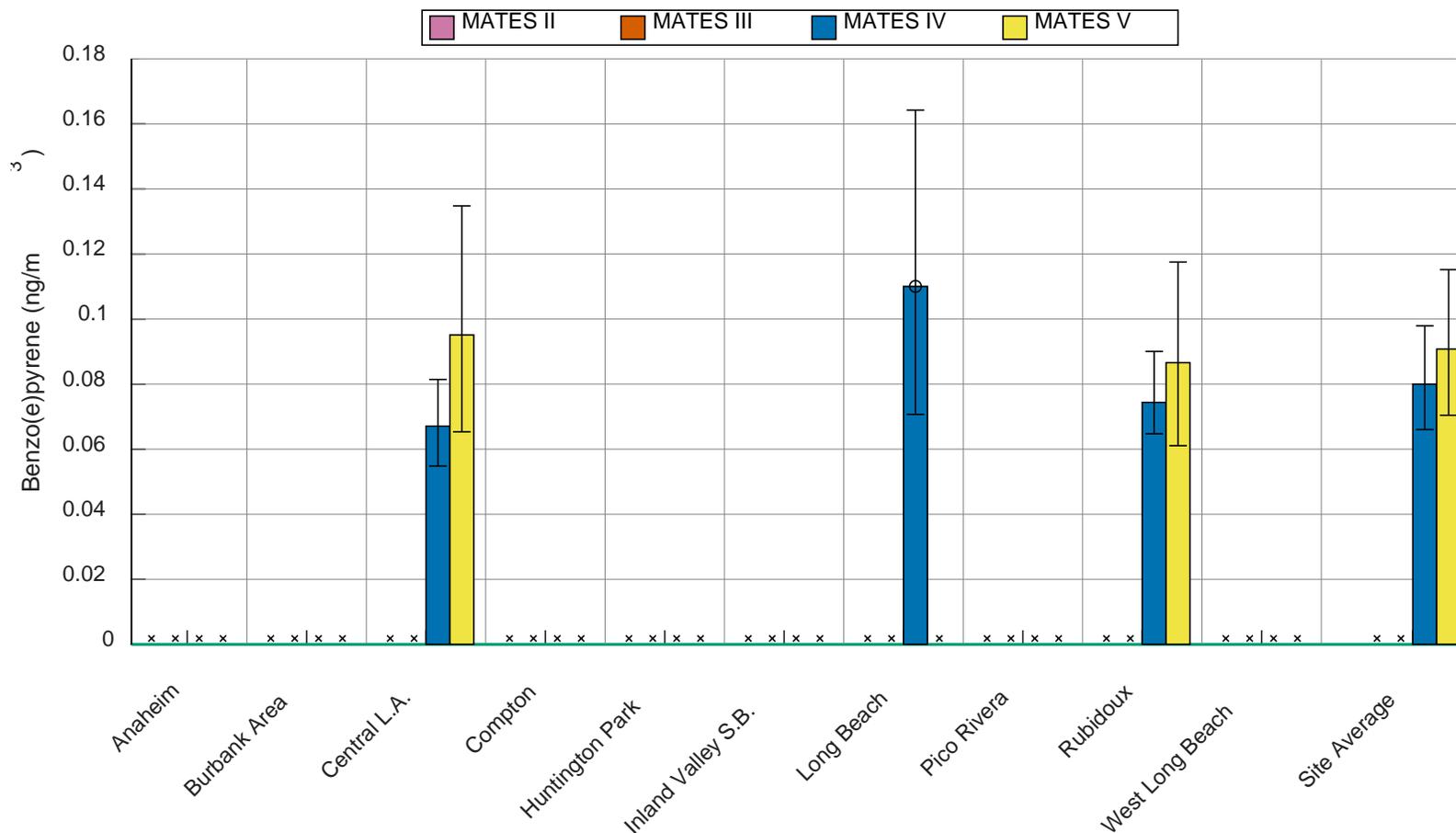


**Figure IV-165.** Geographic distribution of Benzo(b+j+k)Fluoranthene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

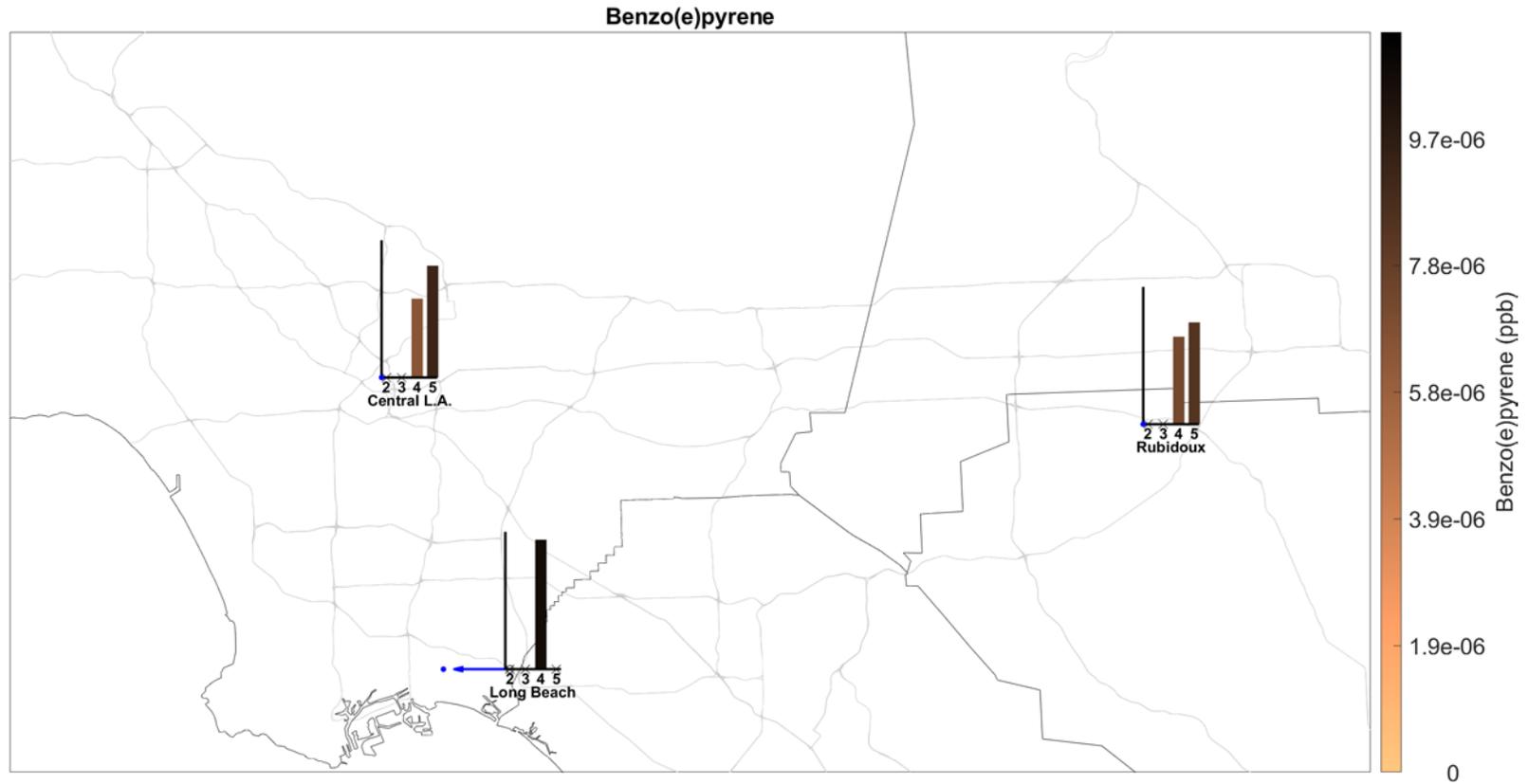
Benzo(e)pyrene

**Table IV-85.** Ambient Concentrations (ng/m<sup>3</sup>) of Benzo(e)pyrene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average						0.11	0.0671		0.0744	
95% CI LB						0.0707	0.0548		0.0647	
95% CI UB						0.164	0.0814		0.09	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						62.7	65.5		70.7	
Max						1.13	0.307		0.341	
MATES V										
Average							0.0951		0.0866	
95% CI LB							0.0653		0.0611	
95% CI UB							0.135		0.118	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		0	
Max							0.914		0.641	



**Figure IV-166.** Annual Average Concentrations of Benzo(e)pyrene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

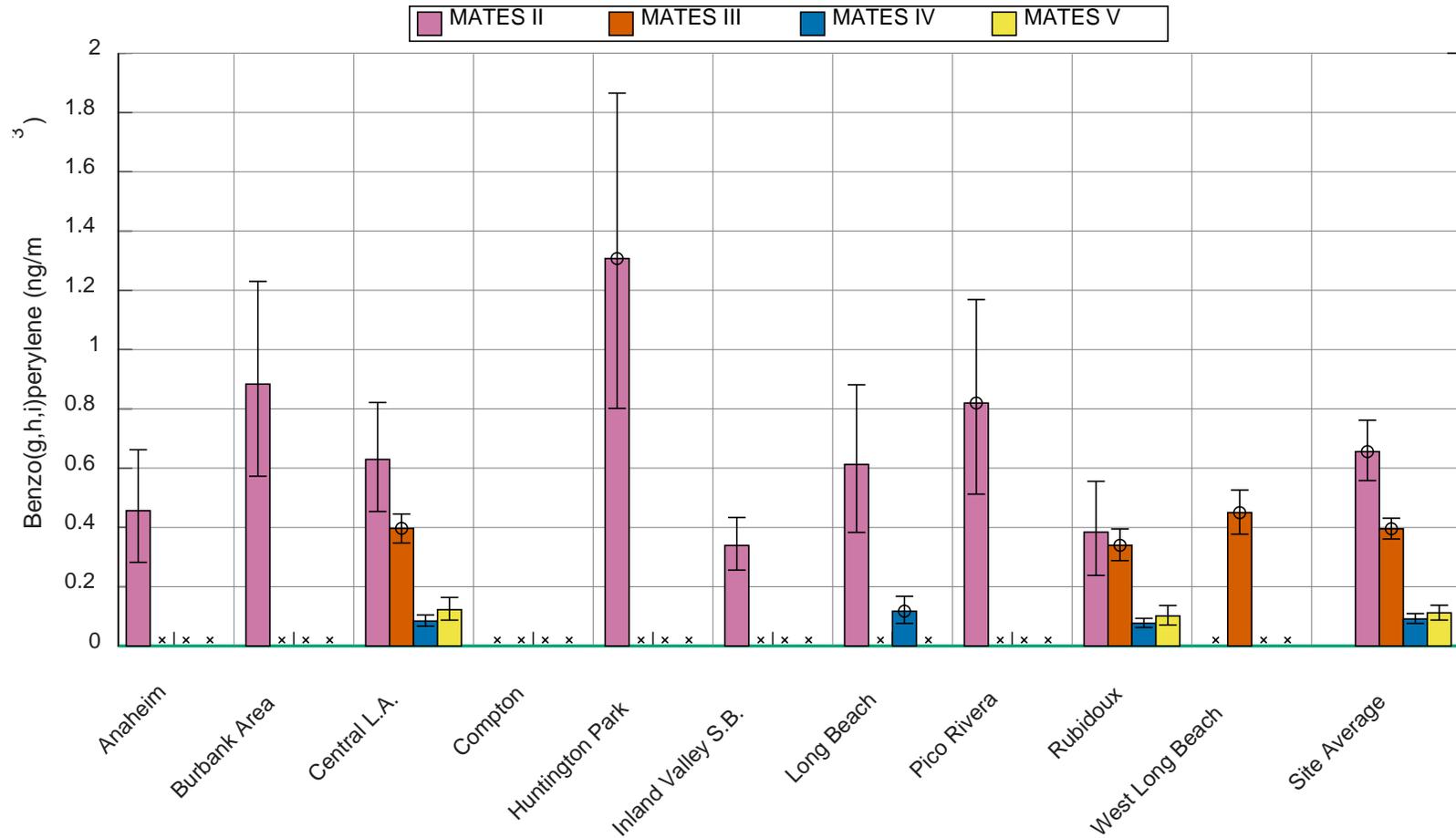


**Figure IV-167.** Geographic distribution of Benzo(e)pyrene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

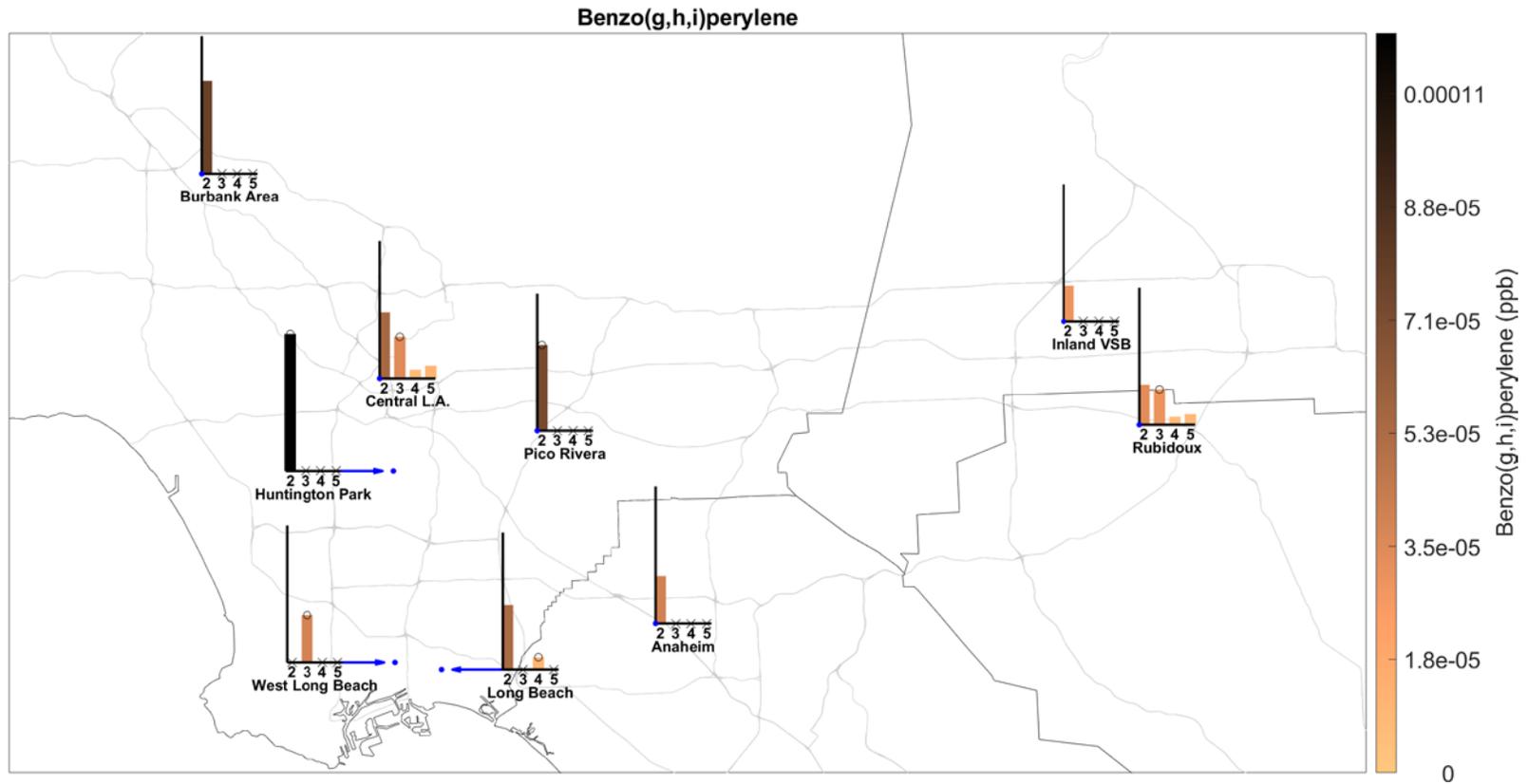
## Benzo(g,h,i)perylene

**Table IV-86.** Ambient Concentrations (ng/m<sup>3</sup>) of Benzo(g,h,i)perylene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.456	0.884		0.339	1.31	0.613	0.629	0.82	0.384	
95% CI LB	0.282	0.573		0.256	0.801	0.383	0.454	0.512	0.238	
95% CI UB	0.662	1.23		0.433	1.87	0.881	0.822	1.17	0.555	
N	31	31	0	31	24	31	31	22	30	0
% < MDL	3.2	0		3.2	0	0	0	0	6.7	
Max	2.4	3.7		1.1	4.3	3	2	3.2	2.2	
MATES III										
Average							0.397		0.34	0.45
95% CI LB							0.347		0.288	0.377
95% CI UB							0.445		0.395	0.526
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							1.38		1.33	1.98
MATES IV										
Average						0.117	0.0841		0.0767	
95% CI LB						0.0761	0.0669		0.0624	
95% CI UB						0.168	0.105		0.0932	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						52.9	32.8		55.2	
Max						0.79	0.39		0.327	
MATES V										
Average							0.122		0.101	
95% CI LB							0.0871		0.0707	
95% CI UB							0.164		0.136	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		1.7	
Max							0.772		0.694	



**Figure IV-168.** Annual Average Concentrations of Benzo(g,h,i)perylene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



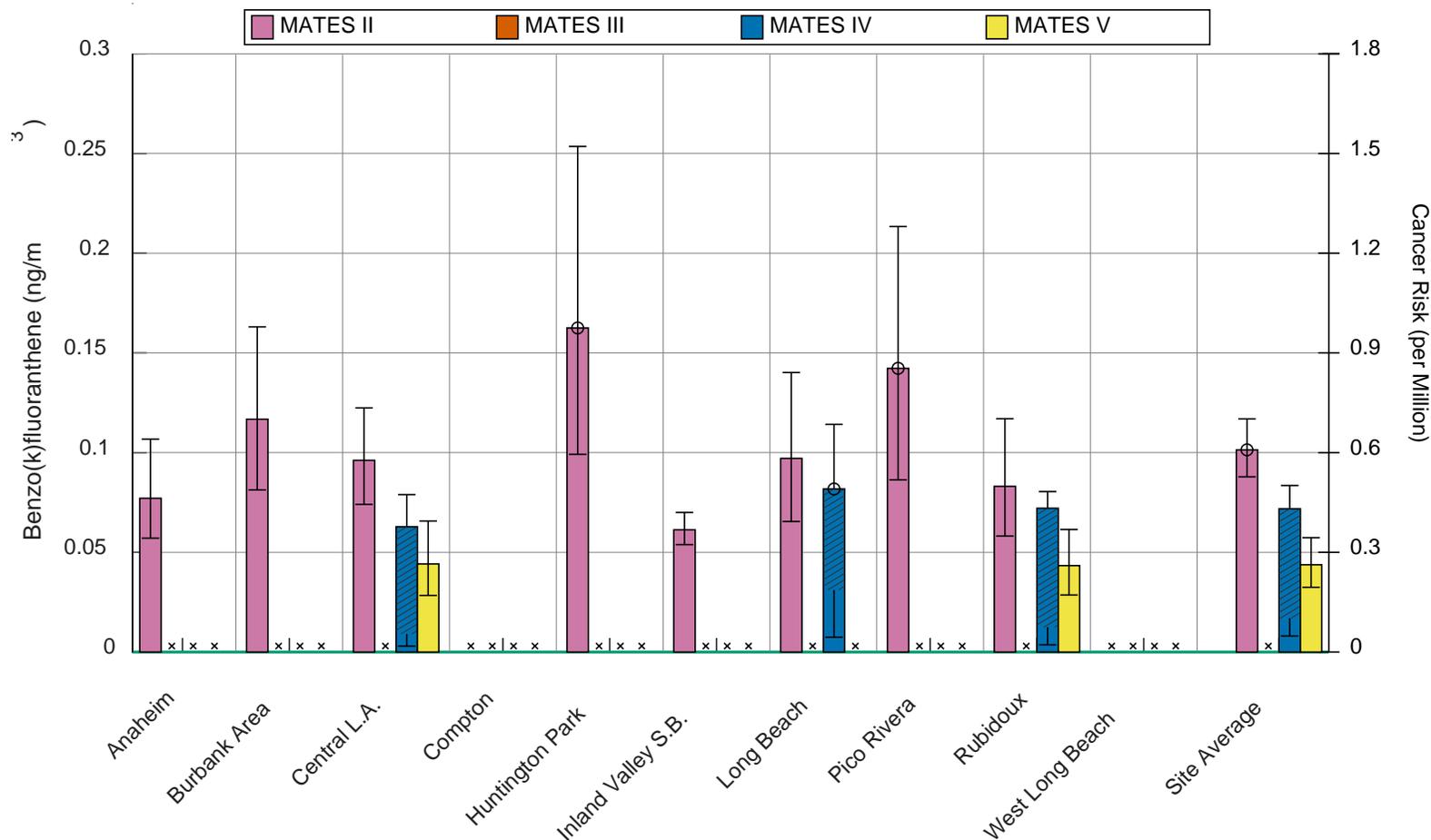
**Figure IV-169.** Geographic distribution of Benzo(g,h,i)perylene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Benzo(k)fluoranthene

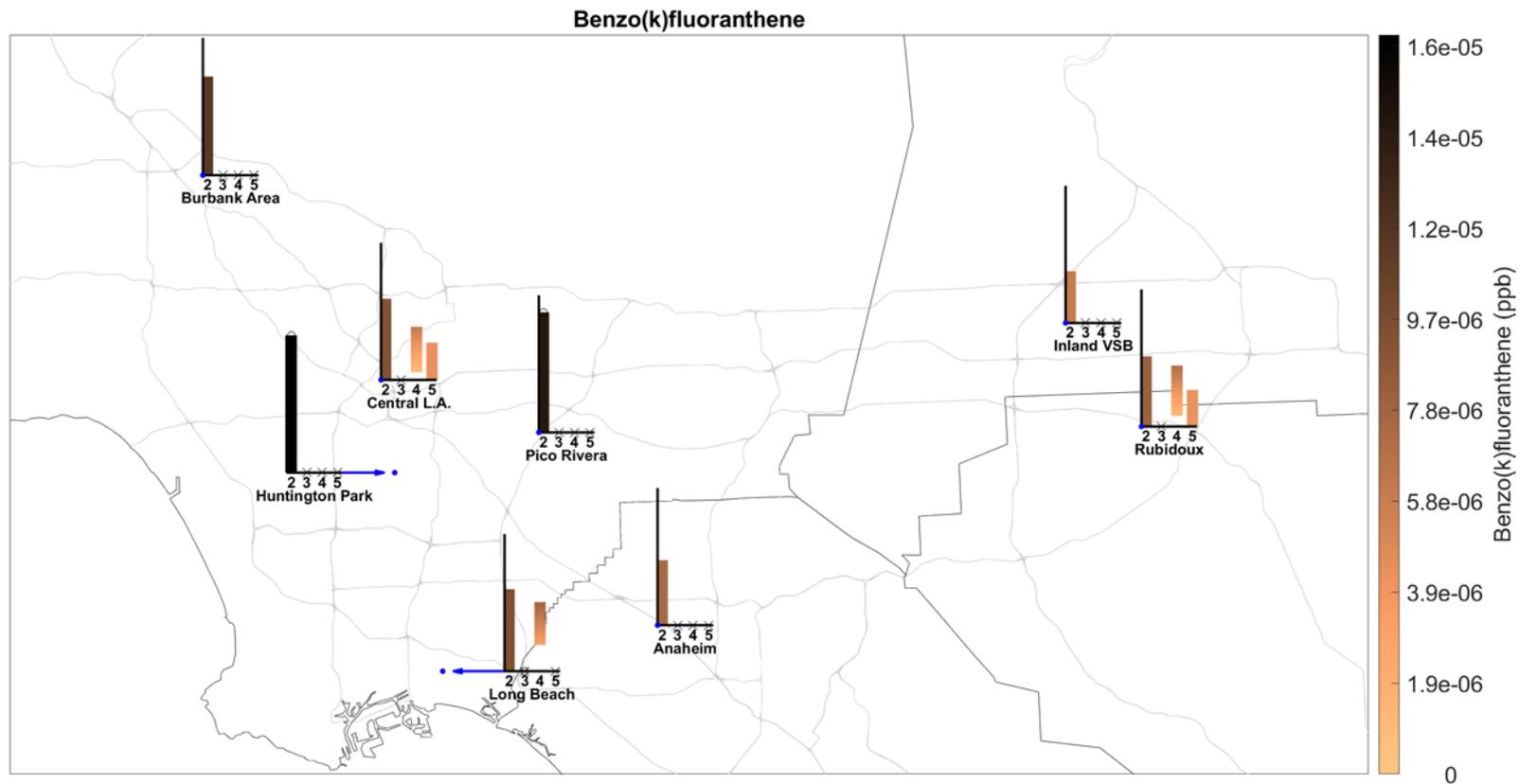
**Table IV-87.** Ambient Concentrations (ng/m<sup>3</sup>) of Benzo(k)fluoranthene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average	0.0771	0.117		0.0613	0.162	0.0971	0.0961	0.142	0.0831	
95% CI LB	0.0571	0.0813		0.0539	0.0992	0.0655	0.074	0.0864	0.0582	
95% CI UB	0.107	0.163		0.07	0.254	0.14	0.122	0.213	0.117	
N	31	31	0	31	24	31	31	22	30	0
% < MDL	67.7	54.8		61.3	37.5	58.1	41.9	45.5	56.7	
Max	0.45	0.65		0.15	0.83	0.65	0.37	0.74	0.515	
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average						0.0311, 0.0818 <sup>a</sup>	0.00903, 0.0628 <sup>a</sup>		0.0125, 0.0721 <sup>a</sup>	
95% CI LB						0.0074 <sup>a</sup>	0.00299 <sup>a</sup>		0.00363 <sup>a</sup>	
95% CI UB						0.114 <sup>a</sup>	0.0789 <sup>a</sup>		0.0805 <sup>a</sup>	
N	0	0	0	0	0	51 <sup>a</sup>	58 <sup>a</sup>	0	58 <sup>a</sup>	0
% < MDL						84.3 <sup>a</sup>	87.9 <sup>a</sup>		87.9 <sup>a</sup>	
Max						0.783 <sup>a</sup>	0.14 <sup>a</sup>		0.254 <sup>a</sup>	
MATES V										
Average							0.0442		0.0434	
95% CI LB							0.0284		0.0286	
95% CI UB							0.0657		0.0615	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							15.5		21.7	
Max							0.479		0.37	

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-170.** Annual Average Concentrations of Benzo(k)fluoranthene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

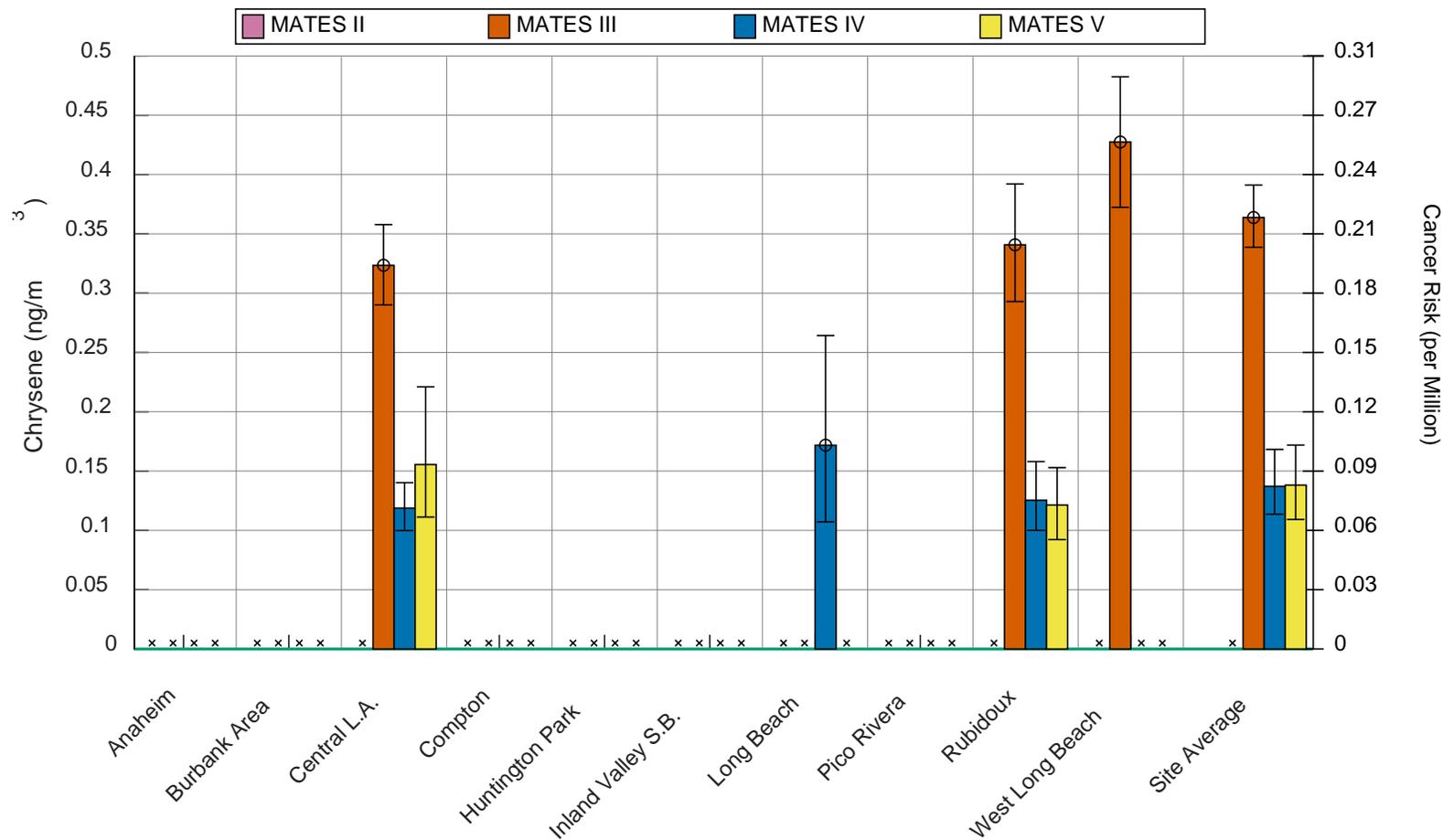


**Figure IV-171.** Geographic distribution of Benzo(k)fluoranthene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

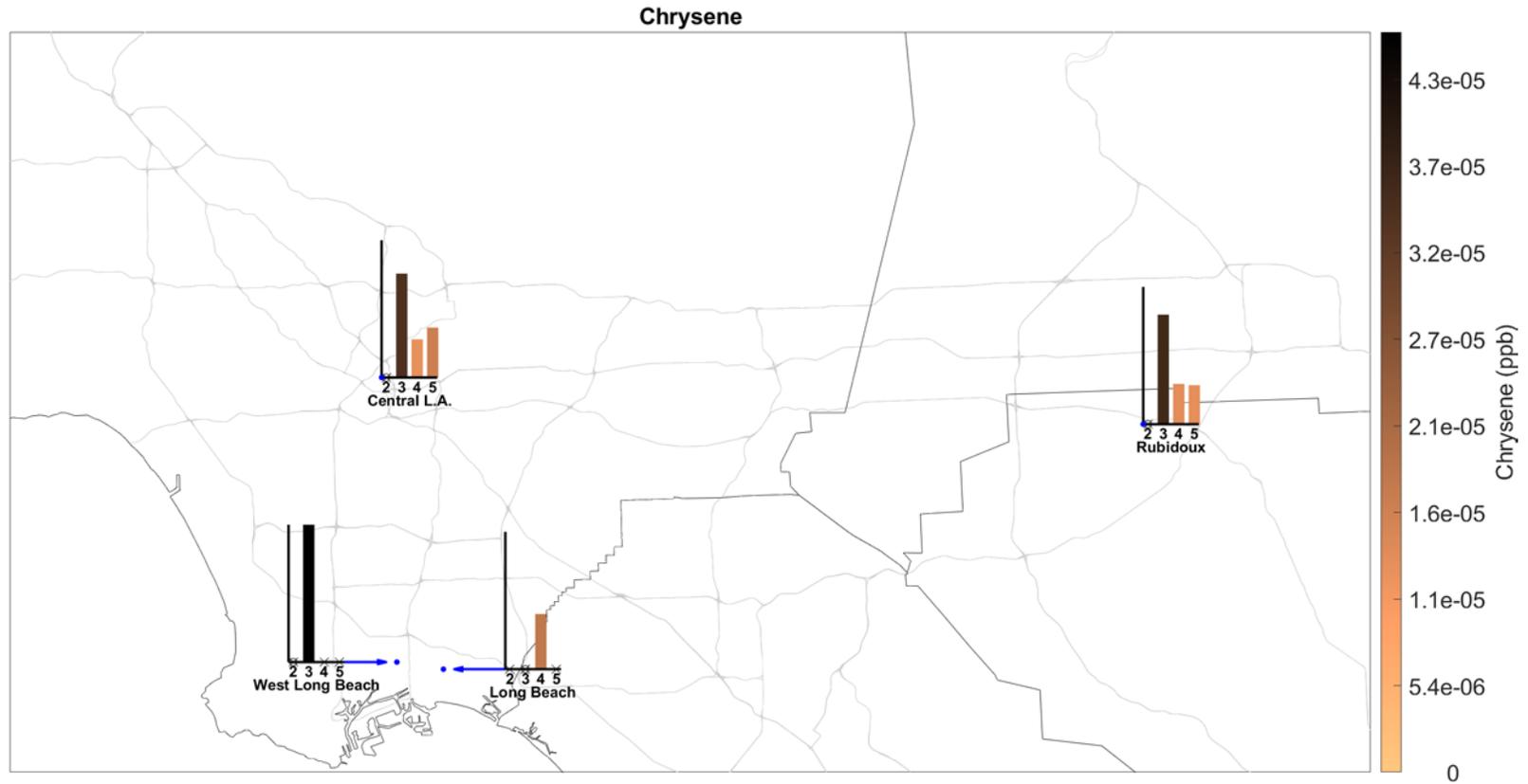
## Chrysene

**Table IV-88.** Ambient Concentrations (ng/m<sup>3</sup>) of Chrysene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							0.323		0.341	0.427
95% CI LB							0.29		0.293	0.372
95% CI UB							0.358		0.392	0.482
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							1.04		1.4	1.53
MATES IV										
Average						0.172	0.119		0.125	
95% CI LB						0.107	0.0998		0.1	
95% CI UB						0.264	0.14		0.158	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						9.8	5.2		6.9	
Max						2	0.434		0.781	
MATES V										
Average							0.156		0.121	
95% CI LB							0.111		0.0922	
95% CI UB							0.221		0.153	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		0	
Max							1.61		0.727	



**Figure IV-172.** Annual Average Concentrations of Chrysene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



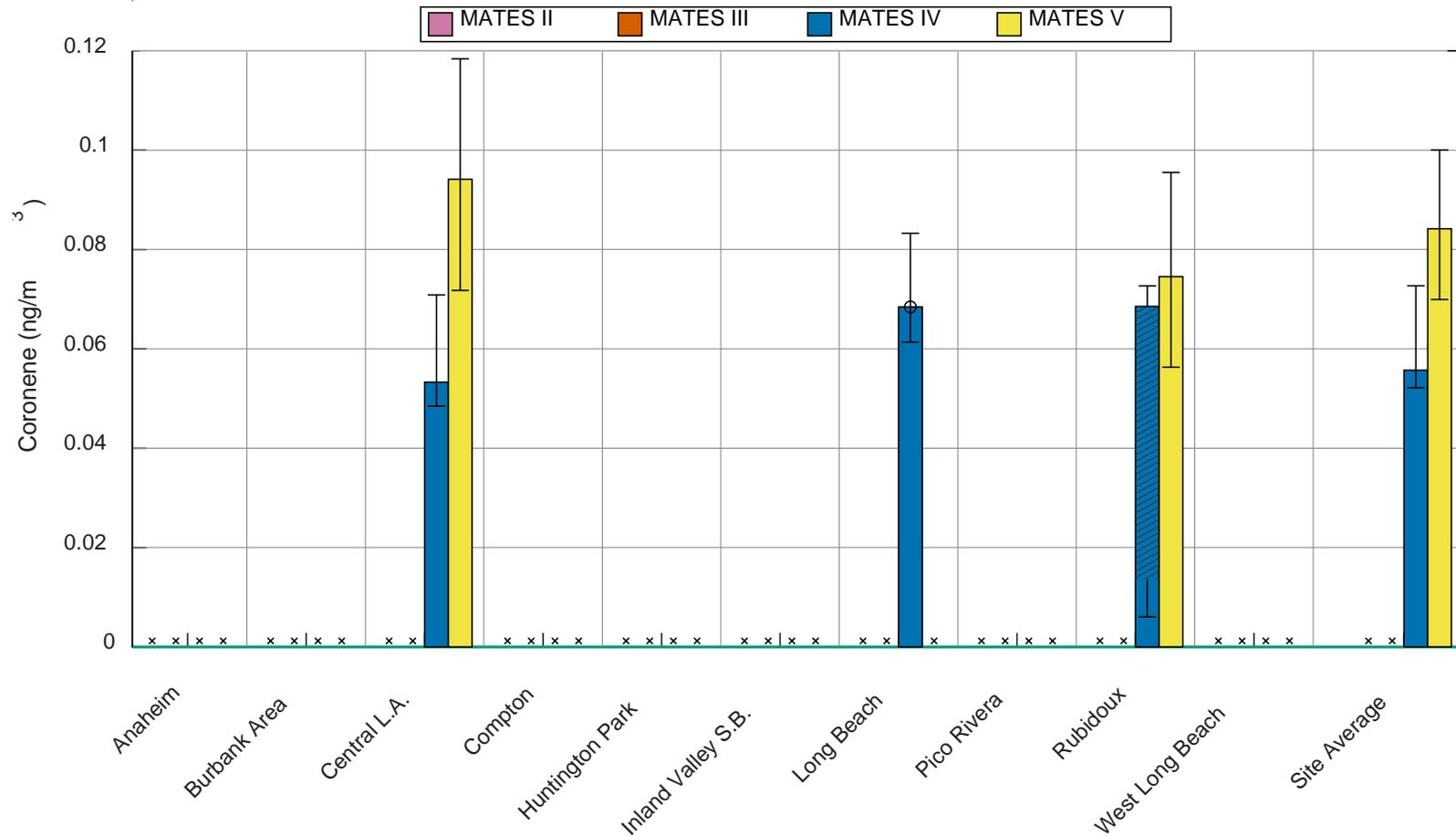
**Figure IV-173.** Geographic distribution of Chrysene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Coronene

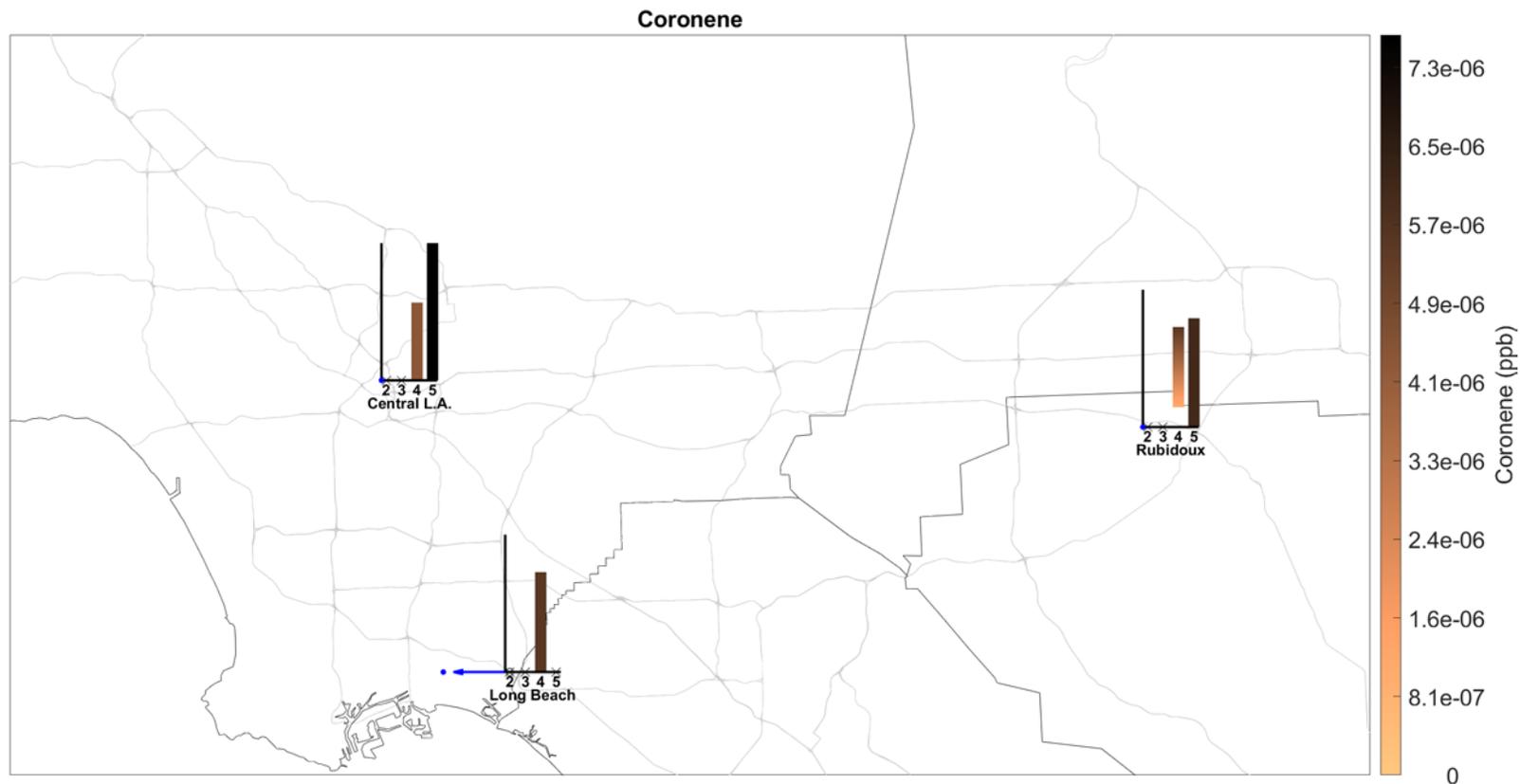
**Table IV-89.** Ambient Concentrations (ng/m<sup>3</sup>) of Coronene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average						0.0684	0.0533		0.0136, 0.0685 <sup>a</sup>	
95% CI LB						0.0614	0.0485		0.00605 <sup>a</sup>	
95% CI UB						0.0833	0.0709		0.0727 <sup>a</sup>	
N	0	0	0	0	0	51	58	0	58 <sup>a</sup>	0
% < MDL						76.5	72.4		82.8 <sup>a</sup>	
Max						0.253	0.177		0.125 <sup>a</sup>	
MATES V										
Average							0.0941		0.0745	
95% CI LB							0.0718		0.0563	
95% CI UB							0.118		0.0955	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		0	
Max							0.445		0.419	

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-174.** Annual Average Concentrations of Coronene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



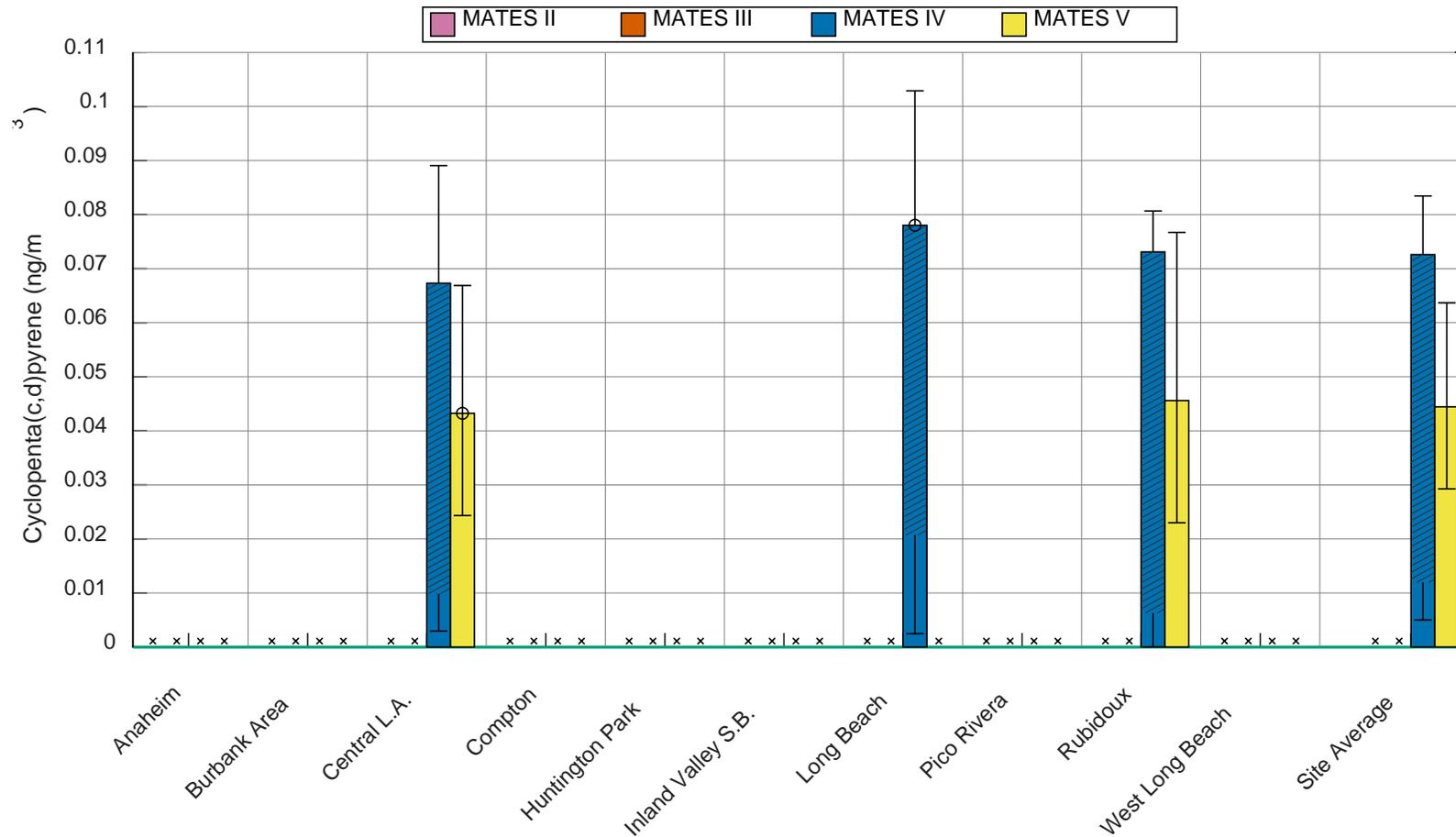
**Figure IV-175.** Geographic distribution of Coronene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Cyclopenta(c,d)pyrene

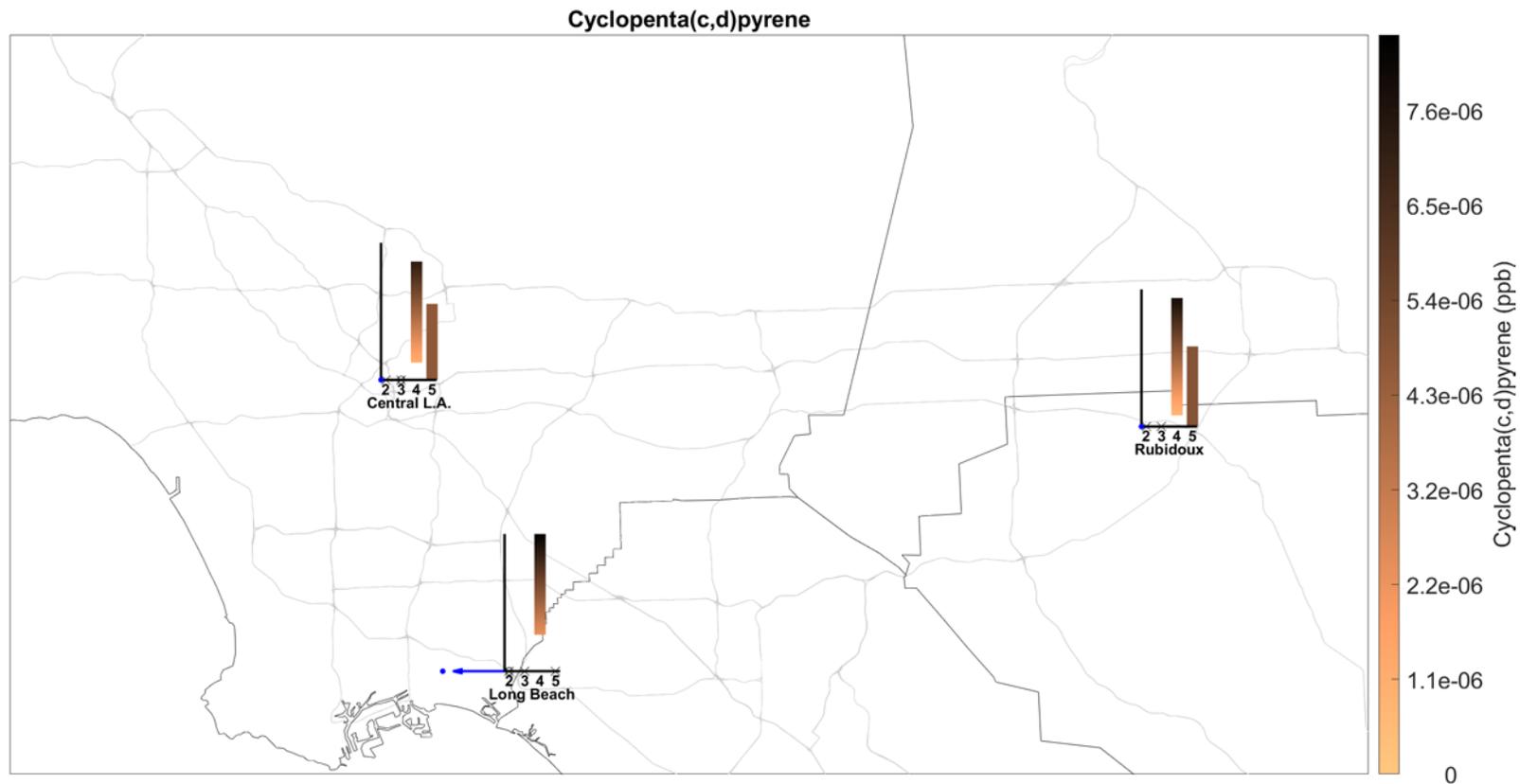
**Table IV-90.** Ambient Concentrations (ng/m<sup>3</sup>) of Cyclopenta(c,d)pyrene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average						0.0207, 0.078 <sup>a</sup>	0.00988, 0.0673 <sup>a</sup>		0.00632, 0.0731 <sup>a</sup>	
95% CI LB						0.00247 <sup>a</sup>	0.00297 <sup>a</sup>		0 <sup>a</sup>	
95% CI UB						0.103 <sup>a</sup>	0.089 <sup>a</sup>		0.0807 <sup>a</sup>	
N	0	0	0	0	0	51 <sup>a</sup>	58 <sup>a</sup>	0	58 <sup>a</sup>	0
% < MDL						90.2 <sup>a</sup>	87.9 <sup>a</sup>		94.8 <sup>a</sup>	
Max						0.586 <sup>a</sup>	0.166 <sup>a</sup>		0.17 <sup>a</sup>	
MATES V										
Average							0.0432		0.0456	
95% CI LB							0.0243		0.023	
95% CI UB							0.0669		0.0767	
N	0	0	0	0	0	0	57	0	59	0
% < MDL							24.6		28.8	
Max							0.411		0.701	

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-176.** Annual Average Concentrations of Cyclopenta(c,d)pyrene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



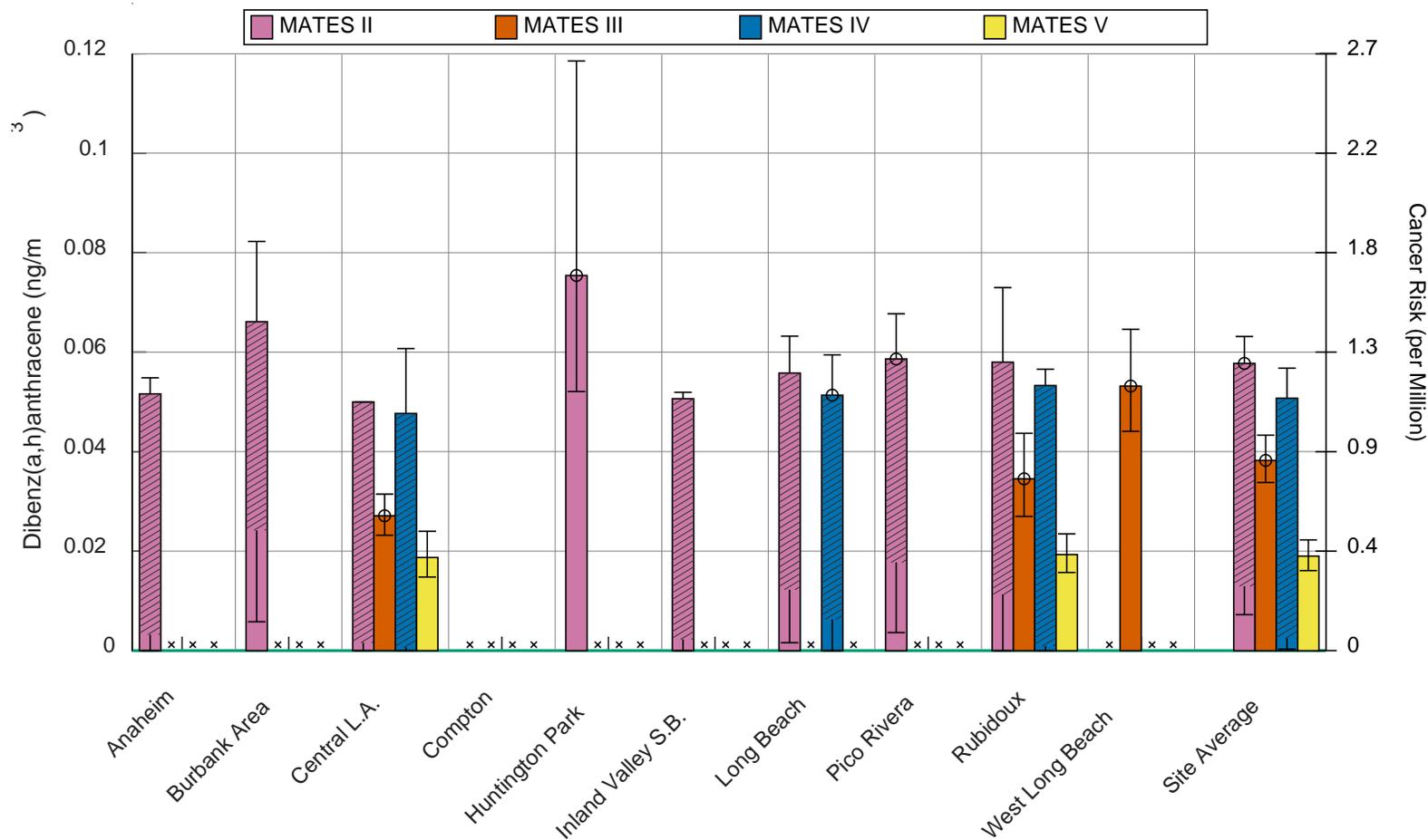
**Figure IV-177.** Geographic distribution of Cyclopenta(c,d)pyrene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Dibenz(a,h)anthracene

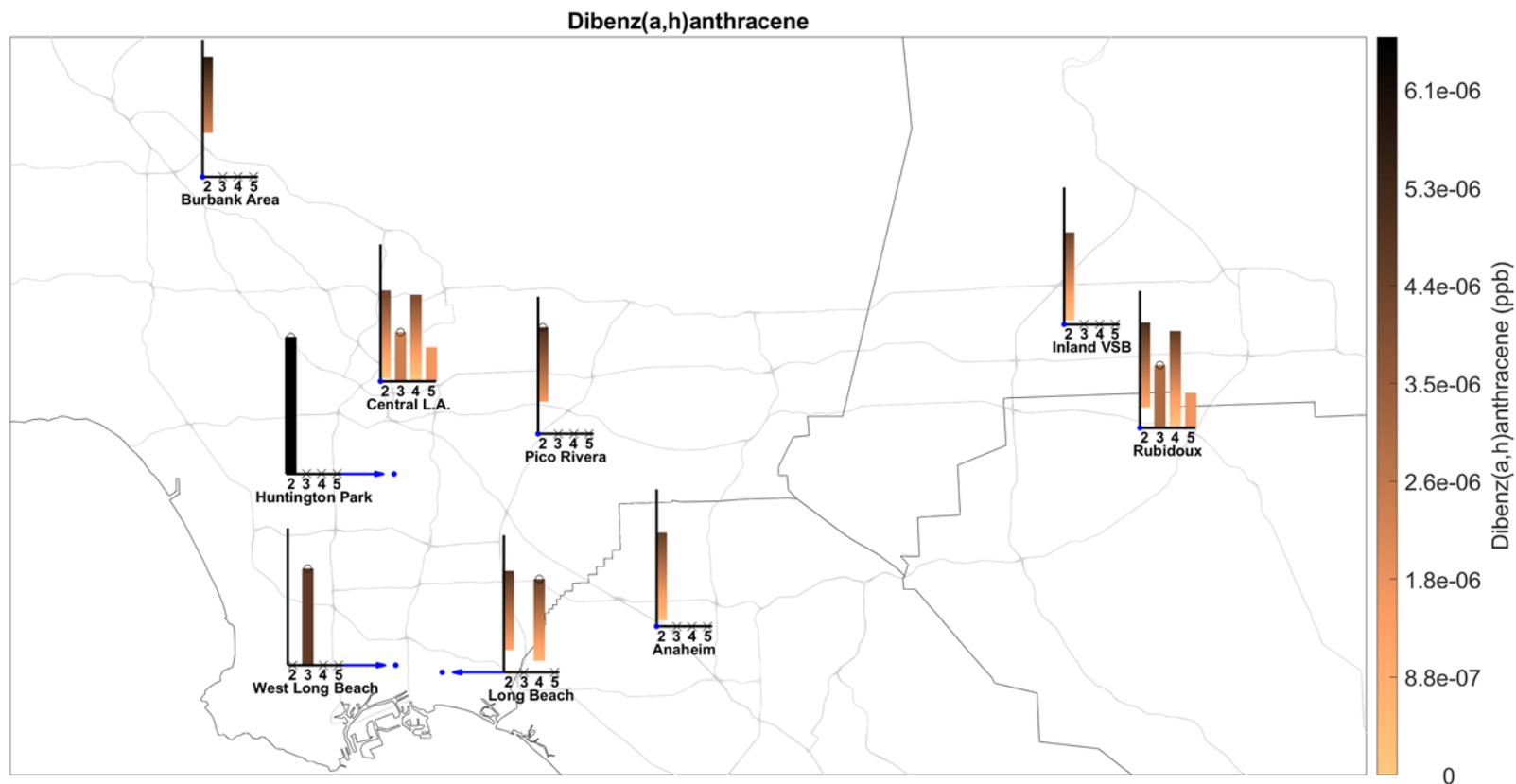
**Table IV-91.** Ambient Concentrations (ng/m<sup>3</sup>) of Dibenz(a,h)anthracene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0.00323, 0.0516 <sup>a</sup>	0.0242, 0.0661 <sup>a</sup>		0.00226, 0.0506 <sup>a</sup>	0.0754	0.0123, 0.0558 <sup>a</sup>	0.00161, 0.05 <sup>a</sup>	0.0177, 0.0586 <sup>a</sup>	0.0113, 0.058 <sup>a</sup>	
95% CI LB	0 <sup>a</sup>	0.00581 <sup>a</sup>		0 <sup>a</sup>	0.0521	0.00161 <sup>a</sup>	0 <sup>a</sup>	0.00364 <sup>a</sup>	0 <sup>a</sup>	
95% CI UB	0.0548 <sup>a</sup>	0.0823 <sup>a</sup>		0.0519 <sup>a</sup>	0.119	0.0632 <sup>a</sup>	0.05 <sup>a</sup>	0.0677 <sup>a</sup>	0.073 <sup>a</sup>	
N	31 <sup>a</sup>	31 <sup>a</sup>	0	31 <sup>a</sup>	24	31 <sup>a</sup>	31 <sup>a</sup>	22 <sup>a</sup>	30 <sup>a</sup>	0
% < MDL	96.8 <sup>a</sup>	83.9 <sup>a</sup>		96.8 <sup>a</sup>	75	87.1 <sup>a</sup>	96.8 <sup>a</sup>	81.8 <sup>a</sup>	93.3 <sup>a</sup>	
Max	0.1 <sup>a</sup>	0.2 <sup>a</sup>		0.07 <sup>a</sup>	0.49	0.14 <sup>a</sup>	0.05 <sup>a</sup>	0.12 <sup>a</sup>	0.26 <sup>a</sup>	
<b>MATES III</b>										
Average							0.0271		0.0345	0.0532
95% CI LB							0.0232		0.027	0.0441
95% CI UB							0.0315		0.0437	0.0646
N	0	0	0	0	0	0	129	0	128	128
% < MDL							1.6		2.3	0
Max							0.13		0.396	0.529
<b>MATES IV</b>										
Average						0.00629, 0.0514 <sup>a</sup>	0.000664, 0.0477 <sup>a</sup>		0.000903, 0.0533 <sup>a</sup>	
95% CI LB						0 <sup>a</sup>	0 <sup>a</sup>		0 <sup>a</sup>	
95% CI UB						0.0595 <sup>a</sup>	0.0607 <sup>a</sup>		0.0566 <sup>a</sup>	
N	0	0	0	0	0	51 <sup>a</sup>	58 <sup>a</sup>	0	58 <sup>a</sup>	0
% < MDL						94.1 <sup>a</sup>	98.3 <sup>a</sup>		98.3 <sup>a</sup>	
Max						0.217 <sup>a</sup>	0.0385 <sup>a</sup>		0.0524 <sup>a</sup>	
<b>MATES V</b>										
Average							0.0187		0.0193	
95% CI LB							0.0148		0.0157	
95% CI UB							0.024		0.0235	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							63.8		61.7	
Max							0.121		0.101	

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-178.** Annual Average Concentrations of Dibenz(a,h)anthracene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

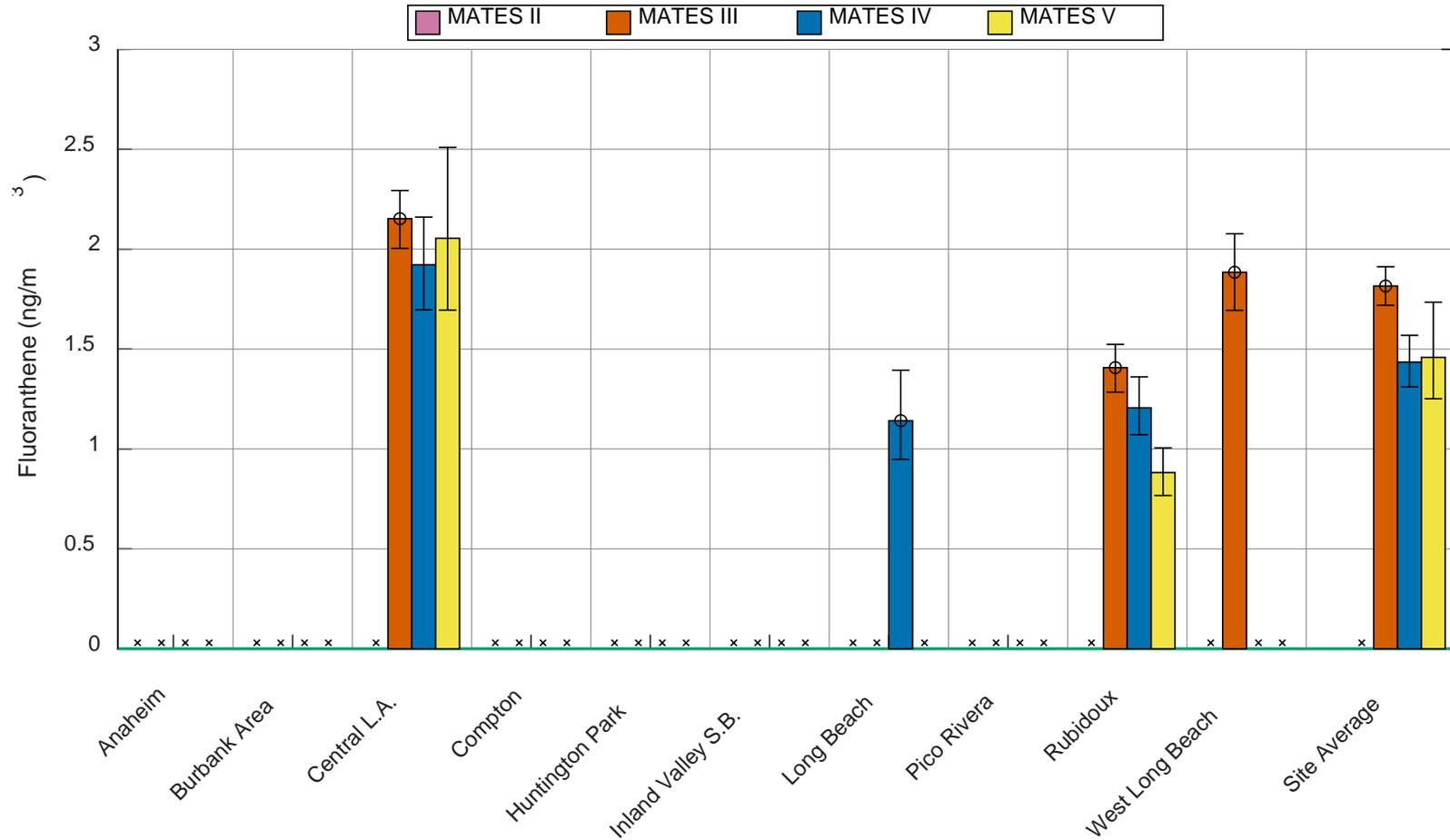


**Figure IV-179.** Geographic distribution of Dibenz(a,h)anthracene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

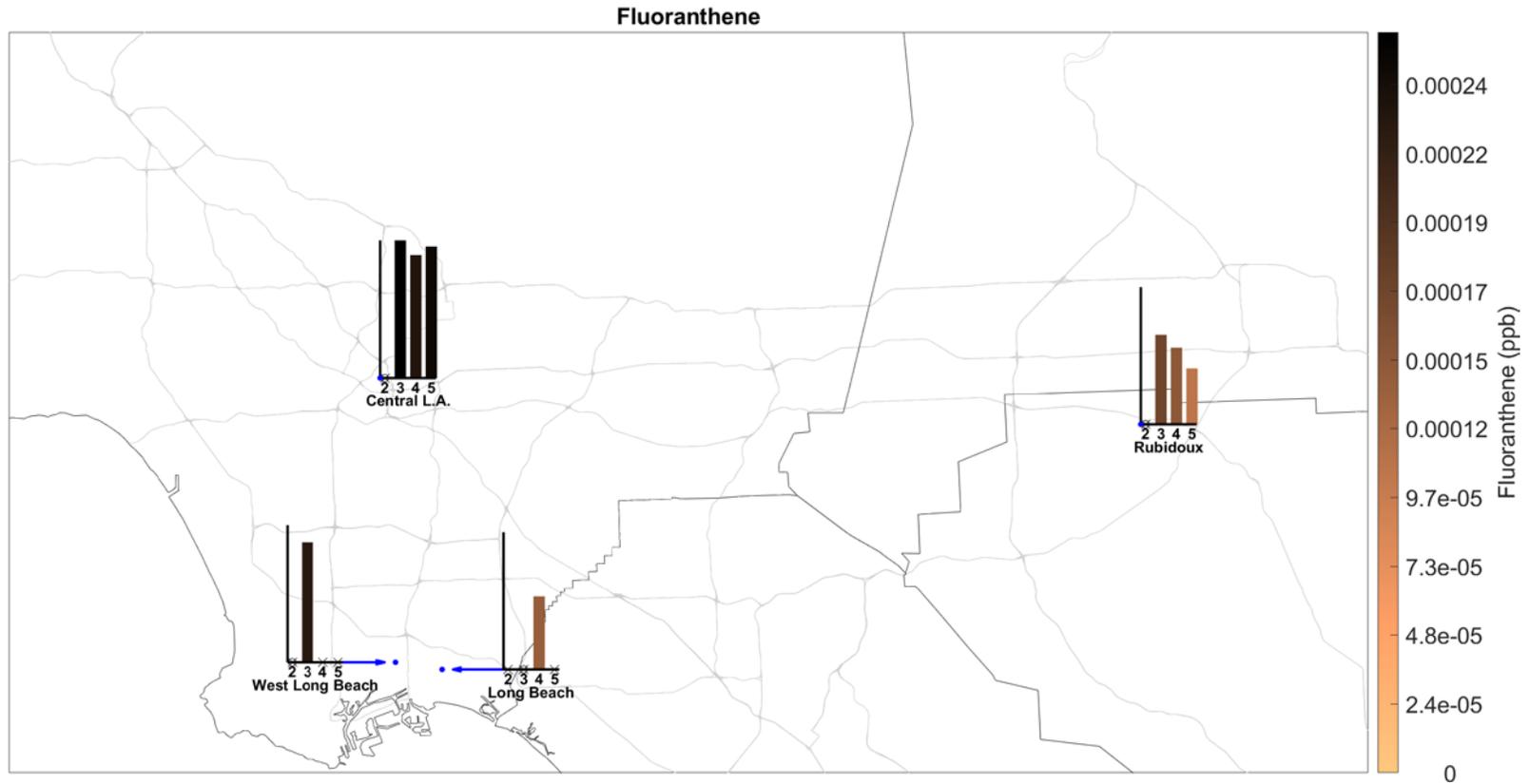
## Fluoranthene

**Table IV-92.** Ambient Concentrations (ng/m<sup>3</sup>) of Fluoranthene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							2.15		1.41	1.88
95% CI LB							2		1.28	1.69
95% CI UB							2.29		1.52	2.08
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							4.64		3.09	4.92
MATES IV										
Average						1.14	1.92		1.21	
95% CI LB						0.948	1.7		1.07	
95% CI UB						1.39	2.16		1.36	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						0	0		0	
Max						5.71	4.56		3.31	
MATES V										
Average							2.05		0.882	
95% CI LB							1.69		0.767	
95% CI UB							2.51		1.01	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		0	
Max							11.1		2.88	



**Figure IV-180.** Annual Average Concentrations of Fluoranthene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

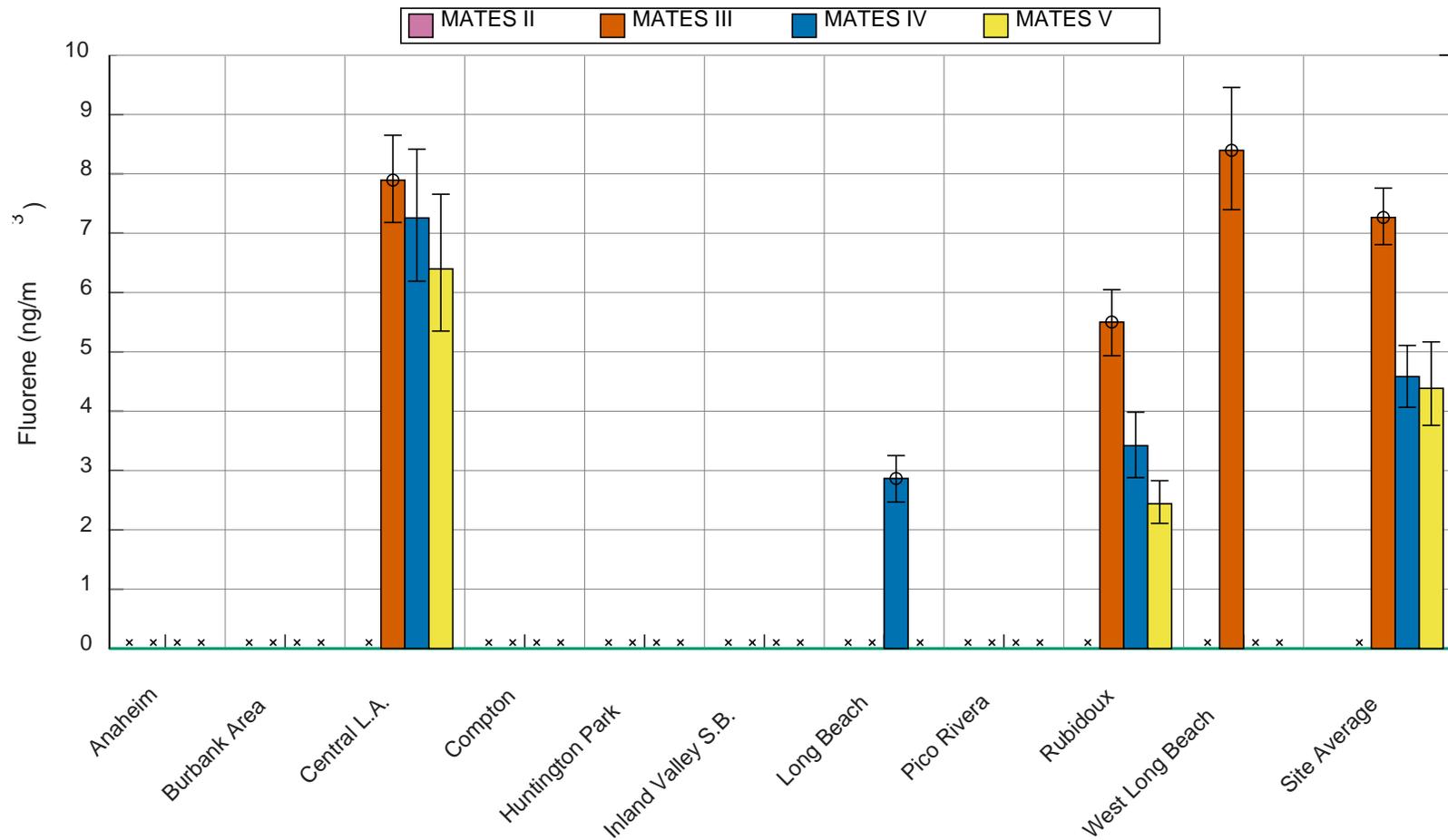


**Figure IV-181.** Geographic distribution of Fluoranthene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

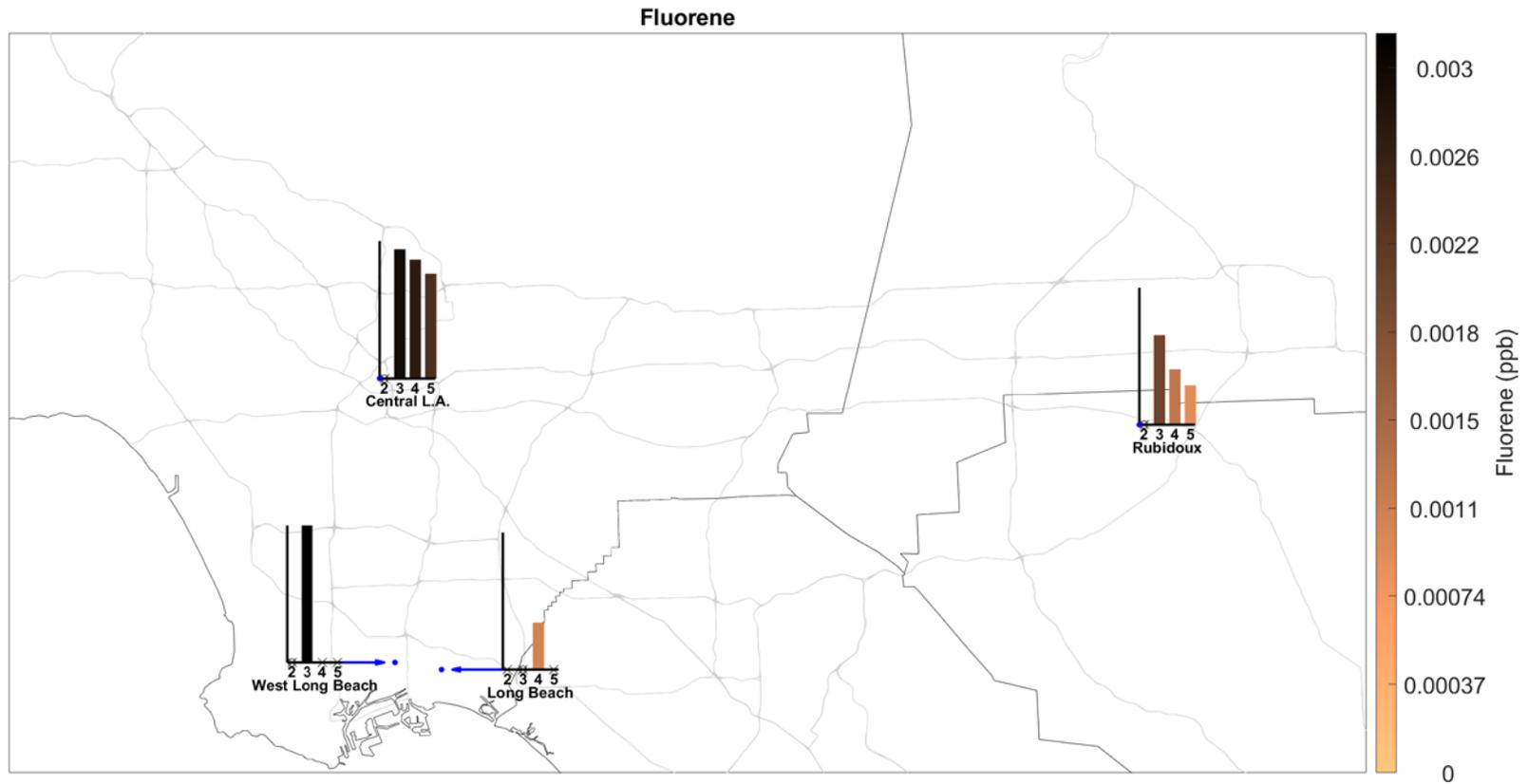
Fluorene

**Table IV-93.** Ambient Concentrations (ng/m<sup>3</sup>) of Fluorene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							7.89		5.5	8.4
95% CI LB							7.18		4.93	7.4
95% CI UB							8.65		6.05	9.46
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							25.8		15.1	27.9
MATES IV										
Average						2.87	7.26		3.42	
95% CI LB						2.47	6.19		2.88	
95% CI UB						3.25	8.41		3.98	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						5.9	1.7		13.8	
Max						5.4	19.3		8.67	
MATES V										
Average							6.4		2.44	
95% CI LB							5.35		2.11	
95% CI UB							7.66		2.83	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		0	
Max							29.5		9.79	



**Figure IV-182.** Annual Average Concentrations of Fluorene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

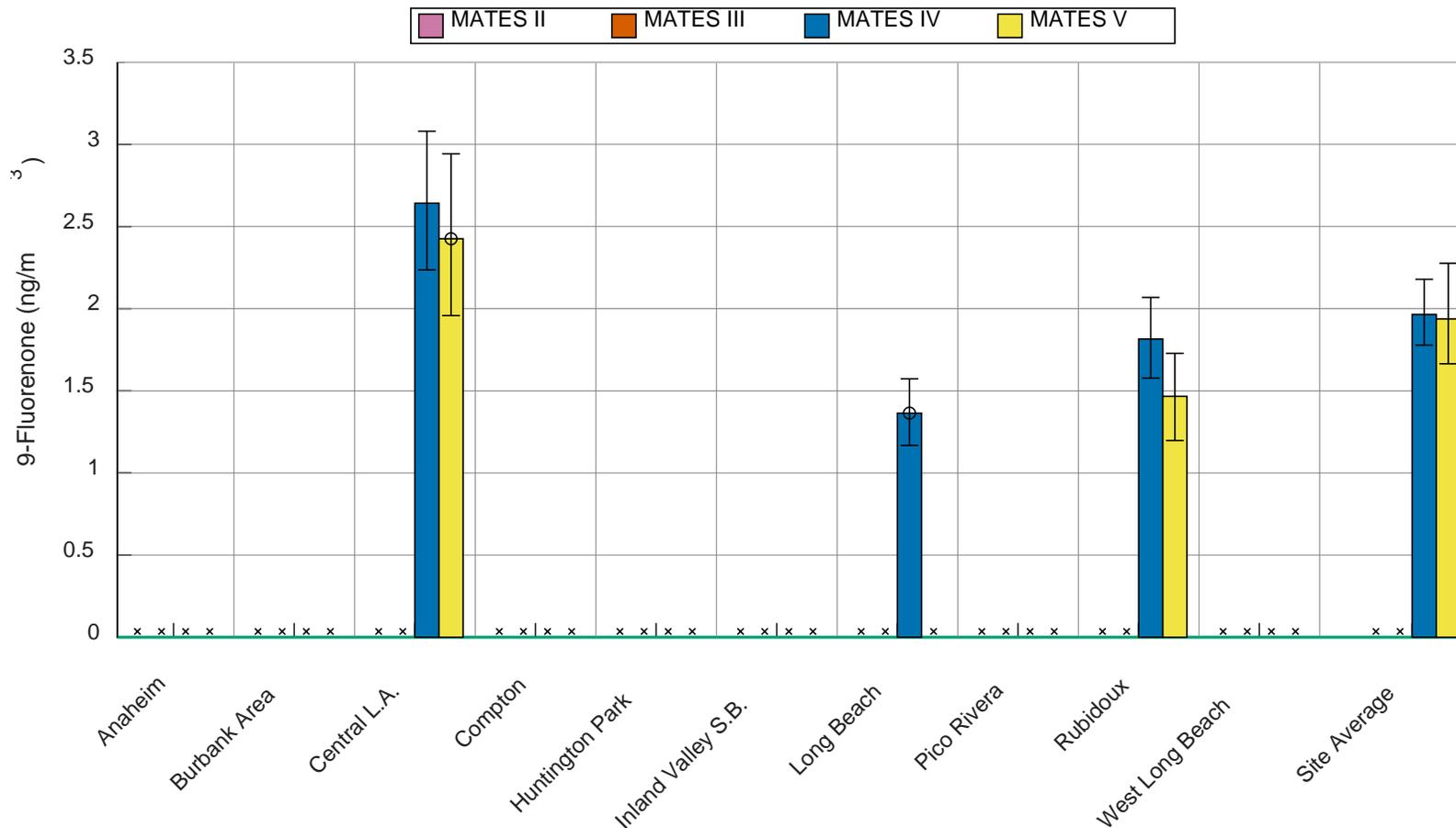


**Figure IV-183.** Geographic distribution of Fluorene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

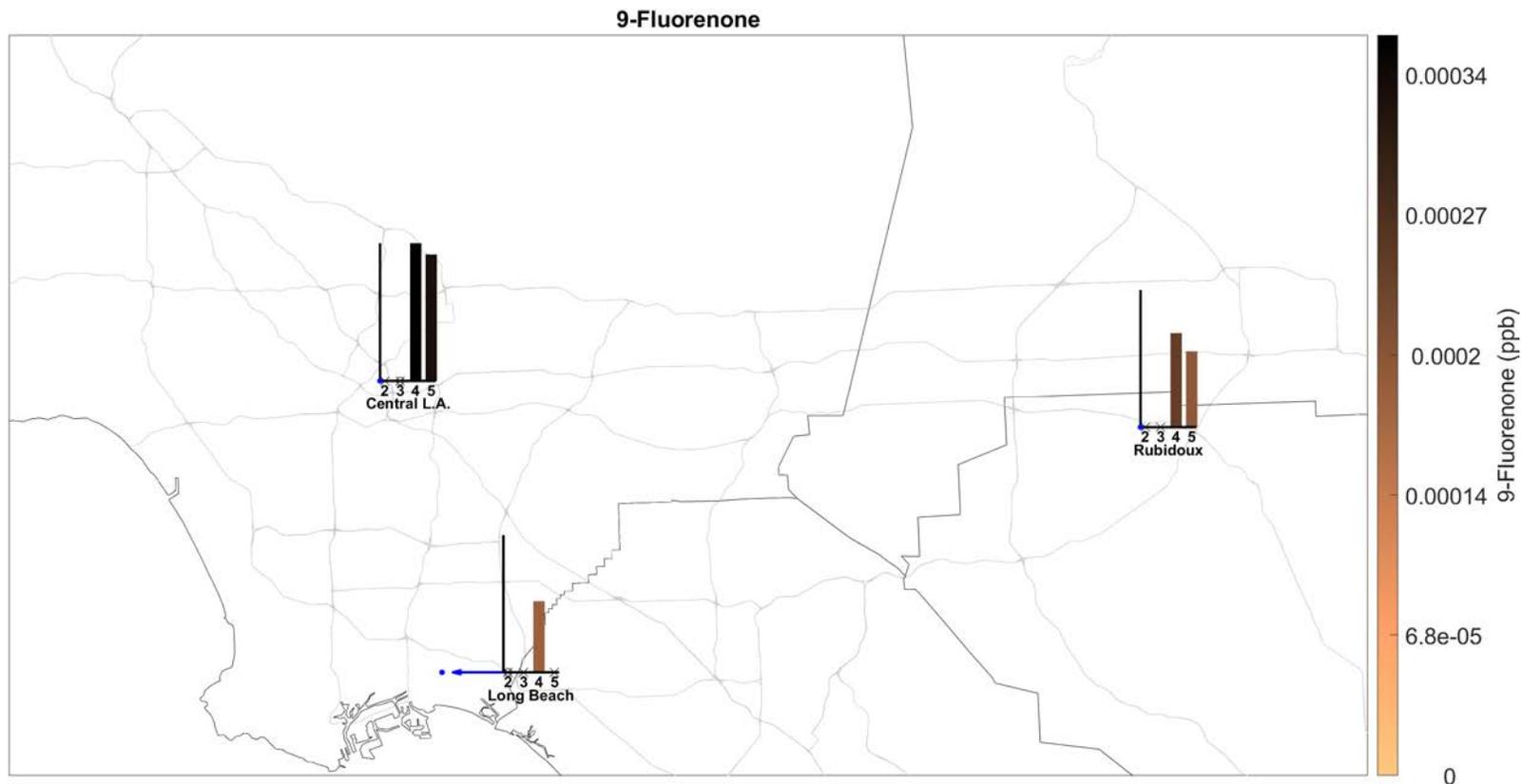
9-Fluorenone

**Table IV-94.** Ambient Concentrations (ng/m<sup>3</sup>) of 9-Fluorenone from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average						1.36	2.64		1.81	
95% CI LB						1.17	2.24		1.58	
95% CI UB						1.57	3.08		2.07	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						0	0		0	
Max						3.31	8.14		4.61	
MATES V										
Average							2.43		1.47	
95% CI LB							1.96		1.2	
95% CI UB							2.94		1.73	
N	0	0	0	0	0	0	57	0	59	0
% < MDL							10.5		13.6	
Max							10.3		5.33	



**Figure IV-184.** Annual Average Concentrations of 9-Fluorenone in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

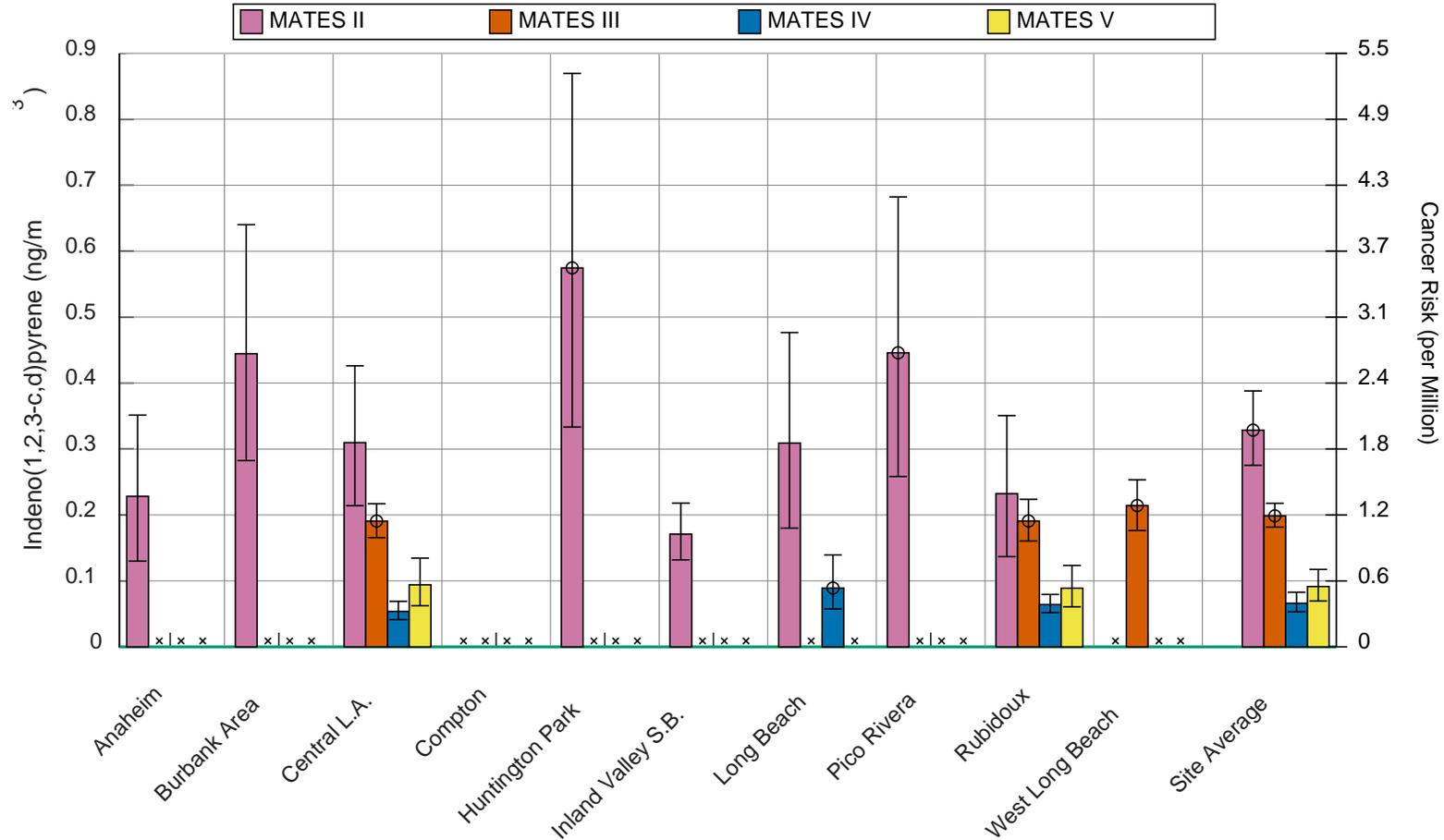


**Figure IV-185.** Geographic distribution of 9-Fluorenone from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

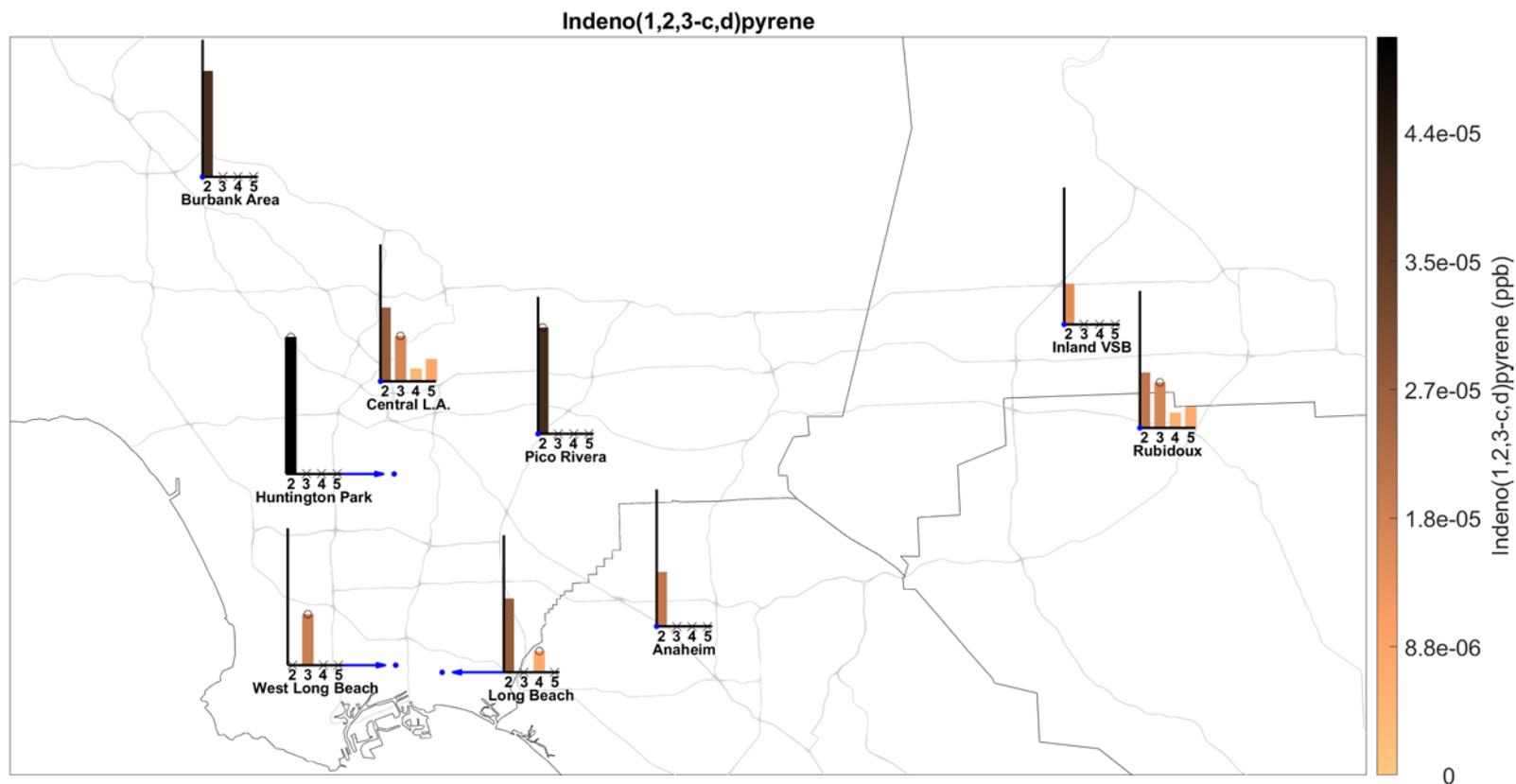
Indeno(1,2,3-c,d)pyrene

**Table IV-95.** Ambient Concentrations (ng/m<sup>3</sup>) of Indeno(1,2,3-c,d)pyrene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	0.228	0.445		0.171	0.575	0.309	0.31	0.446	0.232	
95% CI LB	0.13	0.283		0.132	0.333	0.18	0.214	0.258	0.137	
95% CI UB	0.351	0.64		0.218	0.87	0.477	0.426	0.682	0.351	
N	31	31	0	31	24	31	31	22	30	0
% < MDL	29	6.5		9.7	0	19.4	12.9	4.5	23.3	
Max	1.7	2.5		0.52	2.9	2.2	1.5	2.3	1.65	
<b>MATES III</b>										
Average							0.191		0.191	0.214
95% CI LB							0.166		0.161	0.177
95% CI UB							0.217		0.224	0.253
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							0.884		1.11	1.25
<b>MATES IV</b>										
Average						0.0892	0.0538		0.0642	
95% CI LB						0.0575	0.0414		0.0518	
95% CI UB						0.139	0.0691		0.0796	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						66.7	65.5		63.8	
Max						0.966	0.302		0.316	
<b>MATES V</b>										
Average							0.0941		0.0891	
95% CI LB							0.0625		0.0608	
95% CI UB							0.135		0.123	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							5.2		8.3	
Max							0.89		0.687	



**Figure IV-186.** Annual Average Concentrations of Indeno(1,2,3-c,d)pyrene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

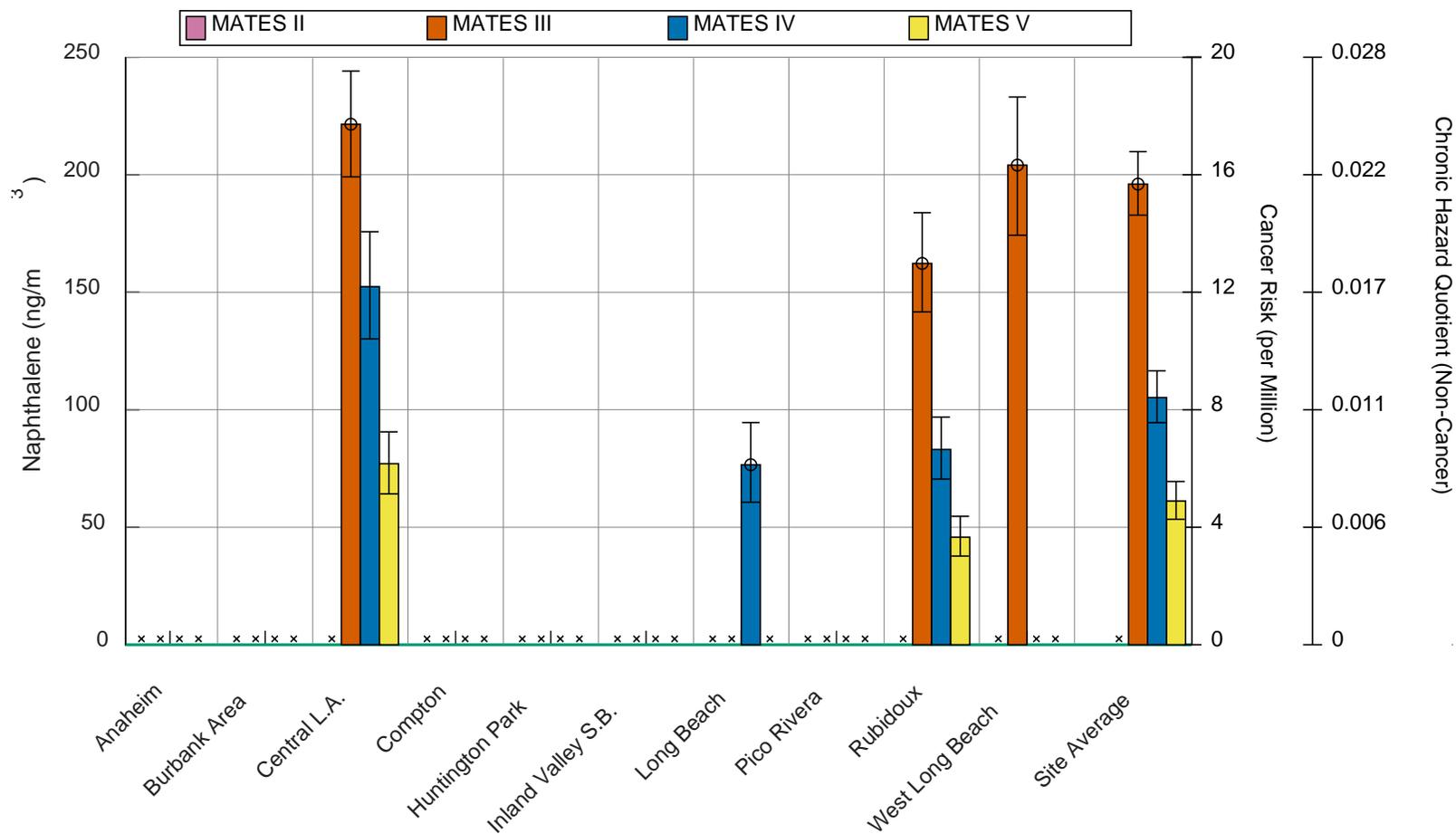


**Figure IV-187.** Geographic distribution of Indeno(1,2,3-c,d)pyrene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

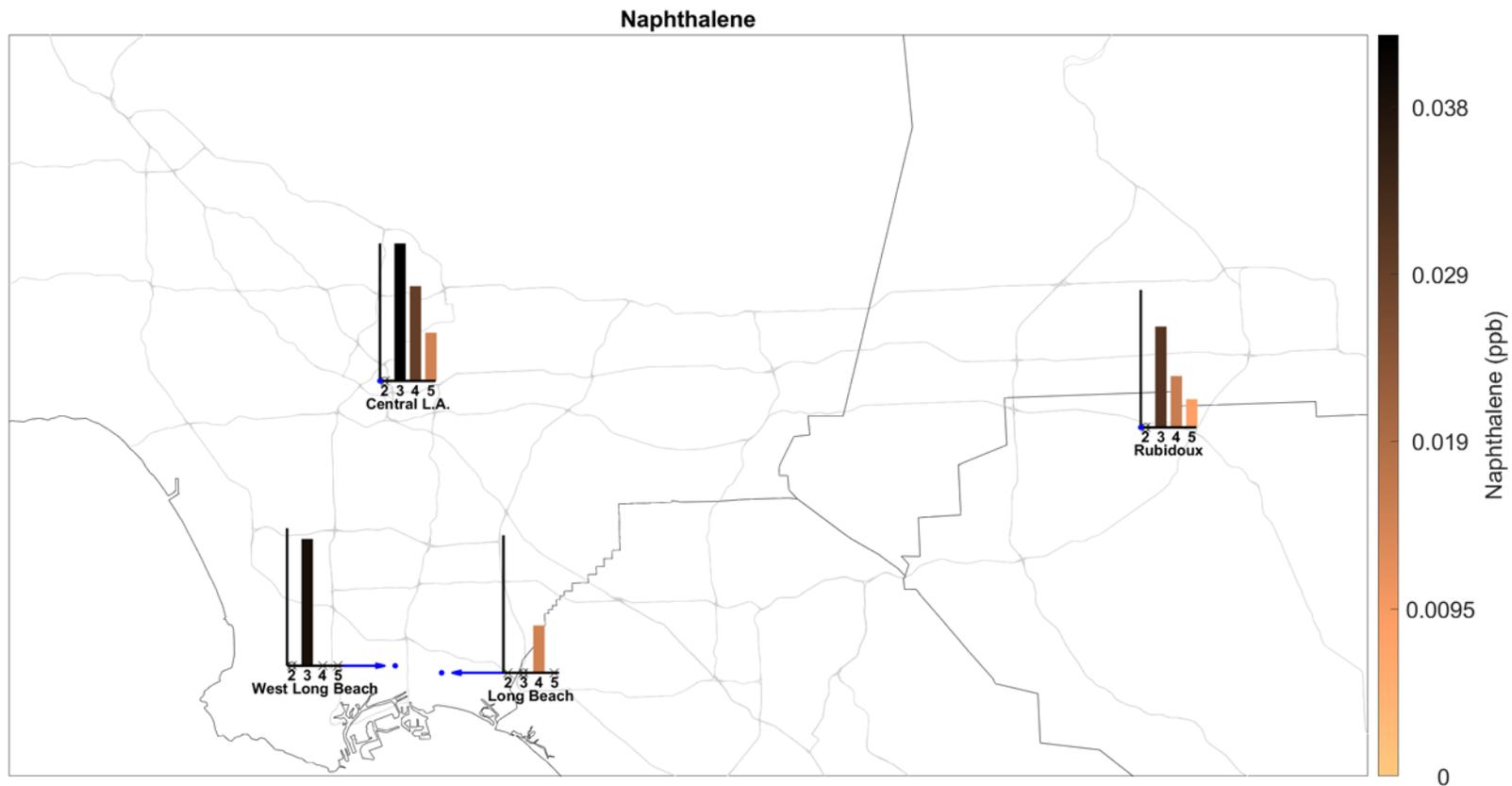
Naphthalene

**Table IV-96.** Ambient Concentrations (ng/m<sup>3</sup>) of Naphthalene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							221		162	204
95% CI LB							199		142	174
95% CI UB							244		184	233
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							701		534	817
MATES IV										
Average						76.6	152		83.1	
95% CI LB						60.6	130		70.5	
95% CI UB						94.5	176		96.9	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						0	0		0	
Max						270	338		245	
MATES V										
Average							77		45.8	
95% CI LB							64.2		37.7	
95% CI UB							90.6		54.7	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		0	
Max							195		181	



**Figure IV-188.** Annual Average Concentrations of Naphthalene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



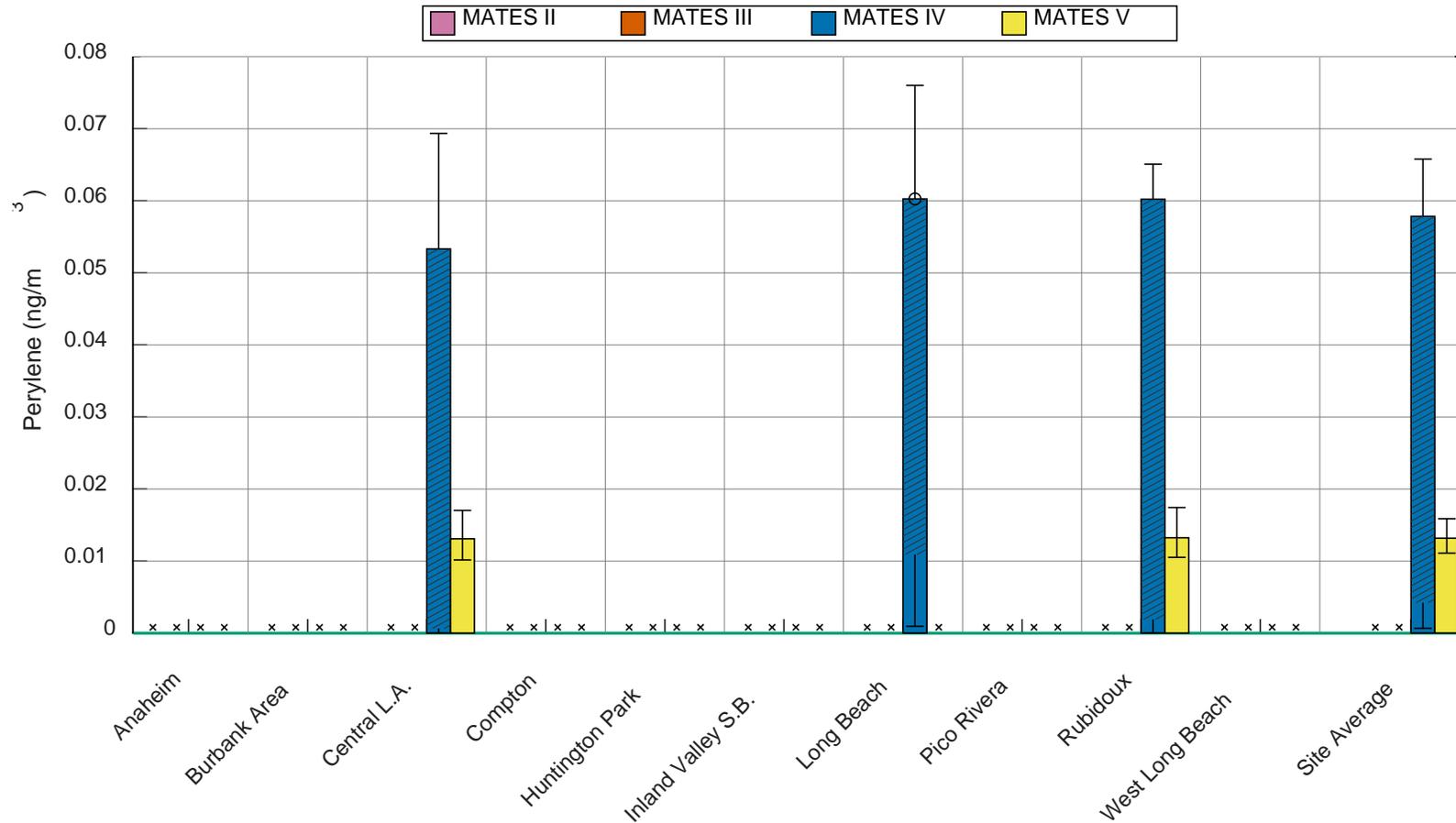
**Figure IV-189.** Geographic distribution of Naphthalene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Perylene

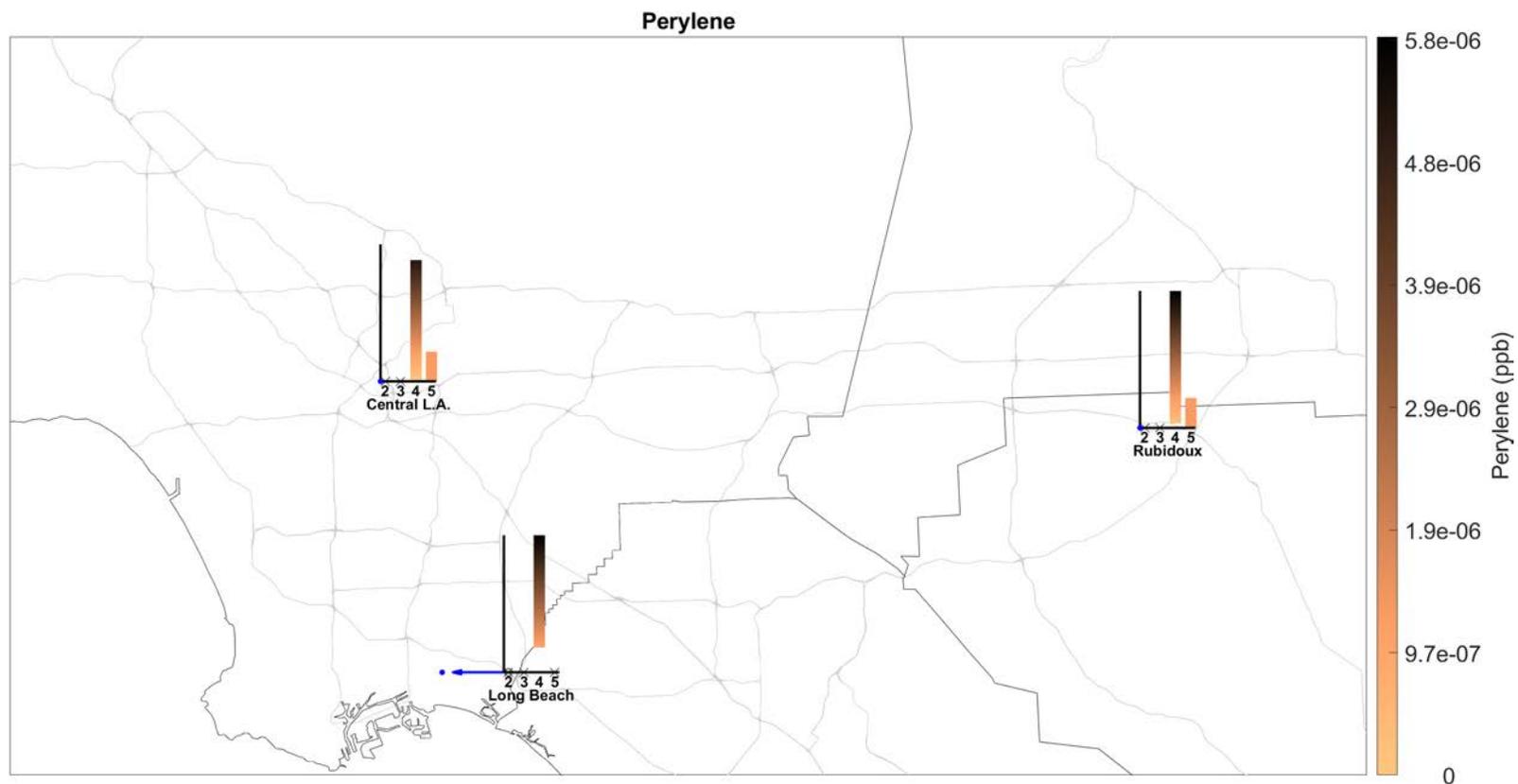
**Table IV-97.** Ambient Concentrations (ng/m<sup>3</sup>) of Perylene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average						0.0109, 0.0603 <sup>a</sup>	0.000631, 0.0533 <sup>a</sup>		0.00188, 0.0602 <sup>a</sup>	
95% CI LB						0.000945 <sup>a</sup>	0 <sup>a</sup>		0 <sup>a</sup>	
95% CI UB						0.076 <sup>a</sup>	0.0693 <sup>a</sup>		0.0651 <sup>a</sup>	
N	0	0	0	0	0	51 <sup>a</sup>	58 <sup>a</sup>	0	58 <sup>a</sup>	0
% < MDL						92.2 <sup>a</sup>	98.3 <sup>a</sup>		98.3 <sup>a</sup>	
Max						0.388 <sup>a</sup>	0.0366 <sup>a</sup>		0.109 <sup>a</sup>	
MATES V										
Average							0.0131		0.0132	
95% CI LB							0.0102		0.0105	
95% CI UB							0.017		0.0174	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							75.9		75	
Max							0.0789		0.103	

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-190.** Annual Average Concentrations of Perylene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

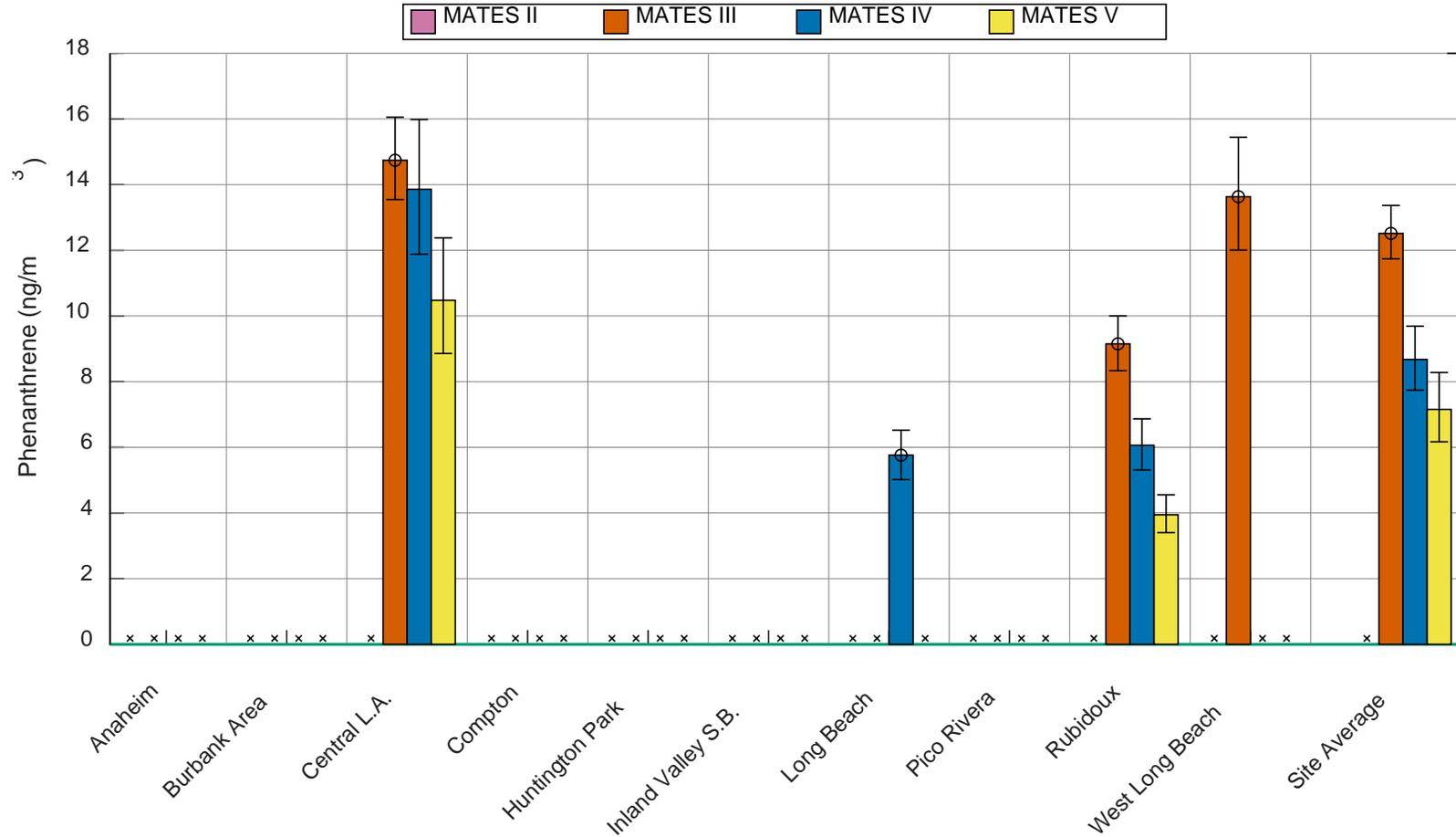


**Figure IV-191.** Geographic distribution of Perylene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

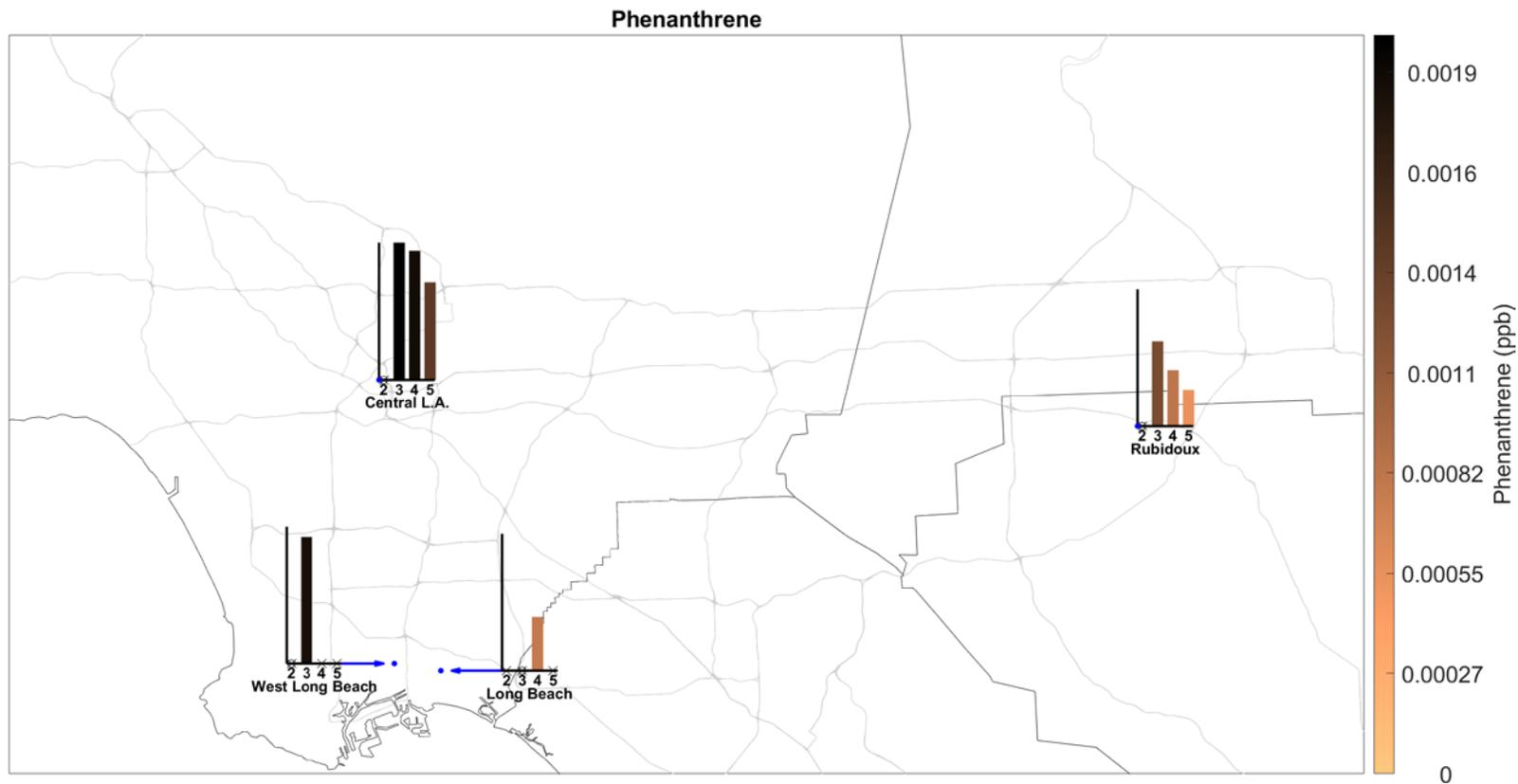
Phenanthrene

**Table IV-98.** Ambient Concentrations (ng/m<sup>3</sup>) of Phenanthrene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							14.7		9.15	13.6
95% CI LB							13.5		8.33	12
95% CI UB							16.1		10	15.4
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							43.4		27.6	58.8
MATES IV										
Average						5.76	13.9		6.06	
95% CI LB						5.02	11.9		5.31	
95% CI UB						6.52	16		6.87	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						0	0		0	
Max						13.9	35.6		15.3	
MATES V										
Average							10.5		3.94	
95% CI LB							8.86		3.4	
95% CI UB							12.4		4.55	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		0	
Max							44.9		14.9	



**Figure IV-192.** Annual Average Concentrations of Phenanthrene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

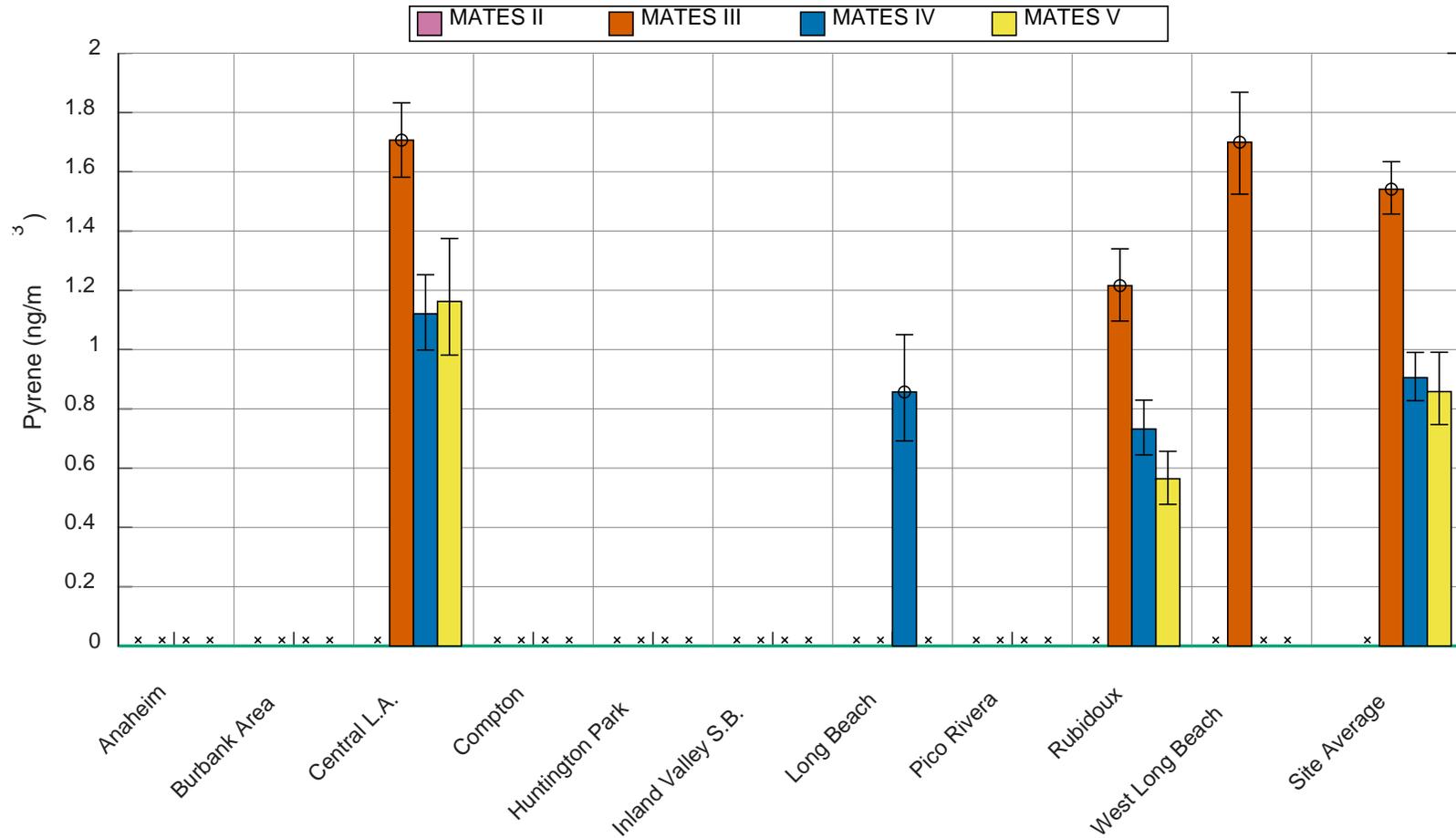


**Figure IV-193.** Geographic distribution of Phenanthrene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

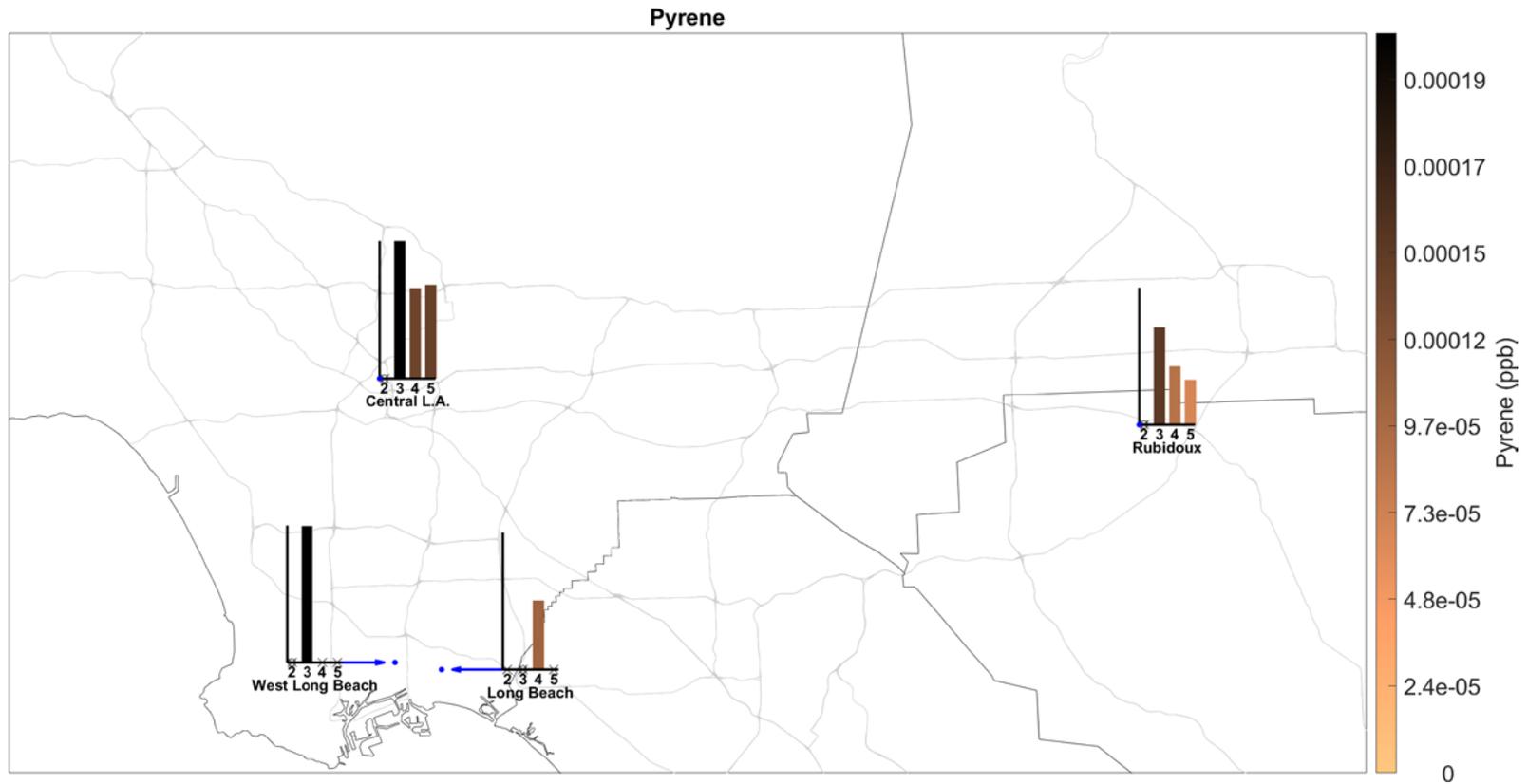
Pyrene

**Table IV-99.** Ambient Concentrations (ng/m<sup>3</sup>) of Pyrene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average							1.71		1.22	1.7
95% CI LB							1.58		1.1	1.52
95% CI UB							1.83		1.34	1.87
N	0	0	0	0	0	0	129	0	128	128
% < MDL							0		0	0
Max							3.82		3.56	5.09
MATES IV										
Average						0.857	1.12		0.732	
95% CI LB						0.692	0.999		0.644	
95% CI UB						1.05	1.25		0.829	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						0	0		0	
Max						3.73	2.34		2.11	
MATES V										
Average							1.16		0.564	
95% CI LB							0.981		0.478	
95% CI UB							1.37		0.657	
N	0	0	0	0	0	0	58	0	60	0
% < MDL							0		0	
Max							4.73		2.09	



**Figure IV-194.** Annual Average Concentrations of Pyrene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

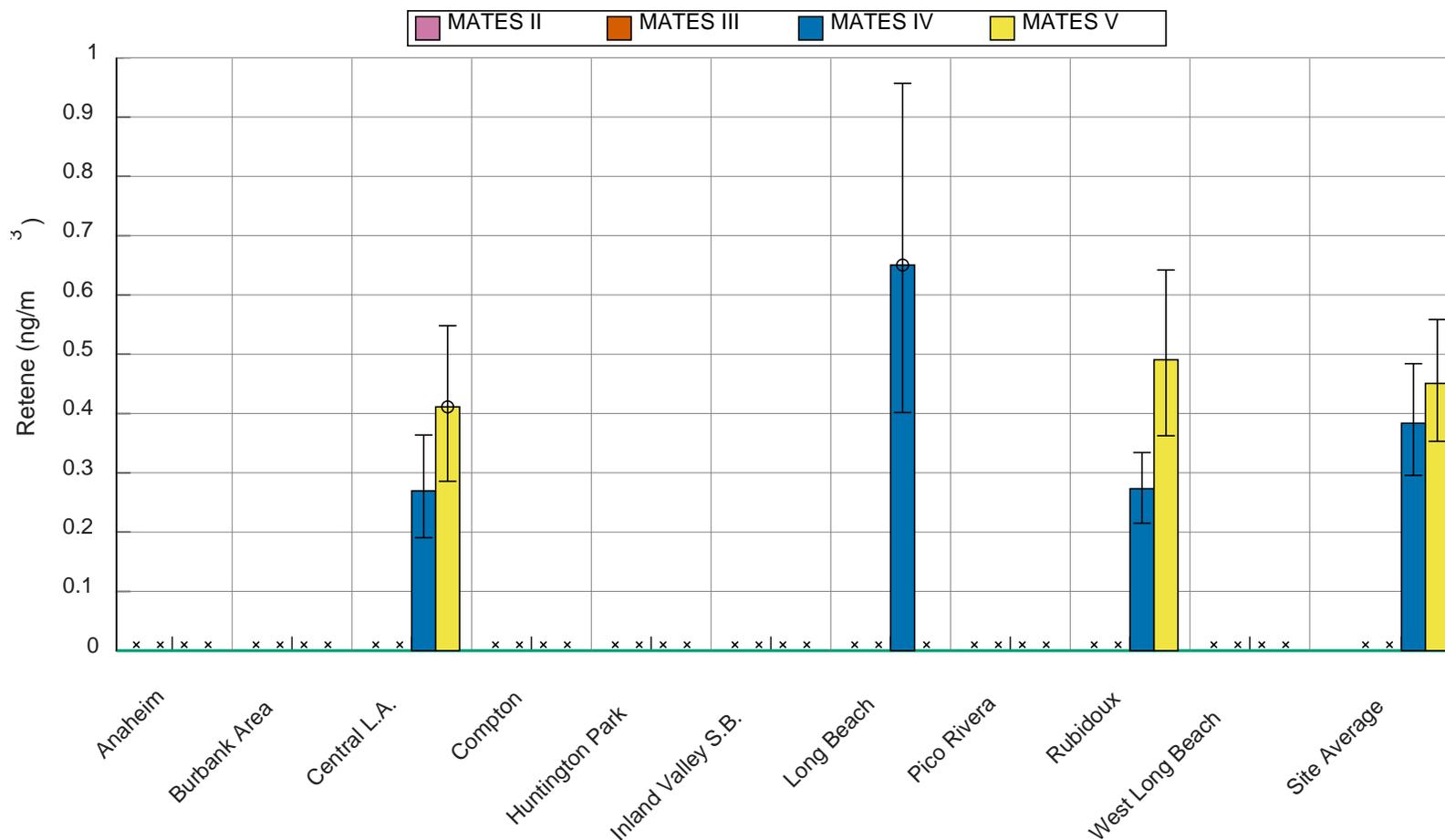


**Figure IV-195.** Geographic distribution of Pyrene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

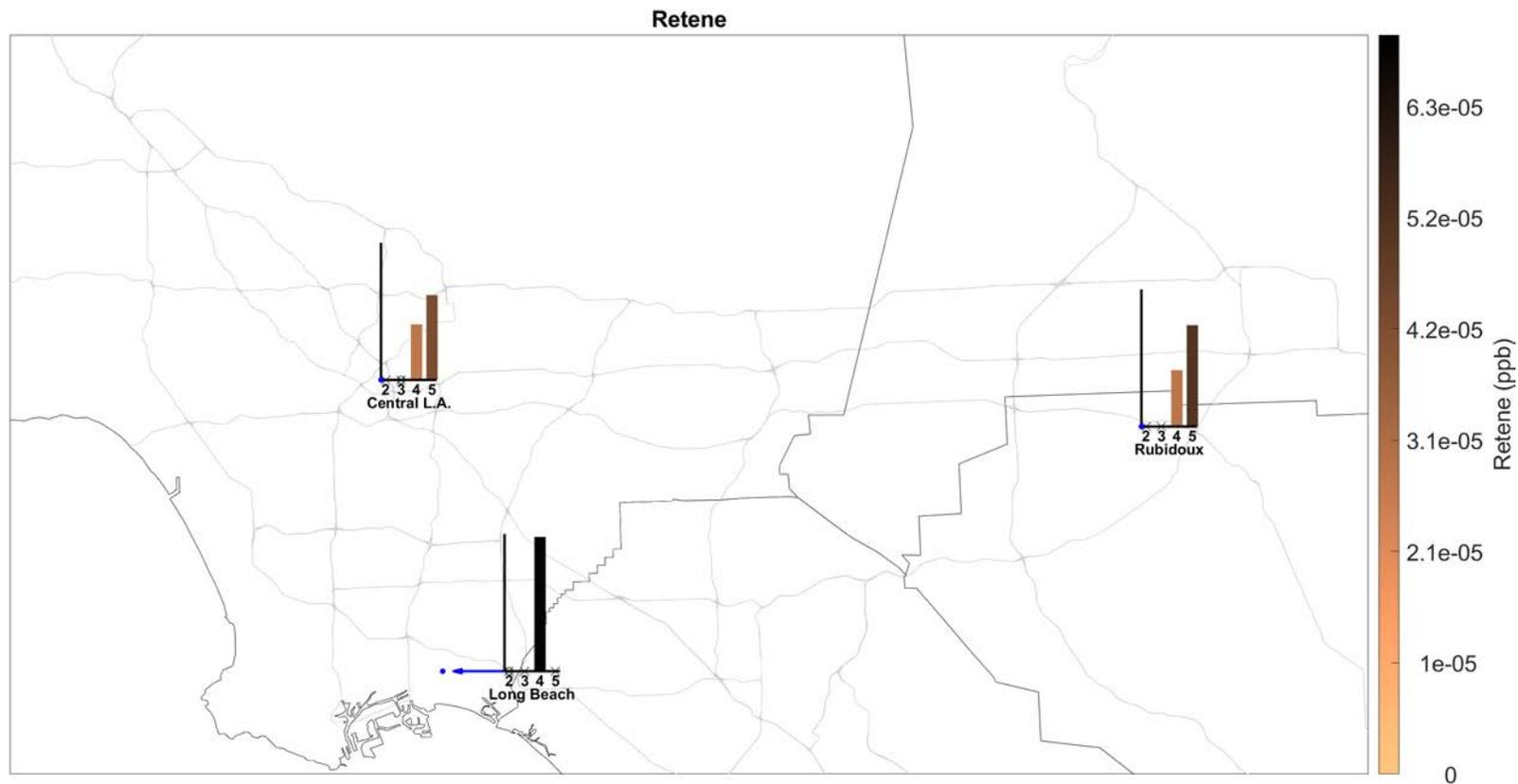
Retene

**Table IV-100.** Ambient Concentrations (ng/m<sup>3</sup>) of Retene from the PAH analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average						0.65	0.269		0.273	
95% CI LB						0.402	0.191		0.215	
95% CI UB						0.957	0.364		0.334	
N	0	0	0	0	0	51	58	0	58	0
% < MDL						31.4	43.1		36.2	
Max						5.17	1.7		1.19	
MATES V										
Average							0.411		0.491	
95% CI LB							0.286		0.362	
95% CI UB							0.548		0.642	
N	0	0	0	0	0	0	57	0	59	0
% < MDL							14		16.9	
Max							2.67		2.84	



**Figure IV-196.** Annual Average Concentrations of Retene in the PAH Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



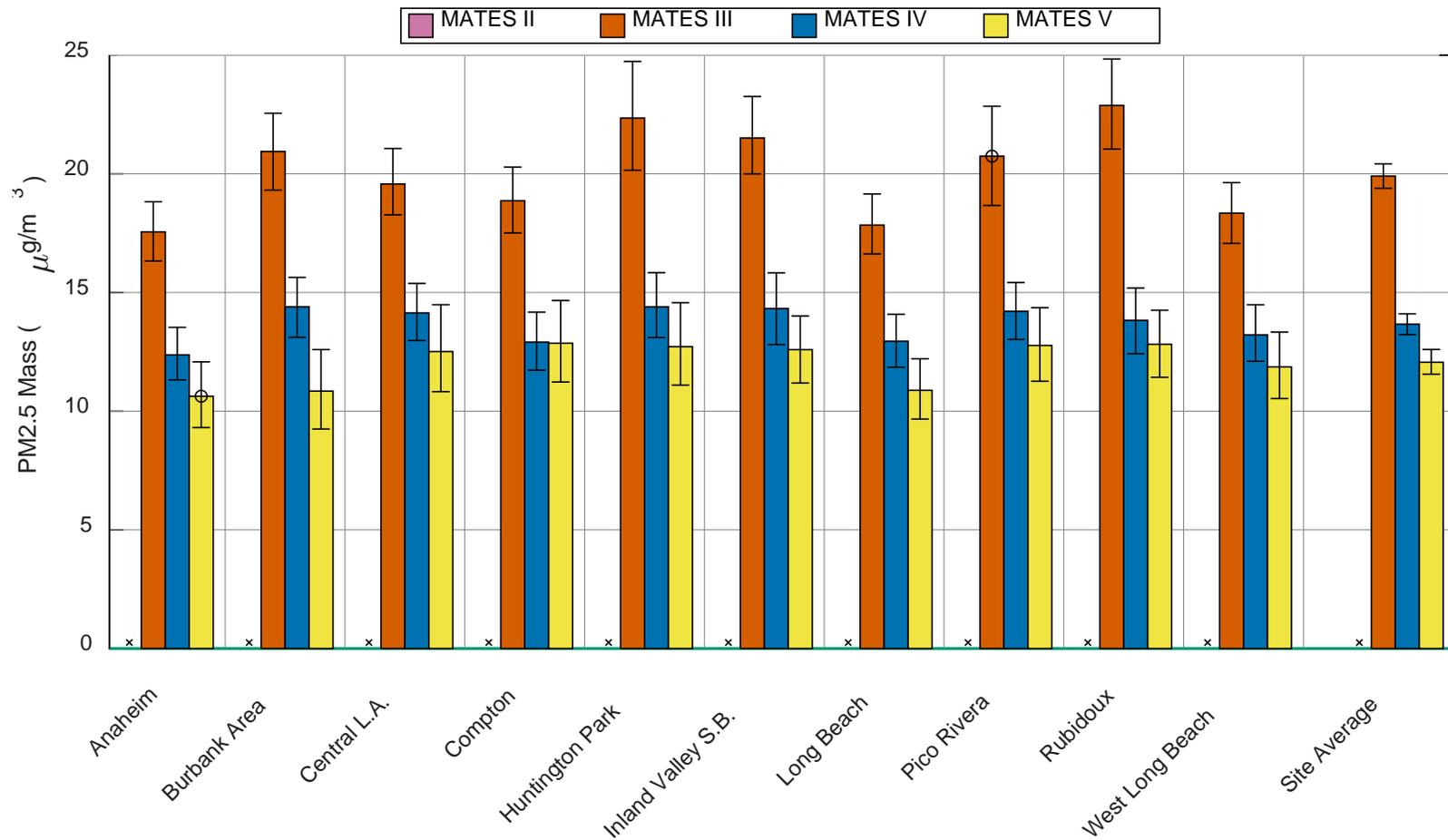
**Figure IV-197.** Geographic distribution of Retene from the PAH Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

PM2.5 Mass (SASS) Analysis

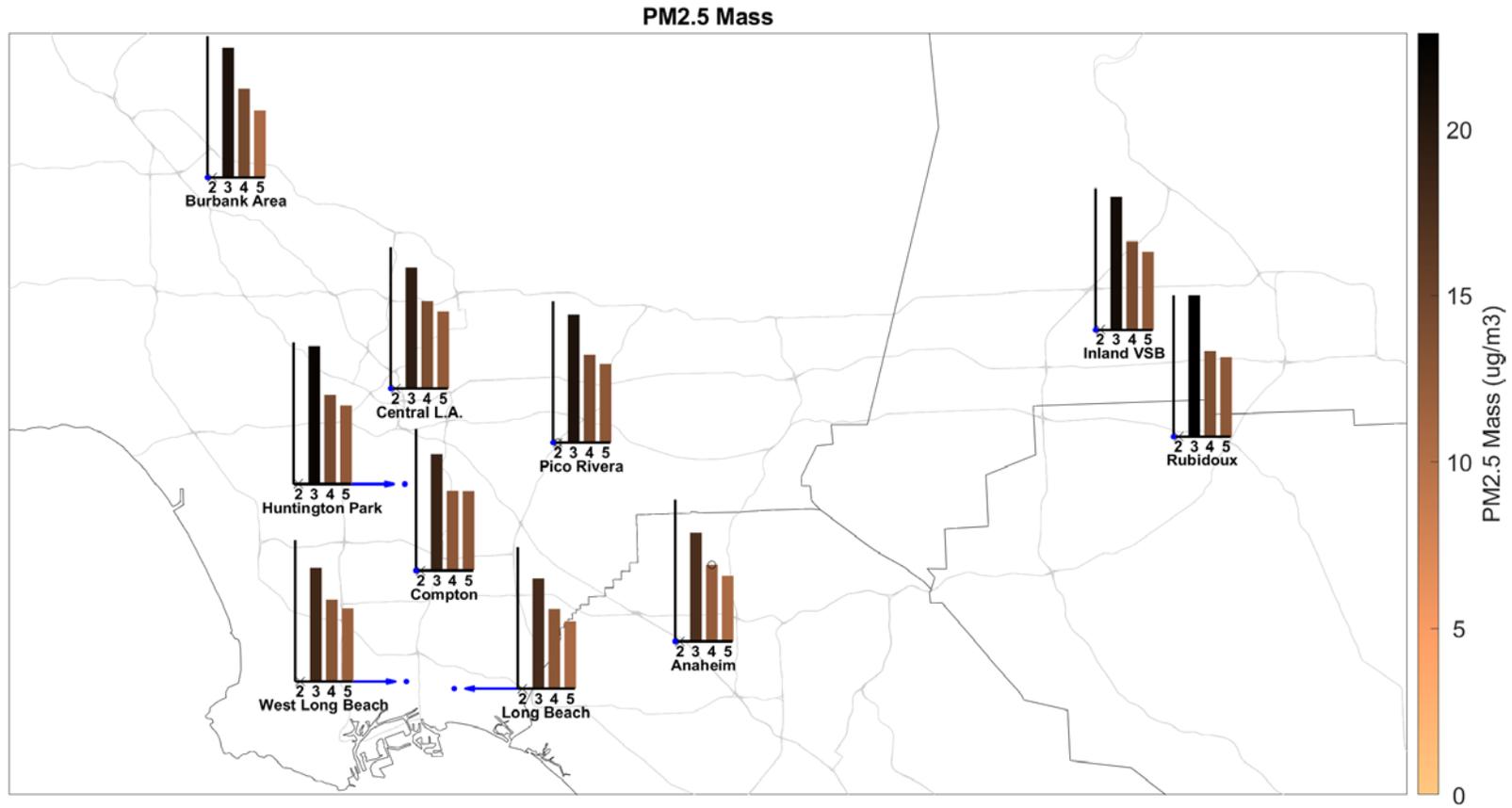
PM2.5 Mass

**Table IV-101.** Ambient Concentrations (µg/m) of PM2.5 Mass from the PM2.5 Mass (SASS) analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	17.6	20.9	18.9	21.5	22.4	17.8	19.6	20.7	22.9	18.3
95% CI LB	16.3	19.3	17.5	20	20.2	16.6	18.3	18.7	21	17.1
95% CI UB	18.8	22.6	20.3	23.3	24.7	19.2	21.1	22.9	24.8	19.6
N	235	233	230	229	113	219	236	109	235	227
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	64	80.8	57.5	112	77.9	61.1	73.2	64.9	110	60.3
MATES IV										
Average	12.4	14.4	12.9	14.3	14.4	12.9	14.1	14.2	13.8	13.2
95% CI LB	11.3	13.1	11.7	12.8	13.1	11.9	13	13	12.4	12.1
95% CI UB	13.5	15.6	14.2	15.8	15.8	14.1	15.4	15.4	15.2	14.5
N	59	59	61	60	57	61	59	58	61	60
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	31.6	27.9	29.6	34.1	35.4	27.1	27.4	29.5	30.3	28.1
MATES V										
Average	10.6	10.8	12.9	12.6	12.7	10.9	12.5	12.8	12.8	11.9
95% CI LB	9.31	9.25	11.2	11.2	11.1	9.67	10.8	11.3	11.4	10.5
95% CI UB	12.1	12.6	14.7	14	14.6	12.2	14.5	14.4	14.3	13.3
N	56	58	61	61	59	61	61	59	60	57
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	28.6	28.1	32.2	27.9	36.9	27.8	45.2	38.6	34.1	29.1



**Figure IV-198.** Annual Average Concentrations of PM2.5 Mass in the PM2.5 Mass (SASS) Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



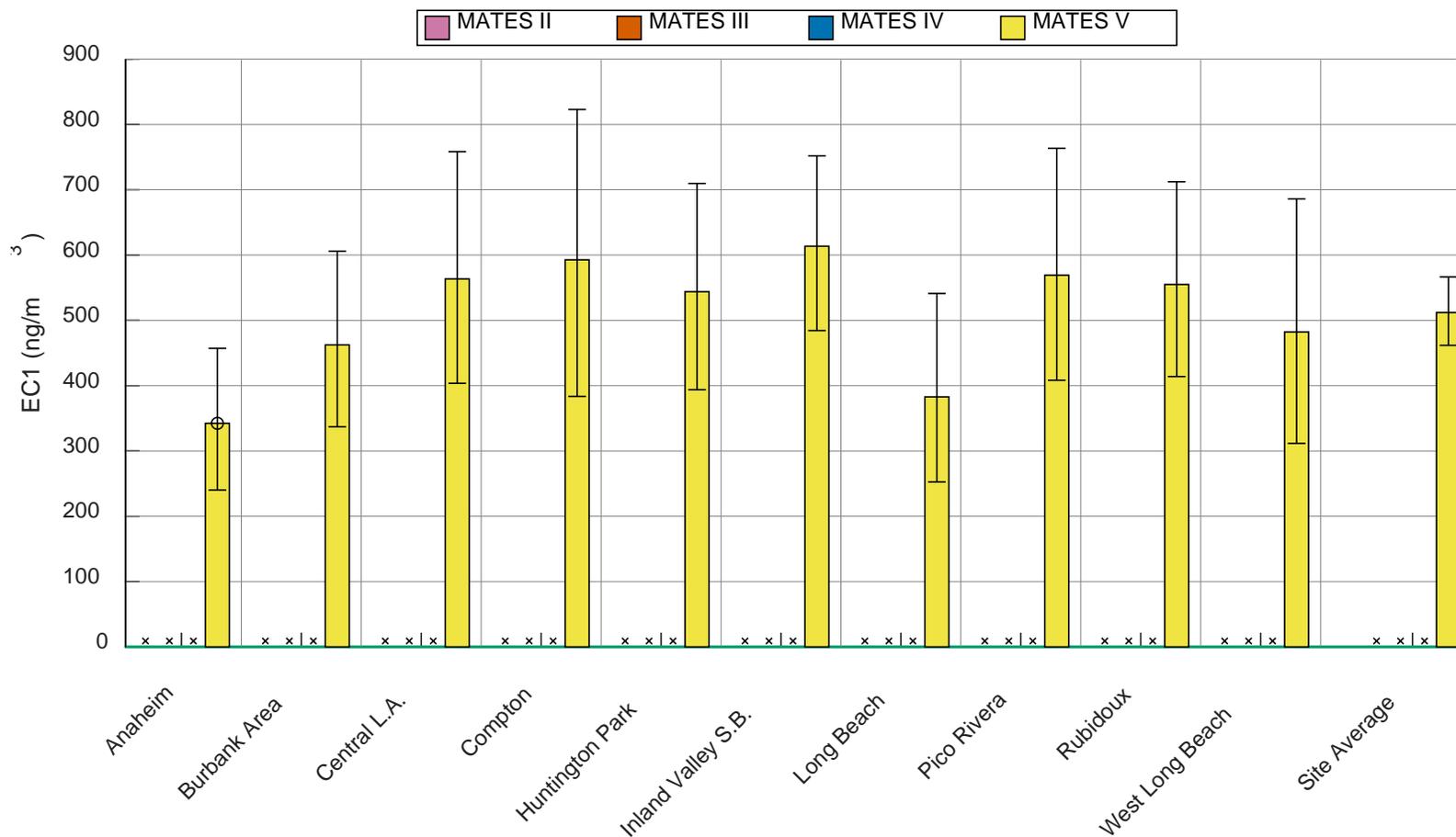
**Figure IV-199.** Geographic distribution of PM2.5 Mass from the PM2.5 Mass (SASS) Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

PM2.5 Carbon Analysis

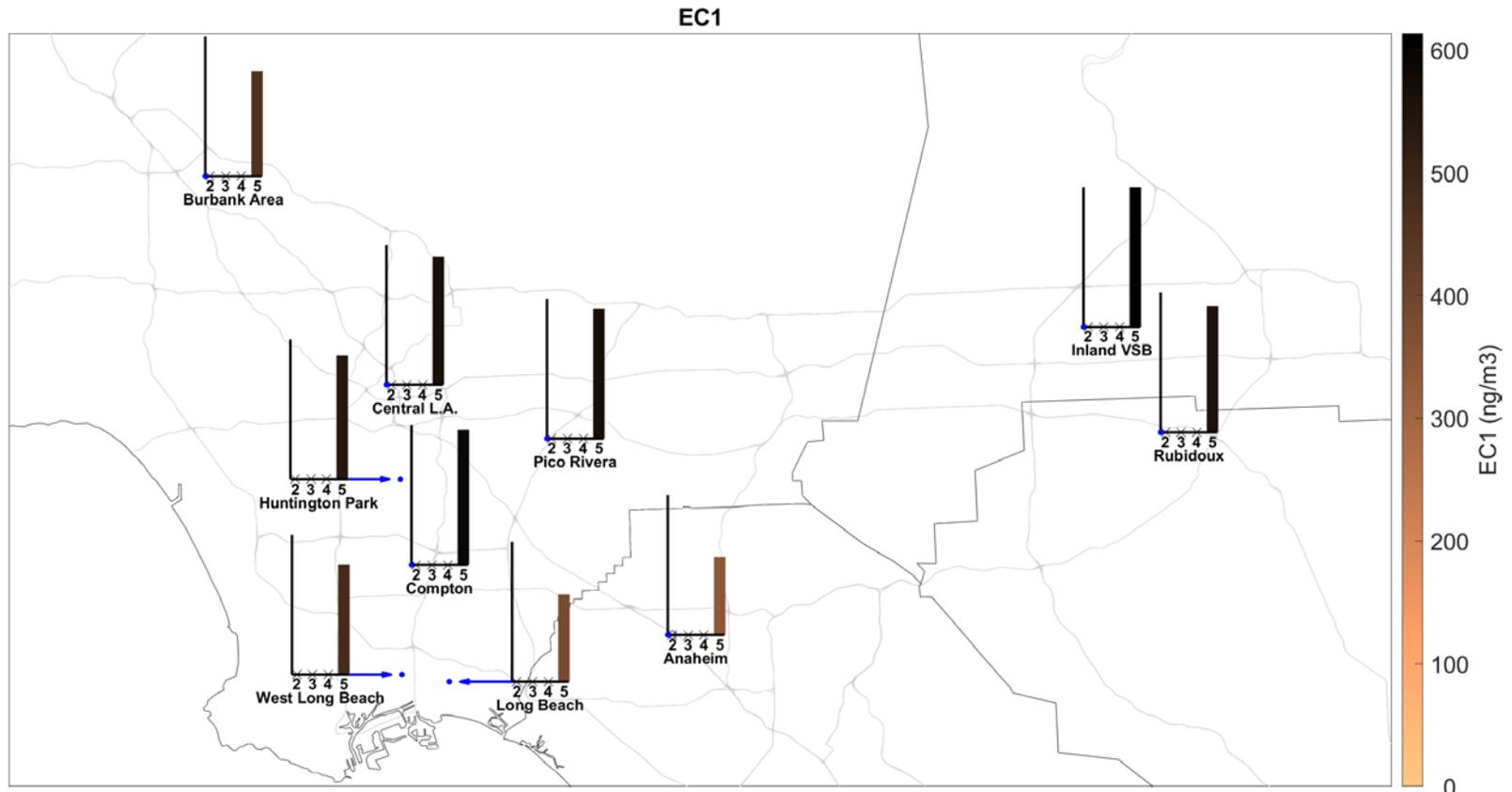
EC1

**Table IV-102.** Ambient Concentrations (ng/m<sup>3</sup>) of EC1 from the PM2.5 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	342	462	593	614	544	383	563	569	555	482
95% CI LB	240	337	384	484	394	253	404	408	414	312
95% CI UB	457	606	823	752	710	541	758	763	712	686
N	56	59	61	60	60	61	61	59	59	55
% < MDL	12.5	16.9	9.8	8.3	8.3	19.7	9.8	6.8	8.5	14.5
Max	1800	3000	4800	2300	2500	2500	4300	3800	2700	3400



**Figure IV-200.** Annual Average Concentrations of EC1 in the PM2.5 Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

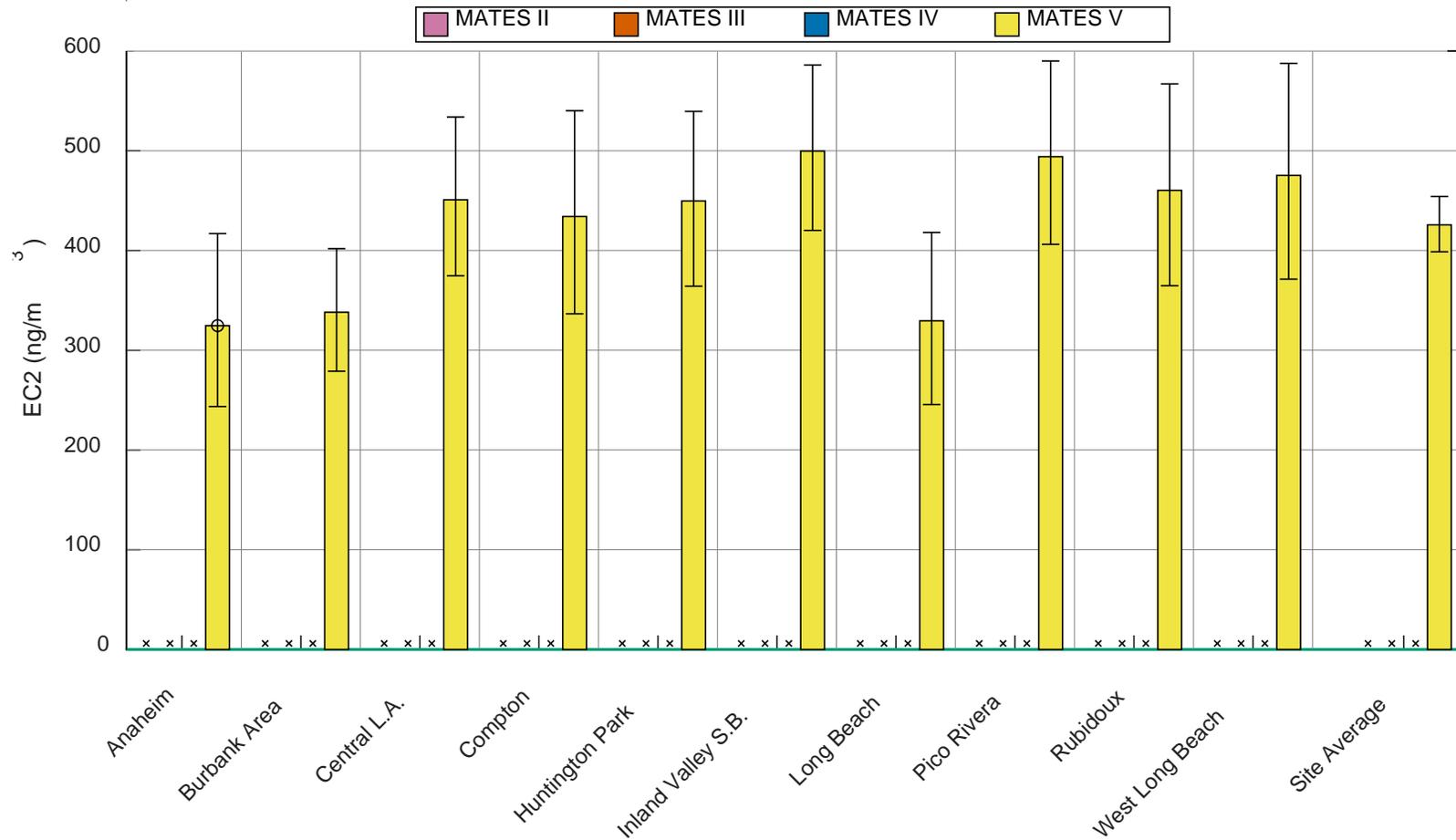


**Figure IV-201.** Geographic distribution of EC1 from the PM<sub>2.5</sub> Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

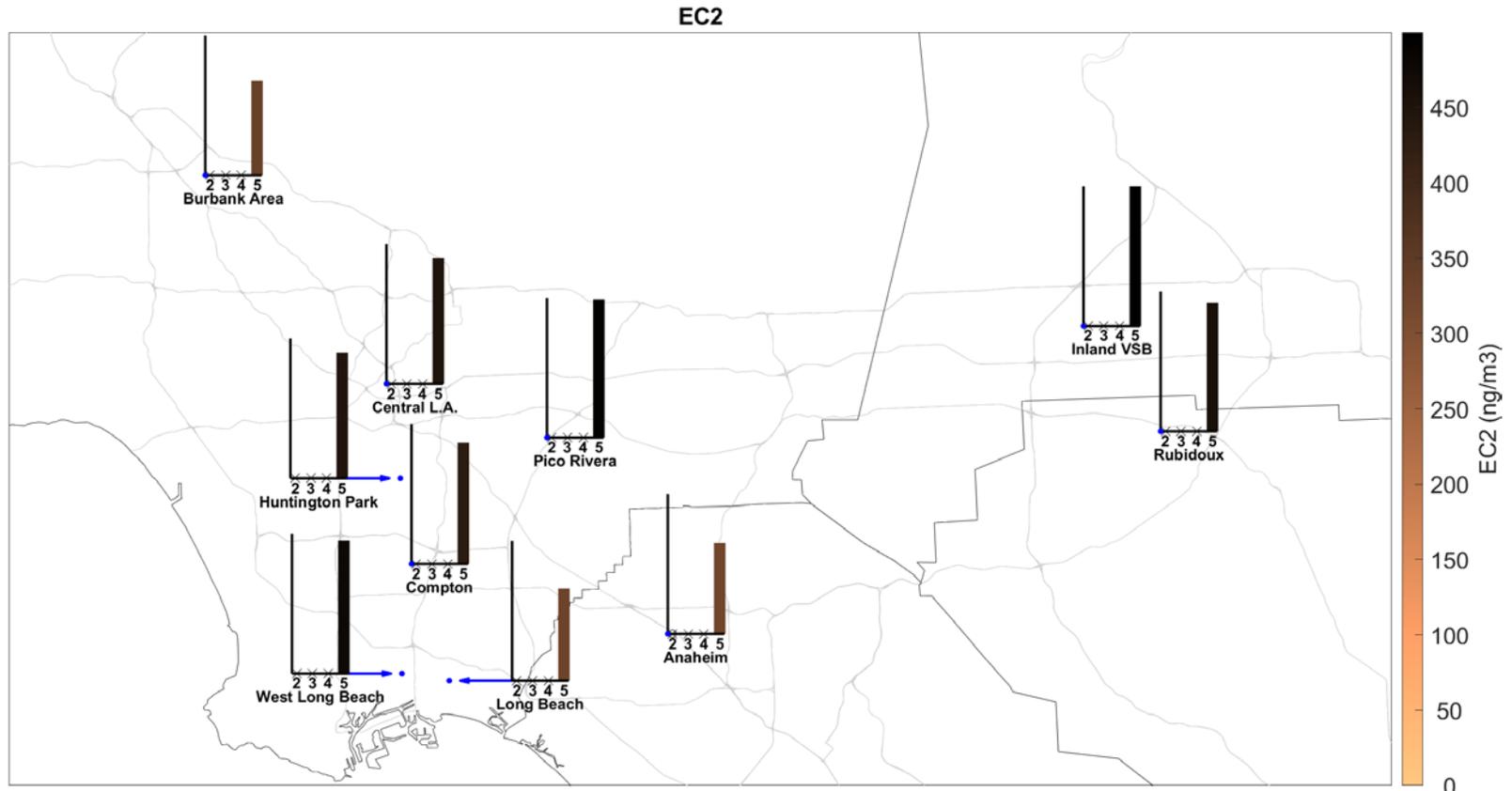
EC2

**Table IV-103.** Ambient Concentrations (ng/m<sup>3</sup>) of EC2 from the PM2.5 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	325	338	434	500	450	330	451	494	460	475
95% CI LB	244	279	337	420	364	246	375	406	365	371
95% CI UB	417	402	540	586	540	418	534	590	567	588
N	56	59	61	60	60	61	61	59	59	55
% < MDL	5.4	3.4	6.6	5	1.7	8.2	1.6	1.7	3.4	1.8
Max	1700	1200	1500	1500	1400	1600	1350	1500	2100	1600



**Figure IV-202.** Annual Average Concentrations of EC2 in the PM2.5 Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



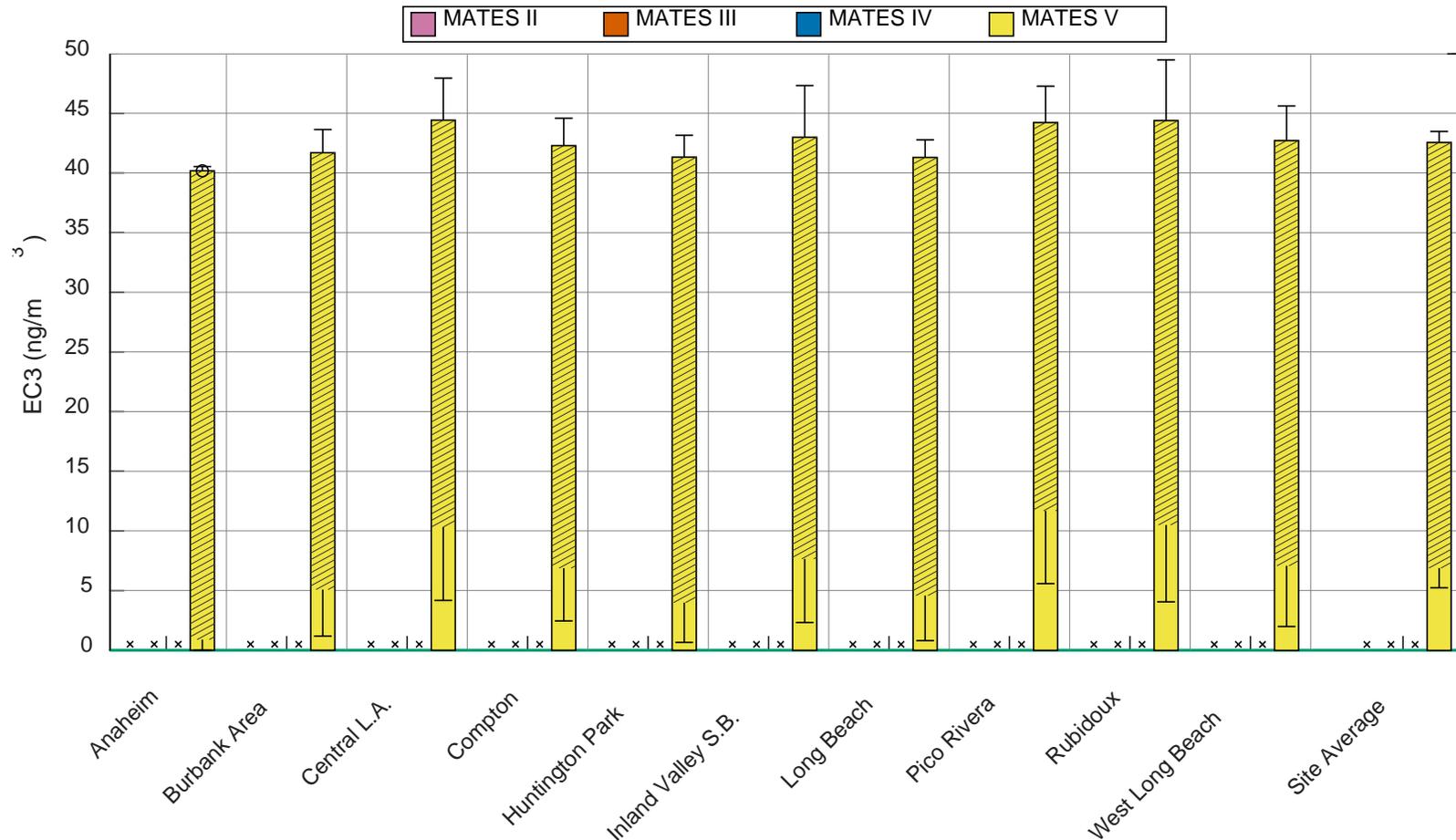
**Figure IV-203.** Geographic distribution of EC2 from the PM2.5 Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

EC3

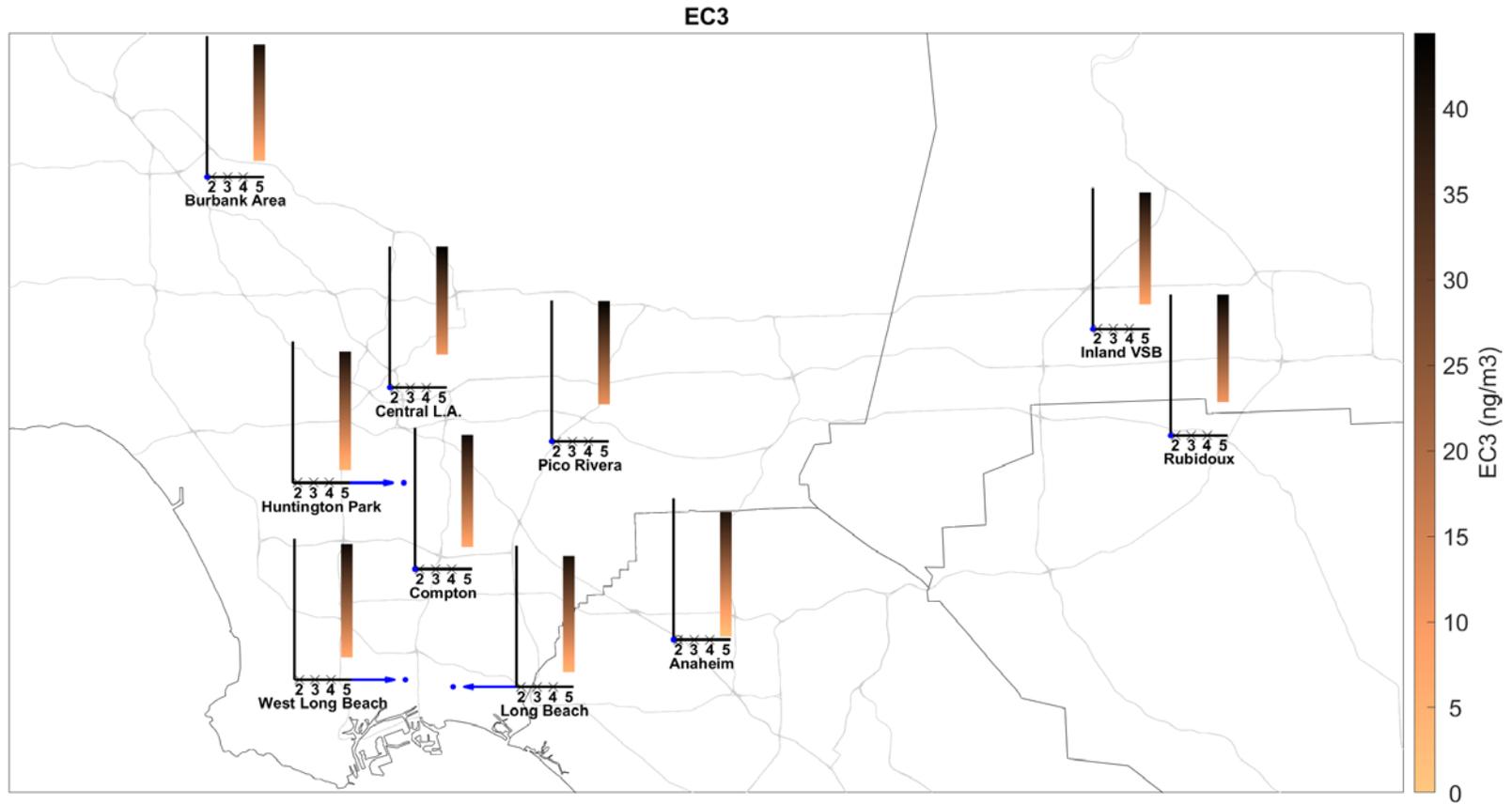
**Table IV-104.** Ambient Concentrations (ng/m<sup>3</sup>) of EC3 from the PM2.5 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	0.893, 40.2 <sup>a</sup>	5.08, 41.7 <sup>a</sup>	6.89, 42.3 <sup>a</sup>	7.67, 43 <sup>a</sup>	4, 41.3 <sup>a</sup>	4.59, 41.3 <sup>a</sup>	10.3, 44.4 <sup>a</sup>	11.7, 44.2 <sup>a</sup>	10.5, 44.4 <sup>a</sup>	7.09, 42.7 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	1.19 <sup>a</sup>	2.46 <sup>a</sup>	2.33 <sup>a</sup>	0.667 <sup>a</sup>	0.82 <sup>a</sup>	4.18 <sup>a</sup>	5.59 <sup>a</sup>	4.07 <sup>a</sup>	2 <sup>a</sup>
95% CI UB	40.5 <sup>a</sup>	43.6 <sup>a</sup>	44.6 <sup>a</sup>	47.3 <sup>a</sup>	43.2 <sup>a</sup>	42.8 <sup>a</sup>	48 <sup>a</sup>	47.3 <sup>a</sup>	49.5 <sup>a</sup>	45.6 <sup>a</sup>
N	56 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	60 <sup>a</sup>	61 <sup>a</sup>	61 <sup>a</sup>	59 <sup>a</sup>	59 <sup>a</sup>	55 <sup>a</sup>
% < MDL	98.2 <sup>a</sup>	91.5 <sup>a</sup>	88.5 <sup>a</sup>	88.3 <sup>a</sup>	93.3 <sup>a</sup>	91.8 <sup>a</sup>	85.2 <sup>a</sup>	81.4 <sup>a</sup>	84.7 <sup>a</sup>	89.1 <sup>a</sup>
Max	50 <sup>a</sup>	80 <sup>a</sup>	90 <sup>a</sup>	150 <sup>a</sup>	70 <sup>a</sup>	70 <sup>a</sup>	95 <sup>a</sup>	110 <sup>a</sup>	140 <sup>a</sup>	90 <sup>a</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-204.** Annual Average Concentrations of EC3 in the PM2.5 Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

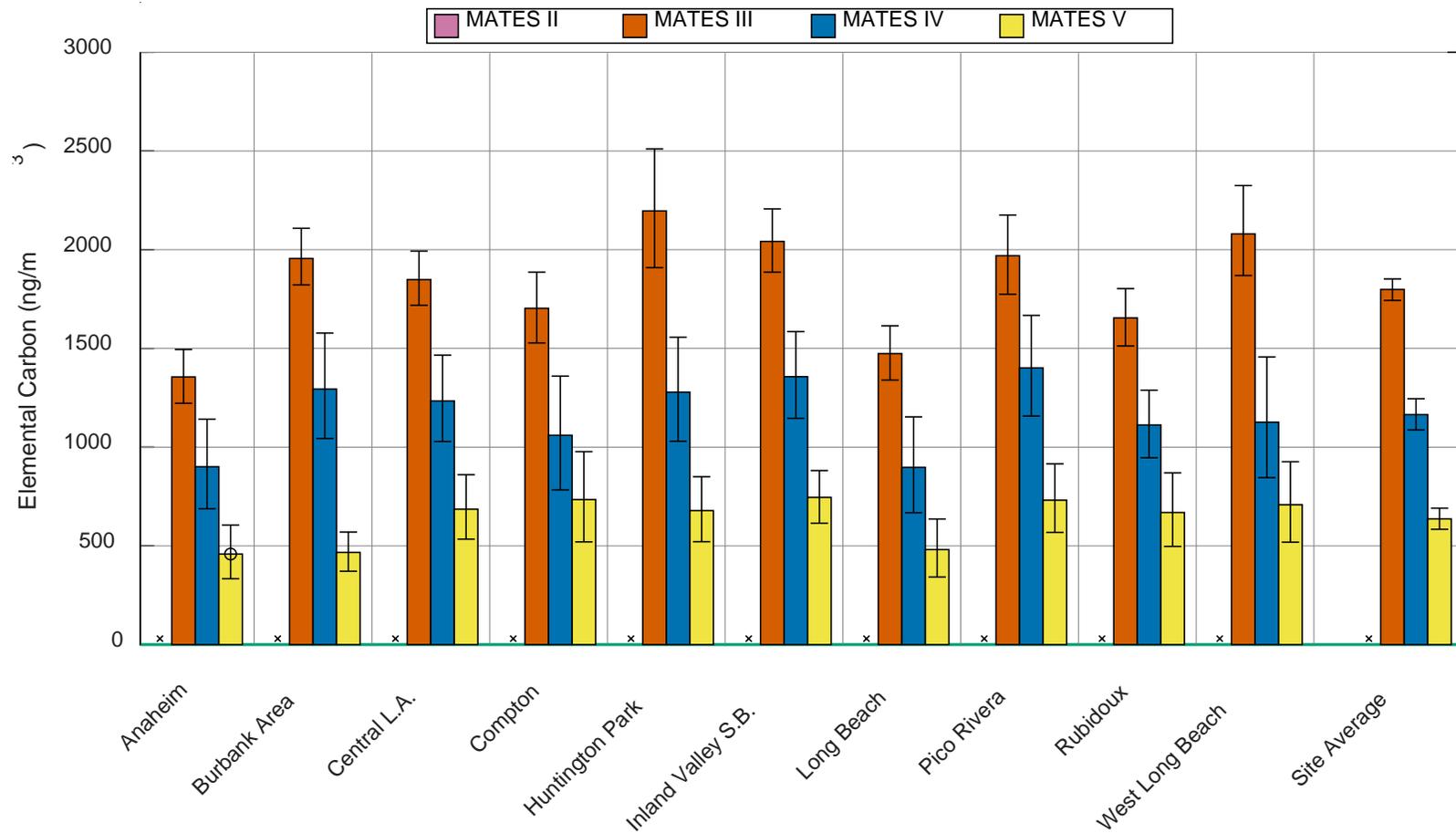


**Figure IV-205.** Geographic distribution of EC3 from the PM2.5 Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

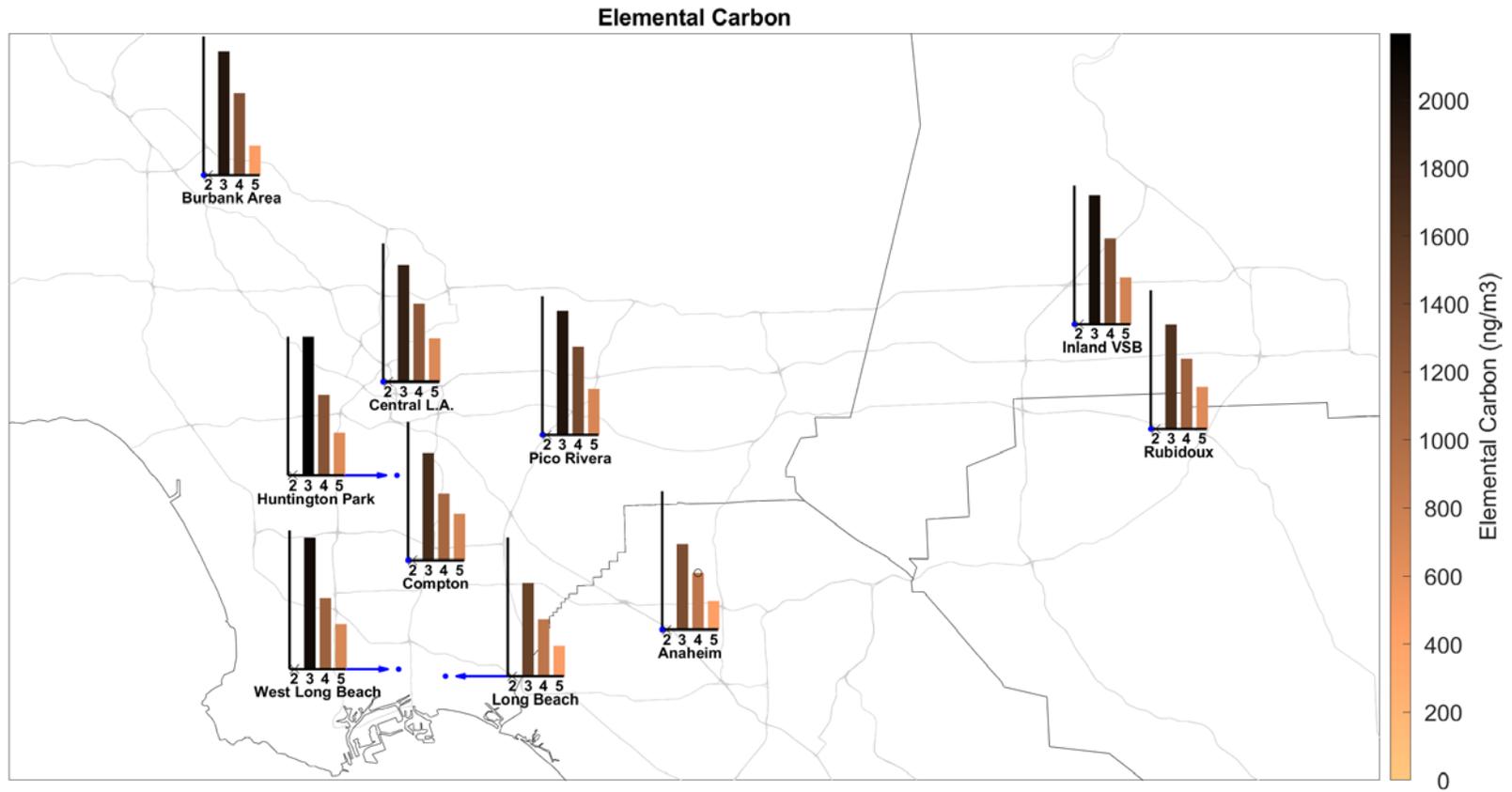
Elemental Carbon

**Table IV-105.** Ambient Concentrations (ng/m<sup>3</sup>) of Elemental Carbon from the PM<sub>2.5</sub> Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	1360	1960	1700	2040	2200	1470	1850	1970	1650	2080
95% CI LB	1220	1820	1530	1890	1910	1340	1720	1770	1510	1870
95% CI UB	1490	2110	1890	2210	2510	1610	1990	2180	1800	2320
N	242	241	235	236	118	228	240	116	235	228
% < MDL	0.4	0	0.4	0.8	0.8	0.4	0	0	0.4	0.4
Max	6440	6280	7180	7100	9080	5990	5300	5180	5700	8780
MATES IV										
Average	901	1290	1060	1360	1280	898	1230	1400	1110	1130
95% CI LB	688	1040	783	1150	1030	668	1030	1160	946	845
95% CI UB	1140	1580	1360	1590	1560	1150	1470	1670	1290	1460
N	59	59	61	60	59	61	60	59	61	61
% < MDL	0	1.7	0	1.7	0	1.6	0	0	0	0
Max	3900	4600	4700	5000	5400	3500	3800	4700	3400	4900
MATES V										
Average	458	467	734	746	679	481	686	732	669	708
95% CI LB	333	371	520	614	521	342	534	568	497	519
95% CI UB	605	570	977	881	850	636	861	916	870	926
N	56	59	61	60	60	61	61	59	59	55
% < MDL	3.6	6.8	6.6	5	0	8.2	1.6	1.7	3.4	1.8
Max	2600	1900	4700	2300	2600	2400	2850	3200	4200	2900



**Figure IV-206.** Annual Average Concentrations of Elemental Carbon in the PM<sub>2.5</sub> Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



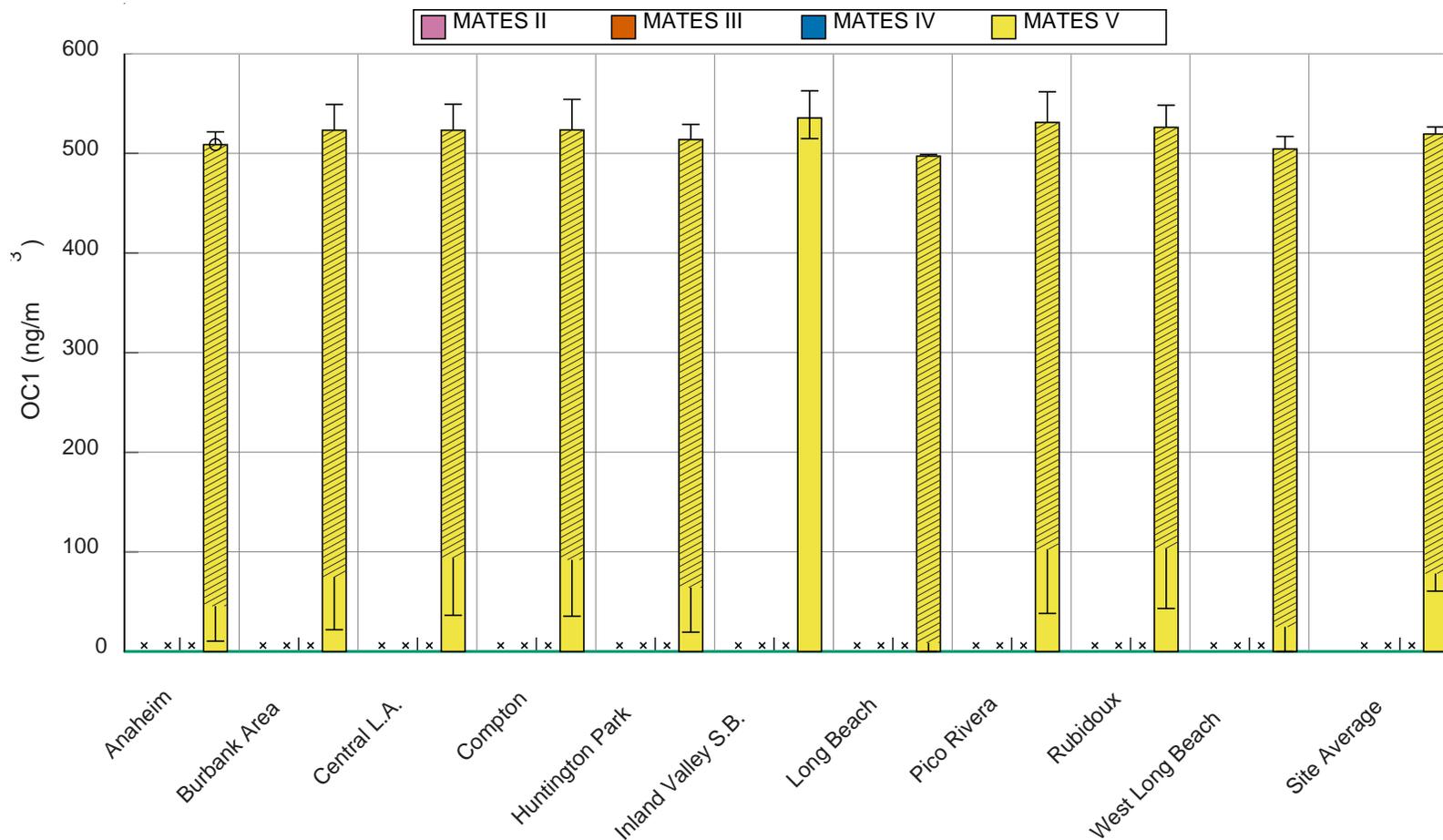
**Figure IV-207.** Geographic distribution of Elemental Carbon from the PM<sub>2.5</sub> Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

OC1

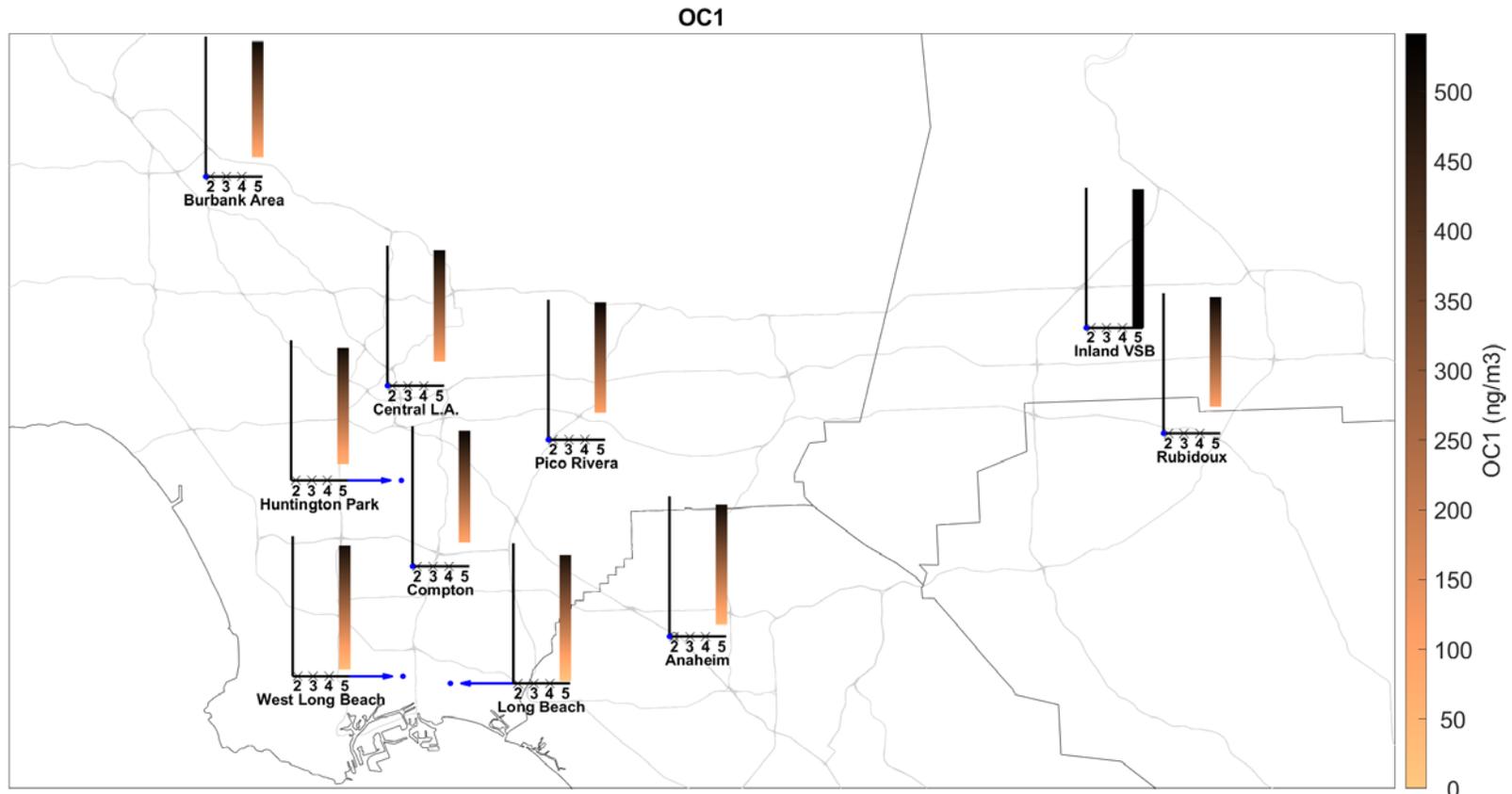
**Table IV-106.** Ambient Concentrations (ng/m<sup>3</sup>) of OC1 from the PM2.5 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	45.5, 509 <sup>a</sup>	74.9, 523 <sup>a</sup>	92, 523 <sup>a</sup>	536	64.2, 514 <sup>a</sup>	8.69, 497 <sup>a</sup>	93.7, 523 <sup>a</sup>	103, 531 <sup>a</sup>	103, 526 <sup>a</sup>	24.7, 504 <sup>a</sup>
95% CI LB	10.4 <sup>a</sup>	21.9 <sup>a</sup>	35.4 <sup>a</sup>	515	19.3 <sup>a</sup>	0 <sup>a</sup>	36.3 <sup>a</sup>	38.2 <sup>a</sup>	43.1 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	522 <sup>a</sup>	549 <sup>a</sup>	554 <sup>a</sup>	563	529 <sup>a</sup>	499 <sup>a</sup>	549 <sup>a</sup>	562 <sup>a</sup>	548 <sup>a</sup>	517 <sup>a</sup>
N	56 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60	60 <sup>a</sup>	61 <sup>a</sup>	61 <sup>a</sup>	59 <sup>a</sup>	59 <sup>a</sup>	55 <sup>a</sup>
% < MDL	92.9 <sup>a</sup>	89.8 <sup>a</sup>	86.9 <sup>a</sup>	75	90 <sup>a</sup>	98.4 <sup>a</sup>	86.9 <sup>a</sup>	86.4 <sup>a</sup>	84.7 <sup>a</sup>	96.4 <sup>a</sup>
Max	760 <sup>a</sup>	1000 <sup>a</sup>	1200 <sup>a</sup>	1000	830 <sup>a</sup>	530 <sup>a</sup>	1000 <sup>a</sup>	1100 <sup>a</sup>	850 <sup>a</sup>	800 <sup>a</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-208.** Annual Average Concentrations of OC1 in the PM2.5 Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

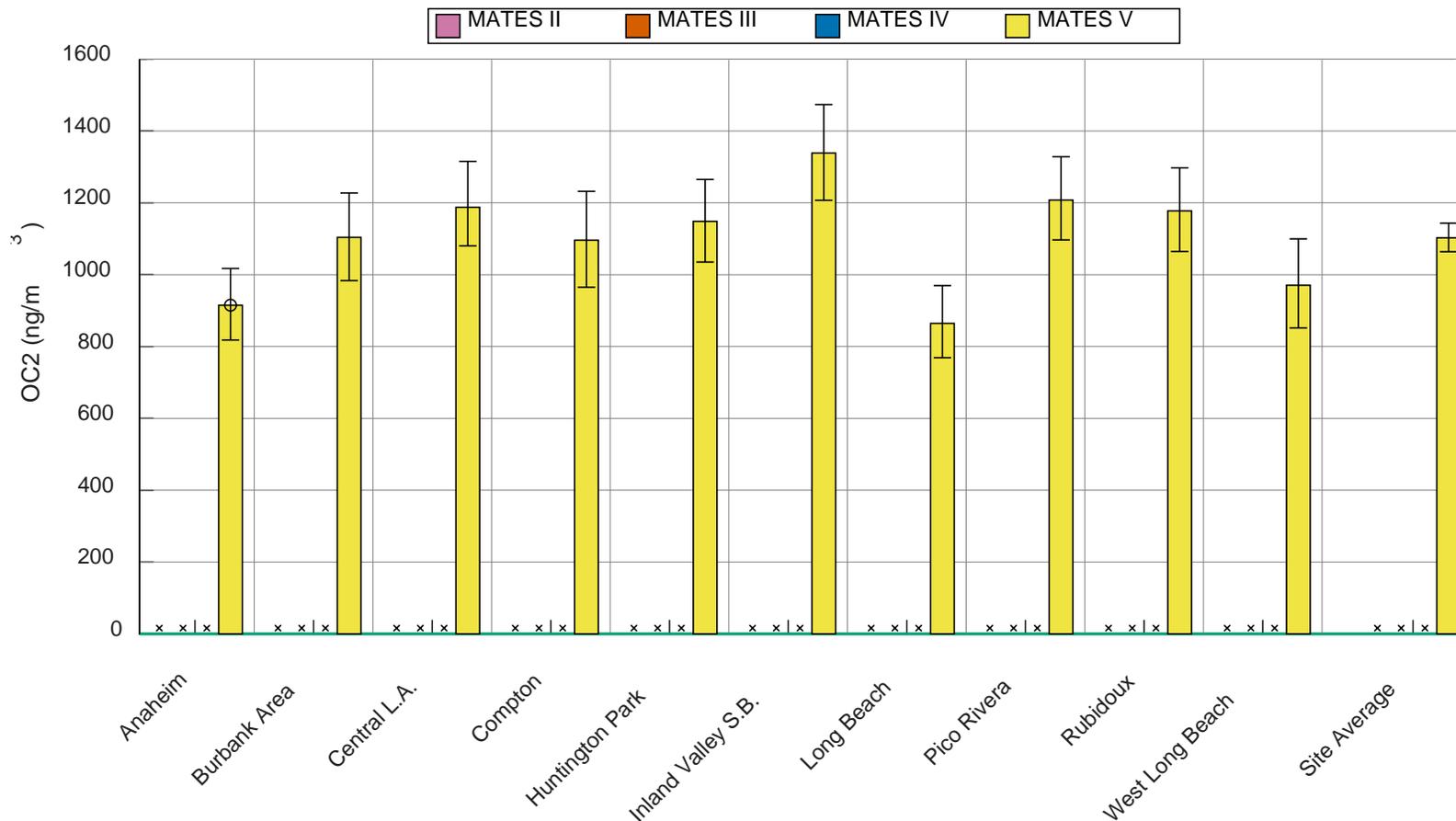


**Figure IV-209.** Geographic distribution of OC1 from the PM<sub>2.5</sub> Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

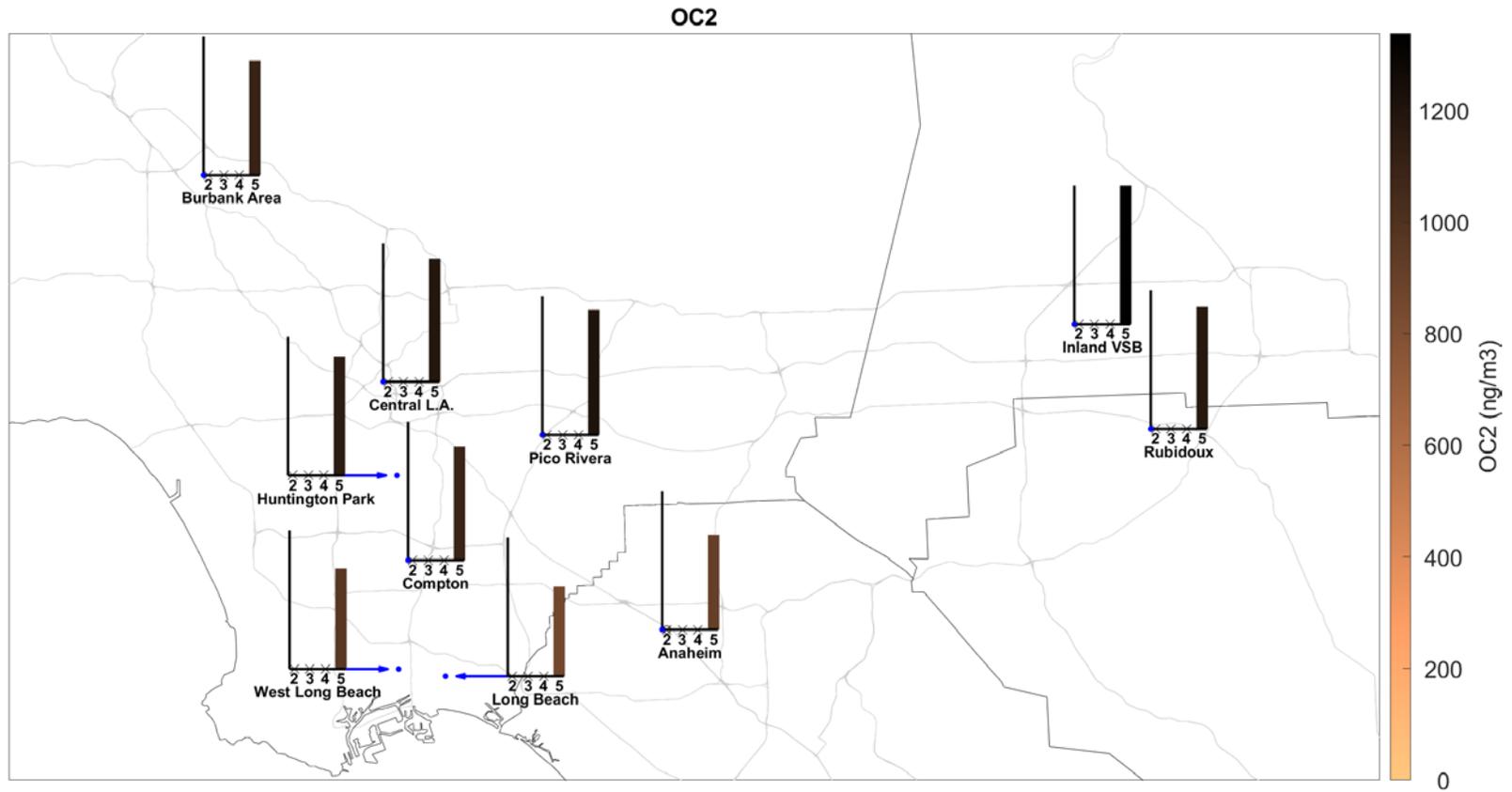
OC2

**Table IV-107.** Ambient Concentrations (ng/m<sup>3</sup>) of OC2 from the PM2.5 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	915	1100	1100	1340	1150	864	1190	1210	1180	971
95% CI LB	818	984	965	1210	1040	769	1080	1100	1060	852
95% CI UB	1020	1230	1230	1470	1270	970	1320	1330	1300	1100
N	56	59	61	60	60	61	61	59	59	55
% < MDL	5.4	10.2	3.3	8.3	3.3	16.4	1.6	0	5.1	9.1
Max	2100	2300	2600	2500	2300	2400	3000	2700	2300	2500



**Figure IV-210.** Annual Average Concentrations of OC2 in the PM2.5 Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

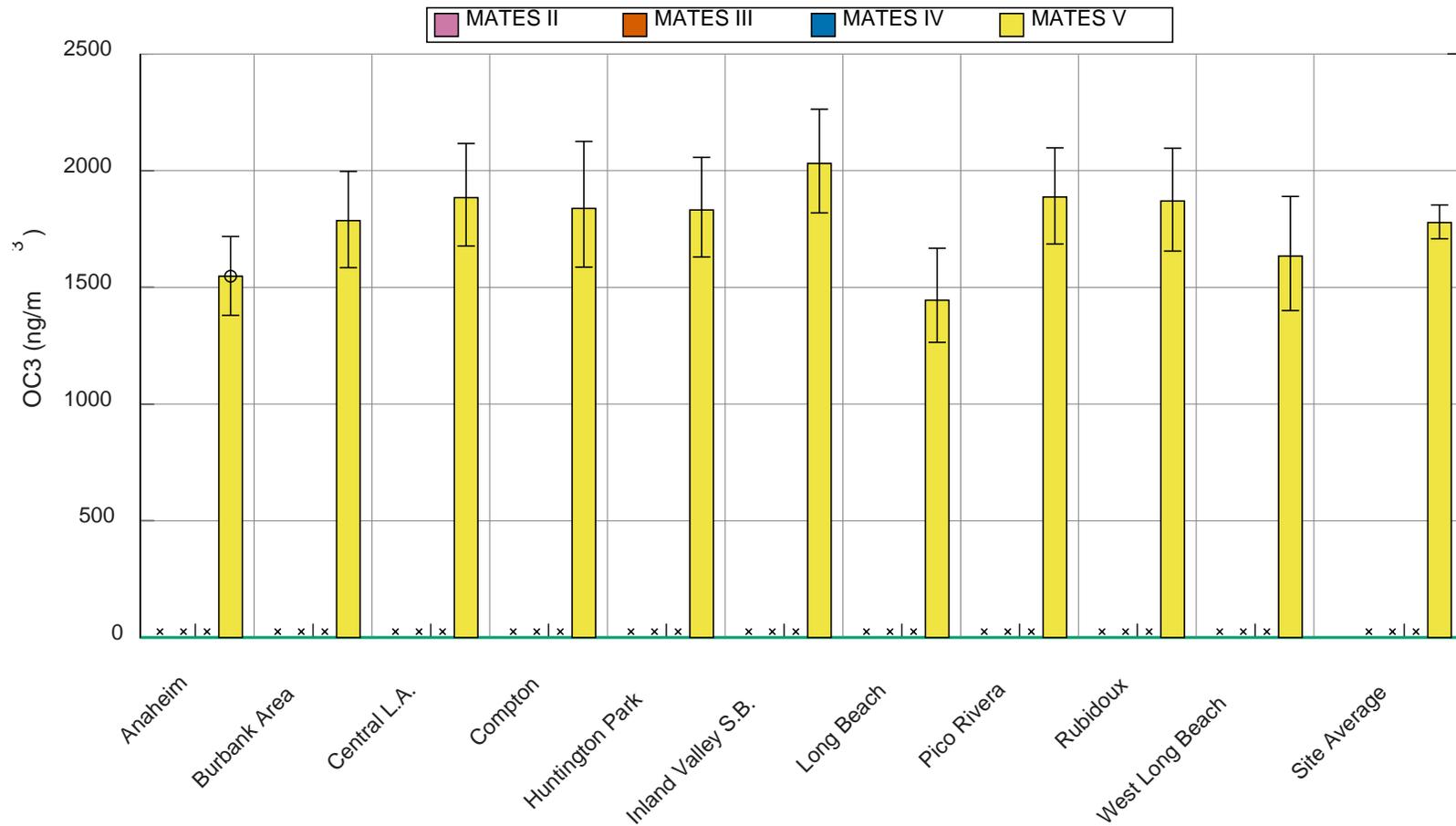


**Figure IV-211.** Geographic distribution of OC2 from the PM2.5 Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

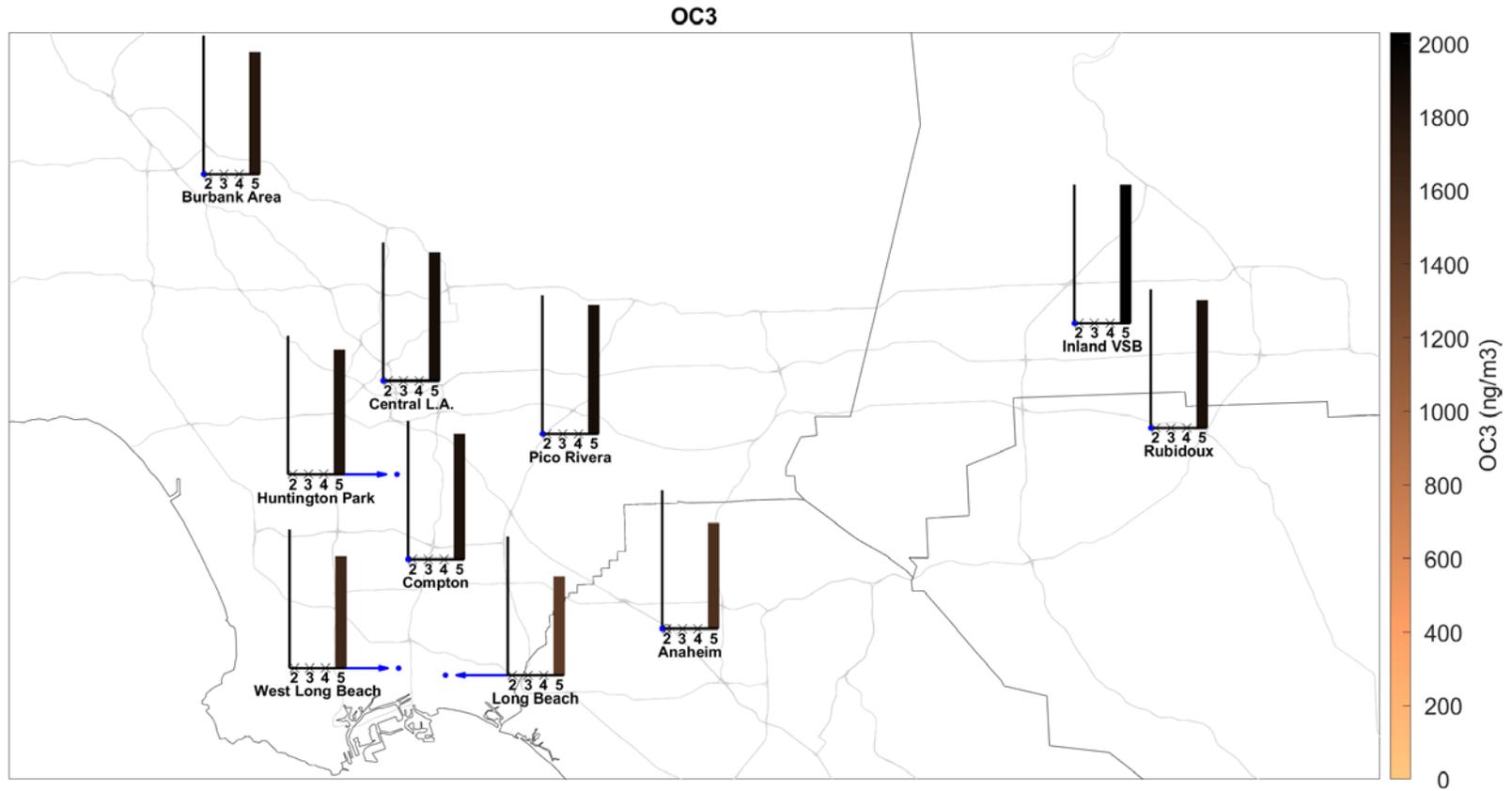
OC3

**Table IV-108.** Ambient Concentrations (ng/m<sup>3</sup>) of OC3 from the PM2.5 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	1550	1790	1840	2030	1830	1450	1880	1890	1870	1630
95% CI LB	1380	1580	1590	1820	1630	1260	1680	1690	1660	1400
95% CI UB	1720	2000	2130	2260	2060	1670	2120	2100	2100	1890
N	56	59	61	60	60	61	61	59	59	55
% < MDL	0	0	0	0	0	0	0	0	1.7	0
Max	3600	4900	5300	4900	5200	4900	5150	4700	4200	5500



**Figure IV-212.** Annual Average Concentrations of OC3 in the PM2.5 Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

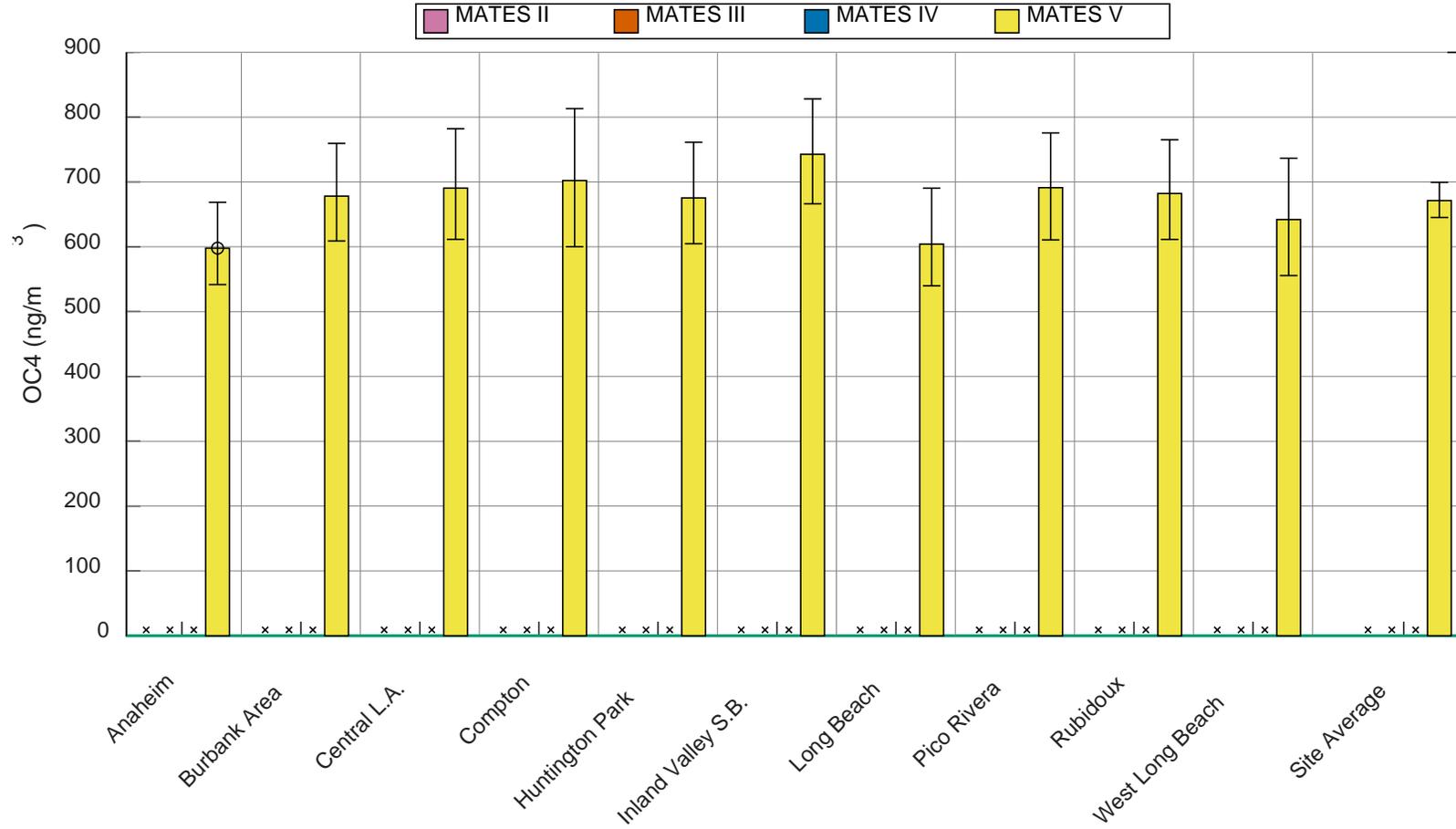


**Figure IV-213.** Geographic distribution of OC3 from the PM<sub>2.5</sub> Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

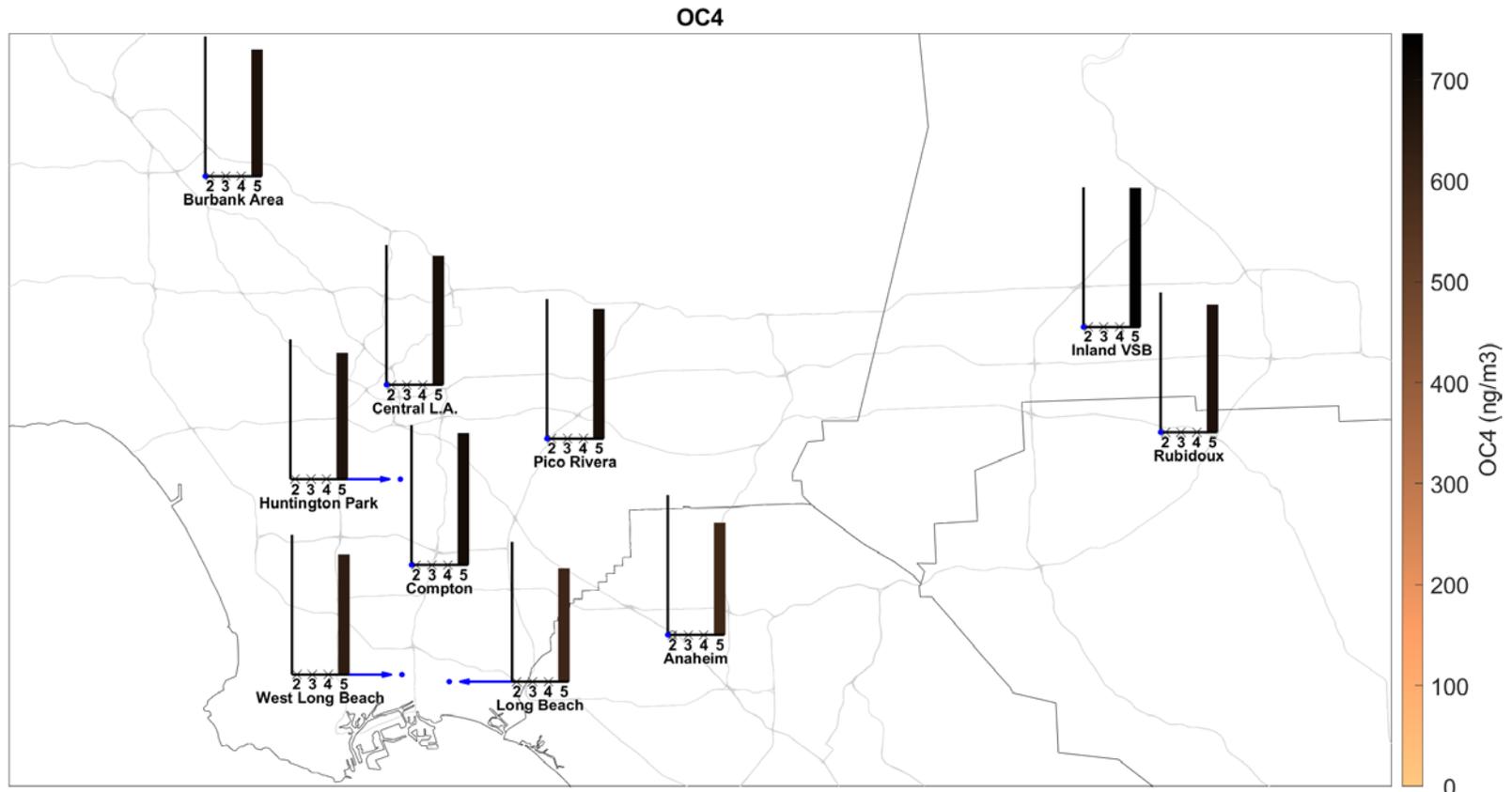
OC4

**Table IV-109.** Ambient Concentrations (ng/m<sup>3</sup>) of OC4 from the PM2.5 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	598	678	702	743	675	604	690	691	682	642
95% CI LB	542	609	600	666	605	540	611	611	611	556
95% CI UB	669	759	813	828	761	690	782	776	765	737
N	56	59	61	60	60	61	61	59	59	55
% < MDL	69.6	50.8	63.9	36.7	56.7	75.4	52.5	50.8	42.4	69.1
Max	1900	2000	2600	2000	1800	1900	2000	1900	1800	2000



**Figure IV-214.** Annual Average Concentrations of OC4 in the PM2.5 Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

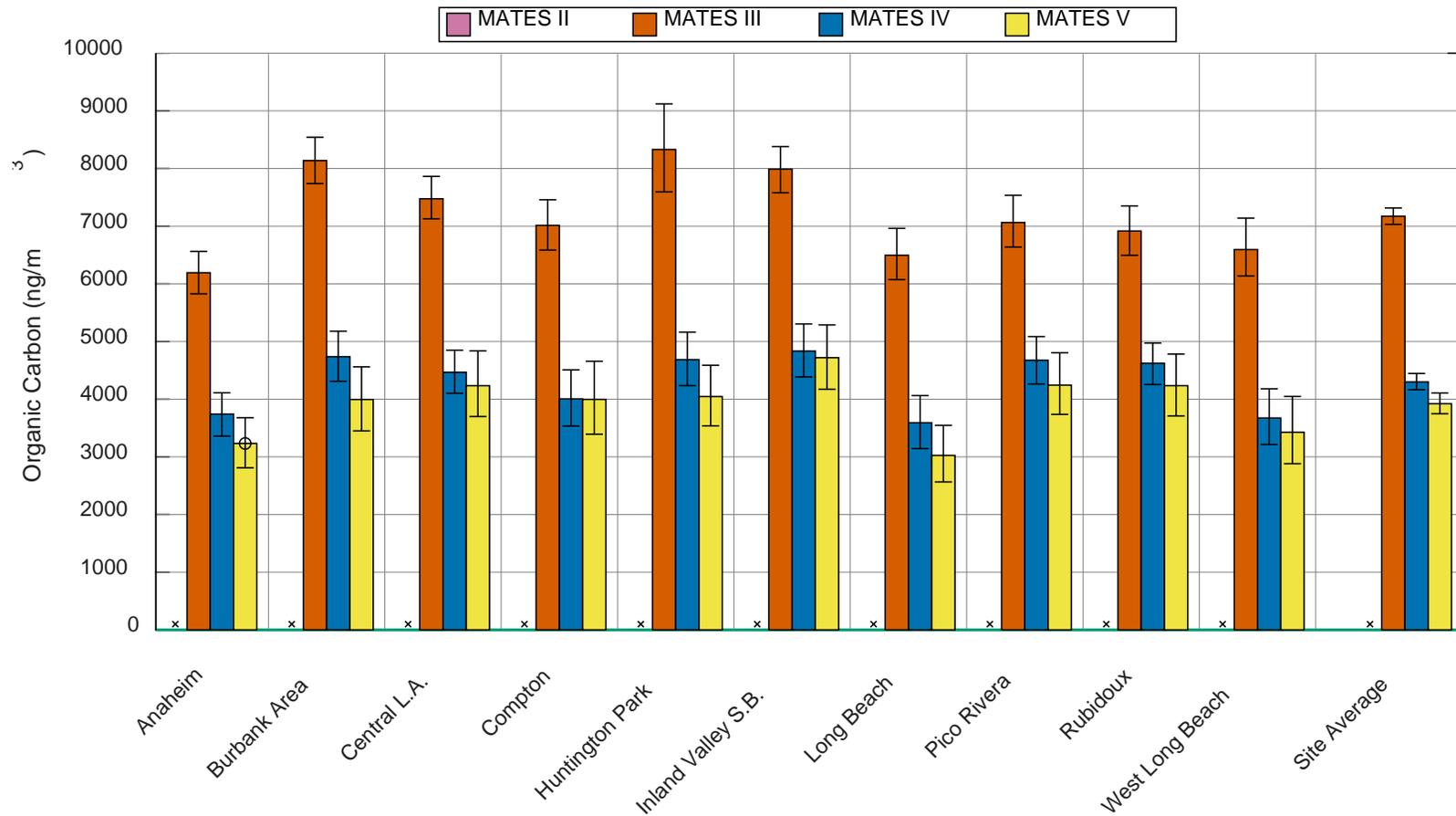


**Figure IV-215.** Geographic distribution of OC4 from the PM<sub>2.5</sub> Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

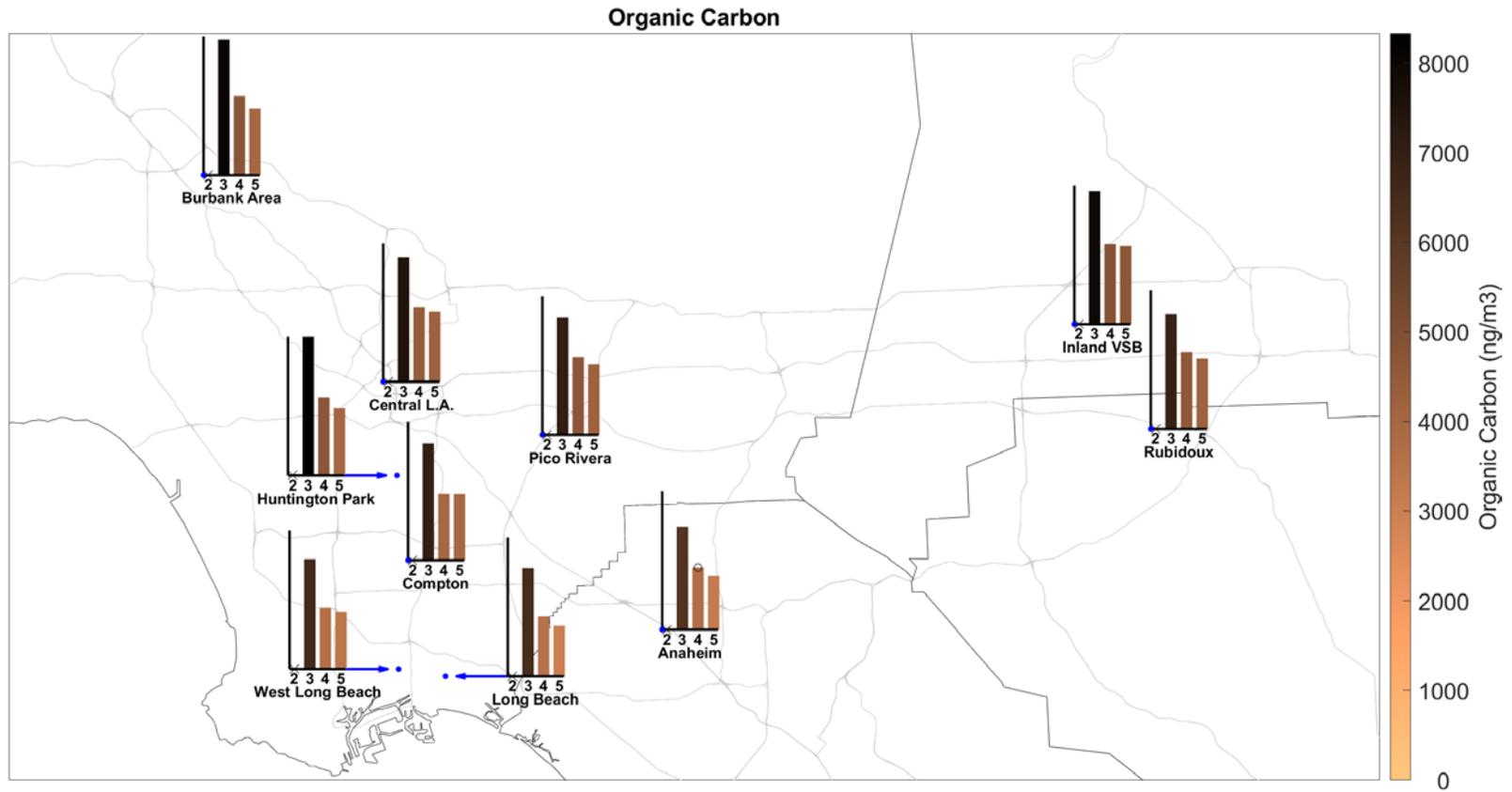
## Organic Carbon

**Table IV-110.** Ambient Concentrations (ng/m<sup>3</sup>) of Organic Carbon from the PM<sub>2.5</sub> Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	6190	8140	7010	7990	8330	6500	7480	7060	6920	6600
95% CI LB	5830	7740	6590	7580	7590	6070	7130	6640	6490	6140
95% CI UB	6560	8540	7460	8380	9120	6960	7860	7540	7350	7140
N	242	241	235	236	118	228	240	116	235	228
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	17700	22300	23700	18000	25500	19800	22300	13800	22400	20000
MATES IV										
Average	3740	4740	4000	4840	4680	3590	4470	4680	4620	3670
95% CI LB	3360	4310	3530	4390	4240	3140	4100	4260	4250	3210
95% CI UB	4110	5180	4510	5310	5160	4060	4850	5090	4970	4180
N	59	59	61	60	59	61	60	59	61	61
% < MDL	0	1.7	0	0	0	0	0	0	0	0
Max	8000	9500	10000	11000	10000	11000	8100	10000	9800	9900
MATES V										
Average	3230	4000	4000	4720	4050	3020	4230	4240	4240	3430
95% CI LB	2810	3450	3390	4170	3540	2570	3700	3740	3710	2880
95% CI UB	3680	4560	4660	5290	4590	3550	4840	4810	4780	4050
N	56	59	61	60	60	61	61	59	59	55
% < MDL	0	0	0	0	0	0	0	0	1.7	0
Max	8800	11000	12000	11000	11000	11000	13500	12000	9900	11000



**Figure IV-216.** Annual Average Concentrations of Organic Carbon in the PM<sub>2.5</sub> Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

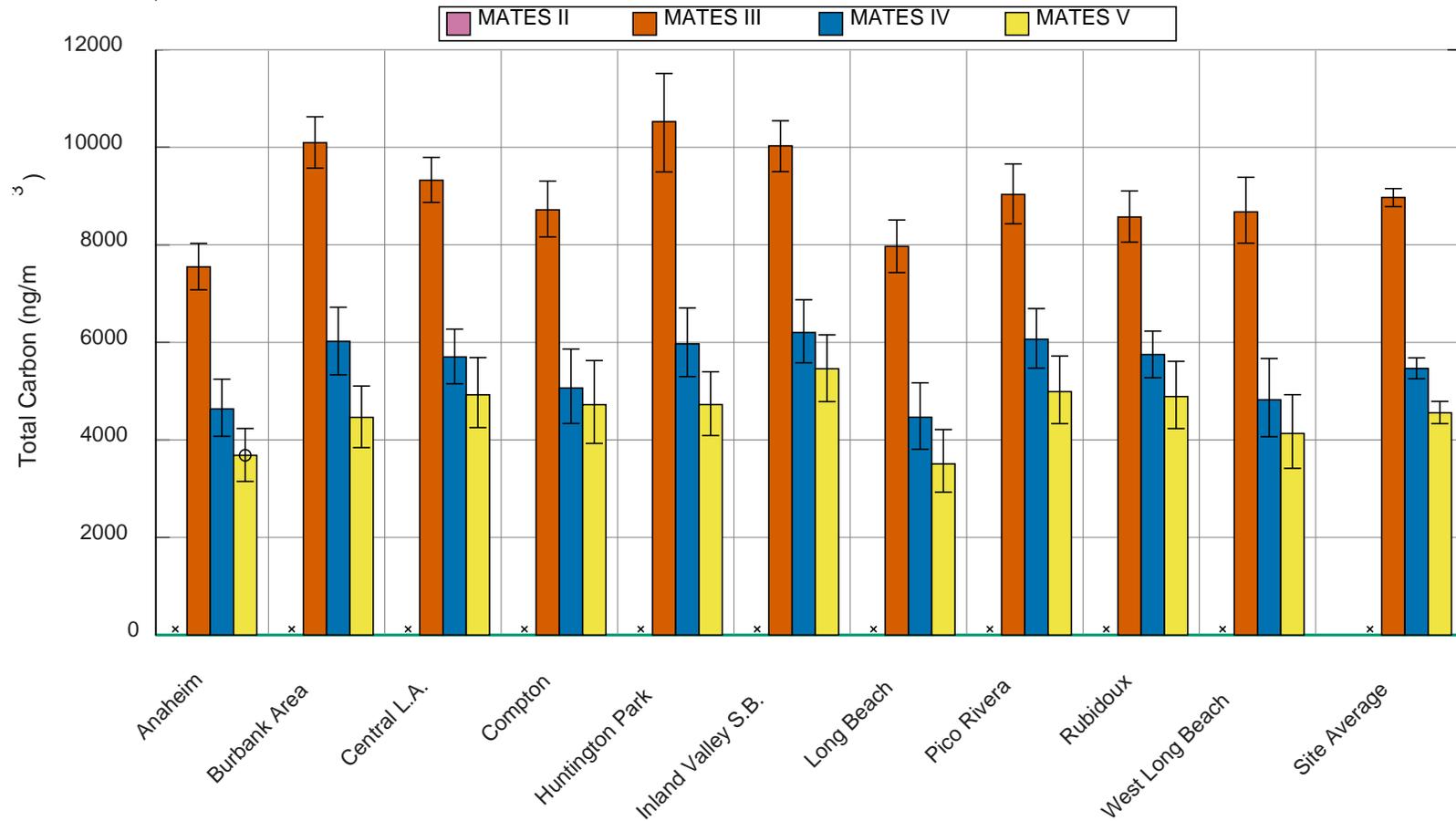


**Figure IV-217.** Geographic distribution of Organic Carbon from the PM<sub>2.5</sub> Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

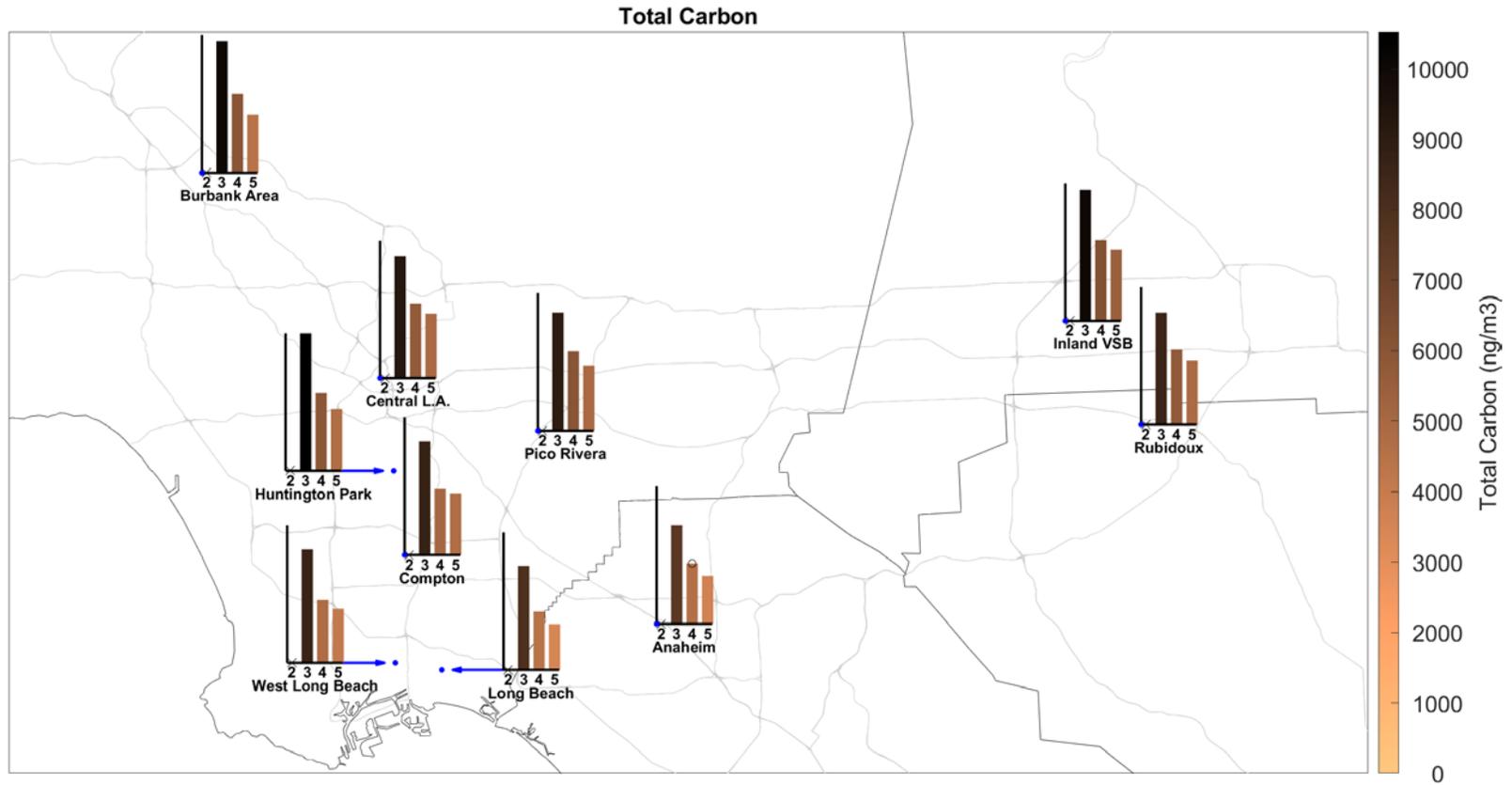
Total Carbon

**Table IV-111.** Ambient Concentrations (ng/m<sup>3</sup>) of Total Carbon from the PM2.5 Carbon analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	7550	10100	8720	10000	10500	7970	9320	9030	8570	8680
95% CI LB	7080	9570	8160	9500	9490	7430	8870	8430	8060	8040
95% CI UB	8030	10600	9310	10500	11500	8510	9790	9660	9100	9380
N	242	241	235	236	118	228	240	116	235	228
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	22600	28600	30800	21400	34000	24800	24500	18200	24600	26900
MATES IV										
Average	4640	6020	5060	6200	5970	4470	5700	6060	5750	4820
95% CI LB	4070	5330	4340	5580	5300	3810	5150	5470	5270	4070
95% CI UB	5240	6720	5860	6870	6710	5170	6270	6690	6230	5670
N	59	59	61	60	59	61	60	59	61	61
% < MDL	0	1.7	0	0	0	0	0	0	0	0
Max	12000	14000	15000	17000	15000	14000	12000	14000	12000	15000
MATES V										
Average	3680	4460	4720	5460	4730	3510	4920	4990	4890	4130
95% CI LB	3150	3840	3930	4790	4090	2930	4250	4330	4230	3420
95% CI UB	4230	5100	5630	6150	5400	4210	5690	5720	5610	4930
N	56	59	61	60	60	61	61	59	59	55
% < MDL	0	0	0	0	0	0	0	0	1.7	0
Max	11000	13000	17000	13000	12000	12000	16500	15000	14000	14000



**Figure IV-218.** Annual Average Concentrations of Total Carbon in the PM<sub>2.5</sub> Carbon Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



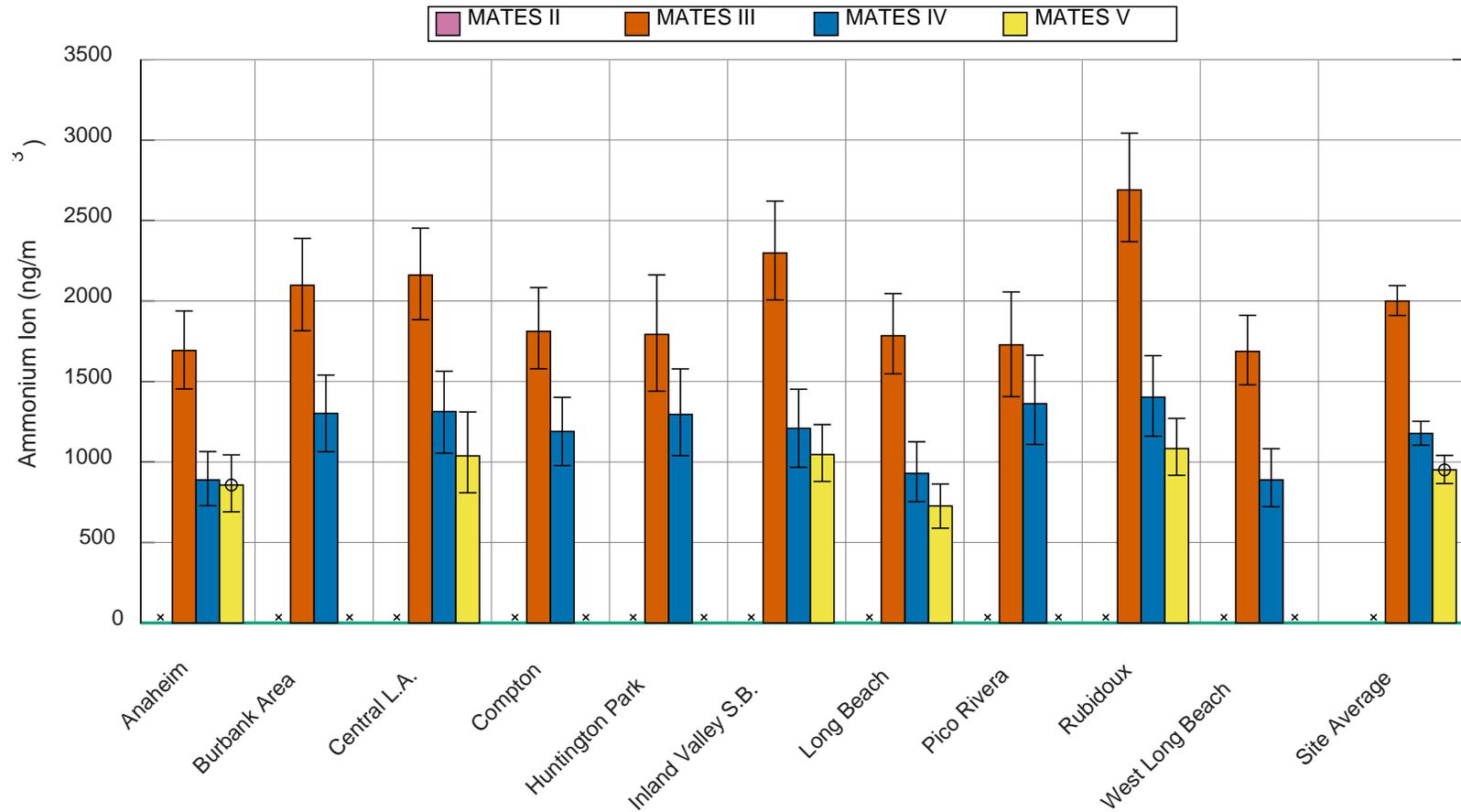
**Figure IV-219.** Geographic distribution of Total Carbon from the PM<sub>2.5</sub> Carbon Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

PM2.5 Ions Analysis

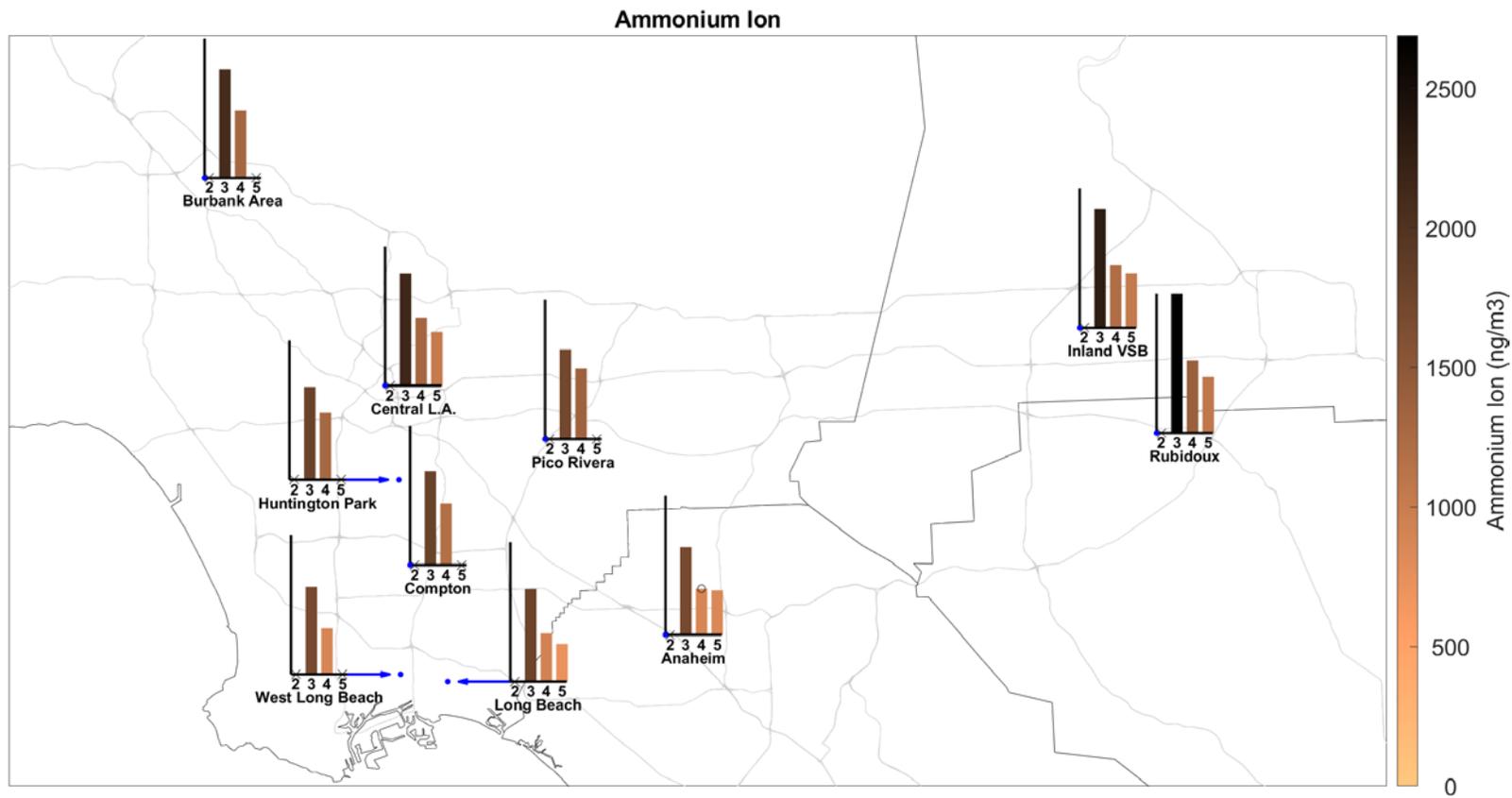
Ammonium Ion

**Table IV-112.** Ambient Concentrations (ng/m<sup>3</sup>) of Ammonium Ion from the PM2.5 Ions analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	1690	2100	1810	2300	1790	1780	2160	1730	2690	1690
95% CI LB	1450	1820	1580	2010	1440	1550	1880	1410	2370	1480
95% CI UB	1940	2390	2080	2620	2160	2050	2450	2060	3040	1910
N	242	241	234	236	118	228	239	116	234	226
% < MDL	9.5	7.9	8.5	7.6	12.7	10.5	9.2	9.5	11.1	8
Max	11300	11400	10300	21900	10300	11000	12200	9080	20600	9280
MATES IV										
Average	888	1300	1190	1210	1300	930	1310	1360	1400	888
95% CI LB	728	1060	978	967	1040	754	1050	1110	1160	722
95% CI UB	1060	1540	1400	1450	1580	1130	1560	1660	1660	1080
N	59	59	61	60	59	61	60	59	61	61
% < MDL	0	3.4	1.6	0	0	0	3.3	0	1.6	1.6
Max	3020	5330	4510	5180	4660	3430	4340	4930	4330	3360
MATES V										
Average	857			1050		727	1040		1080	
95% CI LB	690			879		589	809		918	
95% CI UB	1040			1230		863	1310		1270	
N	56	0	0	60	0	61	61	0	60	0
% < MDL	0			0		0	0		0	
Max	3190			3540		2500	6330		3780	



**Figure IV-220.** Annual Average Concentrations of Ammonium Ion in the PM<sub>2.5</sub> Ions Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

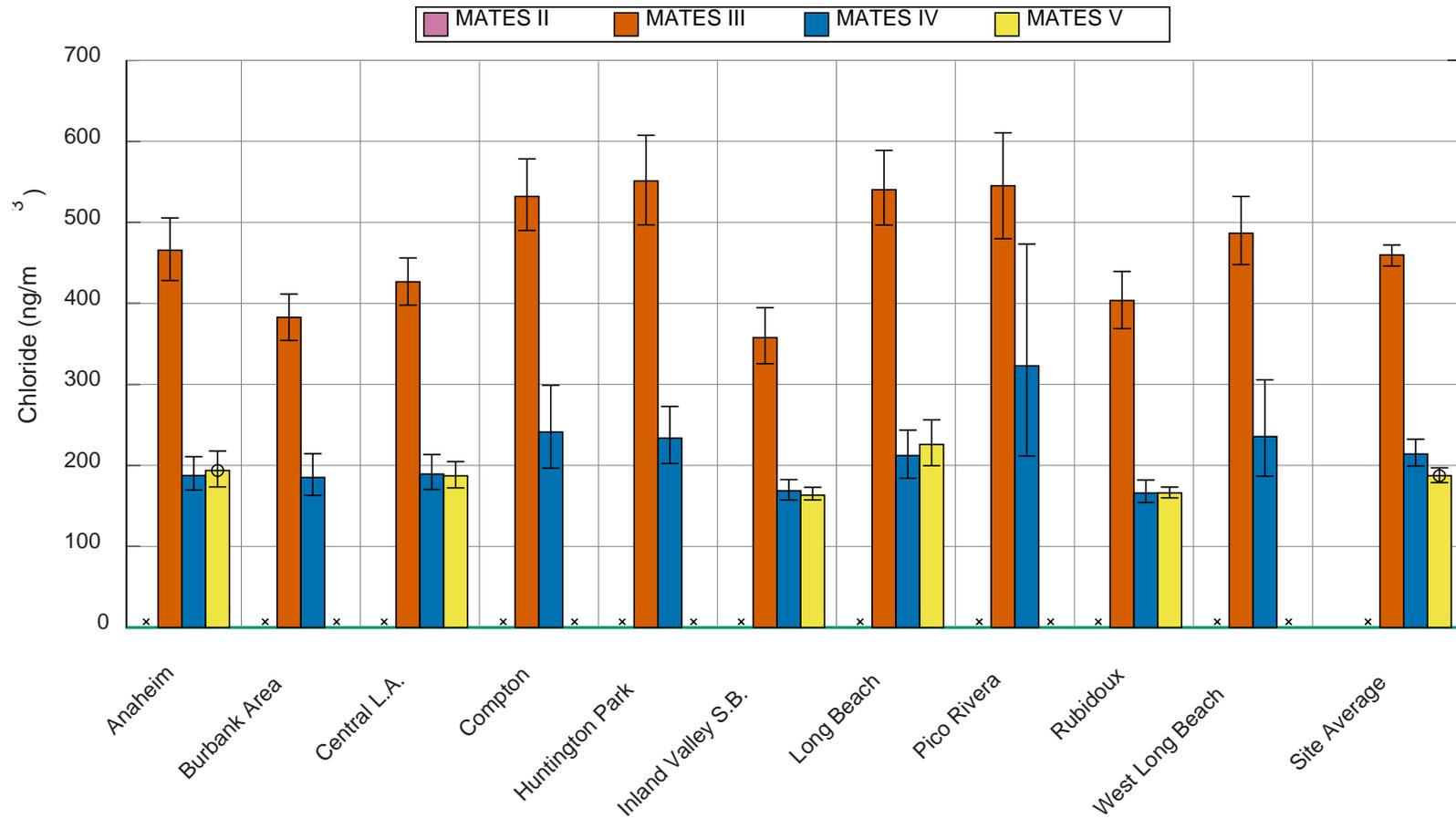


**Figure IV-221.** Geographic distribution of Ammonium Ion from the PM2.5 Ions Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

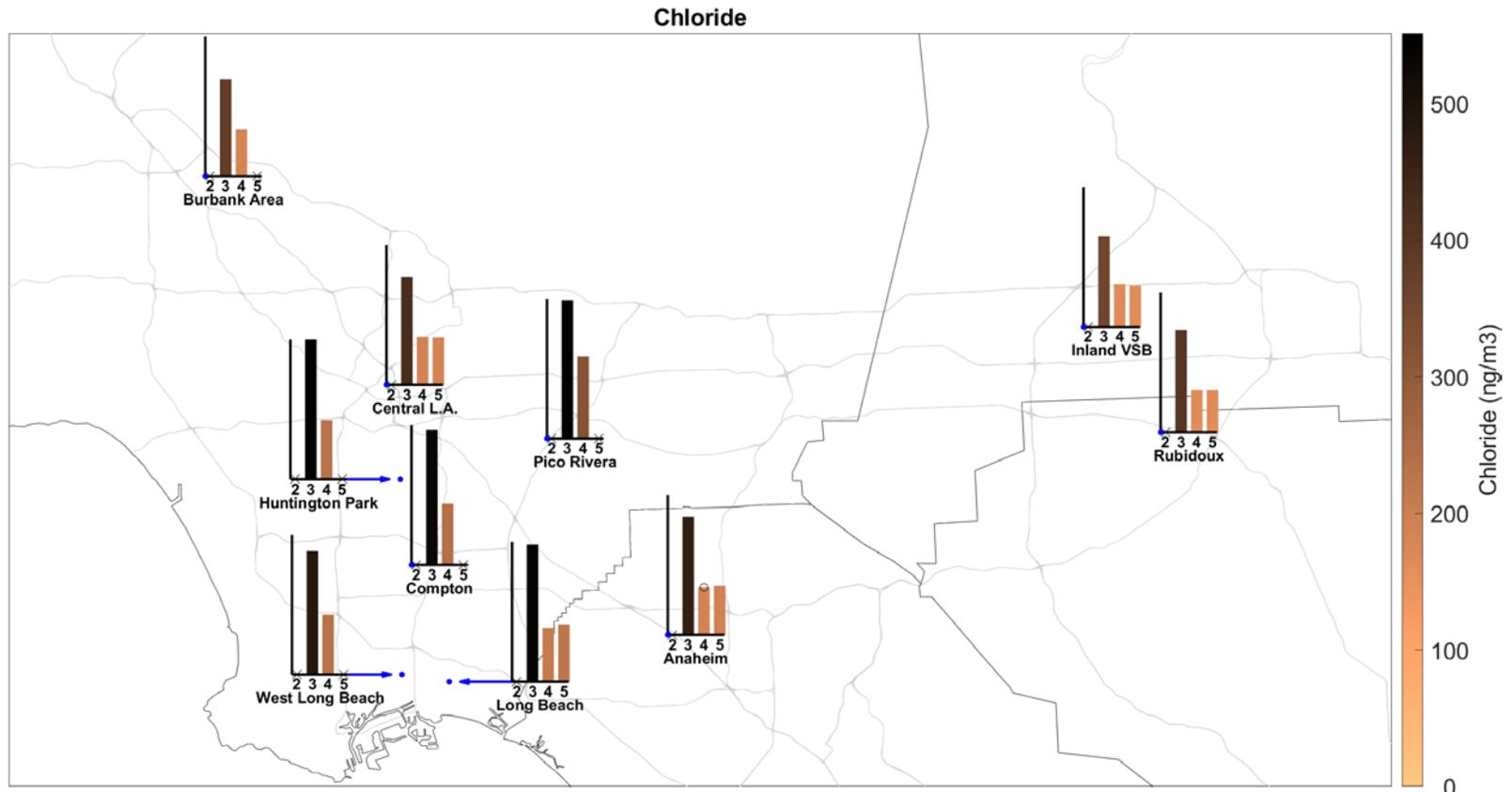
Chloride

**Table IV-113.** Ambient Concentrations (ng/m<sup>3</sup>) of Chloride from the PM2.5 Ions analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	466	383	532	358	551	540	427	545	403	487
95% CI LB	428	354	490	326	497	497	398	480	369	448
95% CI UB	505	411	578	395	607	589	456	610	439	532
N	236	238	230	232	115	226	236	115	229	224
% < MDL	9.3	11.3	5.2	23.3	5.2	4.9	7.2	4.3	19.7	5.4
Max	2090	1230	2400	2340	1700	2870	1330	1850	1570	2590
MATES IV										
Average	187	185	241	169	234	212	189	323	166	236
95% CI LB	169	163	197	157	202	184	170	212	154	187
95% CI UB	211	214	299	182	273	244	213	473	182	306
N	59	59	61	60	59	61	60	59	61	61
% < MDL	62.7	66.1	47.5	80	39	52.5	51.7	49.2	78.7	52.5
Max	650	840	1370	400	890	680	640	3260	490	1820
MATES V										
Average	194			163		226	187		166	
95% CI LB	173			157		200	172		160	
95% CI UB	218			173		256	205		173	
N	56	0	0	60	0	61	61	0	60	0
% < MDL	57.1			76.7		36.1	50.8		65	
Max	540			310		840	420		270	



**Figure IV-222.** Annual Average Concentrations of Chloride in the PM<sub>2.5</sub> Ions Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

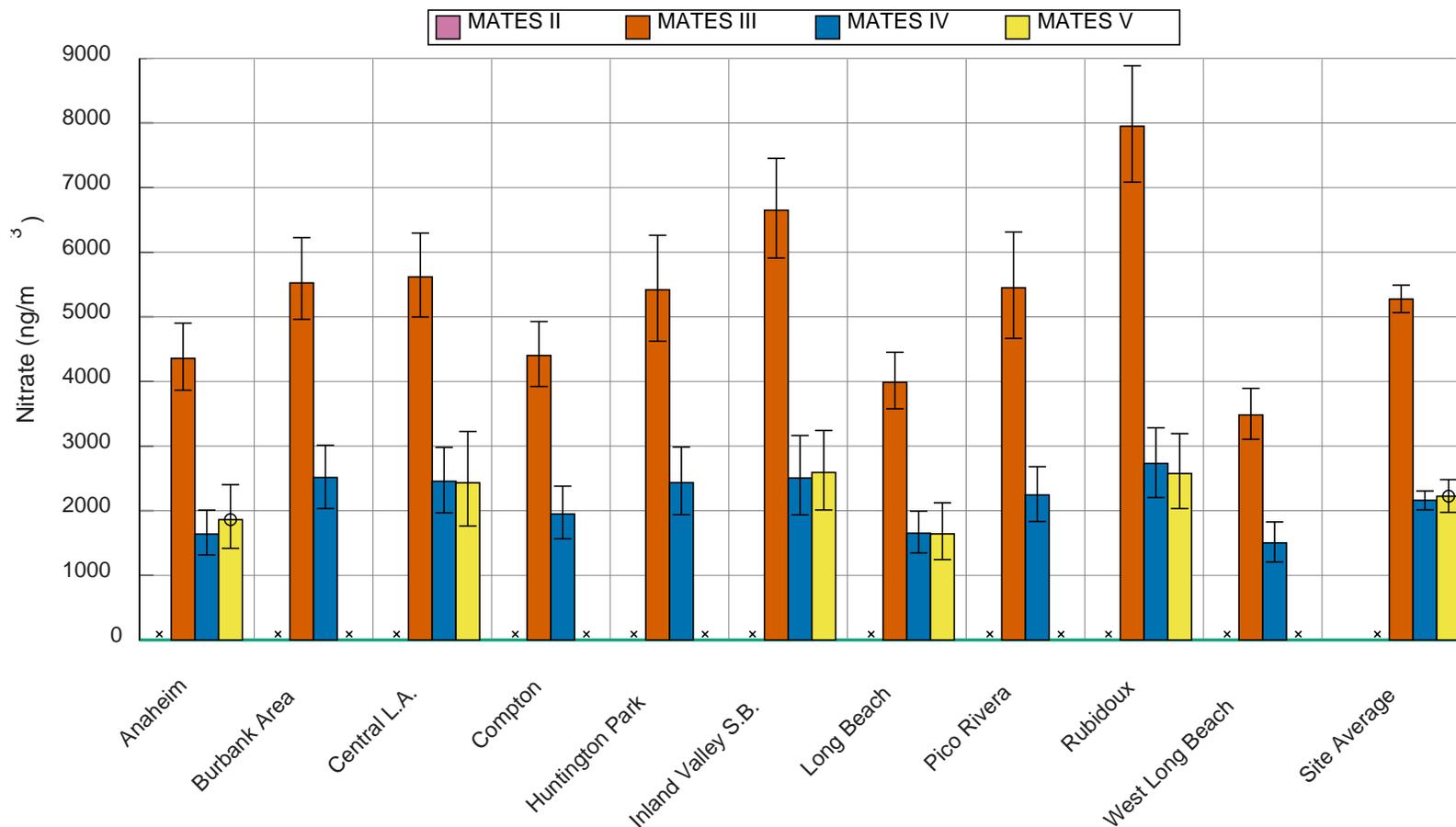


**Figure IV-223.** Geographic distribution of Chloride from the PM<sub>2.5</sub> Ions Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

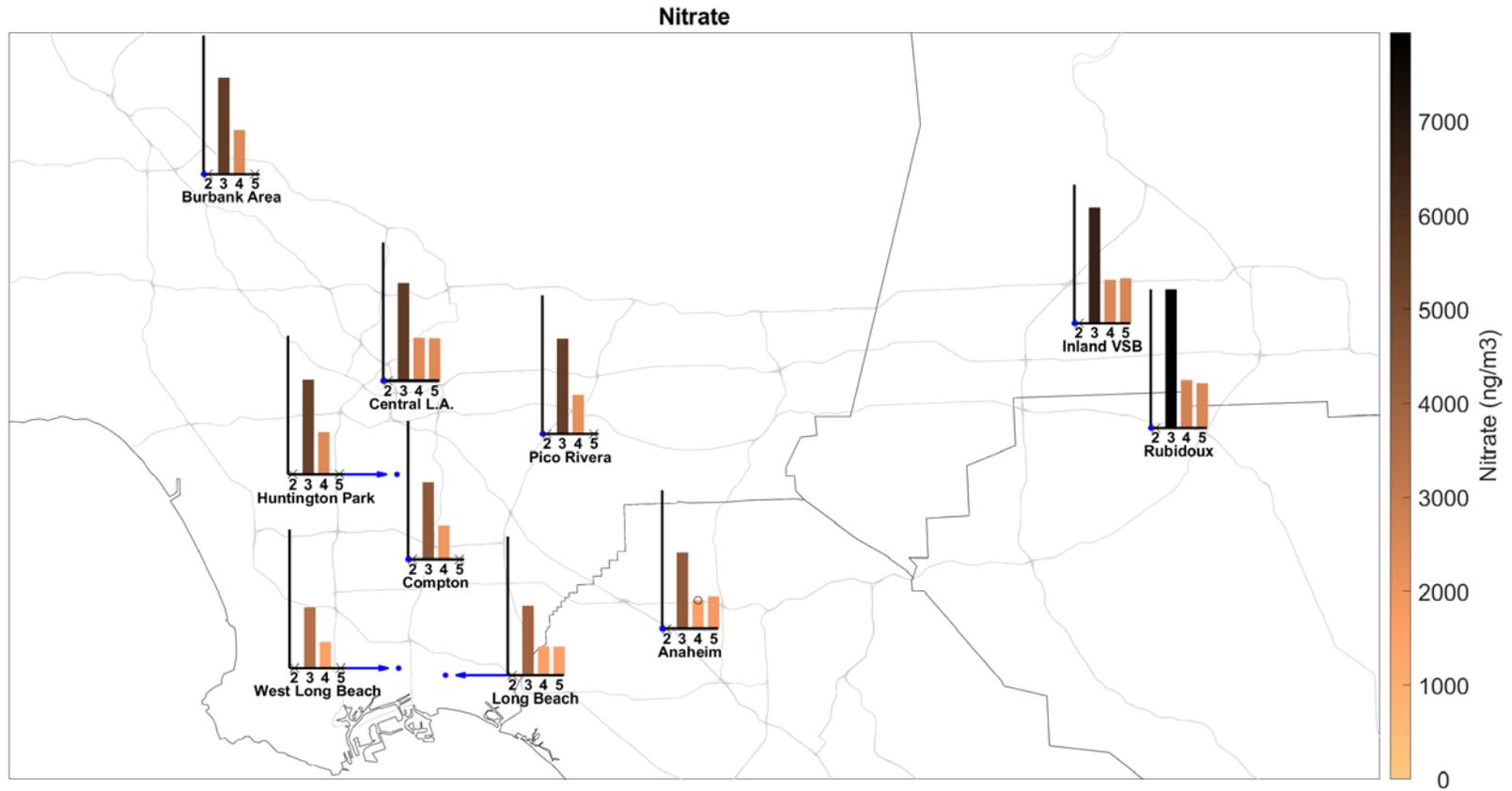
Nitrate

**Table IV-114.** Ambient Concentrations (ng/m<sup>3</sup>) of Nitrate from the PM2.5 Ions analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	4360	5520	4400	6650	5420	3990	5620	5450	7950	3480
95% CI LB	3870	4960	3920	5910	4620	3580	5000	4670	7080	3110
95% CI UB	4900	6230	4930	7450	6260	4450	6300	6310	8880	3890
N	236	238	230	232	115	226	236	115	229	224
% < MDL	0.4	1.7	0.4	0	0.9	0.9	0	0.9	0.4	0.4
Max	29000	28900	25500	52800	24100	26200	30400	25900	55600	21400
MATES IV										
Average	1640	2510	1950	2510	2430	1650	2460	2240	2730	1500
95% CI LB	1320	2030	1570	1940	1940	1350	1970	1830	2200	1210
95% CI UB	2010	3010	2380	3160	2990	1990	2980	2680	3280	1830
N	59	59	61	60	59	61	60	59	61	61
% < MDL	0	1.7	1.6	0	0	1.6	3.3	0	1.6	1.6
Max	6630	11000	9300	11500	10200	6360	8550	7350	9950	5970
MATES V										
Average	1860			2590		1640	2430		2580	
95% CI LB	1420			2010		1240	1760		2030	
95% CI UB	2400			3240		2120	3230		3190	
N	56	0	0	60	0	61	61	0	60	0
% < MDL	0			0		0	0		0	
Max	9480			12900		11300	17000		10700	



**Figure IV-224.** Annual Average Concentrations of Nitrate in the PM2.5 Ions Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

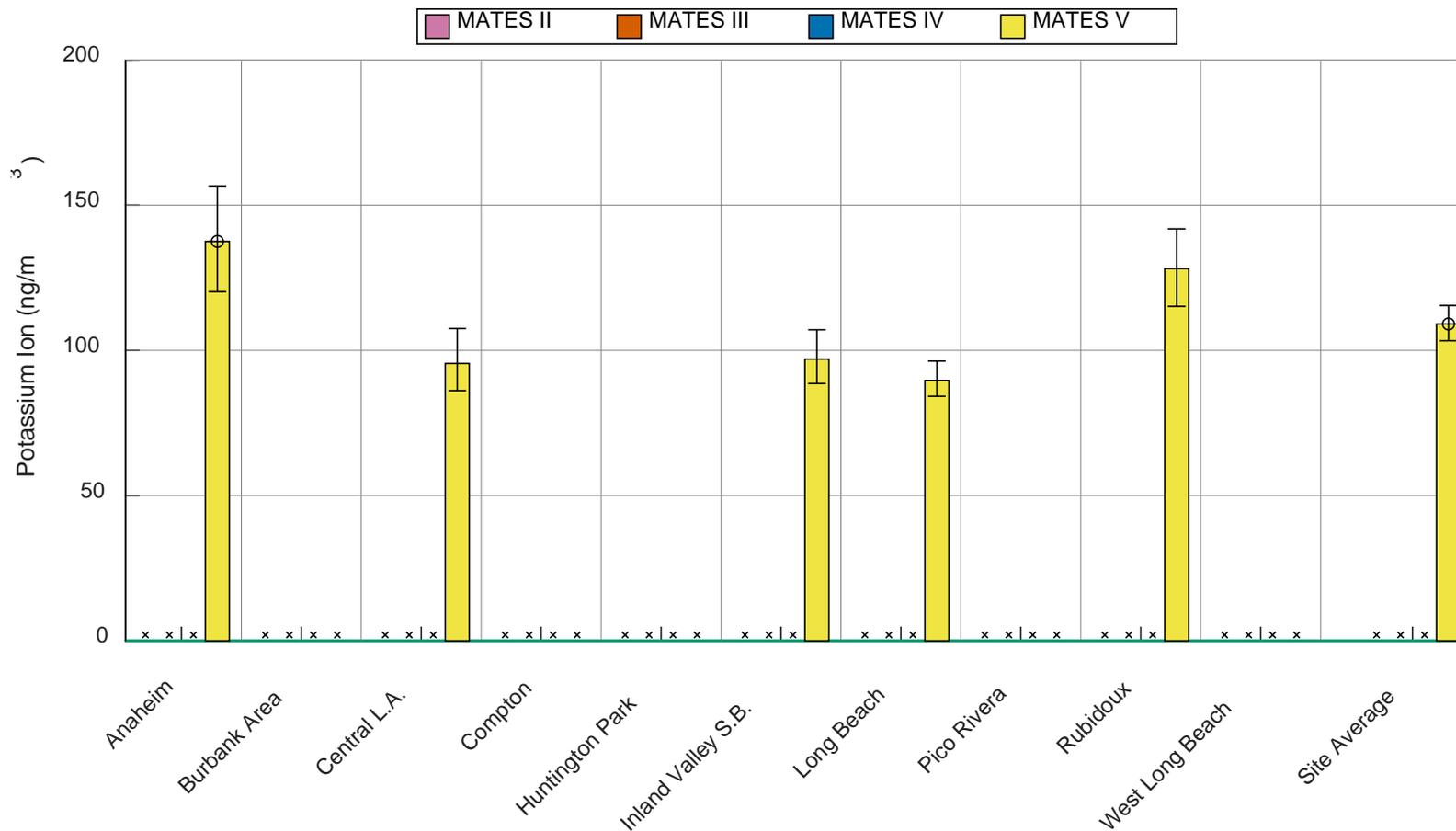


**Figure IV-225.** Geographic distribution of Nitrate from the PM<sub>2.5</sub> Ions Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

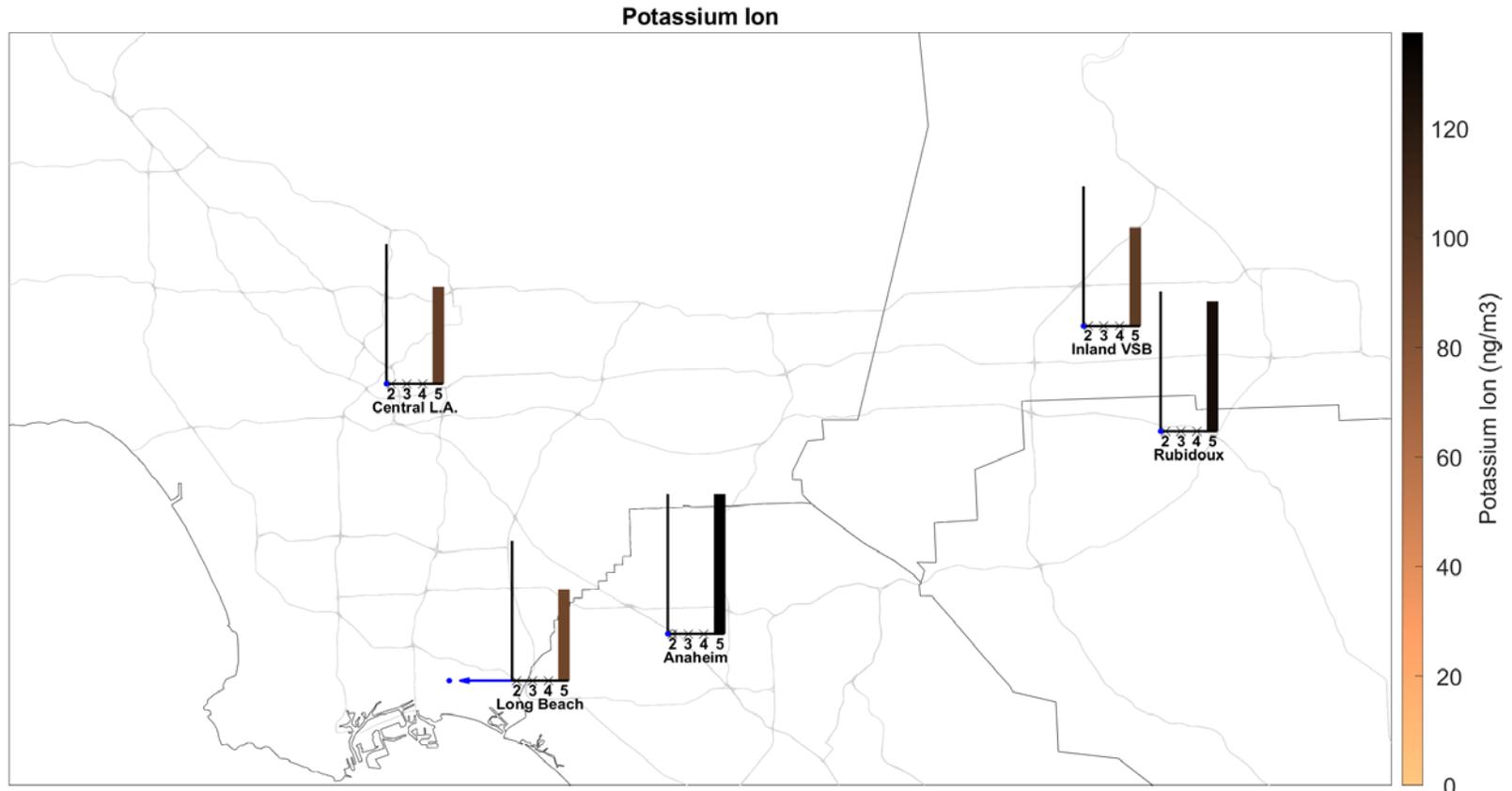
Potassium Ion

**Table IV-115.** Ambient Concentrations (ng/m<sup>3</sup>) of Potassium Ion from the PM2.5 Ions analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	138			97		89.7	95.5		128	
95% CI LB	120			88.6		84.2	86.1		115	
95% CI UB	157			107		96.3	108		142	
N	56	0	0	60	0	61	61	0	60	0
% < MDL	19.6			63.3		78.7	77		33.3	
Max	460			310		200	310		330	



**Figure IV-226.** Annual Average Concentrations of Potassium Ion in the PM2.5 Ions Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

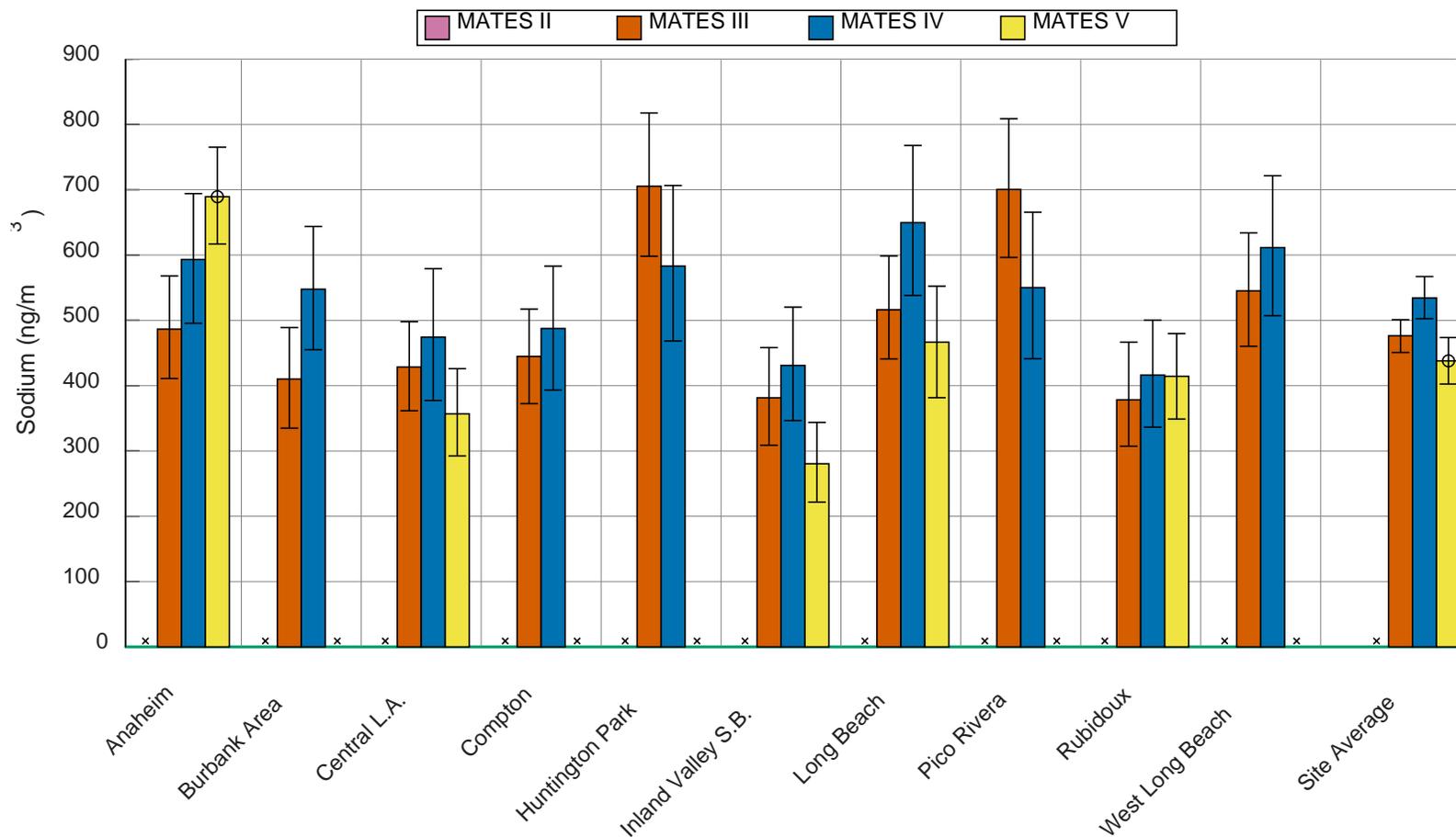


**Figure IV-227.** Geographic distribution of Potassium Ion from the PM<sub>2.5</sub> Ions Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

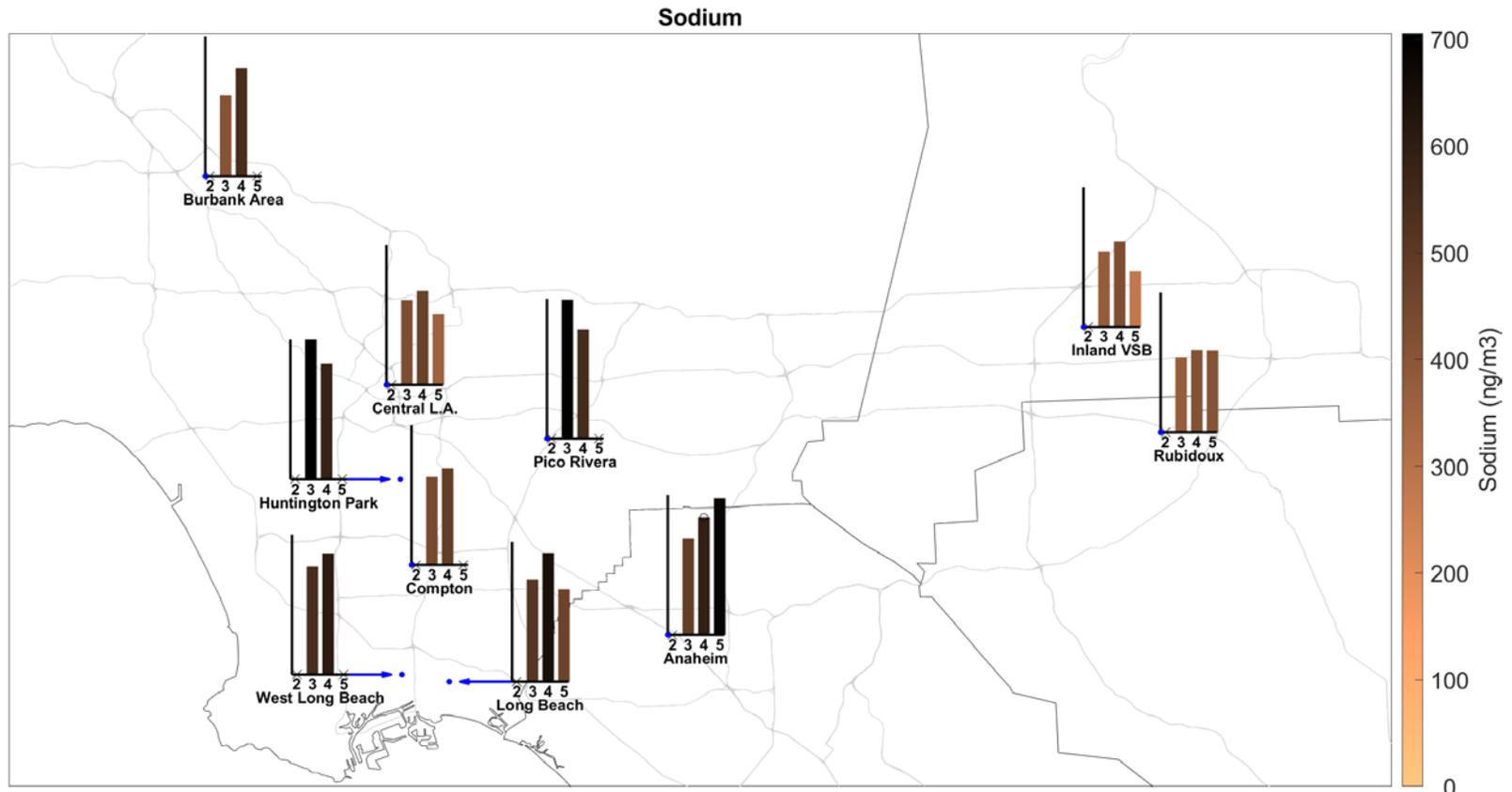
Sodium

**Table IV-116.** Ambient Concentrations (ng/m<sup>3</sup>) of Sodium from the PM2.5 Ions analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	487	410	445	381	705	516	429	700	378	545
95% CI LB	411	335	372	309	598	441	362	596	307	460
95% CI UB	568	489	517	458	818	599	498	809	467	634
N	242	241	234	236	118	228	239	116	234	226
% < MDL	40.1	43.6	38	50	11.9	32	38.5	12.9	51.7	33.6
Max	3600	3210	2710	3040	2680	3430	2360	2560	3870	3820
MATES IV										
Average	593	548	487	431	583	650	474	550	416	611
95% CI LB	496	455	393	346	468	538	377	441	336	507
95% CI UB	694	644	583	520	706	768	579	666	500	721
N	59	59	61	60	59	61	60	59	61	61
% < MDL	0	3.4	1.6	0	0	0	3.3	0	1.6	1.6
Max	1710	1480	1700	1470	1910	2150	1720	1670	1530	1680
MATES V										
Average	689			280		467	357		414	
95% CI LB	617			222		382	292		349	
95% CI UB	765			344		552	426		480	
N	56	0	0	60	0	61	61	0	60	0
% < MDL	0			1.7		0	0		0	
Max	1680			1020		1710	1180		1050	



**Figure IV-228.** Annual Average Concentrations of Sodium in the PM<sub>2.5</sub> Ions Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

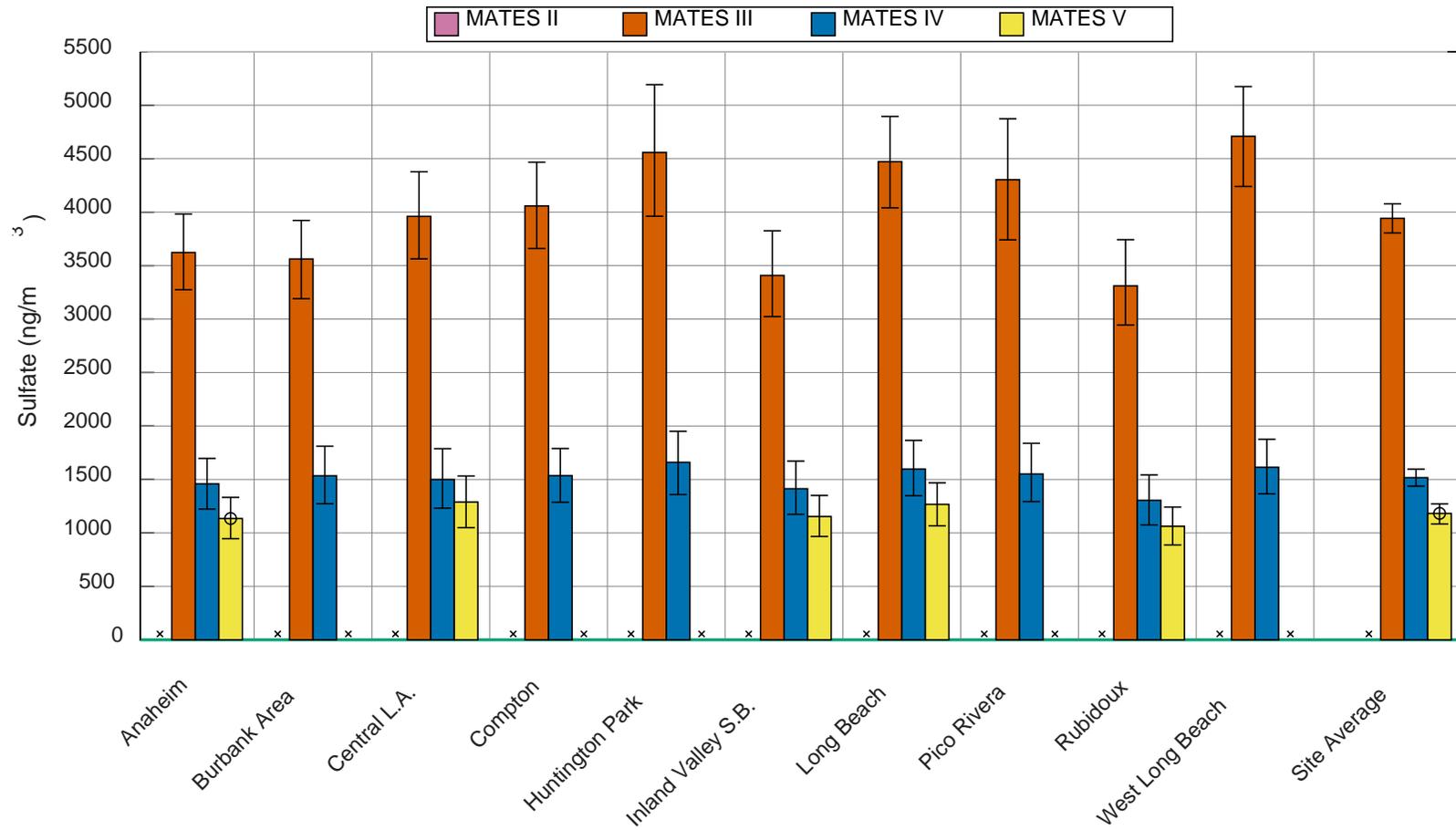


**Figure IV-229.** Geographic distribution of Sodium from the PM<sub>2.5</sub> Ions Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

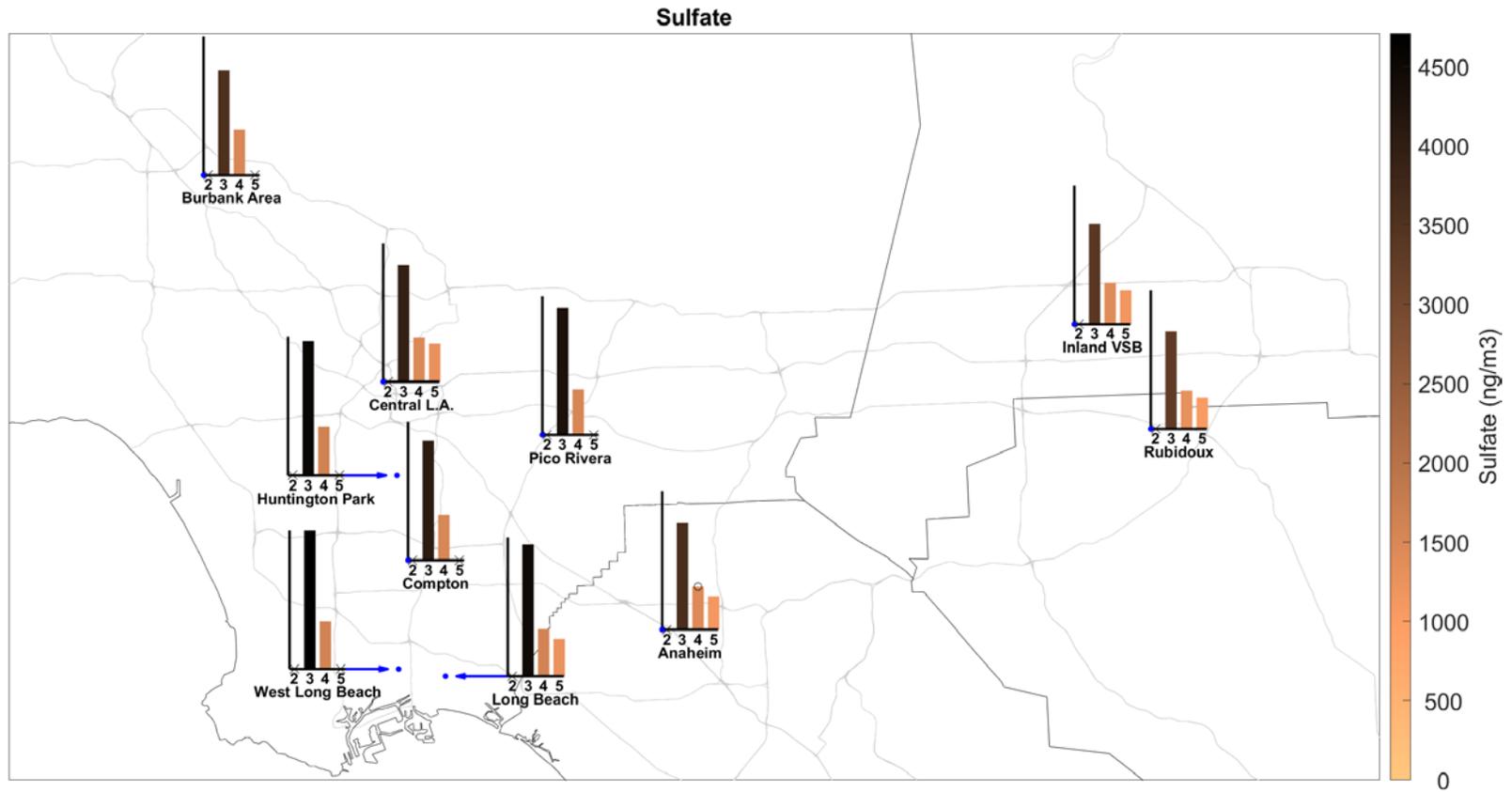
## Sulfate

**Table IV-117.** Ambient Concentrations (ng/m<sup>3</sup>) of Sulfate from the PM<sub>2.5</sub> Ions analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	3620	3560	4060	3410	4560	4470	3960	4300	3310	4710
95% CI LB	3270	3190	3660	3020	3960	4040	3560	3740	2940	4240
95% CI UB	3980	3920	4470	3830	5190	4890	4380	4870	3740	5170
N	236	238	230	232	115	226	236	115	229	224
% < MDL	5.9	7.1	4.8	4.7	0.9	2.7	3	1.7	4.4	4.9
Max	14300	13300	15800	30800	15200	18100	18300	16500	27900	20100
MATES IV										
Average	1460	1530	1540	1410	1660	1600	1500	1550	1300	1610
95% CI LB	1220	1270	1290	1170	1360	1350	1230	1290	1070	1370
95% CI UB	1700	1810	1790	1670	1950	1870	1790	1840	1540	1880
N	59	59	61	60	59	61	60	59	61	61
% < MDL	0	1.7	1.6	1.7	0	0	3.3	0	1.6	1.6
Max	3600	3810	4160	3790	4580	3950	4240	4230	3050	3980
MATES V										
Average	1130			1150		1270	1290		1060	
95% CI LB	946			967		1070	1050		887	
95% CI UB	1330			1350		1470	1530		1240	
N	56	0	0	60	0	61	61	0	60	0
% < MDL	0			1.7		0	0		3.3	
Max	2740			2790		3360	3780		2480	



**Figure IV-230.** Annual Average Concentrations of Sulfate in the PM2.5 Ions Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



**Figure IV-231.** Geographic distribution of Sulfate from the PM2.5 Ions Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

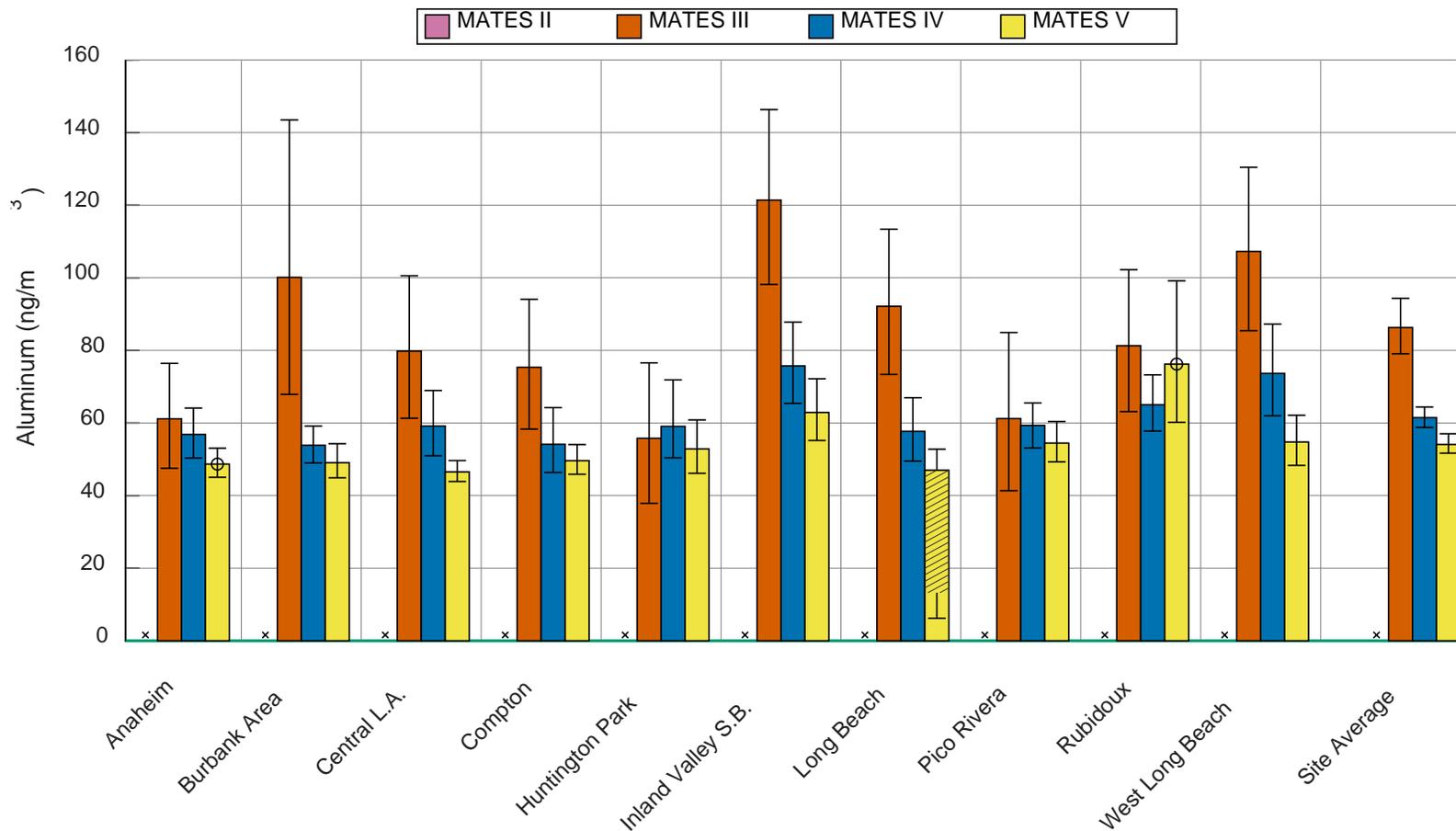
PM2.5 Metals Analysis

## Aluminum

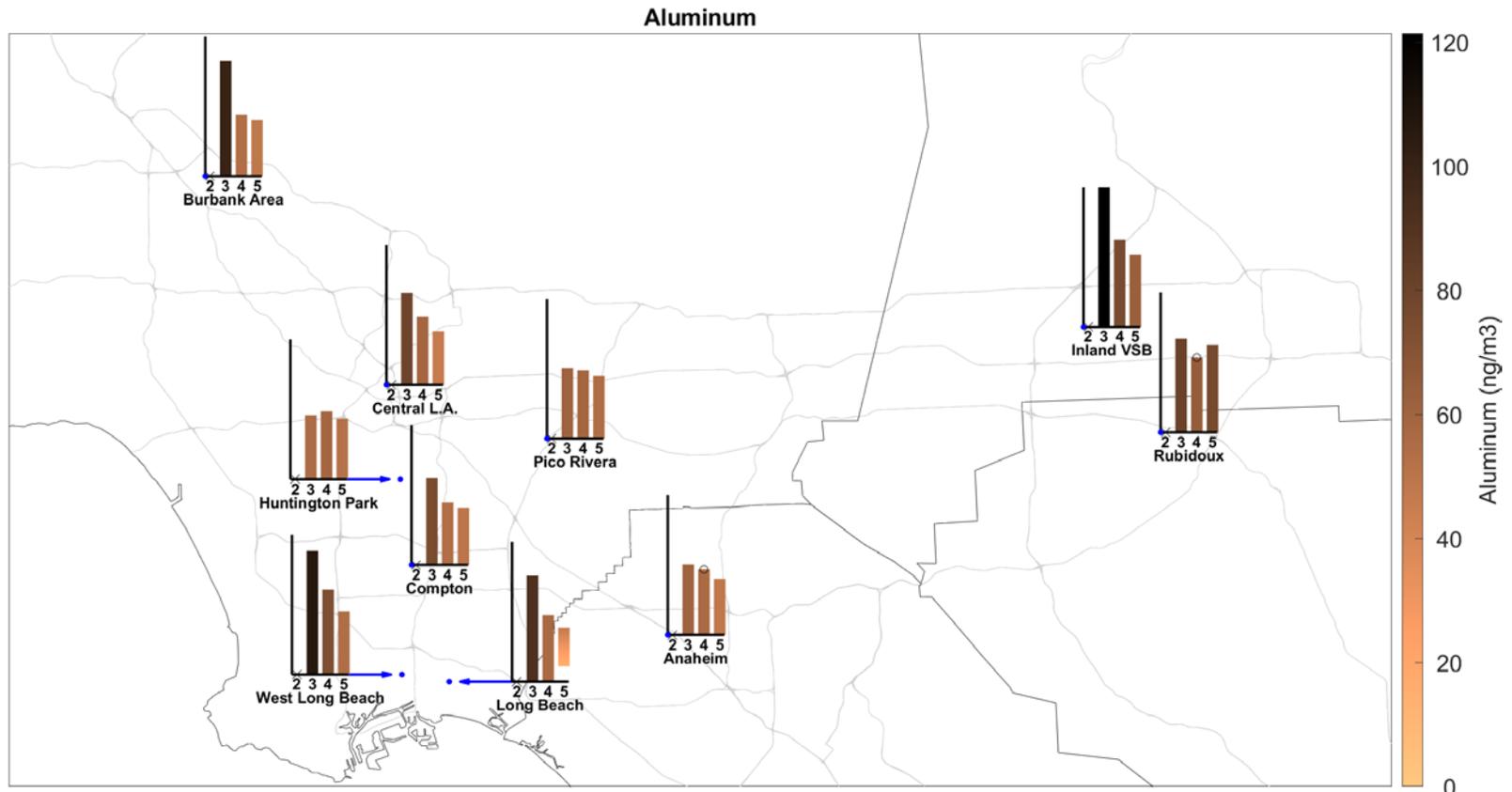
**Table IV-118.** Ambient Concentrations (ng/m<sup>3</sup>) of Aluminum from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	61.1	100	75.3	121	55.8	92.2	79.8	61.2	81.3	107
95% CI LB	47.5	67.9	58.3	98.2	37.8	73.4	61.3	41.3	63.1	85.4
95% CI UB	76.4	143	94.1	146	76.6	113	101	84.9	102	130
N	240	239	234	238	117	228	237	116	236	228
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	773	4360	1100	926	673	898	1130	786	1300	951
MATES IV										
Average	56.8	53.9	54.1	75.7	59	57.7	59.2	59.3	65	73.7
95% CI LB	50.3	49	46.4	65.4	50.4	49.5	50.9	53.1	57.8	62
95% CI UB	64.1	59.2	64.2	87.8	71.9	67	68.9	65.5	73.3	87.2
N	59	59	61	60	59	61	60	59	61	61
% < MDL	61	50.8	67.2	26.7	59.3	54.1	56.7	49.2	42.6	50.8
Max	176	119	286	286	317	285	214	130	161	290
MATES V										
Average	48.7	49.1	49.6	62.9	52.9	13.2, 47 <sup>a</sup>	46.5	54.5	76.2	54.8
95% CI LB	45.1	44.9	45.9	55.2	46.1	6.21 <sup>a</sup>	43.9	49.3	60.2	48.3
95% CI UB	53.1	54.3	54.1	72.2	60.8	52.8 <sup>a</sup>	49.6	60.4	99.2	62.1
N	54	59	61	60	60	61 <sup>a</sup>	61	59	56	57
% < MDL	72.2	67.8	70.5	43.3	70	80.3 <sup>a</sup>	75.4	49.2	42.9	54.4
Max	113	144	114	242	171	185 <sup>a</sup>	99	157	566	148

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-232.** Annual Average Concentrations of Aluminum in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



**Figure IV-233.** Geographic distribution of Aluminum from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

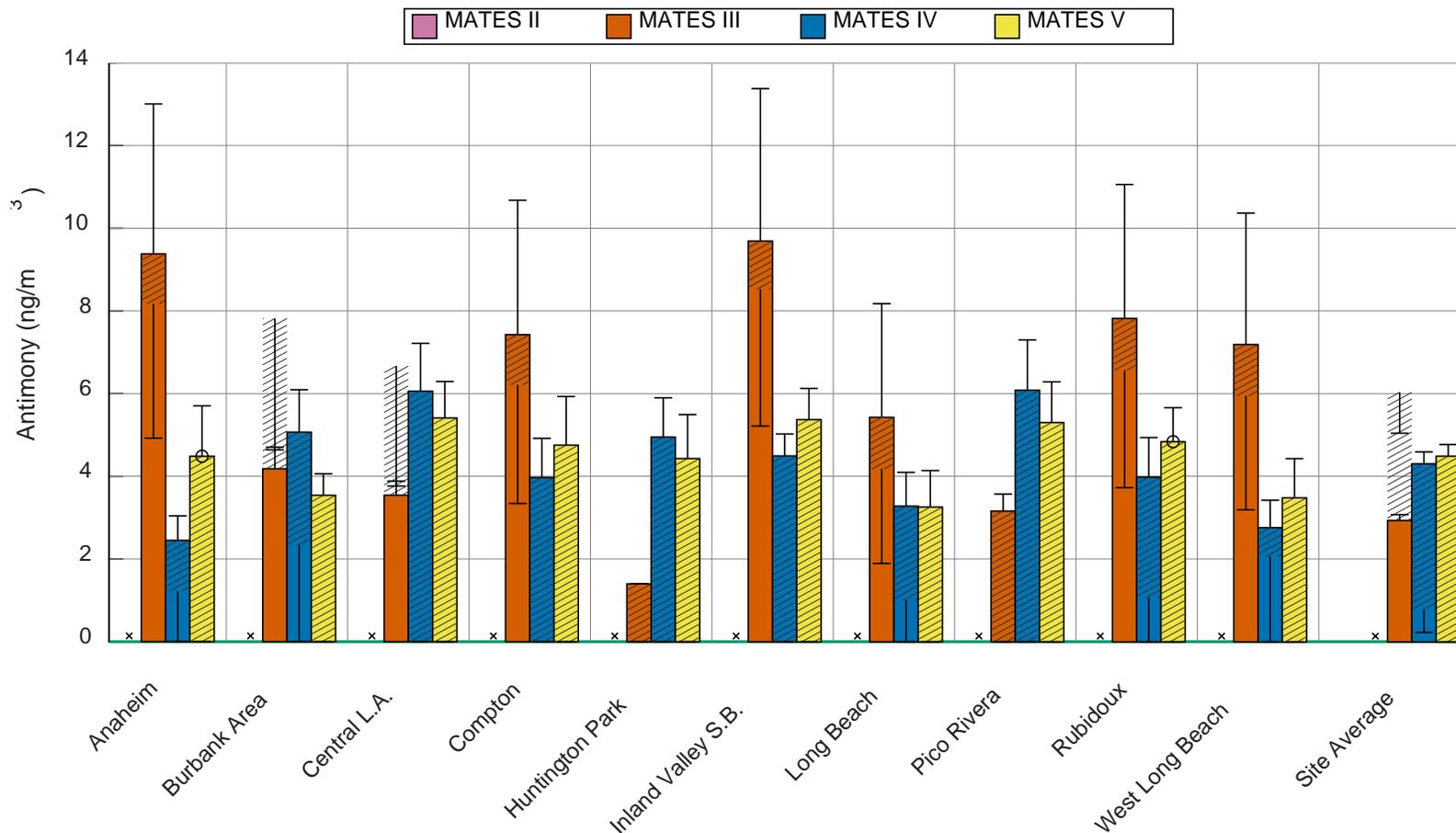
Antimony

**Table IV-119.** Ambient Concentrations (ng/m<sup>3</sup>) of Antimony from the PM2.5 Metals analysis at the Fixed Sites.

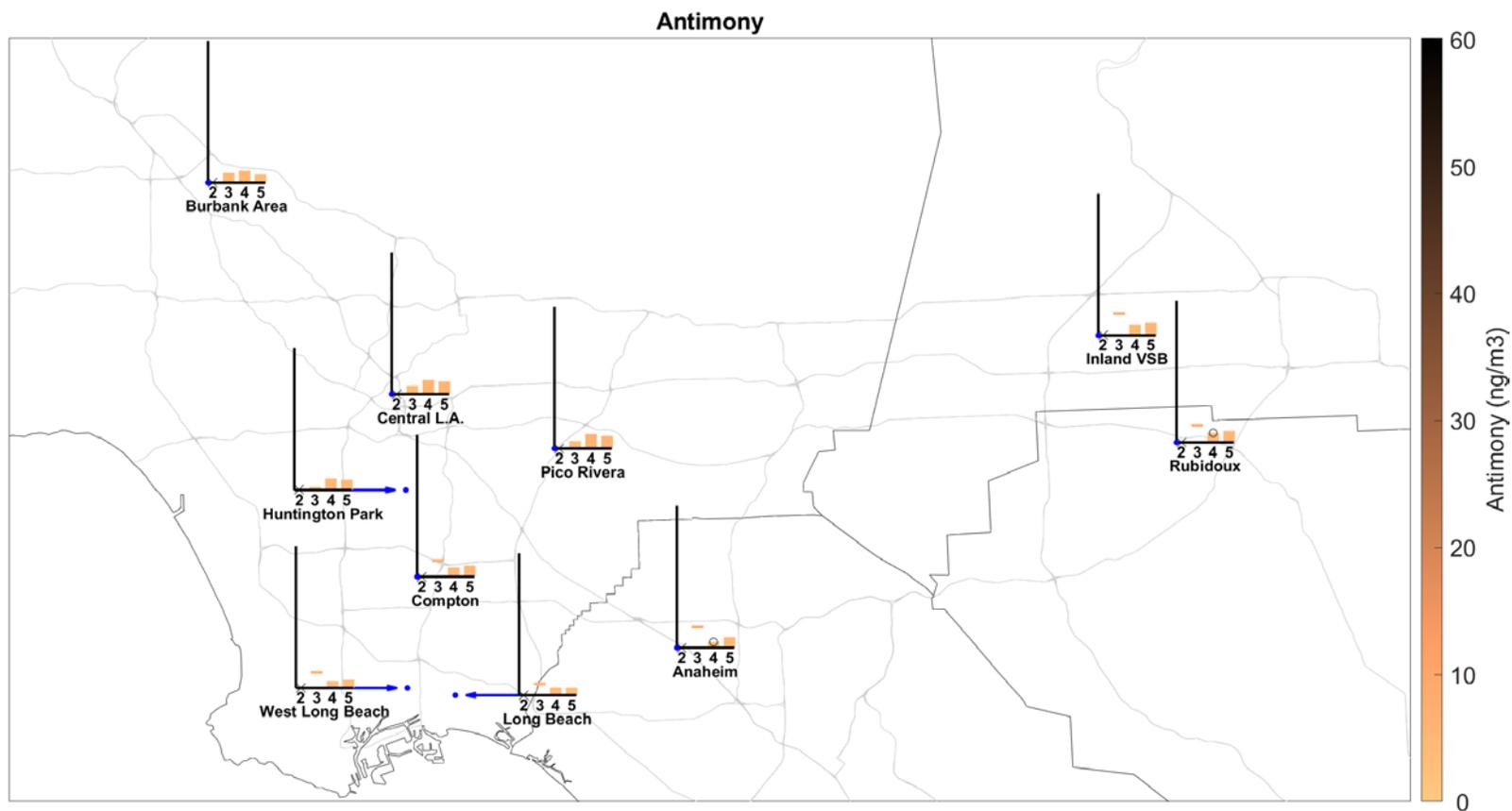
Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	8.17, 9.38 <sup>a</sup>	7.82, 4.18 <sup>b</sup>	6.21, 7.43 <sup>a</sup>	8.53, 9.69 <sup>a</sup>	0, 1.4 <sup>a</sup>	4.18, 5.43 <sup>a</sup>	6.67, 3.54 <sup>b</sup>	0, 3.16 <sup>b</sup>	6.57, 7.82 <sup>a</sup>	5.95, 7.19 <sup>a</sup>
95% CI LB	4.92 <sup>a</sup>	4.64 <sup>b</sup>	3.34 <sup>a</sup>	5.22 <sup>a</sup>	0 <sup>a</sup>	1.9 <sup>a</sup>	3.76 <sup>b</sup>	0 <sup>b</sup>	3.73 <sup>a</sup>	3.19 <sup>a</sup>
95% CI UB	13 <sup>a</sup>	4.7 <sup>b</sup>	10.7 <sup>a</sup>	13.4 <sup>a</sup>	1.4 <sup>a</sup>	8.18 <sup>a</sup>	3.88 <sup>b</sup>	3.57 <sup>b</sup>	11.1 <sup>a</sup>	10.4 <sup>a</sup>
N	240 <sup>a</sup>	239 <sup>b</sup>	234 <sup>a</sup>	238 <sup>a</sup>	117 <sup>a</sup>	228 <sup>a</sup>	237 <sup>b</sup>	116 <sup>b</sup>	236 <sup>a</sup>	228 <sup>a</sup>
% < MDL	86.3 <sup>a</sup>	85.8 <sup>b</sup>	86.8 <sup>a</sup>	83.2 <sup>a</sup>	100 <sup>a</sup>	89 <sup>a</sup>	86.1 <sup>b</sup>	100 <sup>b</sup>	89.4 <sup>a</sup>	88.6 <sup>a</sup>
Max	132 <sup>a</sup>	132 <sup>b</sup>	127 <sup>a</sup>	133 <sup>a</sup>	< MDL <sup>a</sup>	139 <sup>a</sup>	123 <sup>b</sup>	< MDL <sup>b</sup>	122 <sup>a</sup>	138 <sup>a</sup>
MATES IV										
Average	1.22, 2.45 <sup>b</sup>	2.32, 5.07 <sup>b</sup>	0, 3.97 <sup>b</sup>	0, 4.5 <sup>b</sup>	0, 4.95 <sup>b</sup>	1, 3.28 <sup>b</sup>	0, 6.06 <sup>b</sup>	0, 6.09 <sup>b</sup>	1.07, 3.98 <sup>b</sup>	2.07, 2.76 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	3.04 <sup>b</sup>	6.09 <sup>b</sup>	4.92 <sup>b</sup>	5.03 <sup>b</sup>	5.9 <sup>b</sup>	4.1 <sup>b</sup>	7.22 <sup>b</sup>	7.3 <sup>b</sup>	4.94 <sup>b</sup>	3.43 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	98.3 <sup>b</sup>	96.6 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	98.4 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	98.4 <sup>b</sup>	96.7 <sup>b</sup>
Max	72 <sup>b</sup>	69 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	61 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	65 <sup>b</sup>	63 <sup>b</sup>
MATES V										
Average	0, 4.49 <sup>b</sup>	0, 3.54 <sup>b</sup>	0, 4.76 <sup>b</sup>	0, 5.37 <sup>b</sup>	0, 4.43 <sup>b</sup>	0, 3.26 <sup>b</sup>	0, 5.41 <sup>b</sup>	0, 5.3 <sup>b</sup>	0, 4.84 <sup>b</sup>	0, 3.48 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	5.71 <sup>b</sup>	4.06 <sup>b</sup>	5.93 <sup>b</sup>	6.13 <sup>b</sup>	5.5 <sup>b</sup>	4.14 <sup>b</sup>	6.29 <sup>b</sup>	6.29 <sup>b</sup>	5.66 <sup>b</sup>	4.43 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-234.** Annual Average Concentrations of Antimony in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



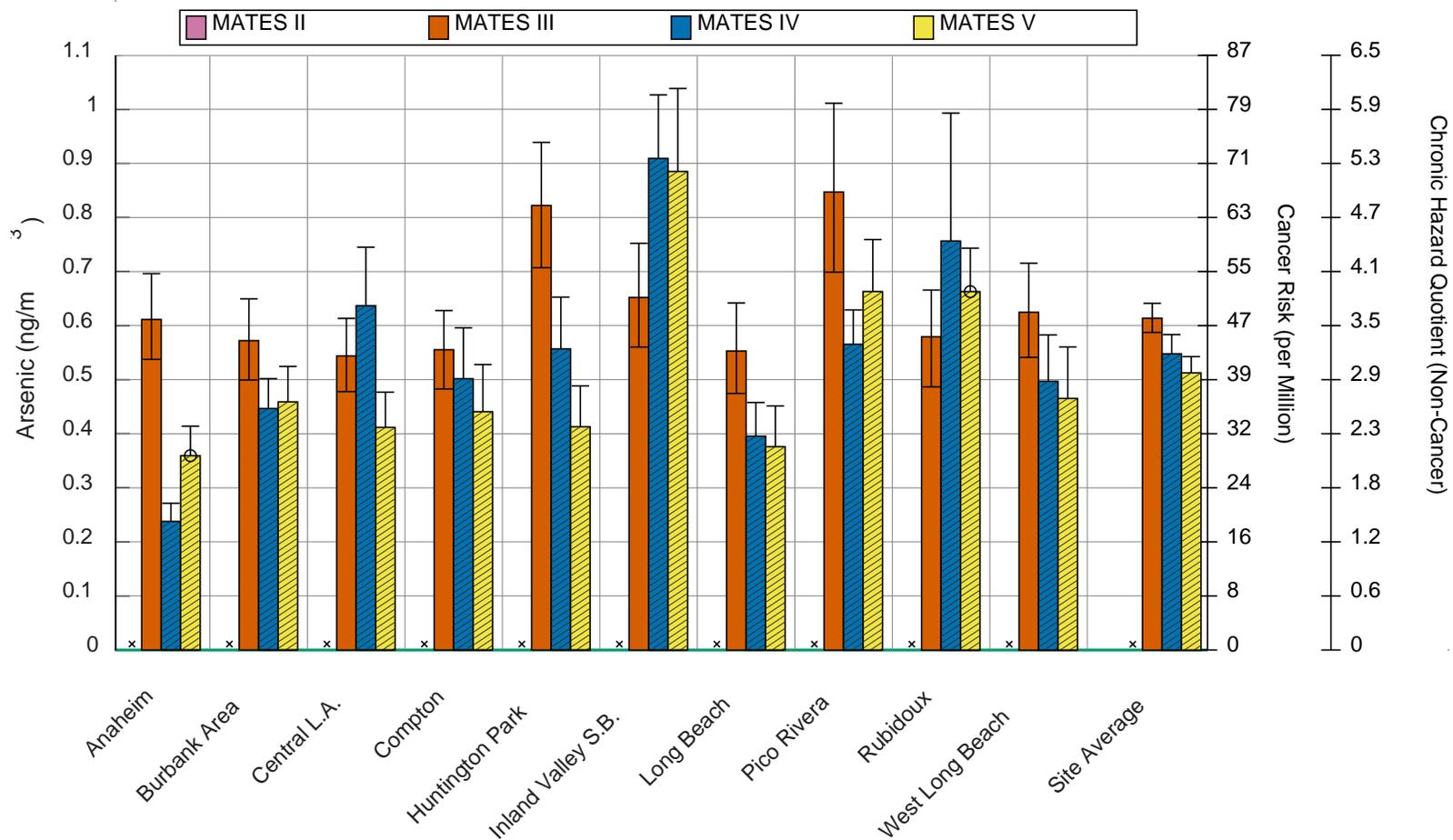
**Figure IV-235.** Geographic distribution of Antimony from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Arsenic

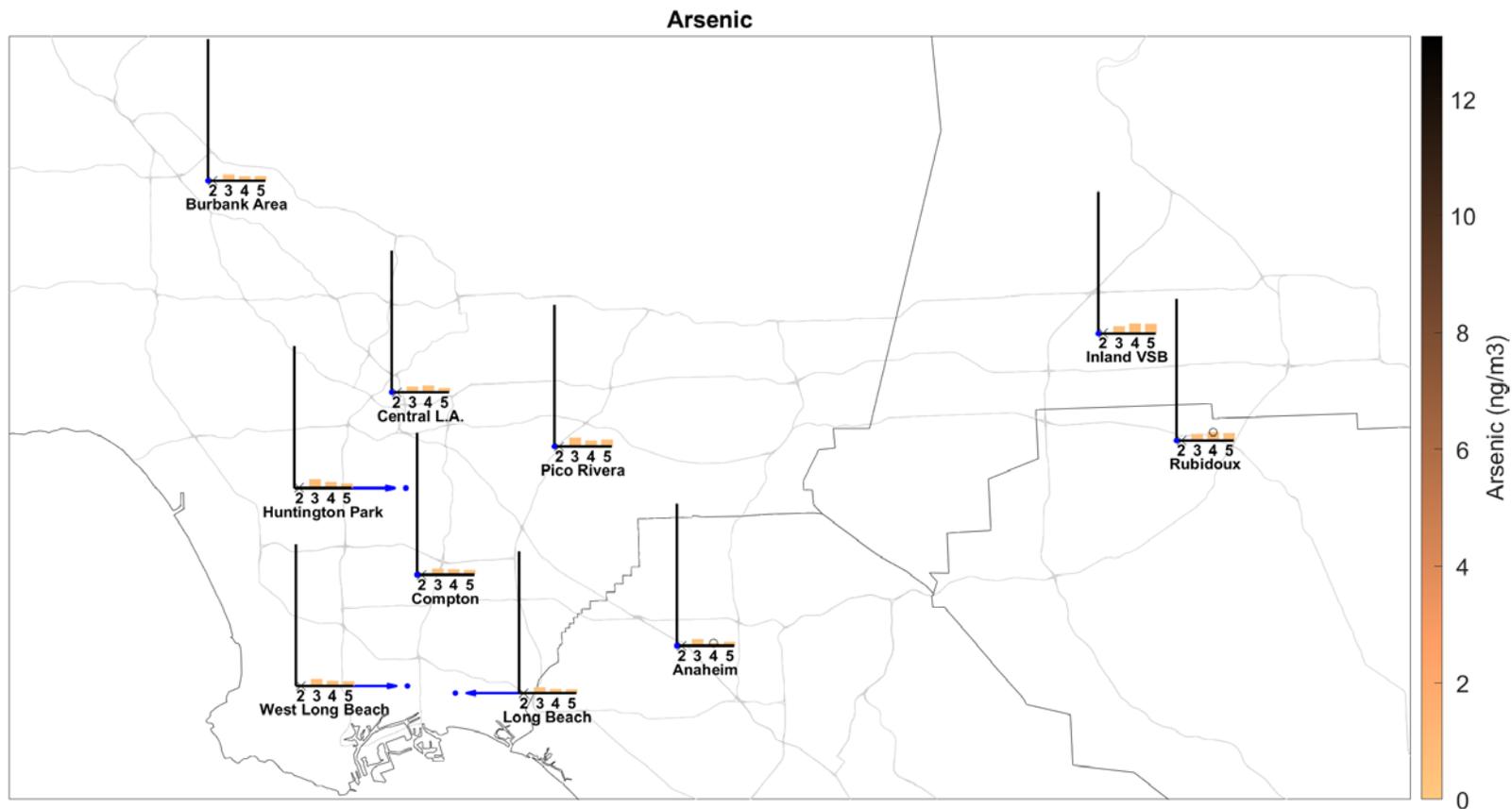
**Table IV-120.** Ambient Concentrations (ng/m<sup>3</sup>) of Arsenic from the PM<sub>2.5</sub> Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	0.611	0.572	0.555	0.652	0.822	0.553	0.544	0.847	0.58	0.625
95% CI LB	0.538	0.499	0.483	0.56	0.707	0.475	0.478	0.699	0.487	0.541
95% CI UB	0.696	0.649	0.628	0.752	0.939	0.642	0.613	1.01	0.666	0.716
N	240	239	234	238	117	228	237	116	236	228
% < MDL	65.8	68.6	68.8	63.4	46.2	70.6	64.6	50	69.5	65.4
Max	3.71	2.48	3.7	7.42	2.48	3.71	3.1	4.96	4.97	3.72
MATES IV										
Average	0, 0.238 <sup>b</sup>	0, 0.447 <sup>b</sup>	0, 0.502 <sup>b</sup>	0, 0.909 <sup>b</sup>	0, 0.557 <sup>b</sup>	0, 0.396 <sup>b</sup>	0, 0.637 <sup>b</sup>	0, 0.566 <sup>b</sup>	0, 0.757 <sup>b</sup>	0, 0.497 <sup>b</sup>
95% CI LB	0 <sup>b</sup>									
95% CI UB	0.271 <sup>b</sup>	0.502 <sup>b</sup>	0.596 <sup>b</sup>	1.03 <sup>b</sup>	0.653 <sup>b</sup>	0.458 <sup>b</sup>	0.745 <sup>b</sup>	0.629 <sup>b</sup>	0.993 <sup>b</sup>	0.583 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	100 <sup>b</sup>									
Max	< MDL <sup>b</sup>									
MATES V										
Average	0, 0.36 <sup>b</sup>	0, 0.459 <sup>b</sup>	0, 0.441 <sup>b</sup>	0, 0.885 <sup>b</sup>	0, 0.413 <sup>b</sup>	0, 0.376 <sup>b</sup>	0, 0.412 <sup>b</sup>	0, 0.663 <sup>b</sup>	0, 0.663 <sup>b</sup>	0, 0.466 <sup>b</sup>
95% CI LB	0 <sup>b</sup>									
95% CI UB	0.414 <sup>b</sup>	0.524 <sup>b</sup>	0.528 <sup>b</sup>	1.04 <sup>b</sup>	0.489 <sup>b</sup>	0.452 <sup>b</sup>	0.477 <sup>b</sup>	0.759 <sup>b</sup>	0.743 <sup>b</sup>	0.561 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>									
Max	< MDL <sup>b</sup>									

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-236.** Annual Average Concentrations of Arsenic in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



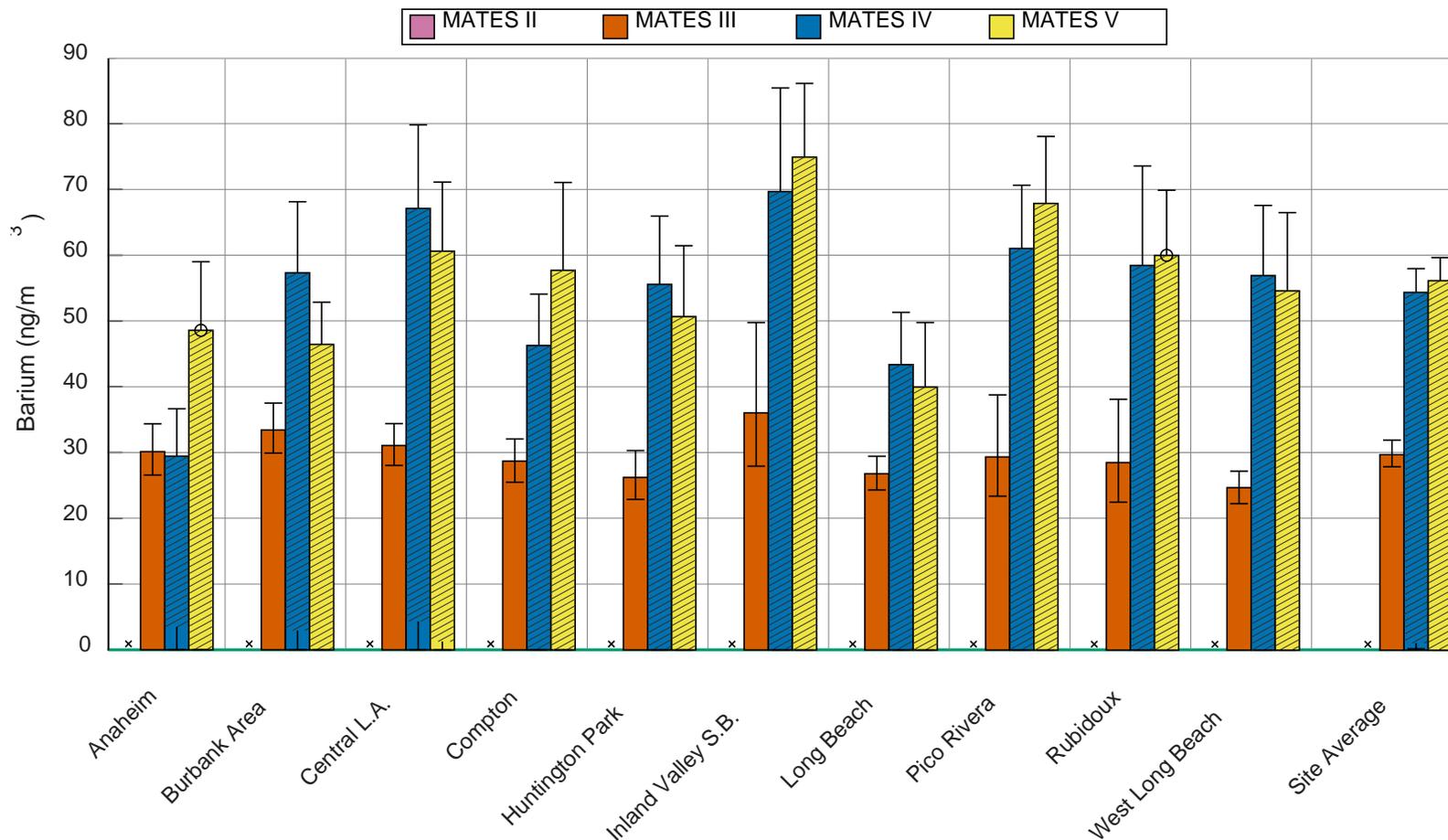
**Figure IV-237.** Geographic distribution of Arsenic from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Barium

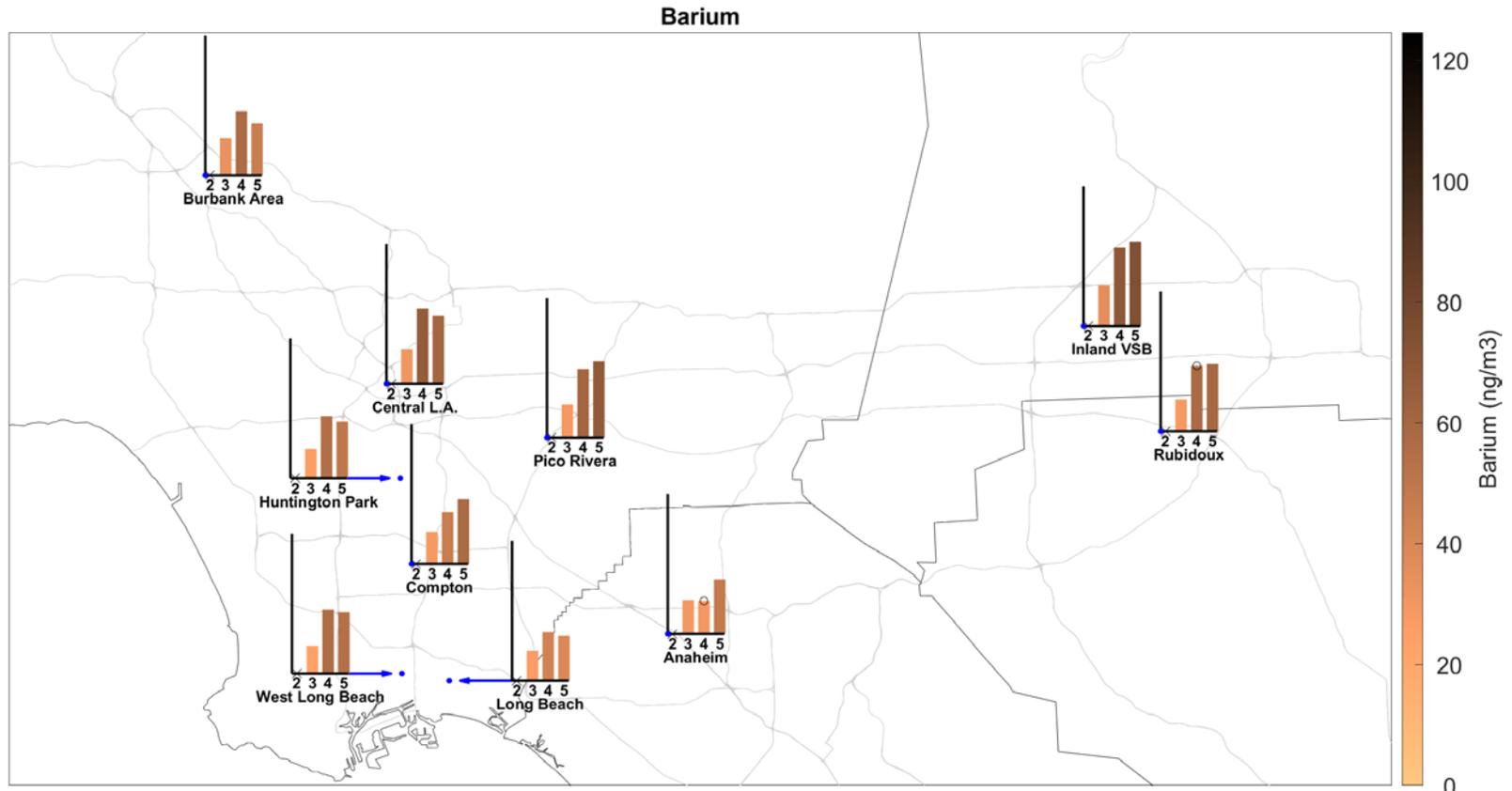
**Table IV-121.** Ambient Concentrations (ng/m<sup>3</sup>) of Barium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	30.1	33.4	28.7	36.1	26.2	26.8	31.1	29.4	28.5	24.7
95% CI LB	26.6	29.9	25.5	27.9	22.9	24.3	28	23.4	22.5	22.3
95% CI UB	34.4	37.5	32.1	49.8	30.3	29.5	34.4	38.8	38.1	27.2
N	240	239	234	238	117	228	237	116	236	228
% < MDL	22.1	20.1	27.4	23.9	23.9	23.7	17.7	19.8	31.4	34.6
Max	355	316	211	1450	144	121	244	486	999	129
MATES IV										
Average	3.49, 29.4 <sup>b</sup>	2.93, 57.3 <sup>b</sup>	0, 46.3 <sup>b</sup>	0, 69.7 <sup>b</sup>	0, 55.6 <sup>b</sup>	0, 43.4 <sup>b</sup>	4.32, 67.1 <sup>b</sup>	0, 61.1 <sup>b</sup>	0, 58.5 <sup>b</sup>	0, 57 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	36.6 <sup>b</sup>	68.1 <sup>b</sup>	54.1 <sup>b</sup>	85.5 <sup>b</sup>	66 <sup>b</sup>	51.3 <sup>b</sup>	79.8 <sup>b</sup>	70.7 <sup>b</sup>	73.6 <sup>b</sup>	67.6 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	98.3 <sup>b</sup>	98.3 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	96.7 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	206 <sup>b</sup>	173 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	135 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>
MATES V										
Average	0, 48.6 <sup>b</sup>	0, 46.4 <sup>b</sup>	0, 57.7 <sup>b</sup>	0, 75 <sup>b</sup>	0, 50.7 <sup>b</sup>	0, 40 <sup>b</sup>	1.27, 60.6 <sup>b</sup>	0, 67.9 <sup>b</sup>	0, 60 <sup>b</sup>	0, 54.6 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	59 <sup>b</sup>	52.9 <sup>b</sup>	71.1 <sup>b</sup>	86.2 <sup>b</sup>	61.5 <sup>b</sup>	49.8 <sup>b</sup>	71.1 <sup>b</sup>	78.1 <sup>b</sup>	69.9 <sup>b</sup>	66.5 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	98.4 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	77.5 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-238.** Annual Average Concentrations of Barium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



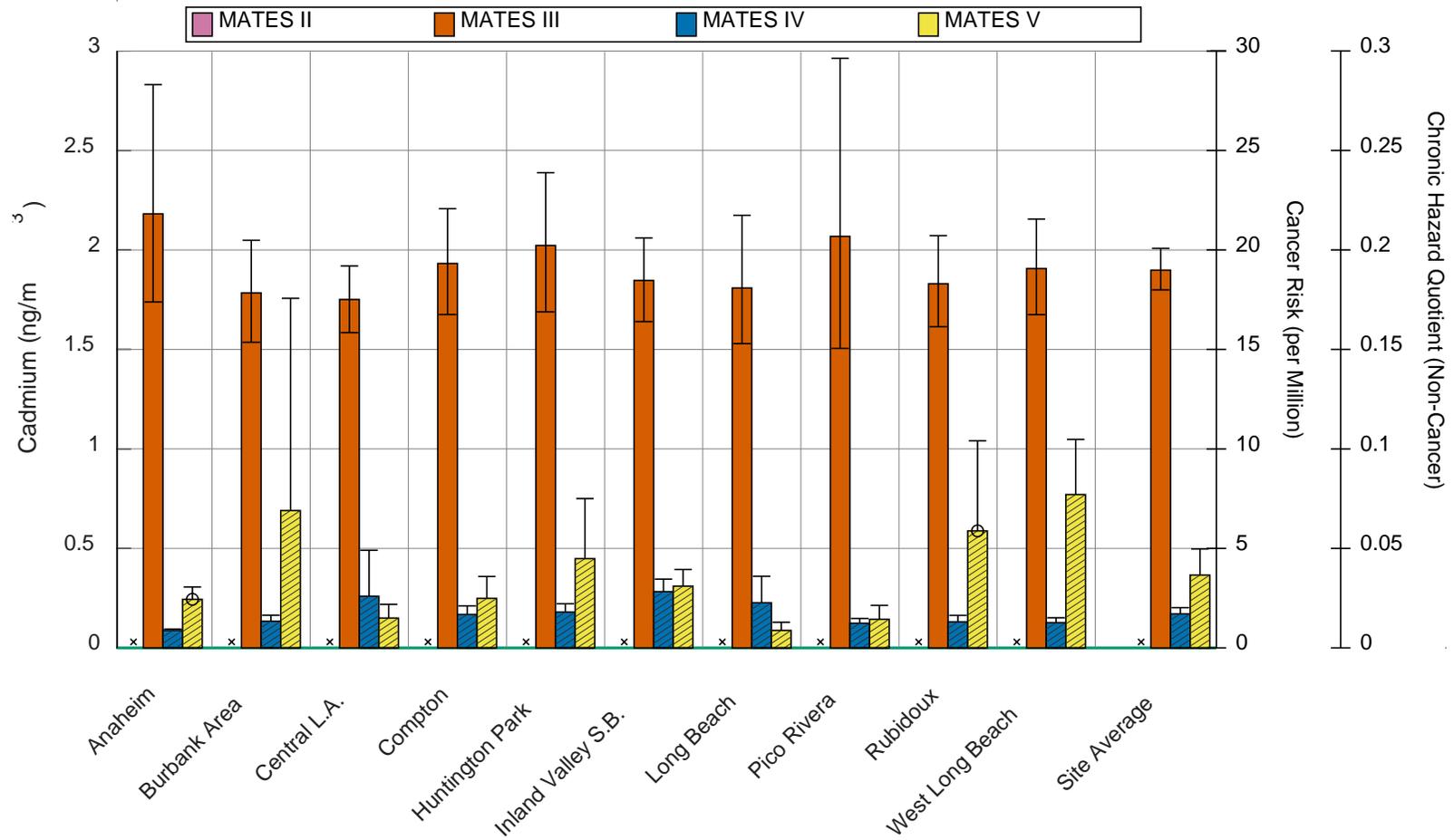
**Figure IV-239.** Geographic distribution of Barium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Cadmium

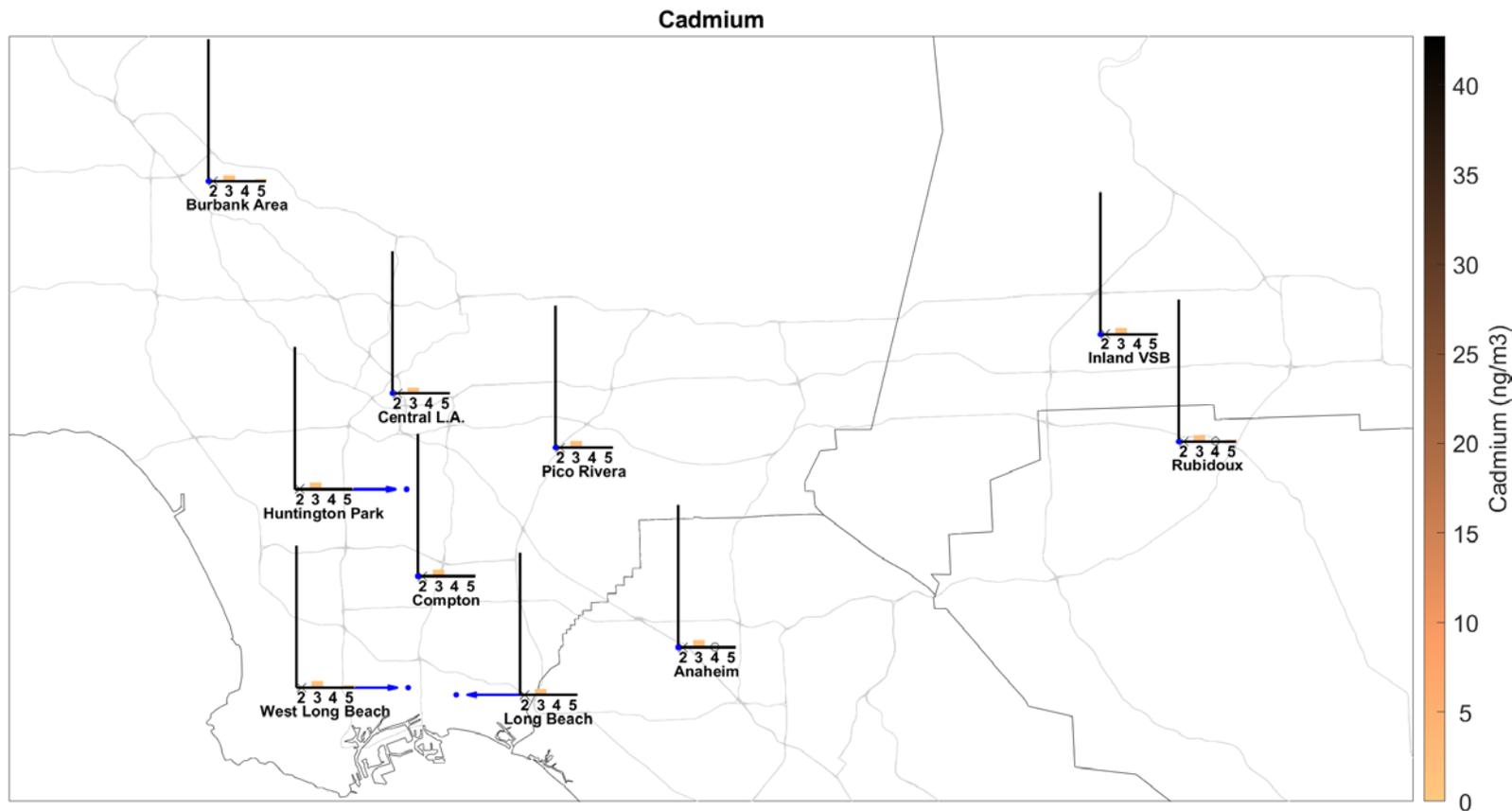
**Table IV-122.** Ambient Concentrations (ng/m<sup>3</sup>) of Cadmium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	2.18	1.78	1.93	1.85	2.02	1.81	1.75	2.07	1.83	1.91
95% CI LB	1.74	1.54	1.68	1.64	1.69	1.53	1.58	1.51	1.61	1.68
95% CI UB	2.83	2.05	2.21	2.06	2.39	2.17	1.92	2.96	2.07	2.16
N	240	239	234	238	117	228	237	116	236	228
% < MDL	52.1	59.8	54.3	52.1	39.3	55.3	53.2	41.4	50.4	53.9
Max	65.6	16.1	17.2	9.91	12.4	32	10.5	44.6	11.2	11.1
<b>MATES IV</b>										
Average	0, 0.0876 <sup>b</sup>	0, 0.134 <sup>b</sup>	0, 0.168 <sup>b</sup>	0, 0.283 <sup>b</sup>	0, 0.181 <sup>b</sup>	0, 0.227 <sup>b</sup>	0, 0.26 <sup>b</sup>	0, 0.124 <sup>b</sup>	0, 0.131 <sup>b</sup>	0, 0.127 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	0.0947 <sup>b</sup>	0.164 <sup>b</sup>	0.211 <sup>b</sup>	0.346 <sup>b</sup>	0.222 <sup>b</sup>	0.36 <sup>b</sup>	0.491 <sup>b</sup>	0.148 <sup>b</sup>	0.164 <sup>b</sup>	0.152 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>
<b>MATES V</b>										
Average	0, 0.244 <sup>b</sup>	0, 0.69 <sup>b</sup>	0, 0.249 <sup>b</sup>	0, 0.311 <sup>b</sup>	0, 0.449 <sup>b</sup>	0, 0.088 <sup>b</sup>	0, 0.15 <sup>b</sup>	0, 0.144 <sup>b</sup>	0, 0.588 <sup>b</sup>	0, 0.771 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	0.306 <sup>b</sup>	1.76 <sup>b</sup>	0.359 <sup>b</sup>	0.394 <sup>b</sup>	0.751 <sup>b</sup>	0.129 <sup>b</sup>	0.219 <sup>b</sup>	0.214 <sup>b</sup>	1.04 <sup>b</sup>	1.05 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-240.** Annual Average Concentrations of Cadmium in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

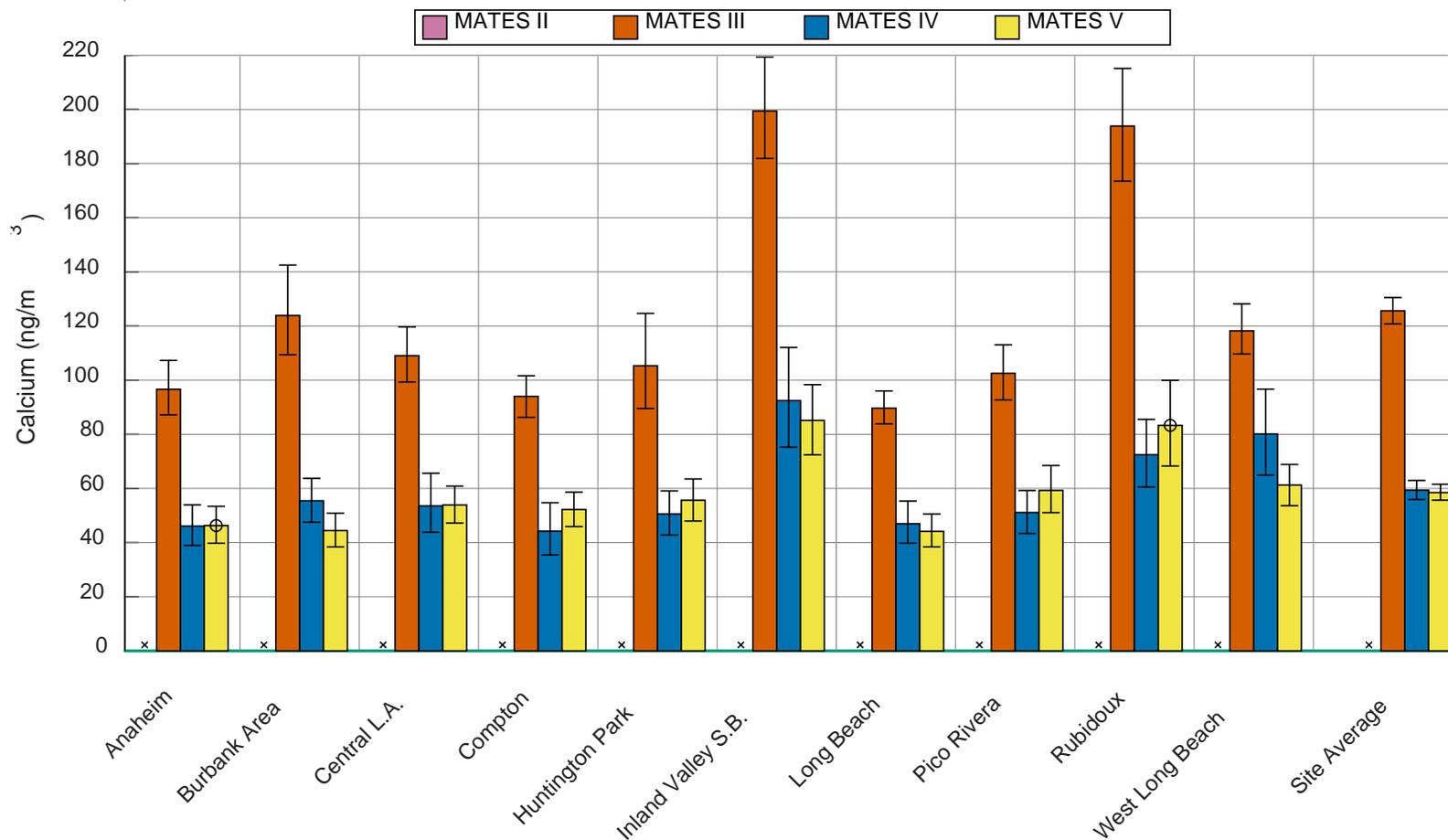


**Figure IV-241.** Geographic distribution of Cadmium from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. "x" indicates that there is no data for a given station/MATES iteration.

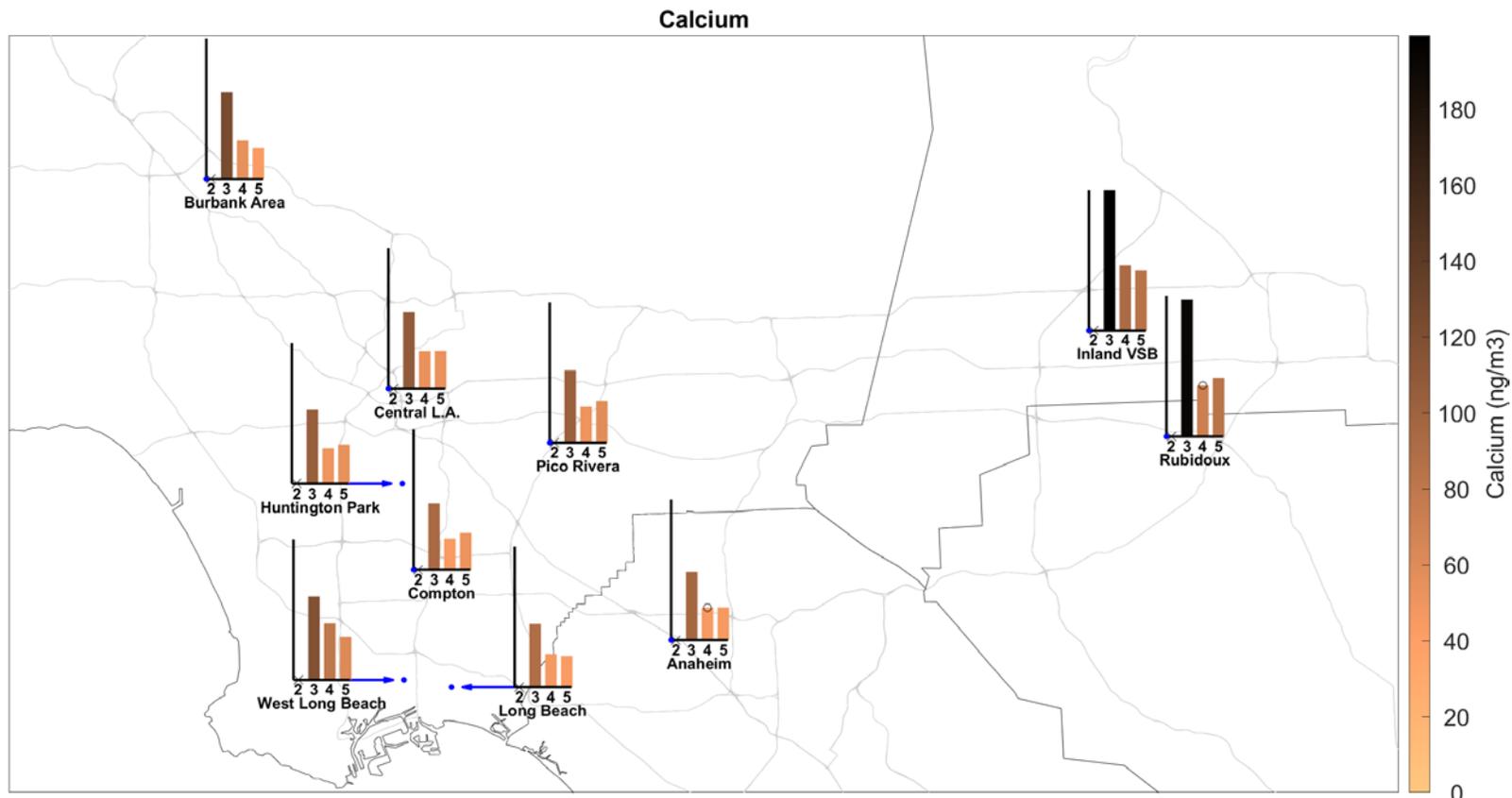
## Calcium

**Table IV-123.** Ambient Concentrations (ng/m<sup>3</sup>) of Calcium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	96.6	124	94	199	105	89.7	109	103	194	118
95% CI LB	87.2	109	86.3	182	89.5	83.9	99.3	92.7	174	110
95% CI UB	107	143	102	219	125	96	120	113	215	128
N	240	239	234	238	117	228	237	116	236	228
% < MDL	0	0	0	0	0.9	0	0	0	0	0
Max	740	1890	619	1560	948	298	601	328	817	574
MATES IV										
Average	46.1	55.4	44.2	92.5	50.6	47	53.5	51.1	72.5	80.1
95% CI LB	39	47.5	35.4	75.2	42.8	39.8	43.8	43.3	60.5	64.9
95% CI UB	53.9	63.7	54.7	112	59.1	55.3	65.6	59.2	85.5	96.7
N	59	59	61	60	59	61	60	59	61	61
% < MDL	10.2	10.2	24.6	8.3	15.3	13.1	11.7	10.2	8.2	6.6
Max	166	132	259	424	142	194	298	138	260	288
MATES V										
Average	46.3	44.4	52.2	85.1	55.6	44.1	53.9	59.3	83.3	61.2
95% CI LB	39.7	38.4	45.9	72.4	48	38.4	47.2	51.1	68.3	53.6
95% CI UB	53.4	50.8	58.6	98.3	63.5	50.5	60.8	68.5	99.9	68.9
N	54	59	61	60	60	61	61	59	56	57
% < MDL	7.4	8.5	3.3	0	1.7	8.2	6.6	0	3.6	1.8
Max	125	121	126	236	145	156	130	189	313	129



**Figure IV-242.** Annual Average Concentrations of Calcium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



**Figure IV-243.** Geographic distribution of Calcium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

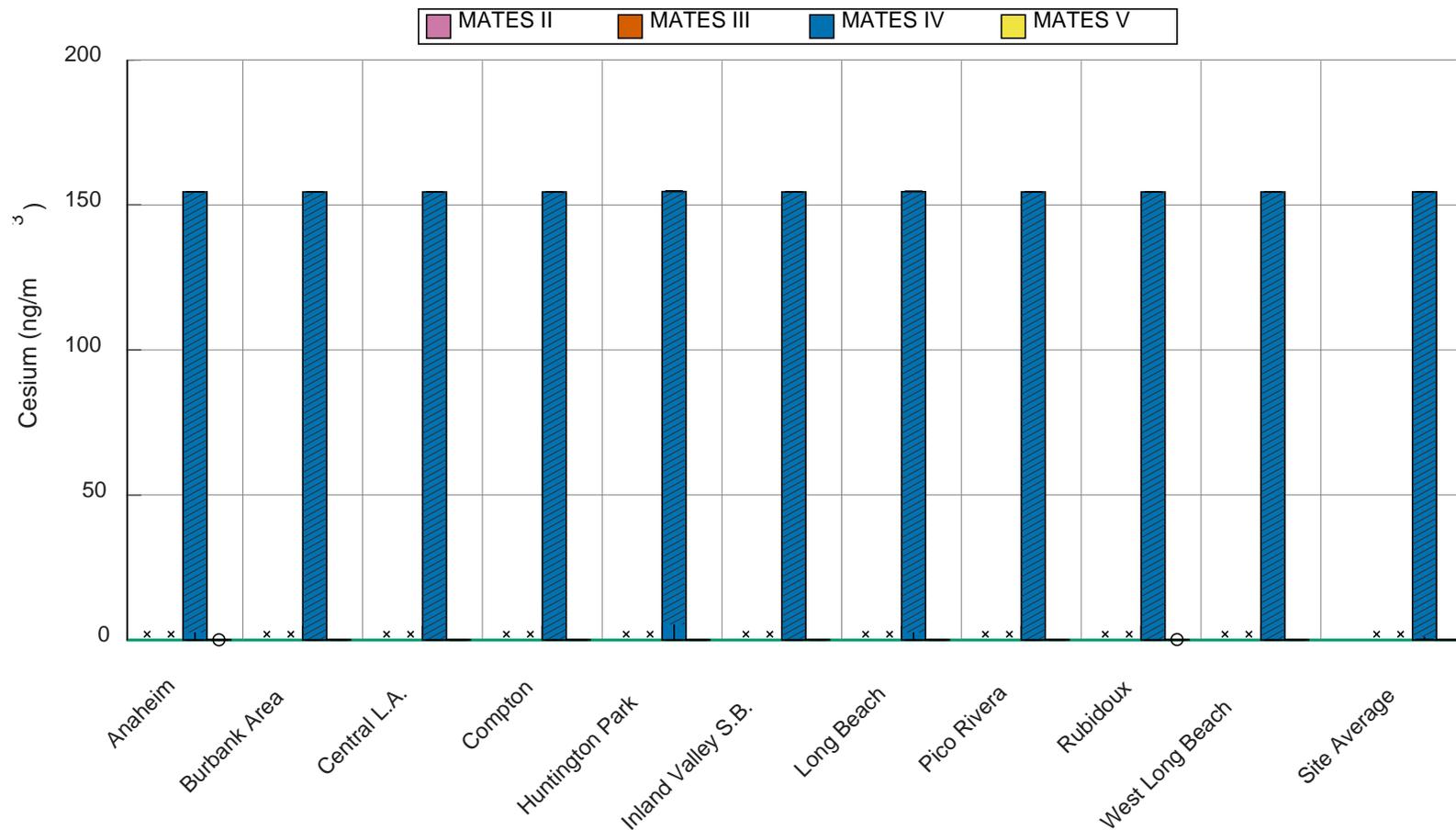
Cesium

**Table IV-124.** Ambient Concentrations (ng/m<sup>3</sup>) of Cesium from the PM2.5 Metals analysis at the Fixed Sites.

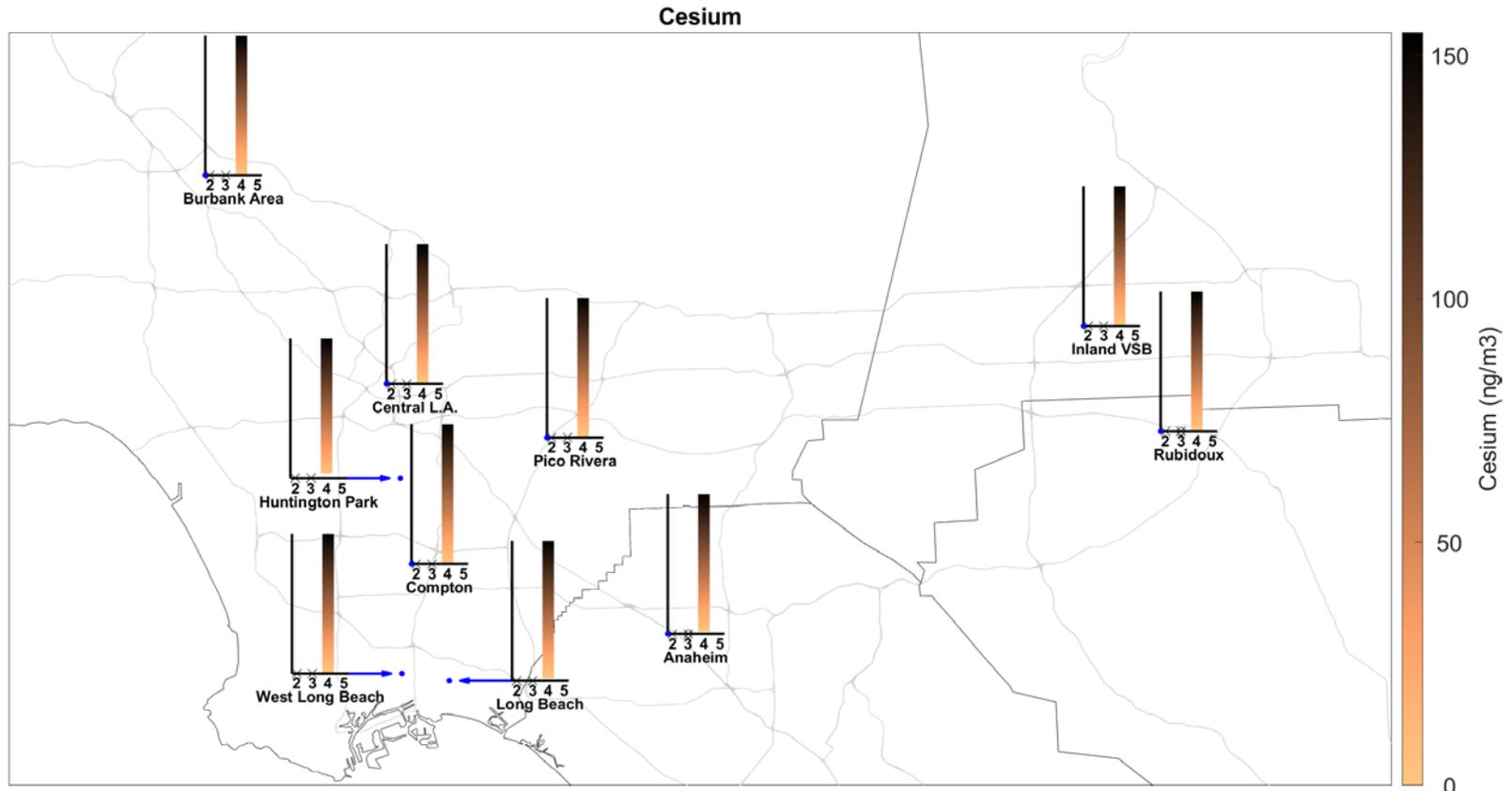
Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES IV</b>										
Average	2.64, 155 <sup>a</sup>	0, 154 <sup>a</sup>	0, 154 <sup>a</sup>	0, 154 <sup>a</sup>	5.37, 155 <sup>a</sup>	2.62, 155 <sup>a</sup>	0, 154 <sup>a</sup>	0, 154 <sup>a</sup>	0, 154 <sup>a</sup>	0, 154 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
95% CI UB	155 <sup>a</sup>	154 <sup>a</sup>	154 <sup>a</sup>	154 <sup>a</sup>	155 <sup>a</sup>	155 <sup>a</sup>	154 <sup>a</sup>	154 <sup>a</sup>	154 <sup>a</sup>	154 <sup>a</sup>
N	59 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	61 <sup>a</sup>
% < MDL	98.3 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	96.6 <sup>a</sup>	98.4 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>a</sup>
Max	156 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	160 <sup>a</sup>	160 <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>a</sup>
<b>MATES V</b>										
Average	0, 0.0757 <sup>b</sup>	0, 0.0773 <sup>b</sup>	0, 0.0644 <sup>b</sup>	0, 0.148 <sup>b</sup>	0, 0.0551 <sup>b</sup>	0, 0.0581 <sup>b</sup>	0, 0.0604 <sup>b</sup>	0, 0.109 <sup>b</sup>	0, 0.162 <sup>b</sup>	0, 0.0746 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	0.0907 <sup>b</sup>	0.0905 <sup>b</sup>	0.0788 <sup>b</sup>	0.179 <sup>b</sup>	0.0671 <sup>b</sup>	0.0742 <sup>b</sup>	0.0699 <sup>b</sup>	0.126 <sup>b</sup>	0.188 <sup>b</sup>	0.0954 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-244.** Annual Average Concentrations of Cesium in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

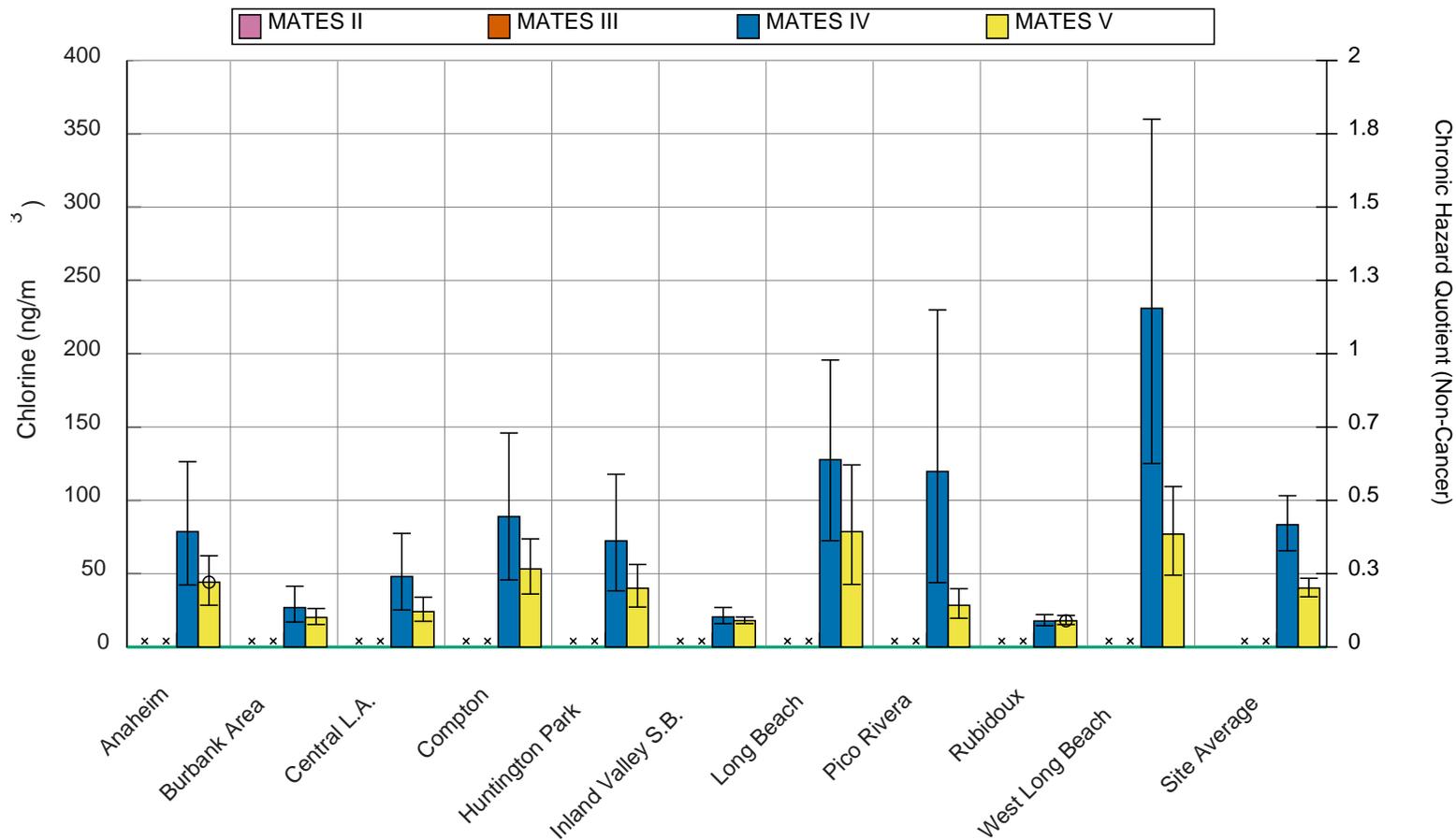


**Figure IV-245.** Geographic distribution of Cesium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

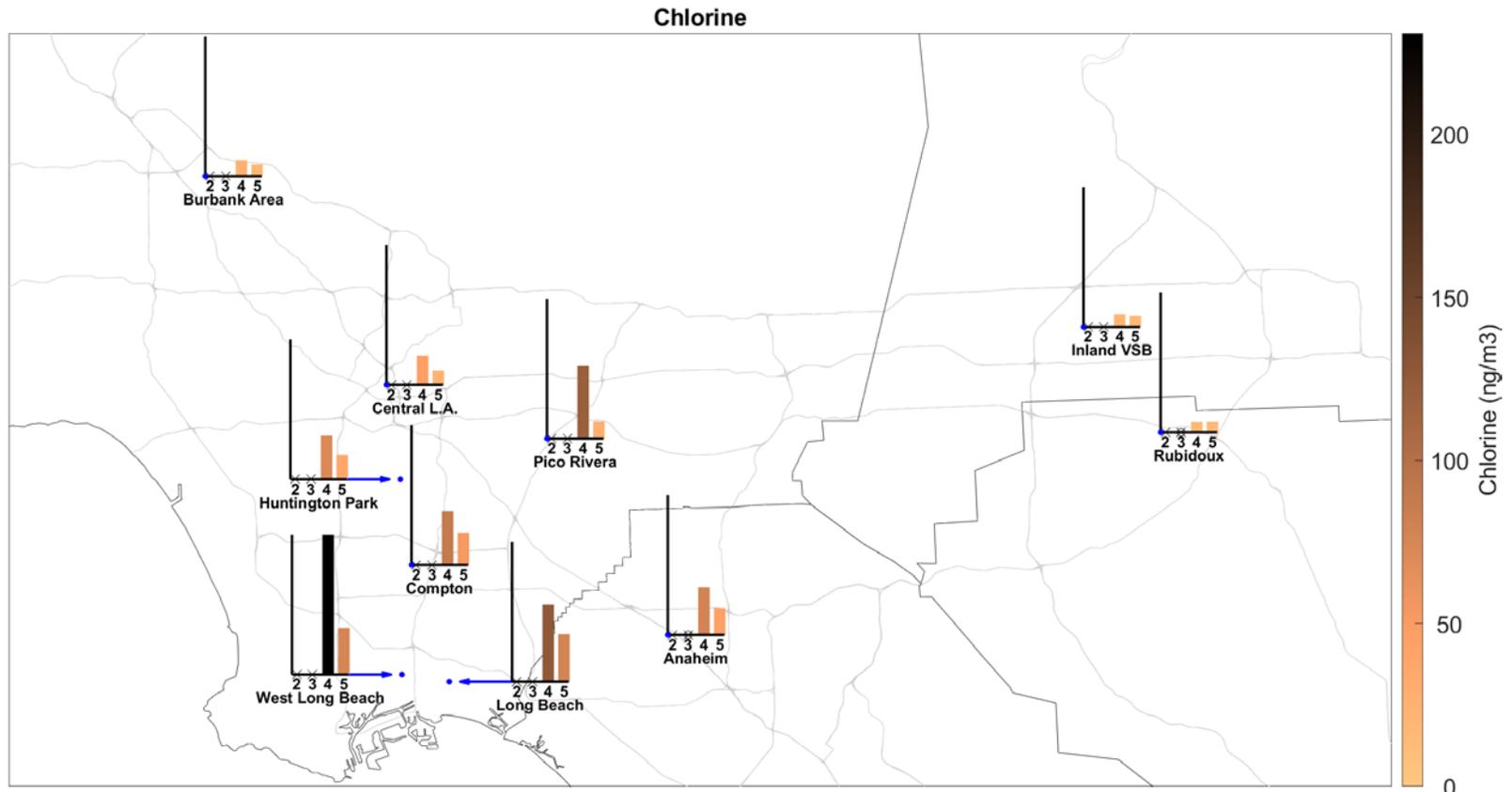
Chlorine

**Table IV-125.** Ambient Concentrations (ng/m<sup>3</sup>) of Chlorine from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average	78.7	26.9	88.9	20.5	72.3	128	48	120	17.7	231
95% CI LB	42.3	17	45.7	15.9	38.3	72.5	25.3	43.9	14.5	125
95% CI UB	126	41.5	146	27	118	196	77.5	230	22.1	360
N	59	59	61	60	59	61	60	59	61	61
% < MDL	40.7	59.3	44.3	55	50.8	39.3	53.3	44.1	67.2	45.9
Max	977	357	1250	161	995	1150	609	2460	116	2580
MATES V										
Average	44.2	20.2	53.2	18	40.1	78.6	24.1	28.4	17.9	77
95% CI LB	28.5	15.3	36.1	15.9	27.2	42.7	17.5	19.6	15.3	49
95% CI UB	62.2	26.3	73.7	20.5	56.3	124	34	39.7	21.5	109
N	54	59	61	60	60	61	61	59	56	57
% < MDL	38.9	76.3	32.8	46.7	43.3	41	54.1	45.8	60.7	28.1
Max	278	129	383	63	320	932	252	228	103	486



**Figure IV-246.** Annual Average Concentrations of Chlorine in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



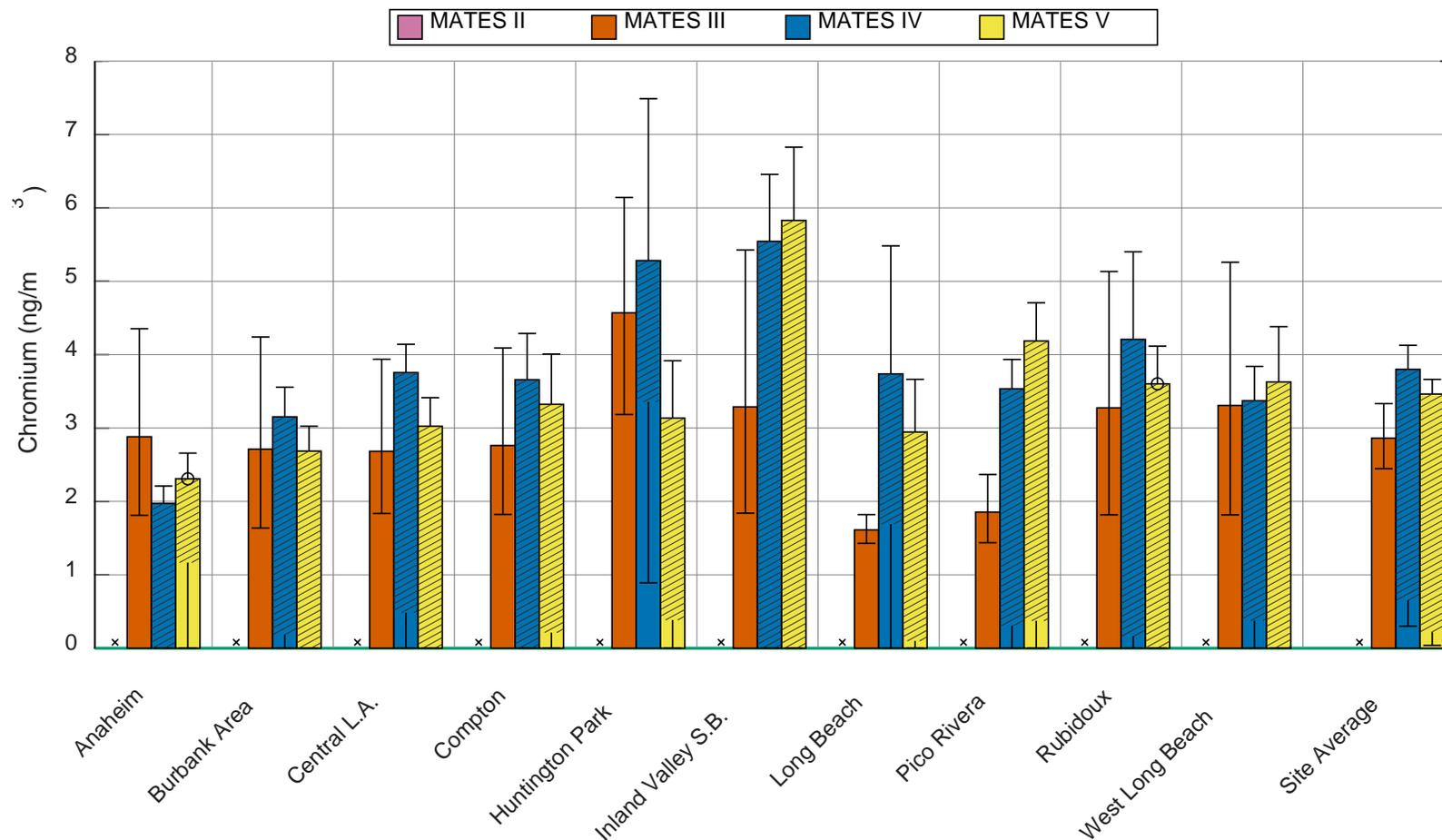
**Figure IV-247.** Geographic distribution of Chlorine from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Chromium

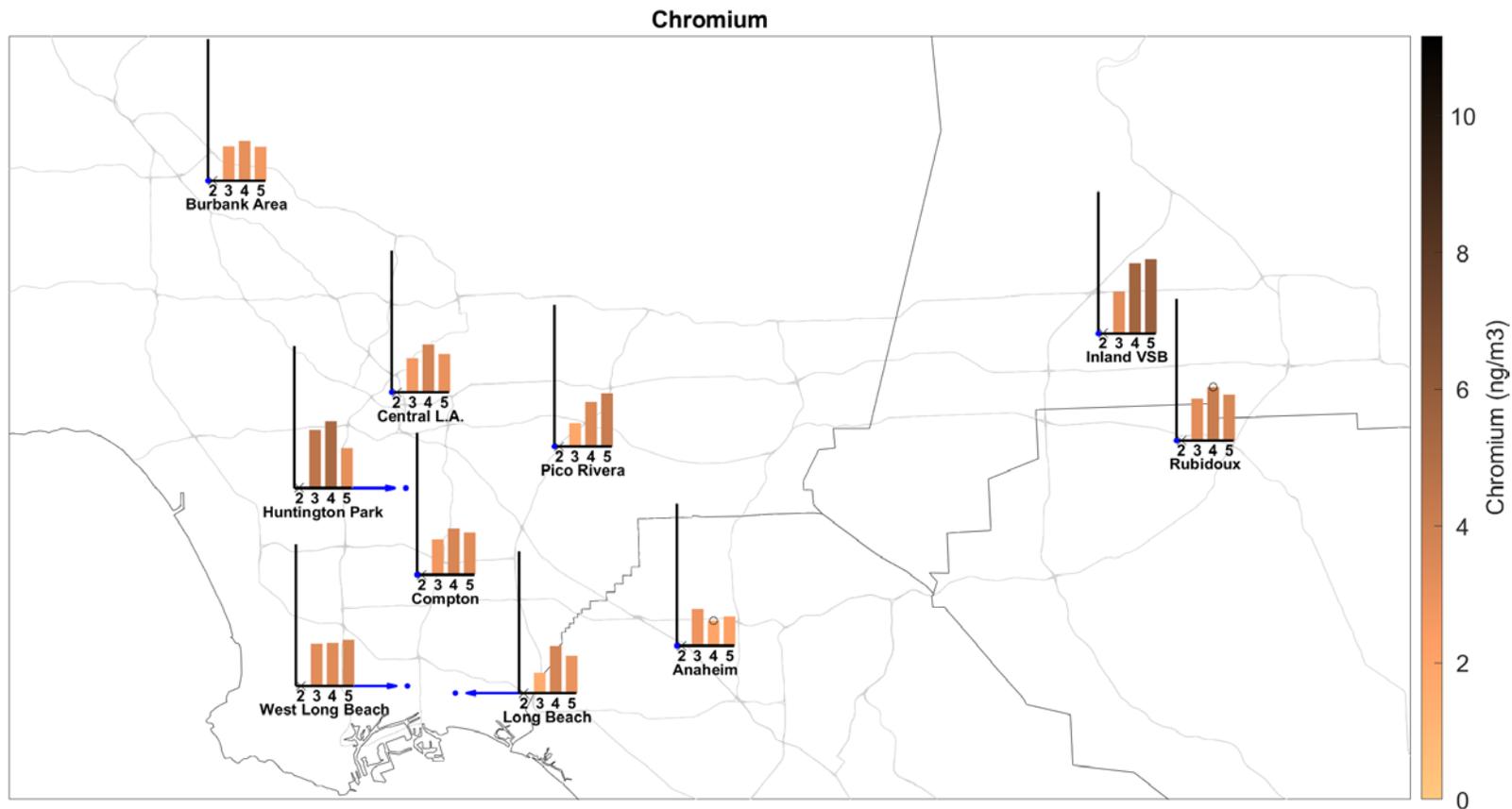
**Table IV-126.** Ambient Concentrations (ng/m<sup>3</sup>) of Chromium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	2.88	2.71	2.76	3.29	4.57	1.61	2.68	1.86	3.28	3.31
95% CI LB	1.81	1.64	1.82	1.84	3.18	1.43	1.84	1.44	1.82	1.82
95% CI UB	4.35	4.24	4.09	5.43	6.14	1.82	3.94	2.37	5.13	5.26
N	240	239	234	238	117	228	237	116	236	228
% < MDL	55.4	53.6	50	51.3	35	56.1	49.8	45.7	57.2	53.1
Max	111	117	122	192	43.3	9.9	117	17.3	118	121
<b>MATES IV</b>										
Average	0, 1.97 <sup>b</sup>	0.186, 3.15 <sup>b</sup>	0, 3.66 <sup>b</sup>	0, 5.54 <sup>b</sup>	3.36, 5.28 <sup>b</sup>	1.69, 3.74 <sup>b</sup>	0.483, 3.76 <sup>b</sup>	0.305, 3.53 <sup>b</sup>	0.164, 4.21 <sup>b</sup>	0.377, 3.37 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0.89 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	2.21 <sup>b</sup>	3.56 <sup>b</sup>	4.29 <sup>b</sup>	6.46 <sup>b</sup>	7.49 <sup>b</sup>	5.48 <sup>b</sup>	4.14 <sup>b</sup>	3.93 <sup>b</sup>	5.4 <sup>b</sup>	3.84 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	100 <sup>b</sup>	98.3 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	88.1 <sup>b</sup>	95.1 <sup>b</sup>	96.7 <sup>b</sup>	98.3 <sup>b</sup>	98.4 <sup>b</sup>	96.7 <sup>b</sup>
Max	< MDL <sup>b</sup>	11 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	68 <sup>b</sup>	76 <sup>b</sup>	20 <sup>b</sup>	18 <sup>b</sup>	10 <sup>b</sup>	14 <sup>b</sup>
<b>MATES V</b>										
Average	1.17, 2.31 <sup>b</sup>	0, 2.69 <sup>b</sup>	0.213, 3.32 <sup>b</sup>	0, 5.83 <sup>b</sup>	0.383, 3.14 <sup>b</sup>	0.0984, 2.95 <sup>b</sup>	0, 3.03 <sup>b</sup>	0.373, 4.19 <sup>b</sup>	0, 3.6 <sup>b</sup>	0, 3.63 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	2.66 <sup>b</sup>	3.03 <sup>b</sup>	4.01 <sup>b</sup>	6.83 <sup>b</sup>	3.92 <sup>b</sup>	3.66 <sup>b</sup>	3.41 <sup>b</sup>	4.71 <sup>b</sup>	4.12 <sup>b</sup>	4.38 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	98.1 <sup>b</sup>	100 <sup>b</sup>	96.7 <sup>b</sup>	100 <sup>b</sup>	98.3 <sup>b</sup>	98.4 <sup>b</sup>	100 <sup>b</sup>	96.6 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	63 <sup>b</sup>	< MDL <sup>b</sup>	7 <sup>b</sup>	< MDL <sup>b</sup>	23 <sup>b</sup>	6 <sup>b</sup>	< MDL <sup>b</sup>	13 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-248.** Annual Average Concentrations of Chromium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



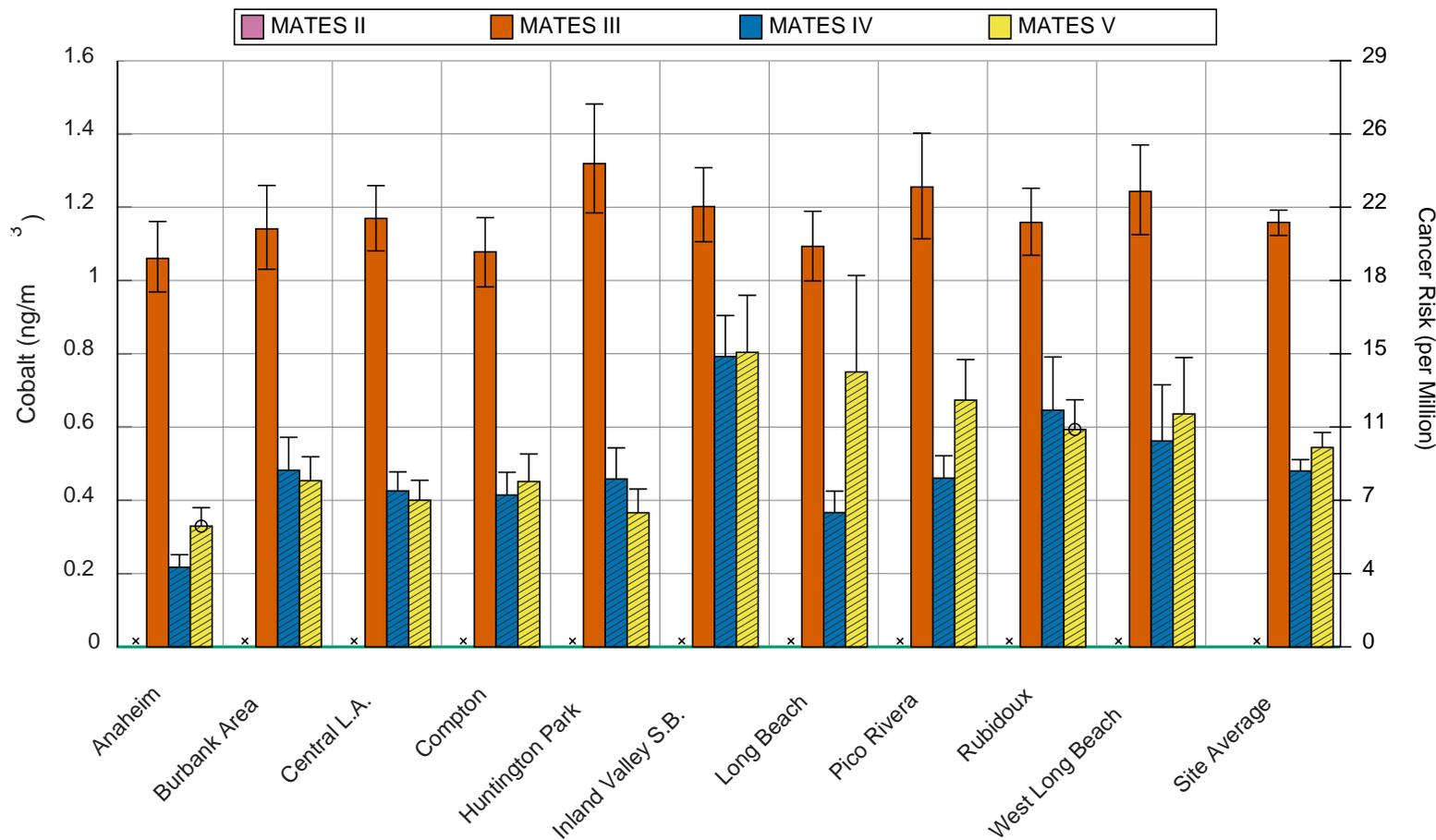
**Figure IV-249.** Geographic distribution of Chromium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Cobalt

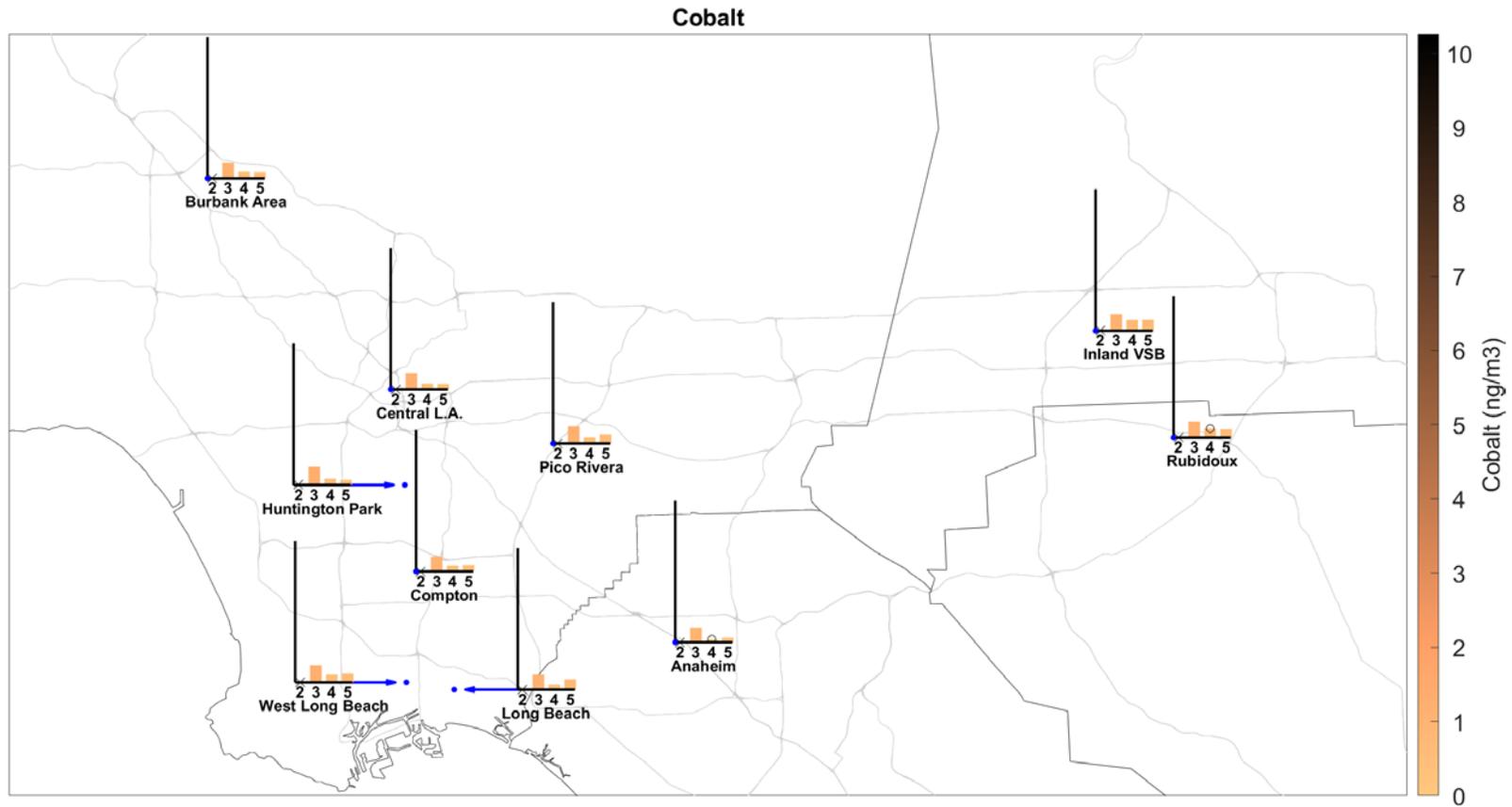
**Table IV-127.** Ambient Concentrations (ng/m<sup>3</sup>) of Cobalt from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	1.06	1.14	1.08	1.2	1.32	1.09	1.17	1.26	1.16	1.24
95% CI LB	0.969	1.03	0.983	1.11	1.18	0.999	1.08	1.11	1.07	1.13
95% CI UB	1.16	1.26	1.17	1.31	1.48	1.19	1.26	1.4	1.25	1.37
N	240	239	234	238	117	228	237	116	236	228
% < MDL	42.1	40.6	41	34	25.6	40.4	24.5	31	36.9	32.9
Max	3.72	6.2	3.72	4.94	3.72	3.71	4.95	4.95	3.72	6.16
<b>MATES IV</b>										
Average	0, 0.217 <sup>b</sup>	0, 0.482 <sup>b</sup>	0, 0.414 <sup>b</sup>	0, 0.792 <sup>b</sup>	0, 0.458 <sup>b</sup>	0, 0.367 <sup>b</sup>	0, 0.426 <sup>b</sup>	0, 0.461 <sup>b</sup>	0, 0.646 <sup>b</sup>	0, 0.562 <sup>b</sup>
95% CI LB	0 <sup>b</sup>									
95% CI UB	0.252 <sup>b</sup>	0.572 <sup>b</sup>	0.477 <sup>b</sup>	0.904 <sup>b</sup>	0.543 <sup>b</sup>	0.425 <sup>b</sup>	0.478 <sup>b</sup>	0.522 <sup>b</sup>	0.791 <sup>b</sup>	0.716 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	100 <sup>b</sup>									
Max	< MDL <sup>b</sup>									
<b>MATES V</b>										
Average	0, 0.329 <sup>b</sup>	0, 0.454 <sup>b</sup>	0, 0.452 <sup>b</sup>	0, 0.804 <sup>b</sup>	0, 0.366 <sup>b</sup>	0, 0.751 <sup>b</sup>	0, 0.4 <sup>b</sup>	0, 0.674 <sup>b</sup>	0, 0.594 <sup>b</sup>	0, 0.636 <sup>b</sup>
95% CI LB	0 <sup>b</sup>									
95% CI UB	0.38 <sup>b</sup>	0.519 <sup>b</sup>	0.527 <sup>b</sup>	0.96 <sup>b</sup>	0.431 <sup>b</sup>	1.01 <sup>b</sup>	0.455 <sup>b</sup>	0.784 <sup>b</sup>	0.675 <sup>b</sup>	0.79 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>									
Max	< MDL <sup>b</sup>									

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-250.** Annual Average Concentrations of Cobalt in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



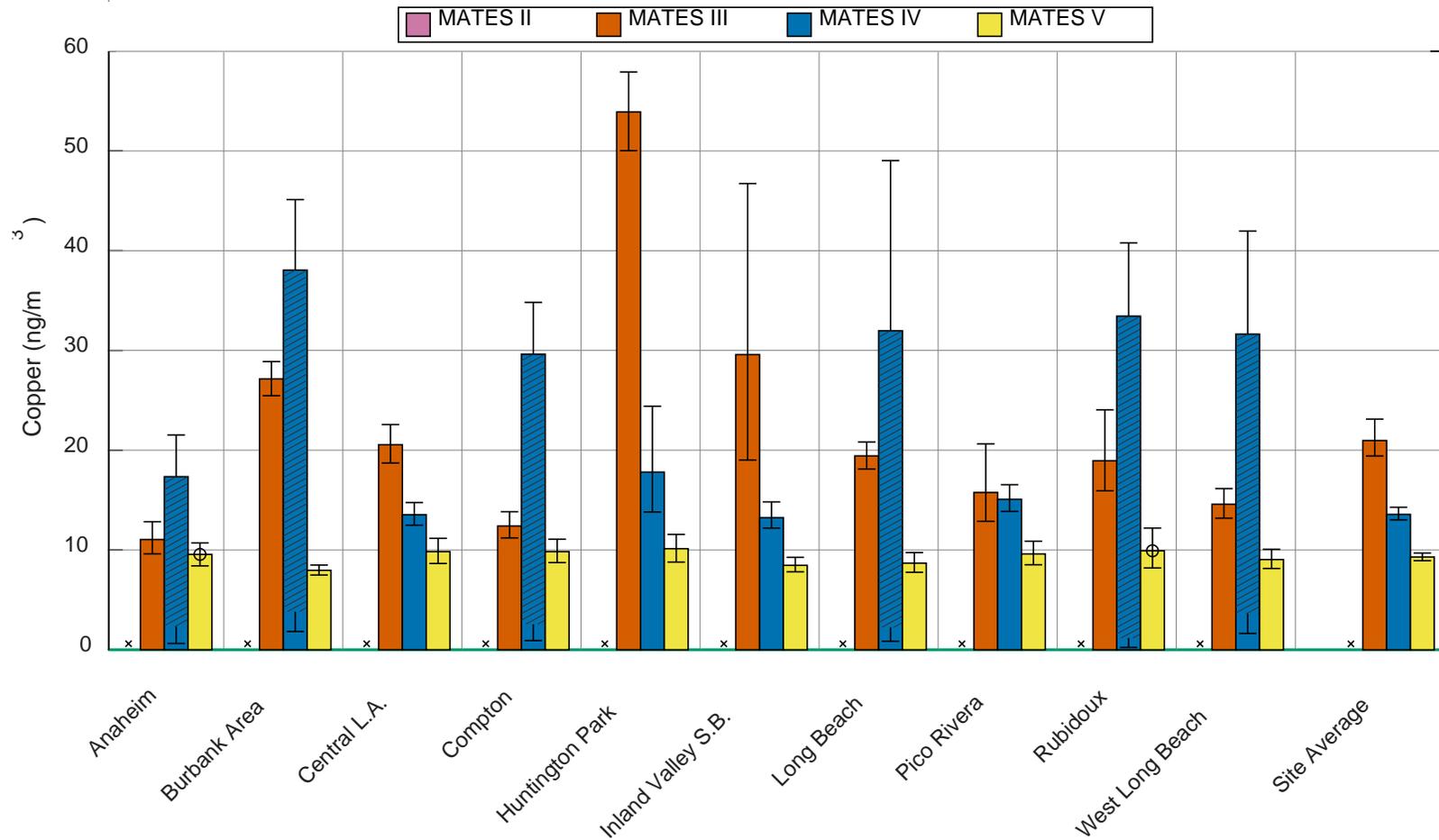
**Figure IV-251.** Geographic distribution of Cobalt from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Copper

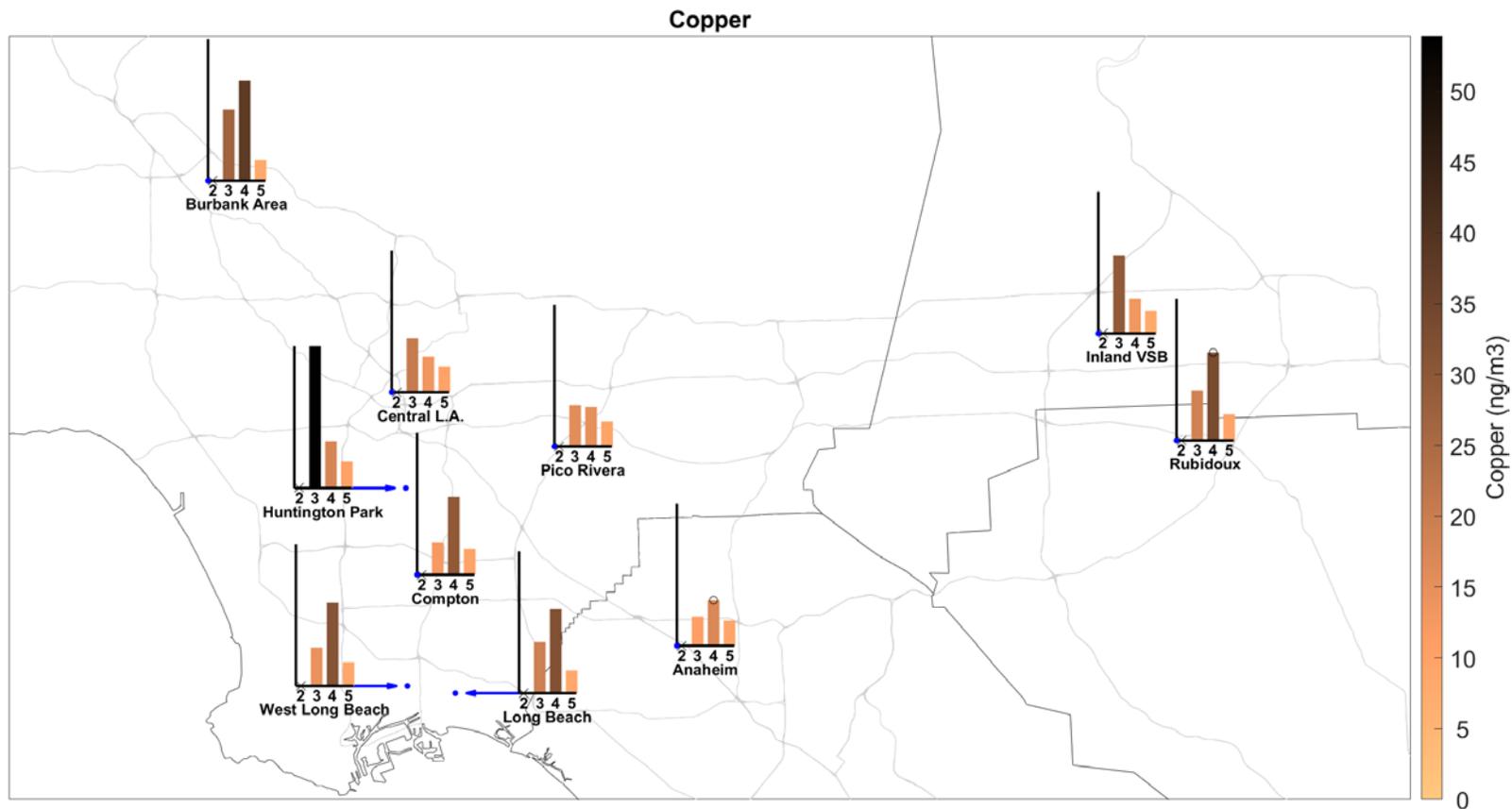
**Table IV-128.** Ambient Concentrations (ng/m<sup>3</sup>) of Copper from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	11	27.1	12.4	29.6	53.9	19.4	20.6	15.8	19	14.6
95% CI LB	9.61	25.5	11.2	19	50	18.1	18.7	12.9	15.9	13.2
95% CI UB	12.8	28.9	13.8	46.7	57.9	20.8	22.6	20.6	24.1	16.2
N	240	239	234	238	117	228	237	116	236	228
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	188	181	108	1640	146	54.4	143	266	544	122
<b>MATES IV</b>										
Average	2.32, 17.3 <sup>b</sup>	3.83, 38 <sup>b</sup>	2.56, 29.6 <sup>b</sup>	13.2	17.8	2.25, 32 <sup>b</sup>	13.5	15.1	1.18, 33.4 <sup>b</sup>	3.61, 31.6 <sup>b</sup>
95% CI LB	0.627 <sup>b</sup>	1.83 <sup>b</sup>	0.918 <sup>b</sup>	12.2	13.8	0.852 <sup>b</sup>	12.5	13.9	0.246 <sup>b</sup>	1.64 <sup>b</sup>
95% CI UB	21.5 <sup>b</sup>	45.1 <sup>b</sup>	34.8 <sup>b</sup>	14.8	24.4	49 <sup>b</sup>	14.8	16.5	40.8 <sup>b</sup>	42 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60	59	61 <sup>b</sup>	60	59	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	89.8 <sup>b</sup>	81.4 <sup>b</sup>	86.9 <sup>b</sup>	68.3	72.9	86.9 <sup>b</sup>	70	49.2	91.8 <sup>b</sup>	82 <sup>b</sup>
Max	35 <sup>b</sup>	28 <sup>b</sup>	33 <sup>b</sup>	51	175	24 <sup>b</sup>	30	29	21 <sup>b</sup>	44 <sup>b</sup>
<b>MATES V</b>										
Average	9.56	7.97	9.84	8.47	10.1	8.69	9.84	9.61	9.93	9.05
95% CI LB	8.41	7.49	8.74	7.82	8.79	7.77	8.65	8.53	8.21	8.16
95% CI UB	10.7	8.49	11.1	9.27	11.6	9.75	11.2	10.9	12.2	10.1
N	54	59	61	60	60	61	61	59	56	57
% < MDL	57.4	59.3	57.4	50	53.3	67.2	55.7	50.8	66.1	56.1
Max	26	14	24	20	32	22	27	29	63	22

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-252.** Annual Average Concentrations of Copper in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

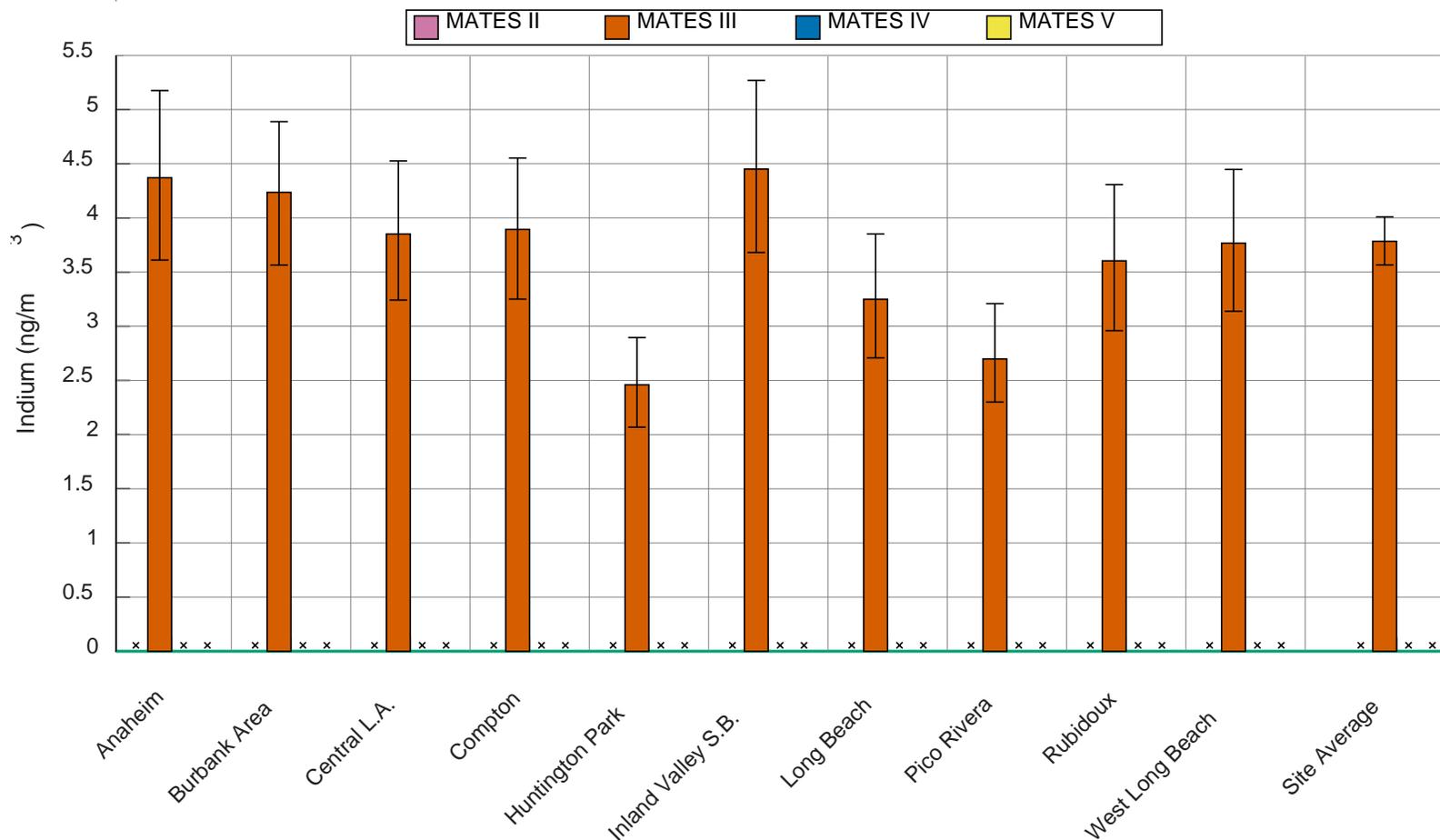


**Figure IV-253.** Geographic distribution of Copper from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

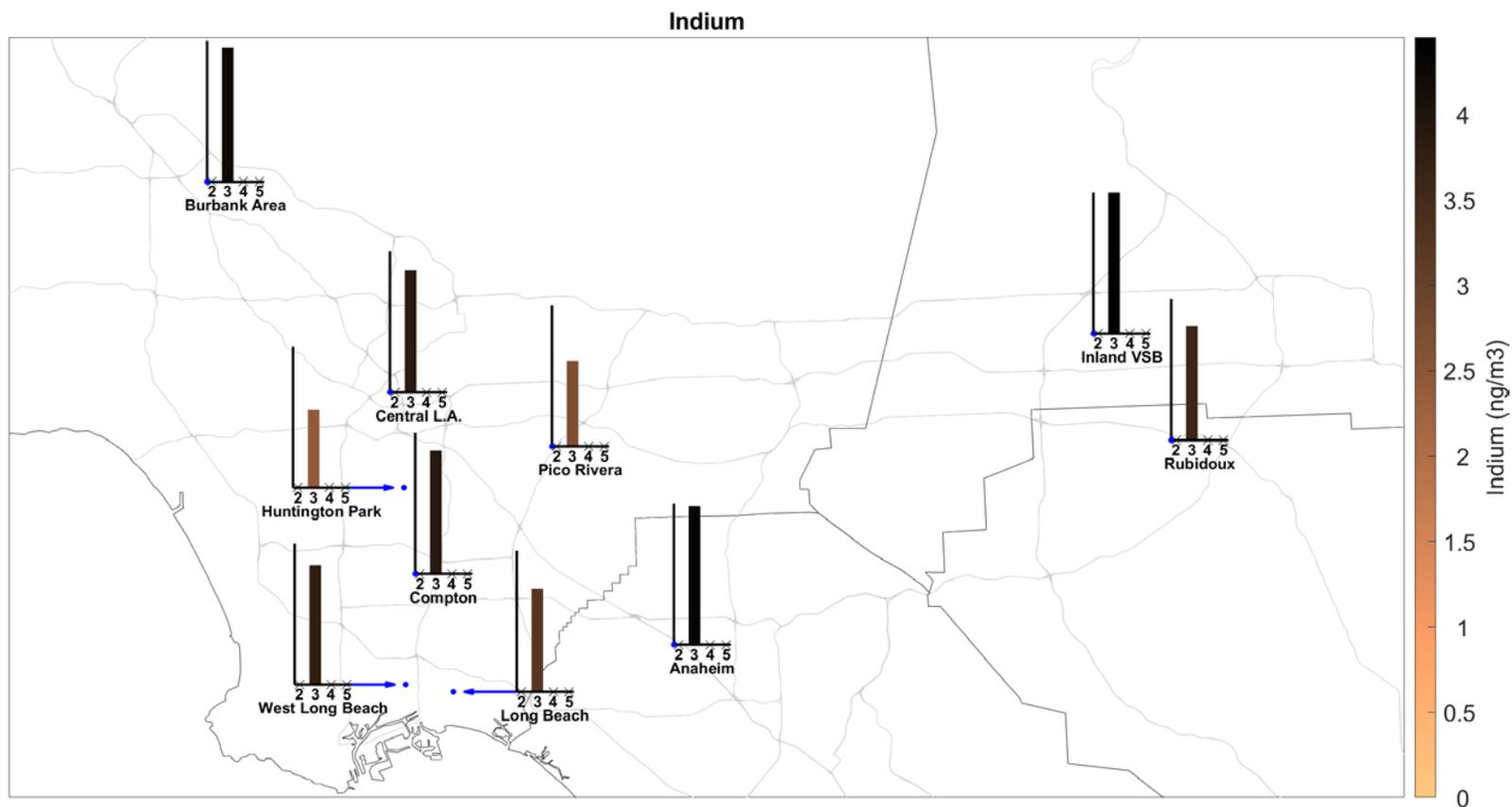
Indium

**Table IV-129.** Ambient Concentrations (ng/m<sup>3</sup>) of Indium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	4.37	4.24	3.89	4.45	2.46	3.25	3.85	2.7	3.6	3.77
95% CI LB	3.61	3.56	3.25	3.68	2.07	2.71	3.24	2.3	2.96	3.14
95% CI UB	5.18	4.89	4.55	5.27	2.9	3.85	4.53	3.21	4.31	4.45
N	240	239	234	238	117	228	237	116	236	228
% < MDL	36.3	36	38.9	32.8	33.3	39.5	32.1	31.9	42.4	35.1
Max	35.8	29.6	30.8	35.8	11.1	33.4	29.1	11.1	33.5	28.3
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-254.** Annual Average Concentrations of Indium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

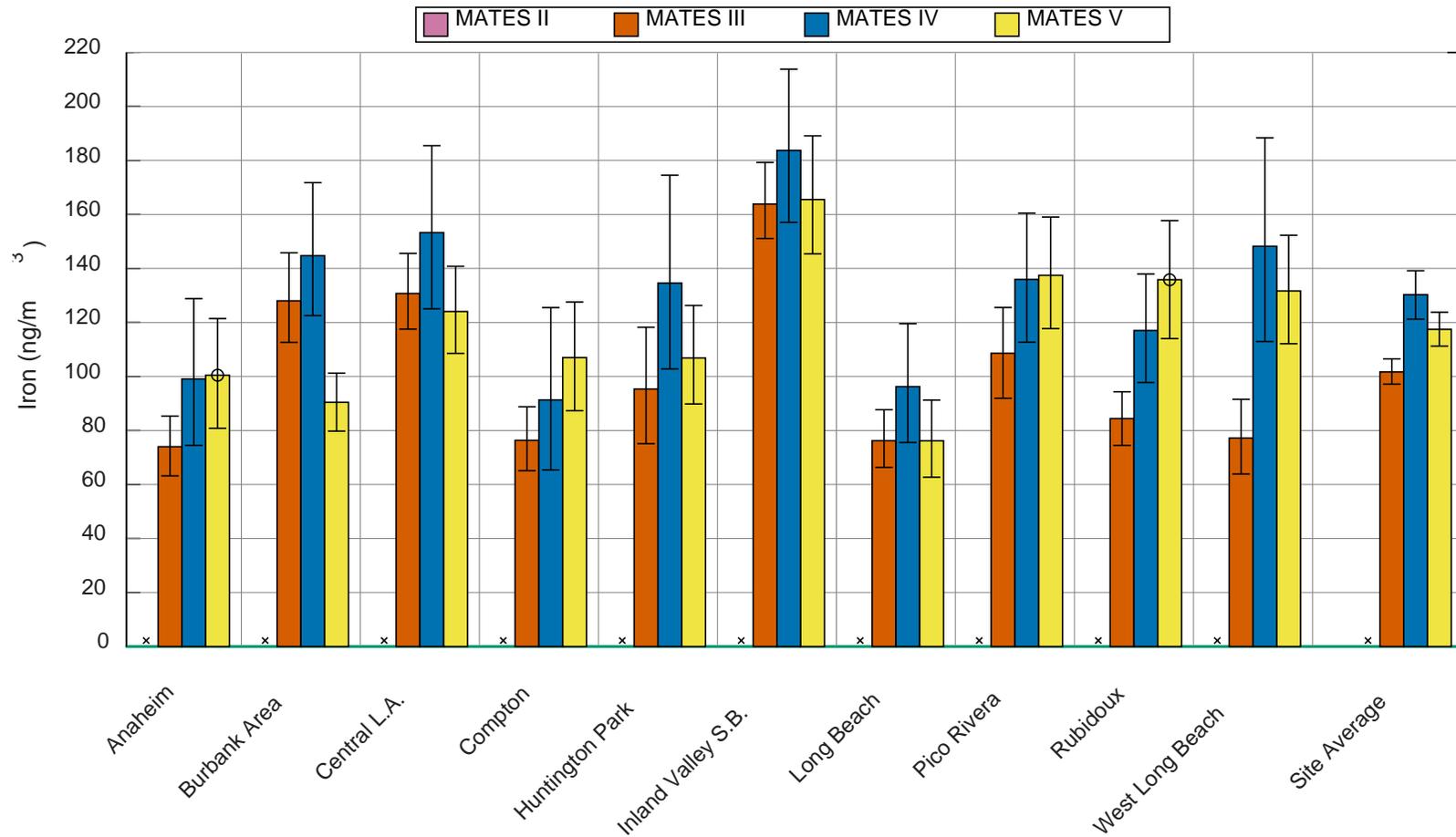


**Figure IV-255.** Geographic distribution of Indium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

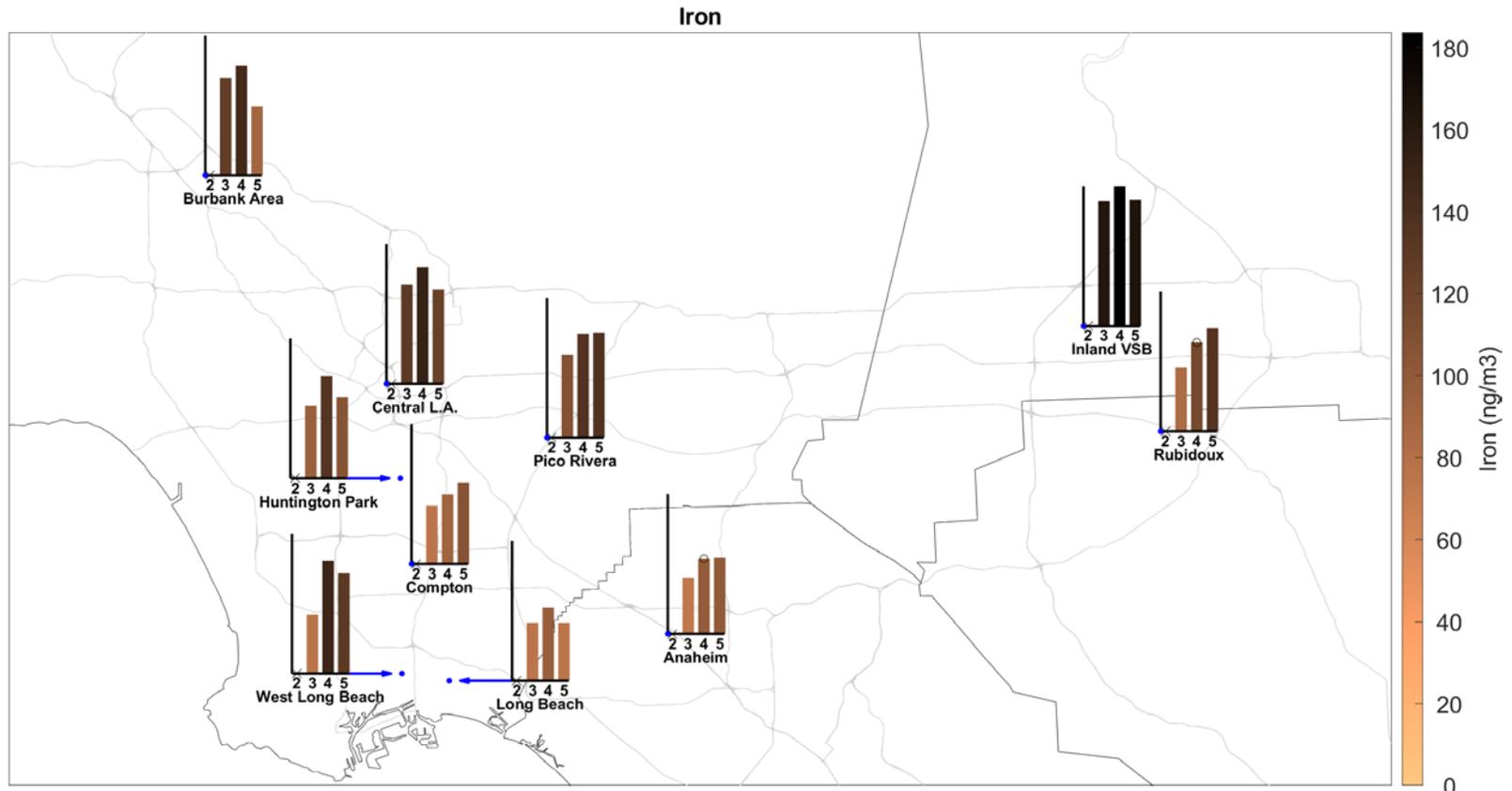
## Iron

**Table IV-130.** Ambient Concentrations (ng/m<sup>3</sup>) of Iron from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	74	128	76.3	164	95.4	76.2	131	109	84.4	77.2
95% CI LB	63.2	113	65.1	151	75.1	66.3	118	91.9	74.5	63.9
95% CI UB	85.3	146	88.8	179	118	87.7	146	126	94.3	91.5
N	240	239	234	238	117	228	237	116	236	228
% < MDL	6.7	0.8	5.1	0.8	0.9	0.9	0.8	0	3	10.5
Max	561	1500	817	823	816	441	687	398	539	651
MATES IV										
Average	99.1	145	91.3	184	135	96.2	153	136	117	148
95% CI LB	74.5	123	65.4	157	103	75.6	125	113	97.8	113
95% CI UB	129	172	126	214	175	120	185	160	138	188
N	59	59	61	60	59	61	60	59	61	61
% < MDL	5.1	1.7	1.6	0	3.4	0	1.7	1.7	1.6	0
Max	608	472	716	657	612	399	653	379	474	1060
MATES V										
Average	100	90.4	107	166	107	76.2	124	137	136	132
95% CI LB	80.8	79.8	87.3	145	89.8	62.7	109	118	114	112
95% CI UB	121	101	128	189	126	91.3	141	159	158	152
N	54	59	61	60	60	61	61	59	56	57
% < MDL	0	3.4	0	0	0	1.6	1.6	0	0	1.8
Max	346	189	374	394	329	247	362	436	429	371



**Figure IV-256.** Annual Average Concentrations of Iron in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



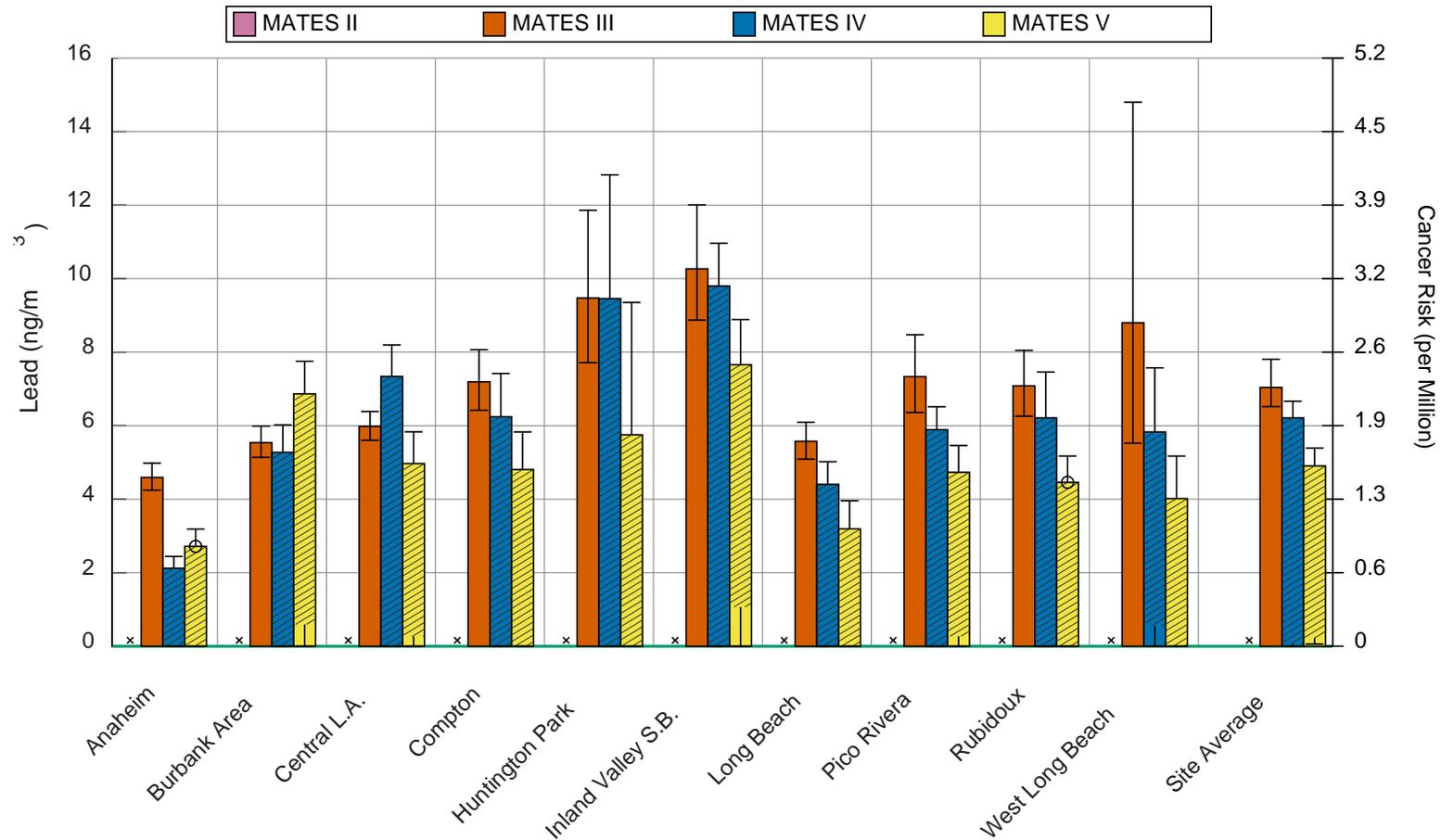
**Figure IV-257.** Geographic distribution of Iron from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Lead

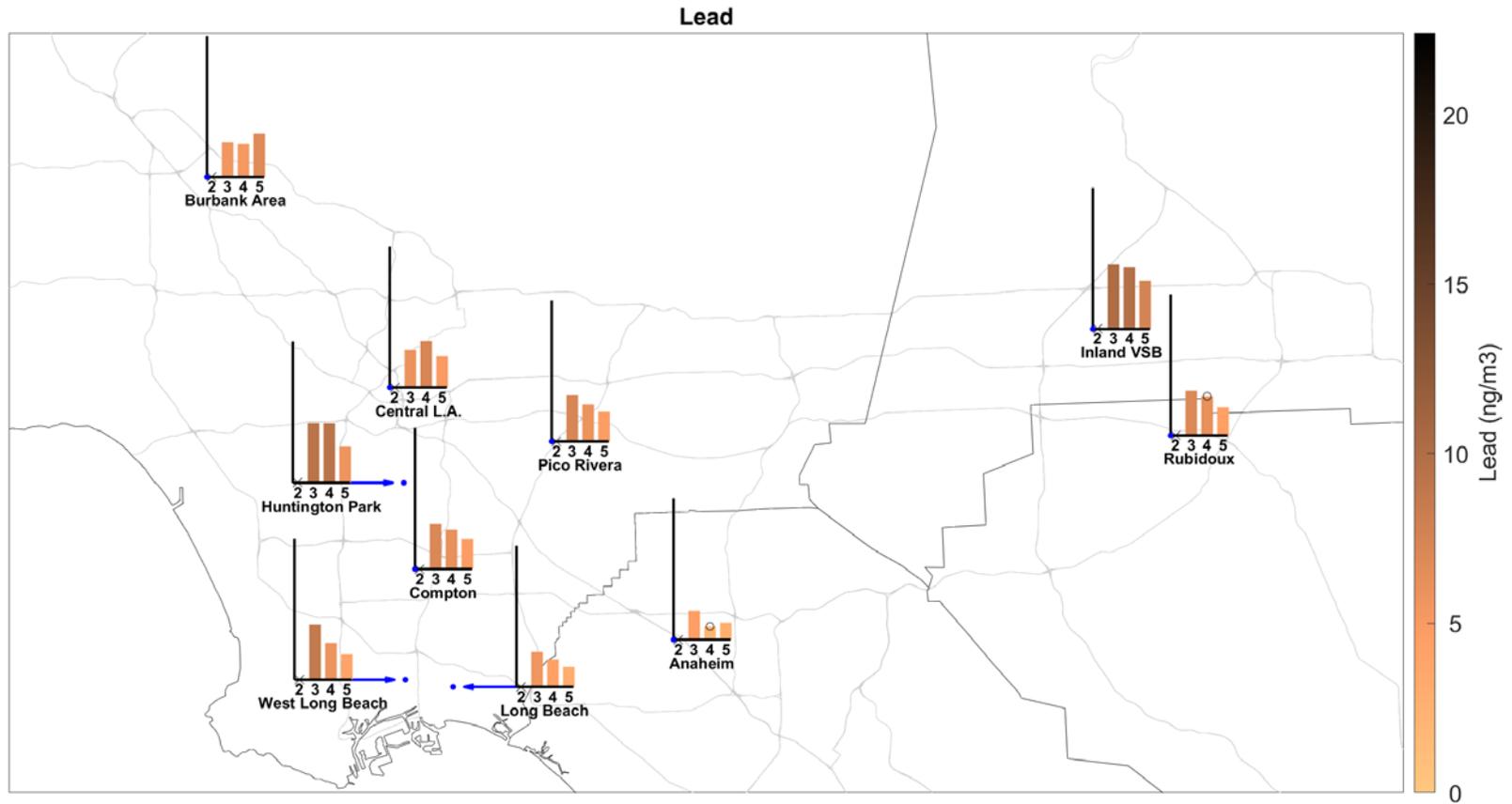
**Table IV-131.** Ambient Concentrations (ng/m<sup>3</sup>) of Lead from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	4.59	5.54	7.19	10.3	9.47	5.57	5.98	7.33	7.08	8.8
95% CI LB	4.24	5.14	6.42	8.87	7.71	5.09	5.6	6.36	6.26	5.52
95% CI UB	4.98	5.99	8.06	12	11.9	6.09	6.39	8.47	8.05	14.8
N	240	239	234	238	117	228	237	116	236	228
% < MDL	47.9	36.4	34.2	21	18.8	43	20.3	19	28	41.7
Max	33.4	34.7	57	132	113	24.7	19.8	54.4	77	646
MATES IV										
Average	0, 2.12 <sup>b</sup>	0, 5.27 <sup>b</sup>	0, 6.24 <sup>b</sup>	0, 9.8 <sup>b</sup>	0, 9.46 <sup>b</sup>	0, 4.4 <sup>b</sup>	0, 7.34 <sup>b</sup>	0, 5.89 <sup>b</sup>	0, 6.21 <sup>b</sup>	0.541, 5.83 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	2.44 <sup>b</sup>	6.02 <sup>b</sup>	7.42 <sup>b</sup>	11 <sup>b</sup>	12.8 <sup>b</sup>	5.02 <sup>b</sup>	8.19 <sup>b</sup>	6.51 <sup>b</sup>	7.46 <sup>b</sup>	7.57 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	98.4 <sup>b</sup>
Max	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	33 <sup>b</sup>
MATES V										
Average	0, 2.72 <sup>b</sup>	0.593, 6.87 <sup>b</sup>	0, 4.81 <sup>b</sup>	1.07, 7.66 <sup>b</sup>	0, 5.75 <sup>b</sup>	0, 3.19 <sup>b</sup>	0.262, 4.97 <sup>b</sup>	0.271, 4.73 <sup>b</sup>	0, 4.46 <sup>b</sup>	0, 4.02 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	3.19 <sup>b</sup>	7.75 <sup>b</sup>	5.83 <sup>b</sup>	8.89 <sup>b</sup>	9.35 <sup>b</sup>	3.96 <sup>b</sup>	5.83 <sup>b</sup>	5.46 <sup>b</sup>	5.17 <sup>b</sup>	5.17 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>	96.6 <sup>b</sup>	100 <sup>b</sup>	95 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	98.4 <sup>b</sup>	98.3 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	18 <sup>b</sup>	< MDL <sup>b</sup>	31 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	16 <sup>b</sup>	16 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-258.** Annual Average Concentrations of Lead in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

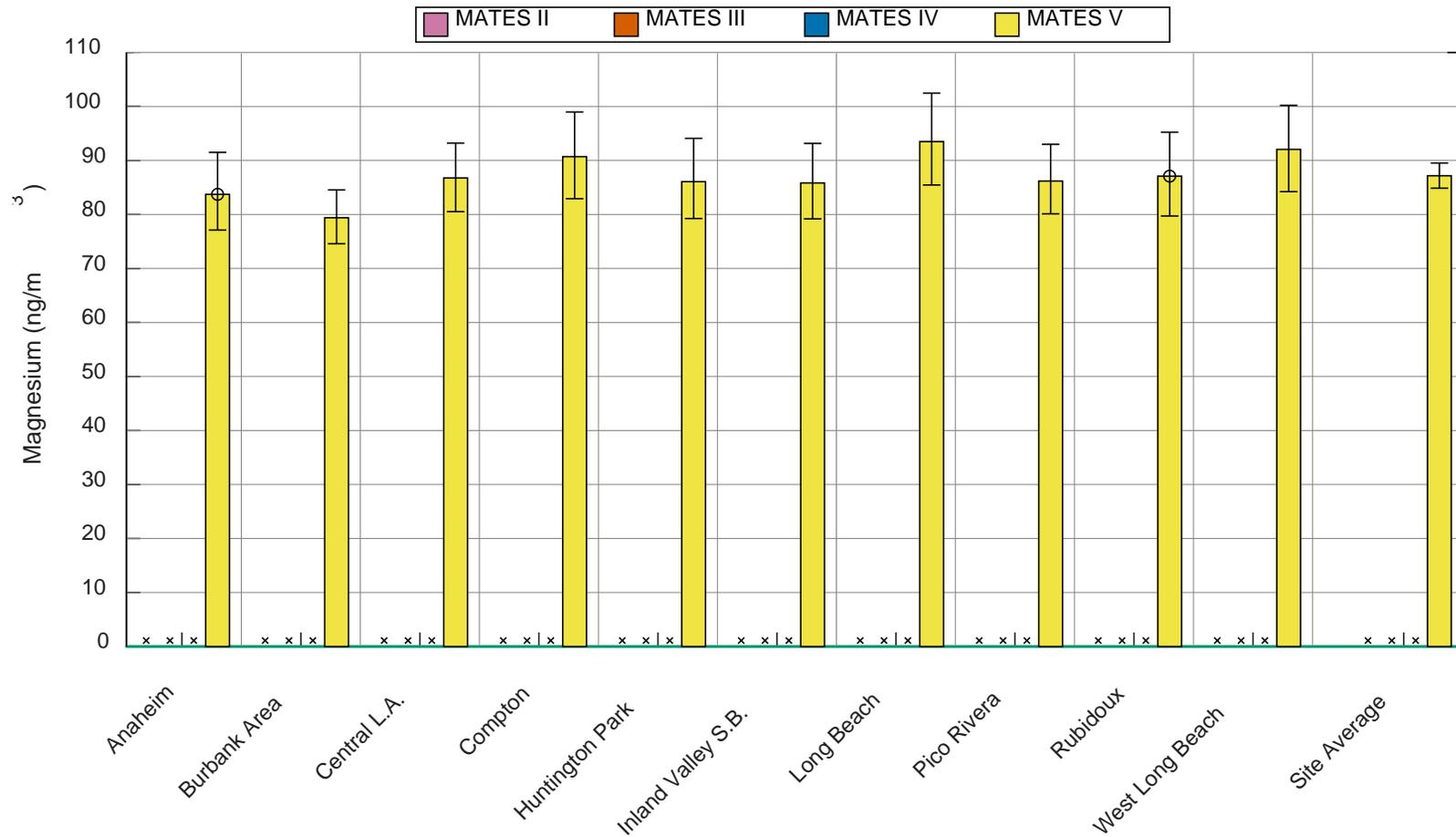


**Figure IV-259.** Geographic distribution of Lead from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

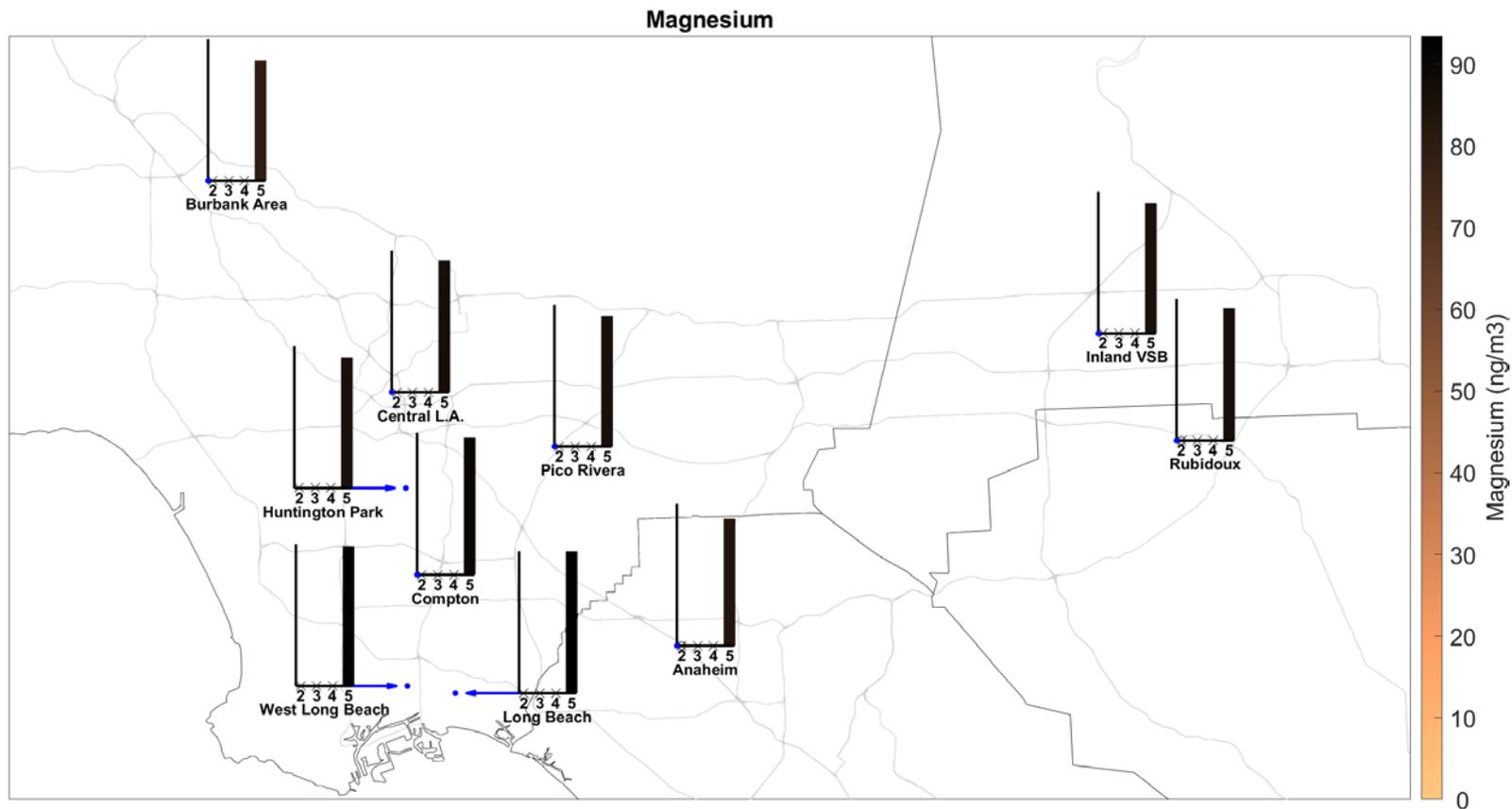
Magnesium

**Table IV-132.** Ambient Concentrations (ng/m<sup>3</sup>) of Magnesium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	83.7	79.4	90.7	85.8	86.1	93.5	86.8	86.2	87.1	92.1
95% CI LB	77.1	74.6	82.9	79.2	79.3	85.5	80.5	80.1	79.7	84.2
95% CI UB	91.5	84.5	99	93.2	94.1	102	93.2	93	95.2	100
N	54	59	61	60	60	61	61	59	56	57
% < MDL	48.1	55.9	45.9	46.7	51.7	41	49.2	50.8	44.6	42.1
Max	194	138	184	199	214	259	181	189	219	199



**Figure IV-260.** Annual Average Concentrations of Magnesium in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



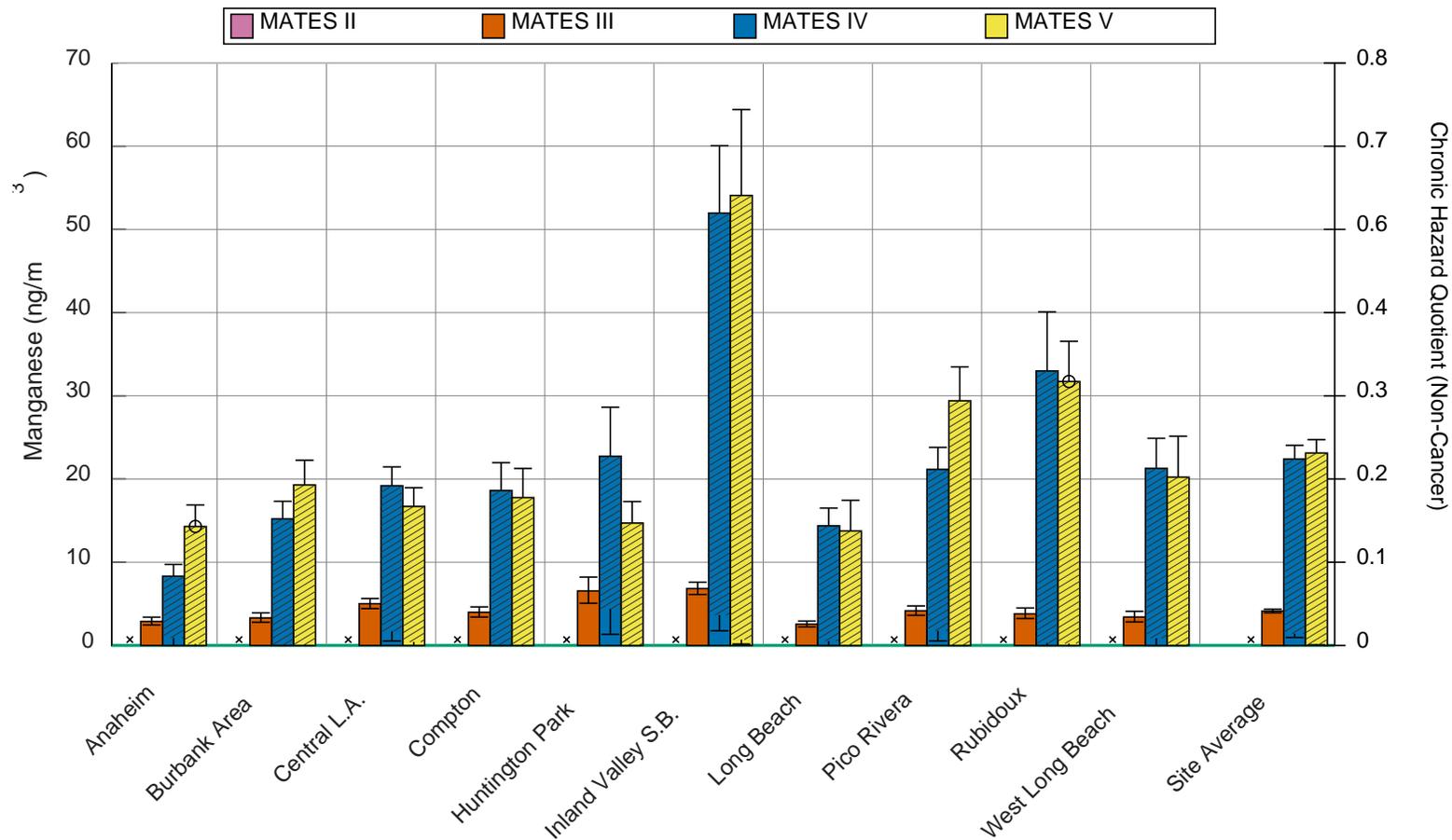
**Figure IV-261.** Geographic distribution of Magnesium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Manganese

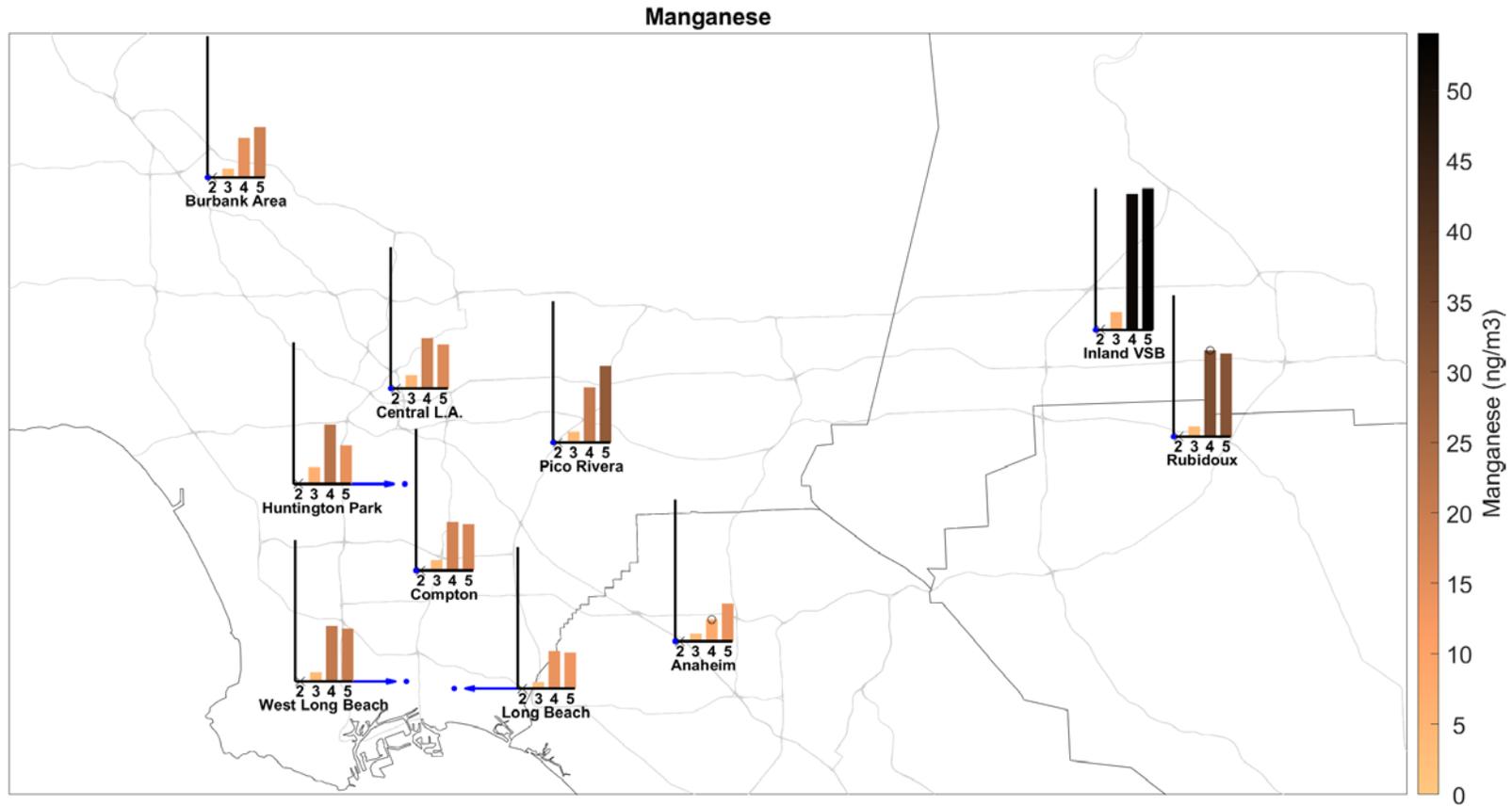
**Table IV-133.** Ambient Concentrations (ng/m<sup>3</sup>) of Manganese from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	2.88	3.3	3.99	6.84	6.55	2.56	5.02	4.16	3.8	3.41
95% CI LB	2.46	2.79	3.41	6.13	5.07	2.23	4.43	3.62	3.24	2.83
95% CI UB	3.4	3.92	4.63	7.6	8.22	2.93	5.64	4.75	4.5	4.1
N	240	239	234	238	117	228	237	116	236	228
% < MDL	29.6	23.4	21.8	14.3	6.8	30.7	14.3	6.9	19.9	26.3
Max	37	40.8	52.9	46.9	44.5	12.4	43.7	13.6	43.2	41.9
<b>MATES IV</b>										
Average	0.915, 8.32 <sup>b</sup>	0, 15.2 <sup>b</sup>	0, 18.6 <sup>b</sup>	3.65, 52 <sup>b</sup>	4.42, 22.7 <sup>b</sup>	0.525, 14.4 <sup>b</sup>	1.7, 19.2 <sup>b</sup>	1.76, 21.2 <sup>b</sup>	0.279, 33 <sup>b</sup>	0.869, 21.3 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	1.77 <sup>b</sup>	1.34 <sup>b</sup>	0 <sup>b</sup>	0.533 <sup>b</sup>	0.542 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	9.73 <sup>b</sup>	17.3 <sup>b</sup>	22 <sup>b</sup>	60.1 <sup>b</sup>	28.6 <sup>b</sup>	16.5 <sup>b</sup>	21.5 <sup>b</sup>	23.8 <sup>b</sup>	40.1 <sup>b</sup>	24.9 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	94.9 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	81.7 <sup>b</sup>	88.1 <sup>b</sup>	96.7 <sup>b</sup>	90 <sup>b</sup>	89.8 <sup>b</sup>	98.4 <sup>b</sup>	95.1 <sup>b</sup>
Max	23 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	32 <sup>b</sup>	82 <sup>b</sup>	16 <sup>b</sup>	22 <sup>b</sup>	23 <sup>b</sup>	17 <sup>b</sup>	18 <sup>b</sup>
<b>MATES V</b>										
Average	0.167, 14.3 <sup>b</sup>	0, 19.3 <sup>b</sup>	0, 17.8 <sup>b</sup>	0.7, 54.1 <sup>b</sup>	0, 14.7 <sup>b</sup>	0.148, 13.8 <sup>b</sup>	0.418, 16.7 <sup>b</sup>	0, 29.4 <sup>b</sup>	0.232, 31.7 <sup>b</sup>	0, 20.2 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0.167 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	16.9 <sup>b</sup>	22.3 <sup>b</sup>	21.3 <sup>b</sup>	64.4 <sup>b</sup>	17.3 <sup>b</sup>	17.4 <sup>b</sup>	19 <sup>b</sup>	33.5 <sup>b</sup>	36.5 <sup>b</sup>	25.1 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	98.1 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	93.3 <sup>b</sup>	100 <sup>b</sup>	98.4 <sup>b</sup>	96.7 <sup>b</sup>	100 <sup>b</sup>	98.2 <sup>b</sup>	100 <sup>b</sup>
Max	9 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	11 <sup>b</sup>	< MDL <sup>b</sup>	9 <sup>b</sup>	13.5 <sup>b</sup>	< MDL <sup>b</sup>	13 <sup>b</sup>	< MDL <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-262.** Annual Average Concentrations of Manganese in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



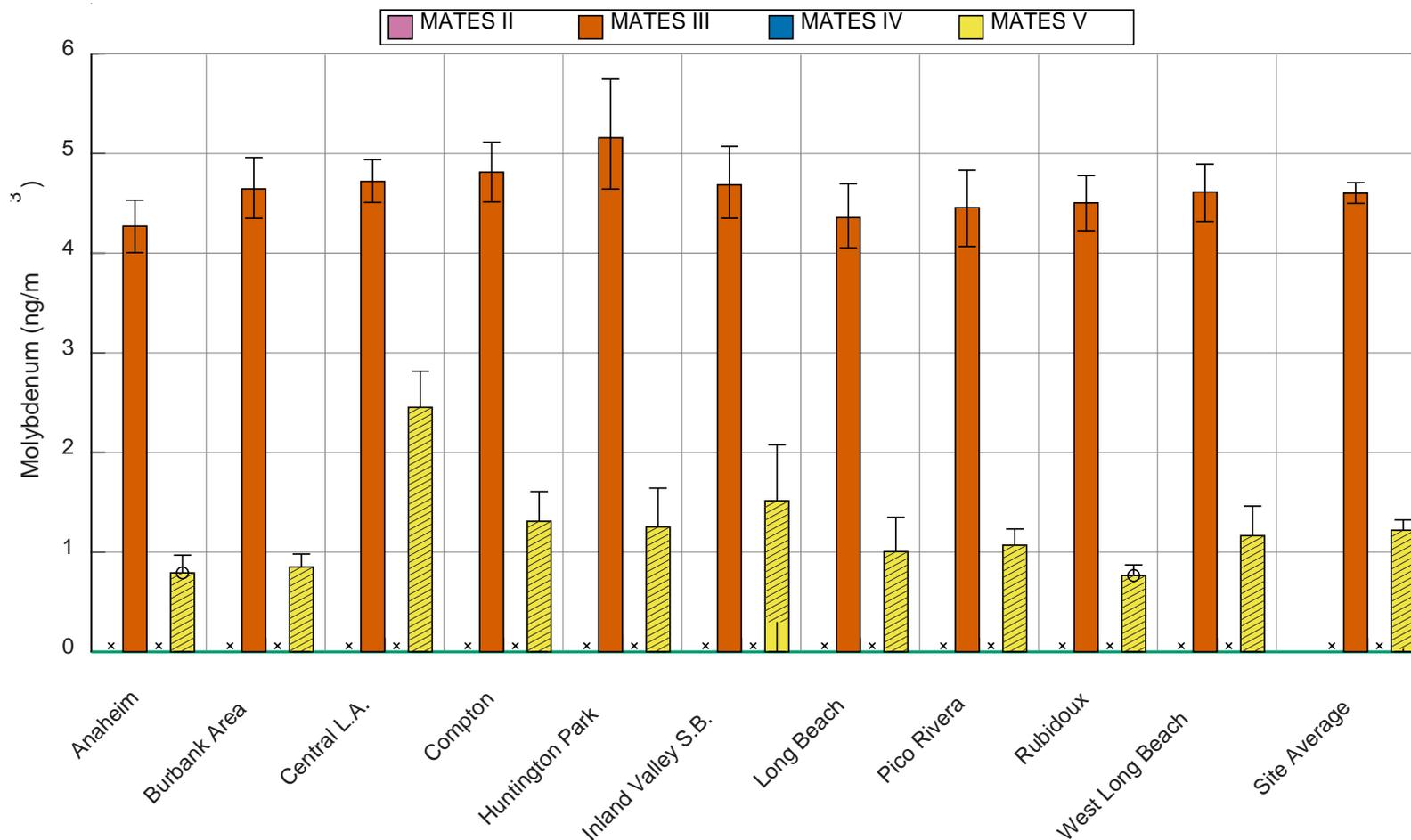
**Figure IV-263.** Geographic distribution of Manganese from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Molybdenum

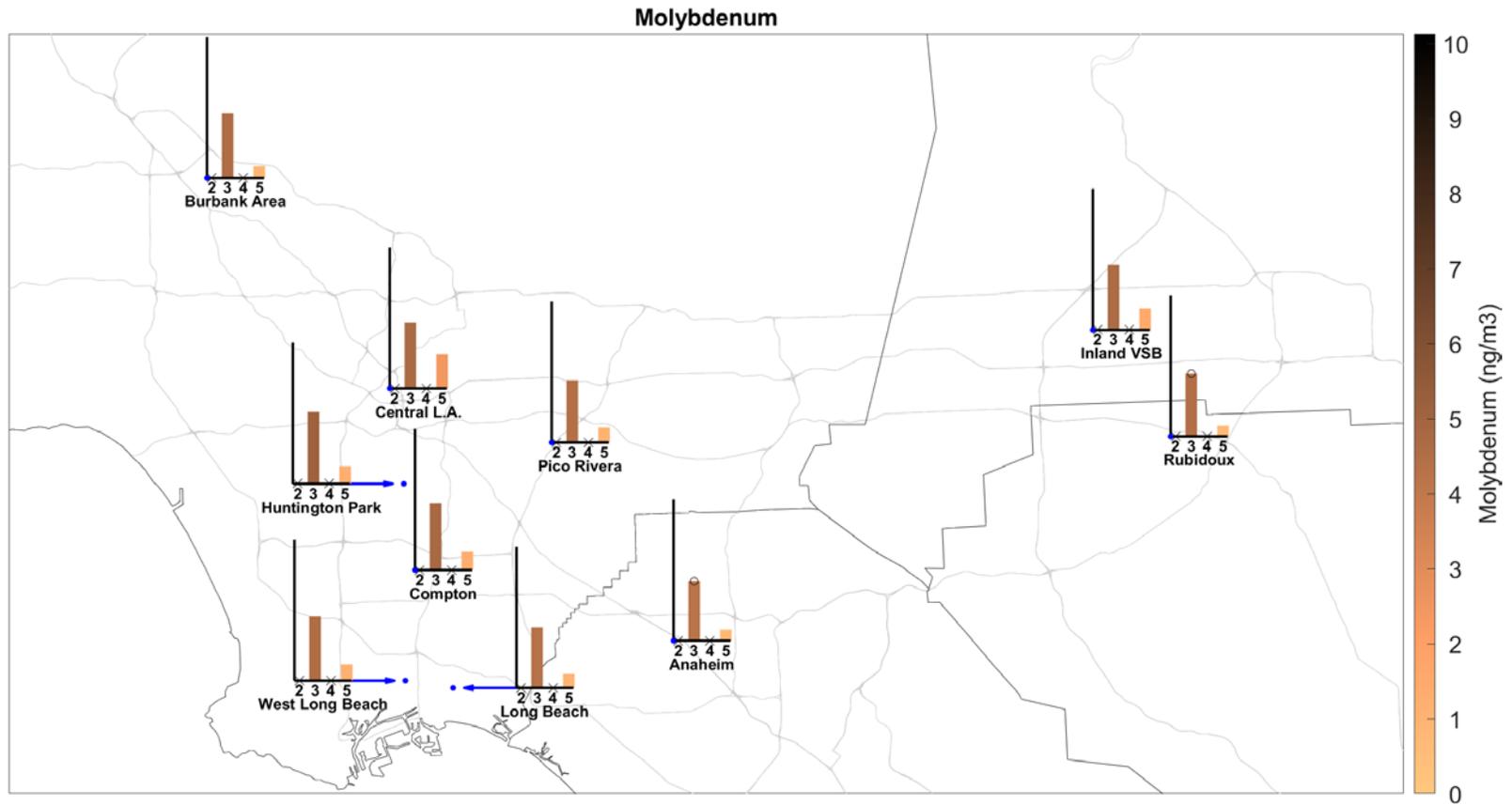
**Table IV-134.** Ambient Concentrations (ng/m<sup>3</sup>) of Molybdenum from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	4.27	4.64	4.81	4.68	5.16	4.36	4.72	4.46	4.5	4.61
95% CI LB	4	4.35	4.51	4.35	4.64	4.05	4.51	4.07	4.23	4.32
95% CI UB	4.53	4.96	5.11	5.07	5.75	4.7	4.94	4.83	4.78	4.89
N	240	239	234	238	117	228	237	116	236	228
% < MDL	2.9	1.3	2.6	2.1	1.7	3.5	0	1.7	0.8	0.4
Max	13.6	19.8	14.8	33.5	23.5	16.1	12.3	9.9	12.3	14.8
<b>MATES IV</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES V</b>										
Average	0, 0.793 <sup>b</sup>	0, 0.852 <sup>b</sup>	0, 1.31 <sup>b</sup>	0.3, 1.52 <sup>b</sup>	0, 1.25 <sup>b</sup>	0, 1 <sup>b</sup>	0, 2.45 <sup>b</sup>	0, 1.07 <sup>b</sup>	0, 0.766 <sup>b</sup>	0, 1.17 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	0.97 <sup>b</sup>	0.981 <sup>b</sup>	1.61 <sup>b</sup>	2.08 <sup>b</sup>	1.64 <sup>b</sup>	1.35 <sup>b</sup>	2.82 <sup>b</sup>	1.23 <sup>b</sup>	0.873 <sup>b</sup>	1.46 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	98.3 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	18 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-264.** Annual Average Concentrations of Molybdenum in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



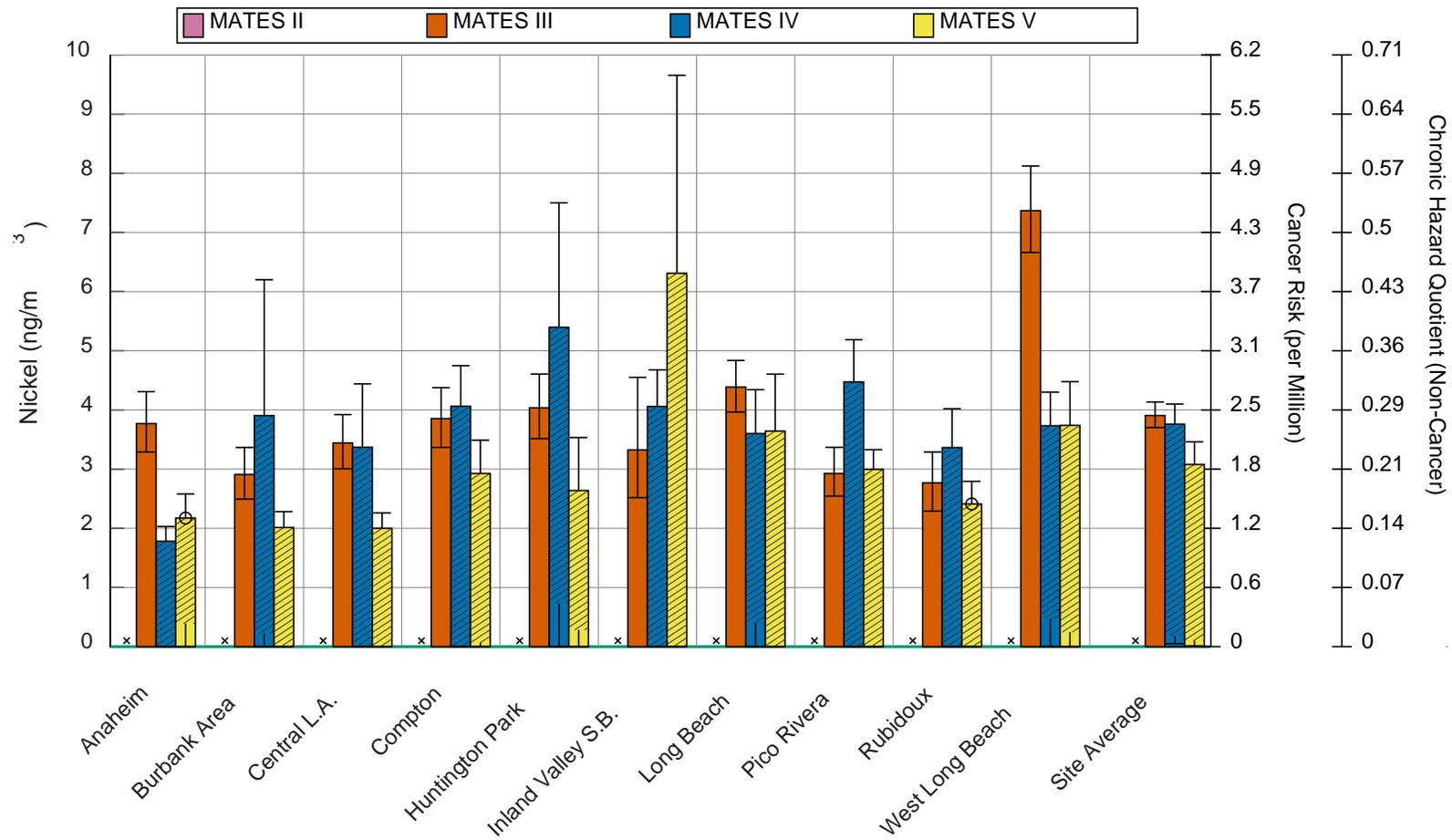
**Figure IV-265.** Geographic distribution of Molybdenum from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Nickel

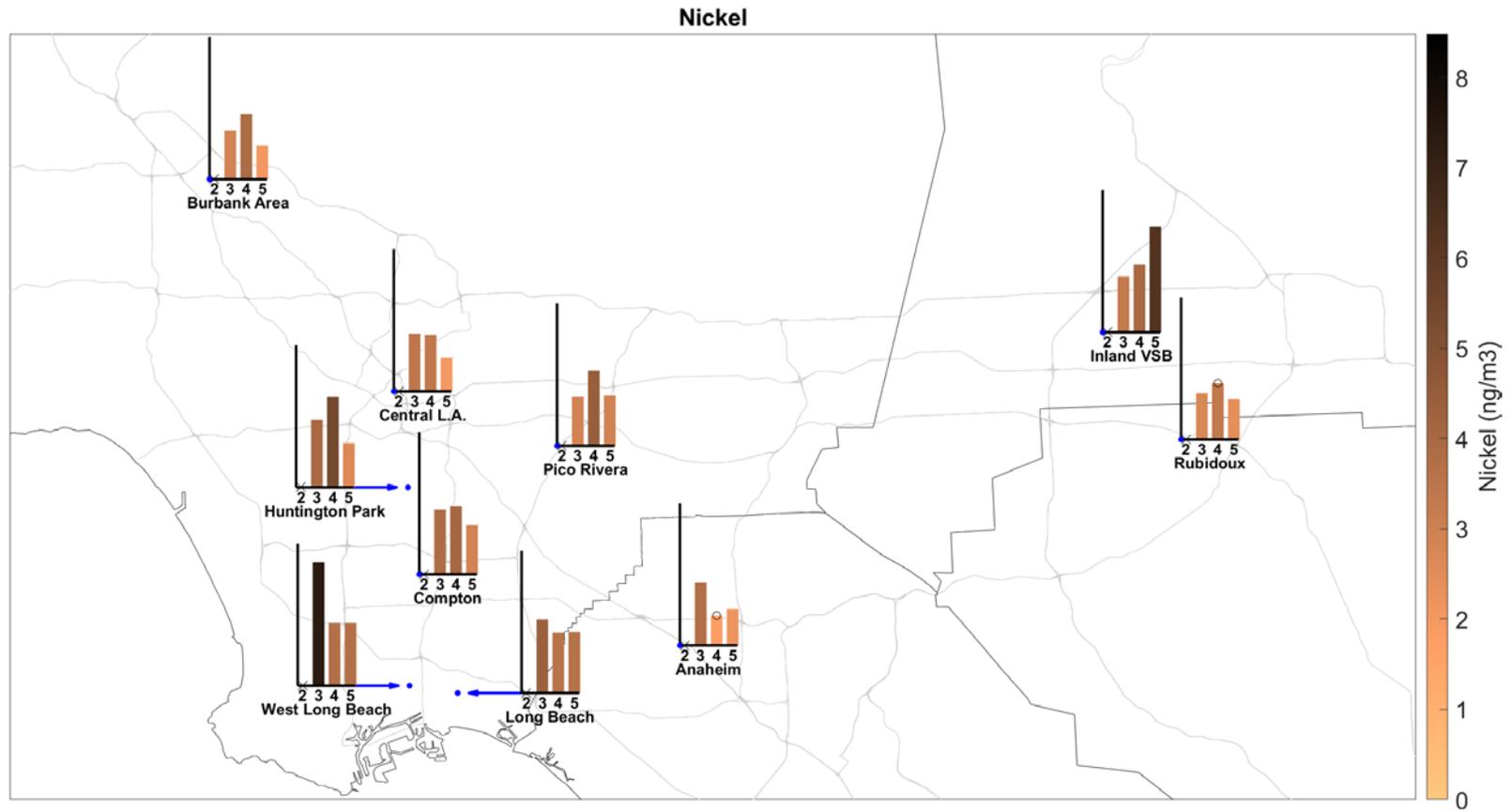
**Table IV-135.** Ambient Concentrations (ng/m<sup>3</sup>) of Nickel from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	3.77	2.91	3.85	3.33	4.04	4.39	3.44	2.93	2.77	7.37
95% CI LB	3.29	2.49	3.37	2.52	3.51	3.96	3.01	2.54	2.29	6.66
95% CI UB	4.31	3.37	4.38	4.55	4.61	4.84	3.92	3.37	3.29	8.12
N	240	239	234	238	117	228	237	116	236	228
% < MDL	7.5	14.2	7.7	17.6	3.4	6.1	6.3	6.9	16.9	2.6
Max	33.3	28.4	34.5	120	16.1	18.5	28.3	12.4	32.1	38.2
<b>MATES IV</b>										
Average	0, 1.78 <sup>b</sup>	0.22, 3.9 <sup>b</sup>	0, 4.06 <sup>b</sup>	0, 4.06 <sup>b</sup>	0.729, 5.4 <sup>b</sup>	0.393, 3.6 <sup>b</sup>	0, 3.37 <sup>b</sup>	0, 4.47 <sup>b</sup>	0, 3.36 <sup>b</sup>	0.475, 3.73 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	2.03 <sup>b</sup>	6.2 <sup>b</sup>	4.75 <sup>b</sup>	4.68 <sup>b</sup>	7.5 <sup>b</sup>	4.34 <sup>b</sup>	4.44 <sup>b</sup>	5.19 <sup>b</sup>	4.02 <sup>b</sup>	4.3 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	100 <sup>b</sup>	98.3 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	96.6 <sup>b</sup>	98.4 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	96.7 <sup>b</sup>
Max	< MDL <sup>b</sup>	13 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	32 <sup>b</sup>	24 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	20 <sup>b</sup>
<b>MATES V</b>										
Average	0.389, 2.17 <sup>b</sup>	0, 2.01 <sup>b</sup>	0.0656, 2.93 <sup>b</sup>	0, 6.31 <sup>b</sup>	0.283, 2.64 <sup>b</sup>	0, 3.64 <sup>b</sup>	0, 2 <sup>b</sup>	0, 3 <sup>b</sup>	0, 2.41 <sup>b</sup>	0.246, 3.74 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	2.58 <sup>b</sup>	2.28 <sup>b</sup>	3.49 <sup>b</sup>	9.66 <sup>b</sup>	3.53 <sup>b</sup>	4.6 <sup>b</sup>	2.26 <sup>b</sup>	3.33 <sup>b</sup>	2.79 <sup>b</sup>	4.48 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	98.1 <sup>b</sup>	100 <sup>b</sup>	98.4 <sup>b</sup>	100 <sup>b</sup>	98.3 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	96.5 <sup>b</sup>
Max	21 <sup>b</sup>	< MDL <sup>b</sup>	4 <sup>b</sup>	< MDL <sup>b</sup>	17 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	10 <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-266.** Annual Average Concentrations of Nickel in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



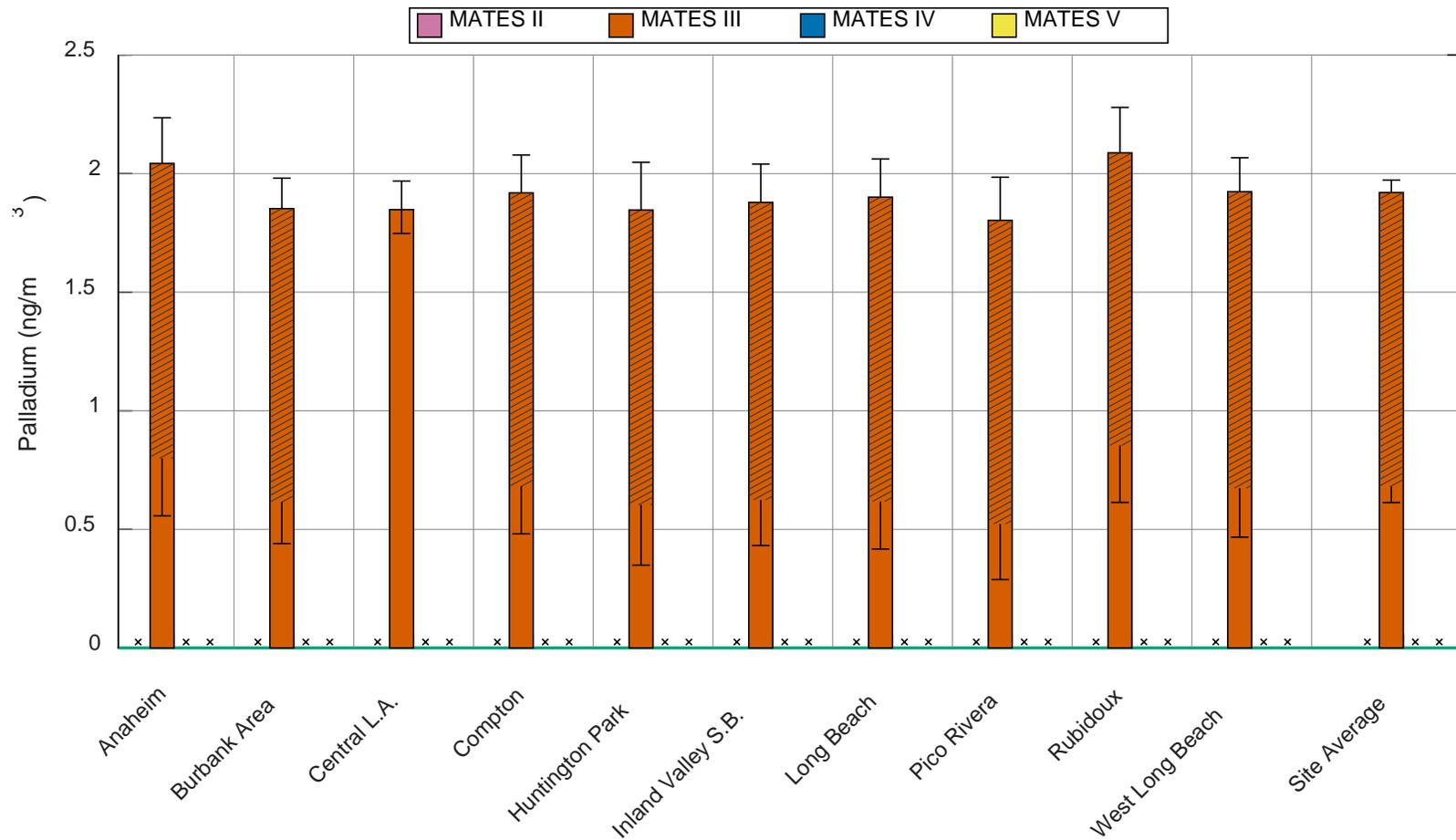
**Figure IV-267.** Geographic distribution of Nickel from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Palladium

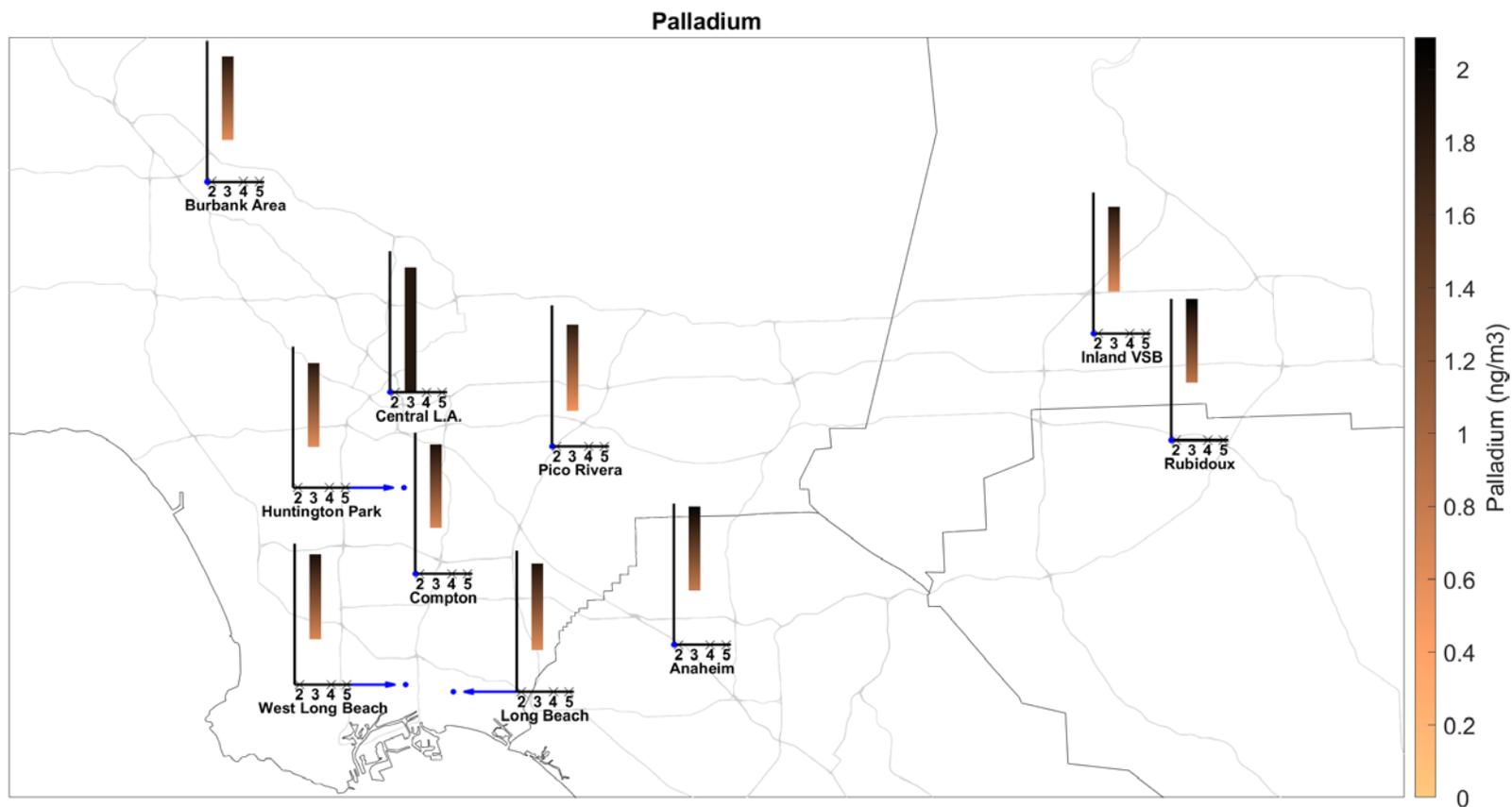
**Table IV-136.** Ambient Concentrations (ng/m<sup>3</sup>) of Palladium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	0.799, 2.04 <sup>a</sup>	0.616, 1.85 <sup>a</sup>	0.682, 1.92 <sup>a</sup>	0.624, 1.88 <sup>a</sup>	0.603, 1.85 <sup>a</sup>	0.618, 1.9 <sup>a</sup>	1.85	0.523, 1.8 <sup>a</sup>	0.854, 2.09 <sup>a</sup>	0.673, 1.92 <sup>a</sup>
95% CI LB	0.557 <sup>a</sup>	0.44 <sup>a</sup>	0.481 <sup>a</sup>	0.432 <sup>a</sup>	0.349 <sup>a</sup>	0.417 <sup>a</sup>	1.75	0.288 <sup>a</sup>	0.613 <sup>a</sup>	0.467 <sup>a</sup>
95% CI UB	2.24 <sup>a</sup>	1.98 <sup>a</sup>	2.08 <sup>a</sup>	2.04 <sup>a</sup>	2.05 <sup>a</sup>	2.06 <sup>a</sup>	1.97	1.98 <sup>a</sup>	2.28 <sup>a</sup>	2.07 <sup>a</sup>
N	240 <sup>a</sup>	239 <sup>a</sup>	234 <sup>a</sup>	238 <sup>a</sup>	117 <sup>a</sup>	228 <sup>a</sup>	237	116 <sup>a</sup>	236 <sup>a</sup>	228 <sup>a</sup>
% < MDL	82.9 <sup>a</sup>	82.4 <sup>a</sup>	82.5 <sup>a</sup>	83.6 <sup>a</sup>	82.9 <sup>a</sup>	85.5 <sup>a</sup>	77.6	85.3 <sup>a</sup>	82.2 <sup>a</sup>	83.3 <sup>a</sup>
Max	13.6 <sup>a</sup>	9.91 <sup>a</sup>	8.66 <sup>a</sup>	12.4 <sup>a</sup>	8.65 <sup>a</sup>	9.87 <sup>a</sup>	8.66	7.42 <sup>a</sup>	8.68 <sup>a</sup>	7.43 <sup>a</sup>
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-268.** Annual Average Concentrations of Palladium in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

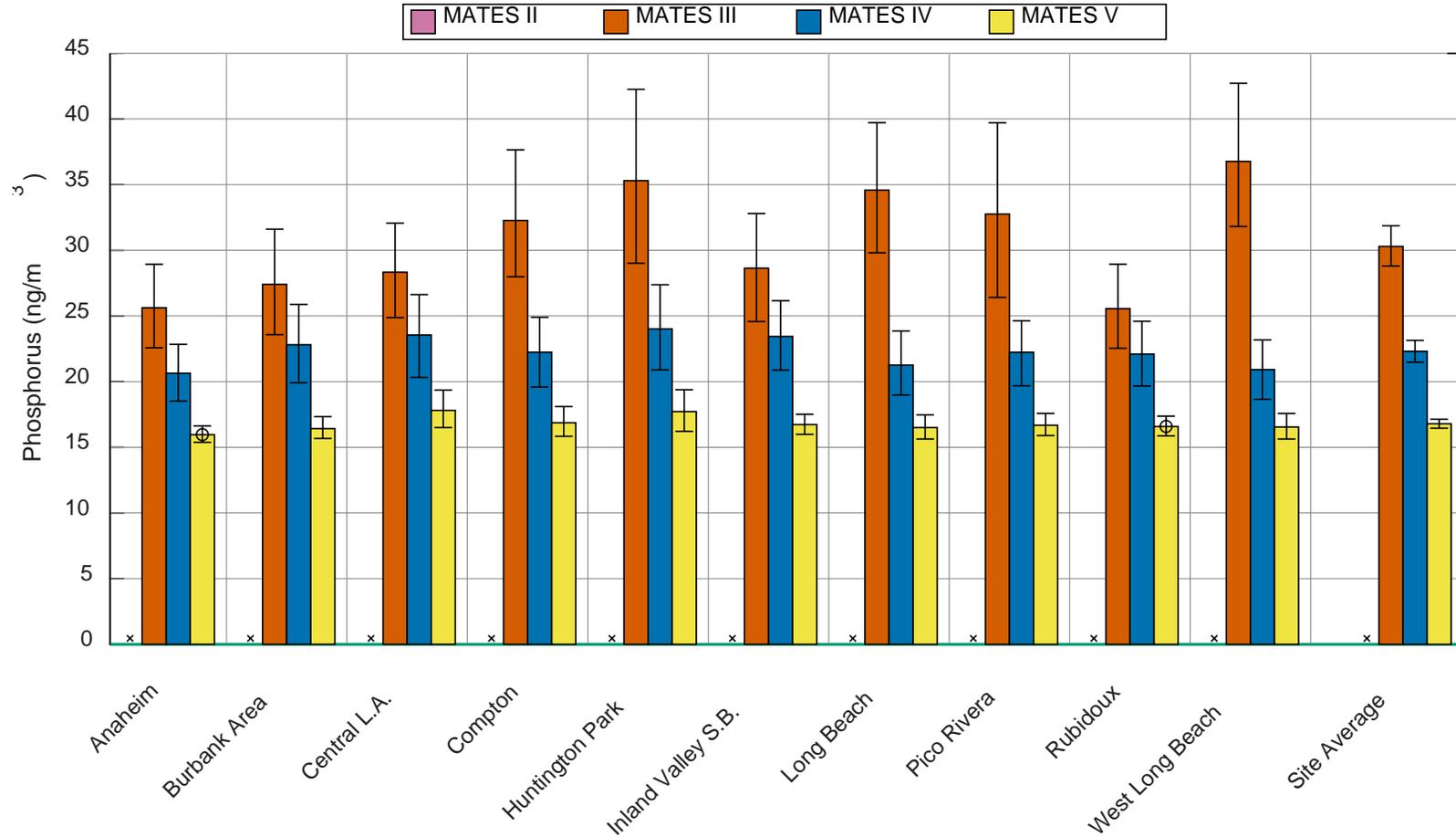


**Figure IV-269.** Geographic distribution of Palladium from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. "x" indicates that there is no data for a given station/MATES iteration.

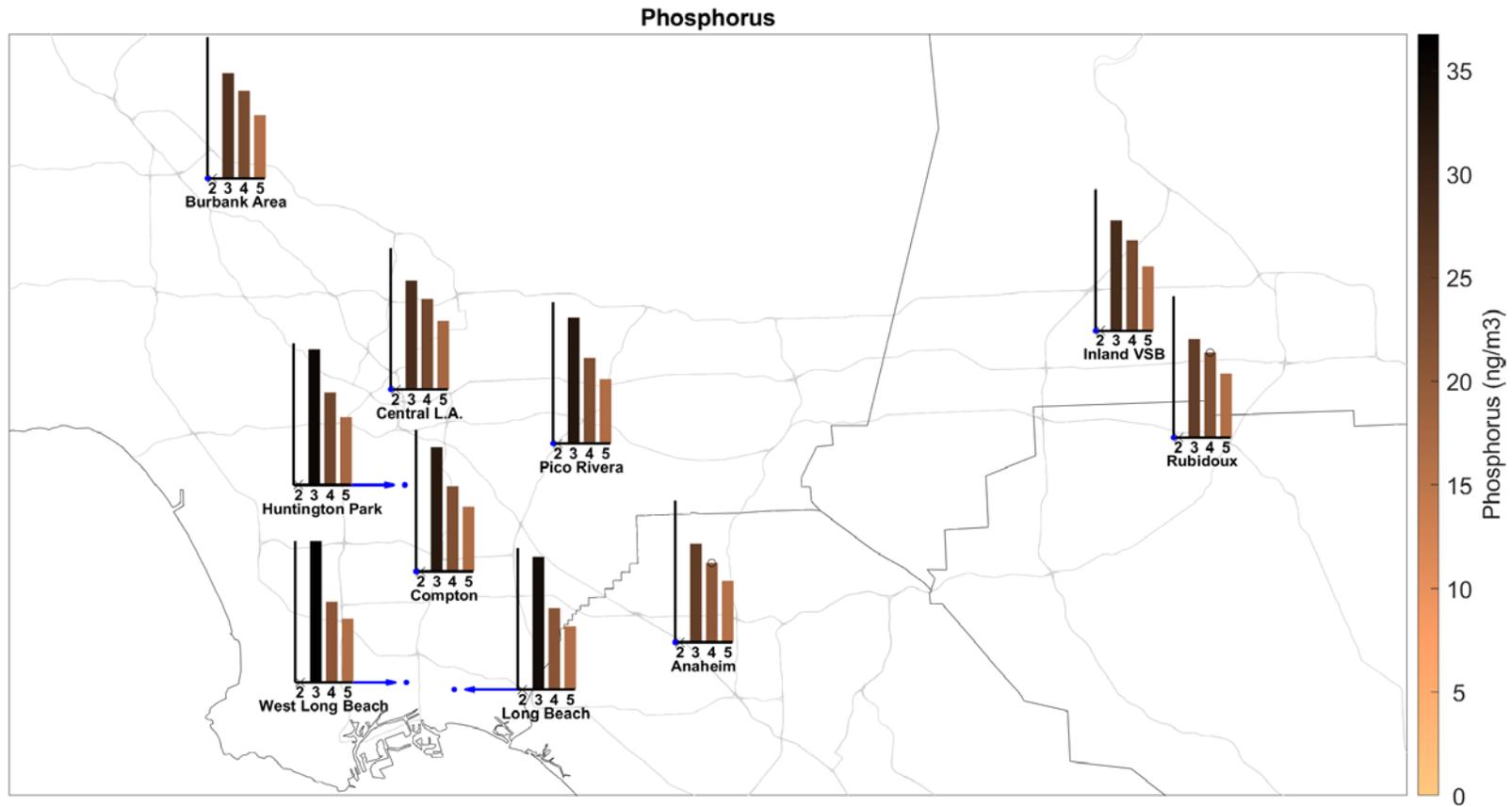
Phosphorus

**Table IV-137.** Ambient Concentrations (ng/m<sup>3</sup>) of Phosphorus from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	25.6	27.4	32.3	28.6	35.3	34.6	28.3	32.8	25.6	36.8
95% CI LB	22.6	23.6	28	24.6	29	29.8	24.9	26.4	22.5	31.8
95% CI UB	28.9	31.6	37.6	32.8	42.3	39.7	32.1	39.7	28.9	42.7
N	240	239	234	238	117	228	237	116	236	228
% < MDL	59.6	62.8	56.8	58	46.2	54.8	51.5	48.3	63.6	49.6
Max	152	214	217	236	184	204	186	222	164	315
MATES IV										
Average	20.6	22.8	22.2	23.4	24	21.3	23.5	22.2	22.1	20.9
95% CI LB	18.5	19.9	19.6	20.9	20.9	19	20.3	19.7	19.7	18.7
95% CI UB	22.8	25.9	24.9	26.2	27.4	23.9	26.6	24.6	24.6	23.2
N	59	59	61	60	59	61	60	59	61	61
% < MDL	61	57.6	52.5	51.7	49.2	55.7	53.3	50.8	52.5	52.5
Max	48	64	54	55	74	60	69	46	52	49
MATES V										
Average	16	16.4	16.9	16.7	17.7	16.5	17.8	16.7	16.6	16.5
95% CI LB	15.4	15.7	15.8	16	16.2	15.6	16.5	15.9	15.9	15.6
95% CI UB	16.6	17.3	18.1	17.5	19.4	17.5	19.4	17.6	17.4	17.6
N	54	59	61	60	60	61	61	59	56	57
% < MDL	77.8	79.7	73.8	66.7	70	73.8	67.2	72.9	67.9	75.4
Max	25	28	35	27	40	32	37.5	28	25	33



**Figure IV-270.** Annual Average Concentrations of Phosphorus in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

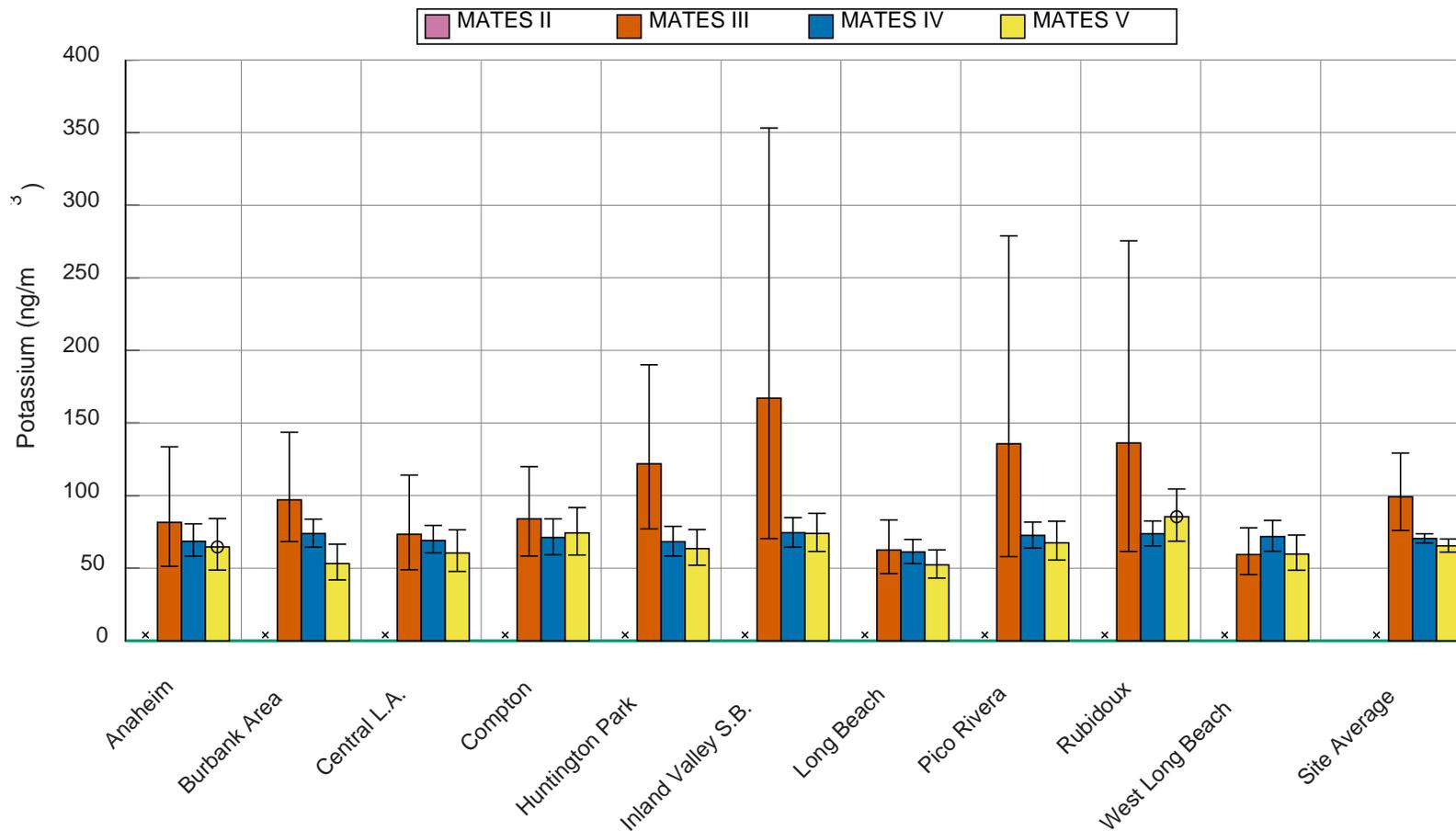


**Figure IV-271.** Geographic distribution of Phosphorus from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

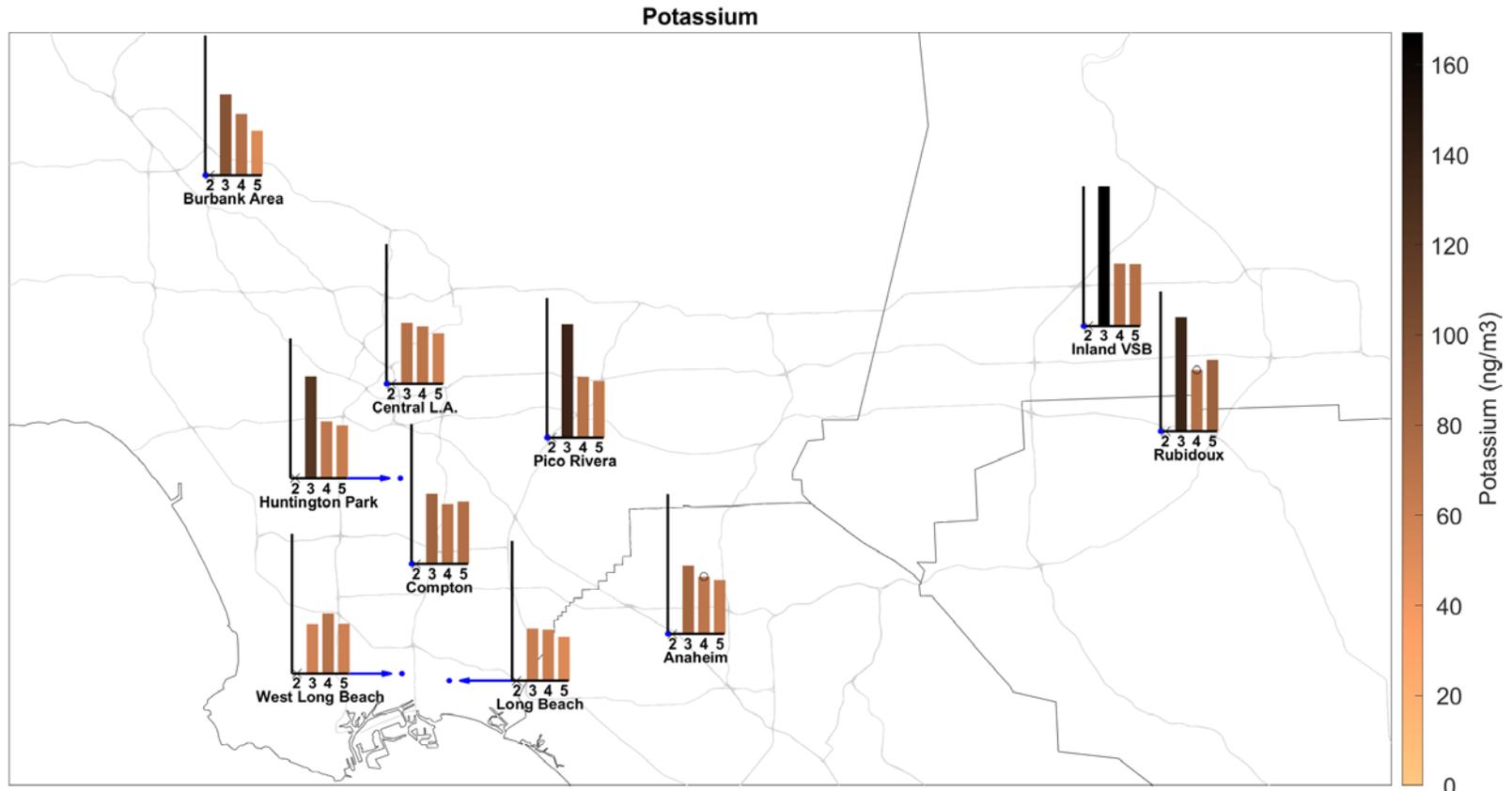
## Potassium

**Table IV-138.** Ambient Concentrations (ng/m<sup>3</sup>) of Potassium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	81.6	97.1	84	167	122	62.5	73.4	136	136	59.4
95% CI LB	51.3	68.3	58.4	70.4	77	46.2	48.9	57.9	61.5	45.5
95% CI UB	134	144	120	353	190	83.2	114	279	275	77.8
N	240	239	234	238	117	228	237	116	236	228
% < MDL	3.3	1.7	3.4	2.9	2.6	4.4	1.7	1.7	3.4	6.1
Max	5530	4770	2990	21500	2980	1600	4080	7850	14900	1550
MATES IV										
Average	68.5	73.9	71.1	74.4	68.2	61.2	69	72.6	73.7	71.8
95% CI LB	58.3	64.5	59.2	64.5	58.4	53.1	60.5	63.8	65.3	61.7
95% CI UB	80.5	83.7	83.9	84.8	78.8	69.8	79.4	81.7	82.5	82.9
N	59	59	61	60	59	61	60	59	61	61
% < MDL	0	1.7	0	0	3.4	0	1.7	1.7	1.6	0
Max	290	191	229	187	203	152	213	176	183	245
MATES V										
Average	64.6	53.2	74.3	73.9	63.5	52.3	60.5	67.4	85.4	59.7
95% CI LB	48.7	41.9	59.1	61.5	52.1	43.2	47.8	55.6	68.6	48.6
95% CI UB	84.2	66.5	91.7	87.8	76.6	62.6	76.4	82.3	105	72.8
N	54	59	61	60	60	61	61	59	56	57
% < MDL	1.9	0	0	0	0	0	0	0	0	1.8
Max	399	304	335	267	269	209	375	385	383	272



**Figure IV-272.** Annual Average Concentrations of Potassium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



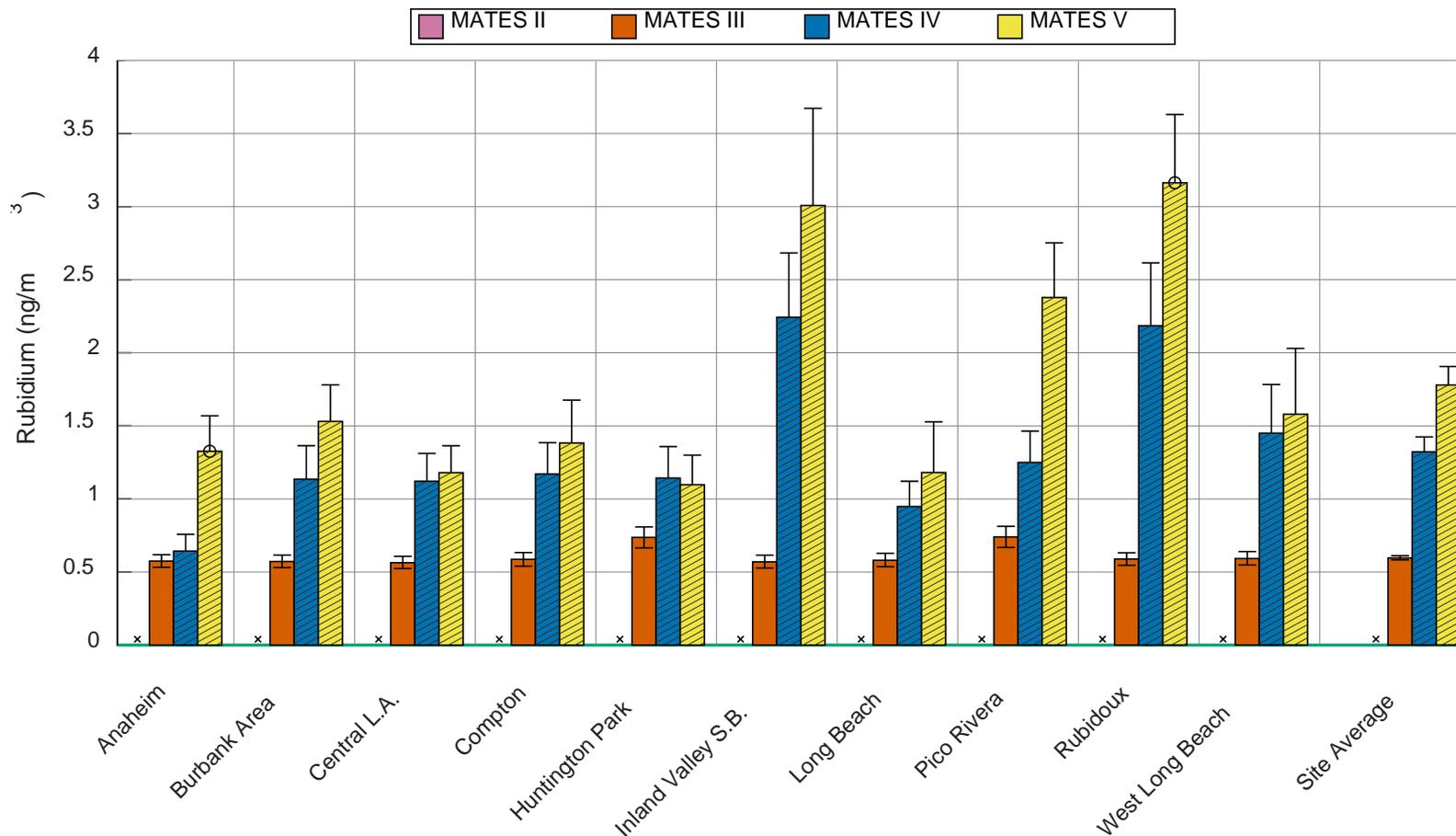
**Figure IV-273.** Geographic distribution of Potassium from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Rubidium

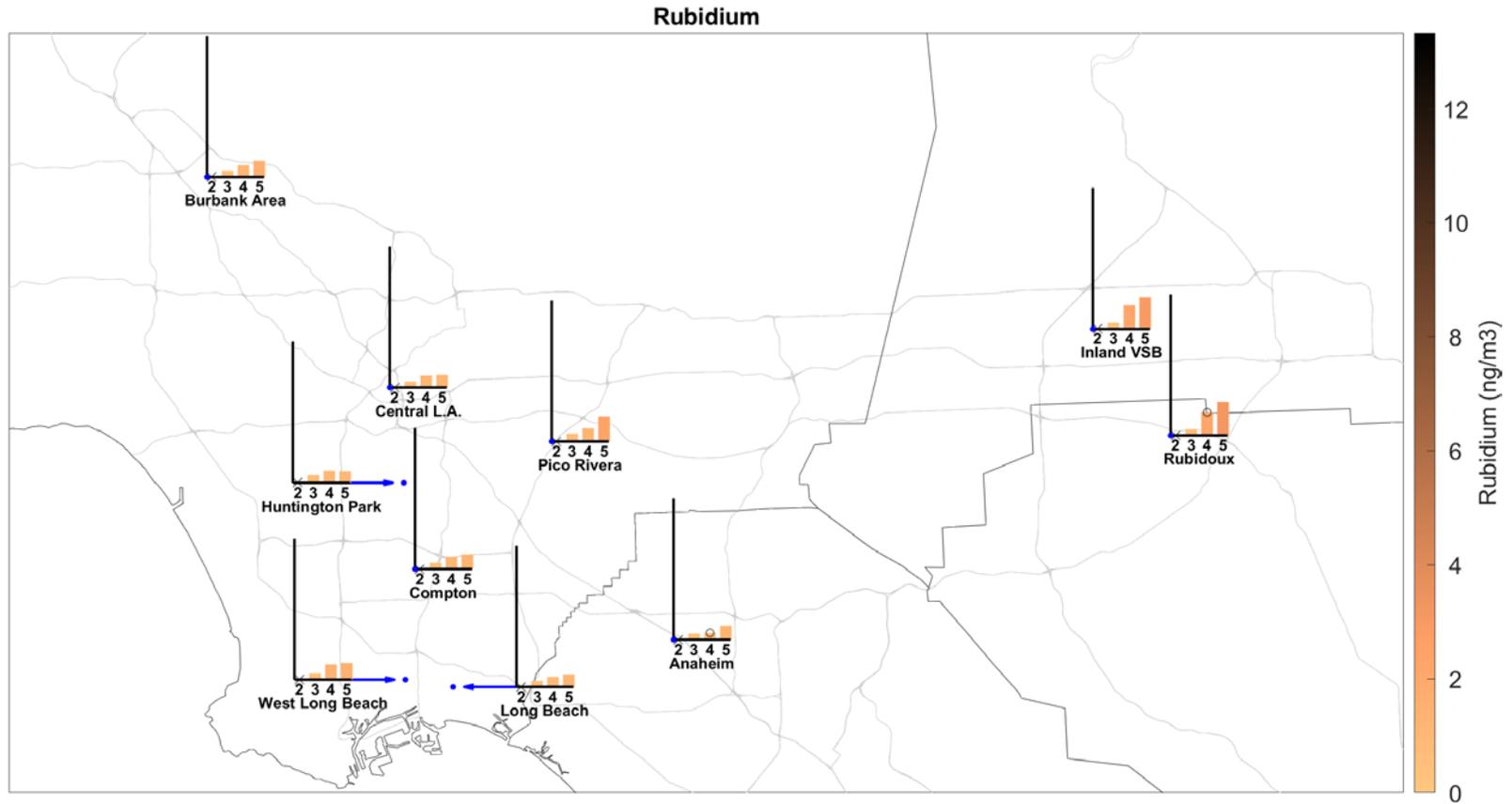
**Table IV-139.** Ambient Concentrations (ng/m<sup>3</sup>) of Rubidium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	0.575	0.572	0.586	0.569	0.737	0.58	0.564	0.74	0.588	0.591
95% CI LB	0.533	0.53	0.54	0.527	0.665	0.536	0.524	0.667	0.546	0.547
95% CI UB	0.618	0.616	0.633	0.615	0.808	0.627	0.607	0.812	0.631	0.639
N	240	239	234	238	117	228	237	116	236	228
% < MDL	79.2	79.5	77.8	79.8	59.8	78.5	79.3	59.5	77.5	77.2
Max	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.25	1.24	1.27
<b>MATES IV</b>										
Average	0, 0.643 <sup>b</sup>	0, 1.14 <sup>b</sup>	0, 1.17 <sup>b</sup>	0, 2.24 <sup>b</sup>	0, 1.14 <sup>b</sup>	0, 0.948 <sup>b</sup>	0, 1.12 <sup>b</sup>	0, 1.25 <sup>b</sup>	0, 2.18 <sup>b</sup>	0, 1.45 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	0.758 <sup>b</sup>	1.36 <sup>b</sup>	1.39 <sup>b</sup>	2.68 <sup>b</sup>	1.36 <sup>b</sup>	1.12 <sup>b</sup>	1.31 <sup>b</sup>	1.46 <sup>b</sup>	2.61 <sup>b</sup>	1.78 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>
<b>MATES V</b>										
Average	0, 1.33 <sup>b</sup>	0, 1.53 <sup>b</sup>	0, 1.38 <sup>b</sup>	0, 3.01 <sup>b</sup>	0, 1.1 <sup>b</sup>	0, 1.18 <sup>b</sup>	0, 1.18 <sup>b</sup>	0, 2.38 <sup>b</sup>	0, 3.16 <sup>b</sup>	0, 1.58 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	1.57 <sup>b</sup>	1.78 <sup>b</sup>	1.68 <sup>b</sup>	3.67 <sup>b</sup>	1.3 <sup>b</sup>	1.53 <sup>b</sup>	1.36 <sup>b</sup>	2.75 <sup>b</sup>	3.63 <sup>b</sup>	2.03 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-274.** Annual Average Concentrations of Rubidium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



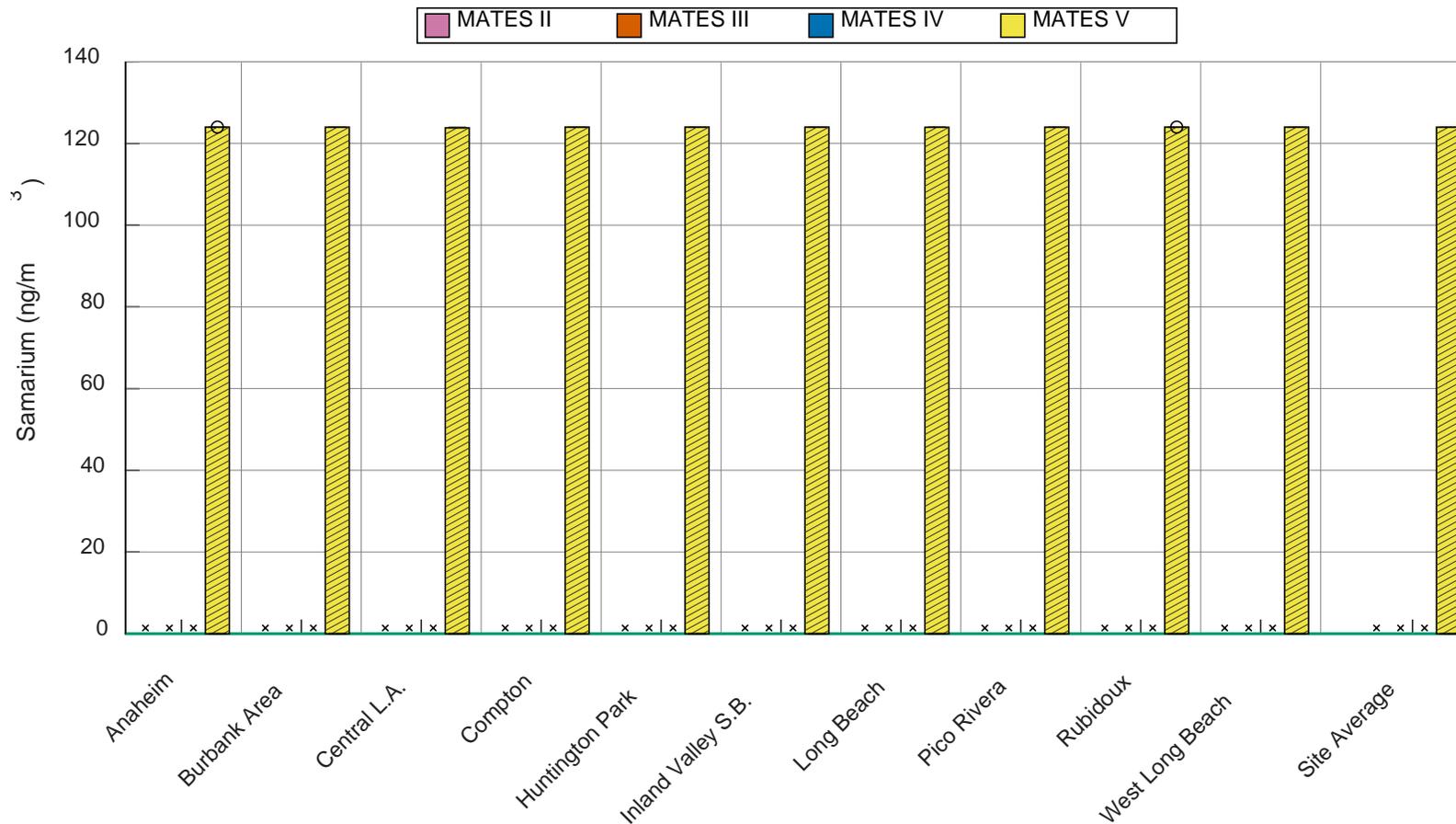
**Figure IV-275.** Geographic distribution of Rubidium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Samarium

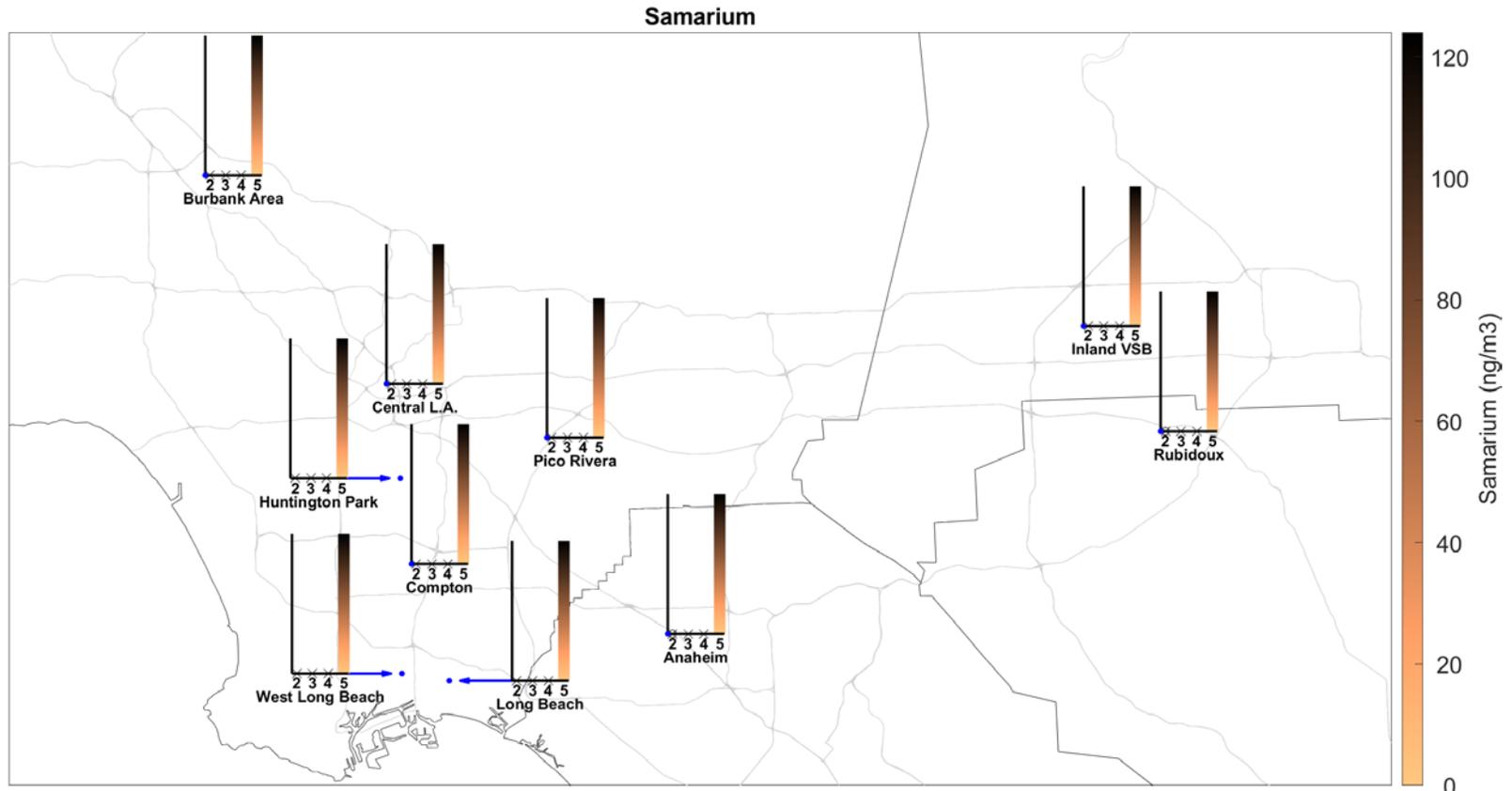
**Table IV-140.** Ambient Concentrations (ng/m<sup>3</sup>) of Samarium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	0, 124 <sup>a</sup>									
95% CI LB	0 <sup>a</sup>									
95% CI UB	124 <sup>a</sup>									
N	54 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	60 <sup>a</sup>	61 <sup>a</sup>	61 <sup>a</sup>	59 <sup>a</sup>	56 <sup>a</sup>	57 <sup>a</sup>
% < MDL	100 <sup>a</sup>									
Max	< MDL <sup>a</sup>									

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-276.** Annual Average Concentrations of Samarium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



**Figure IV-277.** Geographic distribution of Samarium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

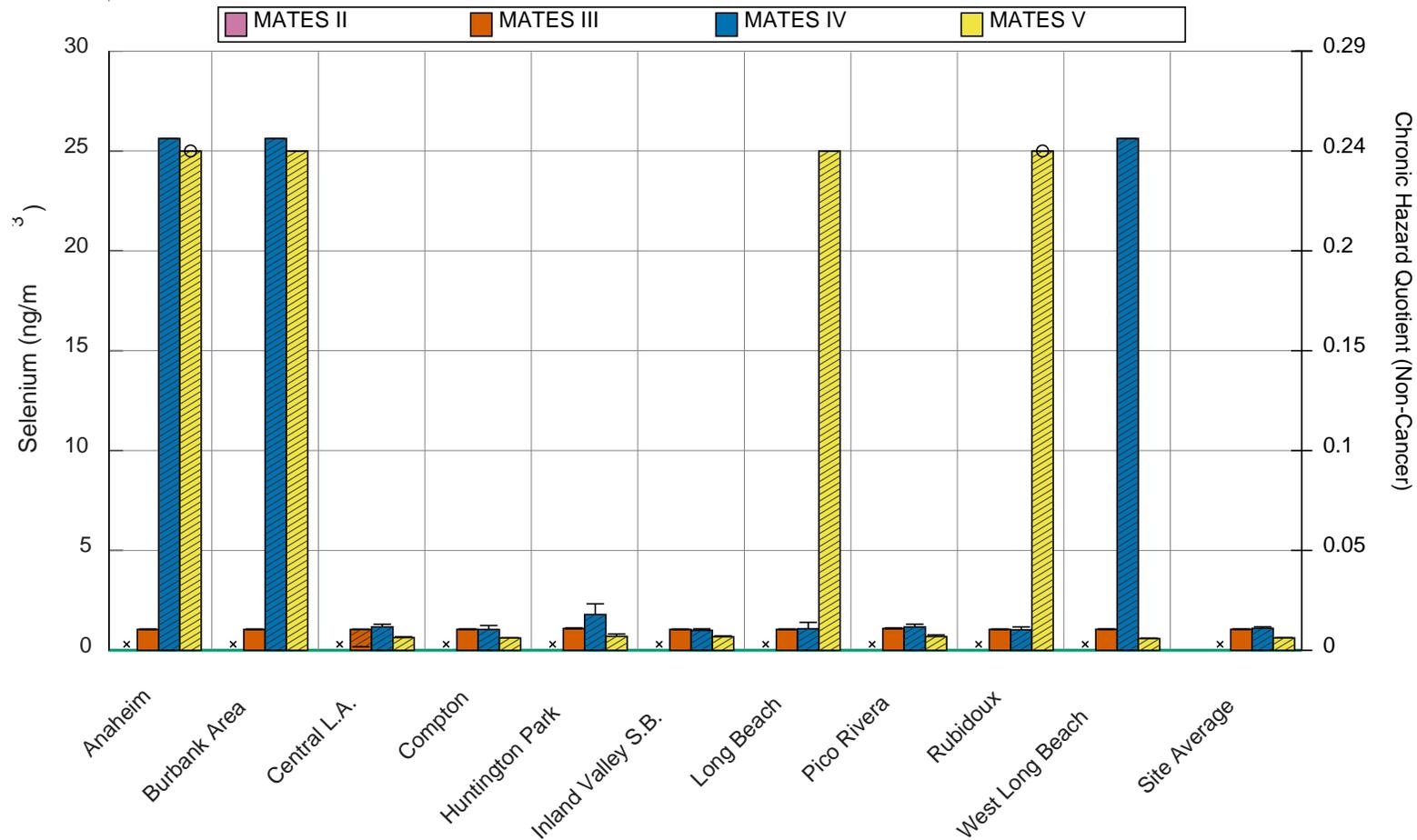
Selenium

**Table IV-141.** Ambient Concentrations (ng/m<sup>3</sup>) of Selenium from the PM2.5 Metals analysis at the Fixed Sites.

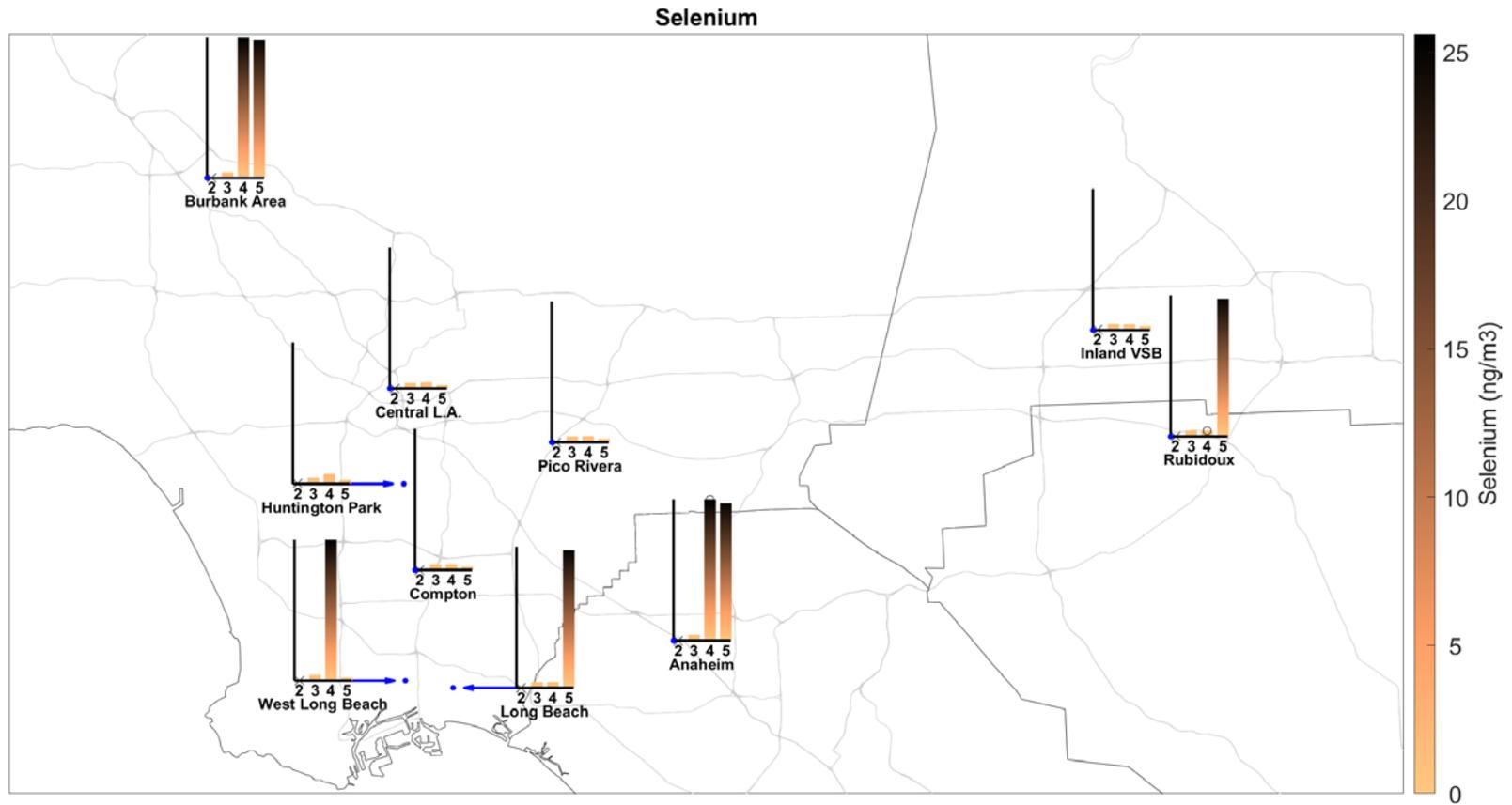
Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	1.05	1.05	1.05	1.05	1.1	1.05	0.235, 1.05 <sup>a</sup>	1.09	1.05	1.05
95% CI LB	1.04	1.04	1.04	1.04	1.08	1.04	0.178 <sup>a</sup>	1.07	1.04	1.04
95% CI UB	1.06	1.06	1.07	1.06	1.12	1.06	1.06 <sup>a</sup>	1.12	1.06	1.07
N	240	239	234	238	117	228	237 <sup>a</sup>	116	236	228
% < MDL	79.2	79.5	77.8	79.8	59.8	78.9	81 <sup>a</sup>	60.3	78.8	77.2
Max	1.24	1.24	1.24	1.24	1.24	1.24	1.24 <sup>a</sup>	1.25	1.24	1.27
MATES IV										
Average	0, 25.6 <sup>a</sup>	0, 25.6 <sup>a</sup>	0, 1.04 <sup>b</sup>	0, 1 <sup>b</sup>	0, 1.79 <sup>b</sup>	0, 1.08 <sup>b</sup>	0, 1.17 <sup>b</sup>	0, 1.17 <sup>b</sup>	0, 1.02 <sup>b</sup>	0, 25.6 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>a</sup>
95% CI UB	25.6 <sup>a</sup>	25.6 <sup>a</sup>	1.24 <sup>b</sup>	1.07 <sup>b</sup>	2.33 <sup>b</sup>	1.4 <sup>b</sup>	1.3 <sup>b</sup>	1.3 <sup>b</sup>	1.17 <sup>b</sup>	25.6 <sup>a</sup>
N	59 <sup>a</sup>	59 <sup>a</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>a</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>a</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>a</sup>
MATES V										
Average	0, 25 <sup>a</sup>	0, 25 <sup>a</sup>	0, 0.614 <sup>b</sup>	0, 0.681 <sup>b</sup>	0, 0.697 <sup>b</sup>	0, 25 <sup>a</sup>	0, 0.637 <sup>b</sup>	0, 0.691 <sup>b</sup>	0, 25 <sup>a</sup>	0, 0.591 <sup>b</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>a</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>a</sup>	0 <sup>b</sup>
95% CI UB	25 <sup>a</sup>	25 <sup>a</sup>	0.638 <sup>b</sup>	0.723 <sup>b</sup>	0.817 <sup>b</sup>	25 <sup>a</sup>	0.681 <sup>b</sup>	0.771 <sup>b</sup>	25 <sup>a</sup>	0.608 <sup>b</sup>
N	54 <sup>a</sup>	59 <sup>a</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>a</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>a</sup>	57 <sup>b</sup>
% < MDL	100 <sup>a</sup>	100 <sup>a</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>a</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>a</sup>	100 <sup>b</sup>
Max	< MDL <sup>a</sup>	< MDL <sup>a</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>a</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>a</sup>	< MDL <sup>b</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-278.** Annual Average Concentrations of Selenium in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



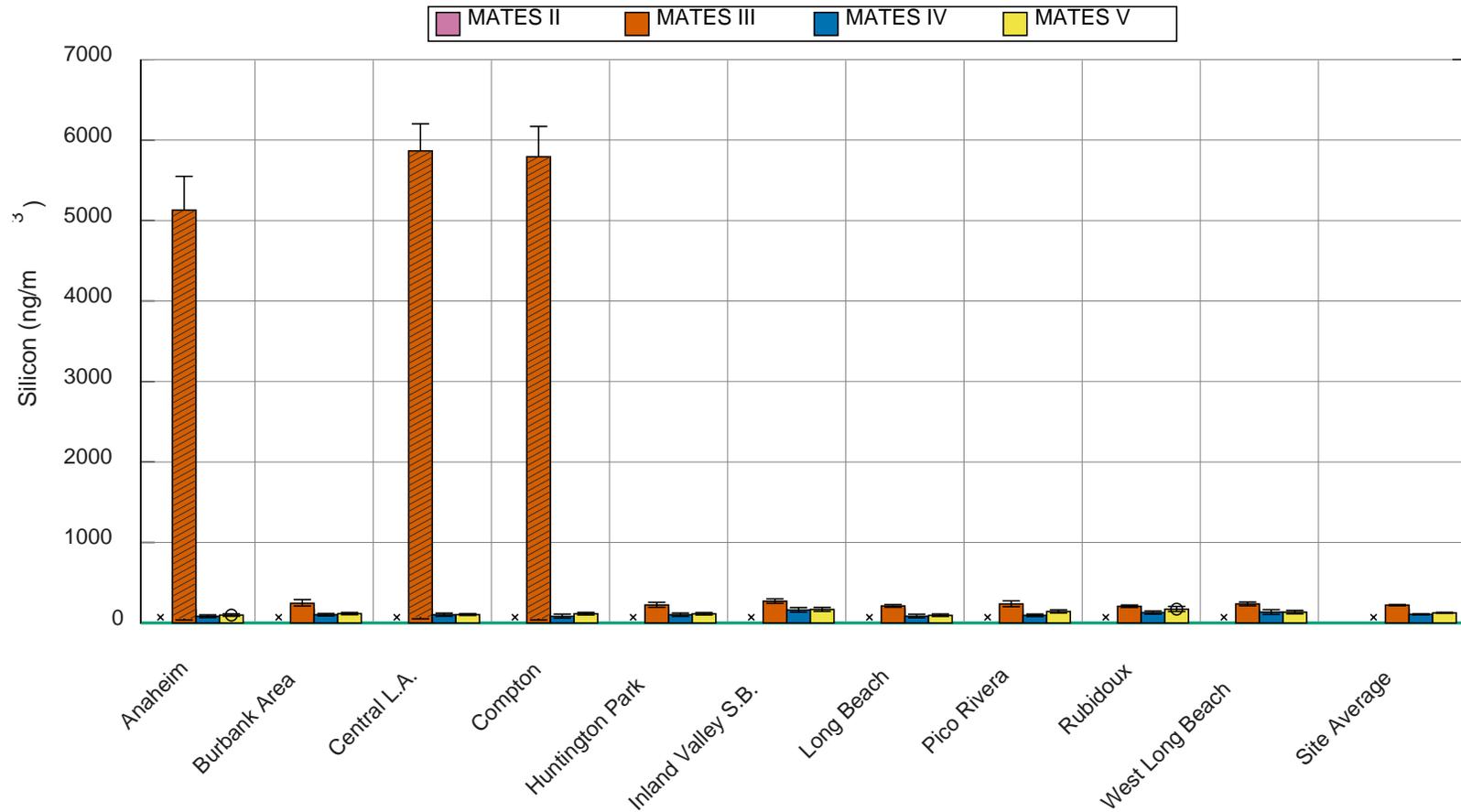
**Figure IV-279.** Geographic distribution of Selenium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

## Silicon

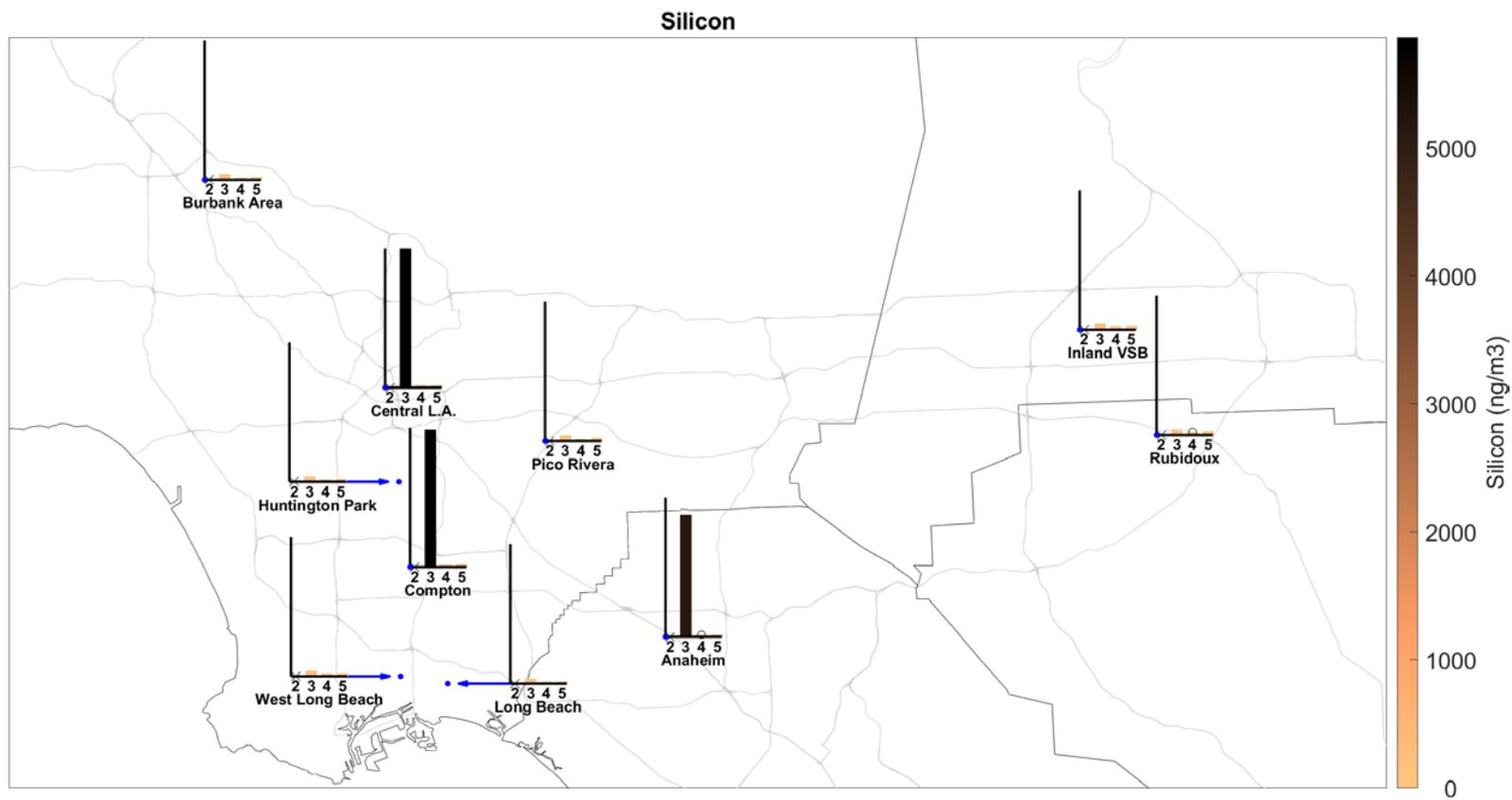
**Table IV-142.** Ambient Concentrations (ng/m<sup>3</sup>) of Silicon from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	55.6, 5130 <sup>b</sup>	244	56.1, 5790 <sup>b</sup>	271	223	211	74.4, 5870 <sup>b</sup>	236	206	236
95% CI LB	36.5 <sup>b</sup>	210	37.3 <sup>b</sup>	244	195	195	50.8 <sup>b</sup>	202	193	213
95% CI UB	5550 <sup>b</sup>	290	6170 <sup>b</sup>	300	256	229	6200 <sup>b</sup>	275	222	260
N	240 <sup>b</sup>	239	234 <sup>b</sup>	238	117	228	237 <sup>b</sup>	116	236	228
% < MDL	86.7 <sup>b</sup>	76.2	85 <sup>b</sup>	65.1	78.6	79.8	83.1 <sup>b</sup>	73.3	79.7	75.9
Max	1120 <sup>b</sup>	4300	1120 <sup>b</sup>	1720	1620	1010	1430 <sup>b</sup>	1440	924	1800
MATES IV										
Average	82.5	102	82	162	101	83.8	101	94.8	129	135
95% CI LB	66.5	86.9	61.1	135	81.8	64.4	83.1	79.8	110	107
95% CI UB	100	118	109	191	123	108	122	110	149	165
N	59	59	61	60	59	61	60	59	61	61
% < MDL	10.2	10.2	19.7	5	8.5	13.1	15	11.9	11.5	4.9
Max	300	268	664	615	398	552	399	223	352	567
MATES V										
Average	97.3	116	114	167	114	94.6	104	142	171	134
95% CI LB	82.8	103	99	143	99.1	81	92.9	124	142	114
95% CI UB	113	130	131	193	130	111	116	163	205	156
N	54	59	61	60	60	61	61	59	56	57
% < MDL	0	0	0	0	0	0	0	0	1.8	0
Max	285	321	369	583	360	435	259	458	819	411

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-280.** Annual Average Concentrations of Silicon in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

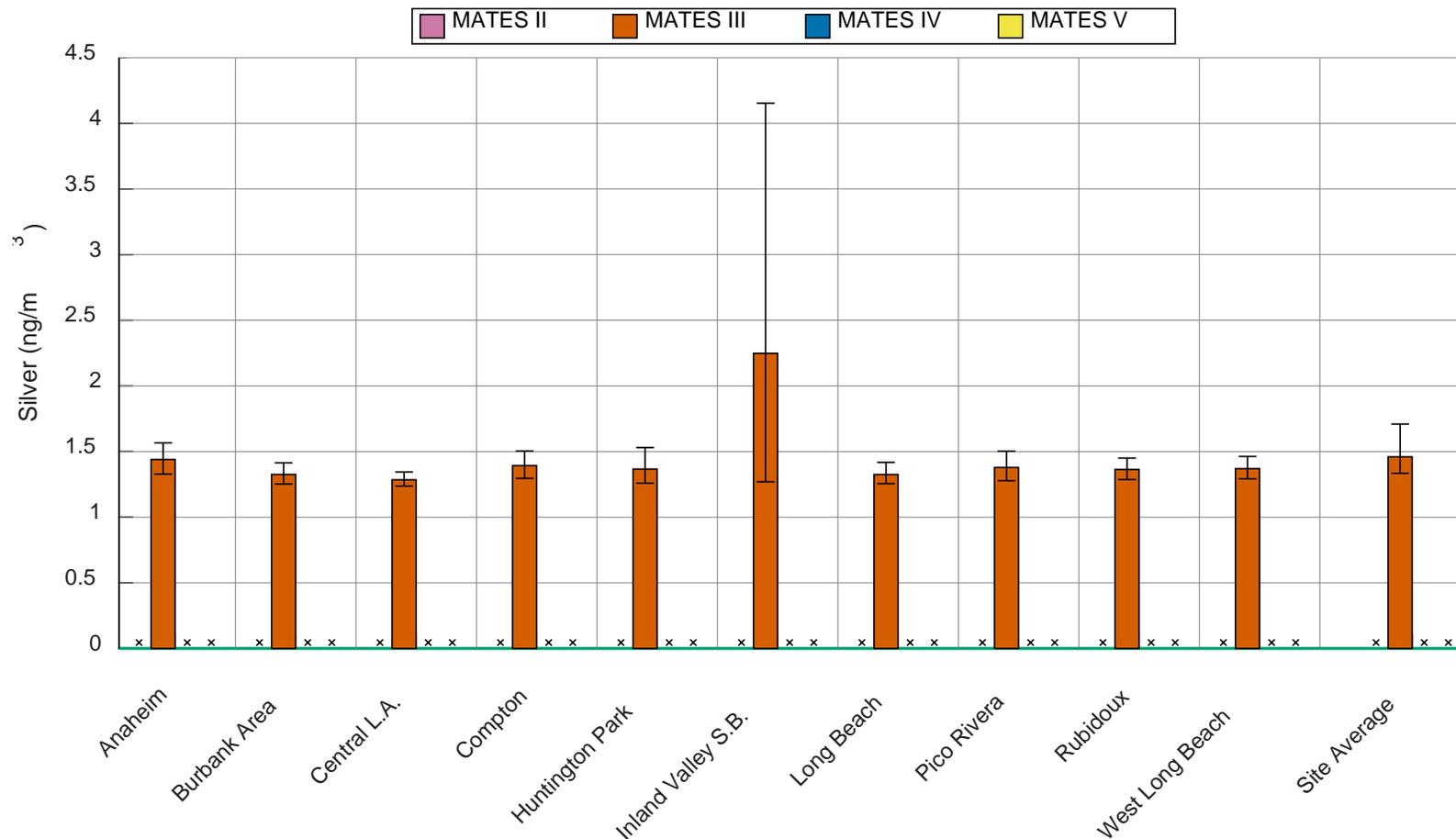


**Figure IV-281.** Geographic distribution of Silicon from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. "x" indicates that there is no data for a given station/MATES iteration.

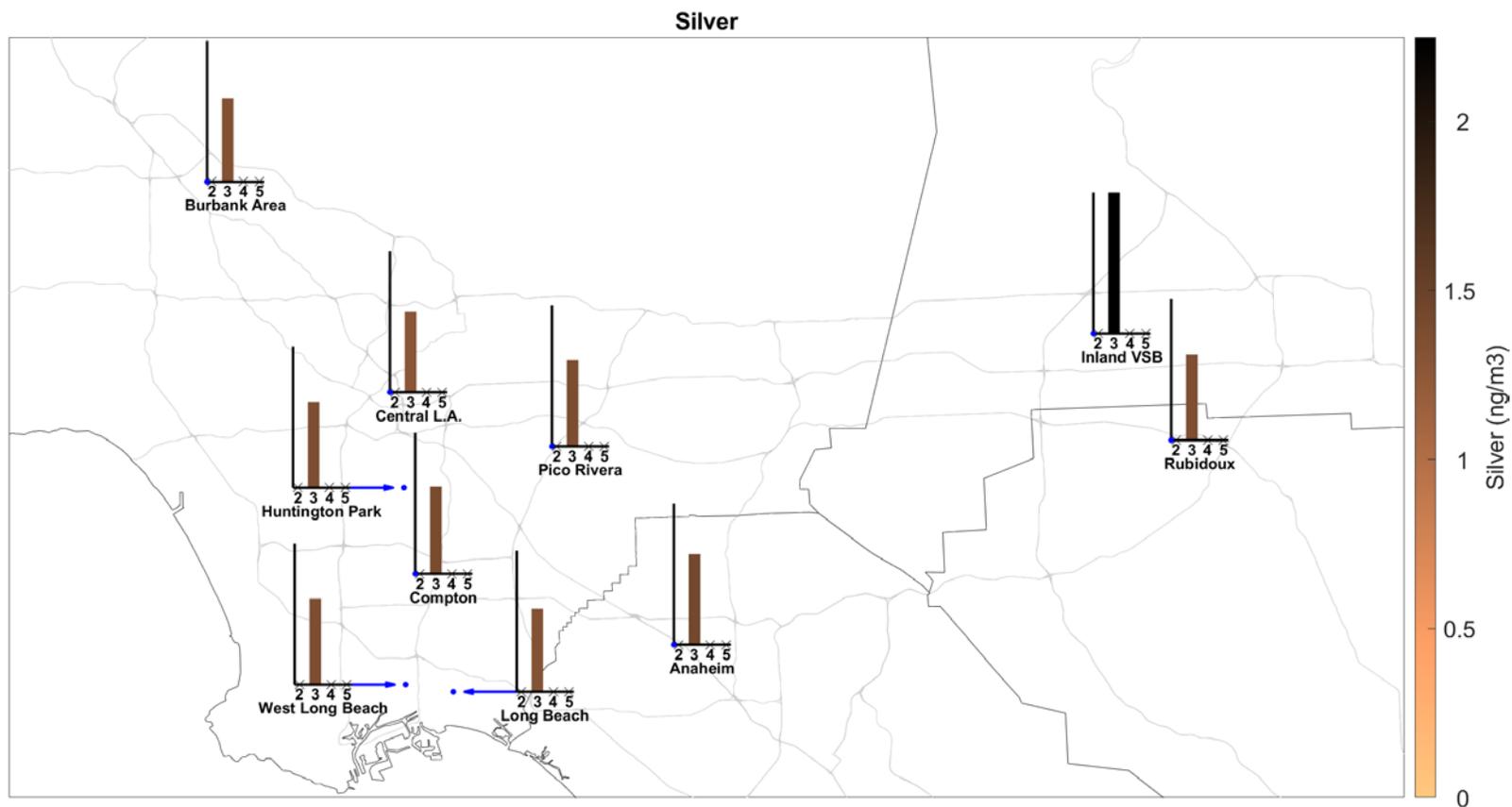
Silver

**Table IV-143.** Ambient Concentrations (ng/m<sup>3</sup>) of Silver from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	1.44	1.33	1.39	2.25	1.37	1.32	1.28	1.38	1.36	1.37
95% CI LB	1.33	1.25	1.3	1.27	1.26	1.26	1.24	1.28	1.29	1.29
95% CI UB	1.57	1.41	1.5	4.15	1.53	1.42	1.34	1.5	1.45	1.46
N	240	239	234	238	117	228	237	116	236	228
% < MDL	67.9	69.9	64.5	68.5	51.3	68.9	71.7	50	69.5	68
Max	8.65	7.43	8.67	222	7.42	7.42	6.18	6.18	6.17	7.43
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										



**Figure IV-282.** Annual Average Concentrations of Silver in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



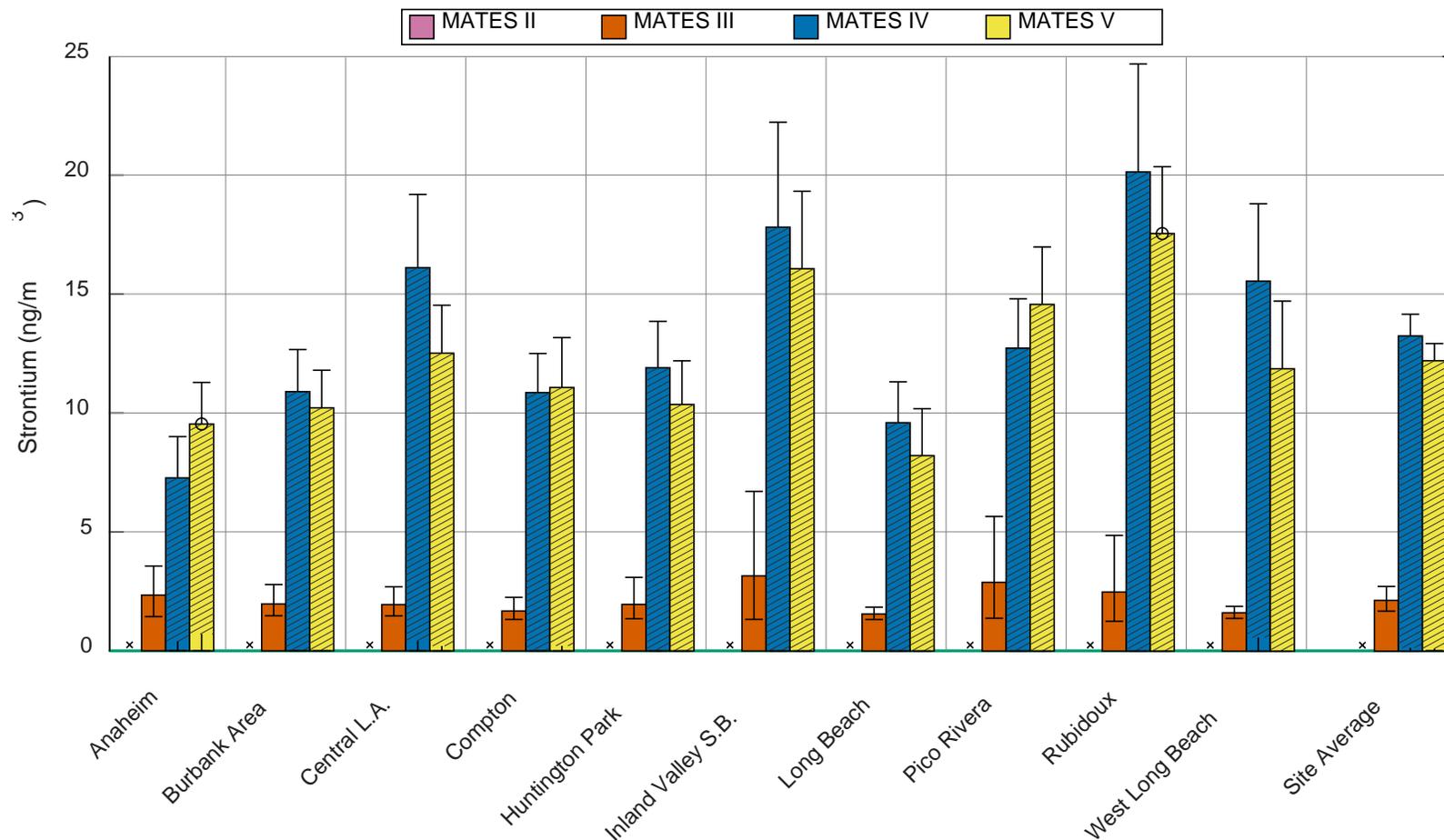
**Figure IV-283.** Geographic distribution of Silver from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Strontium

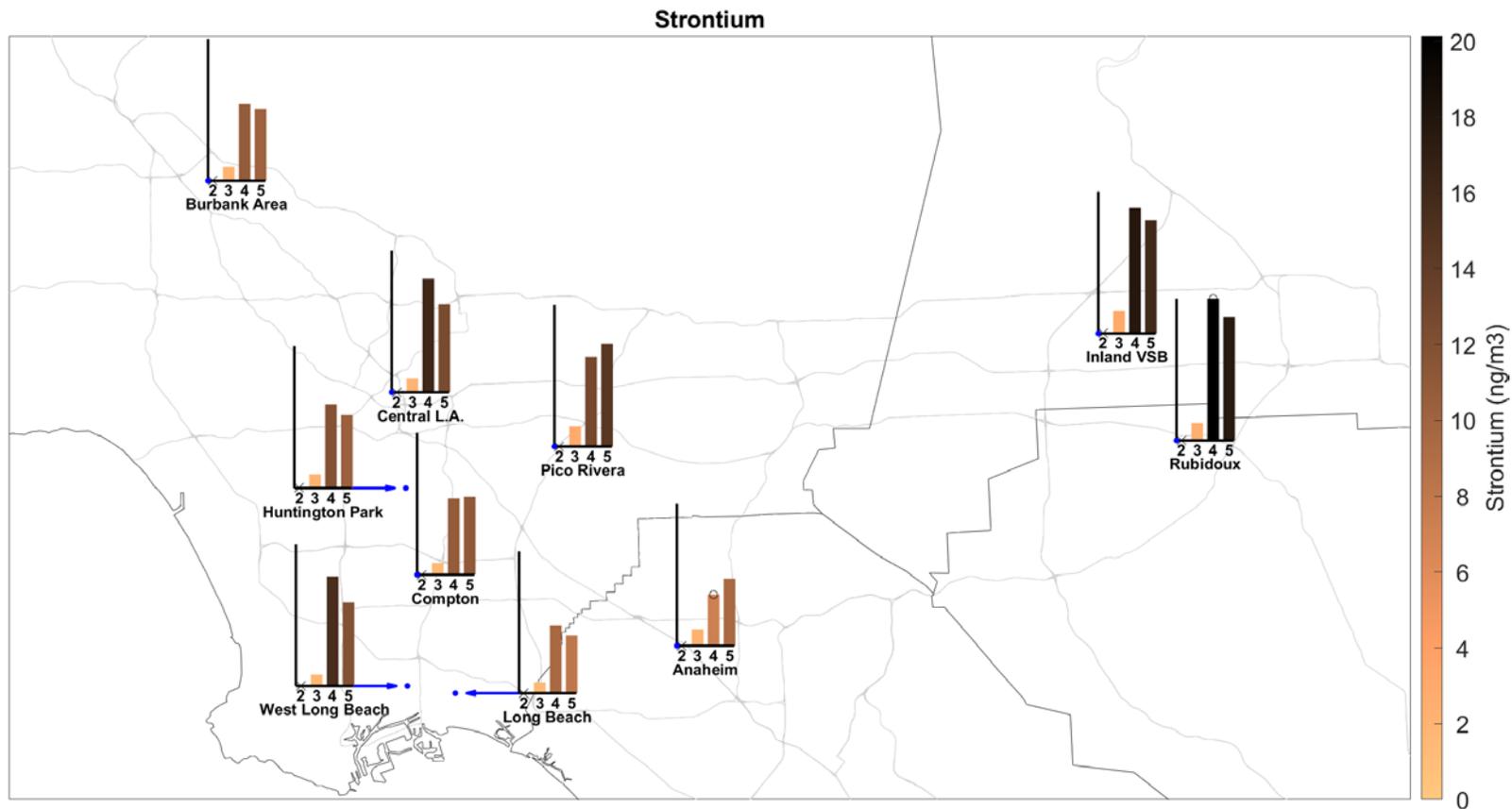
**Table IV-144.** Ambient Concentrations (ng/m<sup>3</sup>) of Strontium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	2.34	1.97	1.68	3.16	1.96	1.56	1.94	2.89	2.48	1.61
95% CI LB	1.44	1.48	1.32	1.33	1.36	1.32	1.47	1.38	1.25	1.38
95% CI UB	3.56	2.79	2.25	6.71	3.09	1.84	2.7	5.66	4.86	1.88
N	240	239	234	238	117	228	237	116	236	228
% < MDL	57.1	52.3	53	53.8	41	58.8	55.3	41.4	56.4	48.2
Max	101	82.9	54.5	414	52	19.8	74.2	148	276	21.1
MATES IV										
Average	0.407, 7.27 <sup>b</sup>	0, 10.9 <sup>b</sup>	0, 10.9 <sup>b</sup>	0, 17.8 <sup>b</sup>	0, 11.9 <sup>b</sup>	0, 9.6 <sup>b</sup>	0.417, 16.1 <sup>b</sup>	0, 12.7 <sup>b</sup>	0, 20.1 <sup>b</sup>	0.574, 15.6 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	9.01 <sup>b</sup>	12.7 <sup>b</sup>	12.5 <sup>b</sup>	22.2 <sup>b</sup>	13.9 <sup>b</sup>	11.3 <sup>b</sup>	19.2 <sup>b</sup>	14.8 <sup>b</sup>	24.7 <sup>b</sup>	18.8 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	98.3 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	98.3 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	98.4 <sup>b</sup>
Max	24 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	25 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	35 <sup>b</sup>
MATES V										
Average	0.704, 9.54 <sup>b</sup>	0, 10.2 <sup>b</sup>	0.213, 11.1 <sup>b</sup>	0, 16.1 <sup>b</sup>	0, 10.4 <sup>b</sup>	0, 8.22 <sup>b</sup>	0.205, 12.5 <sup>b</sup>	0, 14.6 <sup>b</sup>	0, 17.6 <sup>b</sup>	0, 11.9 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	11.3 <sup>b</sup>	11.8 <sup>b</sup>	13.2 <sup>b</sup>	19.3 <sup>b</sup>	12.2 <sup>b</sup>	10.2 <sup>b</sup>	14.5 <sup>b</sup>	17 <sup>b</sup>	20.4 <sup>b</sup>	14.7 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	94.4 <sup>b</sup>	100 <sup>b</sup>	98.4 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	98.4 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	16 <sup>b</sup>	< MDL <sup>b</sup>	13 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	12.5 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-284.** Annual Average Concentrations of Strontium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

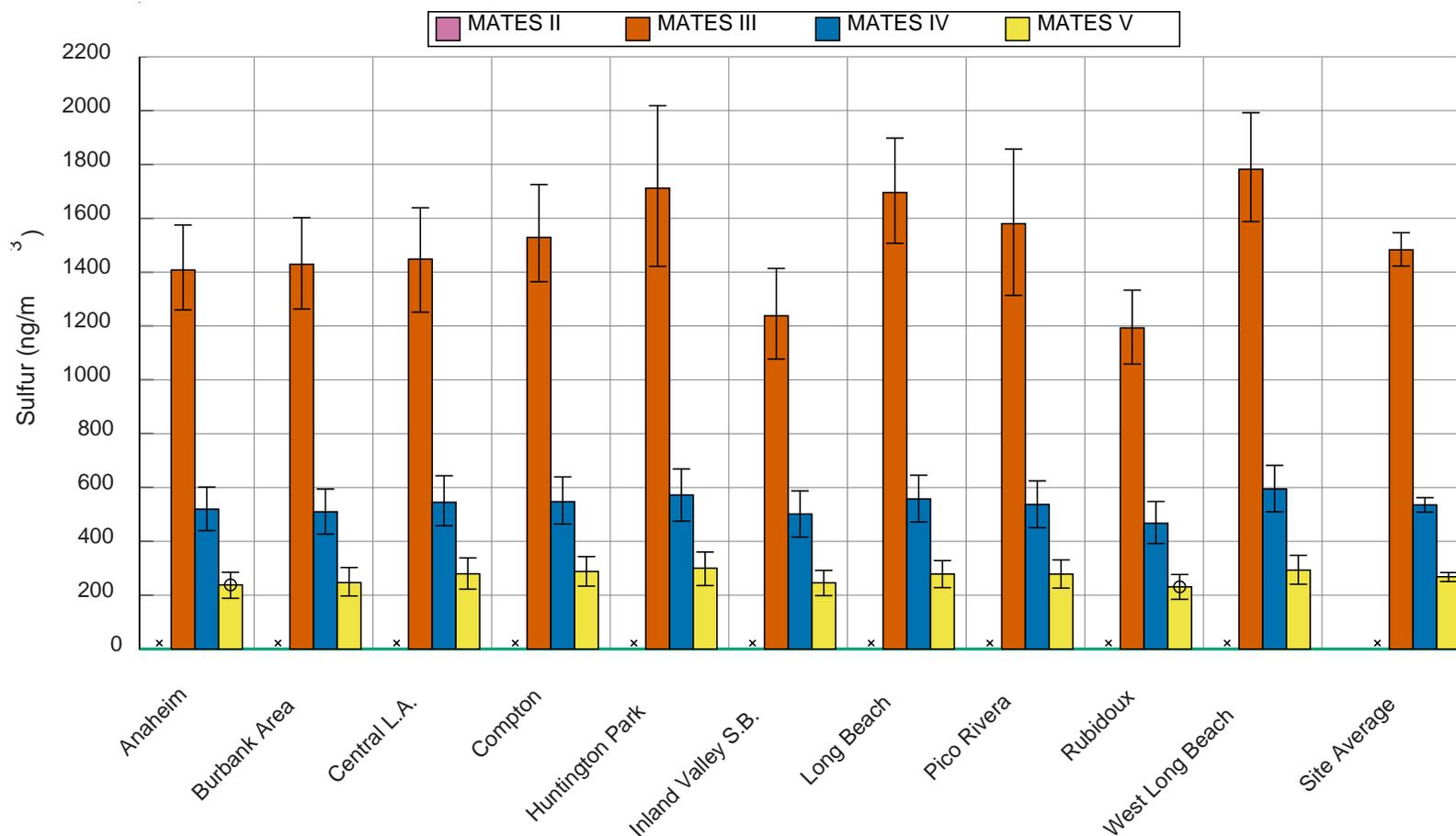


**Figure IV-285.** Geographic distribution of Strontium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

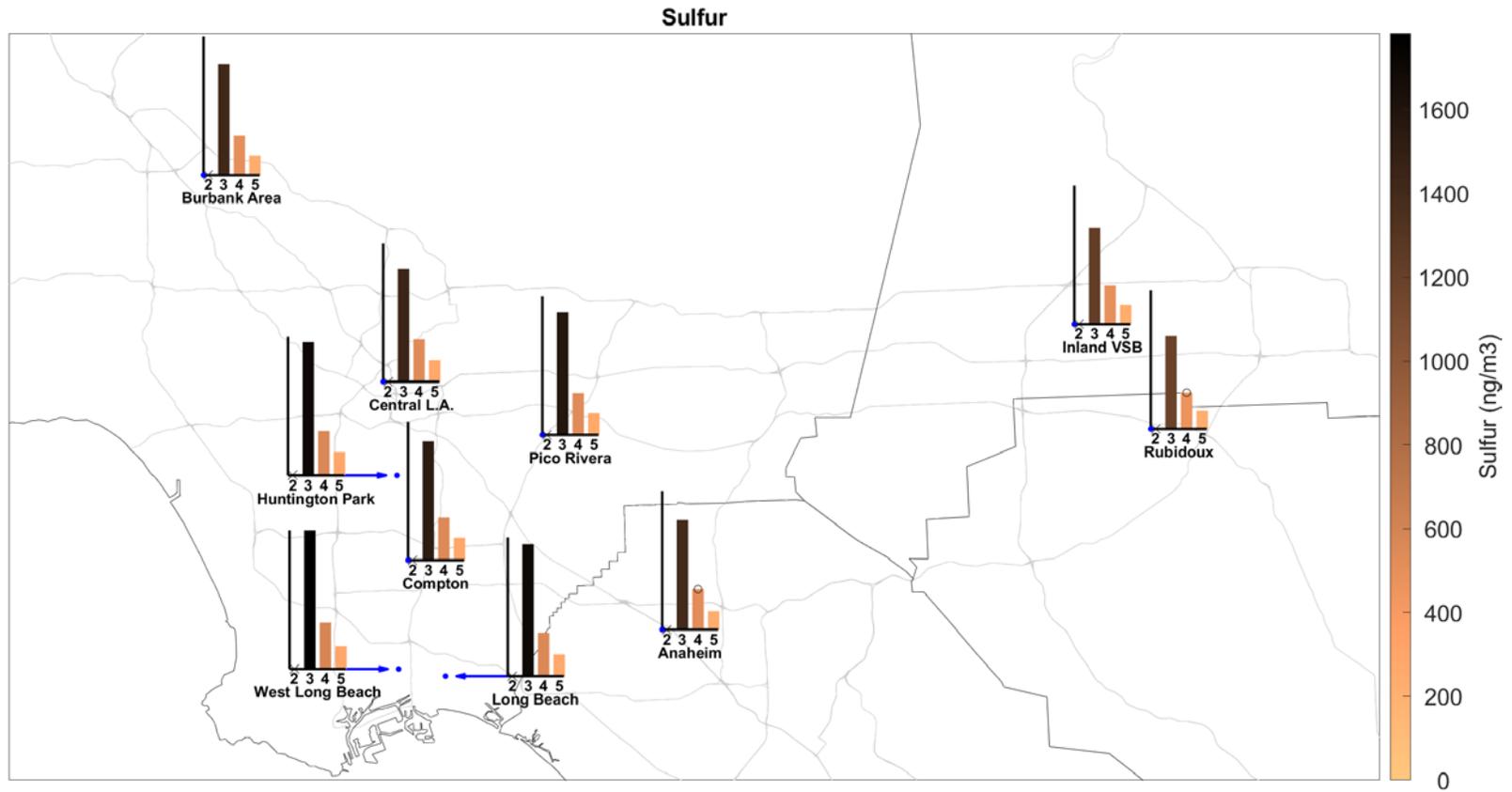
## Sulfur

**Table IV-145.** Ambient Concentrations (ng/m<sup>3</sup>) of Sulfur from the PM<sub>2.5</sub> Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	1410	1430	1530	1240	1710	1700	1450	1580	1190	1780
95% CI LB	1260	1260	1360	1080	1420	1510	1250	1310	1060	1590
95% CI UB	1580	1600	1730	1410	2020	1900	1640	1860	1330	1990
N	240	239	234	238	117	228	237	116	236	228
% < MDL	0.8	1.3	0.9	2.5	2.6	0.4	1.3	0.9	5.5	0
Max	6090	5810	6340	10500	6930	7920	7680	6860	8480	9070
MATES IV										
Average	520	510	547	501	572	558	545	537	467	595
95% CI LB	440	426	464	416	475	472	458	451	392	510
95% CI UB	602	594	639	587	669	646	644	625	548	682
N	59	59	61	60	59	61	60	59	61	61
% < MDL	0	1.7	0	0	3.4	0	1.7	1.7	1.6	0
Max	1320	1260	1480	1350	1640	1470	1720	1510	1100	1670
MATES V										
Average	238	247	288	246	300	279	279	278	231	293
95% CI LB	188	197	234	198	236	228	222	226	185	241
95% CI UB	285	303	343	292	360	328	338	331	277	348
N	54	59	61	60	60	61	61	59	56	57
% < MDL	11.1	15.3	3.3	11.7	8.3	8.2	13.1	6.8	10.7	5.3
Max	649	766	858	641	928	759	841	731	649	812



**Figure IV-286.** Annual Average Concentrations of Sulfur in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



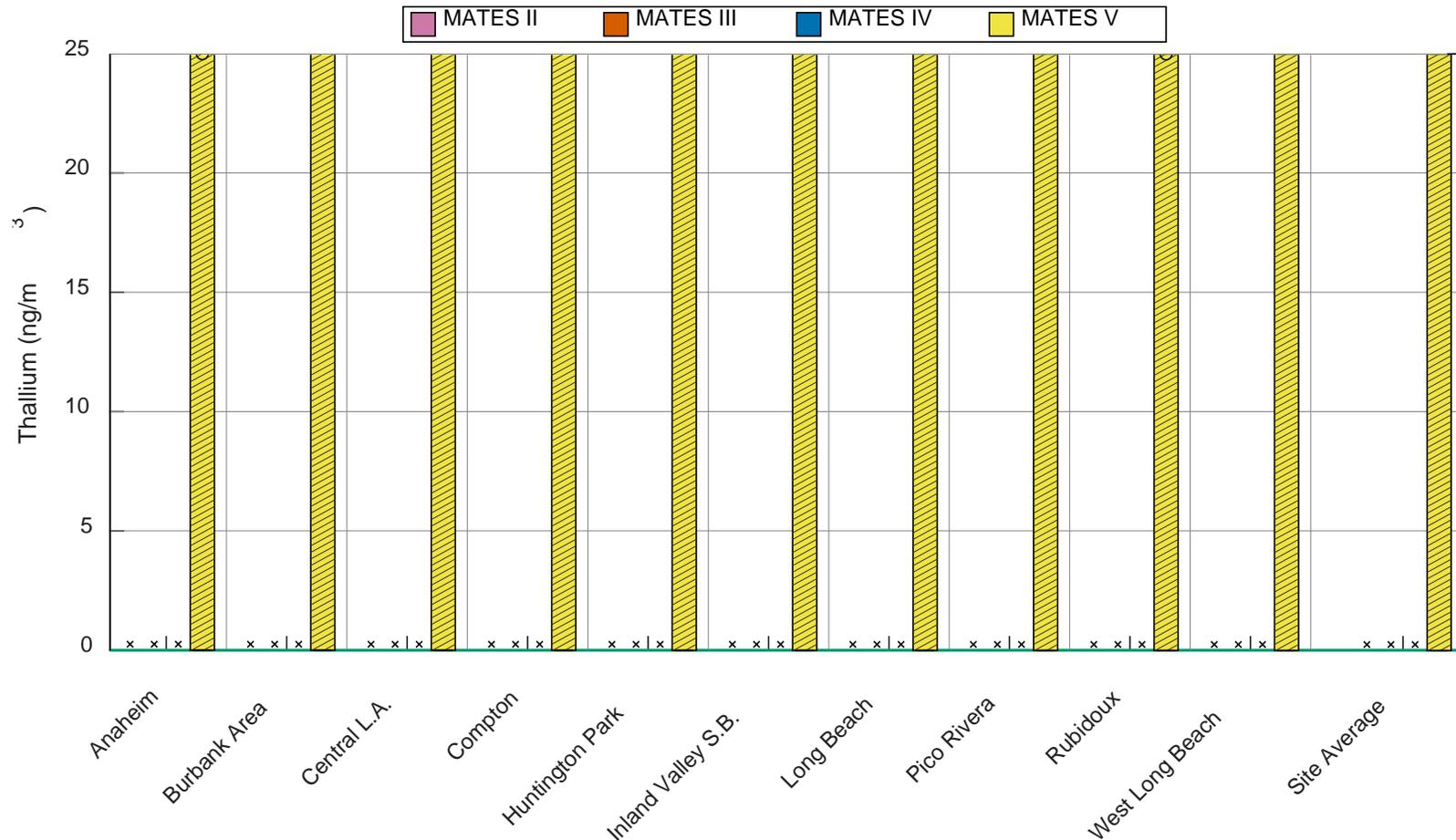
**Figure IV-287.** Geographic distribution of Sulfur from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. "x" indicates that there is no data for a given station/MATES iteration.

Thallium

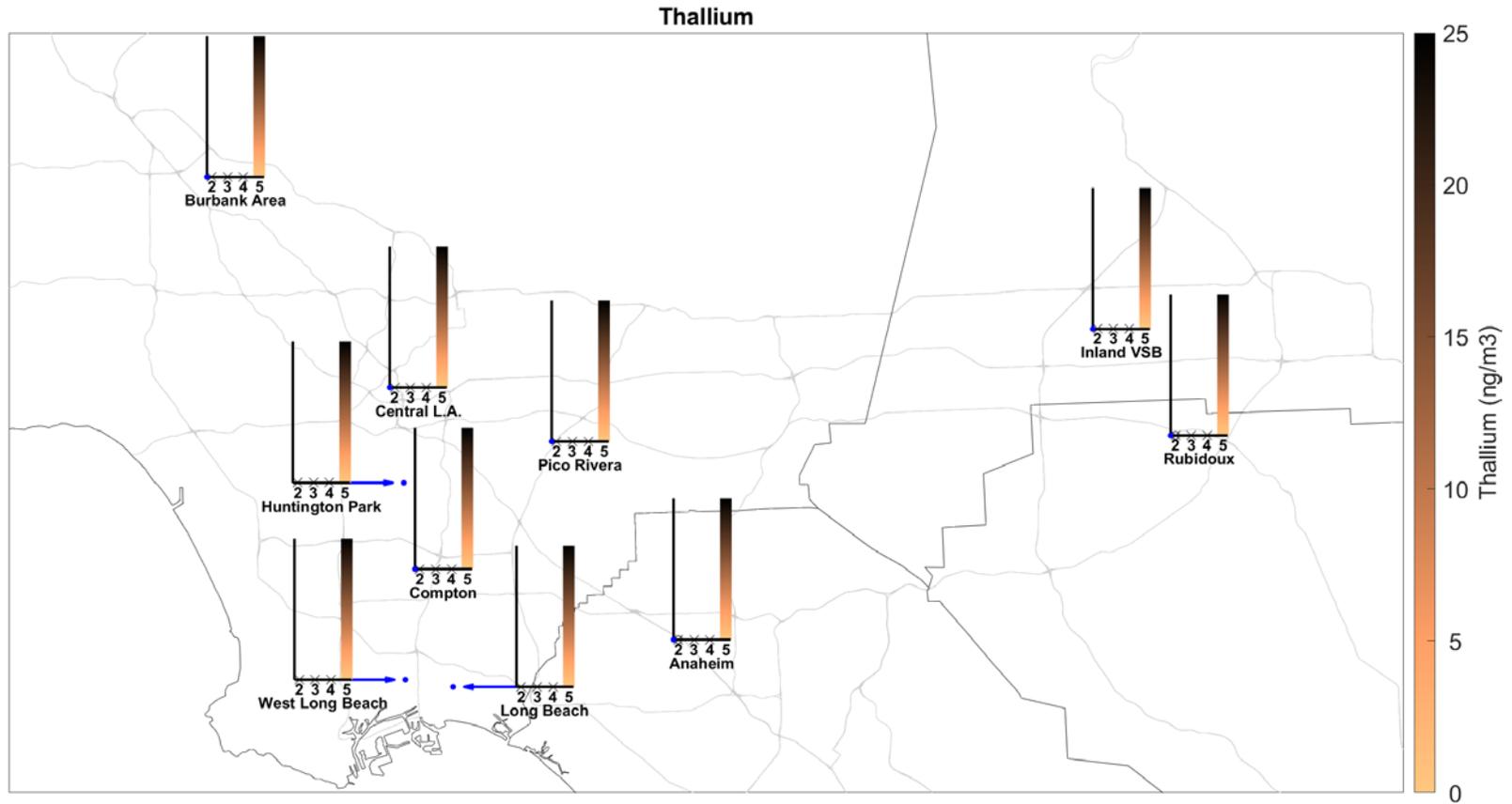
**Table IV-146.** Ambient Concentrations (ng/m<sup>3</sup>) of Thallium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	0, 25 <sup>a</sup>									
95% CI LB	0 <sup>a</sup>									
95% CI UB	25 <sup>a</sup>									
N	54 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	60 <sup>a</sup>	61 <sup>a</sup>	61 <sup>a</sup>	59 <sup>a</sup>	56 <sup>a</sup>	57 <sup>a</sup>
% < MDL	100 <sup>a</sup>									
Max	< MDL <sup>a</sup>									

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-288.** Annual Average Concentrations of Thallium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



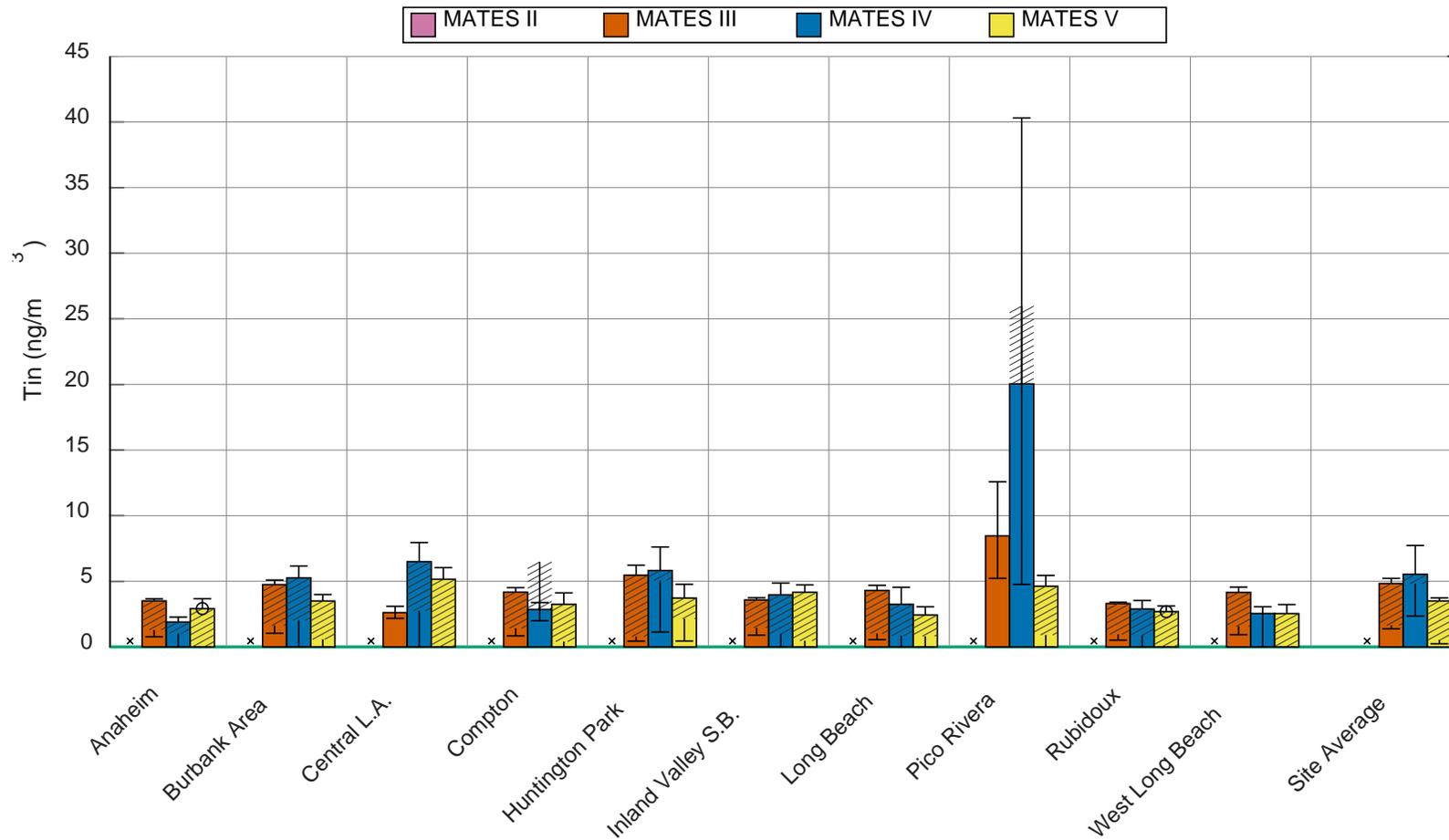
**Figure IV-289.** Geographic distribution of Thallium from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. "x" indicates that there is no data for a given station/MATES iteration.

Tin

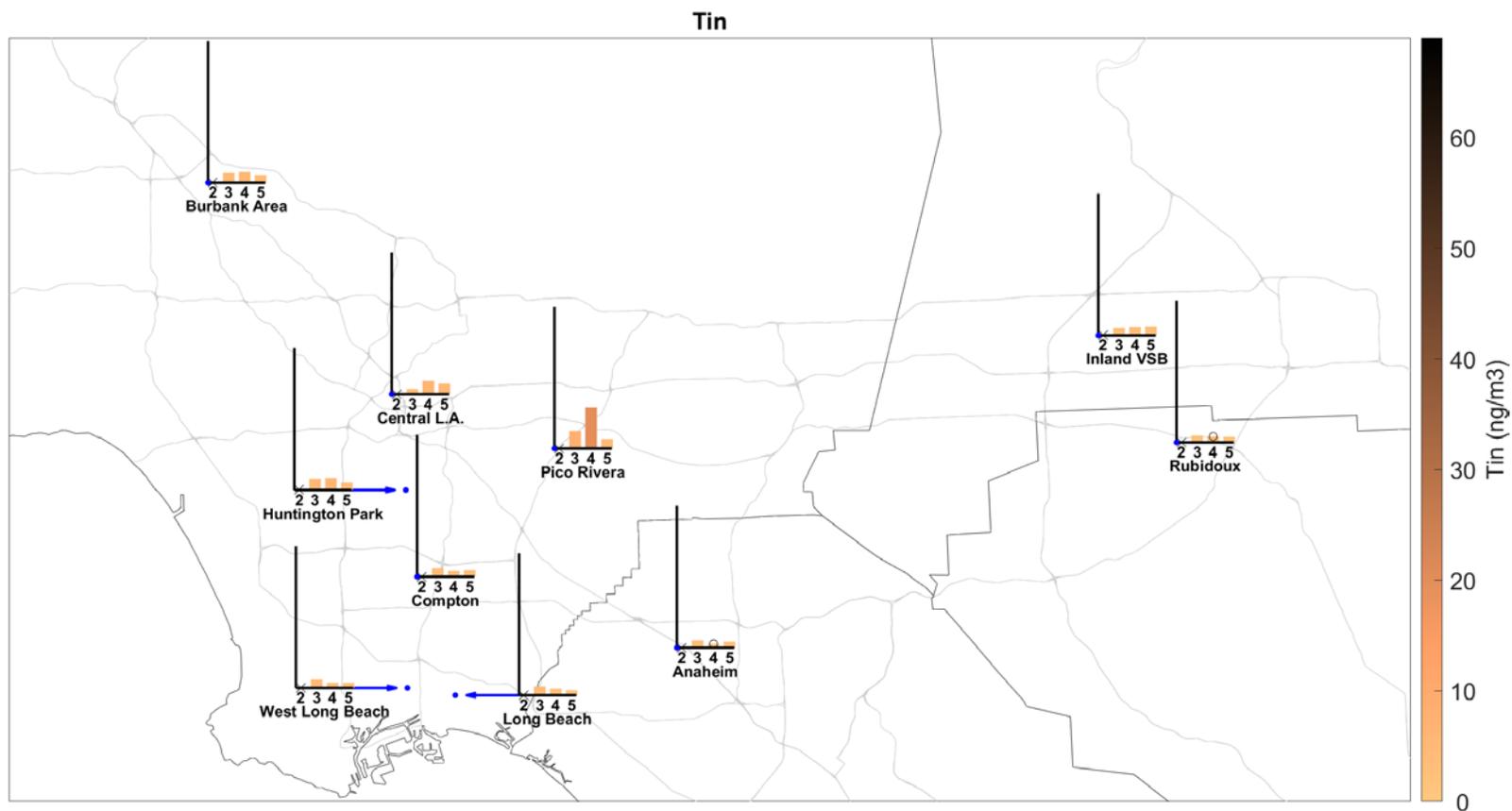
**Table IV-147.** Ambient Concentrations (ng/m<sup>3</sup>) of Tin from the PM<sub>2.5</sub> Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	1.3, 3.51 <sup>b</sup>	1.63, 4.75 <sup>b</sup>	1.42, 4.18 <sup>b</sup>	1.46, 3.58 <sup>b</sup>	0.793, 5.47 <sup>b</sup>	1.02, 4.31 <sup>b</sup>	2.61	8.47	0.963, 3.31 <sup>b</sup>	1.57, 4.16 <sup>b</sup>
95% CI LB	0.777 <sup>b</sup>	1.04 <sup>b</sup>	0.846 <sup>b</sup>	0.899 <sup>b</sup>	0.444 <sup>b</sup>	0.558 <sup>b</sup>	2.18	5.23	0.518 <sup>b</sup>	0.935 <sup>b</sup>
95% CI UB	3.67 <sup>b</sup>	5.1 <sup>b</sup>	4.52 <sup>b</sup>	3.76 <sup>b</sup>	6.23 <sup>b</sup>	4.7 <sup>b</sup>	3.09	12.6	3.41 <sup>b</sup>	4.56 <sup>b</sup>
N	240 <sup>b</sup>	239 <sup>b</sup>	234 <sup>b</sup>	238 <sup>b</sup>	117 <sup>b</sup>	228 <sup>b</sup>	237	116	236 <sup>b</sup>	228 <sup>b</sup>
% < MDL	88.3 <sup>b</sup>	84.5 <sup>b</sup>	86.3 <sup>b</sup>	85.3 <sup>b</sup>	84.6 <sup>b</sup>	89.5 <sup>b</sup>	78.9	71.6	90.7 <sup>b</sup>	86.4 <sup>b</sup>
Max	27.1 <sup>b</sup>	29.6 <sup>b</sup>	36.9 <sup>b</sup>	29.6 <sup>b</sup>	9.9 <sup>b</sup>	27.1 <sup>b</sup>	25.2	116	26 <sup>b</sup>	33.3 <sup>b</sup>
<b>MATES IV</b>										
Average	1.03, 1.9 <sup>b</sup>	2.03, 5.26 <sup>b</sup>	6.48, 2.86 <sup>b</sup>	0.967, 3.98 <sup>b</sup>	5.07, 5.83 <sup>b</sup>	0.852, 3.25 <sup>b</sup>	2.75, 6.5 <sup>b</sup>	26, 20 <sup>b</sup>	0.869, 2.89 <sup>b</sup>	2.59, 2.55 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	2 <sup>b</sup>	0 <sup>b</sup>	1.14 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	4.76 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	2.27 <sup>b</sup>	6.17 <sup>b</sup>	3.38 <sup>b</sup>	4.87 <sup>b</sup>	7.62 <sup>b</sup>	4.55 <sup>b</sup>	7.95 <sup>b</sup>	40.3 <sup>b</sup>	3.55 <sup>b</sup>	3.07 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	98.3 <sup>b</sup>	96.6 <sup>b</sup>	90.2 <sup>b</sup>	98.3 <sup>b</sup>	91.5 <sup>b</sup>	98.4 <sup>b</sup>	95 <sup>b</sup>	86.4 <sup>b</sup>	98.4 <sup>b</sup>	95.1 <sup>b</sup>
Max	61 <sup>b</sup>	63 <sup>b</sup>	81 <sup>b</sup>	58 <sup>b</sup>	77 <sup>b</sup>	52 <sup>b</sup>	59 <sup>b</sup>	966 <sup>b</sup>	53 <sup>b</sup>	55 <sup>b</sup>
<b>MATES V</b>										
Average	0, 2.92 <sup>b</sup>	0.576, 3.5 <sup>b</sup>	0.41, 3.25 <sup>b</sup>	0.467, 4.17 <sup>b</sup>	2.15, 3.72 <sup>b</sup>	0.82, 2.44 <sup>b</sup>	0, 5.16 <sup>b</sup>	0.915, 4.63 <sup>b</sup>	0, 2.69 <sup>b</sup>	0, 2.54 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0.45 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	3.68 <sup>b</sup>	3.99 <sup>b</sup>	4.12 <sup>b</sup>	4.73 <sup>b</sup>	4.78 <sup>b</sup>	3.07 <sup>b</sup>	6.05 <sup>b</sup>	5.45 <sup>b</sup>	3.13 <sup>b</sup>	3.23 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>	98.3 <sup>b</sup>	98.4 <sup>b</sup>	98.3 <sup>b</sup>	93.3 <sup>b</sup>	96.7 <sup>b</sup>	100 <sup>b</sup>	96.6 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	34 <sup>b</sup>	25 <sup>b</sup>	28 <sup>b</sup>	42 <sup>b</sup>	25 <sup>b</sup>	< MDL <sup>b</sup>	28 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-290.** Annual Average Concentrations of Tin in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



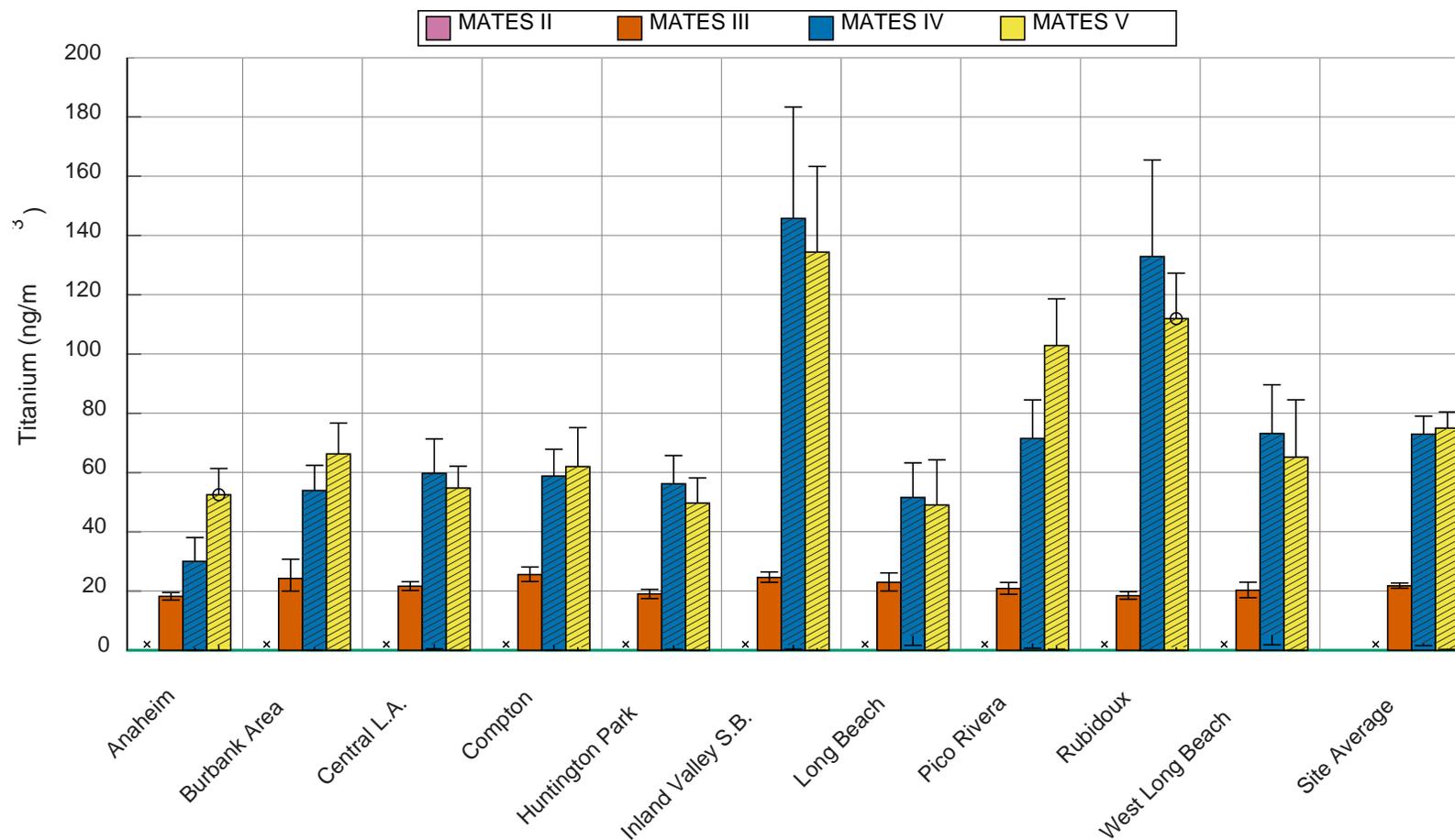
**Figure IV-291.** Geographic distribution of Tin from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Titanium

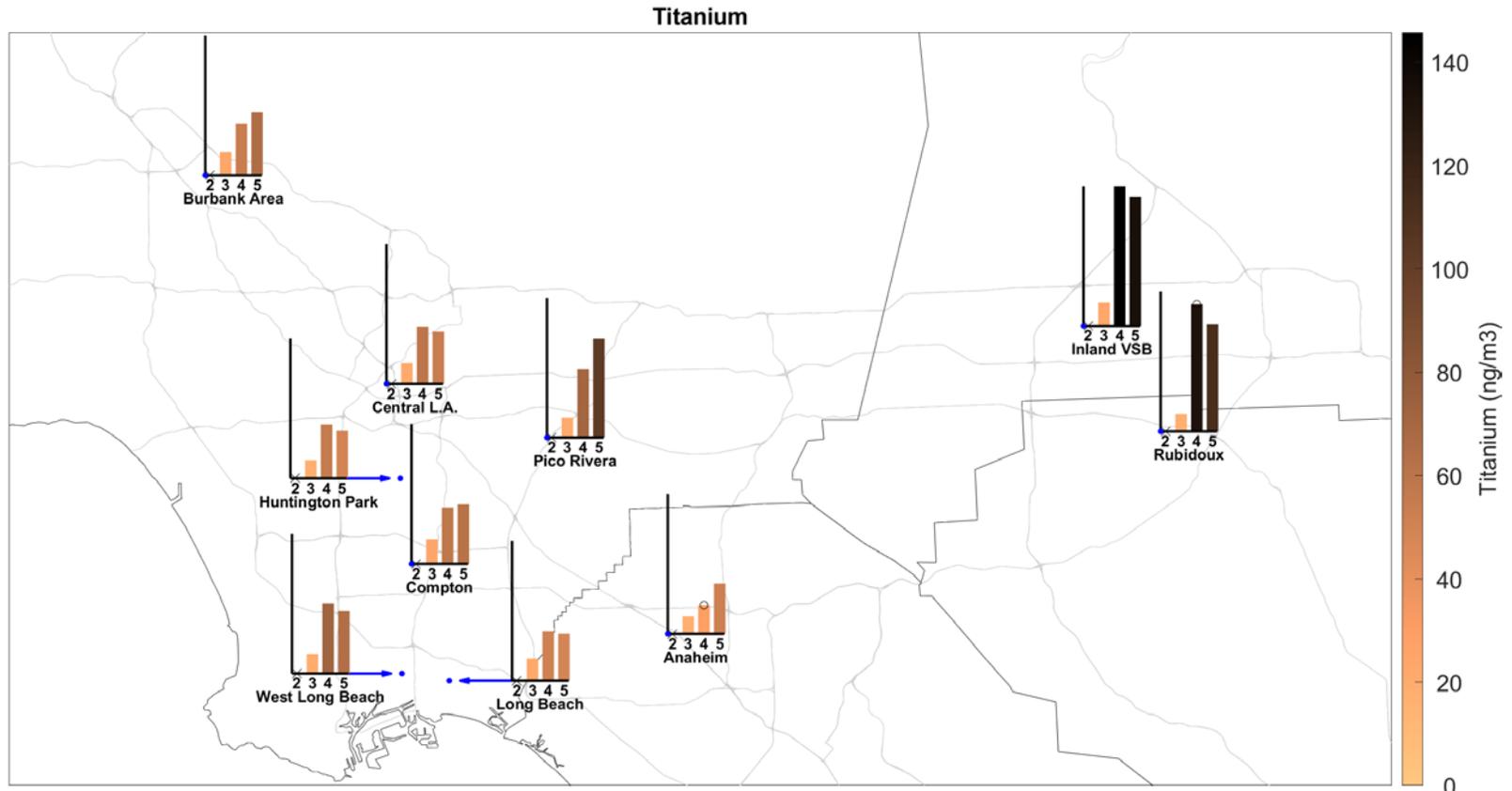
**Table IV-148.** Ambient Concentrations (ng/m<sup>3</sup>) of Titanium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	18.2	24.2	25.5	24.6	19	22.9	21.6	20.8	18.4	20.3
95% CI LB	16.9	20	23.2	22.9	17.4	20	20.2	18.9	17.2	17.7
95% CI UB	19.5	30.7	28.1	26.4	20.6	26.1	23.1	22.9	19.8	23
N	240	239	234	238	117	228	237	116	236	228
% < MDL	0.4	0.4	0	0	0.9	0.4	0	0	0	0.4
Max	57	629	175	136	49.3	120	87.9	63.1	96.9	148
<b>MATES IV</b>										
Average	0.898, 30 <sup>b</sup>	1.07, 53.9 <sup>b</sup>	1.87, 58.8 <sup>b</sup>	1.8, 146 <sup>b</sup>	1.69, 56.2 <sup>b</sup>	4.82, 51.6 <sup>b</sup>	2.02, 59.7 <sup>b</sup>	2.34, 71.5 <sup>b</sup>	0.426, 133 <sup>b</sup>	5.21, 73.1 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0.367 <sup>b</sup>	0.339 <sup>b</sup>	1.62 <sup>b</sup>	0.483 <sup>b</sup>	0.678 <sup>b</sup>	0 <sup>b</sup>	1.84 <sup>b</sup>
95% CI UB	38 <sup>b</sup>	62.4 <sup>b</sup>	67.8 <sup>b</sup>	183 <sup>b</sup>	65.7 <sup>b</sup>	63.2 <sup>b</sup>	71.3 <sup>b</sup>	84.5 <sup>b</sup>	165 <sup>b</sup>	89.6 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	96.6 <sup>b</sup>	94.9 <sup>b</sup>	95.1 <sup>b</sup>	93.3 <sup>b</sup>	93.2 <sup>b</sup>	88.5 <sup>b</sup>	91.7 <sup>b</sup>	89.8 <sup>b</sup>	98.4 <sup>b</sup>	86.9 <sup>b</sup>
Max	32 <sup>b</sup>	24 <sup>b</sup>	45 <sup>b</sup>	34 <sup>b</sup>	29 <sup>b</sup>	55 <sup>b</sup>	30 <sup>b</sup>	30 <sup>b</sup>	26 <sup>b</sup>	77 <sup>b</sup>
<b>MATES V</b>										
Average	1.61, 52.5 <sup>b</sup>	0, 66.3 <sup>b</sup>	1.02, 62 <sup>b</sup>	0.733, 134 <sup>b</sup>	0, 49.7 <sup>b</sup>	0, 49 <sup>b</sup>	0, 54.8 <sup>b</sup>	1.47, 103 <sup>b</sup>	1.04, 112 <sup>b</sup>	0, 65.2 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0.339 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>						
95% CI UB	61.3 <sup>b</sup>	76.7 <sup>b</sup>	75.2 <sup>b</sup>	163 <sup>b</sup>	58.2 <sup>b</sup>	64.3 <sup>b</sup>	62.1 <sup>b</sup>	119 <sup>b</sup>	127 <sup>b</sup>	84.5 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	94.4 <sup>b</sup>	100 <sup>b</sup>	95.1 <sup>b</sup>	96.7 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	93.2 <sup>b</sup>	96.4 <sup>b</sup>	100 <sup>b</sup>
Max	37 <sup>b</sup>	< MDL <sup>b</sup>	22 <sup>b</sup>	24 <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	25 <sup>b</sup>	36 <sup>b</sup>	< MDL <sup>b</sup>

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-292.** Annual Average Concentrations of Titanium in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



**Figure IV-293.** Geographic distribution of Titanium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

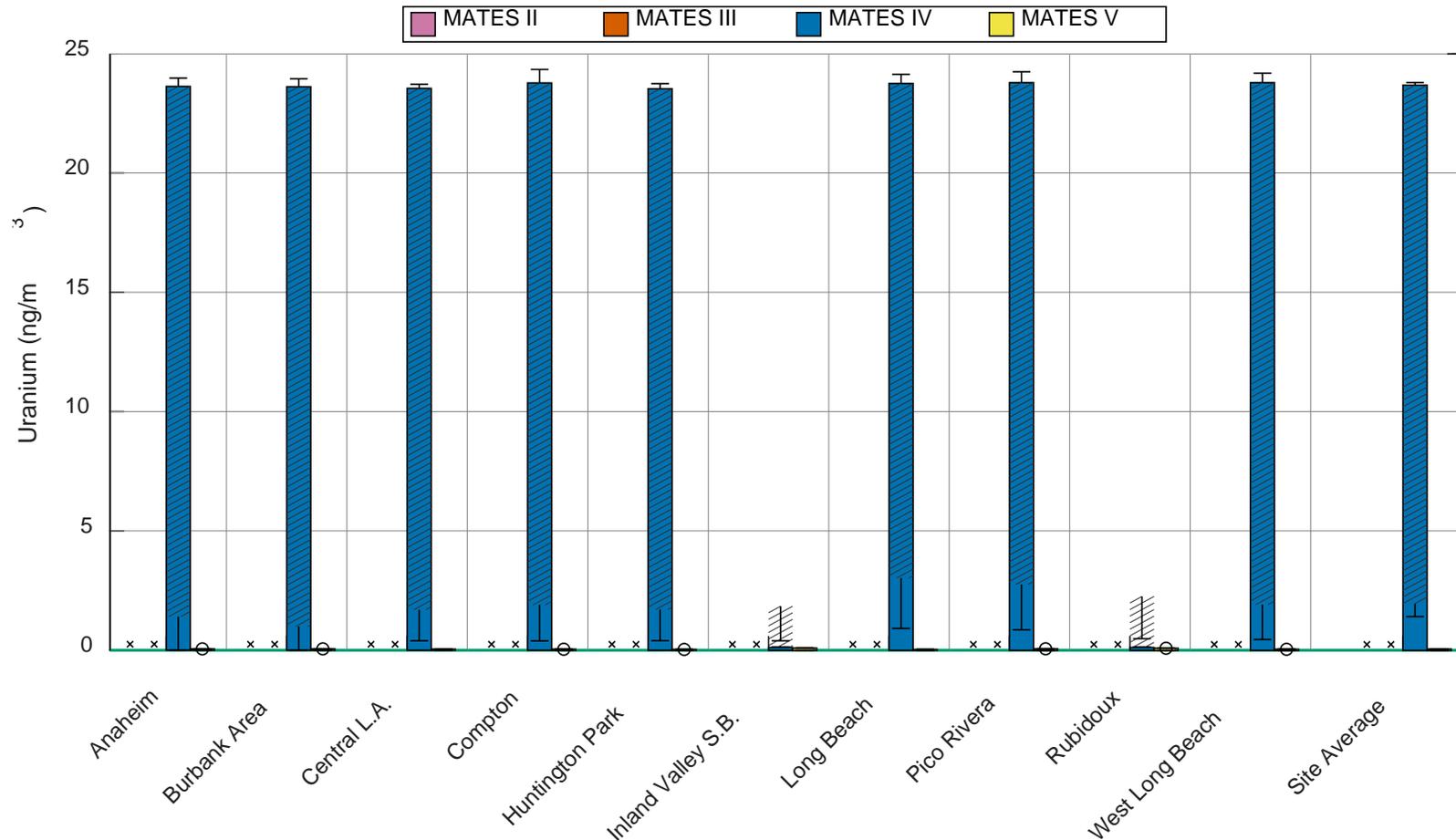
Uranium

**Table IV-149.** Ambient Concentrations (ng/m<sup>3</sup>) of Uranium from the PM2.5 Metals analysis at the Fixed Sites.

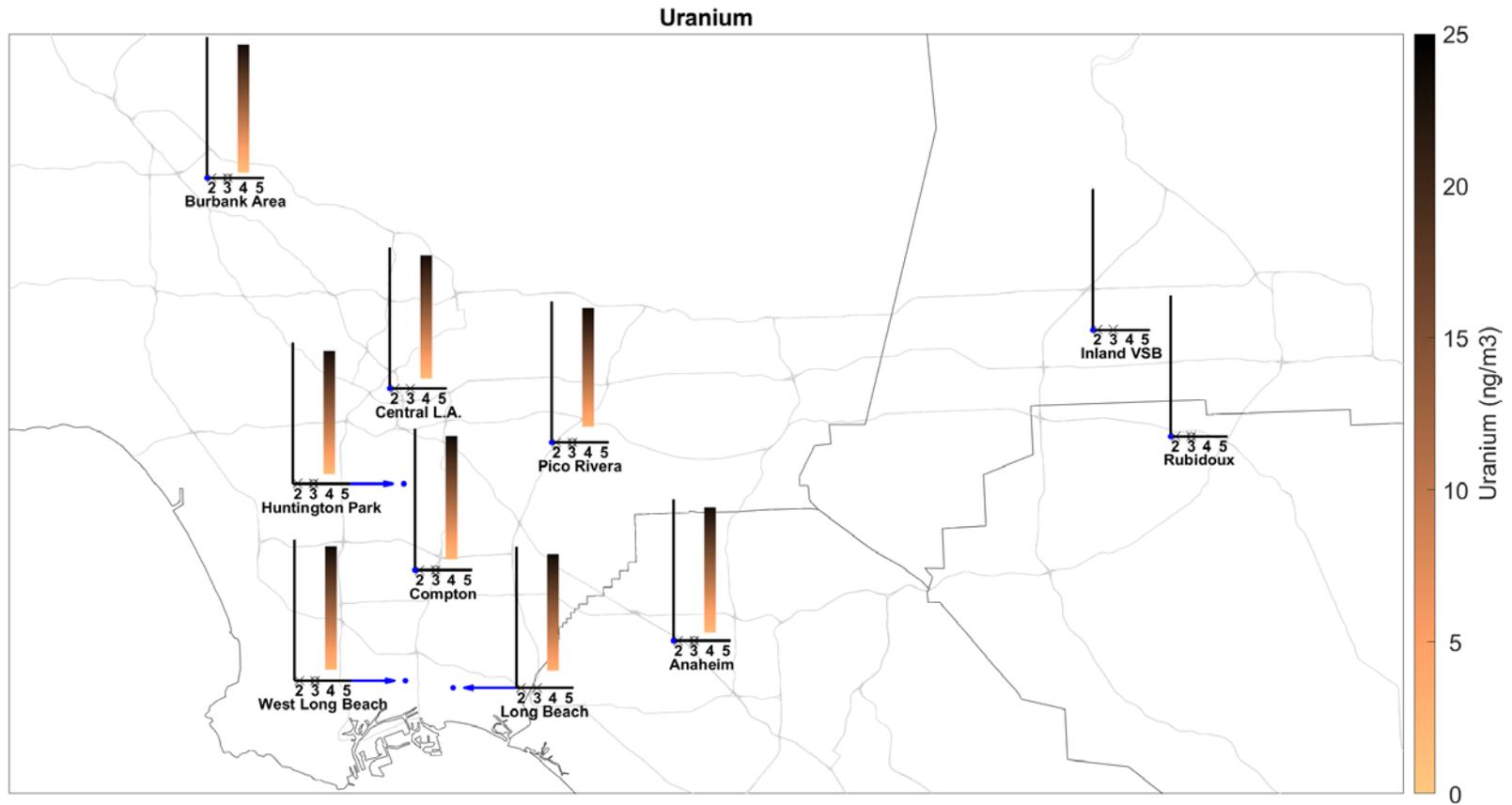
Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES IV</b>										
Average	1.41, 23.6 <sup>a</sup>	1, 23.6 <sup>a</sup>	1.9, 23.8 <sup>a</sup>	1.85, 0.122 <sup>b</sup>	1.71, 23.5 <sup>a</sup>	3.03, 23.8 <sup>a</sup>	1.7, 23.5 <sup>a</sup>	2.76, 23.8 <sup>a</sup>	2.26, 0.123 <sup>b</sup>	1.92, 23.8 <sup>a</sup>
95% CI LB	0 <sup>a</sup>	0 <sup>a</sup>	0.393 <sup>a</sup>	0.4 <sup>b</sup>	0.407 <sup>a</sup>	0.918 <sup>a</sup>	0.4 <sup>a</sup>	0.864 <sup>a</sup>	0.492 <sup>b</sup>	0.459 <sup>a</sup>
95% CI UB	24 <sup>a</sup>	24 <sup>a</sup>	24.3 <sup>a</sup>	0.145 <sup>b</sup>	23.7 <sup>a</sup>	24.1 <sup>a</sup>	23.7 <sup>a</sup>	24.2 <sup>a</sup>	0.147 <sup>b</sup>	24.2 <sup>a</sup>
N	59 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60 <sup>b</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	59 <sup>a</sup>	61 <sup>b</sup>	61 <sup>a</sup>
% < MDL	94.9 <sup>a</sup>	96.6 <sup>a</sup>	93.4 <sup>a</sup>	93.3 <sup>b</sup>	93.2 <sup>a</sup>	88.5 <sup>a</sup>	93.3 <sup>a</sup>	89.8 <sup>a</sup>	91.8 <sup>b</sup>	93.4 <sup>a</sup>
Max	32 <sup>a</sup>	31 <sup>a</sup>	33 <sup>a</sup>	34 <sup>b</sup>	29 <sup>a</sup>	31 <sup>a</sup>	27 <sup>a</sup>	32 <sup>a</sup>	33 <sup>b</sup>	31 <sup>a</sup>
<b>MATES V</b>										
Average	0, 0.0561 <sup>b</sup>	0, 0.0577 <sup>b</sup>	0, 0.0453 <sup>b</sup>	0, 0.0944 <sup>b</sup>	0, 0.0376 <sup>b</sup>	0, 0.036 <sup>b</sup>	0, 0.0465 <sup>b</sup>	0, 0.0664 <sup>b</sup>	0, 0.0908 <sup>b</sup>	0, 0.0475 <sup>b</sup>
95% CI LB	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>
95% CI UB	0.0658 <sup>b</sup>	0.0675 <sup>b</sup>	0.0571 <sup>b</sup>	0.114 <sup>b</sup>	0.0459 <sup>b</sup>	0.0472 <sup>b</sup>	0.0542 <sup>b</sup>	0.0781 <sup>b</sup>	0.105 <sup>b</sup>	0.0647 <sup>b</sup>
N	54 <sup>b</sup>	55 <sup>b</sup>	56 <sup>b</sup>	60 <sup>b</sup>	56 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	54 <sup>b</sup>	56 <sup>b</sup>	52 <sup>b</sup>
% < MDL	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>	100 <sup>b</sup>
Max	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>	< MDL <sup>b</sup>

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-294.** Annual Average Concentrations of Uranium in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



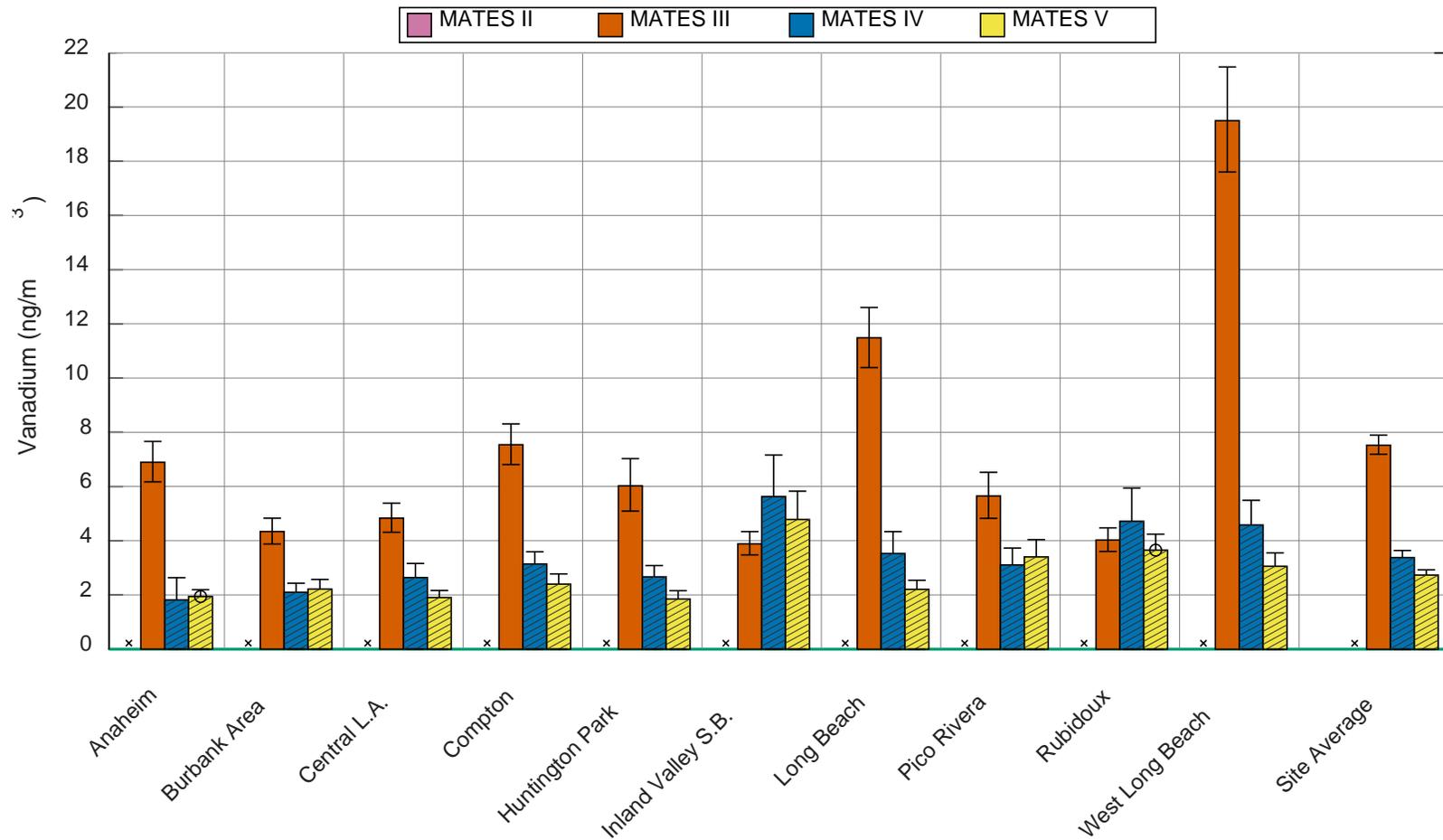
**Figure IV-295.** Geographic distribution of Uranium from the PM2.5 Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. "x" indicates that there is no data for a given station/MATES iteration.

Vanadium

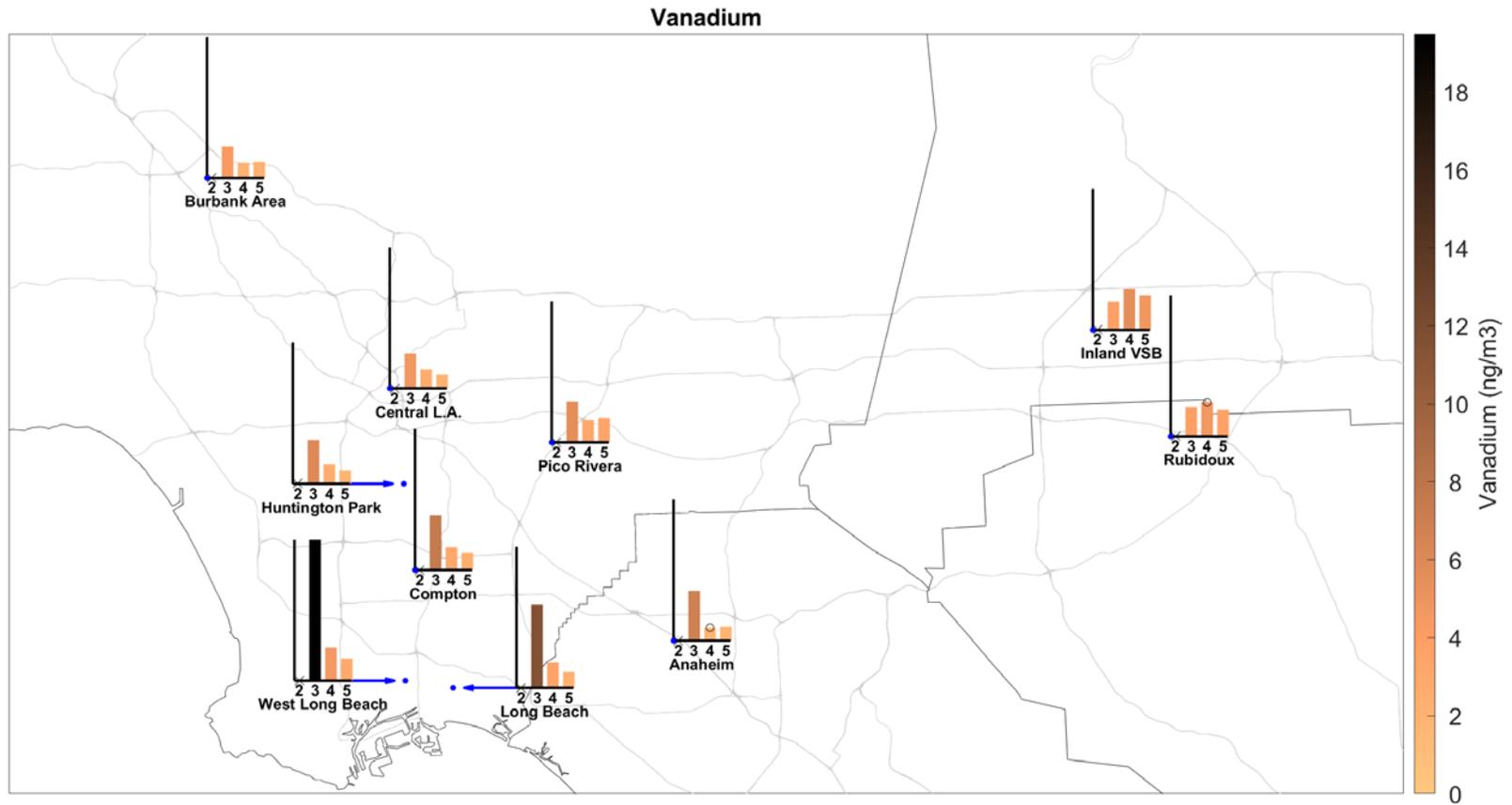
**Table IV-150.** Ambient Concentrations (ng/m<sup>3</sup>) of Vanadium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
<b>MATES III</b>										
Average	6.9	4.34	7.54	3.89	6.03	11.5	4.83	5.65	4.03	19.5
95% CI LB	6.17	3.88	6.81	3.48	5.09	10.4	4.31	4.83	3.61	17.6
95% CI UB	7.66	4.83	8.31	4.34	7.03	12.6	5.38	6.53	4.48	21.5
N	240	239	234	238	117	228	237	116	236	228
% < MDL	7.1	18.4	6.4	20.2	5.1	4.4	17.7	8.6	18.2	2.6
Max	28.5	22.3	34.6	19.8	28.5	50.7	22.9	26	23.5	87.5
<b>MATES IV</b>										
Average	0, 1.82 <sup>b</sup>	0, 2.1 <sup>b</sup>	0, 3.14 <sup>b</sup>	0, 5.63 <sup>b</sup>	0, 2.67 <sup>b</sup>	0, 3.53 <sup>b</sup>	0, 2.64 <sup>b</sup>	0, 3.11 <sup>b</sup>	0, 4.72 <sup>b</sup>	0, 4.58 <sup>b</sup>
95% CI LB	0 <sup>b</sup>									
95% CI UB	2.64 <sup>b</sup>	2.43 <sup>b</sup>	3.59 <sup>b</sup>	7.16 <sup>b</sup>	3.08 <sup>b</sup>	4.34 <sup>b</sup>	3.16 <sup>b</sup>	3.73 <sup>b</sup>	5.94 <sup>b</sup>	5.49 <sup>b</sup>
N	59 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>
% < MDL	100 <sup>b</sup>									
Max	< MDL <sup>b</sup>									
<b>MATES V</b>										
Average	0, 1.94 <sup>b</sup>	0, 2.22 <sup>b</sup>	0, 2.4 <sup>b</sup>	0, 4.78 <sup>b</sup>	0, 1.85 <sup>b</sup>	0, 2.21 <sup>b</sup>	0, 1.9 <sup>b</sup>	0, 3.41 <sup>b</sup>	0, 3.66 <sup>b</sup>	0, 3.06 <sup>b</sup>
95% CI LB	0 <sup>b</sup>									
95% CI UB	2.19 <sup>b</sup>	2.57 <sup>b</sup>	2.78 <sup>b</sup>	5.83 <sup>b</sup>	2.16 <sup>b</sup>	2.54 <sup>b</sup>	2.16 <sup>b</sup>	4.04 <sup>b</sup>	4.24 <sup>b</sup>	3.55 <sup>b</sup>
N	54 <sup>b</sup>	59 <sup>b</sup>	61 <sup>b</sup>	60 <sup>b</sup>	60 <sup>b</sup>	61 <sup>b</sup>	61 <sup>b</sup>	59 <sup>b</sup>	56 <sup>b</sup>	57 <sup>b</sup>
% < MDL	100 <sup>b</sup>									
Max	< MDL <sup>b</sup>									

<sup>b</sup>More than 80% of data are < MDL. Values based on zero substitutions and TSP KM mean.



**Figure IV-296.** Annual Average Concentrations of Vanadium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



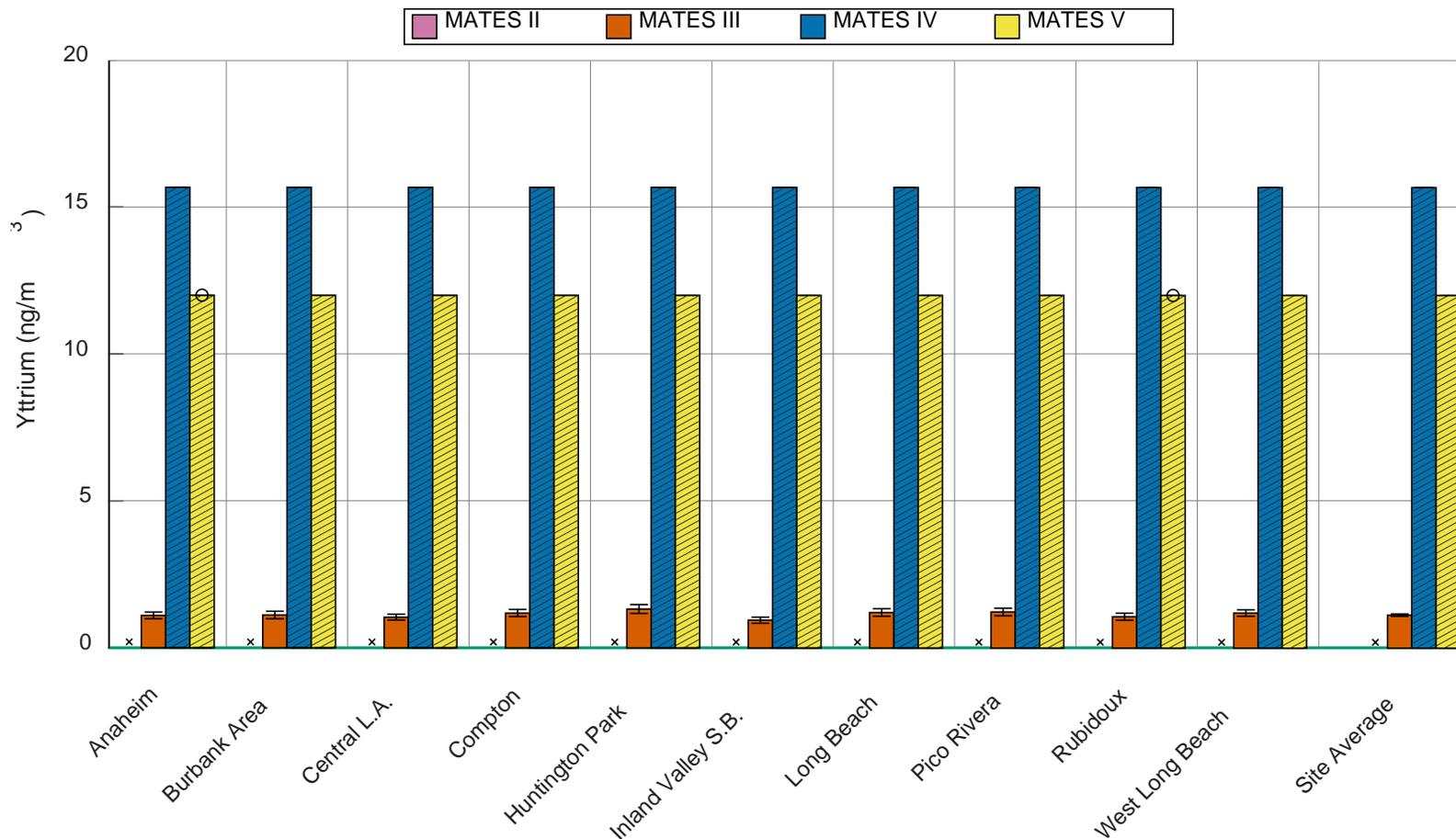
**Figure IV-297.** Geographic distribution of Vanadium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

Yttrium

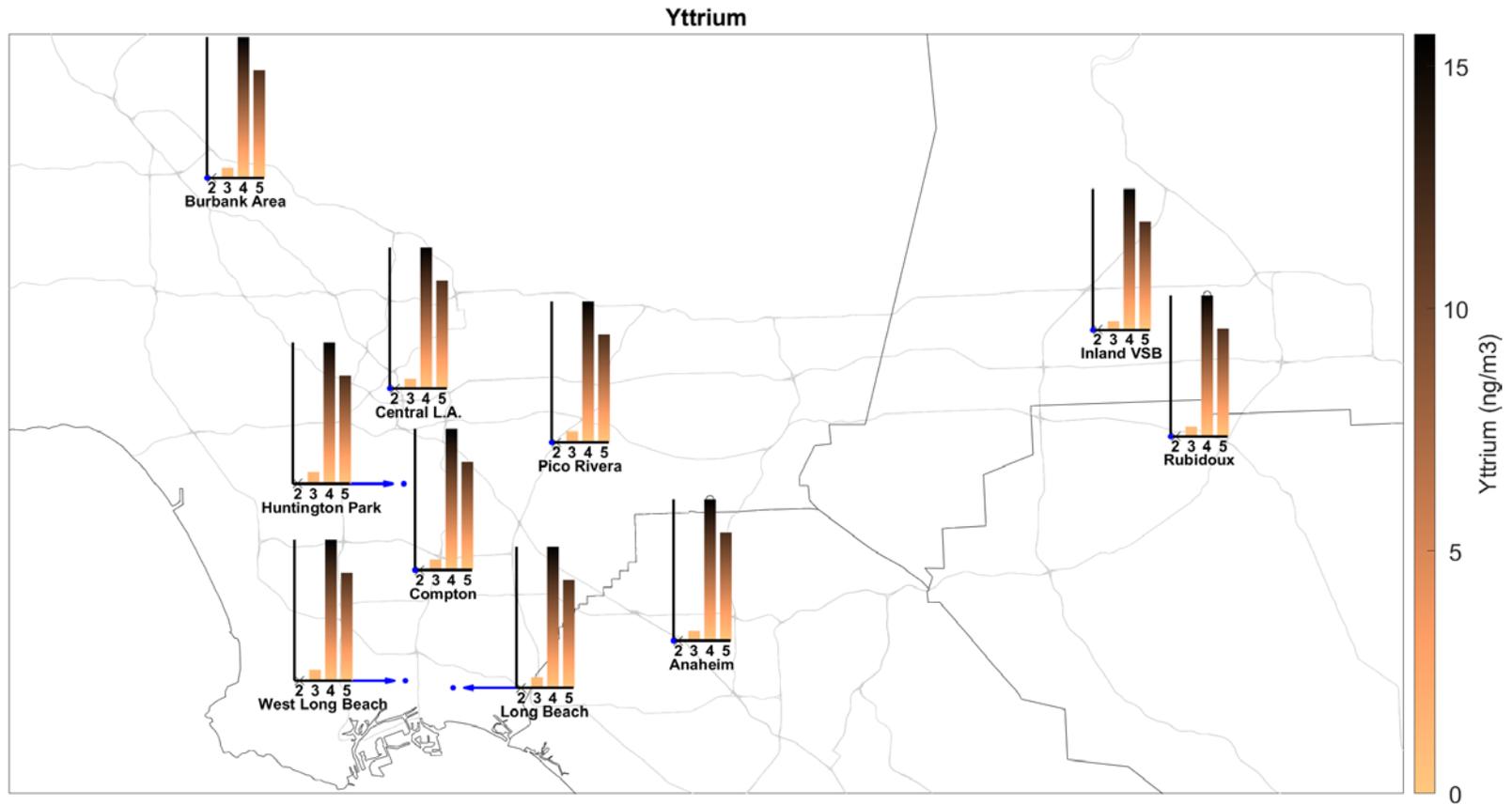
**Table IV-151.** Ambient Concentrations (ng/m<sup>3</sup>) of Yttrium from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	1.1	1.12	1.18	0.947	1.32	1.21	1.04	1.23	1.07	1.19
95% CI LB	0.989	0.99	1.06	0.843	1.17	1.08	0.947	1.1	0.946	1.08
95% CI UB	1.21	1.25	1.31	1.05	1.47	1.34	1.15	1.36	1.19	1.3
N	240	239	234	238	117	228	237	116	236	228
% < MDL	37.1	41	34.6	44.5	21.4	32.5	32.1	21.6	41.5	30.3
Max	4.95	3.72	4.95	4.93	3.72	6.17	3.1	3.72	6.16	3.72
MATES IV										
Average	0, 15.7 <sup>a</sup>									
95% CI LB	0 <sup>a</sup>									
95% CI UB	15.7 <sup>a</sup>									
N	59 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	61 <sup>a</sup>
% < MDL	100 <sup>a</sup>									
Max	< MDL <sup>a</sup>									
MATES V										
Average	0, 12 <sup>a</sup>									
95% CI LB	0 <sup>a</sup>									
95% CI UB	12 <sup>a</sup>									
N	54 <sup>a</sup>	59 <sup>a</sup>	61 <sup>a</sup>	60 <sup>a</sup>	60 <sup>a</sup>	61 <sup>a</sup>	61 <sup>a</sup>	59 <sup>a</sup>	56 <sup>a</sup>	57 <sup>a</sup>
% < MDL	100 <sup>a</sup>									
Max	< MDL <sup>a</sup>									

<sup>a</sup>More than 80% of data are < MDL. Values based on zero and MDL substitutions.



**Figure IV-298.** Annual Average Concentrations of Yttrium in the PM2.5 Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

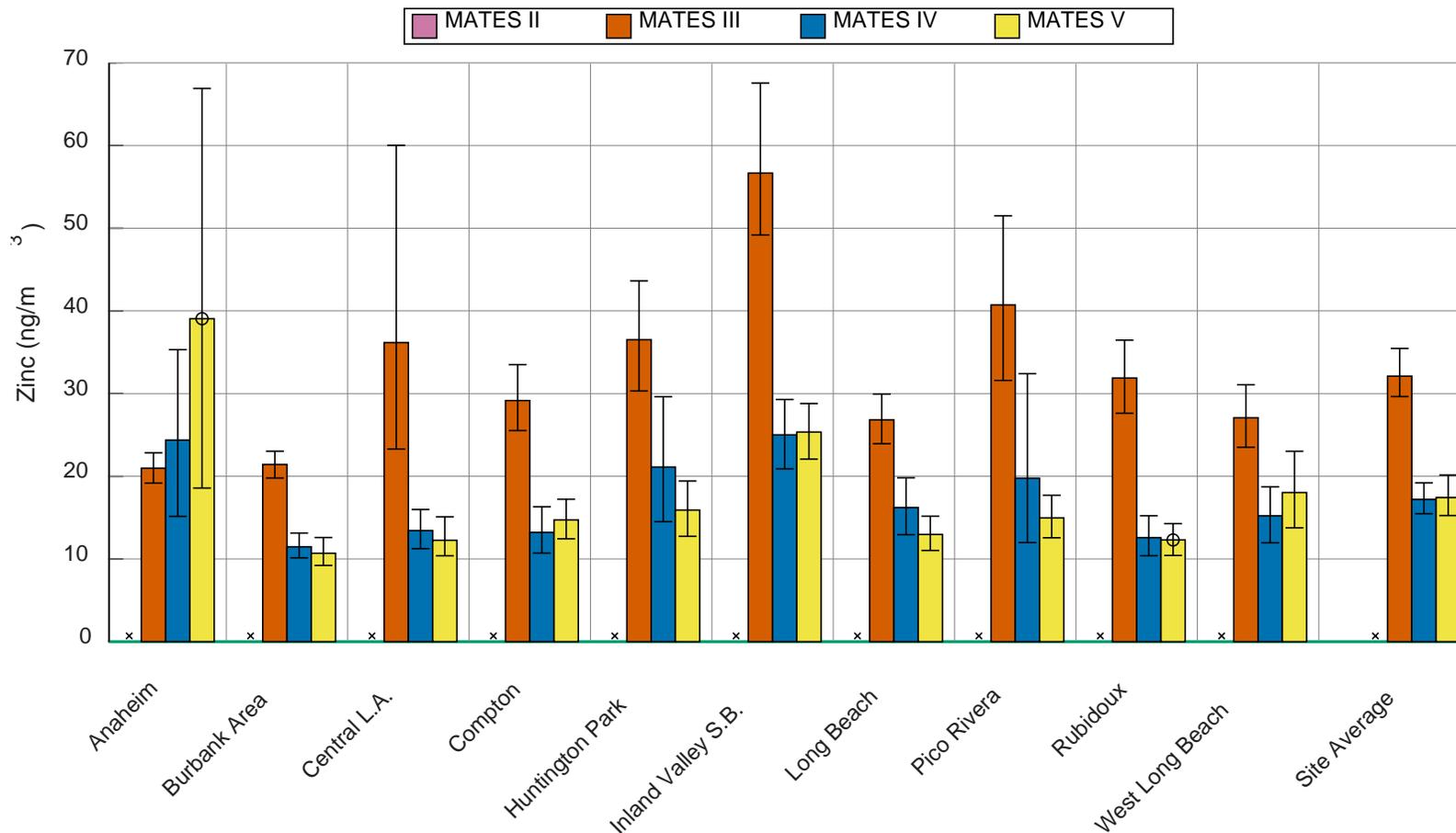


**Figure IV-299.** Geographic distribution of Yttrium from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

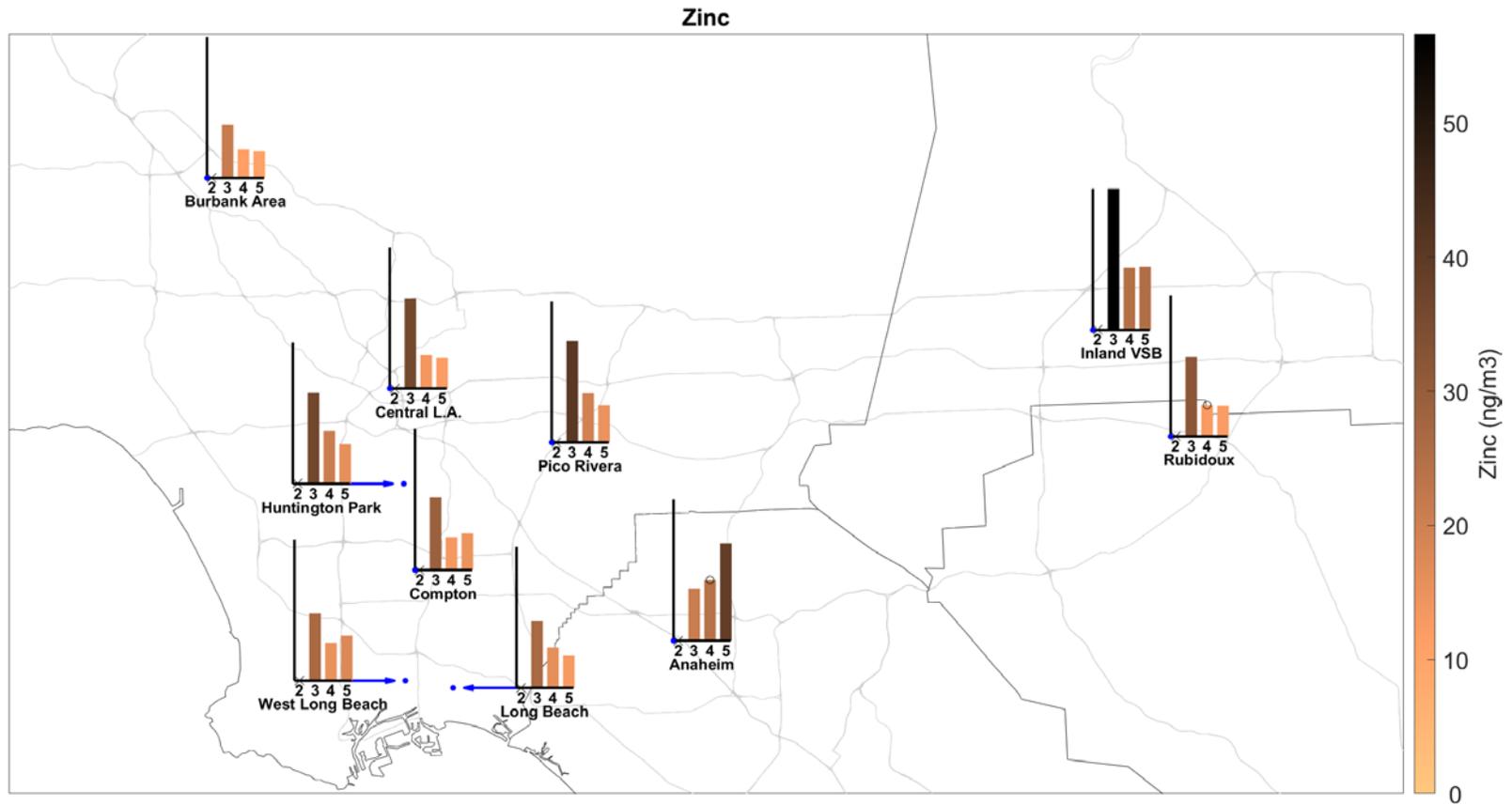
## Zinc

**Table IV-152.** Ambient Concentrations (ng/m<sup>3</sup>) of Zinc from the PM2.5 Metals analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average	21	21.4	29.2	56.7	36.5	26.8	36.2	40.7	31.9	27.1
95% CI LB	19.2	19.8	25.5	49.2	30.3	23.9	23.3	31.6	27.6	23.5
95% CI UB	22.8	23	33.5	67.6	43.6	29.9	60	51.5	36.5	31.1
N	240	239	234	238	117	228	237	116	236	228
% < MDL	0	0	0	0	0	0	0	0	0	0
Max	75.5	79.3	237	1050	224	181	2620	362	262	189
MATES IV										
Average	24.4	11.5	13.2	25	21.1	16.2	13.4	19.8	12.6	15.2
95% CI LB	15.1	10.1	10.7	20.9	14.5	12.9	11.2	12	10.4	12
95% CI UB	35.3	13.1	16.3	29.3	29.6	19.8	16	32.4	15.2	18.7
N	59	59	61	60	59	61	60	59	61	61
% < MDL	59.3	59.3	67.2	16.7	50.8	50.8	53.3	49.2	60.7	50.8
Max	210	36	61	72	189	72	58	332	56	64
MATES V										
Average	39.1	10.7	14.7	25.4	15.9	13	12.3	15	12.3	18
95% CI LB	18.6	9.22	12.4	22.1	12.7	11	10.4	12.6	10.4	13.8
95% CI UB	66.9	12.6	17.2	28.8	19.4	15.2	15.1	17.7	14.3	23
N	54	59	61	60	60	61	61	59	56	57
% < MDL	33.3	33.9	21.3	1.7	16.7	39.3	19.7	13.6	21.4	15.8
Max	525	55	45	71	88	51	79	69	43	97



**Figure IV-300.** Annual Average Concentrations of Zinc in the PM<sub>2.5</sub> Metals Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



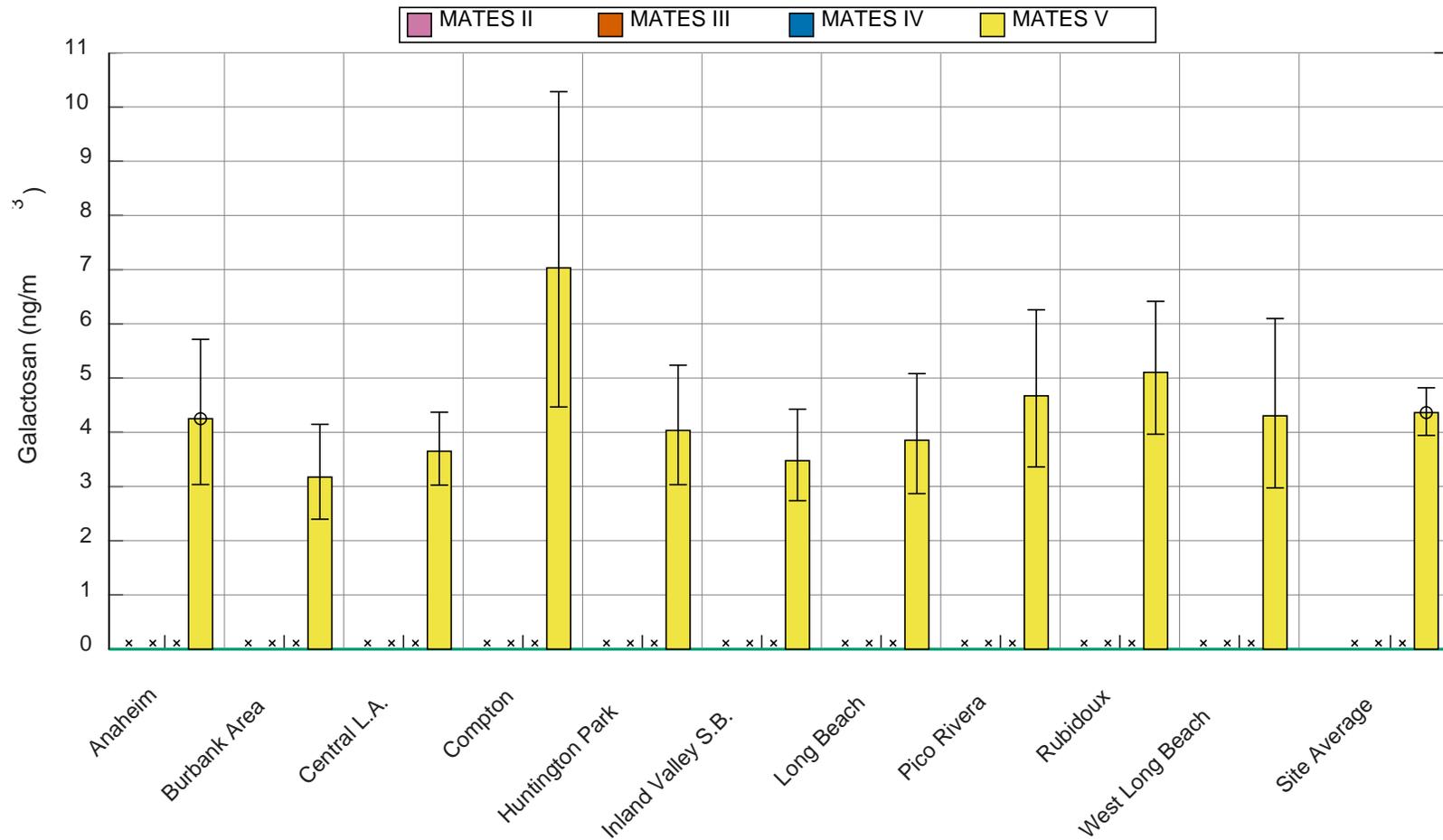
**Figure IV-301.** Geographic distribution of Zinc from the PM<sub>2.5</sub> Metals Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

PM2.5 Levoglucosan Analysis

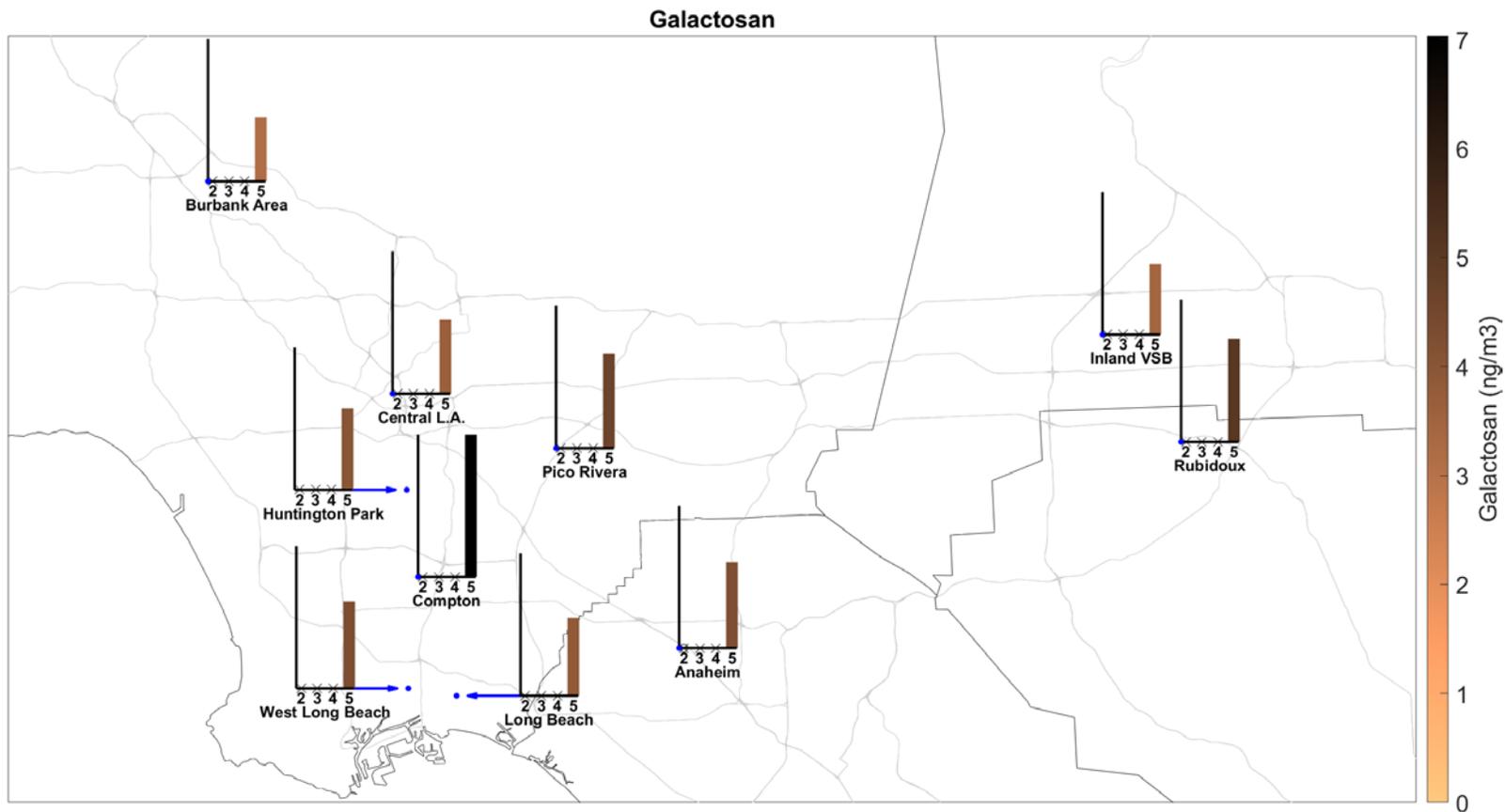
Galactosan

**Table IV-153.** Ambient Concentrations (ng/m<sup>3</sup>) of Galactosan from the PM2.5 Levoglucosan analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	4.25	3.17	7.03	3.48	4.03	3.85	3.65	4.67	5.11	4.3
95% CI LB	3.04	2.4	4.47	2.74	3.03	2.87	3.02	3.36	3.96	2.97
95% CI UB	5.71	4.15	10.3	4.43	5.24	5.08	4.37	6.26	6.42	6.1
N	56	58	60	61	59	61	110	58	113	56
% < MDL	30.4	37.9	45	31.1	44.1	49.2	35.5	34.5	31.9	57.1
Max	24	25	75	22	21	28	23.5	32	40	42



**Figure IV-302.** Annual Average Concentrations of Galactosan in the PM<sub>2.5</sub> Levoglucosan Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

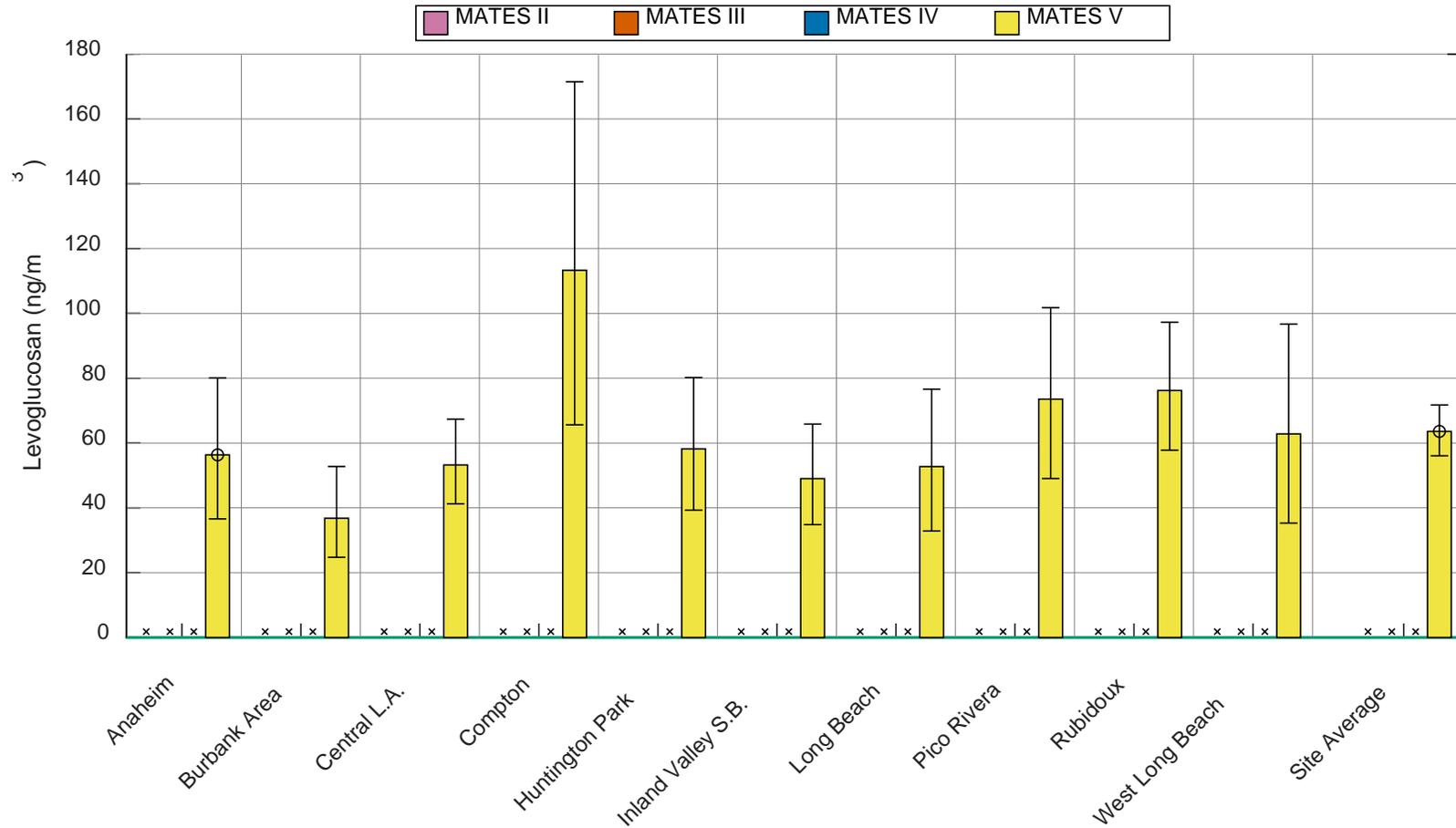


**Figure IV-303.** Geographic distribution of Galactosan from the PM<sub>2.5</sub> Levoglucosan Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

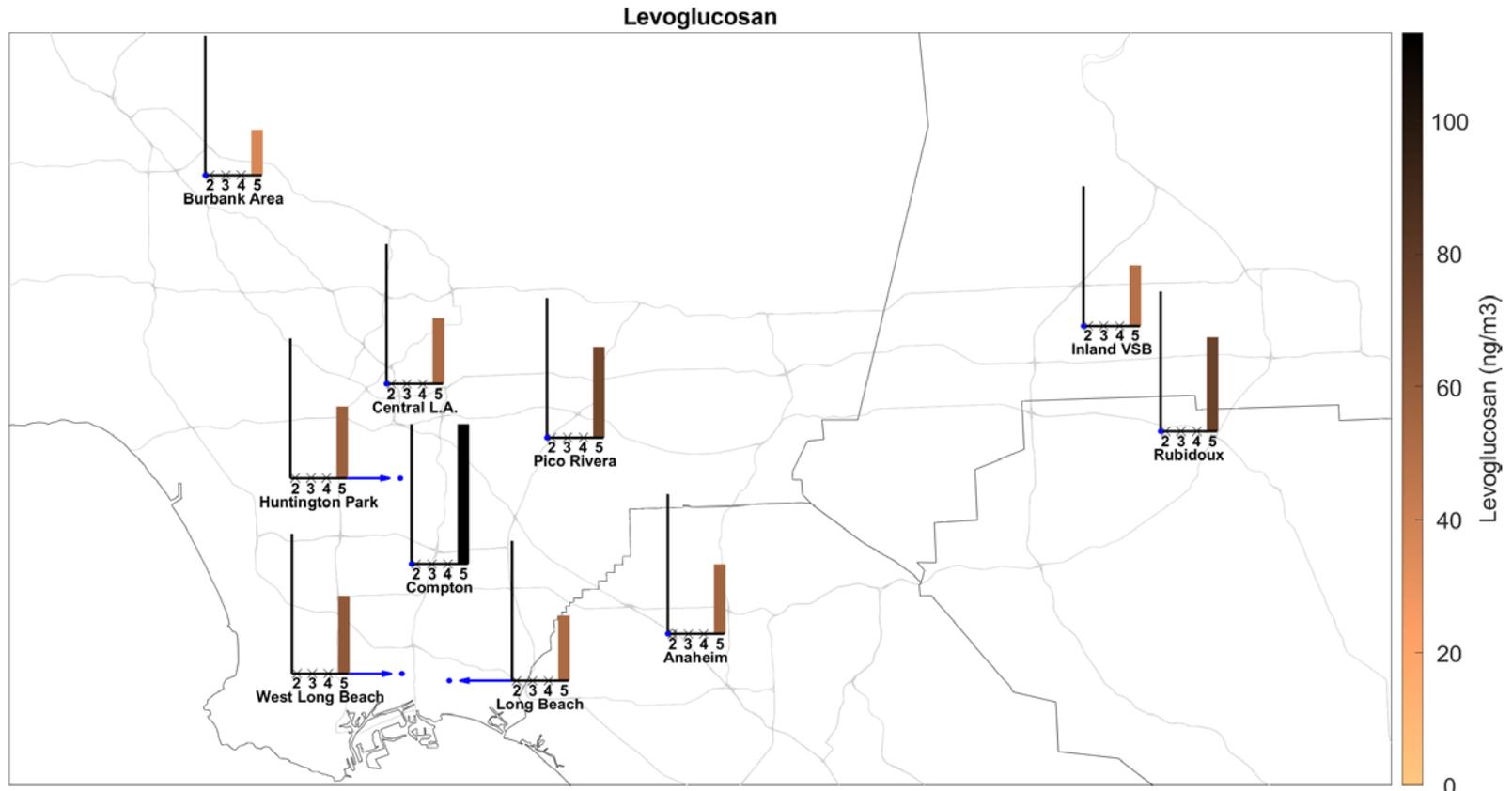
Levoglucosan

**Table IV-154.** Ambient Concentrations (ng/m<sup>3</sup>) of Levoglucosan from the PM2.5 Levoglucosan analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	56.3	36.8	113	49	58.2	52.7	53.2	73.6	76.2	62.8
95% CI LB	36.6	24.7	65.6	34.8	39.3	32.9	41.2	49	57.8	35.3
95% CI UB	80.1	52.8	171	65.8	80.2	76.6	67.4	102	97.3	96.7
N	56	58	60	60	59	60	109	58	112	55
% < MDL	0	1.7	0	0	0	0	0	1.7	0	3.6
Max	400	370	1220	348	389	491	434	480	646	635



**Figure IV-304.** Annual Average Concentrations of Levoglucosan in the PM<sub>2.5</sub> Levoglucosan Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.

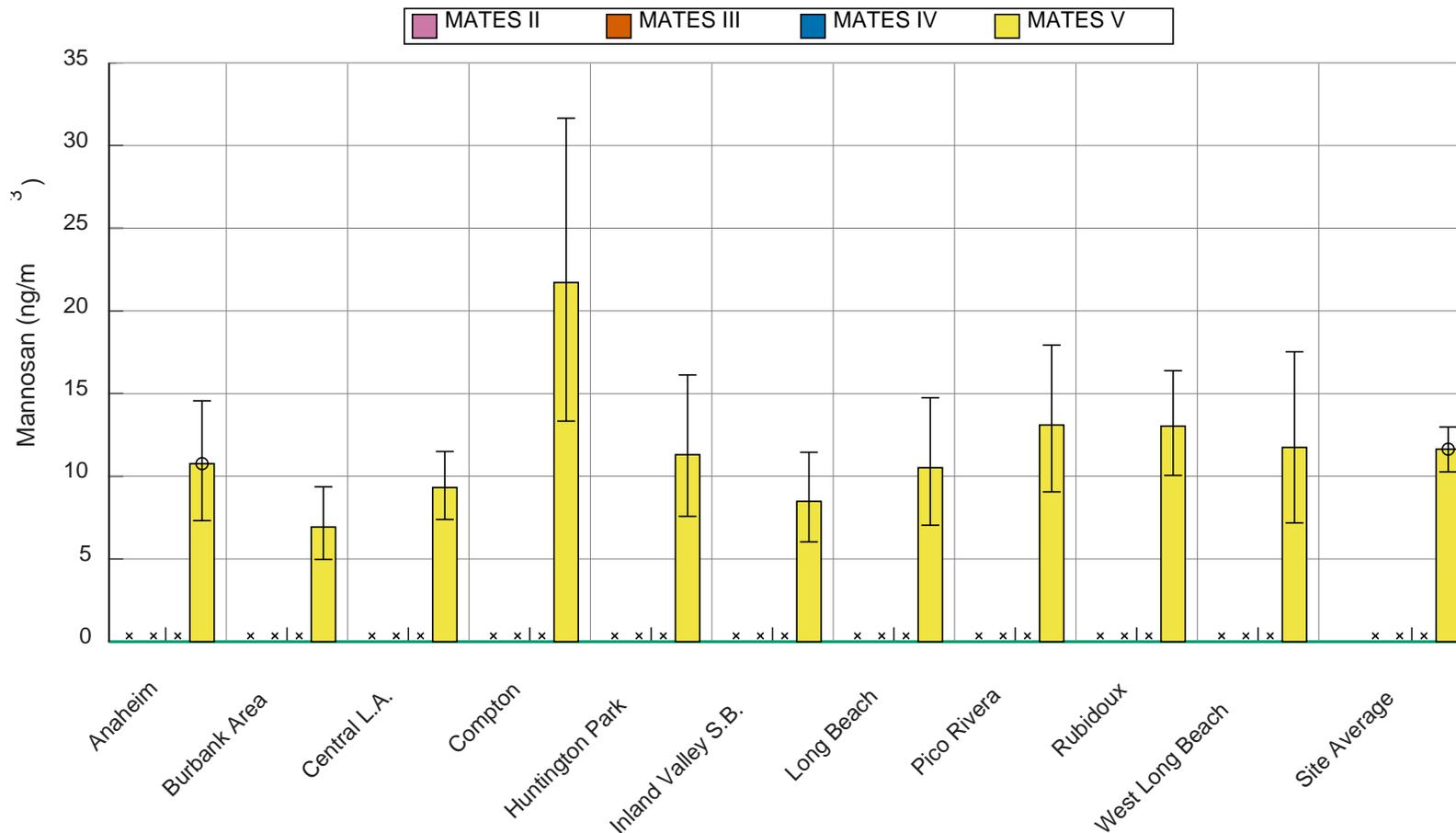


**Figure IV-305.** Geographic distribution of Levoglucosan from the PM<sub>2.5</sub> Levoglucosan Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

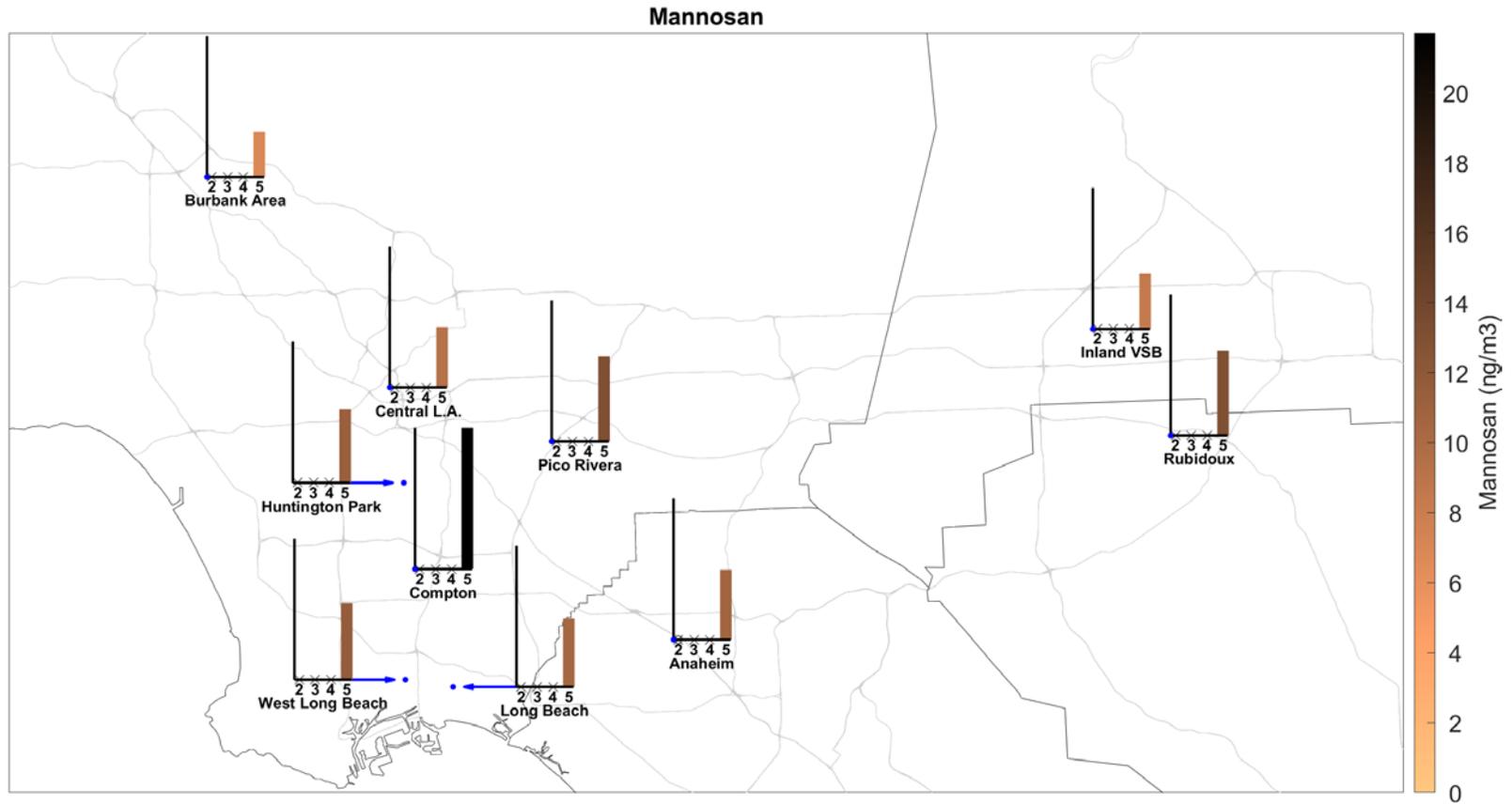
Mannosan

**Table IV-155.** Ambient Concentrations (ng/m<sup>3</sup>) of Mannosan from the PM2.5 Levoglucosan analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
MATES II										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES III										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES IV										
Average										
95% CI LB										
95% CI UB										
N	0	0	0	0	0	0	0	0	0	0
% < MDL										
Max										
MATES V										
Average	10.8	6.93	21.7	8.48	11.3	10.5	9.32	13.1	13	11.7
95% CI LB	7.32	4.97	13.3	6.03	7.58	7.04	7.39	9.06	10.1	7.18
95% CI UB	14.6	9.36	31.7	11.5	16.1	14.8	11.5	17.9	16.4	17.5
N	55	58	60	60	59	60	110	58	113	55
% < MDL	7.3	10.3	6.7	13.3	6.8	15	10.9	6.9	0.9	25.5
Max	67	45	210	64	76	95	56.5	78	101	122



**Figure IV-306.** Annual Average Concentrations of Mannosan in the PM2.5 Levoglucosan Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



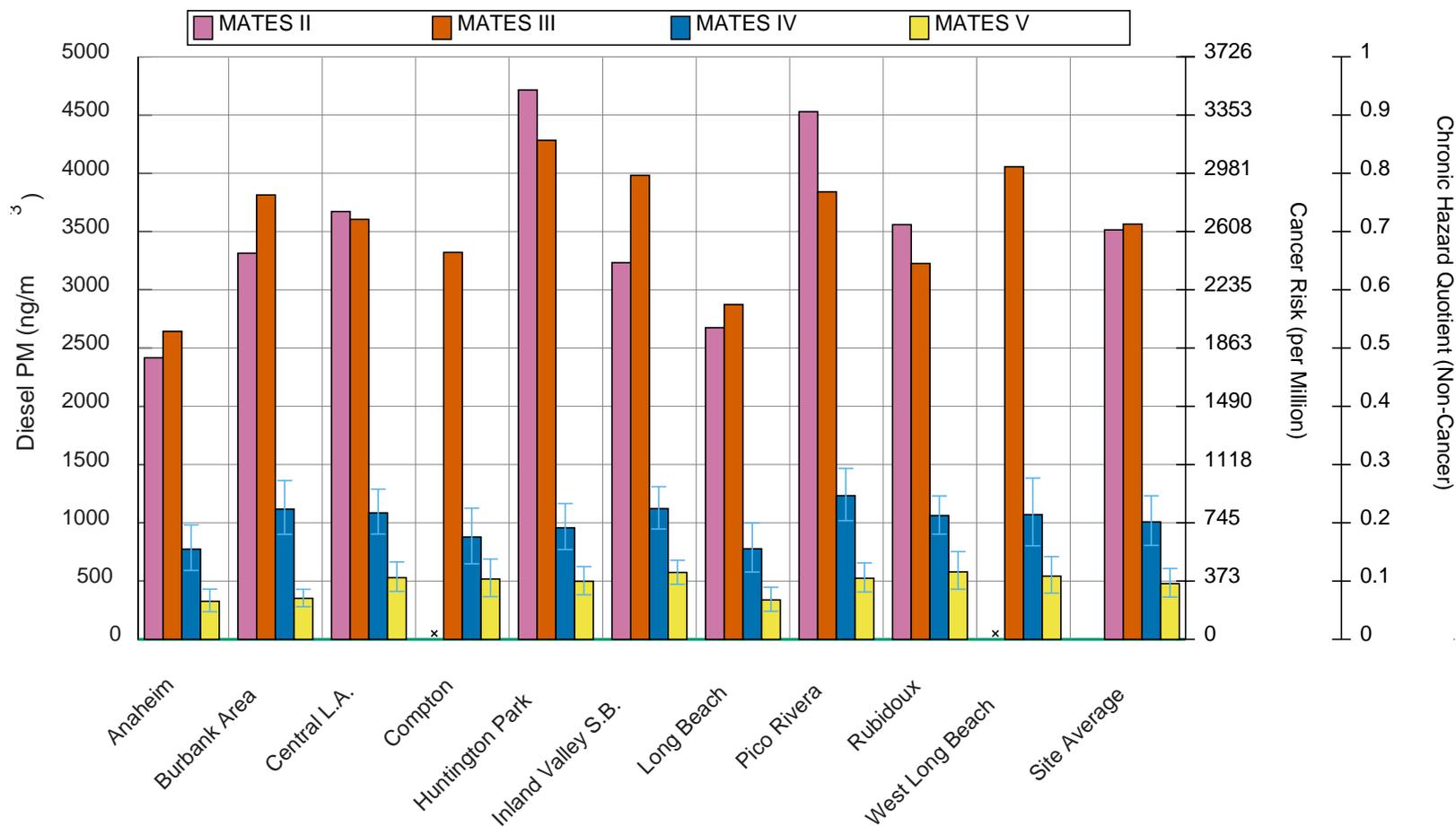
**Figure IV-307.** Geographic distribution of Mannosan from the PM<sub>2.5</sub> Levoglucosan Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

[Diesel PM Analysis](#)

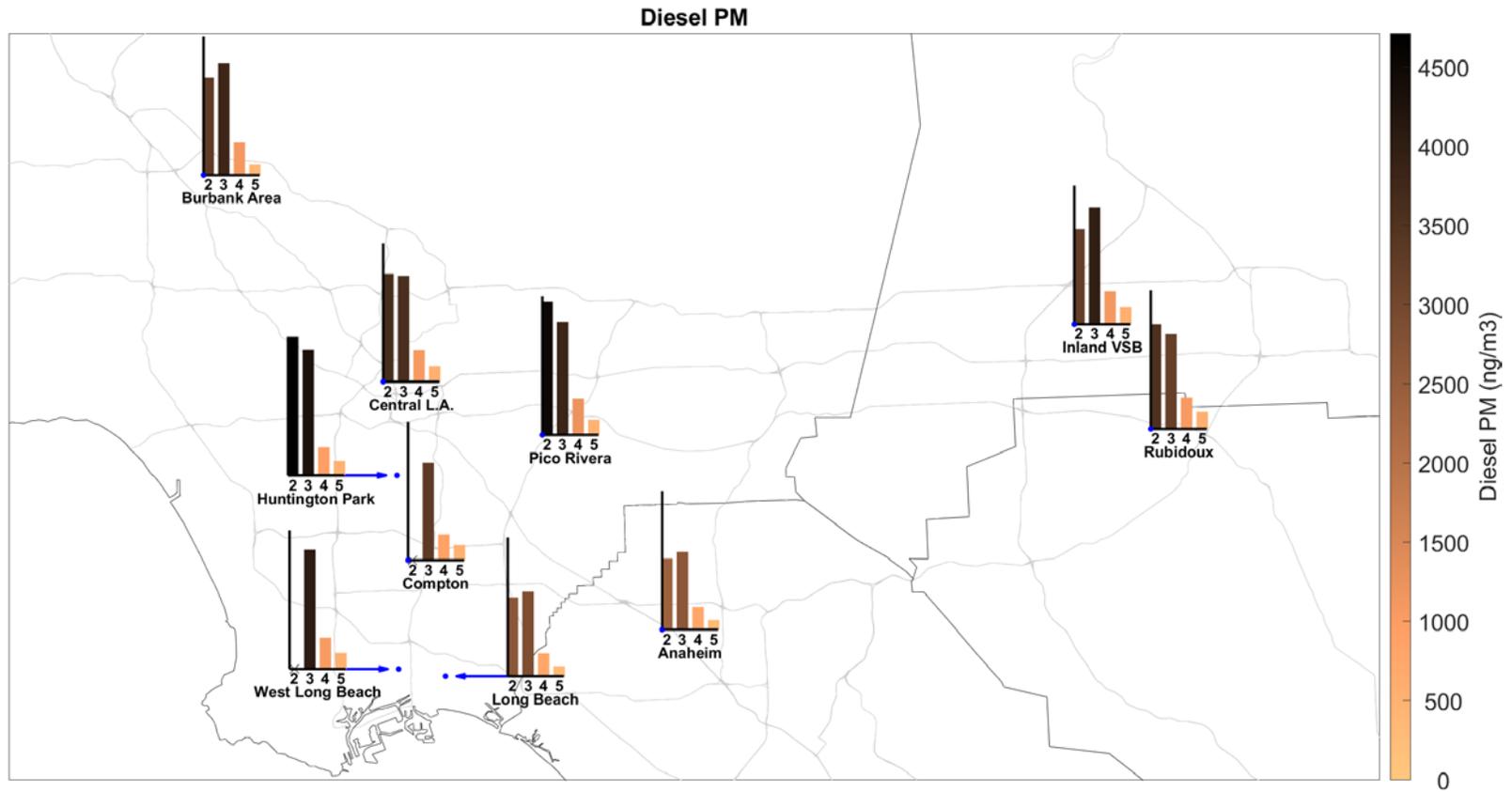
Diesel PM

**Table IV-156.** Ambient Concentrations (ng/m<sup>3</sup>) of Diesel PM from the Diesel PM analysis at the Fixed Sites.

Statistic	Measurement Site									
	AN	BU	CP	SB	HP	LB	LA	PR	RU	WLB
<b>MATES II</b>										
Average	2420	3310		3230	4720	2680	3670	4530	3560	
95% CI LB										
95% CI UB										
N	58	53	0	59	46	58	59	38	62	0
% < MDL	12.1	3.8		5.1	0	20.7	1.7	0	12.9	
Max										
<b>MATES III</b>										
Average	2640	3810	3320	3980	4280	2870	3600	3840	3230	4060
95% CI LB										
95% CI UB										
N	242	241	235	236	118	228	240	116	235	228
% < MDL	0.4	0	0.4	0.8	0.8	0.4	0	0	0.4	0.4
Max										
<b>MATES IV</b>										
Average	774	1120	878	1120	957	777	1080	1230	1060	1070
95% CI LB	591	901	649	947	771	578	904	1020	903	803
95% CI UB	982	1360	1130	1310	1170	998	1290	1470	1230	1380
N	59	59	61	60	59	61	60	59	61	61
% < MDL	0	1.7	0	1.7	0	1.6	0	0	0	0
Max										
<b>MATES V</b>										
Average	327	352	518	574	498	338	529	524	579	543
95% CI LB	238	280	367	473	383	241	412	407	430	398
95% CI UB	431	430	689	679	625	448	664	656	753	710
N	56	59	61	60	60	61	61	59	59	55
% < MDL	3.6	6.8	6.6	5	0	8.2	1.6	1.7	3.4	1.8
Max										



**Figure IV-308.** Annual Average Concentrations of Diesel PM in the Diesel PM Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration.



**Figure IV-309.** Geographic distribution of Diesel PM from the Diesel PM Analysis. The blue dots represent the locations of the MATES V stations. A circle at the top of a bar indicates that at least one quarter has less than 75% data completeness. “x” indicates that there is no data for a given station/MATES iteration.

## IV.2 Methods for Aggregate Risk Calculations

As mentioned in Chapter 2, calculated cumulative risks would be artificially low if some analytes are missing, which would lead to inaccurate comparisons between stations or across MATES studies. To address this issue, missing analytes were substituted to fill in gaps. The method used for substituting data creates additional uncertainty. To address this uncertainty, five different methods were used to calculate cumulative risks to determine if the results are sensitive to the method chosen. For descriptive purposes, these methods are called: Missing Data, Interpolate Trends, Adjacent MATES, Min MATES, and Max MATES. These substitutions are only used for discussions and figures related to aggregate risk, e.g., Figure ES-2 through Figure ES-5 in the Executive Summary and Figure 2-44 through Figure 2-55 in Chapter 2, and not elsewhere in the MATES V report. The results from all five methods are shown in Figure IV-298 through Figure IV-301.

The Missing Data method simply ignores any data that is missing. In other words, this method it does not make any estimates to fill in any missing data, and therefore shows unrealistically low cumulative risks. As a result, we do not rely on this method, and it is shown for comparison purposes only.

The Interpolate Trends, Adjacent MATES, Min MATES, and Max MATES methods all substitute the basin wide average from the same MATES study if it is available. For example, as discussed in Chapter 2, carbonyl and VOC pollutant data were not available due to equipment issues at Anaheim for MATES V. Since these pollutants were measured at other stations during MATES V, the basin-wide averages from MATES V are substituted for the missing carbonyl and VOC data. The results presented in Figure ES-2 through Figure ES-5 in the Executive Summary and Figure 2-44 through Figure 2-55 in Chapter 2 use the Interpolate Trends method.

The Interpolate Trends, Adjacent MATES, Min MATES, and Max MATES methods differ in how they handle missing data when a pollutant is not available for any stations in a given MATES study. For example, as shown in Figure 2-33 in Chapter 2, Total Suspended Particle (TSP) Beryllium was only measured during MATES IV and MATES V. In order to make a fair comparison of trends over time, some substitution of beryllium data needs to be made for MATES II and MATES III. The Missing Data method shows artificially low risks in MATES II and MATES III due to the lack of beryllium data.

For the Interpolate Trends method, if a pollutant has no data for one or more MATES studies, the percent change in basin-wide concentration for that pollutant is calculated for the MATES studies that are available, and then the largest percent change is applied to the highest of any available basin average. For example, if the basin-wide average for a pollutant decreased 83% from MATES III to MATES IV and 34% from MATES IV to MATES V, and the pollutant was not measured in MATES II, the highest basin wide average (i.e., the MATES III basin-wide average in this example) would be multiplied by 1.83. This value would be used for all stations for the MATES study missing that pollutant. These numbers were only provided as an example.

The calculations are done separately for each pollutant. The Interpolate Trends method estimates the higher concentrations we would expect in older MATES projects based on observed trends.

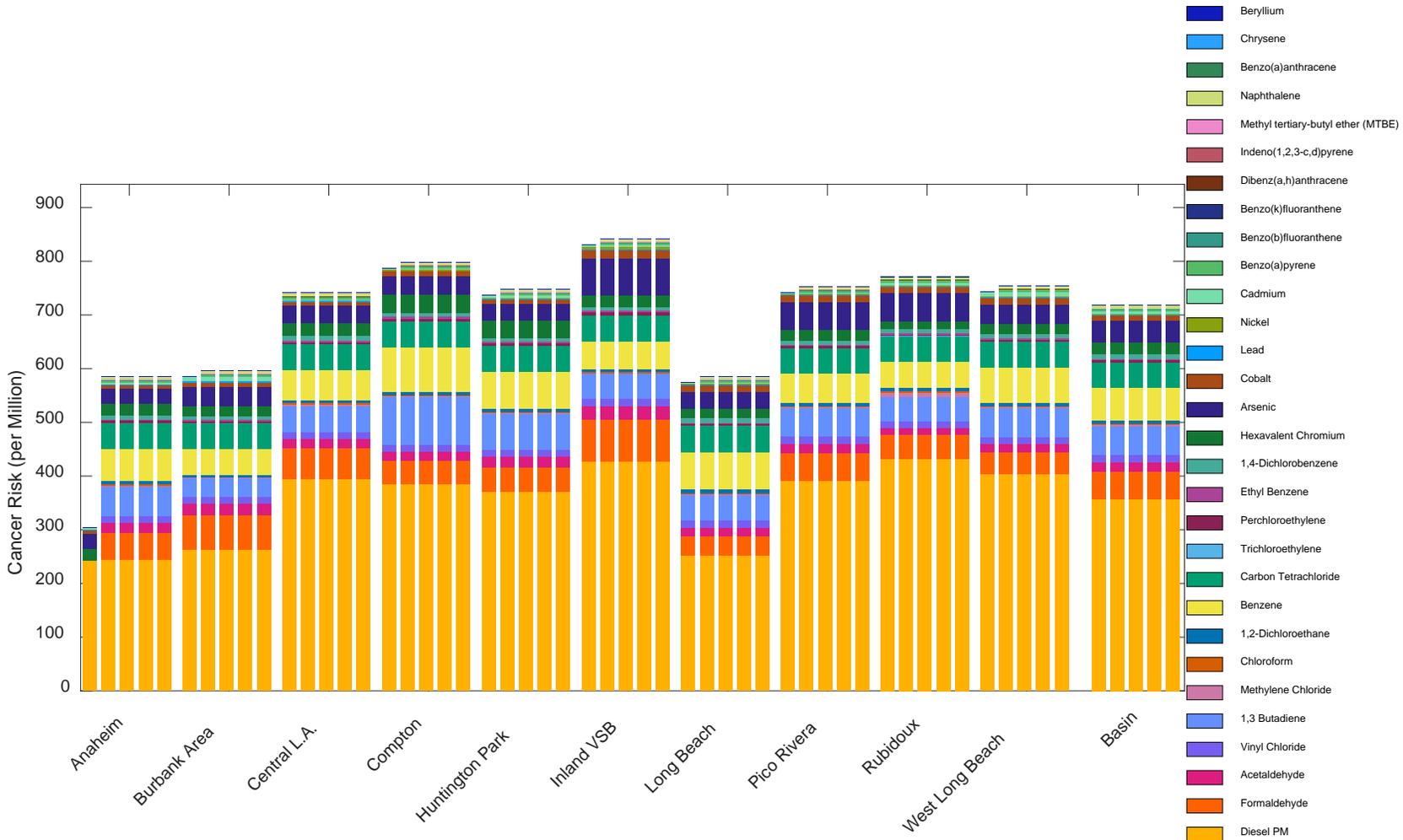
For the Adjacent MATES method, if a pollutant has no data for one or more MATES studies, the basin-wide average from the preceding MATES study is used for substitution, if available (e.g., MATES II data would be used for MATES III data if possible). If data for the preceding MATES study are not available (or MATES II is the study missing data), the basin-wide average from the subsequent MATES study is used, if available. If no data is available from an adjacent MATES study, then data is substituted from the remaining MATES study.

For the Min MATES method, if a pollutant has no data for one or more MATES studies, the minimum value of the basin-wide values from the MATES studies that do have data is used to substitute for the missing data. This method is likely to be an underestimate, particularly if the missing data is from earlier MATES studies, when concentrations were likely higher. In contrast, for the Max MATES method, the maximum value of the basin-wide values from the MATES studies that do have data is used to substitute for the missing data.

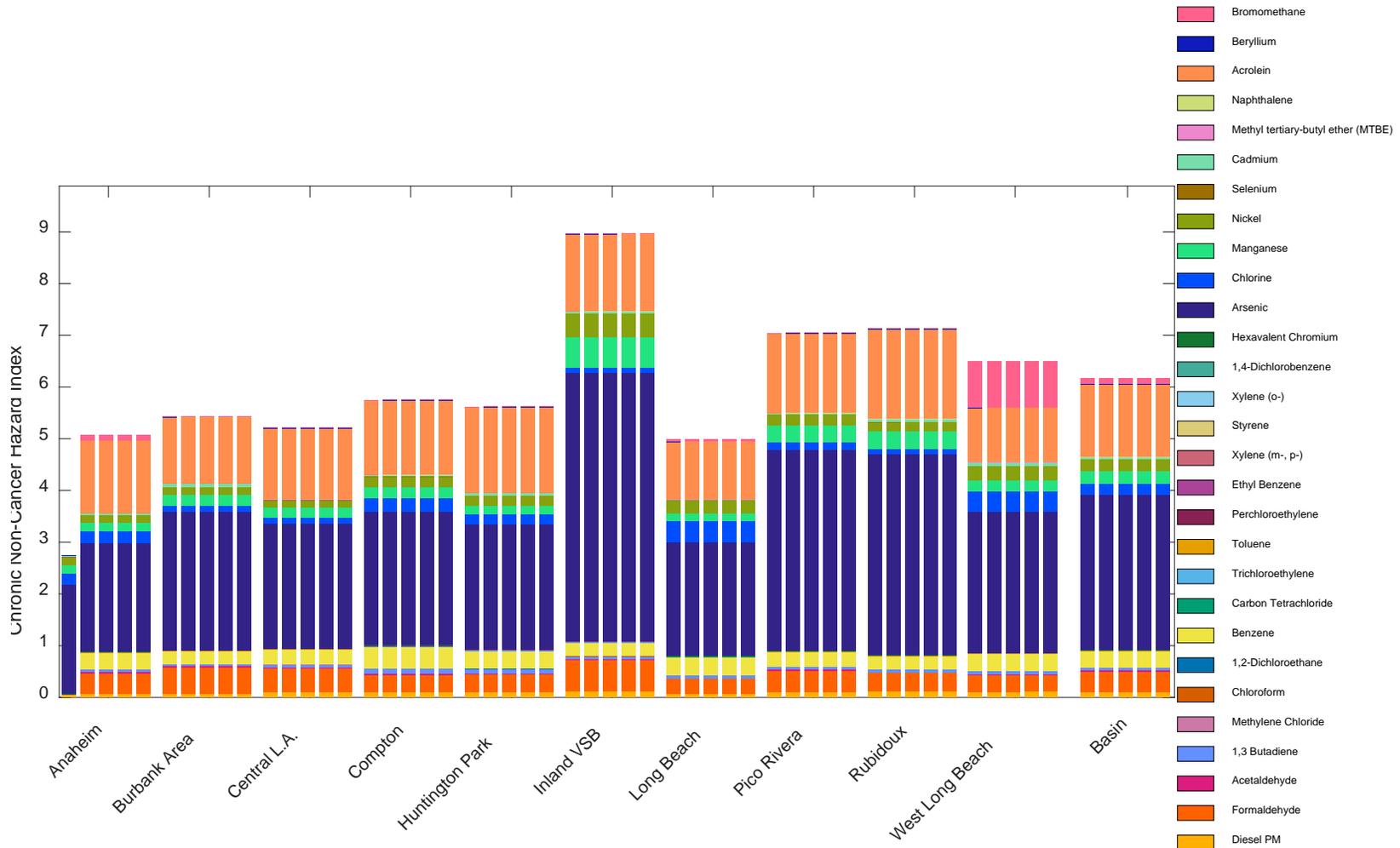
Figure IV-298 shows the results for all five methods used to calculate the aggregate cancer risk for the MATES V data. From left to right for each station, the results are shown for the Missing Data, Adjacent MATES, Min MATES, Max MATES, and Interpolate Trends methods. This order is the same for Figure IV-298 through Figure IV-301. The left-most bar for each station is for the Missing Data method and shows the artificially low aggregate risk estimates if no substitutions are made for missing data, which is particularly noticeable for Anaheim. The other four methods in Figure IV-298 are indistinguishable.

Figure IV-299 shows the results for all five methods used to calculate the aggregate chronic hazard index for the MATES V data. The left-most bar (Missing Data method) for Anaheim is much shorter than the bars for the other methods and shows that the cumulative hazard index estimates are artificially low if nothing is substituted for missing data. The other four methods are indistinguishable in Figure IV-299.

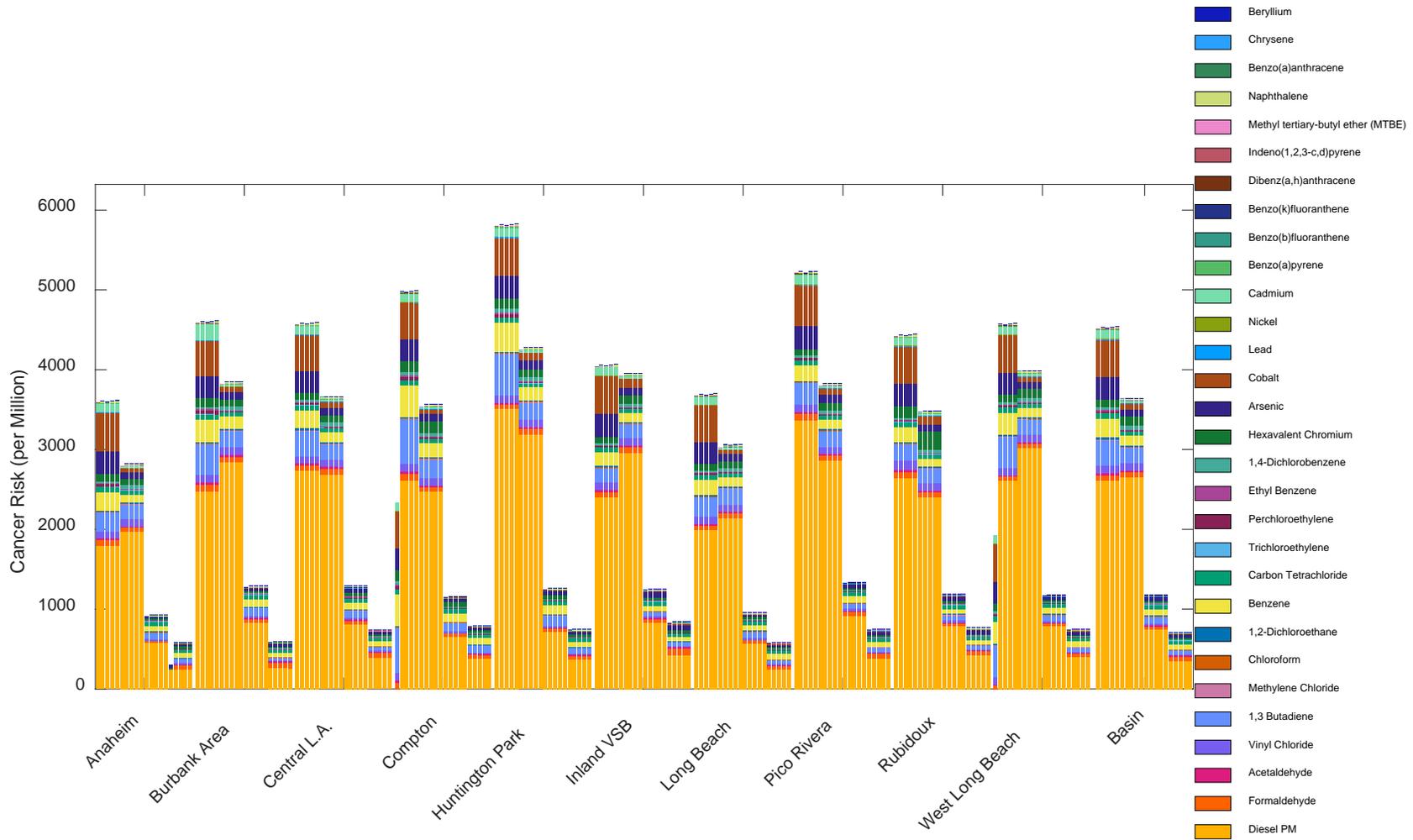
Figure IV-300 and Figure IV-301 are similar to Figure IV-298 and Figure IV-299, respectively, except that they show the data for MATES II through MATES V. Note also that Bromomethane is excluded since it was only measured in MATES V and trends cannot be inferred with data for only one MATES study. The five left-most bars in Figure IV-300 show the results for all five methods for MATES II at Anaheim. The next five bars show the results for MATES III at Anaheim, and so on. The Missing Data method is known to show aggregate risks that are artificially low. The other methods show slight variations in aggregate risks in Figure IV-300 and Figure IV-301, particularly for MATES II and MATES III. These variations, however, do not change conclusions about which MATES study had higher or lower aggregate risks relative to other MATES studies at a given station. The highest aggregate risk estimates are found using the Interpolate Trends method, which are the results presented in Figure ES-2 through Figure ES-5 in the Executive Summary and Figure 2-44 through Figure 2-55 in Chapter 2.



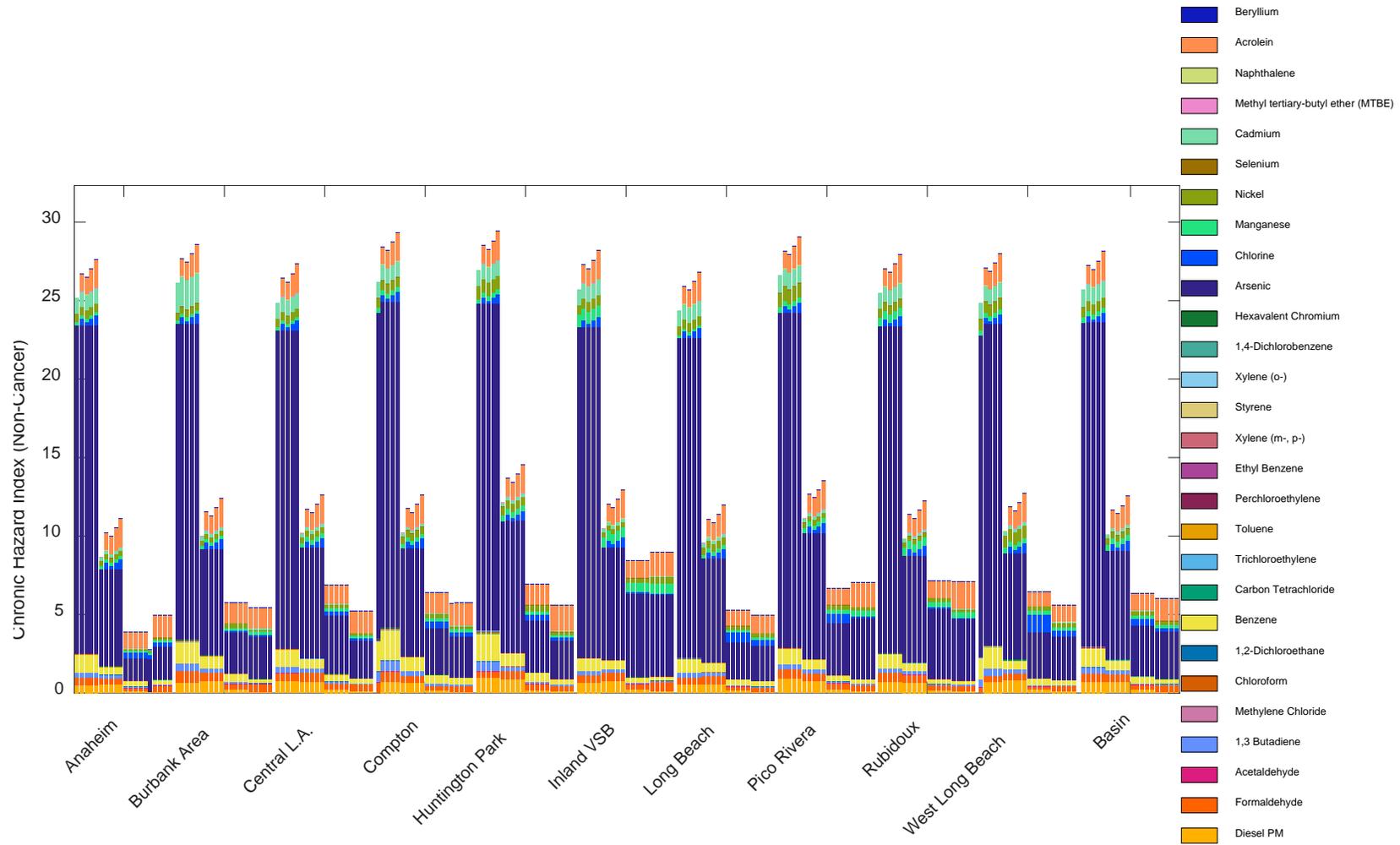
**Figure IV-310** Aggregate cancer risks for all stations and for MATES V only using five methods for substituting for missing data. From left to right for each station, the results are shown for the Missing Data, Adjacent MATES, Min MATES, Max MATES, and Interpolate Trends methods.



**Figure IV-311** Aggregate chronic hazard index for all stations for MATES V only using five methods for substituting for missing data. From left to right for each station, the results are shown for the Missing Data, Adjacent MATES, Min MATES, Max MATES, and Interpolate Trends methods.



**Figure IV-312** Aggregate cancer risks for all stations and all MATES studies using five methods for substituting for missing data. From left to right for each station, the results are shown for the Missing Data, Adjacent MATES, Min MATES, Max MATES, and Interpolate Trends methods. The five left-most bars show the results for all five methods for MATES II at Anaheim. The next five bars show the results for MATES III at Anaheim, and so on.



**Figure IV-313** Aggregate chronic hazard index for all stations and all MATES studies using five methods for substituting for missing data. From left to right for each station, the results are shown for the Missing Data, Adjacent MATES, Min MATES, Max MATES, and Interpolate Trends methods. The five left-most bars show the results for all five methods for MATES II at Anaheim. The next five bars show the results for MATES III at Anaheim, and so on. Bromomethane is excluded since it was only measured in MATES V and trends cannot be inferred with data for only one MATES study.

**APPENDIX V**  
**MATES V**  
**FINAL REPORT**

**Quality Assurance and Quality Control for Monitoring and Analysis**

**DISCLAIMER**

Any or all reference made in this Appendix to a specific product or brand name does not constitute an endorsement of that product or brand by the South Coast Air Quality Management District.

## Appendix V

### Quality Assurance and Quality Control for Monitoring and Analysis

#### V.1.INTRODUCTION

This appendix, in association with the sampling and analysis detail provided in Appendix III of this report, describes the objectives, procedures, documentation, and data review techniques that were used by the South Coast AQMD to assure that MATES V produced data that met or exceeded the accepted criteria for its intended use.

##### V.1.1 Quality Assurance and Quality Control Background

South Coast AQMD is committed to achieving high quality data that meets the objectives for the MATES program, as well as other environmental monitoring programs. The South Coast AQMD is designated by U.S. EPA, with primary responsibility for air monitoring and data quality under its jurisdiction.

##### V.1.1.1 Quality Management Plan (QMP)

The South Coast AQMD Quality Management Plan (QMP<sup>1</sup>), approved by U.S. EPA in 2017 (South Coast AQMD, 2016; see Section V.4, References), is the foundational document describing the agency's quality management system for air monitoring and laboratory analyses. It outlines quality assurance goals, policies, procedures, lines of authority, organizational responsibilities, evaluation, and reporting requirements. It is South Coast AQMD policy that sufficient quality assurance activities are conducted to demonstrate that data collected by and on behalf of South Coast AQMD are scientifically and legally valid for the purposes to which they are intended.

Quality Assurance (QA) encompasses all measures taken by management and staff to ensure that the quality of a finished product meets the regulations and standards of the organization and program. Major QA functions include review and oversight of most aspects of a measurement program, including planning documents, training, records, and procedures, as well as independent audits of sampling equipment, field instruments and performance tests of laboratory analyses.

Quality Control (QC) encompasses all the direct actions taken to achieve and maintain a desired level of quality for a given product. From an environmental monitoring perspective, QC includes all the measures taken by project managers and field, laboratory, and data management personnel to achieve a predetermined level of data reliability. QC is applied from the planning and design stages of the monitoring effort, through the implementation stages, to the handling, storage and reporting of accumulated data.

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<sup>1</sup> The South Coast AQMD Quality Management Plan, Quality Assurance Project Plans (QAPPs) and related Standard Operating Procedures (SOPs) are available upon request through the South Coast AQMD Monitoring and Analysis Division, Quality Assurance Branch.

### **V.1.1.2 Quality Assurance Project Plans (QAPPs)**

Quality Assurance Project Plans (QAPPs) describe the quality control, quality assurance, training, records management, measurement objectives, assessment activities, and other related technical activities for a project or program to ensure data is of a known and verifiable quality meeting its intended purpose. QAPPs also describe the responsibilities within the organization for carrying out each program component. They are intended to be sufficiently complete and detailed to ensure that data meet programmatic Data Quality Objectives (DQOs). The DQOs consider the program or project goals and the types of decisions that the data is intended to address by the end users. QAPPs include Standard Operating Procedures (SOPs) and Operational Assistance Guides (OAGs), which are the specific directions for performing sampling, monitoring, and analytical activities. This includes field monitoring operations, support (e.g., maintenance, repairs, calibrations), lab analyses, and independent audit activities. The QAPP documents list the QA and QC requirements for each activity and provide instructions for data review and validation, QA oversight and audits, and the corrective action process that is used to document issues that may have significant or repeated adverse impacts on data quality, completeness or safety, including the issue's resolution and recurrence minimization.

The QAPPs describe the Data Quality Indicators (DQIs) that are determined to ensure that the data is of known and defensible quality and available in a timely manner to meet the DQOs. DQIs typically include precision, accuracy/bias, completeness, representativeness, sensitivity, and comparability. Precision is a quantitative measure of how reproduceable the data are. Accuracy/bias is a quantitative measure of how well the measurements reflect what is actually in the sample. Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected. Representativeness, related to program site, instrument and method selection, is a measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Comparability is a measure of the confidence with which one data set or method can be compared to another. Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest.

Measurement Quality Objectives (MQOs) are the acceptance or performance criteria for individual DQI's. QAPPs, along with the associated Standard Operating Procedures (SOPs) or Operational Assistance Guides (OAGs), are designed to document and control the various phases of the measurement process (e.g., preparation, sampling, and analysis) to ensure that the total measurement uncertainty is within the range prescribed by the MQOs. For MATES, the MQOs are based upon comparable measurements from ongoing federal and South Coast AQMD measurement programs, using the quality goals, QA/QC activities and procedures described in South Coast AQMD QAPPs.

The quality goals and QA requirements for gaseous and particle pollutants measured during MATES V are found in the various QAPP documents, as outlined below.

### **National Air Toxics Trends Stations (NATTS) Program**

The MATES V quality goals and QA/QC activities for monitoring ambient levels of volatile organic compounds (VOCs), carbonyls, hexavalent chromium, and polycyclic aromatic hydrocarbons (PAHs), and some metals were adopted from the U.S. EPA National Air Toxics Trends Stations (NATTS) program. The South Coast AQMD NATTS QAPP (South Coast AQMD, 2013a) was last revised in 2013 and is currently under revision to incorporate the October 2016 U.S. EPA revised NATTS Technical Assistance Document (TAD; U.S. EPA 2016) and other recent changes to program elements that have been implemented by South Coast AQMD.

#### **Chemical Speciation Program**

The MATES V quality goals and QA/QC activities for monitoring and analyzing the components of fine particulate matter (PM<sub>2.5</sub>), including Organic and Elemental Carbon (OC/EC), Anions and Cations, and trace metals, were adopted from the U.S. EPA CSN program. The requirements can be found in the South Coast AQMD PM<sub>2.5</sub> Chemical Speciation Program QAPP (South Coast AQMD, 2014), which was last approved by the U.S. EPA Region 9 in May 2014. This QAPP is also under review by staff for revision to more fully incorporate both the U.S. EPA CSN Program, where analyses are done by national contract laboratories, and the South Coast AQMD supplemental chemical speciation program, where analyses are done by the South Coast AQMD laboratory (as done for MATES).

#### **Criteria Pollutant Monitoring Program**

The MATES V quality goals and QA/QC activities for monitoring and analyzing TSP-Lead (Pb) and PM<sub>2.5</sub> fine inhalable particle mass were adopted from the U.S. EPA Criteria Pollutant Monitoring Program. These requirements can be found in the South Coast AQMD Criteria Pollutant Monitoring Program QAPP, which, at the time of the MATES V monitoring, had been last revised in 2016. It was recently revised again in April 2020 to incorporate revised programmatic elements and guidance, including the updated U.S. EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Quality Monitoring Program (U.S. EPA 2017a,b). This latest QAPP revision was approved by U.S. EPA Region 9 in July 2020.

#### **Special Monitoring Program**

The South Coast AQMD Special Monitoring program provides air quality measurements in response to events such as wildfires, localized air quality concerns, and pollutants from local sources which also includes rule compliance and rule development monitoring. The MATES V quality goals and QA/QC activities for monitoring and analyzing ultrafine particles (UFPs) and black carbon (BC) can be found in the South Coast AQMD Special Monitoring QAPP (South Coast AQMD, 2013b), which describes the standardized practices and procedures followed by South Coast AQMD for monitoring other "non-criteria" pollutants and performing local-scale or facility focused measurement studies. The current version of this QAPP was last revised in 2013 and reviewed by U.S. EPA in August 2014. The Special Monitoring QAPP is undergoing incorporation into a new QAPP for Special Monitoring and AB 617 Community Air Monitoring Programs. As of this writing, this QAPP is under internal review.

## V.1.2 Glossary of Quality Assurance Terms

### Accuracy/Bias

A determination of how closely reported data values are to true values. Annually conducted performance audits challenge the various samplers and instruments used in this program to assess their accuracy. All valid program data accepted as valid satisfy the criteria set forth in the representative QAPP and SOPs. Accuracy is expressed as “percent” deviation from true and is calculated as follows:

$$\text{Percent Deviation from True} = \frac{\text{Indicated Value} - \text{True Value}}{\text{True Value}} \times 100$$

### Collocated Sampling

The process of running two identical samplers concurrently at the same location. Collocated data measures a method’s precision. One of the samplers is designated *A* and is treated as the true value; while the other sampler is designated *B* and is regarded as the indicated value.

### Data Completeness (DC)

The percent of valid data points actually collected out of the total number of data points possible. The data completeness objectives for the MATES V program. DC is calculated using the following formula:

$$\text{Percent DC} = \frac{\text{Total valid data points}}{\text{Total number of planned data points}} \times 100$$

Data completeness for discrete sampling of air toxics for MATES V, including VOCs and PM metals, is informed by the South Coast AQMD NATTS QAPP, along with the current NATTS TAD (U.S. EPA 2016). A valid sample is one that was collected, analyzed, and reported without null flags, including make-up samples. Note that samples below the MDL that are valid are included as complete. The measurement quality objective for air toxics for annual sample collection completeness is that  $\geq 85\%$  of the scheduled annual air samples on a 1-in-6-day sampling schedule must be valid, equivalent to 52 of the annual 61 expected samples (51 during years when there are only 60 collection events). Invalidation of data beyond this threshold triggers a corrective action process to review the cause and to improve sampling, quality control, or analysis procedures, as needed.

For MATES V continuous data (i.e., BC, UFP, meteorology), the Special Monitoring and Criteria Pollutant QAPPs specify a 75% completeness goal of all possible hourly measurements. The continuous measurements for MATES V greatly exceed the 75% goal.

### Performance Evaluation

An instrument audit procedure conducted to establish individual analyzer and overall sampling and analysis accuracy. Probe audits are used to measure the integrity of both the sampling and analysis systems. Flow audits measure the accuracy of the flow metering devices that assure the sample’s temporal representativeness. Gas standard audits

determine accuracy of laboratory analyzers in measuring known concentrations of toxic compounds.

**Performance Test (PT)**

A procedure from which data collected by execution of a particular test method to analyze samples containing a known amount of an analyte is used to assess compliance with a data quality objective. This is typically performed on but not limit to laboratory analyses performed in support of the NATTS program.

**Precision**

The measure of monitoring system repeatability. Precision is determined by amassing a variety of measurements of the same true value over a period of time and assessing the variability of those measurements.

**Quality Assurance (QA)**

The practice of establishing procedures external to the day-to-day monitoring operations that indicate whether air quality data is accurate, representative, precise, and complete enough to satisfy the needs of the data users. QA activities include, but are not limited to, system and performance evaluation audits and collocated and parallel sampling.

**Quality Control (QC)**

Any procedure incorporated into the internal, day-to-day operations of collection and analysis of samples to satisfy the data user's need for valid data.

**Representativeness**

The goal that samples are representative of both temporal and/or spatial scales at all sites. This is accomplished by conforming to 40CFR58 siting and sampling requirements.

**System Audit**

An inspection and review of the monitoring program, typically including training, records management, instrumentation, data flow and problems that can impact data quality or completeness.

**V.2.MATES V Quality Assurance Activities**

MATES V monitoring was accomplished with discrete 24-hour samples, except for the continuous black carbon (BC), Ultrafine Particles (UFP), and meteorology data. The discrete canister VOC, carbonyl, and PM-speciation samples were prepared by the laboratory staff, then sampled in the field and returned to the lab by the field operations staff with chain-of-custody (COC) documentation. The sample data and supporting information was entered into the laboratory information management system (LIMS) for the laboratory analysis and data validation. Following this, the data was submitted to the U.S. EPA AQS and the MATES V databases. The continuous data was collected onsite using data loggers and telemetered in near-real-time to the South Coast AQMD Data Management System (DMS) for further review and validation prior to inclusion in the MATES V database.

The MATES V field monitoring and laboratory instruments, performance specifications, acceptance testing, siting, operations and sampling schedules, quality control (QC) checks, calibrations, repairs, recordkeeping, and data handling are described further in the QAPPs listed above that support ongoing South Coast AQMD monitoring and analysis programs, along with the associated operations, support, QA and laboratory SOPs. Those documents also further describe analytic procedures and methods employed by the laboratory, as well as the sample handling and chain-of-custody (COC) protocols that impact both the field collection of samples and the lab analytic process. Those intersecting program documents, records, procedures and quality objectives and acceptance criteria provide the backbone for the MATES measurements and analyses. Section III.3 of Appendix III also describes canister use and cleaning, sample distribution, and the sampling media and analytic methods used for canister-sampled VOCs, carbonyls, TSP and PM<sub>2.5</sub> filter-based samples. The filter samples are used for determination of hexavalent chromium and other metals, ions, total mass, organic carbon (OC), elemental carbon (EC) and total carbon (TC).

For MATES V, the South Coast AQMD Quality Assurance Branch conducted independent instrument performance evaluation audits on a semi-annual basis for the MATES V canister VOC, carbonyl, and filter-based PM sampling instruments at all stations. The QA Branch auditors also conducted systems audits of the program monitoring and support activities, site maintenance, and safety, including review of COC forms, maintenance sheets, work orders, and the station and instrument logbooks. Due to the overlap of MATES with the NATTS, CSN and lead (Pb) programs, laboratory analyses performance tests (PTs) were conducted during MATES V to verify acceptable levels of bias in laboratory analysis as compared to other laboratories performing the same analyses under federal programs and to known spiked samples.

### **Corrective Action Process**

For issues that arose during MATES V with potential to impact data quality or safety, beyond the normal application of routine quality assurance checks, calibrations, repairs, and data validation, the South Coast AQMD Corrective Action Process was employed. The Quality Assurance Alert (QAA), as described in Operations Assistance Guide (OAG) QA0002, is used by staff to inform the QA Branch and relevant supervisors and managers of a potential concern. The Corrective Action Request (CAR), described in OAG QA0001, is issued by the QA Branch to document significant issues and their resolution, including those resulting from an audit finding or in response to a QAA. The closure of a CAR includes documenting the issue and its resolution along with steps taken to avoid recurrence.

### V.3.MATES V Sampling Issue and Data Treatment

#### Sampling Issue

Sampling manifold issues occurred during the MATES V sampling period (May 2018 through April 2019), evident in VOC canister and carbonyl samples from three monitoring stations (Central Los Angeles, Rubidoux and Anaheim).<sup>2</sup> This was discovered during the South Coast AQMD Laboratory data validation process as staff noted anomalously high concentrations of carbonyls as compared to historic data. Lab and field operations staff informed the Quality Assurance Branch about the anomalous data with a Quality Assurance Alert (QAA), submitted near the end of MATES V. This triggered further investigation, evaluation, a data treatment plan, and other corrective actions to resolve the issue and minimize the potential for future recurrence and documented in a Corrective Action Request (CAR).

The canister VOC and carbonyl monitoring through the manifold at Central Los Angeles and Rubidoux was ongoing prior to the start of MATES V, due to sampling for NATTS and PAMS. The canister VOC and carbonyl sampling manifold and samplers at Anaheim were operational by April 2018, installed specifically for MATES V.

To identify the occurrence of manifold issues and to assess the severity and time periods of concern, the following were reviewed:

- Manifold system flow checks (flow differential measured at the inlet and after the manifold) to test for leak potential, conducted at all ten MATES V sites. Note that the routine sampler QC flow checks, flow rate verifications/calibrations, and flow rate audits were not able to identify the manifold leaks; testing of the manifold system was needed.
- Sample data for the presence of an indoor air signature potentially due to a leak (e.g., formaldehyde, acetaldehyde, etc. from shelter building materials & furnishings).
- Manifold system records (e.g., station and instrument logbooks, maintenance sheets, and chain-of-custody forms) for potential root causes and timing.
- The physical manifold configuration, fittings, connections, and instruments where leaks were suspected.

The manifold flow tests done at all ten MATES V stations indicated leaks at Rubidoux and Central Los Angeles and a relatively more severe leak at Anaheim. Through physical review of the manifolds at these sites, the cause of the manifold leakage was determined in each case to be loose fittings on the manifold ports, likely due to operator error. For the Anaheim site, a ferule was missed on the manifold inlet upon installation for MATES V. At Central LA, all the fittings

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<sup>2</sup> Note that this sampling manifold issue also impacted other program samples on the same manifold at Central Los Angeles and Rubidoux, as follows: VOC and carbonyl sampling data for NATTS (same samples as MATES V), Photochemical Air Monitoring Stations (PAMS), and CARB Air Toxics Program (VOC canister samples only, since CARB carbonyls are not on the manifold).

were connected but, when evaluated further, staff noted that some were not completely tight. At Rubidoux, a loose cap was found on an unused manifold port.

Records, including the data, logbooks, maintenance sheets and chain-of-custody forms were reviewed and compared to the atypical shifts in the MATES V data by compound and station to evaluate the period of concern. Using the timing of the presence of an indoor air signature in the analyzed data and the manifold-related records, the timing of the leak problems was associated with field operations activities that impacted these manifolds. For Anaheim, the change from outdoor carbonyl sampling with the Xontech 924 to indoor sampling with the ATEC 8000, starting with the April 2, 2018 sample, showed elevated formaldehyde and acetaldehyde. The missing ferule at the inlet occurred at the initial installation of the manifold for MATES V and was not resolved until the end of the study. With this timing, along with laboratory analysis indicating the strong presence of indoor air for the entire sampling period, all MATES V canister VOC and carbonyl data were invalidated for Anaheim.

For Central Los Angeles and Riverside, the manifold flow checks indicated the presence of leaks, although these leaks were less severe compared to the issues at Anaheim. At Central Los Angeles, the timing of the problem was associated with a manifold cleaning procedure completed prior to the August 18, 2018 sample run that was apparently exacerbated shortly thereafter on September 25 by the replacement of a carbonyl sampler in the manifold. This issue was significantly improved by tightening the loose fittings but was not fully resolved until a large O-ring connecting two manifold parts was replaced to pass a manifold leak test in April 2019.

At Rubidoux, the signature of indoor air in the carbonyls data helped define the period of concern, after the outdoor Xontech 924 was changed to an indoor ATEC 8000 carbonyl sampler on the manifold, at the beginning of April 2018. With that change, slightly elevated carbonyls were evident. A review of manifold-related activities from the station and instrument logbooks conservatively identified the period of concern back to the prior manifold cleaning in late 2017. The later sampling data indicated that the leaks were further exasperated, starting in late July 2018, as indicated by an increased indoor air signature. This was likely associated with manifold activities that included the addition of a Picarro continuous formaldehyde instrument for testing. The leak identified at Rubidoux was a loose fitting of a cap on an unused port of the manifold. Tightening the loose fitting in February 2019 resolved this issue.

The leakages were primarily indicated by unusually elevated formaldehyde and acetaldehyde concentrations for the MATES V samples. The concentrations of these analytes were consistent with emissions from station building materials, such as flooring and wallboard. Since the leaks were associated with loose or missing fittings and not from completely disconnected sampling lines, the sampled air was still deemed to be predominantly ambient outdoor air after a thorough statistical evaluation and additional tests. To further evaluate the impact of indoor air leakage on the analyzed compounds, staff conducted indoor/outdoor concurrent VOC canister and carbonyl sampling at each location. These samples were analyzed to identify the potential for the leaks to

bias data, by analyte. This sampling also helped to discount initial concern that the elevated values might have been due a nearby ambient source. Staff also reviewed the suspect sample data as compared it to historical data, including PAMS, NATTS, CARB Toxics Program data, as well as to the current and prior MATES data to assess data outliers.

The MATES V portion of the data collected with each of the sampling manifolds included 22 canister VOC compounds and 4 carbonyl compounds. This issue did not impact PM<sub>2.5</sub> chemical speciation and metals monitoring, as samplers used to collect these type samples were not attached to the compromised manifolds. Criteria pollutant gases are sampled using a separate manifold which was also not compromised; hence they were not impacted.

### **Data Treatment Plan**

Laboratory staff used statistical methods to identify effective screening tools for data outliers (i.e., false positives/negatives). The following data treatment plan was used for the South Coast AQMD samples, including those for MATES V:

- Invalidate all manifold-sampled carbonyls with a null code in the U.S. EPA Air Quality System (AQS) database (BJ= Operator Error). Overall, the indoor/outdoor samples indicate a significant indoor air bias. Routine sample data indicates significant outliers compared to historical trends.
- Invalidate VOC canister data point outliers, by species, with a null code in AQS (BJ= Operator Error), if three conditions are met: (1) indoor/outdoor samples indicate indoor air bias; (2) data points screened as outlier by statistical outlier tests; and (3) data points inconsistent with 5- or 10-year trends, with seasonal variation considered.
- Flag remaining VOC compound data points – with a qualifier code in AQS (3 = Field Issue) to inform data users of the potential issue. In this case the indoor/outdoor sampling did not indicate a significant indoor air contamination bias and the data were not determined to be outliers based on statistical tests and appeared to be consistent with historical trends.

Table V-1 shows the period of the manifold leaks at each station, along with the percentage of the MATES V data invalidated for each site. Due to the presence of significant outliers and a more significant indoor presence of these species in the indoor/outdoor sampling, all MATES V carbonyl data was invalidated during the leak period for the three stations. The invalidated analyte data was removed from the database and replaced with a null code (AQS Null Code BJ, Operator Error). When compared to historical data, the MATES V VOC canister samples for Central Los Angeles and Rubidoux did not indicate outliers for those analytes and the indoor/outdoor sampling did not indicate a significant indoor bias for these analytes; therefore, no MATES V canister data was invalidated at these sites. However, the data was flagged with a qualifier code (AQS Qualifier Code 3, Field Issue) to warn data users of potential data issues should they become evident during data analysis. Due to the more severe magnitude of the

manifold leak at Anaheim throughout the entire MATES V sampling period, all VOC data from this site was invalidated.

**Table V-1. Manifold Leak Periods and Percentages of VOC and Carbonyl Data Invalidated by Site during the 1-Year MATES V Sampling Period**

	Rubidoux	Central Los Angeles	Anaheim
<b>MATES V Sampling Period (1 Year): 5/1/2018 – 4/30/2019</b>			
<b>MATES V Manifold Leak Period</b>	5/1/2018 – 2 /19/2019	8/18/2018 – 4/25/2019	5/1/2018 – 4/30/2019
<b>Percent of Invalidated VOC Samples</b>	0% (0 of 61 samples)	0% (0 of 61 samples)	100% (61 of 61 samples)
<b>Percent of Invalidated Carbonyl Samples</b>	80%* (49 of 61 samples)	69% (42 of 61 samples)	100% (61 of 61 samples)

\* includes 2 Rubidoux carbonyl samples that invalidated due to other sampler run issues

### **Corrective Actions**

South Coast AQMD staff implemented corrective actions to minimize the chance of similar manifold issues occurring in the future. These actions have strengthened the sampling system operations, maintenance, calibration, and audit procedures, along with stressing the timely identification and reporting of potential sampling concerns raised during the laboratory analysis. The revised procedures enhance the periodic maintenance of the entire sampling system (i.e., inlet, manifold, and sampling instruments), including cleaning, leak tests, flow tests, blanking and known standard challenges, records review, and audits. Routine physical manifold review and manifold leak testing follows significant manifold modifications or instrument changes, manifold cleanings, or when routine laboratory analyses or the analysis from an instrument challenge test (zero air blanking and known standard challenge) indicates the distinctive signature from common indoor air analytes. Reviews of the entire manifold system are also done with the twice-annual canister VOC and carbonyl sampler flow audits by the Quality Assurance Branch.

Several manifold design and handling procedures were implemented or enhanced. The larger manifolds, used at Central Los Angeles and Rubidoux, were replaced to remove potential for leakage where two glass manifolds were joined, now using a single-piece glass manifold with fewer connection ports. Revised VOC manifold sampling system procedures now require replacing all O-rings at each cleaning. Work on the manifold systems is to be done by trained personnel, with oversight by experienced staff. The use of the VOC manifolds for testing instruments or temporary studies (other than MATES, NATTS, and PAMS) has been restricted. The CARB Air Toxics Program canister VOC sampling was recently removed from the Central Los Angeles and Rubidoux manifolds to provide routine, independently analyzed collocation samples that can be used for data comparison to help identify potential concerns.

#### V.4. References

South Coast AQMD (2013a). *Quality Assurance Project Plan for the National Air Toxics Trends Stations Program*, Version 2.3, September 2013. [Copies available upon request]

South Coast AQMD (2013b). *Quality Assurance Project Plan for Special Monitoring*, Revision 0, September 2013 (reviewed by U.S. EPA August 7, 2014 – no federal approval required). [Copies available upon request]

South Coast AQMD (2014). *Quality Assurance Project Plan for PM<sub>2.5</sub> Speciation Program*, Revision 2.0 (April 2014; Approved May 15, 2014 by U.S. EPA Region 9). [Copies available upon request]

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**APPENDIX VI**

**MATES V**

**FINAL REPORT**

**Black Carbon Measurements at Fixed Sites**

## Appendix VI

### Black Carbon Measurements at Fixed Sites

#### VI.1 Preface

Black carbon, or soot, is part of fine particulate air pollution (PM<sub>2.5</sub>). The main sources of black carbon (BC) are incomplete burning of biofuels, burning of fossil fuels, and open biomass burning (e.g. open agriculture burning). Black carbon sources vary by region and anthropogenic activity. Multiple studies reported strong correlation between black carbon concentration and diesel vehicle traffic and that exhaust from diesel engines is the major source of soot in urban areas. Therefore, soot is often considered a good proxy for diesel particulate matter in urban areas (Diesel PM) (Schauer, 2003).

The comparison between the average levels of black carbon during MATES V and MATES IV, and temporal variability of these levels are discussed in Chapter 5. This appendix elaborates on the sampling and analytical methods used for this report and provides a further detailed analysis of the temporal and spatial variability of black carbon. In addition, this appendix includes a detailed comparison between optical and thermo-optical methods that are in use for quantifying soot emissions.

A common goal of the MATES studies is to identify and quantify health risks associated with major known toxic air contaminants within the South Coast Air Quality Management District (South Coast AQMD), with a particular focus on the South Coast Air Basin (SCAB). Previous MATES studies assessed the carcinogenic risk due to inhalation exposure to air toxics and found that emissions from diesel-powered engines and boilers accounted for 84% and 68% of this risk during MATES III and MATES IV, respectively (South Coast Air Quality Management District, 2008, 2015a).

#### VI.2 Analytical Methods for Quantifying Atmospheric Soot

Various analytical methods have been developed to quantify the concentration of atmospheric soot particles. Depending on the measurement method used, the non-organic carbon fraction of soot is referred to as black carbon (BC) or elemental carbon (EC). When optical methods that quantify the amount of soot by measuring its interaction with light are used, soot is often referred to as BC. However, when its concentration is measured by thermal or thermal-optical techniques, it is generally referred to as EC.

The measurement of optically absorbing material on a filter is performed by Aethalometers. This instrument measures the attenuation of light of a specific wavelength that is transmitted through a sample collected on a quartz fiber filter, while the filter is continuously collecting ambient aerosols. The measured attenuation is proportional to the mass of BC in the filter deposit. This measurement is affected by the wavelength of the light with which it is made. By using the appropriate value of the specific attenuation for that particular combination of filter and optical components, the concentration of the BC content of the aerosol deposit can be determined at each measurement time.

In the most common thermal analysis EC methods, the particles are collected on a quartz fiber filter. OC can be volatilized and separated from the sample deposit by heating the sample in a non-oxidizing/inert Helium atmosphere. EC is also oxidized by raising the temperature and introducing oxygen. The combusted compounds are then converted to CO<sub>2</sub> using manganese dioxide (MnO<sub>2</sub>) as the oxidizer. Subsequently, CO<sub>2</sub> is converted to methane (CH<sub>4</sub>) using a nickel catalyst, and the concentration of CH<sub>4</sub> is quantified with a flame ionization detector (FID).

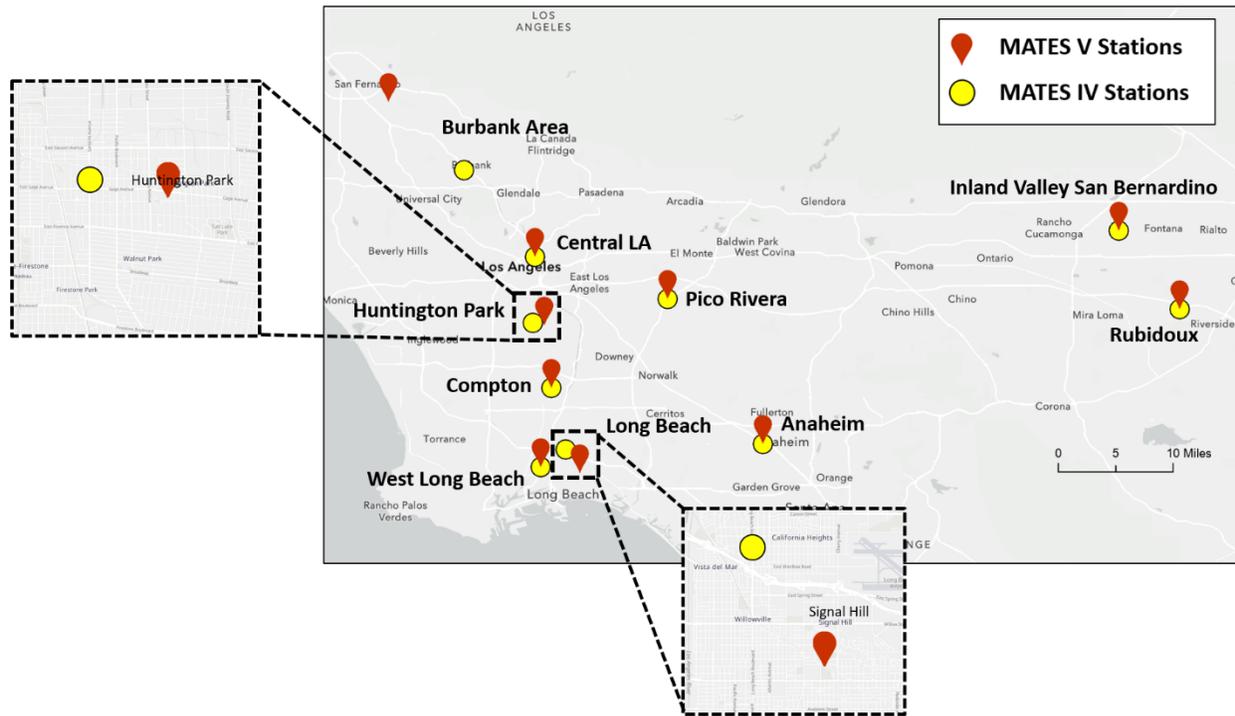
Both optical and thermal measurement techniques are important and considered complementary to each other. However, a significant advantage of monitoring BC by absorption photometry is that it delivers results in real-time with a high time resolution (minutes), in contrast to measuring EC where soot is collected on a filter, usually for 24 hours, and then analyzed. Field deployable versions of the EC/OC methods that provide real-time semi-continuous are also available but require more maintenance than Aethalometers. It should be noted that EC and BC methods do not necessarily yield directly comparable results, although they are generally correlated (Chow et al., 2001; Lack et al., 2014). A comparison between EC and BC measurements during MATES V is provided in the Appendix XIII. Due to higher sampling frequency and lower maintenance and operating costs, BC measurements are often favored for deployment in monitoring networks.

### **VI.3 BC and EC Measurements during MATES V**

BC and EC were measured at all 10 fixed MATES V locations: Anaheim, Burbank Area, Central Los Angeles (Central LA), Compton, Inland Valley San Bernardino (Inland Valley SB), West Long Beach (W. Long Beach), Huntington Park, Long Beach, Pico Rivera, and Rubidoux. Details of the sites, their characteristics and sampling protocols are given in Appendix III of MATES V.

Continuous measurements of BC were carried out from January 2018 until the end of April 2019. Only data collected from May 1, 2018 through April 30, 2019 have been used for the present report to match the sampling period for the MATES V time-integrated samples. For EC and OC analysis, time-integrated PM samples were collected over a period of 24 hours from May 1, 2018 through April 30, 2019 at all fixed MATES V sites.

We note that the locations of three stations: Burbank Area, Long Beach, and Huntington Park have changed from their previous locations during MATES IV. Figure VI-1 presents the locations of all ten sites and the changes of these three sites.



**Figure VI-1.** The locations of MATES V and their location during MATES IV

### VI.3.1 Black Carbon Measurements

The Aethalometer (Magee Scientific, Berkeley, CA) is a photometer that provides a real-time readout of the concentration of black carbon aerosol particles in an air stream. The operating principles of the Aethalometer are described in detail elsewhere (Hansen et al., 1984). Briefly, the instrument collects airborne particulate matter on a filter while continuously measuring the light transmission through the filter. The attenuation in light intensity is caused by light absorption of BC-containing particles that accumulate on the filter over time. This measurement needs to be post-processed to obtain ambient aerosol absorption coefficients which are then converted to BC concentrations. One drawback of this measurement method, inherent in all filter-based photometers, is the nonlinearity of the measurements due to PM loading on the filter media, which reduces the sensitivity of the measurements. Numerous studies have focused on developing algorithms to correct the Aethalometer non-linearity. The Magee Aethalometer model AE33 performs this correction automatically.

During MATES V, aerosol particles were sampled through a ¼" inlet with a PM<sub>2.5</sub> cyclone with a sampling flow rate of 5 L·min<sup>-1</sup>. The Aethalometers were operated in air-conditioned trailers. Typical maintenance operations included flow rate calibration, clean air zero test, filter taper replacement (once every two weeks in locations with high BC concentrations), and cleaning.

### VI.3.2 Elemental Carbon Measurements

OC and EC are determined by thermal-optical analysis of time-integrated PM samples collected over a period of 24 hours. It should be noted that there are several different protocols to measure OC and EC, and results may differ by up to a factor of 2 (HEI, 2010). Hence, extra caution is required when comparing EC measurements from different studies, or when comparing BC and EC measurements. Currently, 24-hour integrated EC concentrations are available for regional and urban monitoring sites throughout the U.S. Interagency Monitoring of Protected Visual Environments (IMPROVE) Network and the U.S. Environmental Protection Agency Chemical Speciation Network.

In MATES V, the EC concentrations were quantified using DRI Model 2001 Thermal/Optical Carbon Analyzer using the IMPROVE\_A thermal protocol (South Coast Air Quality Management District, 2020). The operation of the DRI Model 2001 Thermal/Optical Carbon Analyzer is based on the preferential oxidation of organic carbon (OC) compounds and elemental carbon (EC) at different temperatures. Its function relies on the fact that organic compounds are volatilized from the sample deposit in a non-oxidizing Helium atmosphere, while elemental carbon is combusted by an oxidant, in this case oxygen. The analyzer operates by 1) liberating carbon compounds under different temperature and oxidation environments from a small sample punch of known surface area taken from a quartz-fiber filter; 2) converting these compounds to carbon dioxide (CO<sub>2</sub>) by passing the volatilized compounds through an oxidizer (heated manganese dioxide, MnO<sub>2</sub>); 3) reducing CO<sub>2</sub> to methane (CH<sub>4</sub>) by passing the flow through a methanizer (hydrogen-enriched nickel catalyst); and 4) quantifying CH<sub>4</sub> equivalents with a flame ionization detector (FID).

The principal function of the optical (laser reflectance and transmittance) component of the analyzer is to correct for pyrolysis charring of OC compounds into EC. Without this correction, the OC fraction of the sample might be underestimated, and the EC fraction might include some pyrolyzed OC. The correction for pyrolysis is made by continuously monitoring the filter reflectance and/or transmittance (via a helium-neon laser and a photodetector) throughout an analysis cycle. The reflectance and transmittance, largely dominated by the presence of light-absorbing EC, decrease as pyrolysis takes place and increase as light-absorbing carbon is liberated during the latter part of the analysis. By monitoring the reflectance and transmittance, the portion of the EC peak corresponding to pyrolyzed OC can be accurately assigned to the OC fraction. The correction for the charring conversion of OC to EC is essential for reducing bias in the measurement of carbon fractions (Johnson et al., 1981). The Thermal Optical Reflectance (TOR) and Thermal Optical Transmittance (TOT) charring corrections are not necessarily equivalent due to charring of organic vapors adsorbed within the quartz fiber filter (Chen et al., 2013; Chow et al., 2004). South Coast AQMD reports both OC and EC as determined by both methods to U.S. EPA. Seven temperature fractions, as well as the TOR and TOT charring correction, are individually quantified and reported when the IMPROVE A (Chow et al., 2001, 1993) temperature protocol is applied. Values routinely reported include total OC, total EC, total carbon (TC, sum of total OC and total EC), and pyrolyzed carbon, monitored by both reflectance (OPR) and transmittance (OPT). Depending on the thermal/optical protocol applied for quantification, thermally-derived sub-fractions of OC and EC are reported.

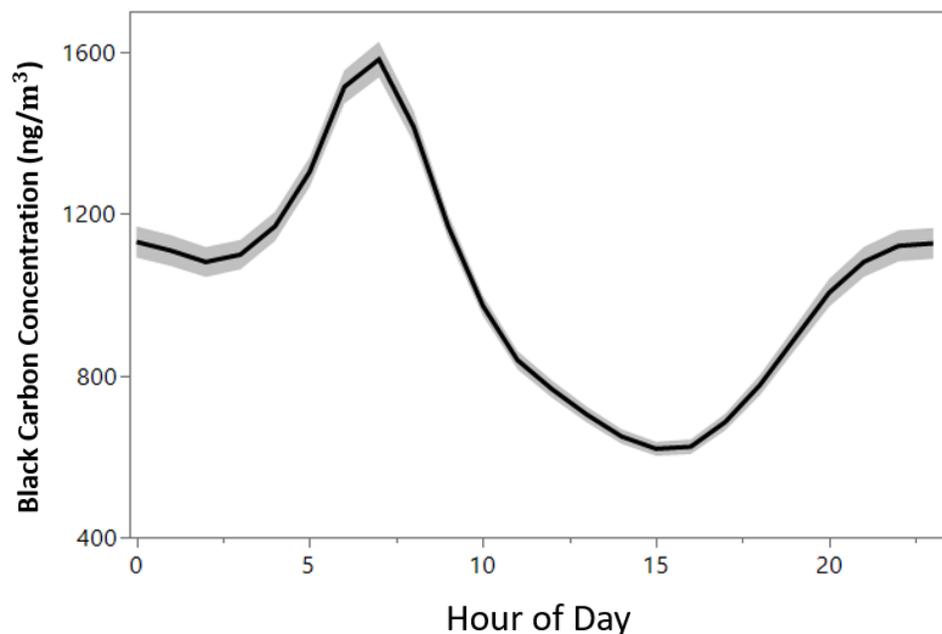
## VI.4 Results

The procedures of data collection, review, analysis, and validation are described in detail in MATES IV, Black Carbon Measurements at Fixed Sites (South Coast Air Quality Management District, 2015b). The screening processes of the data collected from by the aethalometers yielded excellent data completeness, with average data recovery of 98% overall MATES V sites, an improvement over the 96% completeness of the dataset of MATES IV.

### VI.4.1 The Seasonal and diurnal variations in MATES V sites

Typically, BC exhibits a distinct diurnal profile at most locations. BC is associated with primary combustion emissions and is widely considered as one of the best indicators of local mobile sources i.e. diesel exhaust emissions in urban environments.

The 10-site average diurnal variation of BC concentrations (indicative of the typical diurnal BC trend in the South Coast Air Basin) is shown in Figure VI-2. The distinct increase in BC mass starts as early as 4 AM. BC concentration reaches its maximum around 7 AM (all reported times are Pacific standard time) and decreases during the morning hours. This pattern is associated with a shallow atmospheric boundary layer in early morning enhanced with emissions from morning commute traffic.



**Figure VI-2.** Diurnal variation of black carbon concentration in the South Coast Air Basin during MATES V. The shaded areas represent the 95 percent confidence level of the measurement

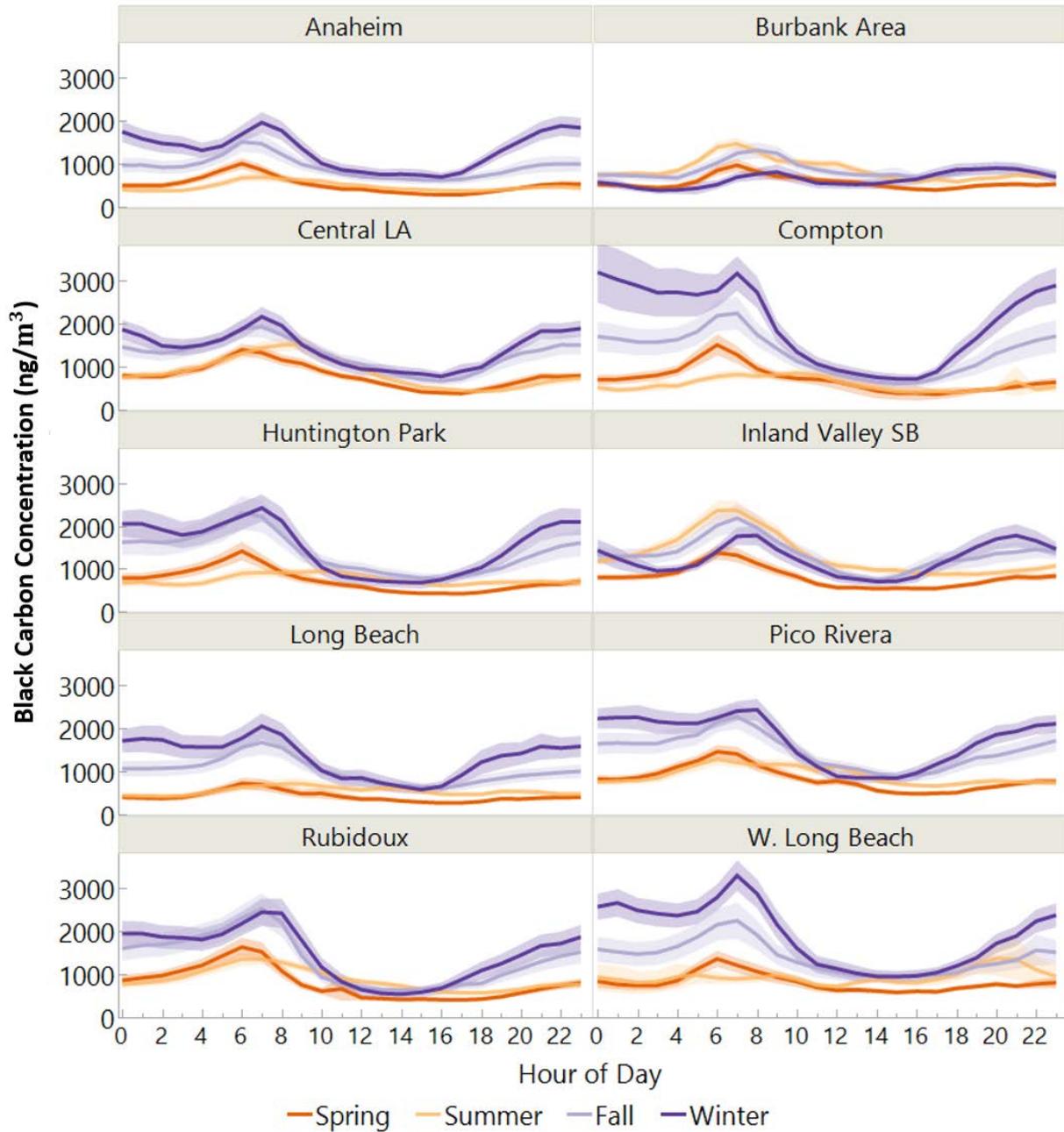
As the day progresses, the increased solar heating leads to greater dispersion of aerosols due to increased turbulent mixing and deeper boundary layer. The dispersion of aerosols causes a dilution of BC near the surface resulting in a gradual decrease in BC concentrations in the

afternoon, reaching daily minimum concentration around 3pm in the afternoon, when the atmospheric convective mixing is the highest. The BC concentration continues to be relatively low until 4 pm and then increases again during the evening hours as the atmospheric boundary layer collapses. Evening commute traffic contribute to the increase too. In addition, lower wind speeds during the night and shallow inversion layer lead to a rapid decline in ventilation. Overnight, there is a progressive and strong reduction in the traffic density and other industrial and commercial activities generating BC emissions, however, stable meteorological conditions, and a lower boundary layer result in the accumulation of BC near the surface until the next morning.

The daily and seasonal levels in each MATES V site are presented in Figure VI-3. The seasonal time periods were averaged over a period of three months (i.e. summer: June, July, and August; fall: September, October, and November; winter: December, January and February; and spring: March, April, and May).

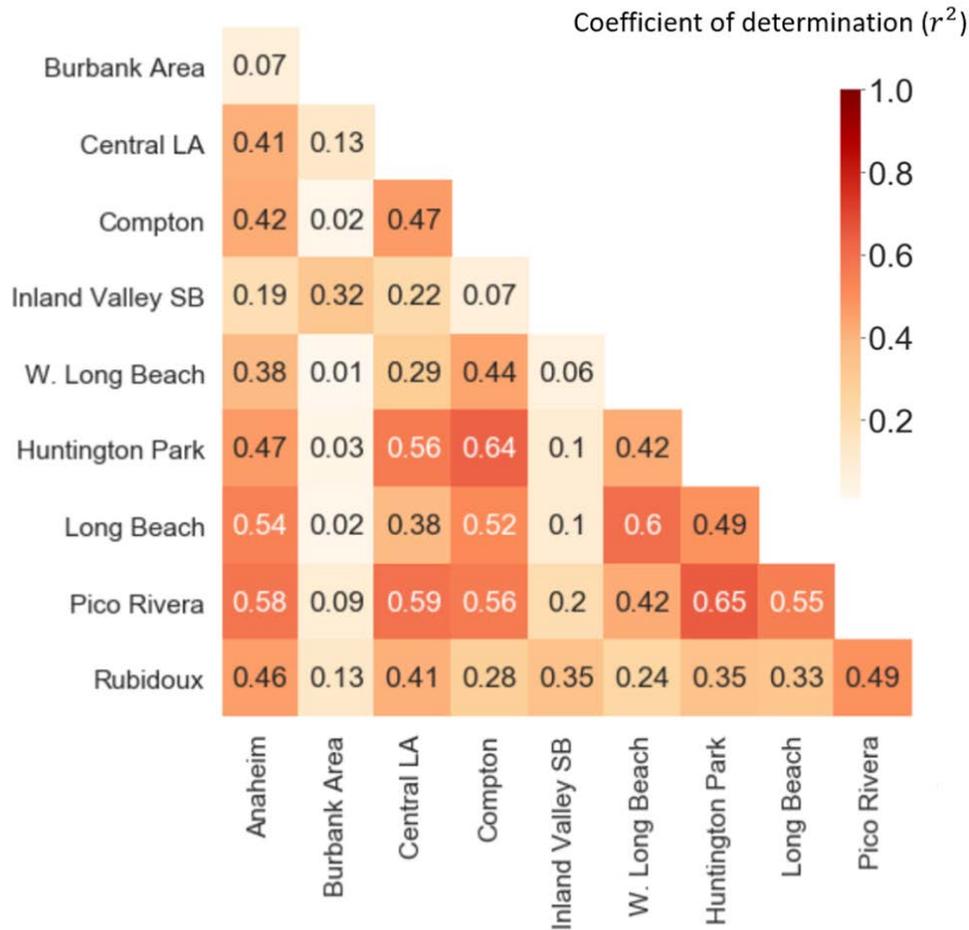
In general, there is a distinct seasonal dependence on the diurnal variations of BC (Figure VI-3). BC concentrations during the winter season show the strongest diurnal variations, mainly attributable to the seasonal changes in the boundary layer dynamics. Due to meteorological conditions, the boundary layer in winter is much shallower compared to its summer counterparts, resulting in lower dispersion and ventilation of aerosols in the Basin, causing an increase in the BC concentrations in winter. Moreover, the secondary evening peak is prominent only during the winter season, gradually diminishing during fall and spring seasons, and almost disappearing during the summer months when afternoons are characterized by strong on-shore sea breezes. It is important to note that during the winter months, there can be additional BC emissions due to residential wood burning, particularly during nighttime when the temperatures drop, which would contribute to the evening peak seen in winter.

BC concentrations vary by season significantly with winter showing the highest concentration followed by fall, summer and spring. Burbank Area and Inland Valley San Bernardino stations are exceptions with the highest BC measured during the summer months.



**Figure VI-3.** Seasonal diurnal trends of black carbon concentrations at each site. The shaded areas represent the 95 percent confidence level of the measurement

In order to assess the temporal associations between each site pair, a linear regression analysis was performed. Figure VI-4 summarizes the correlation coefficients for all site pairs.



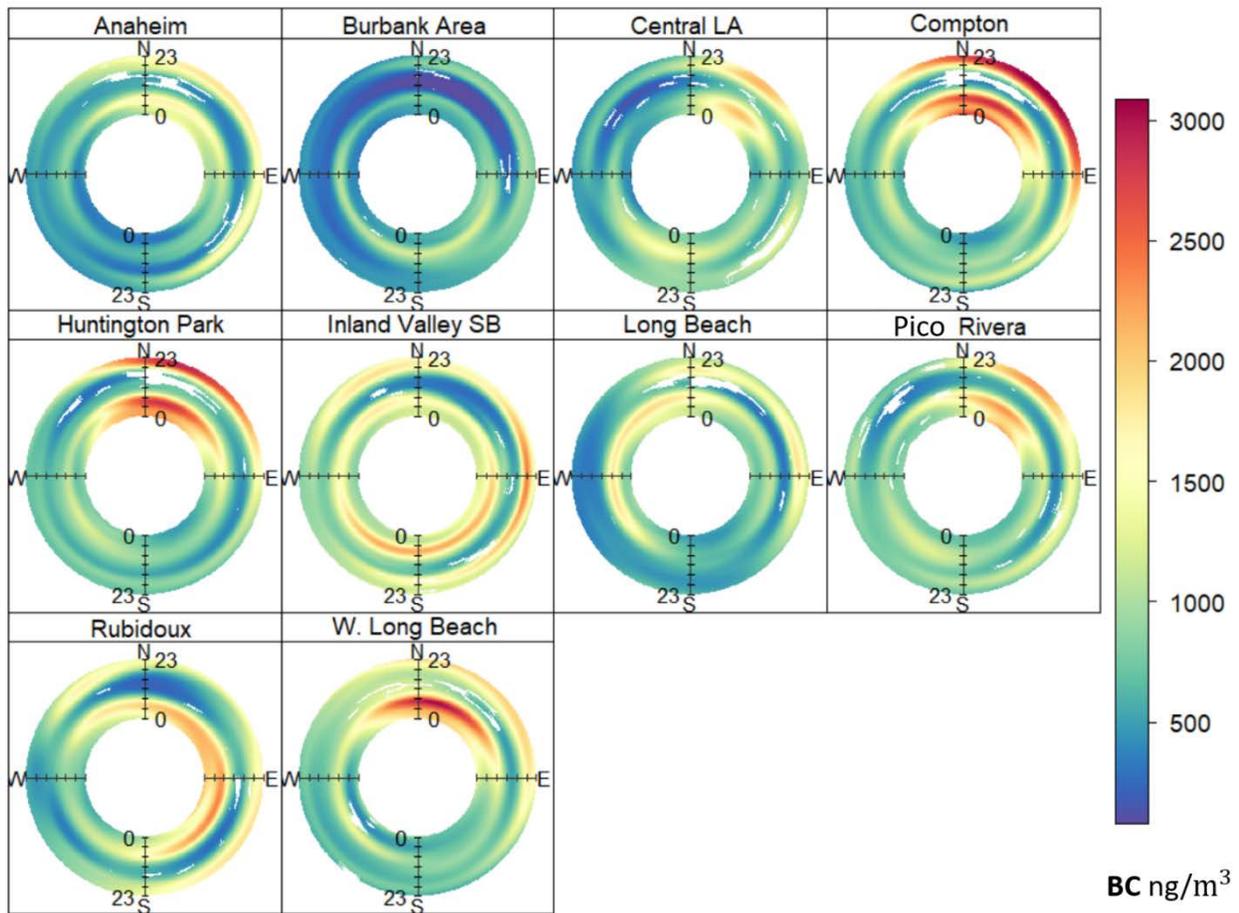
**Figure VI-4.** Coefficients of determination ( $r^2$ ) of black carbon trends between each site pair

Among all site pairs, the highest correlation coefficients were obtained between Huntington Park and Pico Rivera, ( $r^2=0.65$ ) and Huntington Park and Compton ( $r^2=0.64$ ). A high correlation was also found between West Long Beach and Long Beach, which are both located close to the ports. On the other hand, Rubidoux, Inland Valley San Bernardino, and Burbank Area which are each located relatively far away from any other station, showed low correlation with the other stations.

The relatively high  $r^2$  values between the stations that are in the urban areas and between those that are located near the ports suggest that the meteorological patterns and major sources of BC at each of those are similar and that the concentrations vary with a relatively similar temporal pattern. On the other hand, the lack of correlation between the inland stations (Inland Valley San Bernardino and Rubidoux) and Burbank Area (as a more suburban site) with the urban sites indicates that the temporal trends for BC concentrations at these sites are impacted by different emission sources and meteorological patterns.

**VI.4.2 The Directionality of BC Enhancements**

The polar plots in Figure VI-5 show the average BC concentration organized by direction and time of day. The polar angle of the data shows the direction from which that average concentration was observed and the distance from the center of each plot (0 – 23) indicates the time of day. For example, the plot for West Long Beach shows that the highest average BC concentrations during the MATES V period come from the northeast direction and usually occur around the morning which can be the result of the proximity of two major highways (Interstates 405 and 710) to the north and east. Stagnant wind condition caused by the transition of the nocturnal offshore wind to the daytime onshore wind is expected to contribute to the high concentration too.



**Figure VI-5.** Polar time plots of BC concentration at each MATES V station

Compton, Central Los Angeles, Anaheim, Pico Rivera, and Huntington Park have morning and evening peaks when winds from the northeast direction. Rubidoux, Burbank Area, and Inland Valley San Bernardino have higher concentrations coming from the southeast direction. The morning peaks are usually associated with nearby on-road and off-road mobile source activities and transport by prevailing wind directions, while the midnight peaks are produced by a

combination of lower boundary layer height and higher wood-burning activities during the cold months.

### **VI.5 Summary**

Long-term measurements of BC concentrations carried out from May 2018 to April 2019 in a network of 10 sampling sites located in the SCAB, were used to characterize the spatial and temporal variations in BC concentrations and their association to meteorology and local sources, most notably, vehicular traffic.

Based on the MATES V data, BC concentrations show significant temporal variations on all time scales; annual, seasonal, and diurnal (see Chapter 5 for detailed analysis). The diurnal variations at most sites have a distinct morning peak, which was primarily caused by the diurnal variation of the atmospheric boundary layer and emissions from commute traffic. The diurnal variations are more pronounced during the winter. This effect is particularly pronounced during the colder months when the mixing height is the lowest.

The seasonal variations are mostly related to changes in meteorology and the boundary layer dynamics. High concentrations are generally observed in colder months, when there is less convective mixing. Moreover, biomass burning smoke may contribute to the observed elevated BC concentrations in winter. In general, local traffic sources, meteorological conditions, and boundary layer dynamics are the most important parameters influencing the BC concentrations.

Various existing regulations and emission reduction strategies are designed to control the atmospheric concentration of BC, either directly by reducing diesel emissions, or indirectly by reducing total PM emissions. Measures to mitigate BC will also reduce OC and PM emissions. Therefore, mitigating emissions of BC from diesel-engine and biomass burning sources helps to reduce short-lived climate forcing, air toxic exposure, as well as PM exposure.

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**APPENDIX VII**  
**MATES V**  
**FINAL REPORT**

**Ultrafine Particle Measurements at Fixed Sites**

## Appendix VII

### Ultrafine Particle Measurements at Fixed Sites

#### VII.1. Background

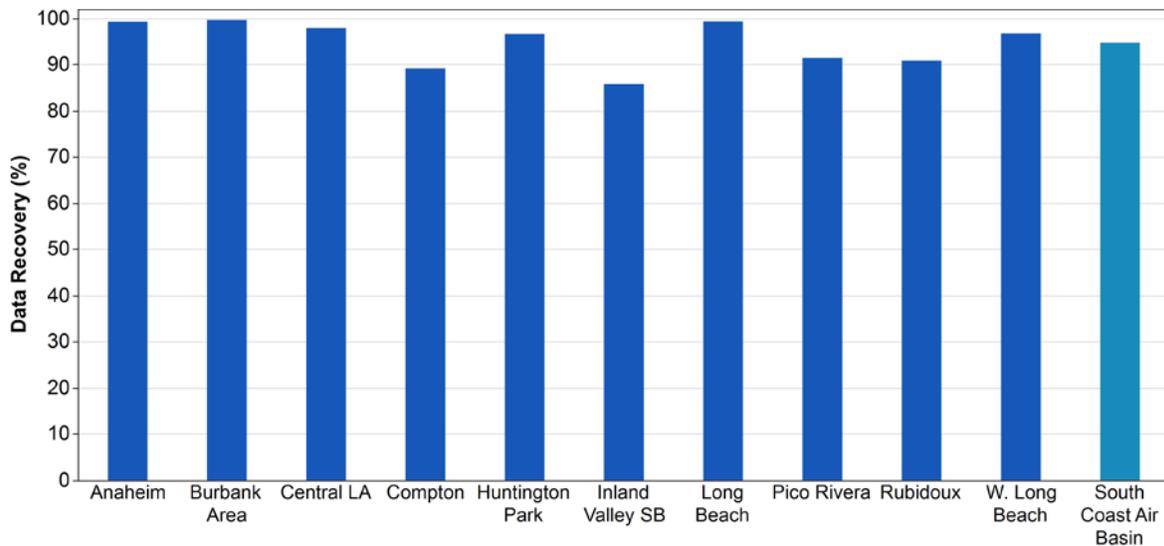
A summary of the average concentrations of ultrafine particles (UFPs) measured during MATES V at each site and basin-wide trends (e.g., diurnal and seasonal profiles) is presented in Chapter 5. This appendix provides additional detail to quantify the differences in seasonal and diurnal trends across sites in greater depth, compares MATES V sites and South Coast AQMD near-road monitoring sites, and discusses the potential causes for the observed differences. Additional details on the validation of this data set are also included in this appendix.

UFPs are emitted from nearly all fuel combustion processes, including diesel, gasoline, and jet engines. UFP nucleation and growth mechanisms are not fully understood, but it is clear that vehicle exhaust is a major contributor to UFPs in urban areas (Guo et al., 2020). Consequently, people living nearby highly trafficked roadways and other sources of combustion-related pollutants (e.g., airports, refineries, and railyards) may be exposed to high levels of UFPs in addition to other air toxics. UFPs have a relatively short lifespan and their concentrations are strongly dependent on local sources and atmospheric conditions. Thus, their number concentrations can vary significantly on short temporal and spatial scales (Kozawa et al., 2009; Shirmohammadi et al., 2017; Zhu et al., 2002a, b).

Primary emissions of ultrafine particles formed in the engine or tailpipe are mostly sub-micrometer agglomerates of carbonaceous material. These particles may also contain metallic ash (from lubricating oil additives and engine wear), hydrocarbons, and sulfur-containing compounds (Morawska et al., 2008). Ultrafine particles can also be formed as hot exhaust gases are expelled from the tailpipe, which subsequently cool and condense on existing particles or nucleate to form new particles. In addition to primary UFP emissions, secondary formation of UFPs resulting from photochemical reactions also contributes to total particle number concentrations. Secondary formation of UFPs depends strongly on the intensity of solar radiation and presence of precursor gases and thus is more important during the summer. Once emitted or formed, UFPs undergo dilution with ambient air and are subject to chemical reactions and physical processes such as evaporation, condensation, and coagulation.

#### VII.2. Data validation

The particle number concentration (PNC) data was downloaded from the instruments using USB drives on a weekly basis. One-minute time resolution data for each site were validated and examined for anomalies. Hourly average particle number concentrations were calculated for each station from the corresponding one-minute data only when the data recovery was 75% or higher (i.e., when more than 45 one-minute data within the hour were valid). The hourly data recoveries for each sampling location are provided in Figure VII-1, with all sites having data recoveries above 85%. The overall hourly data recovery for the ten MATES V sites was 95%.



**Figure VII-1: Data completeness for hourly ultrafine particle measurements during MATES V.**

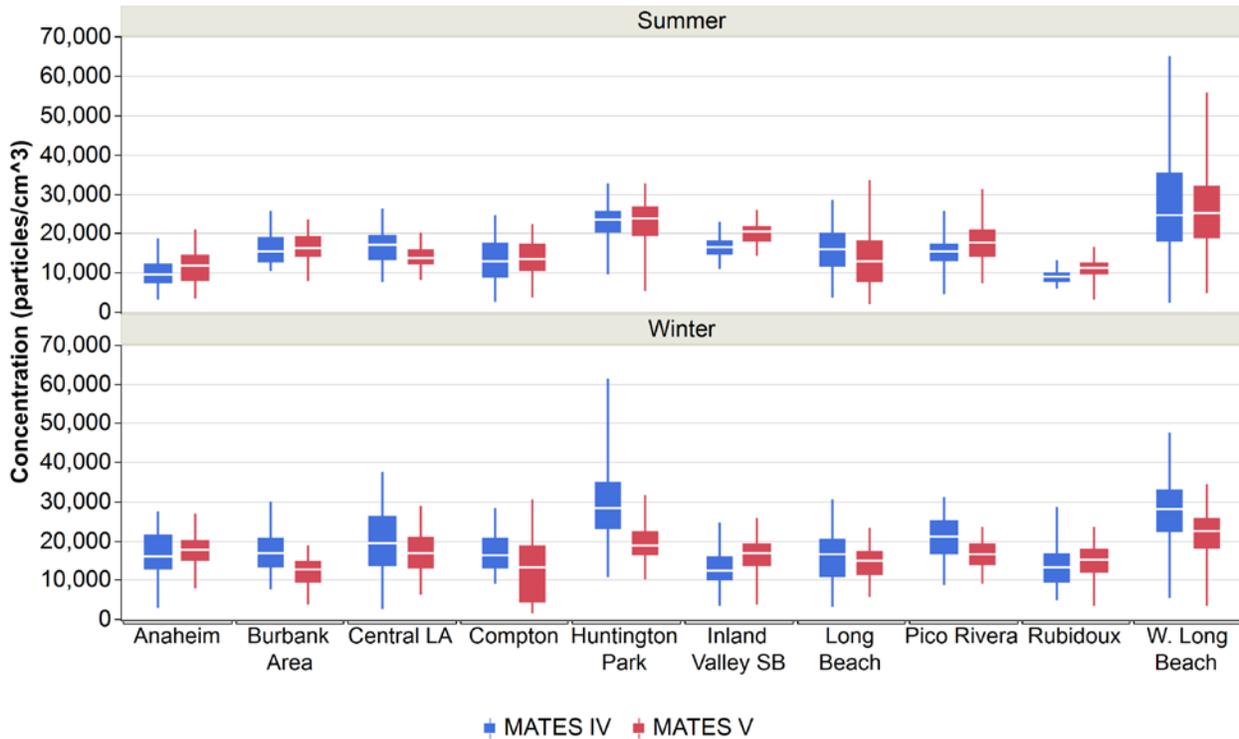
Three collocation studies were performed against a “Gold Standard” CPC (a reference instrument that was only used for collocation purposes) as a QA/QC check and to determine if correction factors should have been applied to the data to account for intra-model variations between CPC performances. These studies indicated that all ten site instruments were in good agreement with the “Gold Standard” CPC (i.e., high correlation coefficients with slopes close to one and small y-intercepts). Thus, no corrections were applied to the field data.

### **VII.3. Diurnal, day of week, and seasonal variations by site**

Since UFP concentrations are highly spatially variable, it is important to consider the differences between sites. In MATES V, the highest average UFP levels observed for all seasons are in West Long Beach. In most instances, the highest average particle number concentrations at all sites are observed during the winter or summer months (see Chapter 5, Figure 5-5). In MATES IV, the highest UFP concentrations by season were consistently observed in the winter months. Average winter UFP concentrations have decreased for many sites with the exception of Anaheim, Inland Valley SB, and Rubidoux (Table VII-1 and Figure VII-2). Since UFP concentrations have mostly decreased during the winter from MATES IV to MATES V and summer concentrations have remained relatively constant, the summertime levels contributed more heavily to the annual average MATES V UFP concentrations compared to their contribution in MATES IV. This implies that secondary formation of UFPs may be playing a more prominent role in the overall UFP concentrations observed in the South Coast Air Basin.

**Table VII-1. Average summer and winter UFP concentrations for MATES IV and MATES V for each site and overall MATES average.**

Site	Average summer concentration (particles/cm <sup>3</sup> )			Average winter concentration (particles/cm <sup>3</sup> )		
	MATES IV	MATES V	Change (%)	MATES IV	MATES V	Change (%)
Anaheim	9877	11441	15.8	16768	17540	4.6
Burbank Area	16006	16353	2.2	17219	12024	-30.2
Central LA	16620	14097	-15.2	19676	16903	-14.1
Compton	13402	13816	3.1	17333	12408	-28.4
Huntington Park	22787	23055	1.2	28694	19387	-32.4
Inland Valley SB	16474	19964	21.2	12650	16085	27.2
Long Beach	15865	13333	-16.0	15968	14498	-9.2
Pico Rivera	15164	17634	16.3	20861	16635	-20.3
Rubidoux	8948	10859	21.4	13486	14615	8.4
W Long Beach	26303	25947	-1.4	27616	21923	-20.6
Overall	16145	16650	3.1	19027	16202	-14.8



**Figure VII-2. Daily average UFP concentrations for summer and winter seasons during MATES IV and V. Box plots show the daily average minimum, first quartile, median, third quartile, and maximum values.**

Seasonal diurnal profiles show significant variation by site (Figures VII-3 and VII-4). For example, the summertime midday photochemical peak is more pronounced on the west side of the SCAB, with the exception of Burbank Area, and less distinct in the inland sites of Inland Valley San Bernardino and Rubidoux. Compton, Long Beach, West Long Beach, and Huntington Park show the largest midday peaks during the summer, exceeding the maximum hourly concentrations observed during the winter at these sites. The Inland Valley San Bernardino location did not reflect

the same seasonal trends as Rubidoux. At Inland Valley San Bernardino, a large broad peak begins in the early morning commute hours at 04:00, reaches a maximum at 14:00, and remains elevated during the evening. This is one of few sites where the summer evening particle number concentrations are higher than the winter evening concentrations. The photochemical peak was also in an earlier time frame compared to the other sampling locations. On the other hand, Rubidoux is the only site where the wintertime morning rush hour peak significantly exceeds the summertime midday peak. The UFP concentrations at Burbank show unique profiles where there is an increase in particle number in the early morning which persists throughout the day for all seasons. Generally, sites that show a prominent morning rush hour peak in the winter on the weekdays, do not show the same peak on the weekends (Figure VII-4). However, sites that show a large midday peak in the summer have equally large peaks on the weekdays and weekends. In fact, in Compton, the midday summer peak is larger on the weekends, further suggesting that secondary formation is important to particle number concentrations, especially during the summer when photochemical activity is the highest.

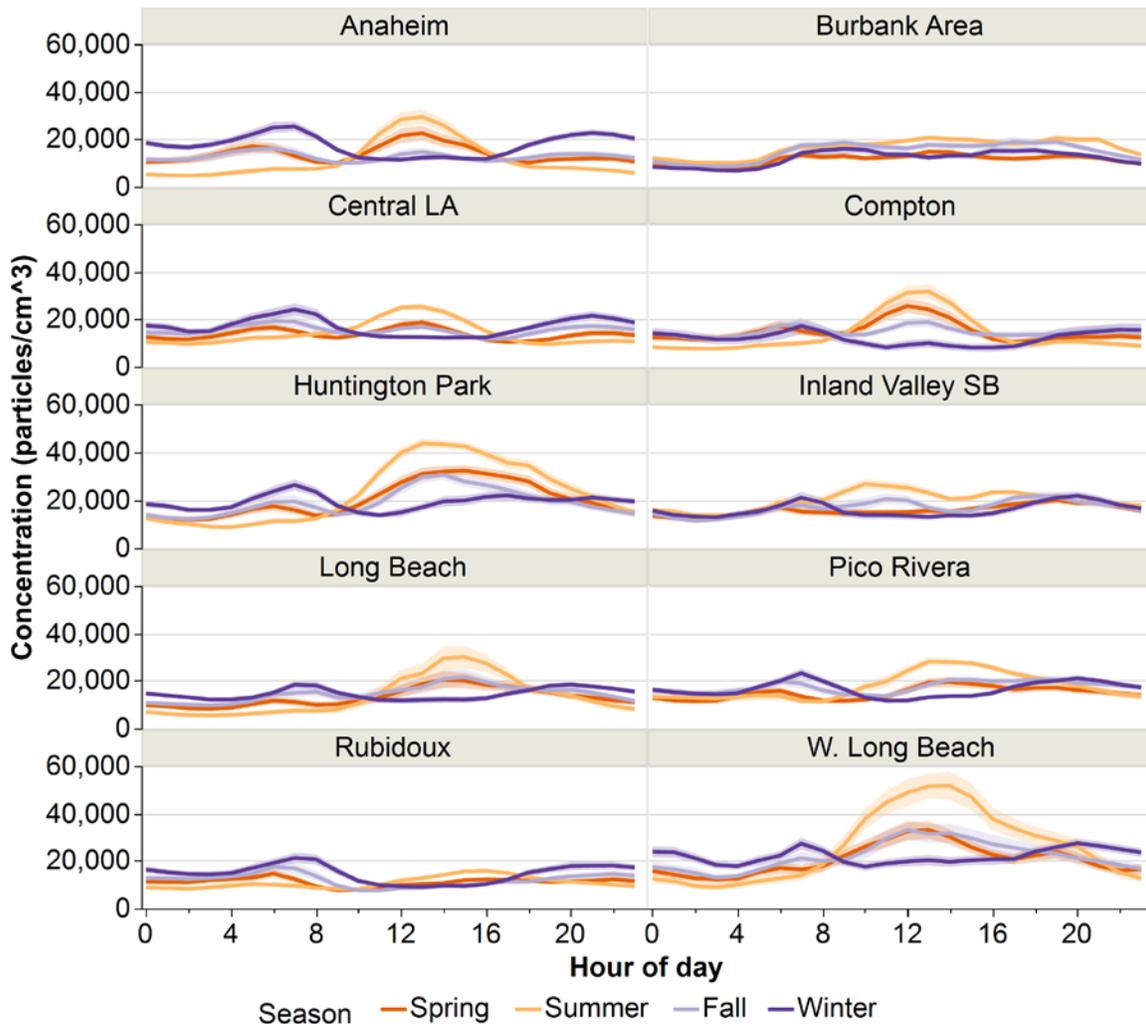
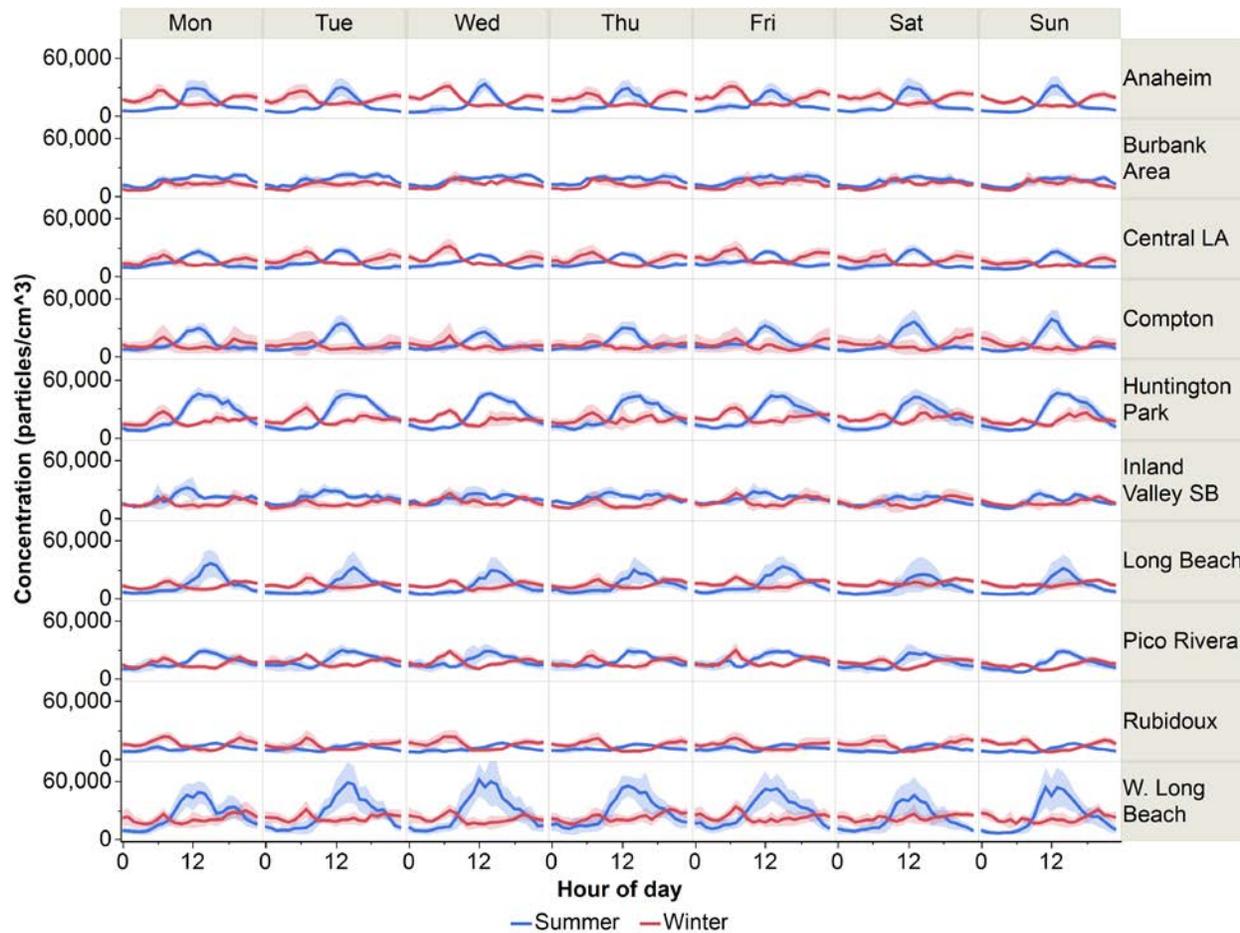


Figure VII-3 Seasonal diurnal profiles of ultrafine particle number concentration by site.



**Figure VII-4. Summer and winter UFP diurnal profiles by day of week and site.**

The seasonal polar time plots (Carslaw and Ropkins, 2012) in Figure VII-5 show the relative UFP concentration at each site organized by source direction and time of day. The polar angle of the data shows the direction from which that average concentration was observed and the distance from the center of each plot (0 – 23) indicates the hour of day. For example, the plots for Long Beach show that the highest average UFP concentrations during the MATES V period come from the northwest direction and usually occurs around midday for spring, summer, and fall. West Long Beach, despite the proximity of two major highways (Interstates 405 and 710) to the north and east, shows that the highest UFP concentrations in the summer come from the west around noon, with a consistent pattern during weekday and weekend, suggesting secondary particle formation when the predominant wind is westerly. Measurements of sulfur dioxide (SO<sub>2</sub>), a potentially important precursor for new particle formation based on the available literature (Saha et al., 2018), also showed higher concentrations at this site during the summer around noon. The distribution of high concentrations seen at West Long Beach indicate the importance of wind direction and local sources to observed particle number concentrations. Some sites show that the direction (i.e., source) of highest UFP concentrations changes with season. For example, in Central Los Angeles, the highest concentrations in the summer come from the southwest direction around noon, suggesting a secondary source. However, the highest concentrations in the fall and winter come

from the northeast in the early morning and evening, suggesting a traffic-related source. Overall, variations in UFP concentrations based on season and time of day depend on site location, meteorology, and the proximity/location of UFP sources and their precursors.

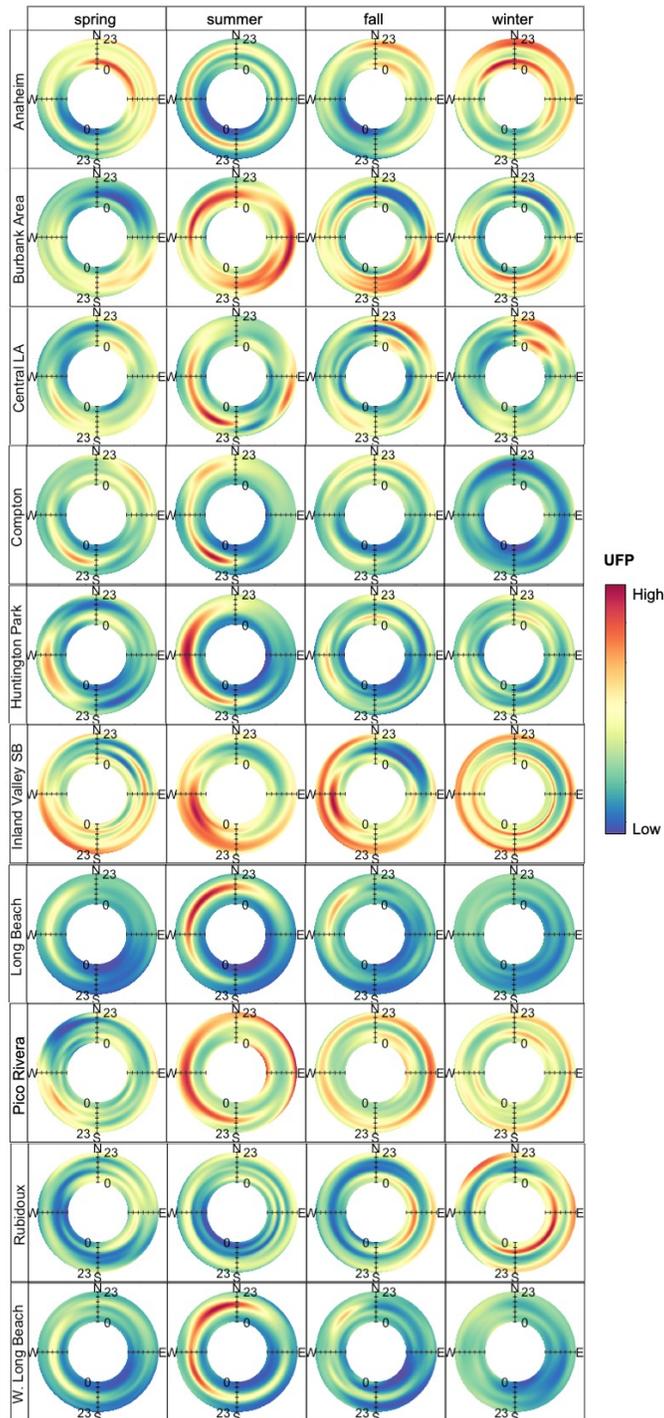
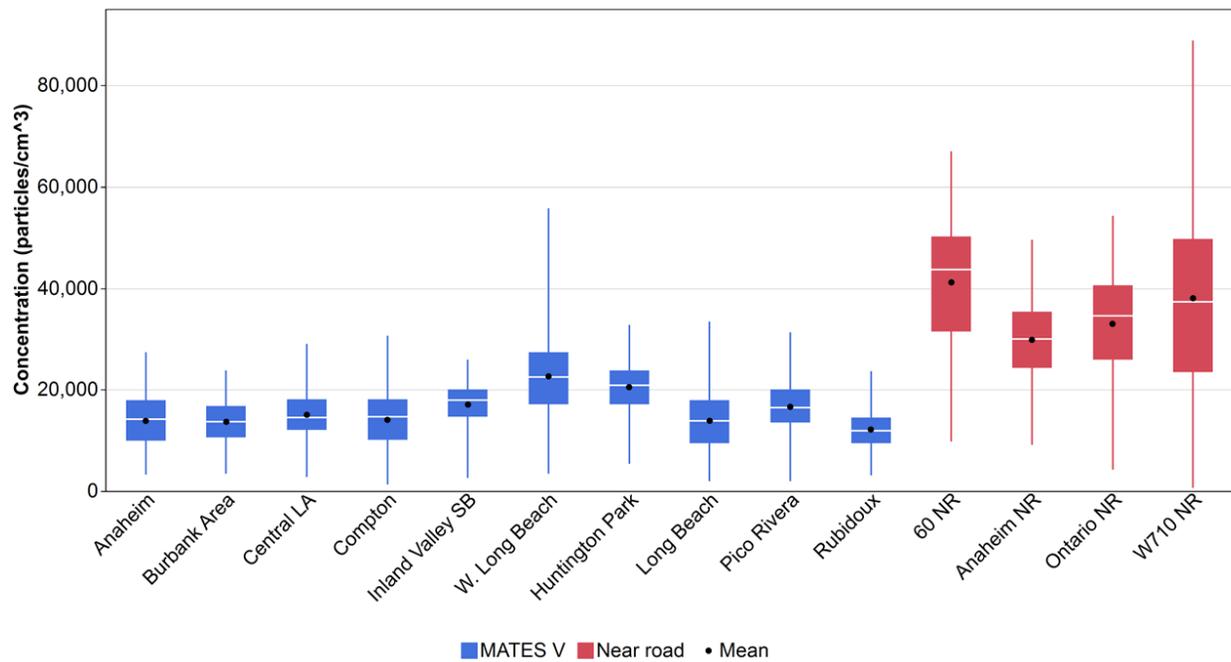


Figure VII-5. Polar time plots of relative UFP concentration by site and season.

VII.4. Comparison with near road sites

In addition to the MATES V sites, South Coast AQMD operates several near-road monitoring stations where ultrafine particles are measured. These sites include near-road stations in Ontario near CA-60 (60 NR), Anaheim near I-5 (Anaheim NR), Ontario near I-10 (Ontario NR), and Long Beach near I-710 (W710). UFP concentrations measured during the MATES V period for the near road monitoring stations are significantly elevated compared to the ten MATES V designated sites (Fig. VII-6). Average concentrations measured at these near-road stations are nearly twice that measured at the MATES V sites. The near-road sites also measured much higher maximum values compared to the MATES V sites, with hourly concentrations in some cases exceeding 100,000 particles per cubic centimeter (W710). These measurements provide further evidence that traffic emissions are major sources of UFPs (Sowlat et al., 2016; Zhu et al., 2002a, b).

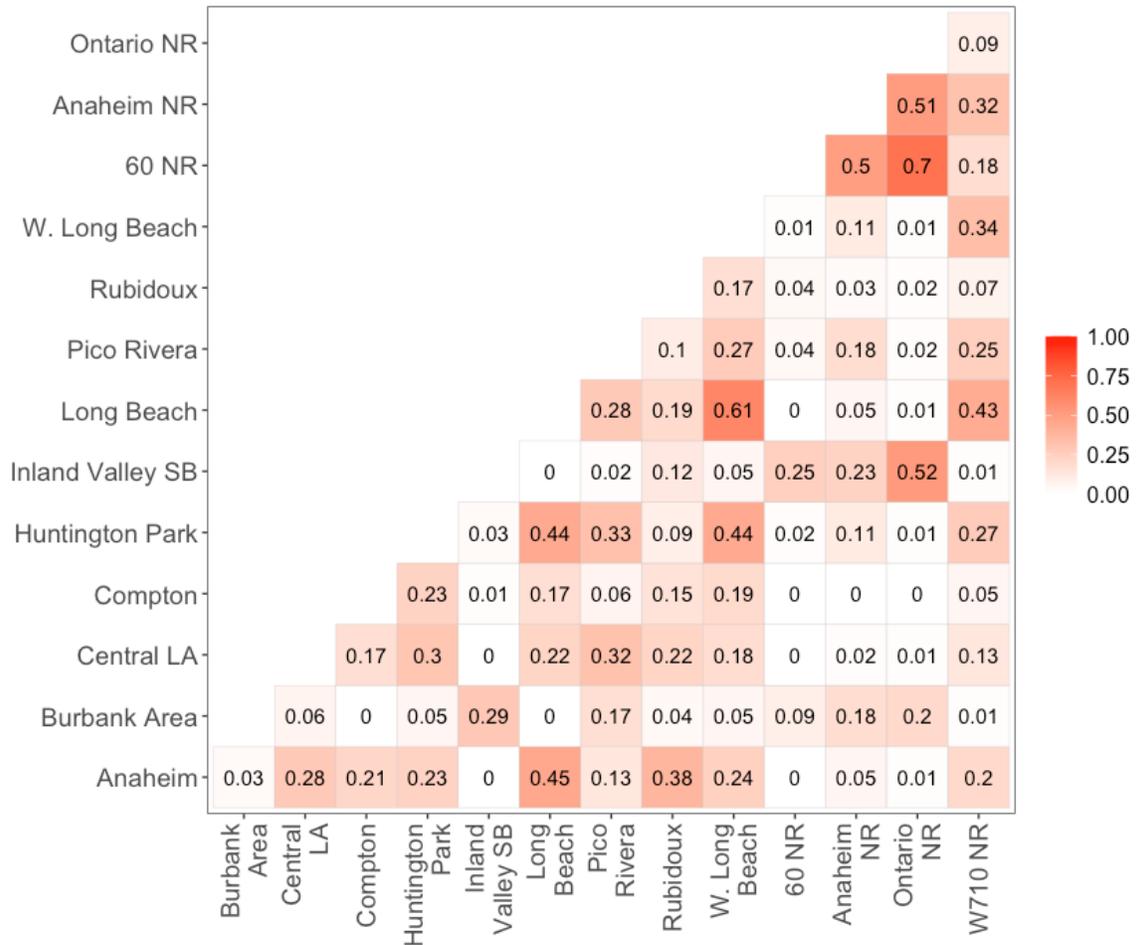


**Figure VII-6. Comparison of UFP concentrations for MATES V sites (blue) and near-road sites (red). Box plots showing the minimum, first quartile, median, third quartile and maximum values observed at each site with outliers removed. Mean values for each site are marked with a black circle.**

**VII.5. Correlations between sites**

Many factors contribute to ultrafine particle formation, including emissions, meteorology, and chemistry. Previous studies have also showed that UFP concentrations show high spatial variability, with very high levels near sources such as major highways, and decreasing steeply with distance from that source (Zhu et al., 2002 a, b). Therefore, it is not surprising that the ten sites studied for MATES V show significantly different UFP concentrations on a day-by-day basis. Figure VII-7 shows the coefficient of determination ( $r^2$ ) matrix between the daily UFP concentrations at each site as a measure of their similarity. All  $r^2$  values are 0.51 or below, with several sites showing little to no correlation with each other. The highest value observed is between West Long Beach and Long Beach, sites that are close in proximity to each other. In general,

Burbank Area, Compton, and Inland Valley San Bernardino show very low  $r^2$  values with the other sites. Other sites typically show more intermediate  $r^2$  values from 0.2 – 0.4.



**Figure VII-7. Coefficient of determination ( $r^2$ ) matrix for MATES V and near-road sites.**

The variability shown here at regionally representative sites emphasizes the heterogeneity of UFPs in the Basin and the impact of the proximity to nearby sources and precursors on measured UFP concentrations. As there is continued interest in studying the health effects of UFPs and continued research to develop improved modeling techniques to estimate long-term UFP exposures, the fixed-site monitoring data from the MATES program can help inform those efforts by providing year-long data in these locations, repeated over time.

In areas impacted by multiple sources of UFP emissions or its precursors, measurements with higher spatial resolution would be important to better quantify and characterize community UFP exposures. This can be achieved by conducting measurements at multiple sites or combining stationary and mobile monitoring to improve the characterization of UFPs.

**VII.6. Summary**

Continuous real-time UFP measurements collected at ten South Coast AQMD monitoring sites during MATES V show high temporal and spatial variability. Generally, wintertime concentrations

of UFPs have decreased (15% decrease in SCAB average) between the MATES IV (July 2012 – June 2013) and MATES V (May 2018 – April 2019) periods; however, summertime concentrations have either remained constant or increased (3% increase in SCAB average). This suggests the growing importance of secondary particle formation to UFP concentrations in the Basin. Diurnal and seasonal profiles vary significantly across sites. A variety of factors, such as the distance to the nearest emission source, type of emission source, traffic volume, wind speed, wind direction, relative humidity, and temperature (among other factors), can all influence the concentration, composition, and dispersion of UFPs. Furthermore, incorporating wind direction data shows that the sources that most impact UFP concentrations at a given site can change throughout the day and over the seasons. Measurements of UFPs at near-road sites are relatively new and show significantly higher UFP concentrations relative to the MATES sites, emphasizing that traffic is still a major source of UFPs. Continued measurements are needed to make robust conclusions on the long-term trends and spatial patterns of UFPs (Presto et al., 2021). Although our understanding of UFPs is increasing, additional information about UFP sources, precursors, and exposures would help improve the understanding of this type of pollution in the South Coast Air Basin.

## VII.7. References

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**APPENDIX VIII**

**MATES V**

**FINAL REPORT**

**2018 Emissions by Major Source Category**

## **Appendix VIII**

### **2018 Emissions by Major Source Category**

The 2018 air toxics emissions inventory by major source category is presented in a table in this appendix. Emissions inventory data is presented separately for the South Coast Air Basin and the Coachella Valley. Toxic gases are provided first, in alphabetical order, followed by the toxic particulates, also in alphabetical order. The particulates are estimated total mass from all size fractions.

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Acetalde- hyde	Acetone	Benzene	1,3 Butadiene	Carbon tetrachloride	Chloroform	1,1 Dichloro- ethane	1,4 dioxane	Ethylene dibromide
<b>Fuel Combustion</b>										
10	Electric Utilities	1.81	0.31	19.01	0.01	0.00	0.00	0.00	0.00	0.00
20	Cogeneration	0.02	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00
30	Oil and Gas Production (combustion)	0.90	0.25	3.99	0.02	0.00	0.00	0.00	0.00	0.00
40	Petroleum Refining (Combustion)	3.19	0.00	11.72	0.00	0.00	0.00	0.00	0.00	0.00
50	Manufacturing and Industrial	43.10	30.01	180.22	1.15	0.00	0.00	0.00	0.00	0.00
52	Food and Agricultural Processing	0.44	0.44	4.86	0.02	0.00	0.00	0.00	0.00	0.00
60	Service and Commercial	14.94	14.03	676.27	0.50	0.00	0.00	0.00	0.00	0.00
99	Other (Fuel Combustion)	24.69	26.44	26.41	2.13	0.51	0.08	0.00	0.00	0.00
	<b>Total</b>	<b>89.08</b>	<b>71.47</b>	<b>923.41</b>	<b>3.82</b>	<b>0.51</b>	<b>0.08</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Waste Disposal</b>										
110	Sewage Treatment	1.02	1.14	3.05	0.00	0.46	51.07	0.00	0.20	0.15
120	Landfills	0.00	123.13	262.26	0.00	0.13	0.90	70.40	0.00	0.00
130	Incineration	0.00	0.00	27.70	0.00	0.00	0.00	0.00	0.00	0.00
140	Soil Remediation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
199	Other (Waste Disposal)	0.03	2299.99	4.17	0.00	0.02	1.75	0.04	0.01	0.01
	<b>Total</b>	<b>1.05</b>	<b>2424.27</b>	<b>297.18</b>	<b>0.00</b>	<b>0.61</b>	<b>53.71</b>	<b>70.43</b>	<b>0.21</b>	<b>0.16</b>
<b>Cleaning and Surface Coatings</b>										
210	Laundering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
220	Degreasing	0.00	3044.60	4.25	0.00	0.00	0.00	0.00	0.00	0.00
230	Coatings and Related Processes	0.00	808.96	0.63	0.00	0.00	0.00	0.00	0.00	0.00
240	Printing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	Adhesives and Sealants	0.00	1198.99	1.78	0.00	0.00	0.00	0.00	0.00	0.00
299	Other (Cleaning and Surface Coatings)	0.00	3.65	1.97	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>5056.20</b>	<b>8.63</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Petroleum Production and Marketing</b>										

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Acetalde-		Benzene	1,3	Carbon	1,1 Dichloro-		Ethylene	
		hyde	Acetone		Butadiene	tetrachloride	Chloroform	ethane	1,4 dioxane	dibromide
310	Oil and Gas Production	0.00	0.00	36.39	0.00	0.00	0.00	0.00	0.00	0.00
320	Petroleum Refining	0.23	0.33	22.13	0.11	0.04	0.01	0.00	0.00	0.00
330	Petroleum Marketing	0.23	0.34	137.82	1.27	0.04	0.01	0.00	0.00	0.00
399	Other (Petroleum Production and Marketing)	0.00	0.00	7.01	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.45</b>	<b>0.67</b>	<b>203.35</b>	<b>1.38</b>	<b>0.07</b>	<b>0.01</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Industrial Processes</b>										
410	Chemical	4.12	8.61	38.50	113.77	0.66	0.09	0.00	0.00	0.00
420	Food and Agriculture	0.06	0.00	0.69	0.01	0.00	0.00	0.00	0.00	0.00
430	Mineral Processes	0.06	0.09	8.69	0.03	0.01	0.00	0.00	0.00	0.00
440	Metal Processes	0.73	1.07	19.95	0.36	0.12	0.02	0.00	0.00	0.00
450	Wood and Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
460	Glass and Related Products	0.10	0.15	0.57	0.05	0.02	0.00	0.00	0.00	0.00
470	Electronics	0.29	0.42	1.63	0.13	0.05	0.01	0.00	0.00	0.00
499	Other (Industrial Processes)	53.20	122.36	309.99	25.66	8.50	1.27	0.00	0.00	0.00
	<b>Total</b>	<b>58.56</b>	<b>132.70</b>	<b>380.02</b>	<b>140.00</b>	<b>9.36</b>	<b>1.39</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Solvent Evaporation</b>										
510	Consumer Products	0.00	15525.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00
520	Architectural Coatings and Related Solvent	4.15	1095.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
530	Pesticides/Fertilizers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
540	Asphalt Paving/Roofing	0.00	0.00	5.34	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>4.15</b>	<b>16620.50</b>	<b>5.35</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Miscellaneous Processes</b>										
610	Residential Fuel Combustion	1328.39	980.24	189.50	0.00	0.00	0.00	0.00	0.00	0.00
620	Farming Operations	0.00	1015.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
630	Construction and Demolition	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Acetalde-		Benzene	1,3	Carbon	1,1 Dichloro-		Ethylene	
		hyde	Acetone		Butadiene	tetrachloride	Chloroform	ethane	1,4 dioxane	dibromide
640	Paved Road Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
645	Unpaved Road Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650	Fugitive Windblown Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
660	Fires	0.00	0.00	0.00	6.36	0.00	0.00	0.00	0.00	0.00
670	Waste Burning and Disposal	0.00	0.00	4.39	14.74	0.00	0.00	0.00	0.00	0.00
690	Cooking	262.85	0.00	14.67	18.56	0.00	0.00	0.00	0.00	0.00
699	Other (Miscellaneous Processes)	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>1591.24</b>	<b>1995.33</b>	<b>208.60</b>	<b>39.66</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Onroad Motor Vehicles</b>										
710	Light Duty Passenger Auto (LDA)	333.63	200.89	1535.86	181.11	0.00	0.00	0.00	0.00	0.00
722	Light Duty Trucks 1 (T1)	59.63	39.27	321.80	30.00	0.00	0.00	0.00	0.00	0.00
723	Light Duty Trucks 2 (T2)	175.04	105.25	853.68	96.51	0.00	0.00	0.00	0.00	0.00
724	Medium Duty Trucks (T3)	159.31	94.16	723.09	91.51	0.00	0.00	0.00	0.00	0.00
732	Light Heavy Duty Gas Trucks 1 (T4)	11.87	7.98	94.54	6.06	0.00	0.00	0.00	0.00	0.00
733	Light Heavy Duty Gas Trucks 2 (T5)	2.28	1.50	18.99	1.15	0.00	0.00	0.00	0.00	0.00
734	Medium Heavy Duty Gas Trucks (T6)	5.04	3.69	25.78	2.33	0.00	0.00	0.00	0.00	0.00
736	Heavy Heavy Duty Gas Trucks ((HHD)	3.05	2.59	14.24	1.19	0.00	0.00	0.00	0.00	0.00
742	Light Heavy Duty Diesel Trucks 1 (T4)	52.37	53.47	14.25	1.35	0.00	0.00	0.00	0.00	0.00
743	Light Heavy Duty Diesel Trucks 2 (T5)	20.96	21.40	5.70	0.54	0.00	0.00	0.00	0.00	0.00
744	Medium Heavy Duty Diesel Truck (T6)	240.57	245.61	65.47	6.22	0.00	0.00	0.00	0.00	0.00
746	Heavy Heavy Duty Diesel Trucks (HHD)	588.82	601.15	160.24	15.22	0.00	0.00	0.00	0.00	0.00
750	Motorcycles (MCY)	135.06	88.15	597.27	91.83	0.00	0.00	0.00	0.00	0.00
760	Diesel Urban Buses (UB)	753.03	768.80	204.92	19.46	0.00	0.00	0.00	0.00	0.00
762	Gas Urban Buses (UB)	0.26	0.17	1.18	0.13	0.00	0.00	0.00	0.00	0.00
771	Gas School Buses (SB)	0.83	0.75	3.68	0.25	0.00	0.00	0.00	0.00	0.00
772	Diesel School Buses (SB)	5.55	5.67	1.51	0.14	0.00	0.00	0.00	0.00	0.00
777	Gas Other Buses (OB)	1.81	1.31	8.86	0.84	0.00	0.00	0.00	0.00	0.00

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Acetalde- hyde	Acetone	Benzene	1,3 Butadiene	Carbon tetrachloride	Chloroform	1,1 Dichloro- ethane	1,4 dioxane	Ethylene dibromide
778	Motor Coaches	9.95	10.16	2.71	0.26	0.00	0.00	0.00	0.00	0.00
779	Diesel Other Buses (OB)	13.78	14.07	3.75	0.36	0.00	0.00	0.00	0.00	0.00
780	Motor Homes (MH)	2.25	2.16	5.07	0.38	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>2575.09</b>	<b>2268.20</b>	<b>4662.59</b>	<b>546.85</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
	<b>Other Mobile Sources</b>									
810	Aircraft	296.38	26.20	127.23	118.53	0.00	0.00	0.00	0.00	0.00
820	Trains	149.49	152.62	40.68	3.86	0.00	0.00	0.00	0.00	0.00
833	Ocean Going Vessels	126.18	128.83	38.31	3.26	0.00	0.00	0.00	0.00	0.00
835	Commercial Harbor Crafts	69.35	70.80	18.87	1.79	0.00	0.00	0.00	0.00	0.00
840	Recreational Boats	425.33	205.50	1535.39	362.70	0.00	0.00	0.00	0.00	0.00
850	Off-Road Recreational Vehicles	10.86	5.24	60.44	9.27	0.00	0.00	0.00	0.00	0.00
860	Off-Road Equipment	1315.96	1050.76	2252.93	483.72	0.00	0.00	0.00	0.00	0.00
870	Farm Equipment	55.66	55.83	22.13	2.97	0.00	0.00	0.00	0.00	0.00
890	Fuel Storage and Handling	0.00	0.00	60.23	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>2449.21</b>	<b>1695.79</b>	<b>4156.20</b>	<b>986.11</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Stationary</b>	<b>1744.54</b>	<b>26301.13</b>	<b>2026.52</b>	<b>184.86</b>	<b>10.55</b>	<b>55.19</b>	<b>70.43</b>	<b>0.21</b>	<b>0.16</b>
<b>Total</b>	<b>On-Road Vehicles</b>	<b>2575.09</b>	<b>2268.20</b>	<b>4662.59</b>	<b>546.85</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Other Mobile</b>	<b>2449.21</b>	<b>1695.79</b>	<b>4156.20</b>	<b>986.11</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Anthropogenic</b>	<b>6768.85</b>	<b>30265.12</b>	<b>10845.32</b>	<b>1717.82</b>	<b>10.55</b>	<b>55.19</b>	<b>70.43</b>	<b>0.21</b>	<b>0.16</b>

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Ethylene dichloride	Ethylene oxide	Formaldehyde	Methyl ethyl ketone	Methylene chloride	MTBE	Naphthalene	p-Dichlorobenzene	Perchloroethylene
<b>Fuel Combustion</b>										
10	Electric Utilities	0.00	0.00	68.18	0.06	0.00	0.00	0.00	0.00	0.00
20	Cogeneration	0.00	0.00	0.46	0.00	0.00	0.00	0.03	0.00	0.00
30	Oil and Gas Production (combustion)	0.00	0.00	20.64	0.05	0.00	0.00	0.02	0.00	0.00
40	Petroleum Refining (Combustion)	0.00	0.00	250.06	0.00	0.00	0.00	0.00	0.00	0.00
50	Manufacturing and Industrial	0.00	0.00	913.26	5.89	0.00	0.00	0.49	0.00	0.00
52	Food and Agricultural Processing	0.00	0.00	10.46	0.09	0.00	0.00	0.01	0.00	0.00
60	Service and Commercial	0.00	0.00	1442.51	2.75	0.00	0.00	0.18	0.00	0.00
99	Other (Fuel Combustion)	4.29	0.13	56.62	7.53	0.00	0.00	0.48	5.49	0.00
	<b>Total</b>	<b>4.29</b>	<b>0.13</b>	<b>2762.19</b>	<b>16.37</b>	<b>0.00</b>	<b>0.00</b>	<b>1.21</b>	<b>5.49</b>	<b>0.00</b>
<b>Waste Disposal</b>										
110	Sewage Treatment	0.28	0.00	5.37	0.00	78.47	0.00	0.00	7.77	63.93
120	Landfills	12.29	0.00	53.91	154.62	367.34	0.00	0.00	0.00	187.13
130	Incineration	0.00	0.00	4.02	0.00	0.00	0.00	0.00	0.00	0.00
140	Soil Remediation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
199	Other (Waste Disposal)	0.02	0.00	0.39	0.08	2.88	0.00	0.00	0.27	2.29
	<b>Total</b>	<b>12.58</b>	<b>0.00</b>	<b>63.69</b>	<b>154.69</b>	<b>448.69</b>	<b>0.00</b>	<b>0.00</b>	<b>8.04</b>	<b>253.35</b>
<b>Cleaning and Surface Coatings</b>										
210	Laundering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1109.72
220	Degreasing	0.00	0.00	0.00	1309.36	7708.81	0.00	2.43	0.00	1020.06
230	Coatings and Related Processes	0.00	0.00	0.00	2157.36	0.00	0.00	0.00	0.00	0.00
240	Printing	0.00	0.00	0.00	219.96	0.00	0.00	3.07	0.00	0.00
250	Adhesives and Sealants	0.00	0.00	0.00	1008.18	32.69	0.00	0.00	0.00	0.00
299	Other (Cleaning and Surface Coatings)	0.00	1.18	0.00	3.43	168.47	0.00	0.64	0.00	184.62
	<b>Total</b>	<b>0.00</b>	<b>1.18</b>	<b>0.00</b>	<b>4698.29</b>	<b>7909.97</b>	<b>0.00</b>	<b>6.14</b>	<b>0.00</b>	<b>2314.40</b>
<b>Petroleum Production and Marketing</b>										

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Ethylene dichloride	Ethylene oxide	Formaldehyde	Methyl ethyl ketone	Methylene chloride	MTBE	Naphthalene	p-Dichlorobenzene	Perchloroethylene
310	Oil and Gas Production	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00
320	Petroleum Refining	0.31	0.01	883.85	0.23	0.00	0.00	0.02	0.39	0.00
330	Petroleum Marketing	0.31	0.01	0.34	0.24	0.00	0.00	7.11	0.40	0.00
399	Other (Petroleum Production and Marketing)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
	<b>Total</b>	<b>0.62</b>	<b>0.02</b>	<b>884.47</b>	<b>0.47</b>	<b>0.00</b>	<b>0.00</b>	<b>7.13</b>	<b>0.79</b>	<b>0.00</b>
<b>Industrial Processes</b>										
410	Chemical	5.58	0.16	0.07	8.25	0.00	0.00	0.04	7.13	0.00
420	Food and Agriculture	0.00	0.00	1.45	0.00	0.00	0.00	0.00	0.00	0.00
430	Mineral Processes	0.08	0.00	5.71	0.06	0.00	0.00	21.03	0.10	0.00
440	Metal Processes	0.99	0.03	6.94	0.75	0.00	0.00	0.09	1.27	0.00
450	Wood and Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
460	Glass and Related Products	0.14	0.00	0.15	0.10	0.00	0.00	0.01	0.17	0.00
470	Electronics	0.40	0.01	0.38	0.30	0.00	0.00	0.02	0.51	0.00
499	Other (Industrial Processes)	71.43	2.12	90.11	54.35	15.80	0.00	4.80	91.42	53.73
	<b>Total</b>	<b>78.62</b>	<b>2.33</b>	<b>104.80</b>	<b>63.81</b>	<b>15.80</b>	<b>0.00</b>	<b>25.98</b>	<b>100.60</b>	<b>53.73</b>
<b>Solvent Evaporation</b>										
510	Consumer Products	0.00	0.00	5.30	1085.09	4281.63	0.00	7.73	2185.31	586.96
520	Architectural Coatings and Related Solvent	0.00	0.00	0.00	24.56	46.93	0.00	2.79	0.00	15.85
530	Pesticides/Fertilizers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
540	Asphalt Paving/Roofing	0.00	0.00	0.00	0.00	0.00	0.00	95.55	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>5.30</b>	<b>1109.65</b>	<b>4328.56</b>	<b>0.00</b>	<b>106.07</b>	<b>2185.31</b>	<b>602.81</b>
<b>Miscellaneous Processes</b>										
610	Residential Fuel Combustion	0.00	0.00	1811.50	0.00	0.00	0.00	0.00	0.00	0.00
620	Farming Operations	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
630	Construction and Demolition	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Ethylene dichloride	Ethylene oxide	Formaldehyde	Methyl ethyl ketone	Methylene chloride	MTBE	Naphthalene	p-Dichlorobenzene	Perchloroethylene
640	Paved Road Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
645	Unpaved Road Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650	Fugitive Windblown Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
660	Fires	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
670	Waste Burning and Disposal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
690	Cooking	0.00	0.00	285.72	0.00	0.00	0.00	2.72	0.00	0.00
699	Other (Miscellaneous Processes)	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>2097.24</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>2.73</b>	<b>0.00</b>	<b>0.00</b>
<b>Onroad Motor Vehicles</b>										
710	Light Duty Passenger Auto (LDA)	0.00	0.00	651.20	40.80	0.00	76.97	66.42	0.00	0.00
722	Light Duty Trucks 1 (T1)	0.00	0.00	122.11	7.68	0.00	16.87	14.25	0.00	0.00
723	Light Duty Trucks 2 (T2)	0.00	0.00	347.17	21.15	0.00	42.72	36.92	0.00	0.00
724	Medium Duty Trucks (T3)	0.00	0.00	326.12	18.70	0.00	34.71	31.58	0.00	0.00
732	Light Heavy Duty Gas Trucks 1 (T4)	0.00	0.00	25.06	1.55	0.00	3.51	2.98	0.00	0.00
733	Light Heavy Duty Gas Trucks 2 (T5)	0.00	0.00	4.61	0.29	0.00	0.67	0.56	0.00	0.00
734	Medium Heavy Duty Gas Trucks (T6)	0.00	0.00	10.92	0.70	0.00	1.74	1.44	0.00	0.00
736	Heavy Heavy Duty Gas Trucks ((HHD)	0.00	0.00	7.71	0.44	0.00	1.26	1.08	0.00	0.00
742	Light Heavy Duty Diesel Trucks 1 (T4)	0.00	0.00	104.81	10.52	0.00	0.00	0.61	0.00	0.00
743	Light Heavy Duty Diesel Trucks 2 (T5)	0.00	0.00	41.94	4.21	0.00	0.00	0.24	0.00	0.00
744	Medium Heavy Duty Diesel Truck (T6)	0.00	0.00	481.40	48.32	0.00	0.00	2.78	0.00	0.00
746	Heavy Heavy Duty Diesel Trucks (HHD)	0.00	0.00	1178.28	118.28	0.00	0.00	6.81	0.00	0.00
750	Motorcycles (MCY)	0.00	0.00	371.06	14.94	0.00	26.08	30.84	0.00	0.00
760	Diesel Urban Buses (UB)	0.00	0.00	1506.87	151.26	0.00	0.00	8.70	0.00	0.00
762	Gas Urban Buses (UB)	0.00	0.00	0.53	0.03	0.00	0.08	0.06	0.00	0.00
771	Gas School Buses (SB)	0.00	0.00	1.93	0.13	0.00	0.40	0.32	0.00	0.00
772	Diesel School Buses (SB)	0.00	0.00	11.11	1.12	0.00	0.00	0.06	0.00	0.00
777	Gas Other Buses (OB)	0.00	0.00	3.87	0.25	0.00	0.62	0.51	0.00	0.00

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Ethylene dichloride	Ethylene oxide	Formaldehyde	Methyl ethyl ketone	Methylene chloride	MTBE	Naphthalene	p-Dichlorobenzene	Perchloroethylene
778	Motor Coaches	0.00	0.00	19.92	2.00	0.00	0.00	0.12	0.00	0.00
779	Diesel Other Buses (OB)	0.00	0.00	27.57	2.77	0.00	0.00	0.16	0.00	0.00
780	Motor Homes (MH)	0.00	0.00	4.97	0.40	0.00	0.46	0.39	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>5249.17</b>	<b>445.56</b>	<b>0.00</b>	<b>206.09</b>	<b>206.83</b>	<b>0.00</b>	<b>0.00</b>
	<b>Other Mobile Sources</b>									
810	Aircraft	0.00	0.00	851.95	0.21	0.00	0.78	37.68	0.00	0.00
820	Trains	0.00	0.00	299.14	30.03	0.00	0.00	1.73	0.00	0.00
833	Ocean Going Vessels	0.00	0.00	252.69	25.35	0.00	0.00	1.59	0.00	0.00
835	Commercial Harbor Crafts	0.00	0.00	138.77	13.93	0.00	0.00	0.80	0.00	0.00
840	Recreational Boats	0.00	0.00	1309.03	26.65	0.00	0.00	57.97	0.00	0.00
850	Off-Road Recreational Vehicles	0.00	0.00	33.45	0.68	0.00	0.00	1.51	0.00	0.00
860	Off-Road Equipment	0.00	0.00	3224.52	189.11	0.00	0.00	83.15	0.00	0.00
870	Farm Equipment	0.00	0.00	113.39	10.93	0.00	0.00	0.88	0.00	0.00
890	Fuel Storage and Handling	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>6222.93</b>	<b>296.87</b>	<b>0.00</b>	<b>0.78</b>	<b>185.35</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Stationary</b>	<b>96.11</b>	<b>3.66</b>	<b>5917.69</b>	<b>6043.28</b>	<b>12703.01</b>	<b>0.00</b>	<b>149.27</b>	<b>2300.24</b>	<b>3224.28</b>
<b>Total</b>	<b>On-Road Vehicles</b>	<b>0.00</b>	<b>0.00</b>	<b>5249.17</b>	<b>445.56</b>	<b>0.00</b>	<b>206.09</b>	<b>206.83</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Other Mobile</b>	<b>0.00</b>	<b>0.00</b>	<b>6222.93</b>	<b>296.87</b>	<b>0.00</b>	<b>0.78</b>	<b>185.35</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Anthropogenic</b>	<b>96.11</b>	<b>3.66</b>	<b>17389.79</b>	<b>6785.71</b>	<b>12703.01</b>	<b>206.86</b>	<b>541.46</b>	<b>2300.24</b>	<b>3224.28</b>

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Propylene oxide	Styrene	Toluene	Trichloro- ethylene	Vinyl chloride	Arsenic	Cadmium	Chromium	Diesel PM (DPM)
<b>Fuel Combustion</b>										
10	Electric Utilities	0.00	0.00	8.77	0.00	0.00	0.03	0.00	0.01	12.84
20	Cogeneration	0.00	0.00	0.89	0.00	0.00	0.00	0.00	0.00	0.00
30	Oil and Gas Production (combustion)	0.00	0.00	2.01	0.00	0.00	0.01	0.00	0.01	12.53
40	Petroleum Refining (Combustion)	0.00	0.00	18.53	0.00	0.00	0.12	0.88	0.92	0.00
50	Manufacturing and Industrial	0.00	0.29	99.51	0.00	0.00	0.05	0.05	0.09	31.33
52	Food and Agricultural Processing	0.00	0.00	2.49	0.00	0.00	0.01	0.01	0.01	3.45
60	Service and Commercial	0.00	0.13	337.92	0.00	0.00	0.13	0.02	0.06	142.94
99	Other (Fuel Combustion)	0.03	7.86	9.42	0.00	2.73	0.01	0.19	0.01	82.52
	<b>Total</b>	<b>0.03</b>	<b>8.30</b>	<b>479.54</b>	<b>0.00</b>	<b>2.73</b>	<b>0.37</b>	<b>1.14</b>	<b>1.11</b>	<b>285.61</b>
<b>Waste Disposal</b>										
110	Sewage Treatment	0.00	0.14	36.29	7.86	0.33	0.00	0.02	0.01	0.00
120	Landfills	0.00	0.00	4598.52	112.12	138.74	0.00	0.00	0.00	0.00
130	Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
140	Soil Remediation	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
199	Other (Waste Disposal)	0.00	0.00	16.21	0.33	0.08	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.14</b>	<b>4651.03</b>	<b>120.31</b>	<b>139.16</b>	<b>0.00</b>	<b>0.02</b>	<b>0.01</b>	<b>0.00</b>
<b>Cleaning and Surface Coatings</b>										
210	Laundering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
220	Degreasing	0.00	0.00	802.29	555.57	0.00	0.00	0.06	0.00	0.00
230	Coatings and Related Processes	0.00	0.00	10141.13	0.00	0.00	0.00	4.68	0.00	0.00
240	Printing	0.00	0.00	4.39	0.00	0.00	0.00	0.00	0.00	0.00
250	Adhesives and Sealants	0.00	0.00	308.80	0.00	0.00	0.00	0.06	0.00	0.00
299	Other (Cleaning and Surface Coatings)	0.00	0.00	207.76	118.53	0.00	0.00	0.06	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>11464.38</b>	<b>674.10</b>	<b>0.00</b>	<b>0.00</b>	<b>4.86</b>	<b>0.00</b>	<b>0.00</b>
<b>Petroleum Production and Marketing</b>										

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Propylene oxide	Styrene	Toluene	Trichloro- ethylene	Vinyl chloride	Arsenic	Cadmium	Chromium	Diesel PM (DPM)
310	Oil and Gas Production	0.00	0.00	17.03	0.00	0.00	0.04	0.00	0.00	0.00
320	Petroleum Refining	0.00	0.55	51.85	0.00	0.19	0.71	0.00	0.00	0.00
330	Petroleum Marketing	0.00	0.56	488.53	0.00	0.20	0.00	0.01	0.00	0.00
399	Other (Petroleum Production and Marketing)	0.00	0.00	22.43	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>1.10</b>	<b>579.84</b>	<b>0.00</b>	<b>0.39</b>	<b>0.75</b>	<b>0.01</b>	<b>0.00</b>	<b>0.00</b>
<b>Industrial Processes</b>										
410	Chemical	0.04	3710.94	137.17	0.00	1093.19	0.01	0.53	0.07	0.00
420	Food and Agriculture	0.00	0.00	6.82	0.00	0.00	0.00	0.00	0.03	0.00
430	Mineral Processes	0.00	0.14	4.37	0.00	0.05	4.43	0.17	8.35	0.00
440	Metal Processes	0.01	1.78	10.07	0.00	0.63	0.58	0.83	6.57	0.00
450	Wood and Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
460	Glass and Related Products	0.00	0.24	0.12	0.00	0.09	0.00	0.00	0.00	0.00
470	Electronics	0.00	0.70	0.34	0.00	0.25	0.00	0.00	0.00	0.00
499	Other (Industrial Processes)	0.43	181.82	147.04	6.25	45.59	0.39	1.15	1.34	0.00
	<b>Total</b>	<b>0.48</b>	<b>3895.63</b>	<b>305.93</b>	<b>6.25</b>	<b>1139.80</b>	<b>5.40</b>	<b>2.68</b>	<b>16.37</b>	<b>0.00</b>
<b>Solvent Evaporation</b>										
510	Consumer Products	0.28	749.45	4797.62	354.17	0.00	0.00	0.00	0.00	0.00
520	Architectural Coatings and Related Solvent	0.00	0.82	93.43	0.00	0.00	0.00	0.00	0.00	0.00
530	Pesticides/Fertilizers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
540	Asphalt Paving/Roofing	0.00	0.00	12.67	0.00	0.00	0.00	0.07	0.00	0.00
	<b>Total</b>	<b>0.28</b>	<b>750.27</b>	<b>4903.72</b>	<b>354.17</b>	<b>0.00</b>	<b>0.00</b>	<b>0.07</b>	<b>0.00</b>	<b>0.00</b>
<b>Miscellaneous Processes</b>										
610	Residential Fuel Combustion	0.00	0.00	513.90	0.00	0.00	0.13	0.05	1.40	0.00
620	Farming Operations	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.49	0.00
630	Construction and Demolition	0.00	0.00	0.00	0.00	0.00	1.57	1.95	20.75	0.00

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Propylene oxide	Styrene	Toluene	Trichloro- ethylene	Vinyl chloride	Arsenic	Cadmium	Chromium	Diesel PM (DPM)
640	Paved Road Dust	0.00	0.00	0.00	0.00	0.00	3.06	0.71	4.01	0.00
645	Unpaved Road Dust	0.00	0.00	0.00	0.00	0.00	0.30	0.26	0.34	0.00
650	Fugitive Windblown Dust	0.00	0.00	0.00	0.00	0.00	0.10	0.14	1.42	0.00
660	Fires	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00
670	Waste Burning and Disposal	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.01	0.00
690	Cooking	0.00	0.00	11.68	0.00	0.00	0.04	0.08	0.32	0.00
699	Other (Miscellaneous Processes)	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>525.58</b>	<b>0.00</b>	<b>0.00</b>	<b>5.27</b>	<b>3.27</b>	<b>28.74</b>	<b>0.00</b>
<b>Onroad Motor Vehicles</b>										
710	Light Duty Passenger Auto (LDA)	0.00	89.91	3979.15	0.00	0.00	0.19	0.05	22.38	70.41
722	Light Duty Trucks 1 (T1)	0.00	15.96	851.37	0.00	0.00	0.02	0.01	1.86	8.03
723	Light Duty Trucks 2 (T2)	0.00	47.91	2232.49	0.00	0.00	0.07	0.02	8.13	2.98
724	Medium Duty Trucks (T3)	0.00	41.71	1838.28	0.00	0.00	0.05	0.01	5.21	13.12
732	Light Heavy Duty Gas Trucks 1 (T4)	0.00	3.17	301.94	0.00	0.00	0.01	0.00	0.72	0.00
733	Light Heavy Duty Gas Trucks 2 (T5)	0.00	0.63	62.39	0.00	0.00	0.00	0.00	0.18	0.00
734	Medium Heavy Duty Gas Trucks (T6)	0.00	1.31	60.22	0.00	0.00	0.00	0.00	0.28	0.00
736	Heavy Heavy Duty Gas Trucks ((HHD)	0.00	0.68	24.33	0.00	0.00	0.00	0.00	0.01	0.00
742	Light Heavy Duty Diesel Trucks 1 (T4)	0.00	0.41	10.49	0.00	0.00	0.01	0.01	0.58	139.31
743	Light Heavy Duty Diesel Trucks 2 (T5)	0.00	0.17	4.20	0.00	0.00	0.00	0.00	0.30	58.71
744	Medium Heavy Duty Diesel Truck (T6)	0.00	1.90	48.19	0.00	0.00	0.02	0.00	3.05	1733.33
746	Heavy Heavy Duty Diesel Trucks (HHD)	0.00	4.64	117.96	0.00	0.00	0.01	0.00	2.69	1994.15
750	Motorcycles (MCY)	0.00	26.47	1246.73	0.00	0.00	0.00	0.00	0.06	0.00
760	Diesel Urban Buses (UB)	0.00	5.94	150.85	0.00	0.00	0.00	0.00	0.11	6.70
762	Gas Urban Buses (UB)	0.00	0.07	2.77	0.00	0.00	0.00	0.00	0.08	0.00
771	Gas School Buses (SB)	0.00	0.20	5.39	0.00	0.00	0.00	0.00	0.15	0.00
772	Diesel School Buses (SB)	0.00	0.04	1.11	0.00	0.00	0.00	0.00	0.40	26.29
777	Gas Other Buses (OB)	0.00	0.47	20.14	0.00	0.00	0.00	0.00	0.13	0.00

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Propylene oxide	Styrene	Toluene	Trichloro- ethylene	Vinyl chloride	Arsenic	Cadmium	Chromium	Diesel PM (DPM)
778	Motor Coaches	0.00	0.08	1.99	0.00	0.00	0.00	0.00	0.07	45.51
779	Diesel Other Buses (OB)	0.00	0.11	2.76	0.00	0.00	0.00	0.00	0.13	89.12
780	Motor Homes (MH)	0.00	0.25	7.76	0.00	0.00	0.00	0.00	0.14	22.95
	<b>Total</b>	<b>0.00</b>	<b>242.04</b>	<b>10970.51</b>	<b>0.00</b>	<b>0.00</b>	<b>0.39</b>	<b>0.11</b>	<b>46.67</b>	<b>4210.61</b>
	<b>Other Mobile Sources</b>									
810	Aircraft	0.00	22.15	66.36	0.00	0.00	0.00	0.00	0.39	0.00
820	Trains	0.00	1.18	29.95	0.00	0.00	0.00	0.04	0.01	645.73
833	Ocean Going Vessels	0.00	1.00	29.23	0.00	0.00	1.83	0.17	1.83	393.65
835	Commercial Harbor Crafts	0.00	0.55	13.89	0.00	0.00	0.00	0.01	0.01	234.97
840	Recreational Boats	0.00	58.32	3216.03	0.00	0.00	0.00	0.00	1.22	6.87
850	Off-Road Recreational Vehicles	0.00	1.48	133.26	0.00	0.00	0.00	0.00	0.01	0.00
860	Off-Road Equipment	0.00	80.14	4415.34	0.00	0.00	0.01	0.11	1.55	3678.18
870	Farm Equipment	0.00	0.68	26.58	0.00	0.00	0.00	0.01	0.02	253.56
890	Fuel Storage and Handling	0.00	0.00	147.64	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>165.50</b>	<b>8078.28</b>	<b>0.00</b>	<b>0.00</b>	<b>1.84</b>	<b>0.34</b>	<b>5.04</b>	<b>5212.97</b>
<b>Total</b>	<b>Stationary</b>	<b>0.79</b>	4655.44	22910.02	<b>1154.83</b>	1282.09	11.79	12.04	46.23	285.61
<b>Total</b>	<b>On-Road Vehicles</b>	<b>0.00</b>	242.04	10970.51	<b>0.00</b>	0.00	0.39	0.11	46.67	4210.61
<b>Total</b>	<b>Other Mobile</b>	<b>0.00</b>	165.50	8078.28	<b>0.00</b>	0.00	1.84	0.34	5.04	5212.97
<b>Total</b>	<b>Anthropogenic</b>	<b>0.79</b>	<b>5062.98</b>	<b>41958.82</b>	<b>1154.83</b>	<b>1282.09</b>	<b>14.03</b>	<b>12.49</b>	<b>97.93</b>	<b>9709.19</b>

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Elemental		Hexavalent		Organic			Silicon	
		DPM2.5	carbon (EC)	EC2.5	chromium	Lead	Nickel	carbon		Selenium
<b>Fuel Combustion</b>										
10	Electric Utilities	12.22	43.59	42.95	0.00	0.12	0.76	630.19	0.00	20.76
20	Cogeneration	0.00	0.20	0.20	0.00	0.00	0.00	5.41	0.00	0.14
30	Oil and Gas Production (combustion)	11.89	15.53	14.98	0.00	0.03	0.55	107.33	0.00	3.76
40	Petroleum Refining (Combustion)	0.00	203.25	200.84	0.00	0.43	3.08	2007.72	0.00	103.38
50	Manufacturing and Industrial	29.82	153.90	119.09	0.00	0.32	4.52	1310.01	0.00	98.34
52	Food and Agricultural Processing	3.24	8.81	8.65	0.00	0.02	0.20	36.33	0.00	2.89
60	Service and Commercial	135.99	201.15	195.77	0.00	0.31	2.44	1361.29	0.00	51.94
99	Other (Fuel Combustion)	78.52	59.90	56.90	0.00	0.01	0.15	87.03	0.00	12.30
	<b>Total</b>	<b>271.67</b>	<b>686.34</b>	<b>639.37</b>	<b>0.00</b>	<b>1.25</b>	<b>11.70</b>	<b>5545.29</b>	<b>0.00</b>	<b>293.50</b>
<b>Waste Disposal</b>										
110	Sewage Treatment	0.00	0.01	0.01	0.00	1.33	0.00	0.19	0.00	0.01
120	Landfills	0.00	9.17	9.07	0.00	0.04	0.12	248.84	0.00	8.11
130	Incineration	0.00	21.81	21.80	0.00	0.00	8.76	9.80	0.00	9.02
140	Soil Remediation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
199	Other (Waste Disposal)	0.00	0.12	0.12	0.00	0.00	0.00	3.25	0.00	0.09
	<b>Total</b>	<b>0.00</b>	<b>31.11</b>	<b>31.00</b>	<b>0.00</b>	<b>1.37</b>	<b>8.89</b>	<b>262.09</b>	<b>0.00</b>	<b>17.22</b>
<b>Cleaning and Surface Coatings</b>										
210	Laundering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
220	Degreasing	0.00	0.42	0.38	0.00	0.00	0.00	9.30	0.00	3.14
230	Coatings and Related Processes	0.00	34.22	31.65	0.00	0.00	0.00	748.66	0.00	253.01
240	Printing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	Adhesives and Sealants	0.00	0.42	0.39	0.00	0.00	0.00	9.41	0.00	3.18
299	Other (Cleaning and Surface Coatings)	0.00	1.61	1.58	0.00	0.00	0.00	9.52	0.00	3.22
	<b>Total</b>	<b>0.00</b>	<b>36.67</b>	<b>34.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>776.89</b>	<b>0.00</b>	<b>262.55</b>
<b>Petroleum Production and Marketing</b>										

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Elemental		Hexavalent		Organic			Silicon	
		DPM2.5	carbon (EC)	EC2.5	chromium	Lead	Nickel	carbon		Selenium
310	Oil and Gas Production	0.00	1.96	2.12	0.00	0.04	0.04	0.42	0.00	8.29
320	Petroleum Refining	0.00	38.12	40.65	0.00	0.71	0.70	0.00	0.00	138.50
330	Petroleum Marketing	0.00	0.04	0.04	0.00	0.00	0.00	0.86	0.00	0.29
399	Other (Petroleum Production and Marketing)	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.01
	<b>Total</b>	<b>0.00</b>	<b>40.12</b>	<b>42.81</b>	<b>0.00</b>	<b>0.75</b>	<b>0.75</b>	<b>1.32</b>	<b>0.00</b>	<b>147.10</b>
<b>Industrial Processes</b>										
410	Chemical	0.00	2.53	1.72	0.00	0.08	0.52	9.15	0.00	1.12
420	Food and Agriculture	0.00	71.99	1.65	0.00	0.01	0.04	38.75	0.00	36.68
430	Mineral Processes	0.00	98.90	79.55	0.01	0.17	8.23	0.94	0.55	5570.51
440	Metal Processes	0.00	75.86	50.49	0.07	11.38	2.89	8.05	0.06	7.95
450	Wood and Paper	0.00	5.70	1.71	0.00	0.01	0.01	5.40	0.00	0.04
460	Glass and Related Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
470	Electronics	0.00	0.04	0.01	0.00	0.00	0.00	0.23	0.00	0.15
499	Other (Industrial Processes)	0.00	47.79	22.81	0.01	0.28	1.50	231.43	0.01	354.92
	<b>Total</b>	<b>0.00</b>	<b>302.82</b>	<b>157.96</b>	<b>0.09</b>	<b>11.92</b>	<b>13.19</b>	<b>293.95</b>	<b>0.63</b>	<b>5971.37</b>
<b>Solvent Evaporation</b>										
510	Consumer Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
520	Architectural Coatings and Related Solvent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
530	Pesticides/Fertilizers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
540	Asphalt Paving/Roofing	0.00	0.50	0.47	0.00	0.00	0.00	11.28	0.00	3.81
	<b>Total</b>	<b>0.00</b>	<b>0.50</b>	<b>0.47</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>11.28</b>	<b>0.00</b>	<b>3.81</b>
<b>Miscellaneous Processes</b>										
610	Residential Fuel Combustion	0.00	2597.96	1899.94	0.00	0.22	2.35	7964.40	1.61	7.46
620	Farming Operations	0.00	16.22	3.33	0.00	0.14	0.12	271.23	0.01	420.35
630	Construction and Demolition	0.00	428.37	28.04	0.00	51.60	5.47	4072.01	0.19	17621.34

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Elemental		Hexavalent		Organic			Selenium	Silicon
		DPM2.5	carbon (EC)	EC2.5	chromium	Lead	Nickel	carbon		
640	Paved Road Dust	0.00	1819.60	125.55	0.00	29.23	2.83	14084.77	0.47	71593.95
645	Unpaved Road Dust	0.00	22.98	1.36	0.00	2.57	0.73	665.01	0.06	6413.14
650	Fugitive Windblown Dust	0.00	19.88	1.16	0.00	2.42	0.35	180.75	0.01	1230.21
660	Fires	0.00	219.29	193.06	0.00	0.05	0.00	215.66	0.00	37.27
670	Waste Burning and Disposal	0.00	275.22	239.23	0.00	0.05	0.00	688.09	0.01	5.54
690	Cooking	0.00	1189.21	1189.19	0.00	3.19	0.73	15145.60	0.01	61.06
699	Other (Miscellaneous Processes)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.14
<b>Total</b>		<b>0.00</b>	<b>6588.73</b>	<b>3680.85</b>	<b>0.00</b>	<b>89.49</b>	<b>12.59</b>	<b>43287.52</b>	<b>2.35</b>	<b>97392.45</b>
<b>Onroad Motor Vehicles</b>										
710	Light Duty Passenger Auto (LDA)	66.96	1625.92	660.59	0.24	2.02	12.33	4269.45	0.45	1273.36
722	Light Duty Trucks 1 (T1)	7.64	151.82	69.70	0.02	0.20	1.02	380.04	0.04	106.26
723	Light Duty Trucks 2 (T2)	2.83	591.81	240.28	0.09	0.75	4.48	1547.04	0.16	463.00
724	Medium Duty Trucks (T3)	12.48	385.36	159.86	0.06	0.49	2.88	1006.79	0.10	296.67
732	Light Heavy Duty Gas Trucks 1 (T4)	0.00	32.29	12.70	0.01	0.05	0.40	97.73	0.01	40.69
733	Light Heavy Duty Gas Trucks 2 (T5)	0.00	7.59	2.96	0.00	0.01	0.10	23.66	0.00	10.43
734	Medium Heavy Duty Gas Trucks (T6)	0.00	11.30	4.24	0.00	0.02	0.15	35.70	0.01	15.81
736	Heavy Heavy Duty Gas Trucks ((HHD)	0.00	1.24	0.45	0.00	0.00	0.01	3.24	0.00	0.79
742	Light Heavy Duty Diesel Trucks 1 (T4)	132.48	64.71	44.38	0.01	0.04	0.32	182.23	0.01	33.20
743	Light Heavy Duty Diesel Trucks 2 (T5)	55.83	28.66	19.24	0.00	0.02	0.16	81.97	0.01	16.92
744	Medium Heavy Duty Diesel Truck (T6)	1648.40	449.58	380.05	0.03	0.11	1.15	626.36	0.04	116.71
746	Heavy Heavy Duty Diesel Trucks (HHD)	1896.44	576.86	410.54	0.02	0.22	0.95	991.56	0.04	93.15
750	Motorcycles (MCY)	0.00	7.25	3.52	0.00	0.02	0.04	19.18	0.00	3.60
760	Diesel Urban Buses (UB)	6.37	13.26	4.96	0.00	0.01	0.06	33.79	0.00	6.01
762	Gas Urban Buses (UB)	0.00	3.13	1.12	0.00	0.00	0.04	10.10	0.00	4.56
771	Gas School Buses (SB)	0.00	3.66	1.51	0.00	0.01	0.08	14.28	0.00	8.61
772	Diesel School Buses (SB)	25.00	11.77	5.84	0.00	0.02	0.22	47.80	0.01	22.32
777	Gas Other Buses (OB)	0.00	5.13	1.88	0.00	0.01	0.07	16.34	0.00	7.30

**Table VIII-1. 2018 Air Toxics Emissions (lbs/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	Elemental		Hexavalent		Organic			Silicon	
		DPM2.5	carbon (EC)	EC2.5	chromium	Lead	Nickel	carbon		Selenium
778	Motor Coaches	43.28	7.12	5.62	0.00	0.00	0.03	19.88	0.00	2.80
779	Diesel Other Buses (OB)	84.76	13.71	10.99	0.00	0.01	0.05	37.91	0.00	5.02
780	Motor Homes (MH)	21.82	11.76	7.95	0.00	0.01	0.08	34.12	0.00	8.04
	<b>Total</b>	<b>4004.29</b>	<b>4003.92</b>	<b>2048.38</b>	<b>0.49</b>	<b>4.01</b>	<b>24.63</b>	<b>9479.17</b>	<b>0.89</b>	<b>2535.25</b>
	<b>Other Mobile Sources</b>									
810	Aircraft	0.00	245.38	219.22	0.02	0.46	0.77	603.41	0.00	9.62
820	Trains	591.18	166.04	156.29	0.00	0.02	0.01	443.69	0.00	1.85
833	Ocean Going Vessels	362.16	72.29	66.50	0.09	1.90	0.17	205.49	0.17	0.00
835	Commercial Harbor Crafts	216.10	145.60	133.91	0.00	0.00	0.00	54.78	0.00	0.52
840	Recreational Boats	4.65	437.56	297.52	0.06	3.27	3.26	1678.59	0.00	44.36
850	Off-Road Recreational Vehicles	0.00	3.56	2.43	0.00	0.03	0.03	13.79	0.00	0.36
860	Off-Road Equipment	3383.30	2788.56	2444.54	0.08	3.86	3.90	2960.01	0.03	63.70
870	Farm Equipment	233.32	160.10	146.62	0.00	0.03	0.02	70.65	0.00	0.86
890	Fuel Storage and Handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>4790.72</b>	<b>4019.10</b>	<b>3467.04</b>	<b>0.26</b>	<b>9.56</b>	<b>8.16</b>	<b>6030.40</b>	<b>0.21</b>	<b>121.27</b>
<b>Total</b>	<b>Stationary</b>	271.67	7686.29	4586.45	0.09	104.78	47.11	50178.34	2.98	104088.00
<b>Total</b>	<b>On-Road Vehicles</b>	4004.29	4003.92	2048.38	0.49	4.01	24.63	9479.17	0.89	2535.25
<b>Total</b>	<b>Other Mobile</b>	4790.72	4019.10	3467.04	0.26	9.56	8.16	6030.40	0.21	121.27
<b>Total</b>	<b>Anthropogenic</b>	<b>9066.68</b>	<b>15709.30</b>	<b>10101.87</b>	<b>0.84</b>	<b>118.35</b>	<b>79.90</b>	<b>65687.91</b>	<b>4.09</b>	<b>106744.52</b>

**Table VIII-2. 2018 Criteria Emissions (tons/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	TOG	VOC	CO	NOx	SOx	TSP	PM10	PM2.5	NH3
<b>Fuel Combustion</b>										
10	Electric Utilities	2.69	0.31	4.25	0.59	0.22	0.51	0.51	0.51	0.68
20	Cogeneration	0.05	0.02	0.12	0.02	0.00	0.02	0.02	0.01	0.18
30	Oil and Gas Production (combustion)	1.11	0.12	0.61	0.71	0.01	0.10	0.09	0.09	0.22
40	Petroleum Refining (Combustion)	6.48	1.33	4.87	0.00	0.01	1.78	1.77	1.77	1.50
50	Manufacturing and Industrial	25.94	4.19	15.30	10.01	0.21	1.25	1.16	1.12	2.26
52	Food and Agricultural Processing	0.07	0.03	0.34	0.11	0.00	0.03	0.03	0.03	0.04
60	Service and Commercial	10.64	4.16	13.58	9.25	0.79	1.16	1.16	1.16	2.70
99	Other (Fuel Combustion)	0.58	0.27	1.31	2.54	0.07	0.18	0.16	0.15	0.05
	<b>Total</b>	<b>47.56</b>	<b>10.43</b>	<b>40.38</b>	<b>23.23</b>	<b>1.33</b>	<b>5.03</b>	<b>4.92</b>	<b>4.85</b>	<b>7.62</b>
<b>Waste Disposal</b>										
110	Sewage Treatment	0.37	0.27	0.00	0.00	0.00	0.02	0.00	0.00	0.23
120	Landfills	640.10	8.88	0.39	0.45	0.37	0.20	0.20	0.20	3.97
130	Incineration	0.19	0.04	0.25	0.98	0.07	0.12	0.06	0.05	0.22
140	Soil Remediation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
199	Other (Waste Disposal)	57.94	4.67	0.01	0.01	0.00	0.00	0.00	0.00	1.08
	<b>Total</b>	<b>698.60</b>	<b>13.86</b>	<b>0.65</b>	<b>1.44</b>	<b>0.44</b>	<b>0.34</b>	<b>0.26</b>	<b>0.25</b>	<b>5.51</b>
<b>Cleaning and Surface Coatings</b>										
210	Laundering	3.41	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
220	Degreasing	66.07	12.12	0.00	0.00	0.00	0.02	0.02	0.02	0.01
230	Coatings and Related Processes	19.08	18.57	0.00	0.00	0.00	1.67	1.60	1.54	0.09
240	Printing	1.17	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.06
250	Adhesives and Sealants	4.82	4.21	0.00	0.00	0.00	0.02	0.02	0.02	0.00
299	Other (Cleaning and Surface Coatings)	1.42	1.08	0.11	0.01	0.00	0.02	0.02	0.02	0.00
	<b>Total</b>	<b>95.98</b>	<b>37.29</b>	<b>0.12</b>	<b>0.01</b>	<b>0.00</b>	<b>1.74</b>	<b>1.67</b>	<b>1.60</b>	<b>0.16</b>
<b>Petroleum Production and Marketing</b>										

**Table VIII-2. 2018 Criteria Emissions (tons/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	TOG	VOC	CO	NOx	SOx	TSP	PM10	PM2.5	NH3
310	Oil and Gas Production	4.86	2.18	0.02	0.01	0.06	0.04	0.03	0.02	0.00
320	Petroleum Refining	6.35	4.43	2.39	0.23	0.24	1.87	1.25	0.88	0.07
330	Petroleum Marketing	54.79	13.80	0.23	0.00	0.00	0.01	0.00	0.00	0.00
399	Other (Petroleum Production and Marketing)	0.60	0.58	0.01	0.01	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>66.60</b>	<b>20.99</b>	<b>2.65</b>	<b>0.25</b>	<b>0.30</b>	<b>1.92</b>	<b>1.28</b>	<b>0.91</b>	<b>0.07</b>
<b>Industrial Processes</b>										
410	Chemical	5.20	3.88	0.12	0.03	0.05	0.59	0.49	0.44	0.01
420	Food and Agriculture	0.58	0.56	0.01	0.00	0.00	0.16	0.07	0.03	0.00
430	Mineral Processes	0.35	0.31	0.29	0.02	0.04	8.22	4.49	2.51	0.08
440	Metal Processes	0.11	0.09	0.25	0.04	0.03	0.38	0.30	0.22	0.00
450	Wood and Paper	0.19	0.19	0.00	0.00	0.00	6.43	4.50	2.70	0.00
460	Glass and Related Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
470	Electronics	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
499	Other (Industrial Processes)	7.01	5.30	0.13	0.05	0.00	1.81	1.12	0.80	9.29
	<b>Total</b>	<b>13.45</b>	<b>10.35</b>	<b>0.79</b>	<b>0.14</b>	<b>0.13</b>	<b>17.60</b>	<b>10.98</b>	<b>6.69</b>	<b>9.39</b>
<b>Solvent Evaporation</b>										
510	Consumer Products	105.32	87.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
520	Architectural Coatings and Related Solvent	12.23	11.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00
530	Pesticides/Fertilizers	1.34	1.34	0.00	0.00	0.00	0.00	0.00	0.00	1.20
540	Asphalt Paving/Roofing	1.06	0.98	0.00	0.00	0.00	0.03	0.02	0.02	0.00
	<b>Total</b>	<b>119.96</b>	<b>101.41</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.03</b>	<b>0.02</b>	<b>0.02</b>	<b>1.20</b>
<b>Miscellaneous Processes</b>										
610	Residential Fuel Combustion	19.29	8.43	46.75	14.56	0.48	7.15	6.79	6.60	0.11
620	Farming Operations	25.38	1.43	0.00	0.00	0.00	1.60	0.78	0.16	8.52
630	Construction and Demolition	0.00	0.00	0.00	0.00	0.00	46.32	22.65	2.27	0.00
640	Paved Road Dust	0.00	0.00	0.00	0.00	0.00	117.88	53.87	8.13	0.00

**Table VIII-2. 2018 Criteria Emissions (tons/day) by Major Source Category for the South Coast Air Basin**

Code	Source Category	TOG	VOC	CO	NOx	SOx	TSP	PM10	PM2.5	NH3
645	Unpaved Road Dust	0.00	0.00	0.00	0.00	0.00	9.87	5.86	0.58	0.00
650	Fugitive Windblown Dust	0.00	0.00	0.00	0.00	0.00	3.20	1.62	0.23	0.00
660	Fires	0.34	0.23	3.02	0.08	0.00	0.45	0.44	0.41	0.00
670	Waste Burning and Disposal	0.81	0.47	6.31	0.19	0.05	0.72	0.70	0.63	0.03
690	Cooking	2.76	1.93	0.00	0.00	0.01	11.46	11.46	11.46	0.00
699	Other (Miscellaneous Processes)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.98
	RECLAIM				17.77	5.48				
	<b>Total</b>	<b>48.57</b>	<b>12.48</b>	<b>56.08</b>	<b>32.59</b>	<b>6.01</b>	<b>198.65</b>	<b>104.17</b>	<b>30.48</b>	<b>34.65</b>
<b>Onroad Motor Vehicles</b>										
710	Light Duty Passenger Auto (LDA)	32.11	28.96	311.82	23.59	0.73	11.62	11.38	4.79	6.16
722	Light Duty Trucks 1 (T1)	7.06	6.41	51.60	5.01	0.07	0.99	0.96	0.42	0.63
723	Light Duty Trucks 2 (T2)	17.98	16.24	160.67	17.21	0.35	4.22	4.13	1.74	3.29
724	Medium Duty Trucks (T3)	14.64	13.17	128.33	14.30	0.27	2.72	2.66	1.13	3.19
732	Light Heavy Duty Gas Trucks 1 (T4)	2.39	2.25	8.59	2.06	0.03	0.33	0.33	0.14	0.25
733	Light Heavy Duty Gas Trucks 2 (T5)	0.49	0.47	1.60	0.46	0.01	0.08	0.08	0.03	0.05
734	Medium Heavy Duty Gas Trucks (T6)	0.49	0.43	4.89	0.84	0.02	0.13	0.12	0.05	0.04
736	Heavy Heavy Duty Gas Trucks ((HHD)	0.22	0.18	5.07	0.70	0.00	0.01	0.01	0.00	0.00
742	Light Heavy Duty Diesel Trucks 1 (T4)	0.36	0.31	1.88	9.34	0.01	0.35	0.34	0.18	0.01
743	Light Heavy Duty Diesel Trucks 2 (T5)	0.14	0.13	0.73	3.51	0.01	0.17	0.17	0.08	0.00
744	Medium Heavy Duty Diesel Truck (T6)	1.64	1.44	5.02	27.69	0.06	1.80	1.78	1.20	0.17
746	Heavy Heavy Duty Diesel Trucks (HHD)	4.00	2.70	14.55	66.49	0.17	2.06	2.04	1.33	0.29
750	Motorcycles (MCY)	10.35	9.09	46.65	2.46	0.00	0.04	0.04	0.02	0.02
760	Diesel Urban Buses (UB)	5.12	0.25	24.41	2.02	0.00	0.07	0.07	0.03	0.00
762	Gas Urban Buses (UB)	0.02	0.02	0.19	0.09	0.01	0.04	0.04	0.01	0.01
771	Gas School Buses (SB)	0.05	0.04	0.42	0.05	0.00	0.06	0.06	0.03	0.00
772	Diesel School Buses (SB)	0.04	0.03	0.12	2.21	0.00	0.18	0.18	0.08	0.01
777	Gas Other Buses (OB)	0.16	0.14	1.67	0.34	0.01	0.06	0.06	0.02	0.02
778	Motor Coaches	0.07	0.06	0.25	1.11	0.00	0.05	0.04	0.03	0.00

**Table VIII-2. 2018 Criteria Emissions (tons/day) by Major Source Category for the South Coast Air Basin**

		TOG	VOC	CO	NOx	SOx	TSP	PM10	PM2.5	NH3
Code	Source Category									
779	Diesel Other Buses (OB)	0.09	0.08	0.26	1.39	0.00	0.08	0.08	0.06	0.01
780	Motor Homes (MH)	0.08	0.07	1.22	0.62	0.01	0.08	0.07	0.04	0.02
	<b>Total</b>	<b>97.51</b>	<b>82.45</b>	<b>769.96</b>	<b>181.50</b>	<b>1.75</b>	<b>25.13</b>	<b>24.65</b>	<b>11.43</b>	<b>14.17</b>
	<b>Other Mobile Sources</b>									
810	Aircraft	3.68	3.63	37.66	15.51	1.77	0.75	0.73	0.66	0.00
820	Trains	1.02	0.85	3.98	17.66	0.01	0.32	0.32	0.30	0.01
833	Ocean Going Vessels	2.61	2.18	3.45	33.35	2.21	0.69	0.69	0.64	0.03
835	Commercial Harbor Crafts	1.27	1.07	6.47	11.45	0.00	0.48	0.48	0.44	0.00
840	Recreational Boats	26.02	22.45	86.44	4.88	0.01	1.54	1.39	1.05	0.01
850	Off-Road Recreational Vehicles	2.63	2.54	3.68	0.07	0.00	0.01	0.01	0.01	0.00
860	Off-Road Equipment	47.83	42.09	544.65	49.95	0.09	3.75	3.57	3.03	0.11
870	Farm Equipment	0.56	0.48	4.92	2.07	0.00	0.14	0.14	0.12	0.00
890	Fuel Storage and Handling	5.48	5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>91.09</b>	<b>80.75</b>	<b>691.25</b>	<b>134.94</b>	<b>4.09</b>	<b>7.69</b>	<b>7.33</b>	<b>6.25</b>	<b>0.15</b>
<b>Total</b>	<b>Stationary</b>	<b>1090.72</b>	<b>206.81</b>	<b>100.67</b>	<b>57.67</b>	<b>8.21</b>	<b>225.30</b>	<b>123.29</b>	<b>44.81</b>	<b>58.61</b>
<b>Total</b>	<b>On-Road Vehicles</b>	<b>97.51</b>	<b>82.45</b>	<b>769.96</b>	<b>181.50</b>	<b>1.75</b>	<b>25.13</b>	<b>24.65</b>	<b>11.43</b>	<b>14.17</b>
<b>Total</b>	<b>Other Mobile</b>	<b>91.09</b>	<b>80.75</b>	<b>691.25</b>	<b>134.94</b>	<b>4.09</b>	<b>7.69</b>	<b>7.33</b>	<b>6.25</b>	<b>0.15</b>
<b>Total</b>	<b>Anthropogenic</b>	<b>1279.32</b>	<b>370.02</b>	<b>1561.87</b>	<b>374.11</b>	<b>14.06</b>	<b>258.12</b>	<b>155.27</b>	<b>62.49</b>	<b>72.93</b>

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Acetalde- hyde	Acetone	Benzene	1,3 Butadiene	Carbon tetrachloride	Chloroform	1,1 Dichloro- ethane	1,4 dioxane	Ethylene dibromide
<b>Fuel Combustion</b>										
10	Electric Utilities	0.04	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00
20	Cogeneration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	Oil and Gas Production (combustion)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	Petroleum Refining (Combustion)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	Manufacturing and Industrial	1.06	1.06	0.72	0.03	0.00	0.00	0.00	0.00	0.00
52	Food and Agricultural Processing	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
60	Service and Commercial	0.19	0.19	22.71	0.00	0.00	0.00	0.00	0.00	0.00
99	Other (Fuel Combustion)	2.55	2.08	0.68	0.02	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>3.85</b>	<b>3.34</b>	<b>24.31</b>	<b>0.05</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Waste Disposal</b>										
110	Sewage Treatment	0.05	0.06	0.15	0.00	0.02	2.62	0.00	0.01	0.01
120	Landfills	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
130	Incineration	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
140	Soil Remediation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
199	Other (Waste Disposal)	0.00	359.57	0.00	0.00	0.00	0.01	0.00	0.00	0.00
	<b>Total</b>	<b>0.05</b>	<b>359.63</b>	<b>0.25</b>	<b>0.00</b>	<b>0.02</b>	<b>2.63</b>	<b>0.00</b>	<b>0.01</b>	<b>0.01</b>
<b>Cleaning and Surface Coatings</b>										
210	Laundering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
220	Degreasing	0.00	76.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
230	Coatings and Related Processes	0.00	77.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
240	Printing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	Adhesives and Sealants	0.00	66.59	0.10	0.00	0.00	0.00	0.00	0.00	0.00
299	Other (Cleaning and Surface Coatings)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>221.24</b>	<b>0.10</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Petroleum Production and Marketing</b>										
310	Oil and Gas Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
320	Petroleum Refining	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Acetalde-		Benzene	1,3	Carbon	1,1 Dichloro-		Ethylene	
		hyde	Acetone		Butadiene	tetrachloride	Chloroform	ethane	1,4 dioxane	dibromide
330	Petroleum Marketing	0.00	0.00	2.84	0.03	0.00	0.00	0.00	0.00	0.00
399	Other (Petroleum Production and Marketing)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>2.84</b>	<b>0.03</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Industrial Processes</b>										
410	Chemical	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
420	Food and Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
430	Mineral Processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
440	Metal Processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
450	Wood and Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
460	Glass and Related Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
470	Electronics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
499	Other (Industrial Processes)	0.13	0.19	0.74	0.06	0.02	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.13</b>	<b>0.19</b>	<b>0.74</b>	<b>0.06</b>	<b>0.02</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Solvent Evaporation</b>										
510	Consumer Products	0.00	413.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00
520	Architectural Coatings and Related Solvent	0.13	34.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
530	Pesticides/Fertilizers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
540	Asphalt Paving/Roofing	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.13</b>	<b>448.35</b>	<b>0.20</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Miscellaneous Processes</b>										
610	Residential Fuel Combustion	68.95	50.88	4.77	0.00	0.00	0.00	0.00	0.00	0.00
620	Farming Operations	0.00	27.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
630	Construction and Demolition	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
640	Paved Road Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
645	Unpaved Road Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650	Fugitive Windblown Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
660	Fires	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00
670	Waste Burning and Disposal	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Acetalde-		Benzene	1,3	Carbon	1,1 Dichloro-		Ethylene	
		hyde	Acetone		Butadiene	tetrachloride	Chloroform	ethane	1,4 dioxane	dibromide
690	Cooking	6.21	0.00	0.35	0.44	0.00	0.00	0.00	0.00	0.00
699	Other (Miscellaneous Processes)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>75.16</b>	<b>78.18</b>	<b>5.12</b>	<b>0.84</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Onroad Motor Vehicles</b>										
710	Light Duty Passenger Auto (LDA)	9.25	5.16	47.09	5.36	0.00	0.00	0.00	0.00	0.00
722	Light Duty Trucks 1 (T1)	1.94	1.29	11.19	0.98	0.00	0.00	0.00	0.00	0.00
723	Light Duty Trucks 2 (T2)	5.36	3.22	28.00	2.96	0.00	0.00	0.00	0.00	0.00
724	Medium Duty Trucks (T3)	4.89	2.88	24.11	2.79	0.00	0.00	0.00	0.00	0.00
732	Light Heavy Duty Gas Trucks 1 (T4)	0.40	0.26	3.36	0.22	0.00	0.00	0.00	0.00	0.00
733	Light Heavy Duty Gas Trucks 2 (T5)	0.09	0.06	0.77	0.05	0.00	0.00	0.00	0.00	0.00
734	Medium Heavy Duty Gas Trucks (T6)	0.32	0.24	1.61	0.14	0.00	0.00	0.00	0.00	0.00
736	Heavy Heavy Duty Gas Trucks ((HHD)	0.35	0.29	1.60	0.15	0.00	0.00	0.00	0.00	0.00
742	Light Heavy Duty Diesel Trucks 1 (T4)	2.22	2.27	0.60	0.06	0.00	0.00	0.00	0.00	0.00
743	Light Heavy Duty Diesel Trucks 2 (T5)	0.94	0.96	0.26	0.02	0.00	0.00	0.00	0.00	0.00
744	Medium Heavy Duty Diesel Truck (T6)	9.48	9.68	2.58	0.24	0.00	0.00	0.00	0.00	0.00
746	Heavy Heavy Duty Diesel Trucks (HHD)	51.62	52.70	14.05	1.33	0.00	0.00	0.00	0.00	0.00
750	Motorcycles (MCY)	5.40	3.53	23.73	3.60	0.00	0.00	0.00	0.00	0.00
760	Diesel Urban Buses (UB)	15.94	16.28	4.34	0.41	0.00	0.00	0.00	0.00	0.00
762	Gas Urban Buses (UB)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
771	Gas School Buses (SB)	0.01	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.00
772	Diesel School Buses (SB)	0.13	0.14	0.04	0.00	0.00	0.00	0.00	0.00	0.00
777	Gas Other Buses (OB)	0.04	0.03	0.17	0.02	0.00	0.00	0.00	0.00	0.00
778	Motor Coaches	0.16	0.17	0.04	0.00	0.00	0.00	0.00	0.00	0.00
779	Diesel Other Buses (OB)	0.23	0.24	0.06	0.01	0.00	0.00	0.00	0.00	0.00
780	Motor Homes (MH)	0.07	0.07	0.12	0.01	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>108.85</b>	<b>99.44</b>	<b>163.78</b>	<b>18.36</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Other Mobile Sources</b>										
810	Aircraft	6.03	0.57	3.16	2.49	0.00	0.00	0.00	0.00	0.00
820	Trains	16.70	17.05	4.55	0.43	0.00	0.00	0.00	0.00	0.00

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Acetalde-		Benzene	1,3	Carbon	1,1 Dichloro-		Ethylene	
		hyde	Acetone		Butadiene	tetrachloride	Chloroform	ethane	1,4 dioxane	dibromide
833	Ocean Going Vessels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
835	Commercial Harbor Crafts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
840	Recreational Boats	7.93	3.83	28.83	6.76	0.00	0.00	0.00	0.00	0.00
850	Off-Road Recreational Vehicles	1.34	0.65	6.54	1.14	0.00	0.00	0.00	0.00	0.00
860	Off-Road Equipment	50.00	41.26	76.61	16.33	0.00	0.00	0.00	0.00	0.00
870	Farm Equipment	7.99	8.06	2.91	0.37	0.00	0.00	0.00	0.00	0.00
890	Fuel Storage and Handling	0.00	0.00	1.81	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>89.99</b>	<b>71.41</b>	<b>124.41</b>	<b>27.52</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Stationary</b>	<b>79.32</b>	<b>1110.93</b>	<b>33.57</b>	<b>0.99</b>	<b>0.04</b>	<b>2.63</b>	<b>0.00</b>	<b>0.01</b>	<b>0.01</b>
<b>Total</b>	<b>On-Road Vehicles</b>	<b>108.85</b>	<b>99.44</b>	<b>163.78</b>	<b>18.36</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Other Mobile</b>	<b>89.99</b>	<b>71.41</b>	<b>124.41</b>	<b>27.52</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Anthropogenic</b>	<b>278.16</b>	<b>1281.79</b>	<b>321.77</b>	<b>46.87</b>	<b>0.04</b>	<b>2.63</b>	<b>0.00</b>	<b>0.01</b>	<b>0.01</b>

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Ethylene dichloride	Ethylene oxide	Formaldehyde	Methyl ethyl ketone	Methylene chloride	MTBE	Naphthalene	p-Dichlorobenzene	Perchloroethylene
<b>Fuel Combustion</b>										
10	Electric Utilities	0.00	0.00	1.11	0.00	0.00	0.00	0.00	0.00	0.00
20	Cogeneration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	Oil and Gas Production (combustion)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	Petroleum Refining (Combustion)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	Manufacturing and Industrial	0.00	0.00	34.91	0.21	0.00	0.00	0.01	0.00	0.00
52	Food and Agricultural Processing	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00
60	Service and Commercial	0.00	0.00	45.20	0.04	0.00	0.00	0.00	0.00	0.00
99	Other (Fuel Combustion)	0.00	0.00	3.56	0.14	0.00	0.00	0.01	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>84.88</b>	<b>0.39</b>	<b>0.00</b>	<b>0.00</b>	<b>0.02</b>	<b>0.00</b>	<b>0.00</b>
<b>Waste Disposal</b>										
110	Sewage Treatment	0.01	0.00	0.28	0.00	4.02	0.00	0.00	0.40	3.28
120	Landfills	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
130	Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
140	Soil Remediation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
199	Other (Waste Disposal)	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01
	<b>Total</b>	<b>0.01</b>	<b>0.00</b>	<b>0.28</b>	<b>0.00</b>	<b>4.04</b>	<b>0.00</b>	<b>0.00</b>	<b>0.40</b>	<b>3.29</b>
<b>Cleaning and Surface Coatings</b>										
210	Laundering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.27
220	Degreasing	0.00	0.00	0.00	32.59	171.41	0.00	0.00	0.00	4.48
230	Coatings and Related Processes	0.00	0.00	0.00	228.32	0.00	0.00	0.00	0.00	10.10
240	Printing	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
250	Adhesives and Sealants	0.00	0.00	0.00	55.99	1.91	0.00	0.00	0.00	0.00
299	Other (Cleaning and Surface Coatings)	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.05
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>316.90</b>	<b>173.36</b>	<b>0.00</b>	<b>0.10</b>	<b>0.00</b>	<b>47.90</b>
<b>Petroleum Production and Marketing</b>										
310	Oil and Gas Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
320	Petroleum Refining	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Ethylene dichloride	Ethylene oxide	Formaldehyde	Methyl ethyl ketone	Methylene chloride	MTBE	Naphthalene	p-Dichlorobenzene	Perchloroethylene
330	Petroleum Marketing	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00
399	Other (Petroleum Production and Marketing)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.19</b>	<b>0.00</b>	<b>0.00</b>
<b>Industrial Processes</b>										
410	Chemical	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
420	Food and Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
430	Mineral Processes	0.00	0.00	0.00	0.00	0.00	0.00	1.39	0.00	0.00
440	Metal Processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
450	Wood and Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
460	Glass and Related Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
470	Electronics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
499	Other (Industrial Processes)	0.18	0.01	0.19	0.13	0.51	0.00	0.01	0.23	1.72
	<b>Total</b>	<b>0.18</b>	<b>0.01</b>	<b>0.19</b>	<b>0.13</b>	<b>0.51</b>	<b>0.00</b>	<b>1.40</b>	<b>0.23</b>	<b>1.72</b>
<b>Solvent Evaporation</b>										
510	Consumer Products	0.00	0.00	0.16	28.94	128.54	0.00	0.20	66.92	17.88
520	Architectural Coatings and Related Solvent	0.00	0.00	0.00	0.77	1.48	0.00	0.09	0.00	0.50
530	Pesticides/Fertilizers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
540	Asphalt Paving/Roofing	0.00	0.00	0.00	0.00	0.00	0.00	5.58	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>0.16</b>	<b>29.71</b>	<b>130.02</b>	<b>0.00</b>	<b>5.87</b>	<b>66.92</b>	<b>18.38</b>
<b>Miscellaneous Processes</b>										
610	Residential Fuel Combustion	0.00	0.00	83.81	0.00	0.00	0.00	0.00	0.00	0.00
620	Farming Operations	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
630	Construction and Demolition	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
640	Paved Road Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
645	Unpaved Road Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650	Fugitive Windblown Dust	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
660	Fires	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
670	Waste Burning and Disposal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Ethylene dichloride	Ethylene oxide	Formaldehyde	Methyl ethyl ketone	Methylene chloride	MTBE	Naphthalene	p-Dichlorobenzene	Perchloroethylene
690	Cooking	0.00	0.00	6.77	0.00	0.00	0.00	0.06	0.00	0.00
699	Other (Miscellaneous Processes)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>90.58</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.06</b>	<b>0.00</b>	<b>0.00</b>
<b>Onroad Motor Vehicles</b>										
710	Light Duty Passenger Auto (LDA)	0.00	0.00	17.54	1.08	0.00	1.84	1.63	0.00	0.00
722	Light Duty Trucks 1 (T1)	0.00	0.00	4.02	0.25	0.00	0.55	0.47	0.00	0.00
723	Light Duty Trucks 2 (T2)	0.00	0.00	10.65	0.65	0.00	1.31	1.13	0.00	0.00
724	Medium Duty Trucks (T3)	0.00	0.00	9.82	0.58	0.00	1.09	0.97	0.00	0.00
732	Light Heavy Duty Gas Trucks 1 (T4)	0.00	0.00	0.84	0.05	0.00	0.11	0.09	0.00	0.00
733	Light Heavy Duty Gas Trucks 2 (T5)	0.00	0.00	0.18	0.01	0.00	0.02	0.02	0.00	0.00
734	Medium Heavy Duty Gas Trucks (T6)	0.00	0.00	0.70	0.05	0.00	0.12	0.10	0.00	0.00
736	Heavy Heavy Duty Gas Trucks (HHD)	0.00	0.00	0.89	0.05	0.00	0.13	0.12	0.00	0.00
742	Light Heavy Duty Diesel Trucks 1 (T4)	0.00	0.00	4.44	0.45	0.00	0.00	0.03	0.00	0.00
743	Light Heavy Duty Diesel Trucks 2 (T5)	0.00	0.00	1.88	0.19	0.00	0.00	0.01	0.00	0.00
744	Medium Heavy Duty Diesel Truck (T6)	0.00	0.00	18.97	1.90	0.00	0.00	0.11	0.00	0.00
746	Heavy Heavy Duty Diesel Trucks (HHD)	0.00	0.00	103.30	10.37	0.00	0.00	0.60	0.00	0.00
750	Motorcycles (MCY)	0.00	0.00	14.93	0.58	0.00	1.05	1.25	0.00	0.00
760	Diesel Urban Buses (UB)	0.00	0.00	31.91	3.20	0.00	0.00	0.18	0.00	0.00
762	Gas Urban Buses (UB)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
771	Gas School Buses (SB)	0.00	0.00	0.03	0.00	0.00	0.01	0.01	0.00	0.00
772	Diesel School Buses (SB)	0.00	0.00	0.27	0.03	0.00	0.00	0.00	0.00	0.00
777	Gas Other Buses (OB)	0.00	0.00	0.08	0.01	0.00	0.01	0.01	0.00	0.00
778	Motor Coaches	0.00	0.00	0.33	0.03	0.00	0.00	0.00	0.00	0.00
779	Diesel Other Buses (OB)	0.00	0.00	0.46	0.05	0.00	0.00	0.00	0.00	0.00
780	Motor Homes (MH)	0.00	0.00	0.15	0.01	0.00	0.01	0.01	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>221.39</b>	<b>19.53</b>	<b>0.00</b>	<b>6.25</b>	<b>6.74</b>	<b>0.00</b>	<b>0.00</b>
<b>Other Mobile Sources</b>										
810	Aircraft	0.00	0.00	17.22	0.02	0.00	0.06	0.77	0.00	0.00
820	Trains	0.00	0.00	33.42	3.36	0.00	0.00	0.19	0.00	0.00

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Ethylene dichloride	Ethylene oxide	Formaldehyde	Methyl ethyl ketone	Methylene chloride	MTBE	Naphthalene	p-Dichlorobenzene	Perchloroethylene
833	Ocean Going Vessels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
835	Commercial Harbor Crafts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
840	Recreational Boats	0.00	0.00	24.40	0.50	0.00	0.00	1.08	0.00	0.00
850	Off-Road Recreational Vehicles	0.00	0.00	4.12	0.08	0.00	0.00	0.18	0.00	0.00
860	Off-Road Equipment	0.00	0.00	119.68	7.53	0.00	0.00	2.85	0.00	0.00
870	Farm Equipment	0.00	0.00	16.21	1.58	0.00	0.00	0.12	0.00	0.00
890	Fuel Storage and Handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>215.06</b>	<b>13.06</b>	<b>0.00</b>	<b>0.06</b>	<b>5.20</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Stationary</b>	<b>0.19</b>	<b>0.01</b>	<b>176.09</b>	<b>347.14</b>	<b>307.92</b>	<b>0.00</b>	<b>7.66</b>	<b>67.55</b>	<b>71.29</b>
<b>Total</b>	<b>On-Road Vehicles</b>	<b>0.00</b>	<b>0.00</b>	<b>221.39</b>	<b>19.53</b>	<b>0.00</b>	<b>6.25</b>	<b>6.74</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Other Mobile</b>	<b>0.00</b>	<b>0.00</b>	<b>215.06</b>	<b>13.06</b>	<b>0.00</b>	<b>0.06</b>	<b>5.20</b>	<b>0.00</b>	<b>0.00</b>
<b>Total</b>	<b>Anthropogenic</b>	<b>0.19</b>	<b>0.01</b>	<b>612.54</b>	<b>379.72</b>	<b>307.92</b>	<b>6.30</b>	<b>19.60</b>	<b>67.55</b>	<b>71.29</b>

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Propylene oxide	Styrene	Toluene	Trichloro- ethylene	Vinyl chloride	Arsenic	Cadmium	Chromium	Diesel PM (DPM)
<b>Fuel Combustion</b>										
10	Electric Utilities	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.04
20	Cogeneration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	Oil and Gas Production (combustion)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	Petroleum Refining (Combustion)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	Manufacturing and Industrial	0.00	0.01	0.42	0.00	0.00	0.00	0.00	0.00	0.25
52	Food and Agricultural Processing	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
60	Service and Commercial	0.00	0.00	10.84	0.00	0.00	0.00	0.00	0.00	2.05
99	Other (Fuel Combustion)	0.00	0.01	0.77	0.00	0.00	0.00	0.07	0.00	3.60
	<b>Total</b>	<b>0.00</b>	<b>0.02</b>	<b>12.11</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.07</b>	<b>0.00</b>	<b>5.94</b>
<b>Waste Disposal</b>										
110	Sewage Treatment	0.00	0.01	1.86	0.40	0.02	0.00	0.00	0.00	0.00
120	Landfills	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
130	Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
140	Soil Remediation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
199	Other (Waste Disposal)	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.01</b>	<b>1.87</b>	<b>0.40</b>	<b>0.02</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Cleaning and Surface Coatings</b>										
210	Laundering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
220	Degreasing	0.00	0.00	5.81	0.74	0.00	0.00	0.00	0.00	0.00
230	Coatings and Related Processes	0.00	0.00	508.30	0.00	0.00	0.00	0.20	0.00	0.00
240	Printing	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00
250	Adhesives and Sealants	0.00	0.00	17.15	0.00	0.00	0.00	0.00	0.00	0.00
299	Other (Cleaning and Surface Coatings)	0.00	0.00	0.05	0.03	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>531.46</b>	<b>0.78</b>	<b>0.00</b>	<b>0.00</b>	<b>0.20</b>	<b>0.00</b>	<b>0.00</b>
<b>Petroleum Production and Marketing</b>										
310	Oil and Gas Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
320	Petroleum Refining	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Propylene oxide	Styrene	Toluene	Trichloro- ethylene	Vinyl chloride	Arsenic	Cadmium	Chromium	Diesel PM (DPM)
330	Petroleum Marketing	0.00	0.00	10.77	0.00	0.00	0.00	0.00	0.00	0.00
399	Other (Petroleum Production and Marketing)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>10.77</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Industrial Processes</b>										
410	Chemical	0.00	98.16	0.00	0.00	26.52	0.00	0.01	0.00	0.00
420	Food and Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
430	Mineral Processes	0.00	0.00	1.49	0.00	0.00	0.36	0.00	0.60	0.00
440	Metal Processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
450	Wood and Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
460	Glass and Related Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
470	Electronics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
499	Other (Industrial Processes)	0.00	5.43	0.19	0.20	0.11	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>103.59</b>	<b>1.68</b>	<b>0.20</b>	<b>26.63</b>	<b>0.36</b>	<b>0.01</b>	<b>0.60</b>	<b>0.00</b>
<b>Solvent Evaporation</b>										
510	Consumer Products	0.01	22.66	123.41	10.91	0.00	0.00	0.00	0.00	0.00
520	Architectural Coatings and Related Solvent	0.00	0.03	2.94	0.00	0.00	0.00	0.00	0.00	0.00
530	Pesticides/Fertilizers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
540	Asphalt Paving/Roofing	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.01</b>	<b>22.69</b>	<b>126.83</b>	<b>10.91</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Miscellaneous Processes</b>										
610	Residential Fuel Combustion	0.00	0.00	24.14	0.00	0.00	0.01	0.00	0.04	0.00
620	Farming Operations	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.38	0.00
630	Construction and Demolition	0.00	0.00	0.00	0.00	0.00	0.76	0.94	10.05	0.00
640	Paved Road Dust	0.00	0.00	0.00	0.00	0.00	0.23	0.05	0.30	0.00
645	Unpaved Road Dust	0.00	0.00	0.00	0.00	0.00	0.09	0.08	0.10	0.00
650	Fugitive Windblown Dust	0.00	0.00	0.00	0.00	0.00	0.05	0.08	0.79	0.00
660	Fires	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
670	Waste Burning and Disposal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Propylene oxide	Styrene	Toluene	Trichloro- ethylene	Vinyl chloride	Arsenic	Cadmium	Chromium	Diesel PM (DPM)
690	Cooking	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.01	0.00
699	Other (Miscellaneous Processes)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>24.31</b>	<b>0.00</b>	<b>0.00</b>	<b>1.17</b>	<b>1.19</b>	<b>11.67</b>	<b>0.00</b>
<b>Onroad Motor Vehicles</b>										
710	Light Duty Passenger Auto (LDA)	0.00	2.58	133.50	0.00	0.00	0.01	0.00	0.66	1.84
722	Light Duty Trucks 1 (T1)	0.00	0.52	30.26	0.00	0.00	0.00	0.00	0.06	0.25
723	Light Duty Trucks 2 (T2)	0.00	1.48	75.55	0.00	0.00	0.00	0.00	0.26	0.09
724	Medium Duty Trucks (T3)	0.00	1.32	64.15	0.00	0.00	0.00	0.00	0.19	0.37
732	Light Heavy Duty Gas Trucks 1 (T4)	0.00	0.11	11.11	0.00	0.00	0.00	0.00	0.03	0.00
733	Light Heavy Duty Gas Trucks 2 (T5)	0.00	0.03	2.57	0.00	0.00	0.00	0.00	0.01	0.00
734	Medium Heavy Duty Gas Trucks (T6)	0.00	0.08	3.57	0.00	0.00	0.00	0.00	0.02	0.00
736	Heavy Heavy Duty Gas Trucks ((HHD)	0.00	0.07	2.81	0.00	0.00	0.00	0.00	0.00	0.00
742	Light Heavy Duty Diesel Trucks 1 (T4)	0.00	0.02	0.44	0.00	0.00	0.00	0.00	0.02	6.10
743	Light Heavy Duty Diesel Trucks 2 (T5)	0.00	0.01	0.19	0.00	0.00	0.00	0.00	0.01	2.65
744	Medium Heavy Duty Diesel Truck (T6)	0.00	0.07	1.90	0.00	0.00	0.00	0.00	0.14	94.19
746	Heavy Heavy Duty Diesel Trucks (HHD)	0.00	0.41	10.34	0.00	0.00	0.00	0.00	0.40	302.02
750	Motorcycles (MCY)	0.00	1.04	48.54	0.00	0.00	0.00	0.00	0.00	0.00
760	Diesel Urban Buses (UB)	0.00	0.13	3.19	0.00	0.00	0.00	0.00	0.00	0.24
762	Gas Urban Buses (UB)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
771	Gas School Buses (SB)	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.01	0.00
772	Diesel School Buses (SB)	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.59
777	Gas Other Buses (OB)	0.00	0.01	0.33	0.00	0.00	0.00	0.00	0.00	0.00
778	Motor Coaches	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	1.00
779	Diesel Other Buses (OB)	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	1.80
780	Motor Homes (MH)	0.00	0.01	0.19	0.00	0.00	0.00	0.00	0.00	1.41
	<b>Total</b>	<b>0.00</b>	<b>7.88</b>	<b>388.84</b>	<b>0.00</b>	<b>0.00</b>	<b>0.01</b>	<b>0.00</b>	<b>1.84</b>	<b>412.55</b>
<b>Other Mobile Sources</b>										
810	Aircraft	0.00	0.49	2.53	0.00	0.00	0.00	0.00	0.02	0.00
820	Trains	0.00	0.13	3.35	0.00	0.00	0.00	0.01	0.00	78.43

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Propylene		Toluene	Trichloro-ethylene	Vinyl chloride	Arsenic	Cadmium	Chromium	Diesel PM (DPM)
		oxide	Styrene							
833	Ocean Going Vessels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
835	Commercial Harbor Crafts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
840	Recreational Boats	0.00	1.09	60.58	0.00	0.00	0.00	0.00	0.02	0.12
850	Off-Road Recreational Vehicles	0.00	0.18	14.19	0.00	0.00	0.00	0.00	0.00	0.00
860	Off-Road Equipment	0.00	2.73	148.02	0.00	0.00	0.00	0.00	0.06	170.95
870	Farm Equipment	0.00	0.09	3.24	0.00	0.00	0.00	0.00	0.00	36.94
890	Fuel Storage and Handling	0.00	0.00	4.45	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>4.71</b>	<b>236.35</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.01</b>	<b>0.11</b>	<b>286.43</b>
<b>Total</b>	<b>Stationary</b>	<b>0.01</b>	<b>126.31</b>	<b>709.02</b>	<b>12.29</b>	<b>26.65</b>	<b>1.53</b>	<b>1.47</b>	<b>12.27</b>	<b>5.94</b>
<b>Total</b>	<b>On-Road Vehicles</b>	<b>0.00</b>	<b>7.88</b>	<b>388.84</b>	<b>0.00</b>	<b>0.00</b>	<b>0.01</b>	<b>0.00</b>	<b>1.84</b>	<b>412.55</b>
<b>Total</b>	<b>Other Mobile</b>	<b>0.00</b>	<b>4.71</b>	<b>236.35</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.01</b>	<b>0.11</b>	<b>286.43</b>
<b>Total</b>	<b>Anthropogenic</b>	<b>0.01</b>	<b>138.90</b>	<b>1334.21</b>	<b>12.29</b>	<b>26.65</b>	<b>1.54</b>	<b>1.49</b>	<b>14.22</b>	<b>704.93</b>

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Elemental		Hexavalent			Organic			
		DPM2.5	carbon (EC)	EC2.5	chromium	Lead	Nickel	carbon	Selenium	Silicon
<b>Fuel Combustion</b>										
10	Electric Utilities	0.04	0.80	0.79	0.00	0.00	0.01	20.93	0.00	0.55
20	Cogeneration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	Oil and Gas Production (combustion)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	Petroleum Refining (Combustion)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	Manufacturing and Industrial	0.24	0.83	0.80	0.00	0.00	0.01	13.85	0.00	0.42
52	Food and Agricultural Processing	0.00	0.09	0.09	0.00	0.00	0.00	0.42	0.00	0.04
60	Service and Commercial	1.93	3.37	3.28	0.00	0.01	0.04	35.13	0.00	1.12
99	Other (Fuel Combustion)	3.42	3.19	3.05	0.00	0.00	0.00	11.59	0.00	3.64
	<b>Total</b>	<b>5.63</b>	<b>8.29</b>	<b>8.00</b>	<b>0.00</b>	<b>0.01</b>	<b>0.06</b>	<b>81.93</b>	<b>0.00</b>	<b>5.77</b>
<b>Waste Disposal</b>										
110	Sewage Treatment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
120	Landfills	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
130	Incineration	0.00	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00
140	Soil Remediation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
199	Other (Waste Disposal)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>0.12</b>	<b>0.12</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
<b>Cleaning and Surface Coatings</b>										
210	Laundering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
220	Degreasing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
230	Coatings and Related Processes	0.00	1.44	1.33	0.00	0.00	0.00	32.24	0.00	10.89
240	Printing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	Adhesives and Sealants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
299	Other (Cleaning and Surface Coatings)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>1.44</b>	<b>1.33</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>32.24</b>	<b>0.00</b>	<b>10.89</b>
<b>Petroleum Production and Marketing</b>										
310	Oil and Gas Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
320	Petroleum Refining	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Elemental		Hexavalent			Organic			Silicon
		DPM2.5	carbon (EC)	EC2.5	chromium	Lead	Nickel	carbon	Selenium	
330	Petroleum Marketing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
399	Other (Petroleum Production and Marketing)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>								
<b>Industrial Processes</b>										
410	Chemical	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
420	Food and Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
430	Mineral Processes	0.00	4.97	5.06	0.00	0.00	0.17	0.02	0.00	138.74
440	Metal Processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
450	Wood and Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
460	Glass and Related Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
470	Electronics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
499	Other (Industrial Processes)	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.00	1.23
	<b>Total</b>	<b>0.00</b>	<b>4.98</b>	<b>5.06</b>	<b>0.00</b>	<b>0.00</b>	<b>0.18</b>	<b>0.06</b>	<b>0.00</b>	<b>139.97</b>
<b>Solvent Evaporation</b>										
510	Consumer Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
520	Architectural Coatings and Related Solvent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
530	Pesticides/Fertilizers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
540	Asphalt Paving/Roofing	0.00	0.01	0.01	0.00	0.00	0.00	0.28	0.00	0.10
	<b>Total</b>	<b>0.00</b>	<b>0.01</b>	<b>0.01</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.28</b>	<b>0.00</b>	<b>0.10</b>
<b>Miscellaneous Processes</b>										
610	Residential Fuel Combustion	0.00	119.17	86.11	0.00	0.01	0.06	328.43	0.04	0.19
620	Farming Operations	0.00	8.09	0.44	0.00	0.11	0.09	49.39	0.00	345.83
630	Construction and Demolition	0.00	207.45	13.58	0.00	24.99	2.65	1971.97	0.09	8533.57
640	Paved Road Dust	0.00	135.16	9.33	0.00	2.17	0.21	1046.25	0.04	5318.19
645	Unpaved Road Dust	0.00	6.84	0.40	0.00	0.76	0.22	197.96	0.02	1909.04
650	Fugitive Windblown Dust	0.00	8.47	0.52	0.00	1.86	0.20	99.91	0.00	670.83
660	Fires	0.00	5.11	4.53	0.00	0.00	0.00	4.30	0.00	0.99
670	Waste Burning and Disposal	0.00	3.98	3.55	0.00	0.00	0.00	7.77	0.00	0.15

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Elemental		Hexavalent			Organic			
		DPM2.5	carbon (EC)	EC2.5	chromium	Lead	Nickel	carbon	Selenium	Silicon
690	Cooking	0.00	27.07	27.07	0.00	0.07	0.02	348.00	0.00	1.34
699	Other (Miscellaneous Processes)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>0.00</b>	<b>521.36</b>	<b>145.54</b>	<b>0.00</b>	<b>29.98</b>	<b>3.44</b>	<b>4054.00</b>	<b>0.19</b>	<b>16780.13</b>
<b>Onroad Motor Vehicles</b>										
710	Light Duty Passenger Auto (LDA)	1.75	46.61	18.38	0.01	0.06	0.36	123.68	0.01	37.38
722	Light Duty Trucks 1 (T1)	0.23	4.65	2.08	0.00	0.01	0.03	11.80	0.00	3.35
723	Light Duty Trucks 2 (T2)	0.08	18.79	7.41	0.00	0.02	0.15	49.66	0.01	15.05
724	Medium Duty Trucks (T3)	0.35	13.29	5.27	0.00	0.02	0.10	35.24	0.00	10.62
732	Light Heavy Duty Gas Trucks 1 (T4)	0.00	1.20	0.46	0.00	0.00	0.01	3.65	0.00	1.53
733	Light Heavy Duty Gas Trucks 2 (T5)	0.00	0.33	0.12	0.00	0.00	0.00	1.04	0.00	0.46
734	Medium Heavy Duty Gas Trucks (T6)	0.00	0.73	0.27	0.00	0.00	0.01	2.31	0.00	1.03
736	Heavy Heavy Duty Gas Trucks ((HHD)	0.00	0.08	0.03	0.00	0.00	0.00	0.21	0.00	0.05
742	Light Heavy Duty Diesel Trucks 1 (T4)	5.81	2.74	1.91	0.00	0.00	0.01	7.70	0.00	1.35
743	Light Heavy Duty Diesel Trucks 2 (T5)	2.52	1.22	0.84	0.00	0.00	0.01	3.48	0.00	0.67
744	Medium Heavy Duty Diesel Truck (T6)	89.57	23.49	20.33	0.00	0.00	0.05	30.93	0.00	4.94
746	Heavy Heavy Duty Diesel Trucks (HHD)	287.22	90.74	66.54	0.00	0.03	0.14	140.66	0.01	13.34
750	Motorcycles (MCY)	0.00	0.32	0.14	0.00	0.00	0.00	0.83	0.00	0.17
760	Diesel Urban Buses (UB)	0.23	0.37	0.15	0.00	0.00	0.00	0.97	0.00	0.20
762	Gas Urban Buses (UB)	0.00	0.24	0.07	0.00	0.00	0.00	0.58	0.00	0.11
771	Gas School Buses (SB)	0.00	0.14	0.06	0.00	0.00	0.00	0.57	0.00	0.34
772	Diesel School Buses (SB)	0.56	0.34	0.16	0.00	0.00	0.01	1.36	0.00	0.67
777	Gas Other Buses (OB)	0.00	0.19	0.07	0.00	0.00	0.00	0.60	0.00	0.27
778	Motor Coaches	0.95	0.15	0.12	0.00	0.00	0.00	0.43	0.00	0.06
779	Diesel Other Buses (OB)	1.71	0.33	0.24	0.00	0.00	0.00	0.95	0.00	0.18
780	Motor Homes (MH)	1.34	0.55	0.42	0.00	0.00	0.00	1.55	0.00	0.26
	<b>Total</b>	<b>392.34</b>	<b>206.49</b>	<b>125.09</b>	<b>0.02</b>	<b>0.15</b>	<b>0.90</b>	<b>418.19</b>	<b>0.03</b>	<b>92.00</b>
<b>Other Mobile Sources</b>										
810	Aircraft	0.00	11.31	9.54	0.00	0.03	0.04	30.81	0.00	0.58
820	Trains	71.63	20.17	18.94	0.00	0.00	0.00	53.89	0.00	0.23

**Table VIII-3. 2018 Air Toxics Emissions (lbs/day) by Major Sources Category for the Coachella Valley**

Code	Source Category	Elemental		Hexavalent		Organic				
		DPM2.5	carbon (EC)	EC2.5	chromium	Lead	Nickel	carbon	Selenium	Silicon
833	Ocean Going Vessels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
835	Commercial Harbor Crafts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
840	Recreational Boats	0.10	8.11	5.54	0.00	0.06	0.06	31.12	0.00	0.82
850	Off-Road Recreational Vehicles	0.00	0.36	0.25	0.00	0.00	0.00	1.40	0.00	0.04
860	Off-Road Equipment	157.14	126.58	111.46	0.00	0.16	0.16	120.88	0.00	2.52
870	Farm Equipment	34.08	23.20	21.34	0.00	0.00	0.00	9.83	0.00	0.11
890	Fuel Storage and Handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>262.96</b>	<b>189.73</b>	<b>167.06</b>	<b>0.01</b>	<b>0.26</b>	<b>0.27</b>	<b>247.94</b>	<b>0.00</b>	<b>4.29</b>
<b>Total</b>	<b>Stationary</b>	<b>5.63</b>	<b>536.19</b>	<b>160.06</b>	<b>0.00</b>	<b>30.00</b>	<b>3.69</b>	<b>4168.51</b>	<b>0.19</b>	<b>16936.87</b>
<b>Total</b>	<b>On-Road Vehicles</b>	<b>392.34</b>	<b>206.49</b>	<b>125.09</b>	<b>0.02</b>	<b>0.15</b>	<b>0.90</b>	<b>418.19</b>	<b>0.03</b>	<b>92.00</b>
<b>Total</b>	<b>Other Mobile</b>	<b>262.96</b>	<b>189.73</b>	<b>167.06</b>	<b>0.01</b>	<b>0.26</b>	<b>0.27</b>	<b>247.94</b>	<b>0.00</b>	<b>4.29</b>
<b>Total</b>	<b>Anthropogenic</b>	<b>660.93</b>	<b>932.41</b>	<b>452.22</b>	<b>0.02</b>	<b>30.40</b>	<b>4.86</b>	<b>4834.63</b>	<b>0.23</b>	<b>17033.16</b>

**Table VIII-4. 2018 Criteria Emissions (tons/day) by Major Source Category for the Coachella Valley**

Code	Source Category	TOG	VOC	CO	NOx	SOx	TSP	PM10	PM2.5	NH3
<b>Fuel Combustion</b>										
10	Electric Utilities	0.07	0.01	0.03	0.00	0.00	0.02	0.02	0.02	0.02
20	Cogeneration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	Oil and Gas Production (combustion)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	Petroleum Refining (Combustion)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	Manufacturing and Industrial	0.25	0.16	0.39	0.29	0.02	0.01	0.01	0.01	0.00
52	Food and Agricultural Processing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	Service and Commercial	0.29	0.13	0.39	0.31	0.01	0.03	0.03	0.03	0.01
99	Other (Fuel Combustion)	0.03	0.02	0.12	0.60	0.15	0.03	0.03	0.02	0.00
	<b>Total</b>	<b>0.65</b>	<b>0.31</b>	<b>0.94</b>	<b>1.20</b>	<b>0.19</b>	<b>0.08</b>	<b>0.08</b>	<b>0.08</b>	<b>0.04</b>
<b>Waste Disposal</b>										
110	Sewage Treatment	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
120	Landfills	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
130	Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
140	Soil Remediation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
199	Other (Waste Disposal)	8.99	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.12
	<b>Total</b>	<b>9.01</b>	<b>0.73</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.13</b>
<b>Cleaning and Surface Coatings</b>										
210	Laundering	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
220	Degreasing	1.59	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
230	Coatings and Related Processes	1.32	1.27	0.00	0.00	0.00	0.07	0.07	0.07	0.00
240	Printing	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	Adhesives and Sealants	0.27	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
299	Other (Cleaning and Surface Coatings)	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>3.33</b>	<b>1.82</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.07</b>	<b>0.07</b>	<b>0.07</b>	<b>0.00</b>
<b>Petroleum Production and Marketing</b>										
310	Oil and Gas Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
320	Petroleum Refining	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table VIII-4. 2018 Criteria Emissions (tons/day) by Major Source Category for the Coachella Valley**

Code	Source Category	TOG	VOC	CO	NOx	SOx	TSP	PM10	PM2.5	NH3
330	Petroleum Marketing	1.35	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
399	Other (Petroleum Production and Marketing)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>1.35</b>	<b>0.34</b>	<b>0.00</b>						
<b>Industrial Processes</b>										
410	Chemical	0.12	0.09	0.00	0.00	0.00	0.01	0.01	0.01	0.00
420	Food and Agriculture	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
430	Mineral Processes	0.02	0.02	0.00	0.00	0.00	0.24	0.09	0.03	0.00
440	Metal Processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
450	Wood and Paper	0.00	0.00	0.00	0.00	0.00	0.23	0.16	0.09	0.00
460	Glass and Related Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
470	Electronics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
499	Other (Industrial Processes)	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	<b>Total</b>	<b>0.24</b>	<b>0.20</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.48</b>	<b>0.26</b>	<b>0.14</b>	<b>0.02</b>
<b>Solvent Evaporation</b>										
510	Consumer Products	3.09	2.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
520	Architectural Coatings and Related Solvent	0.38	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
530	Pesticides/Fertilizers	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.57
540	Asphalt Paving/Roofing	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>3.83</b>	<b>3.30</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.57</b>
<b>Miscellaneous Processes</b>										
610	Residential Fuel Combustion	0.94	0.41	2.13	0.38	0.02	0.30	0.29	0.28	0.00
620	Farming Operations	0.68	0.05	0.00	0.00	0.00	0.92	0.42	0.06	0.27
630	Construction and Demolition	0.00	0.00	0.00	0.00	0.00	22.43	10.97	1.10	0.00
640	Paved Road Dust	0.00	0.00	0.00	0.00	0.00	8.76	4.00	0.60	0.00
645	Unpaved Road Dust	0.00	0.00	0.00	0.00	0.00	2.94	1.75	0.17	0.00
650	Fugitive Windblown Dust	0.00	0.00	0.00	0.00	0.00	1.73	0.92	0.13	0.00
660	Fires	0.01	0.01	0.08	0.00	0.00	0.01	0.01	0.01	0.00
670	Waste Burning and Disposal	0.01	0.01	0.09	0.00	0.00	0.01	0.01	0.01	0.00
690	Cooking	0.06	0.05	0.00	0.00	0.00	0.26	0.26	0.26	0.00

**Table VIII-4. 2018 Criteria Emissions (tons/day) by Major Source Category for the Coachella Valley**

Code	Source Category	TOG	VOC	CO	NOx	SOx	TSP	PM10	PM2.5	NH3
699	Other (Miscellaneous Processes)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81
	RECLAIM				0.11	0.00				
	<b>Total</b>	<b>1.71</b>	<b>0.52</b>	<b>2.29</b>	<b>0.49</b>	<b>0.02</b>	<b>37.36</b>	<b>18.62</b>	<b>2.63</b>	<b>1.08</b>
<b>Onroad Motor Vehicles</b>										
710	Light Duty Passenger Auto (LDA)	1.10	1.03	8.93	0.67	0.02	0.34	0.33	0.14	0.18
722	Light Duty Trucks 1 (T1)	0.26	0.24	1.86	0.18	0.00	0.03	0.03	0.01	0.02
723	Light Duty Trucks 2 (T2)	0.63	0.58	5.47	0.58	0.01	0.14	0.13	0.06	0.11
724	Medium Duty Trucks (T3)	0.53	0.48	4.40	0.50	0.01	0.10	0.09	0.04	0.12
732	Light Heavy Duty Gas Trucks 1 (T4)	0.09	0.08	0.30	0.08	0.00	0.01	0.01	0.01	0.01
733	Light Heavy Duty Gas Trucks 2 (T5)	0.02	0.02	0.06	0.02	0.00	0.00	0.00	0.00	0.00
734	Medium Heavy Duty Gas Trucks (T6)	0.03	0.03	0.32	0.07	0.00	0.01	0.01	0.00	0.00
736	Heavy Heavy Duty Gas Trucks ((HHD)	0.03	0.02	0.78	0.12	0.00	0.00	0.00	0.00	0.00
742	Light Heavy Duty Diesel Trucks 1 (T4)	0.02	0.01	0.10	0.46	0.00	0.01	0.01	0.01	0.00
743	Light Heavy Duty Diesel Trucks 2 (T5)	0.01	0.01	0.04	0.19	0.00	0.01	0.01	0.00	0.00
744	Medium Heavy Duty Diesel Truck (T6)	0.06	0.06	0.22	1.24	0.00	0.09	0.09	0.06	0.01
746	Heavy Heavy Duty Diesel Trucks (HHD)	0.35	0.29	1.78	7.79	0.02	0.30	0.30	0.20	0.04
750	Motorcycles (MCY)	0.42	0.37	2.20	0.11	0.00	0.00	0.00	0.00	0.00
760	Diesel Urban Buses (UB)	0.11	0.01	0.53	0.04	0.00	0.00	0.00	0.00	0.00
762	Gas Urban Buses (UB)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
771	Gas School Buses (SB)	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
772	Diesel School Buses (SB)	0.00	0.00	0.00	0.06	0.00	0.01	0.01	0.00	0.00
777	Gas Other Buses (OB)	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00
778	Motor Coaches	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
779	Diesel Other Buses (OB)	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00
780	Motor Homes (MH)	0.00	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>3.65</b>	<b>3.22</b>	<b>27.07</b>	<b>12.19</b>	<b>0.07</b>	<b>1.06</b>	<b>1.04</b>	<b>0.54</b>	<b>0.49</b>
<b>Other Mobile Sources</b>										
810	Aircraft	0.08	0.08	1.28	0.24	0.03	0.03	0.03	0.03	0.00
820	Trains	0.11	0.10	0.68	2.36	0.00	0.04	0.04	0.04	0.00
833	Ocean Going Vessels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table VIII-4. 2018 Criteria Emissions (tons/day) by Major Source Category for the Coachella Valley**

		<b>TOG</b>	<b>VOC</b>	<b>CO</b>	<b>NOx</b>	<b>SOx</b>	<b>TSP</b>	<b>PM10</b>	<b>PM2.5</b>	<b>NH3</b>
<b>Code</b>	<b>Source Category</b>									
835	Commercial Harbor Crafts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
840	Recreational Boats	0.50	0.43	1.61	0.09	0.00	0.03	0.03	0.02	0.00
850	Off-Road Recreational Vehicles	0.24	0.23	0.38	0.01	0.00	0.00	0.00	0.00	0.00
860	Off-Road Equipment	1.60	1.41	16.08	2.08	0.00	0.16	0.15	0.13	0.00
870	Farm Equipment	0.07	0.06	0.57	0.30	0.00	0.02	0.02	0.02	0.00
890	Fuel Storage and Handling	0.17	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	<b>Total</b>	<b>2.77</b>	<b>2.47</b>	<b>20.59</b>	<b>5.08</b>	<b>0.04</b>	<b>0.28</b>	<b>0.27</b>	<b>0.23</b>	<b>0.01</b>
<b>Total</b>	<b>Stationary</b>	<b>20.12</b>	<b>7.21</b>	<b>3.23</b>	<b>1.70</b>	<b>0.20</b>	<b>37.99</b>	<b>19.03</b>	<b>2.91</b>	<b>1.85</b>
<b>Total</b>	<b>On-Road Vehicles</b>	<b>3.65</b>	<b>3.22</b>	<b>27.07</b>	<b>12.19</b>	<b>0.07</b>	<b>1.06</b>	<b>1.04</b>	<b>0.54</b>	<b>0.49</b>
<b>Total</b>	<b>Other Mobile</b>	<b>2.77</b>	<b>2.47</b>	<b>20.59</b>	<b>5.08</b>	<b>0.04</b>	<b>0.28</b>	<b>0.27</b>	<b>0.23</b>	<b>0.01</b>
<b>Total</b>	<b>Anthropogenic</b>	<b>26.54</b>	<b>12.91</b>	<b>50.90</b>	<b>18.97</b>	<b>0.31</b>	<b>39.34</b>	<b>20.34</b>	<b>3.68</b>	<b>2.34</b>

**APPENDIX IX**  
**MATES V**  
**FINAL REPORT**

**Regional Modeling Analyses**

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## Appendix IX

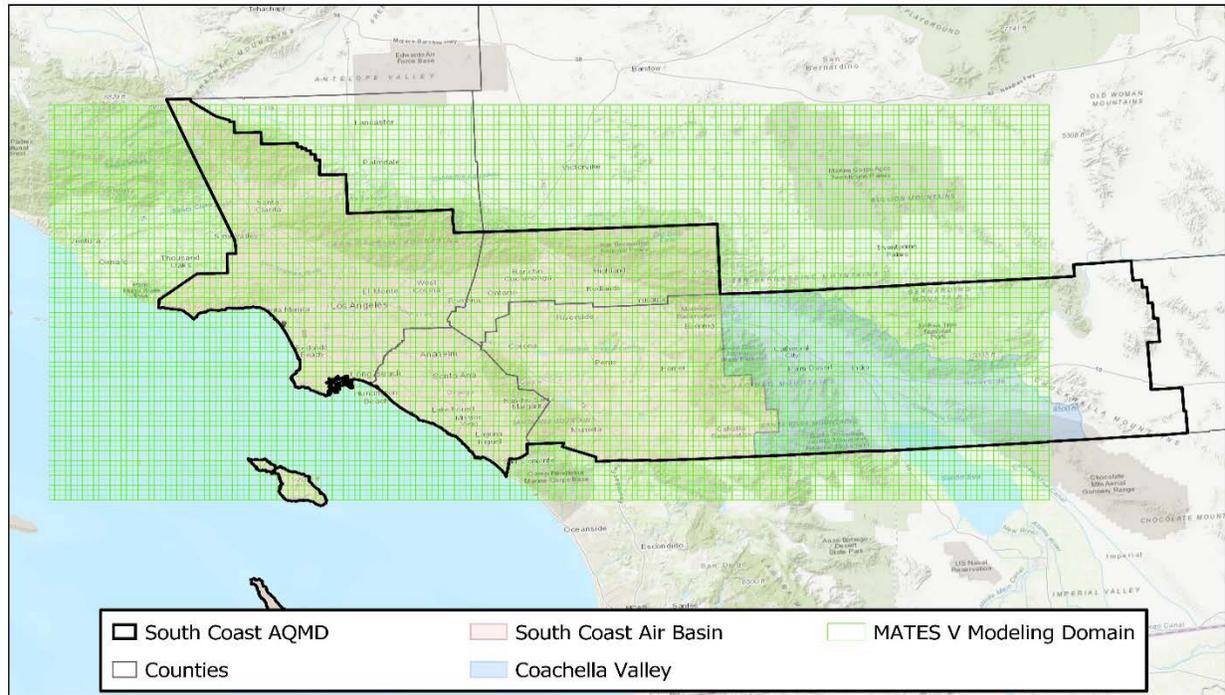
### Regional Modeling Analyses

#### IX.1 Introduction

The MATES V regional modeling analysis is presented in Chapter 4 of the main report. This appendix provides the analyses to complement and support the regional modeling demonstration. These include characterization and validation of the meteorological input data, development of the MATES V modeling emissions inventory, development of boundary conditions, model performance, and risk analysis.

The Comprehensive Air Quality Model with Extensions enhanced with a reactive tracer modeling capability (CAMx RTRAC, Ramboll Environment and Health, 2018) provided the dispersion modeling platform and chemistry used to simulate annual impacts of both gaseous and aerosol toxic compounds in the Basin. The version of the RTRAC “probing tool” in CAMx used in the modeling simulations includes an air toxics chemistry module to treat the formation and destruction of reactive air toxic compounds.

Numerical modeling was conducted on a domain that includes Coachella Valley, the entire Orange and Los Angeles Counties and populated areas of Riverside and San Bernardino Counties (Figure IX-1-1). Compared to the MATES IV domain, the MATES V domain is extended further east by 40 kilometers. The 2016 Air Quality Management Plan (AQMP) is the basis for the toxics emissions inventory developed for MATES V with updates incorporated for several source categories. The 2018 inventory used for the MATES V modeling analysis is projected from the 2012 baseline emissions inventory in the 2016 AQMP for area and off-road sources while the point source emissions are based on the 2018 Annual Emissions Reports (AER). Emissions from ocean-going vessels (OGV) from the 2018 CARB SIP update (CARB, 2018) are used. On-road emissions are updated based on the latest CARB’s on-road emissions model, EMFAC 2017 (CARB, 2017) and travel activity data from Southern California Association of Governments 2016 Regional Transportation Plan (SCAG, 2016).



**Figure IX-1-1.**  
MATES V Modeling Domain

Grid-based, hourly meteorological fields were generated from the Weather Research Forecast (WRF) mesoscale model (Skamarock, 2008). The National Centers for Environmental Prediction (NCEP) North American Regional Reanalysis (NARR) field was employed as initial and lateral boundary values for the WRF modeling. Four Dimensional Data Assimilation (FDDA) was conducted using grid analysis data, so the NARR data was enhanced with available surface and vertical sounding data. The WRF model was simulated for the period of May 1, 2018 to April 30, 2019, which provided the dispersion platform for the chemical transport modeling using CAMx.

## IX.2 Background

The modeling system used for MATES air toxics cancer risk simulations has evolved over the past decades. The MATES II (South Coast AQMD, 2000) analysis used the Urban Airshed Model with TOX (UAMTOX) chemistry to simulate the advection and accumulation of toxic compound emissions throughout the Basin. UAMTOX was simulated for 2 km by 2 km grid domain that overlaid the Basin. The analysis relied on the 1997-1998 emissions projection from the 1997 AQMP and meteorological data fields for 1997-1998 generated from objective analysis using a diagnostic wind model. These tools were consistent with those used in both the 1997 and 2003 AQMP attainment demonstrations.

For the MATES III analysis (South Coast AQMD, 2007), the regional modeling dispersion platform and chemistry simulations progressed from the UAMTOX model to CAMx RTRAC. The second major change in the MATES III modeling analysis was the incorporation of the

Mesoscale Meteorological Model 5 (MM5, Grell, 1994) to drive the meteorological data simulation. At that time, MM5 was the state-of-the-art meteorological model used in numerous regional modeling analyses, worldwide. The transition to CAMx and MM5 was made based on suggestions from peer review for the 2003 AQMP modeling efforts.

The CAMx-MM5 modeling platform from MATES III was updated to the CAMx-WRF coupled system in MATES IV. The WRF, a state-of-the-science meteorological modeling tool, offers a variety of user options to cover atmospheric boundary layer parameterizations, turbulent diffusion, cumulus parameterizations, land surface-atmosphere interactions, which can be customized to specific geographical and climatological situations. South Coast AQMD performed extensive sensitivity tests and developments to improve the WRF performance for the South Coast Air Basin, of which geographical and climatological characteristics impose great challenges in predicting complex meteorological structures associated with air quality episodes.

MATES V simulations continued to rely on CAMx-WRF modeling system. Same as previous MATES, RTRAC algorithms available in CAMx continued to serve to track chemically active toxic elements individually to assess the contribution of each source category. The RTRAC algorithm provides a flexible approach for tracking the emission, dispersion, chemistry, and deposition of multiple gas- and particle-phase species that are not otherwise included in the model's chemistry mechanisms.

### **IX.3 Meteorological modeling**

This section provides various analysis about meteorological conditions occurring during the MATES V study period compared to the MATES IV period and climatological average conditions. Detailed evaluation on WRF performance against available measurements were discussed as well.

#### **IX.3.1 Comparison of observed meteorological elements during MATES V and past 20-year averages**

The meteorological elements including annual average temperature, relative humidity, wind speed and annual total rain at 15 weather stations located in the region were used to evaluate weather patterns during the MATES V period with climatology using data from 2000 to 2019. The 15 weather stations are Los Angeles International Airport (LAX), Santa Monica Municipal Airport (SMO), Hawthorne Municipal Airport (HHR), Torrance Municipal Airport (TOA), Long Beach Airport (LGB), John Wayne Airport (SNA), Fullerton Municipal Airport (FUL), San Gabriel Valley Airport (EMT), Chino Airport (CNO), Ontario International Airport (ONT), Riverside Municipal Airport (RAL), March Air Reserve Base (RIV), Palm Springs International Airport (PSP), Burbank Bob Hope Airport (BUR) and (Van Nuys Airport) VNY. The results are shown in Figures IX-3-1 through IX-3-4.

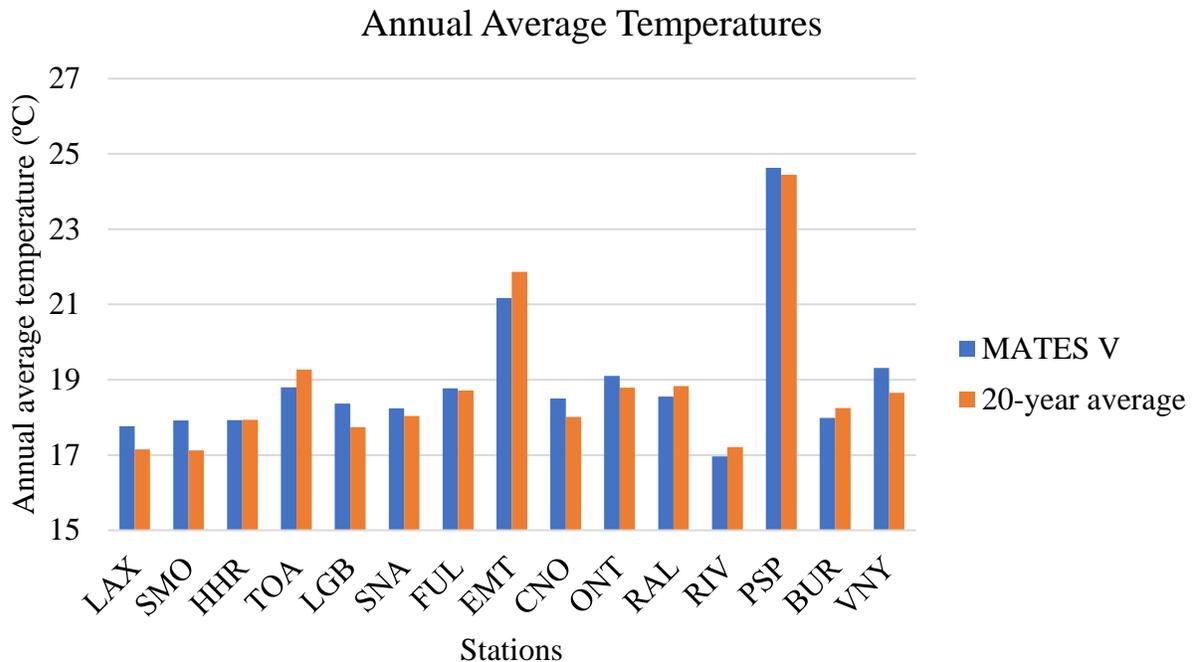
As shown in Figure IX-3-1, the annual average temperatures during MATES V and the past 20-year average time periods are in reasonable agreement across most of the stations. The largest difference occurs at SMO station where the average temperature during MATES V period is  $\sim 0.8^{\circ}\text{C}$  higher than the past 20-year average temperature. The second largest difference occurs at

VNY station with the MATES V average temperature being  $\sim 0.7^{\circ}\text{C}$  higher than past 20-year average. The minimum difference is seen at HHR station with marginal difference between the two datasets ( $0.003^{\circ}\text{C}$ ). Of the 15 total stations, there are 5 stations (TOA, EMT, RAL, RIV and BUR) that show a lower temperature during MATES V compared to the past 20-year average.

As seen from Figure IX-3-2, most stations (11 out of 15 stations) have slightly higher relative humidity during the MATES V period compared to the past 20-year average. The largest annual average relative humidity (RH) difference between the two datasets occurs at BUR station where the MATES V period average is 6.6% higher than 20-year average; the minimum difference is seen at SMO station with 20-year average value being only 0.2% higher. The highest and lowest average relative humidity are at the LAX and PSP stations, respectively, according to both datasets.

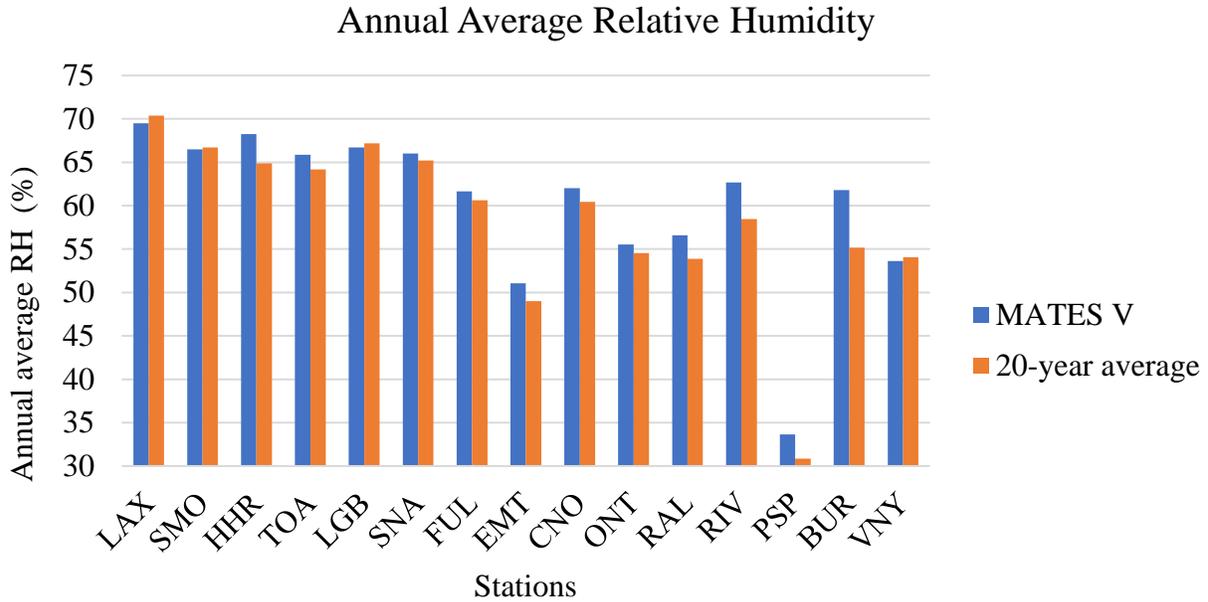
The wind speed annual averages are also higher during MATES V period at most of the stations (11 out of 15). The ONT station shows the greatest difference where the MATES V average is 0.34 (m/s) higher than the past 20-year average (see Figure IX-3-3).

Among all the meteorological elements, the most notable difference between the two datasets appears to be related to total annual average rainfall (Figure IX-3-4). As shown in Figure IX-3-4, the average annual rainfall during the MATES V period is significantly higher than the 20-year average in all stations. These differences are due to unusually higher amounts of rain during the spring of 2019. The difference between the two datasets ranges from 2.6 inches at ONT station to 8.9 inches at CNO station.



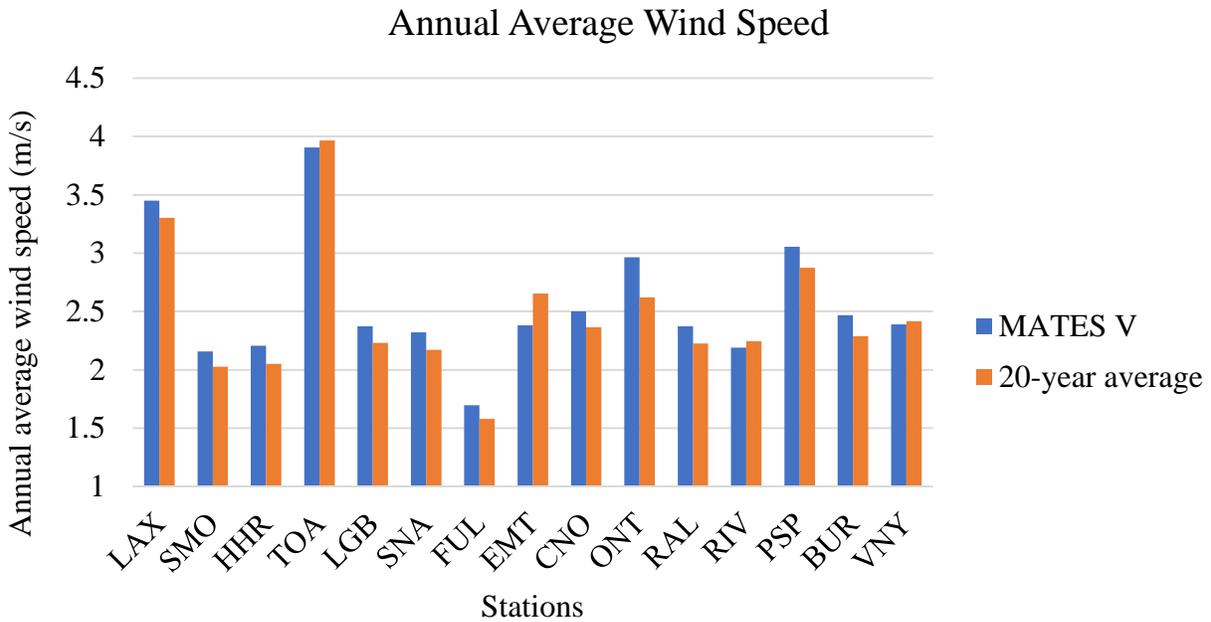
**Figure IX-3-1.**

Annual average temperature at each station during MATES V and past 20-year averages



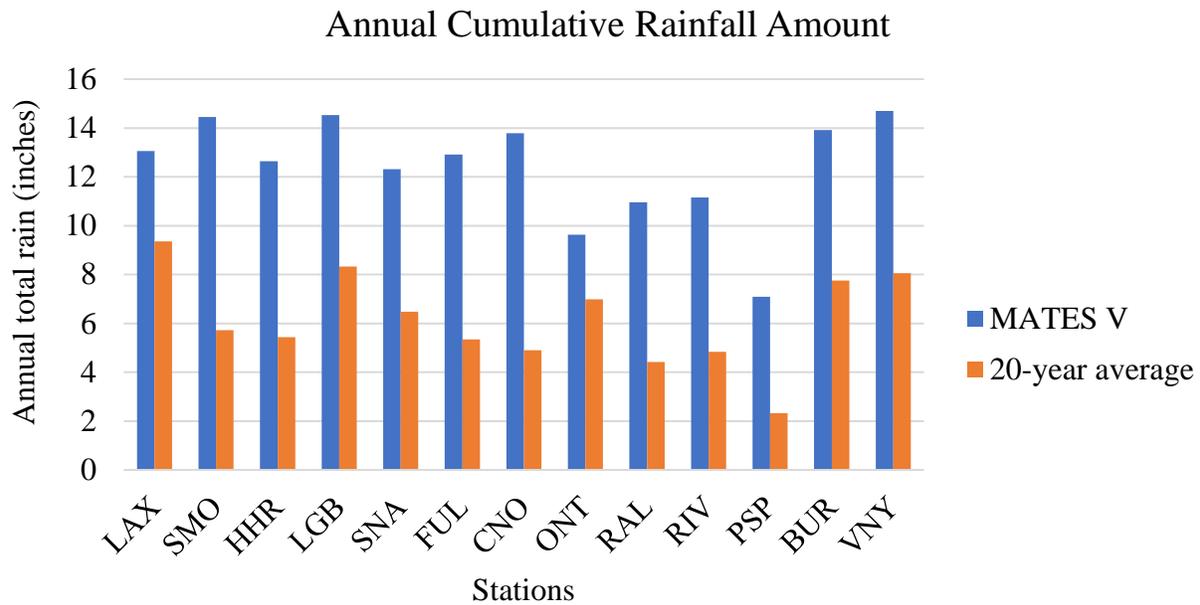
**Figure IX-3-2.**

Annual average relative humidity at each station during MATES V and past 20-year averages



**Figure IX-3-3.**

Annual average wind speed at each station during MATES V and past 20-year averages



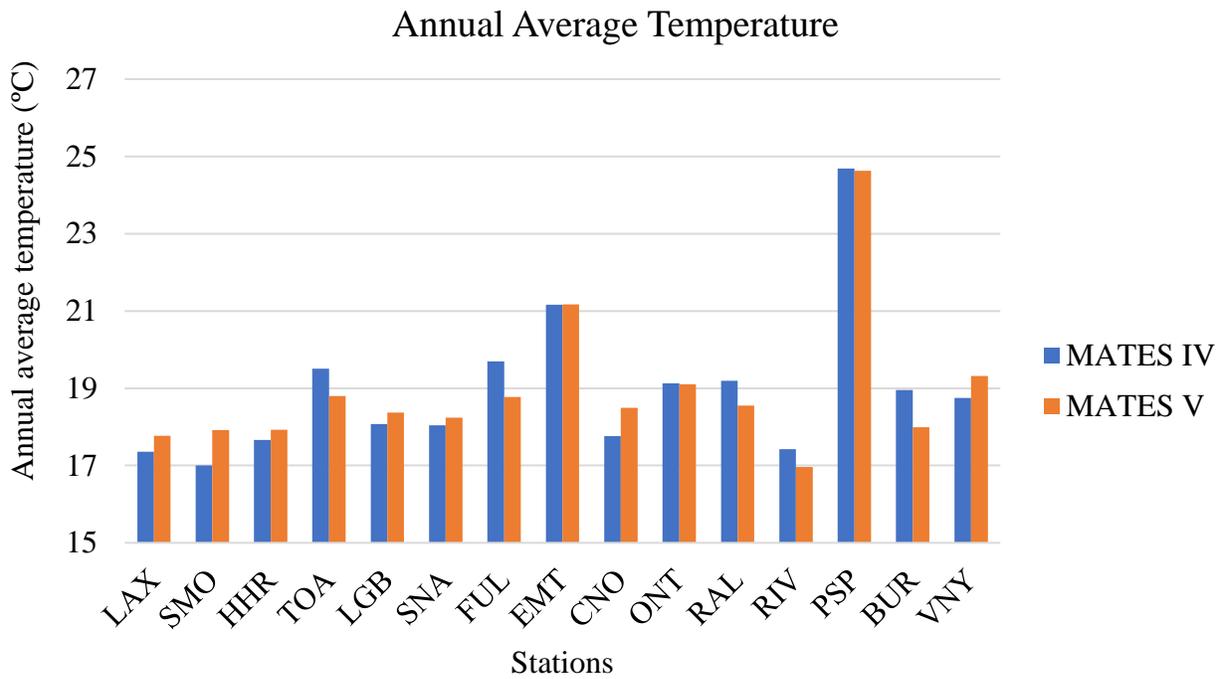
**Figure IX-3-4.**

Annual cumulative rainfall amount at each station during MATES V and past 20-year averages

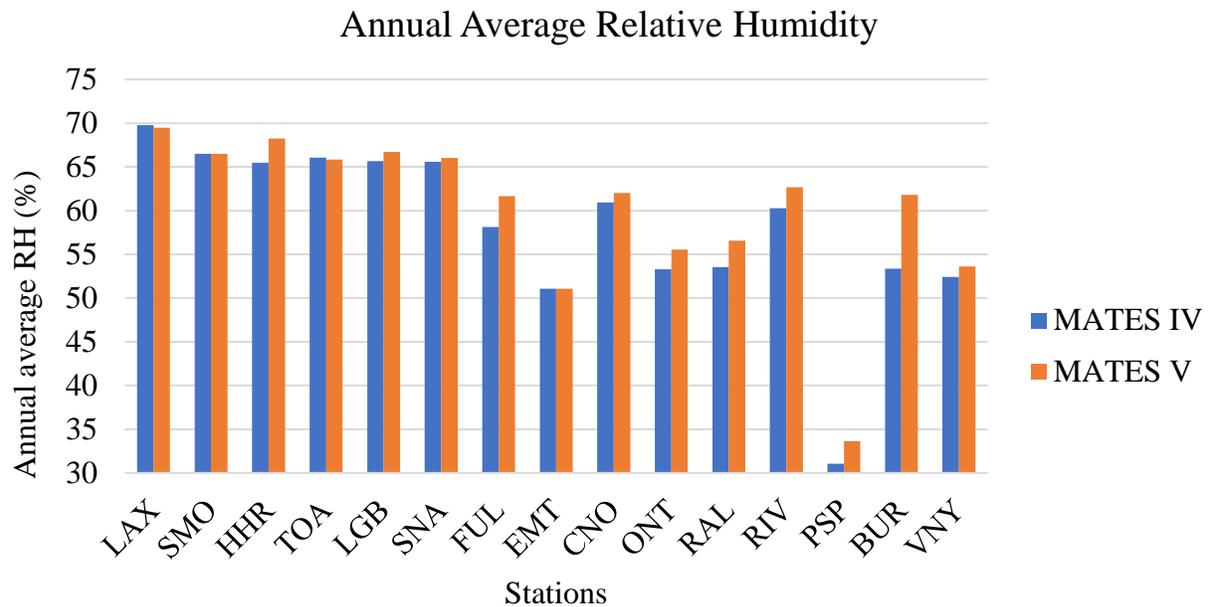
**IX.3.2 Comparison of meteorological fields between MATES IV and MATES V**

Various meteorological parameter averages, including the annual average temperature, relative humidity (RH), wind speed and annual total rain at 15 weather stations in the South Coast Air Basin for the MATES IV and MATES V periods are shown in Figure IX-3-5 through IX-3-8. The MATES IV period (July 2012 through June 2013) is characterized as a dry year based on the observational data analysis in MATES IV report.

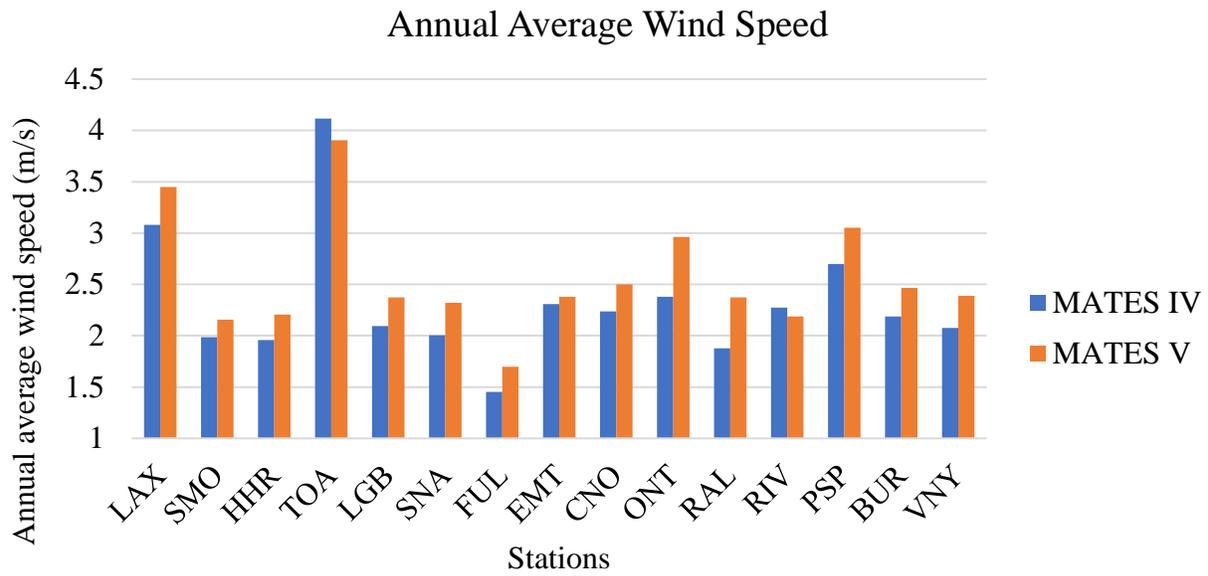
The largest difference between the MATES IV and MATES V period averages is related to annual total rain; the MATES V averages show higher values in all stations, as mentioned previously, due to the fact that an unusually high amount of rain occurred during spring 2019. The annual average temperature, annual average RH, and annual average wind speed values do not show significant differences between MATES IV and MATES V. The maximum difference in annual average temperature occurs at BUR station where MATES V is ~0.97 (°C) less than MATES IV. The maximum difference in annual RH occurs at BUR station where MATES V is 8.5 (%) higher than MATES IV. MATES IV averages show higher values for annual average wind speed at most of the stations (Figure IX-3-7); maximum difference occurs at ONT station with MATES V being 0.58 (m/s) higher than MATES IV.



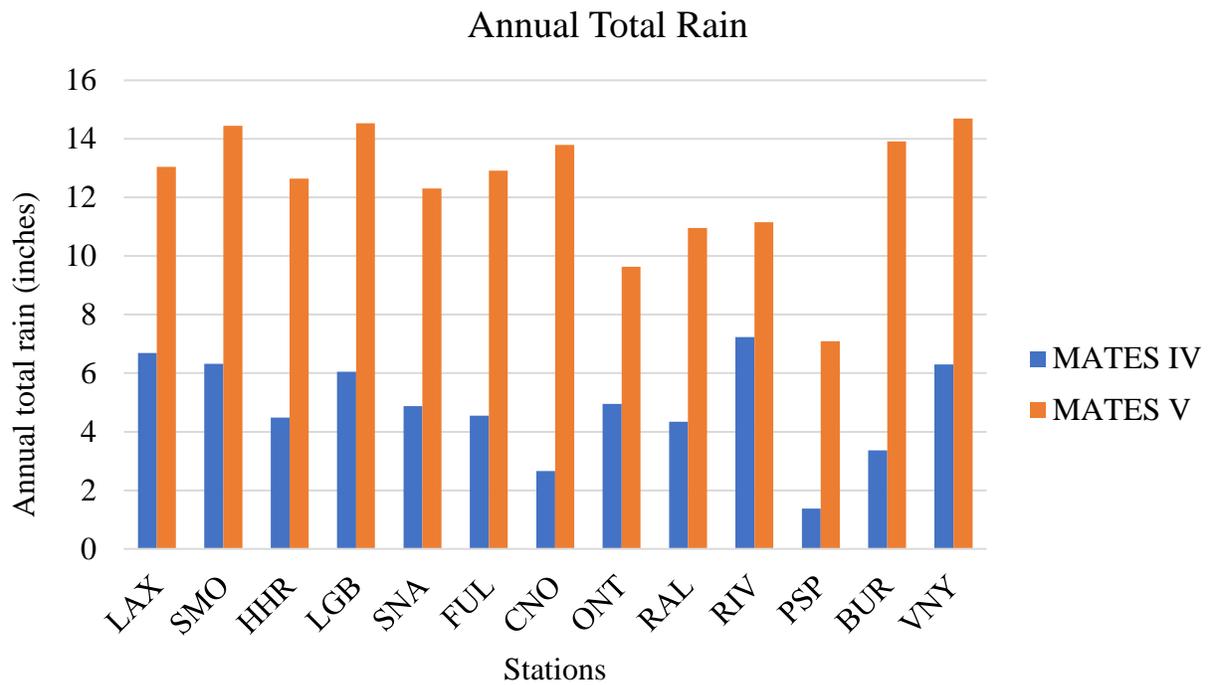
**Figure IX-3-5**  
Annual average temperatures at each station during MATES IV and MATES V



**Figure IX-3-6**  
Annual average relative humidity at each station during MATES IV and MATES V



**Figure IX-3-7**  
Annual average wind speed at each station during MATES IV and MATES V



**Figure IX-3-8**  
Annual total rain at each station during MATES IV and MATES V

### IX.3.3 Weather Research and Forecasting (WRF) Numerical Model Configuration

The WRF model is one of the most widely used meteorological models that serves a wide range of meteorological applications across scales from tens of meters to thousands of kilometers. WRF has been applied to a wide range of phenomena, such as regional climate, monsoons, baroclinic waves, cyclones, mesoscale fronts, hurricane, deep convection, land-sea breezes, mountain-valley circulations, large eddy simulations, fire event, etc. The model has been in active development and it is a collaborative partnership of the National Center for Atmospheric Research (NCAR), the National Oceanic and Atmospheric Administration (represented by the National Centers for Environmental Prediction (NCEP) and the Earth System Research Laboratory), the U.S. Air Force, the Naval Research Laboratory, the University of Oklahoma, and the Federal Aviation Administration (FAA). The WRF system contains two dynamical solvers, referred to as the ARW (Advanced Research WRF) core and the NMM (Nonhydrostatic Mesoscale Model) core. The ARW configuration was chosen for the current modeling analyses. The ARW is primarily developed and maintained by the National Center for Atmospheric Research (NCAR) mesoscale and microscale meteorology laboratory.

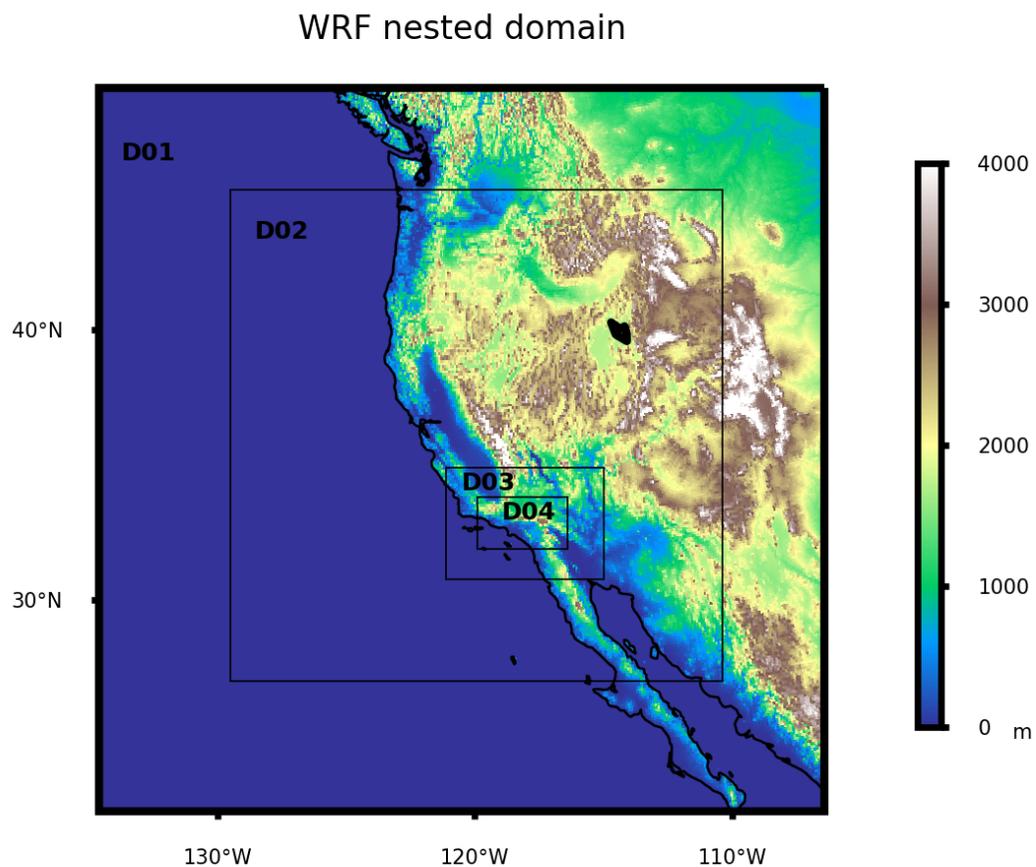
The WRF model is a fully compressible and nonhydrostatic model (with a run-time hydrostatic option). Its vertical coordinate is selectable as either a terrain-following or hybrid vertical coordinate hydrostatic pressure coordinate. The grid staggering is the Arakawa C-grid. It uses a time-split small step for acoustic and gravity-wave mode. The dynamics conserves scalar variables. The WRF is designed to be a flexible, state-of-the-art atmospheric simulation system that is portable and efficient on parallel computing platforms.

The WRF simulation domain designed for the MATES V study encompasses the greater Los Angeles and suburban areas, its surrounding mountains, and the sea off the coast of the Basin, as shown in Figure IX-3-9. WRF simulations were conducted with four nested domains at grid resolutions of 36 km, 12 km, 4 km and 2 km. The innermost domain has 187 by 107 grid points in abscissa and ordinate, respectively, which spans 374km by 214 km in east-west and north-south directions, respectively. The figure also shows the relative locations and sizes of the four nested grids. The innermost domain presented in Figure IX-3-10, excluding three boundary columns and rows, served as the CAMx chemical transport modeling domain.

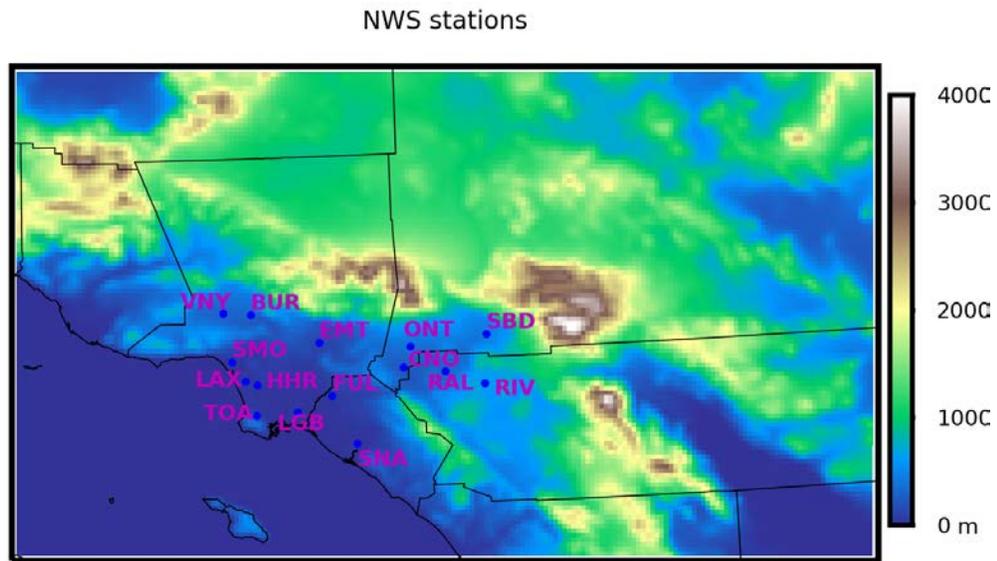
The WRF simulation employed 30 layers vertically with the lowest computational layer being approximately 20 m above ground level (agl) and the top layer at 50 hPa. Four Dimensional Data Assimilation (FDDA) was conducted using grid analysis data that was enhanced with available surface and vertical sounding data. The Sea Surface Temperature (SST) is a critical factor that drives the land-sea breeze and up-slope/down-slope flow. The SST data from the Global Data Assimilation Experiment (GODAE) are used to update the WRF modeling every 6 hours to better represent the sea surface temperature. The Yon-Sei University (YSU) scheme (Hong and Pan, 1996) was used to model the planetary boundary layer (PBL). The WRF simulation with this

configuration is referred as “control” simulation. The flowchart (Figure IX-3-11) of WRF simulation shows the meteorology input data, the processing steps, the observation nudging and the one-way nesting for high resolution inner domain.

After careful testing of different WRF physics options, the longwave radiation scheme of Rapid Radiative Transfer Model (RRTM), the shortwave radiation scheme of Dudhia and WRF Single-Moment 3-class scheme of micro physics were chosen for simulations. Kain-Fritsch cumulus schemes were employed to the outer three domains, while no cumulus parameterization was used for the innermost domain. The selections of the land surface model (LSM) scheme, the impacts of vertical and spatial resolution (1km) are discussed further in the next section.



**Figure IX-3-9**  
Four nested WRF modeling domains (36km, 12km, 4km, 2km horizontal resolution). Color scale represents topography



**Figure IX-3-10**

The inner most WRF simulation domain on the topographic map, and the 15 National Weather Service (NWS) stations used in the model performance evaluation

Table IX-3-1 below provides a summary of the WRF configuration used in MATES V in comparison with MATES IV. Major parameters finalized for MATES V are similar to those used in MATES IV. Sensitivity simulations were performed to evaluate land surface schemes and spatial and vertical resolutions of modeling configuration (Table IX-3-2). Those options identified as critical to describe air pollution episodes are presented.

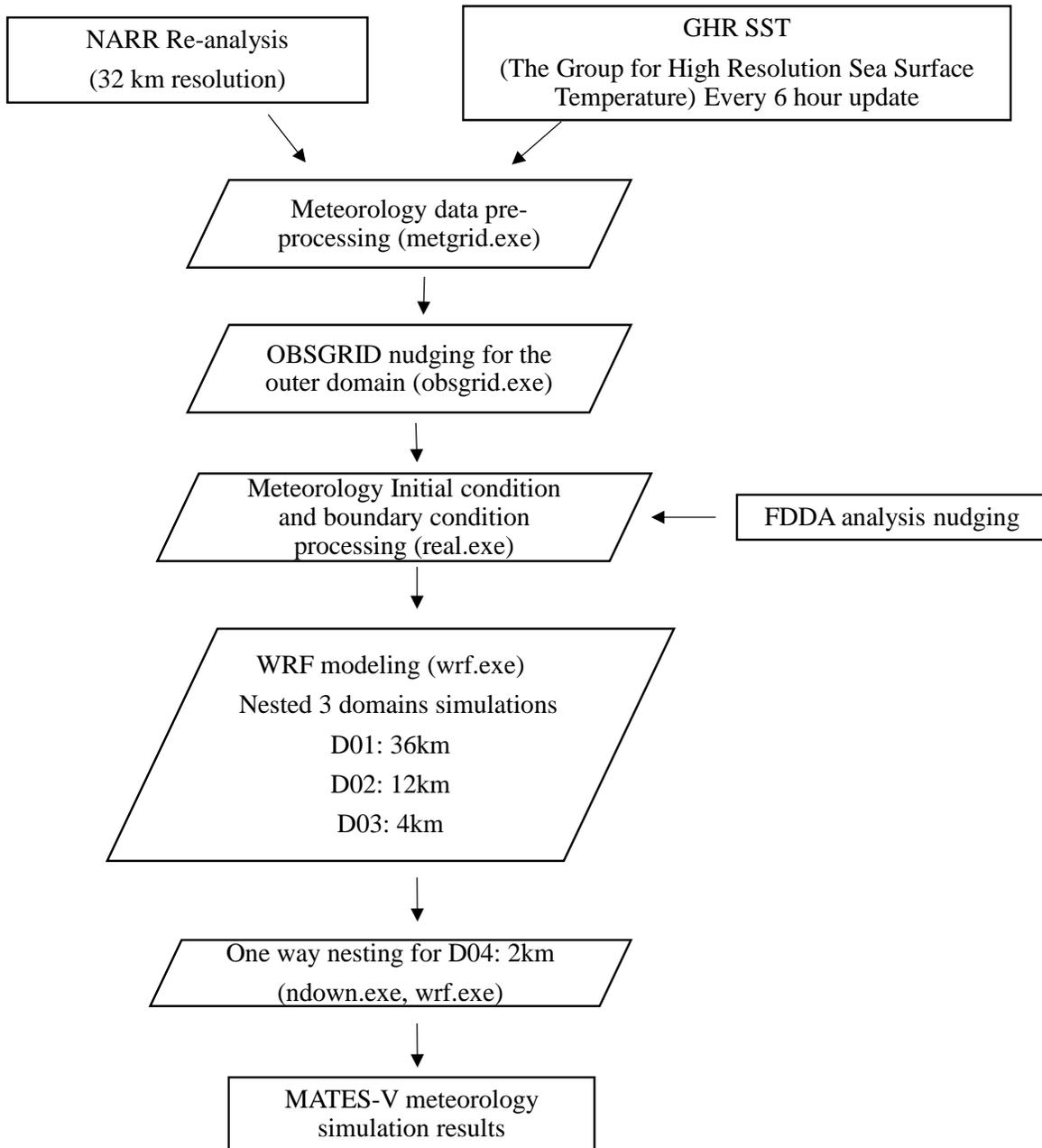
**Table IX-3-1**

Overview of WRF configuration for MATES V in comparison with MATES IV

Component	MATES IV (July 2012-June 2013)	MATES V (May 2018-April 2019)
Numerical Platform	WRF version 3.4.1	WRF Version 4.0.3
Number of domains	4 nested domains	
Nested Domain setting	D01: 36 km (71 X 71)	D01: 36 km (83 X 83)
	D02: 12 km (133 X 133)	D02: 12 km (169 X 169)
	D03: 4 km (163 X 115)	
	D04: 2km (167 X 87)	D04: 2km (187 X 107)
Number of vertical layers	30 layers, the lowest layer is at ~ 20 m agl.	
Simulation Length	4 day with 24-hour spin-up	
Initial and boundary values	NCEP NAM* analysis (40 km X 40 km)	NCEP NARR# Re-analysis (32 km X 32 km)
Sea Surface Temperature	GHRSSST <sup>+</sup>	
Boundary layer scheme	YSU (Yon-Sei University) scheme	
Land Surface model	Five-layer soil model	Unified Noah
Cumulus parameterization	Kain-Fritsch for the outer two domains Explicit for inner two domains	Kain-Fritsch for the outer three domains Explicit for the innermost domain
Micro physics	Simple ice	WRF Single-Moment 3-class
Radiation	Cloud radiation	RRTM scheme for longwave, Dudhia scheme for shortwave
Four-dimensional data analysis	Analysis nudging with NWS surface and upper air Measurements	

\*NAM - The North American Mesoscale Forecast System

<sup>+</sup>GHRSSST - The Group for High Resolution Sea Surface Temperature (<https://www.ghrsst.org/>)<sup>#</sup>NARR - North American Regional Reanalysis



**Figure IX-3-11**  
Flowchart of WRF simulation for MATES V

**TABLE IX-3-1**

The list of WRF sensitivity simulations

#	Testing Categories	Database
1	Land Surface Scheme	Pleim-Xiu land surface scheme
2	High Spatial Resolution	1km × 1km simulation*
3	High Vertical Resolution	35 layers in total, added 5 more layers between 0.8km – 3 km

\*Considering the computational cost, only 4 month simulations (April 2018, July 2018, October 2018 and January 2019) were conducted

### IX.3.4 Model Performance Evaluation of Metrological fields– Surface Level

The performance of the control simulations along with other sensitivity testing simulations are summarized in Table IX-3-3 and Table IX-3-4 for the summer season (June, July, and August of 2018) and winter season (December 2018, January and February 2019), respectively. All the results shown in Table IX-3-3 and IX-3-4 are averaged values for the 15 NWS stations. The locations of the NWS stations are shown in Figure IX-3-10. Overall, the WRF simulation for 2018 summer and winter provided representative meteorological fields that well characterized the observed conditions. These fields were used directly in the CAMx joint particulate and ozone simulations.

The performance of WRF control simulations used as transport fields for the CAMx modeling is provided in Figure IX-3-12 through Figure IX-3-20. The model performance was evaluated for each month at the airport stations in the model domain for May 2018 through April 2019. However, only one summer month (July) and one winter month (January) are shown here.

Three NWS stations are selected for surface level model performance evaluation: Hawthorne Municipal Airport (HHR, a coastal site), Fullerton Municipal Airport (FUL, an inland Orange County station), and Chino Airport (CNO, located in mid-Basin). The diurnal variation of temperature, humidity and surface wind are well represented by the WRF control simulations. Temperature and wind speed predictions are more accurate in the summer season than the winter months (Figure IX-12 – Figure IX-17). The observed temperature gradient from the coastal station of HHR to the inland station of CNO is well captured by the WRF model. During summer, the median temperature is 295, 300, and 305 K at HHR, FUL and CNO, respectively, from both WRF simulations and observations. For the inland stations of CNO and FUL, the WRF control simulations show slight underestimation of daily highest temperature during the days in July of 2018. At the near coast station of HHR, the WRF control simulation shows better performance in predicting daily highest values in summer.

During the winter month of January 2019, the WRF-simulated temperature values has better performance at the HHR station compare to the two other stations; the model performance at this

station during January 2019 ( $R = 0.89$ ) is slightly better than in July 2019 ( $R = 0.87$ ) as well. The model predictions of temperature at CNO and FUL stations during July 2019 are also better than the predictions during January 2019. The daily peak values are in better agreement with observations towards the end of the month of January 2019 at all stations; the model tends to overpredict the minimum values during this month.

The wind speed in summer shows distinct diurnal variation from both the WRF simulation and observation at all three stations with a strong sea breeze in the early afternoon. Daily maximum wind speed values show slight variations during the summer month of July 2019, unlike the winter month of January 2019 (e.g. from 2.5 to 12.5  $\text{m s}^{-1}$  during January at CNO station). The model performance in predicting the wind speed is significantly better during summer month of July 2019 compared to the winter month of January 2019 at all stations;  $R$  values change from 0.82, 0.73, and 0.78 in July 2019, at CNO, FUL, and HHR stations, respectively, to 0.46, 0.41, 0.37 in January 2019. The model underestimates the daily peak wind speed values at the HHR station during the entire month of July 2019.

The WRF model has predicted the water vapor mixing ratio trends fairly well at all stations. The observations and predictions are in good agreement during winter with correlation coefficients of 0.83, 0.86, and 0.87 in January 2019 at CNO, FUL, and HHR stations, respectively; the corresponding values for the month of July are 0.61, 0.63, and 0.54. The WRF control run yields comparable magnitude of water vapor mixing ratio in summer without the general underestimation issue that occur in winter months. For both summer and winter months, the WRF control simulation did not capture a few episodes of sudden shift between dryness and wetness.

**Table IX-3-3**

WRF performance statistics for the seasonal average of June, July and August 2018 at 15 NWS stations

	Control	Pleim-Xiu Land Surface Scheme	High Spatial Resolution	High Vertical Resolution
2m Temperature Mean OBS (K)	299.1	299.1	299.1	299.1
2m Temperature Mean SIM (K)	297.6	297.7	298.9	297.5
2m Temperature Bias (K)	0.3	0.5	-0.1	0.3
2m Temperature Gross Error (K)	1.6	1.5	1.7	1.6
2m Temperature RMSE (K)	2.2	1.9	2.2	2.2
Water vapor mixing ratio Mean OBS (kg/kg)	11.2	11.2	11.2	11.2
Water vapor mixing ratio Mean SIM (kg/kg)	10.9	11.2	11.6	10.9
Water vapor mixing ratio Bias (kg/kg)	0.2	0.5	0.4	0.2
Water vapor mixing ratio Gross Error (kg/kg)	1.4	1.4	1.5	1.4

Water vapor mixing ratio RMSE (kg/kg)	2.4	2.4	2.6	2.4
Wind Speed Mean OBS (m/s)	2.8	2.8	2.8	2.8
Wind Speed Mean PRD (m/s)	2.4	2.4	2.5	2.4
Wind Speed Bias (m/s)	-0.3	-0.4	-0.3	-0.3
Wind Speed Gross Error (m/s)	1.1	1.1	1.2	1.1
Wind Speed RMSE (m/s)	1.5	1.4	1.5	1.5

**Table IX-3-4**

WRF performance statistics for the seasonal average of December 2018, and January and February 2019 at 15 NWS stations

	Control	Pleim Xiu	High Spatial resolution	High Vertical resolution
2m Temperature Mean OBS (K)	286.7	286.7	286.7	286.7
2m Temperature Mean SIM (K)	286	285	286.5	286
2m Temperature Bias (K)	0	-1	-0.2	0
2m Temperature Gross Error (K)	1.7	1.9	1.9	1.7
2m Temperature RMSE (K)	2.2	2.4	2.5	2.2
Water vapor mixing ratio Mean OBS (kg/kg)	5.9	5.9	5.9	5.9
Water vapor mixing ratio Mean SIM (kg/kg)	4.8	5.2	5	4.9
Water vapor mixing ratio Bias (kg/kg)	-0.8	-0.4	-0.9	-0.7
Water vapor mixing ratio Gross Error (kg/kg)	1.2	1.2	1.2	1.2
Water vapor mixing ratio RMSE (kg/kg)	1.7	1.7	1.6	1.7
Wind Speed Mean OBS (m/s)	2.1	2.1	2.1	2.1
Wind Speed Mean PRD (m/s)	2.1	1.9	2	2.1
Wind Speed Bias (m/s)	0	-0.1	0	0
Wind Speed Gross Error (m/s)	1.4	1.4	1.5	1.5
Wind Speed RMSE (m/s)	1.9	1.9	2	1.9

\*To save computing time, only 4 month simulations – April 2018, July 2018, October 2018 and January 2019 are conducted for the WRF simulation with 1 X 1 km.

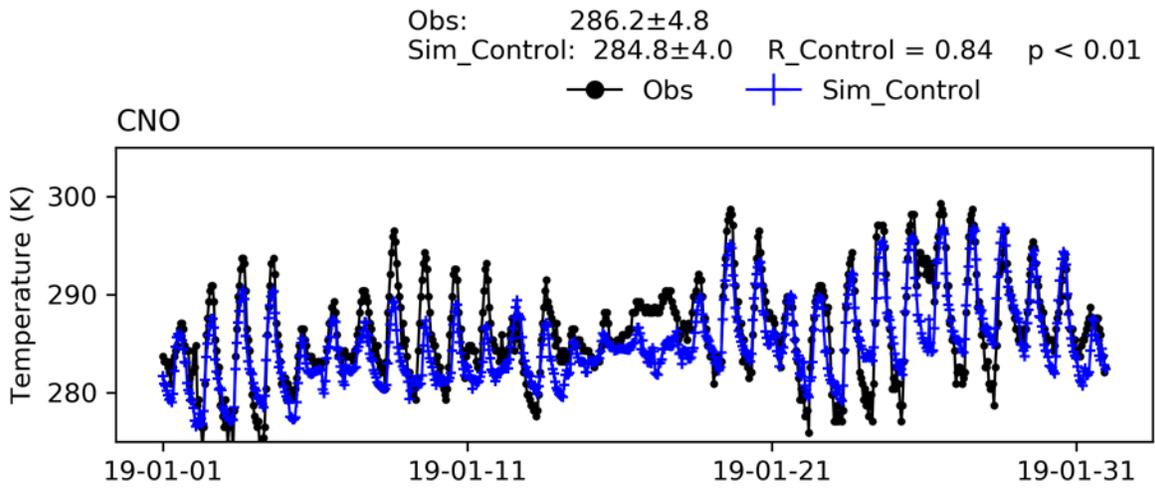
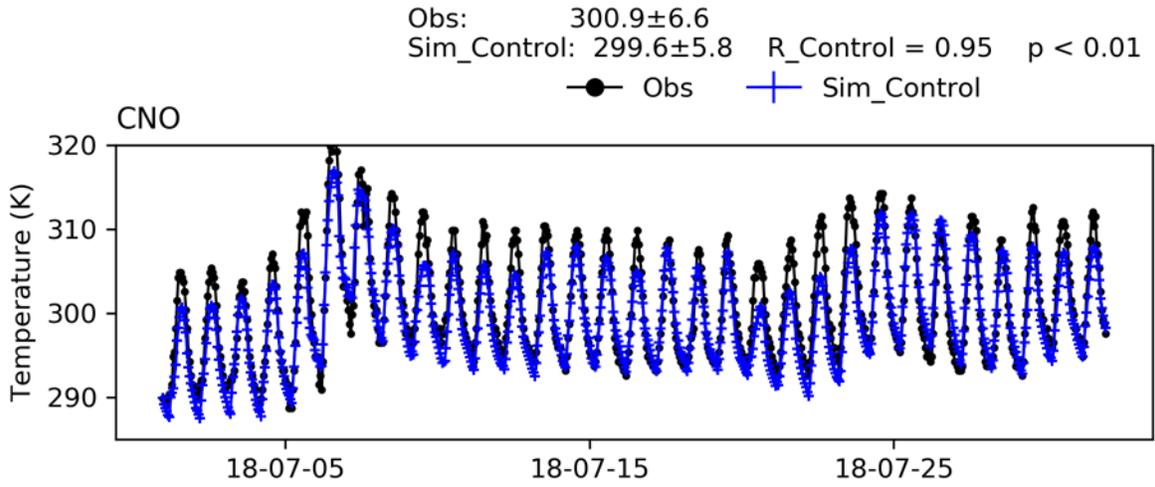
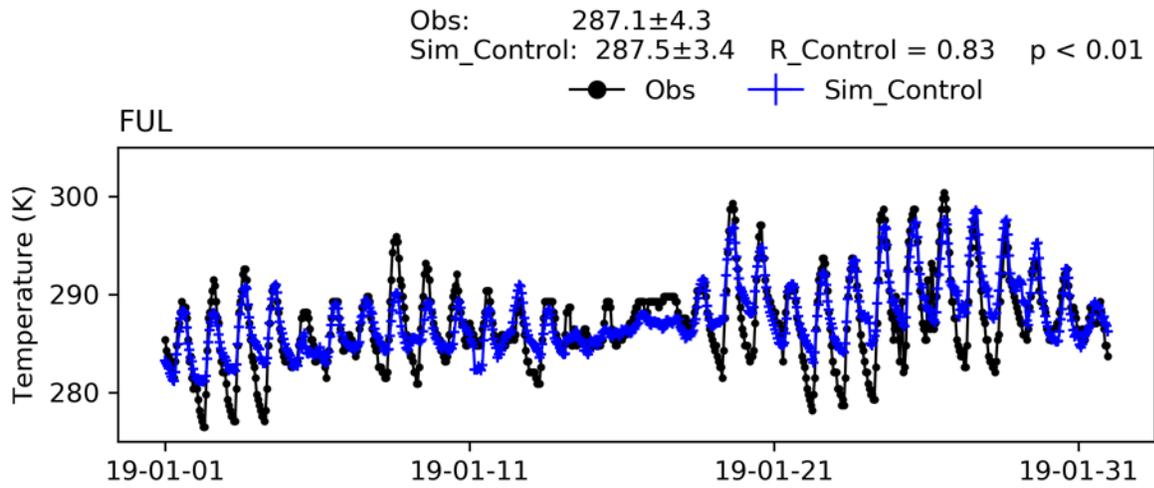
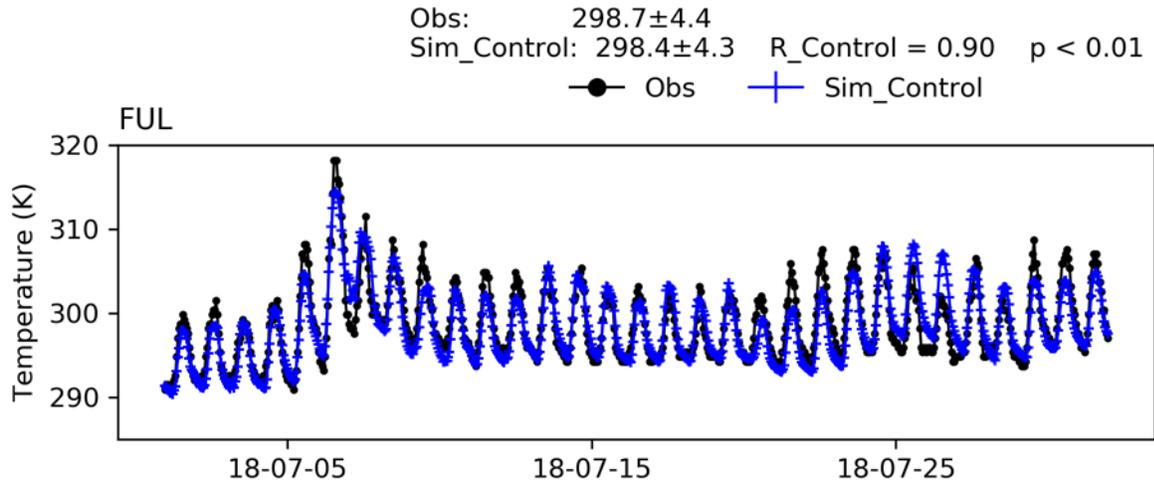


Figure IX-3-12

Time series of hourly temperature from measurement and WRF control simulations at Chino (CNO) station for July 2018 and January 2019



**Figure IX-3-13**

Time series of hourly temperature from measurements and WRF control simulations at Fullerton (FUL) station for July 2018 and January 2019

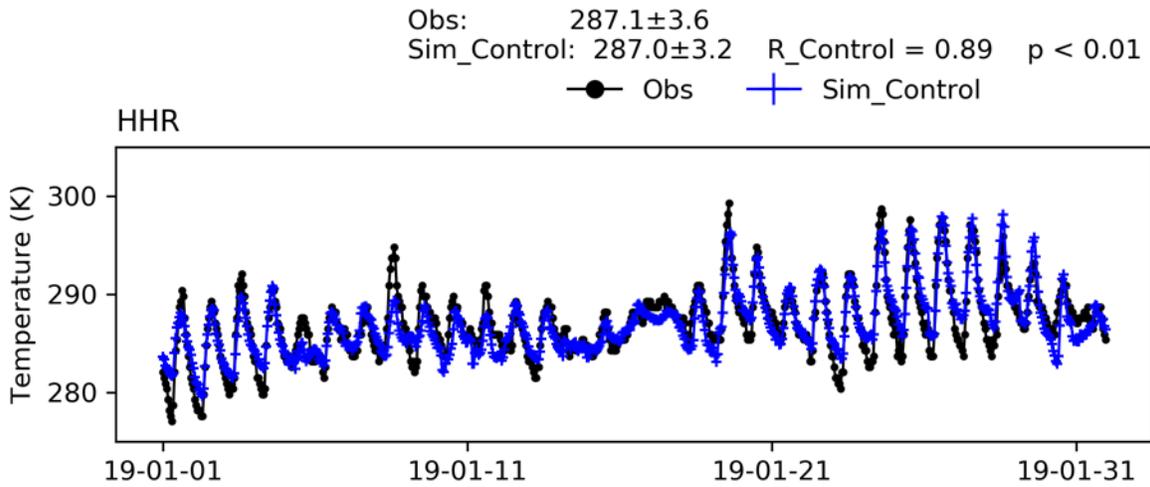
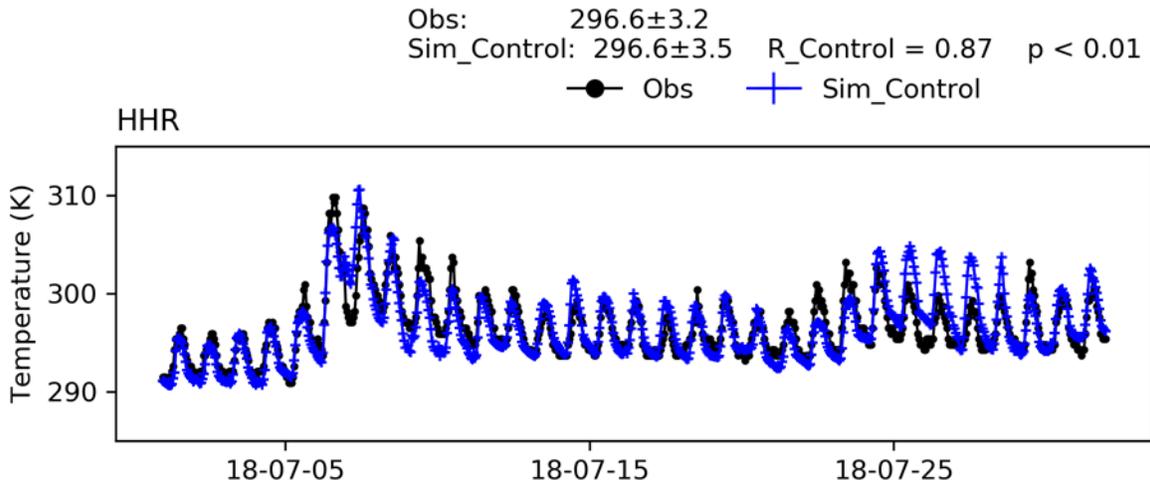
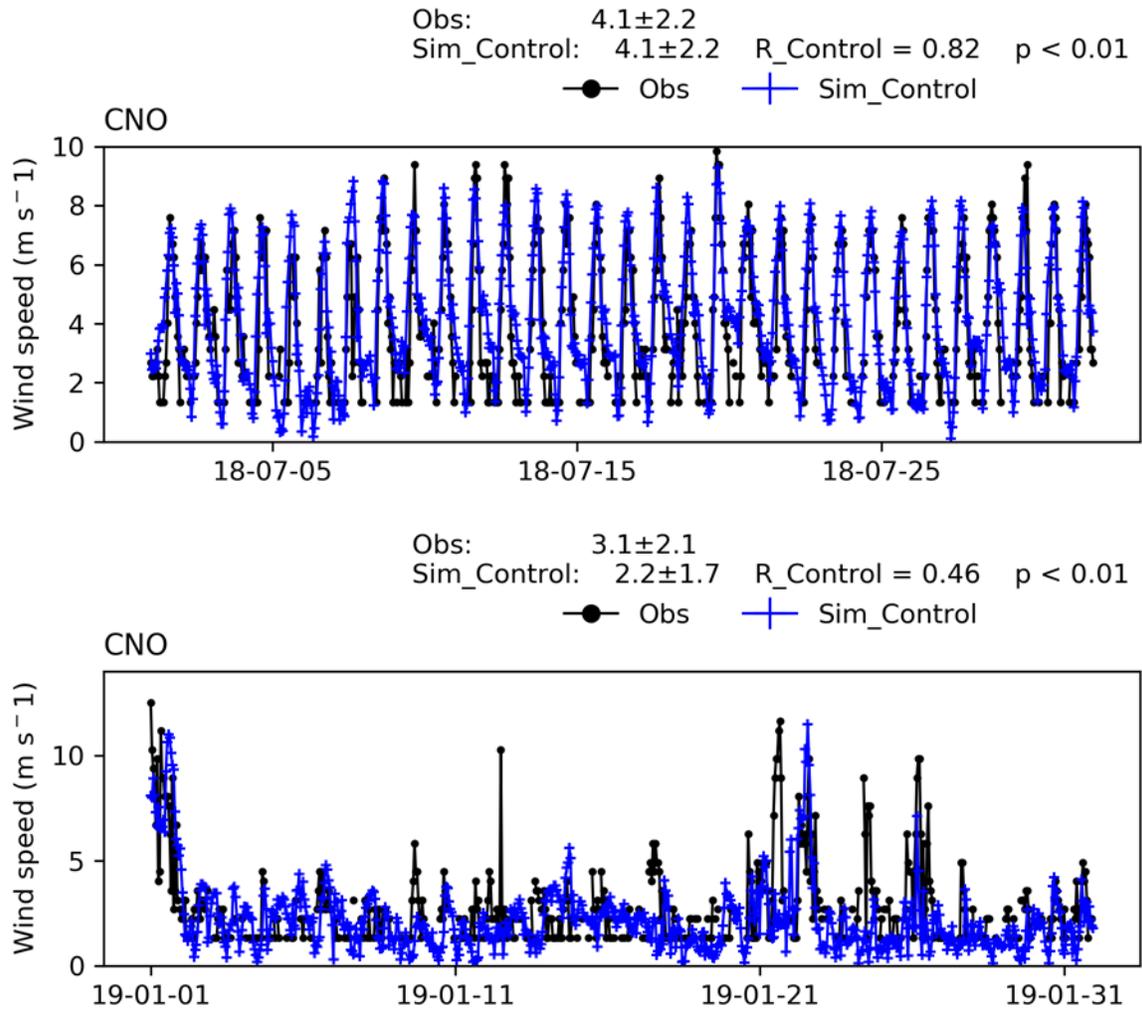


Figure IX-3-14

Time series of hourly temperature from measurements and WRF control simulations at Hawthorne (HHR) station for July 2018 and January 2019



**Figure IX-3-15**

Time series of hourly wind speed from measurements and WRF control simulations at Chino (CNO) station for July 2018 and January 2019

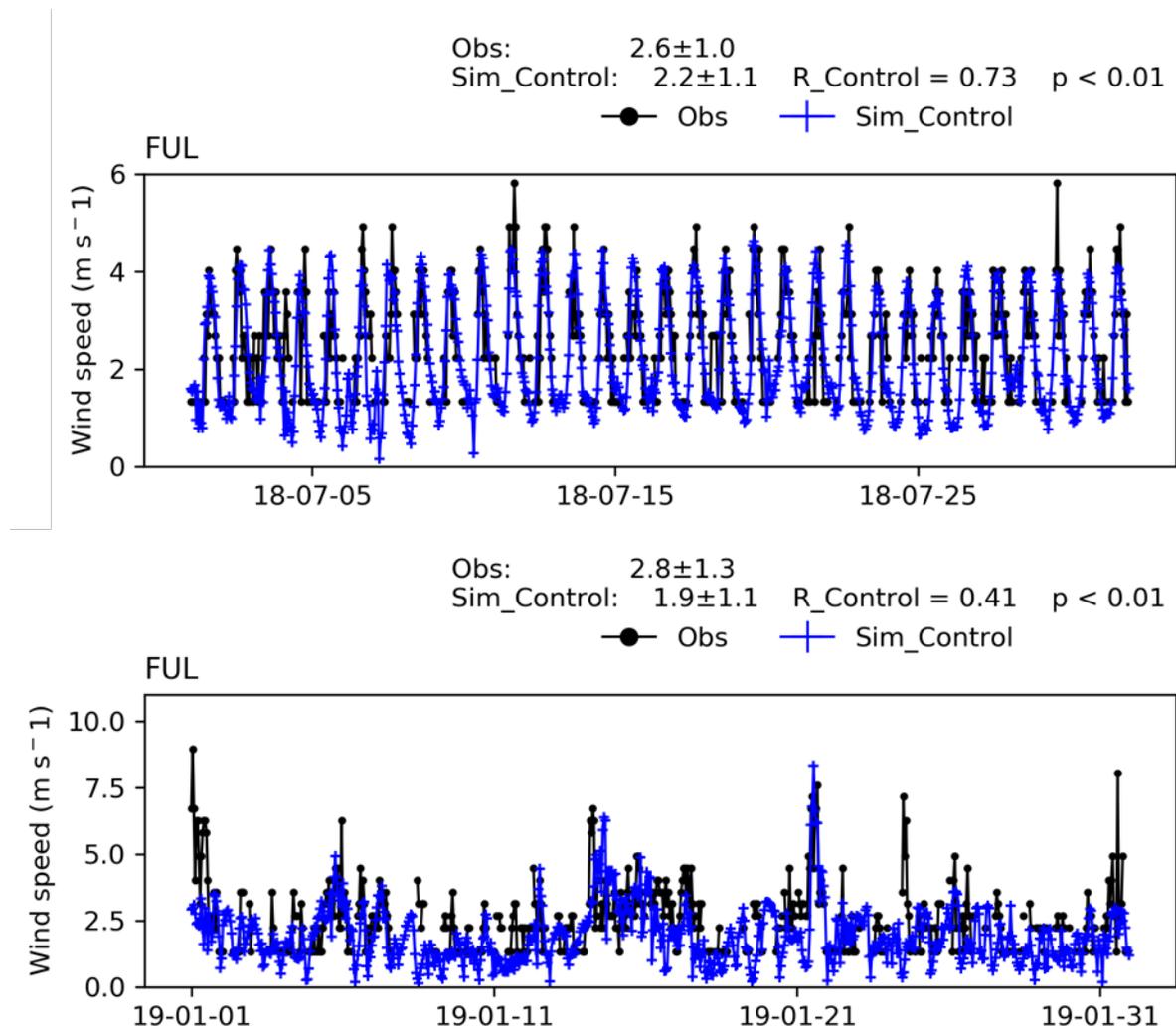
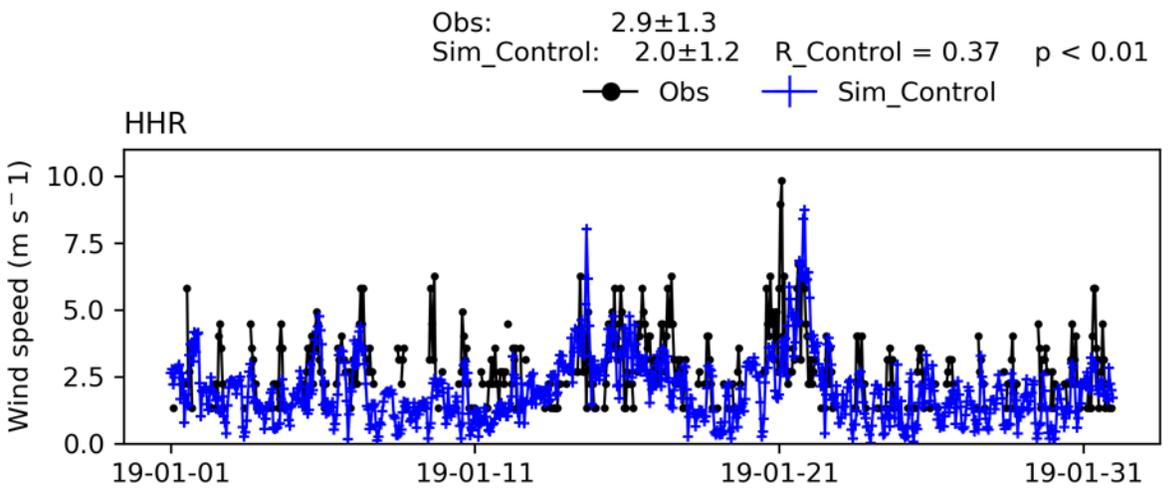
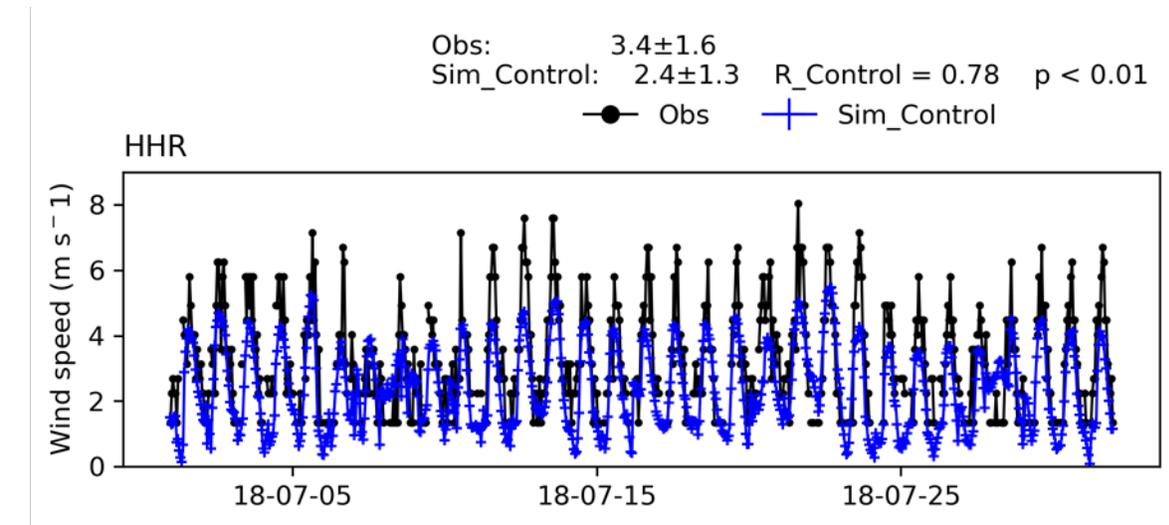


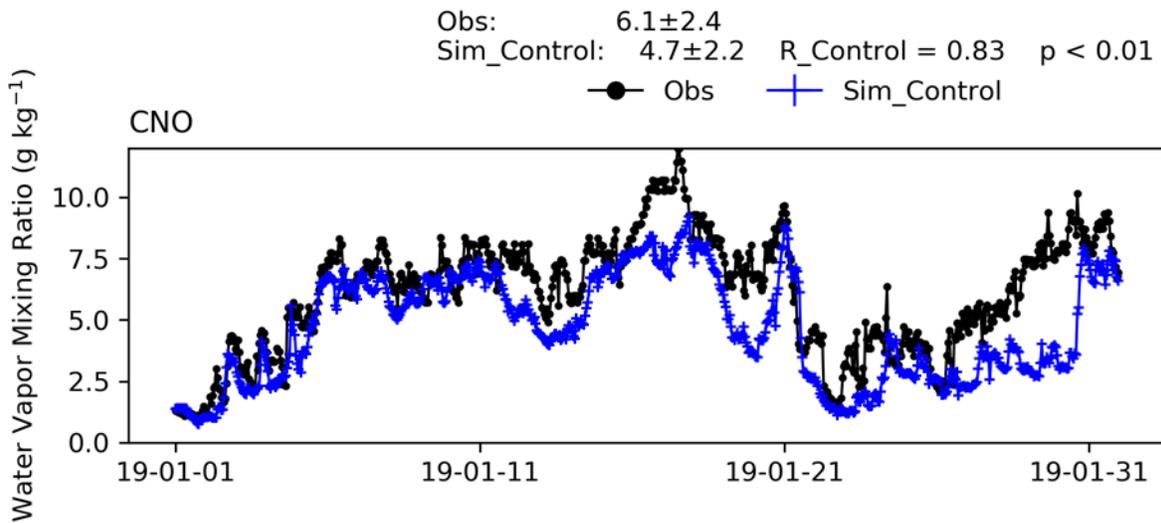
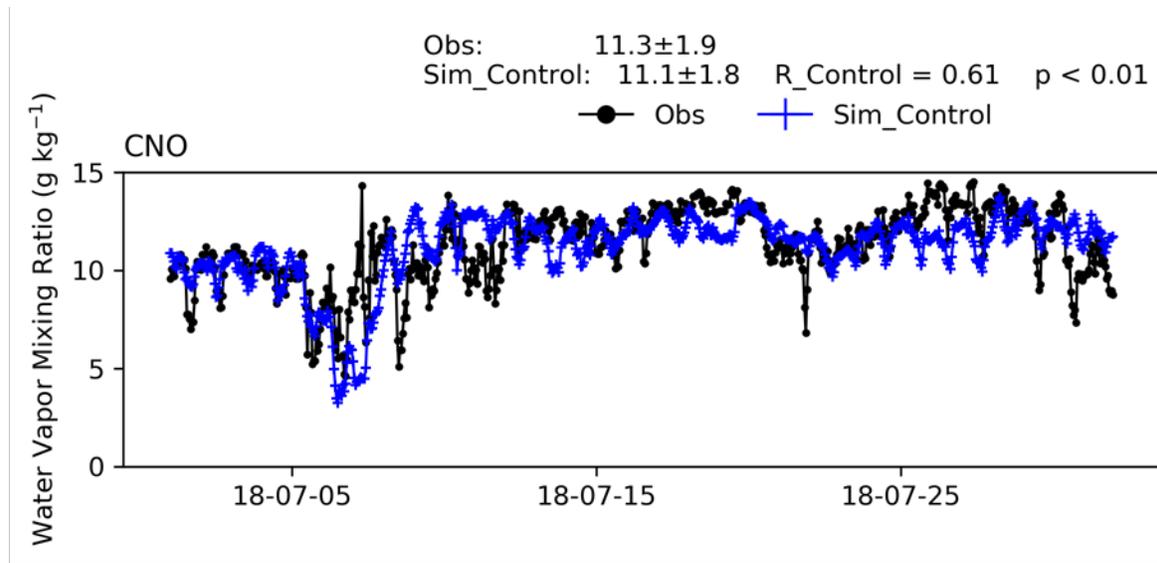
Figure IX-3-16

Time series of hourly wind speed from measurements and WRF control simulations at Fullerton (FUL) station for July 2018 and January 2019



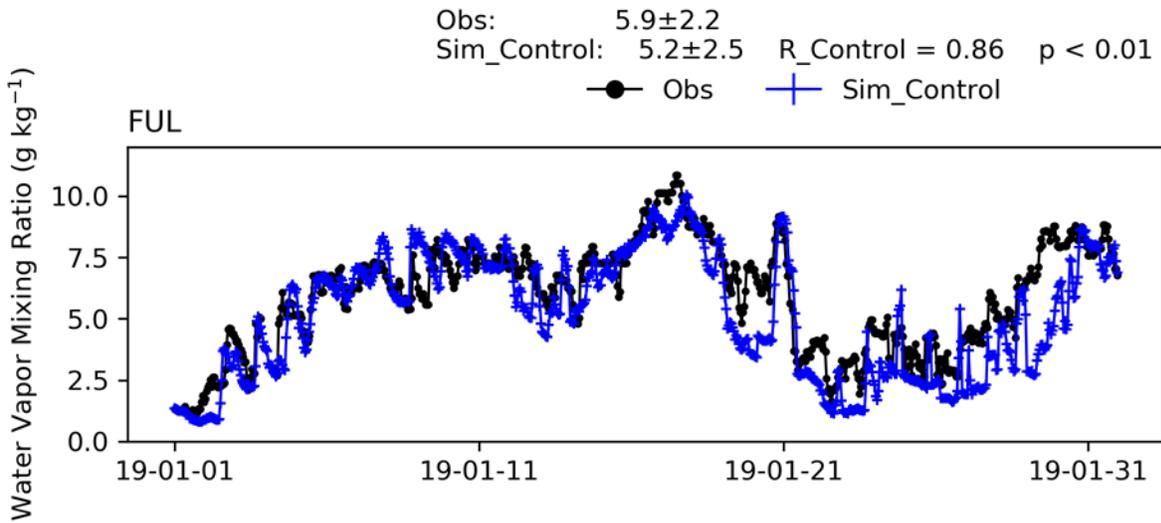
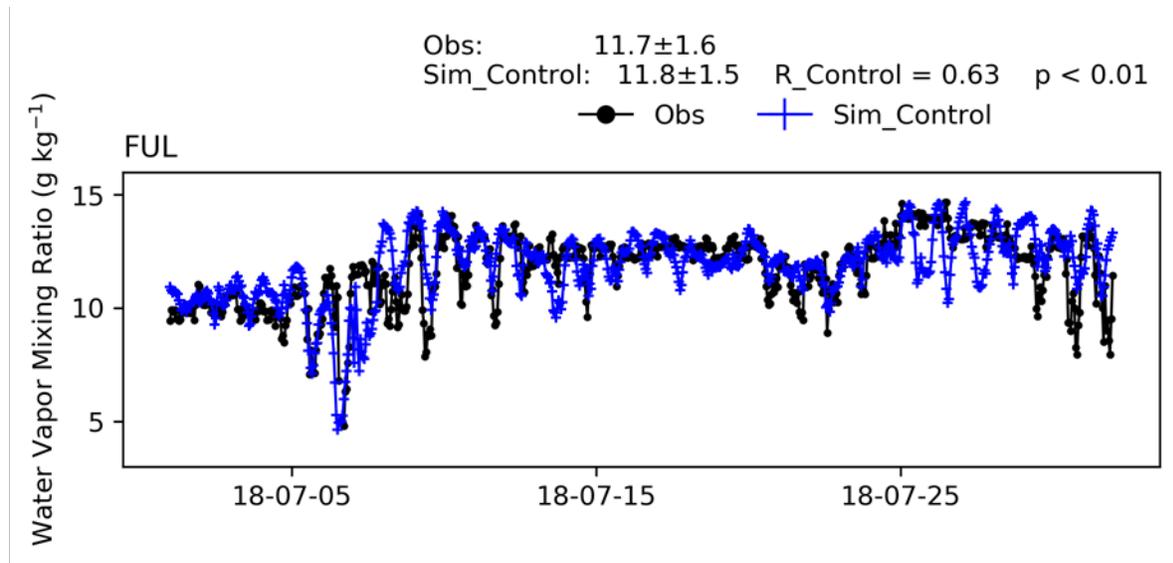
**Figure IX-3-17**

Time series of hourly wind speed from measurements and WRF control simulations at Hawthorne (HHR) station for July 2018 and January 2019



**Figure IX-3-18**

Time series of hourly water vapor mixing ratio from measurements and WRF control simulations at Chino (CNO) station for July 2018 and January 2019



**Figure IX-3-19**

Time series of hourly water vapor mixing ratio from measurements and WRF control simulations at Fullerton (FUL) station for July 2018 and January 2019

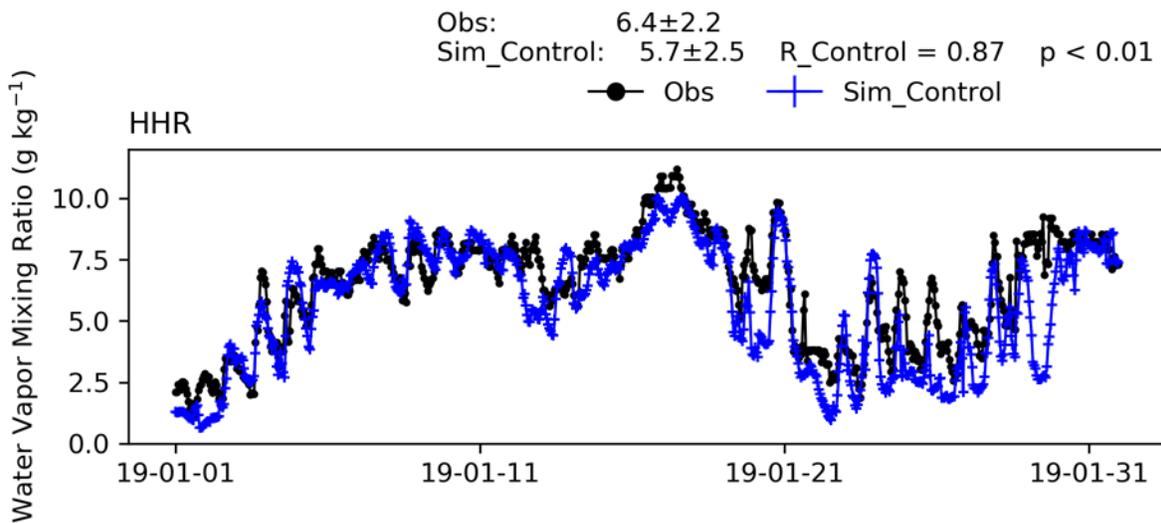
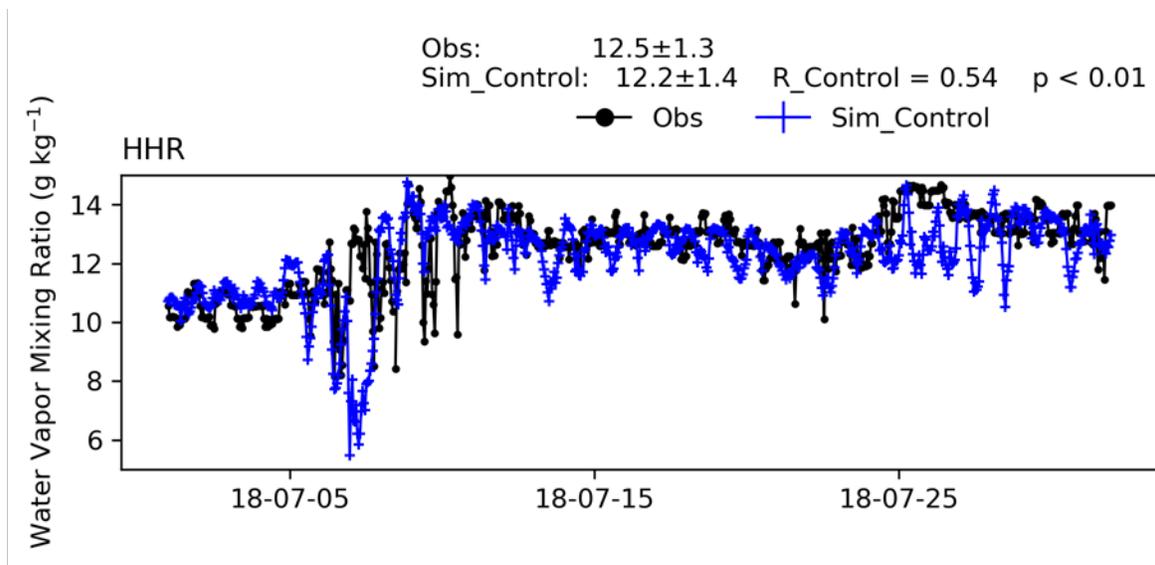


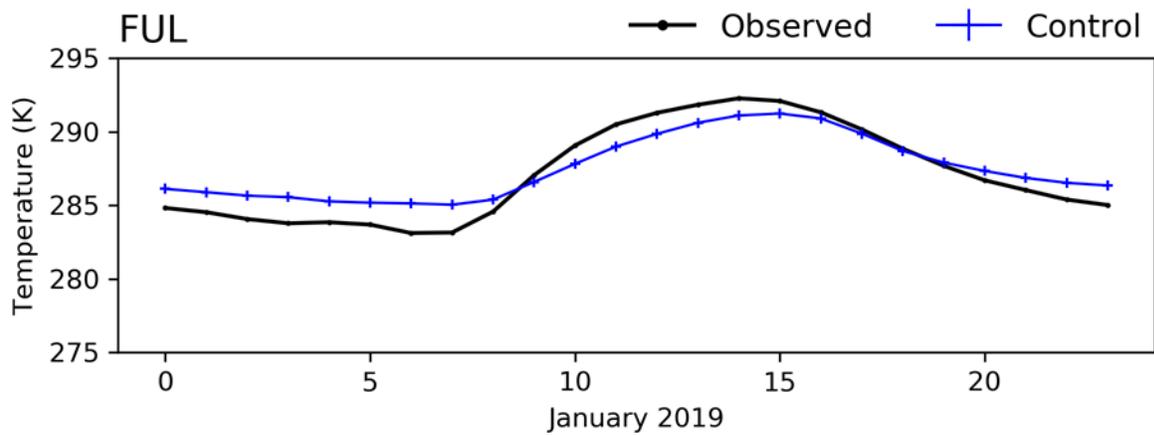
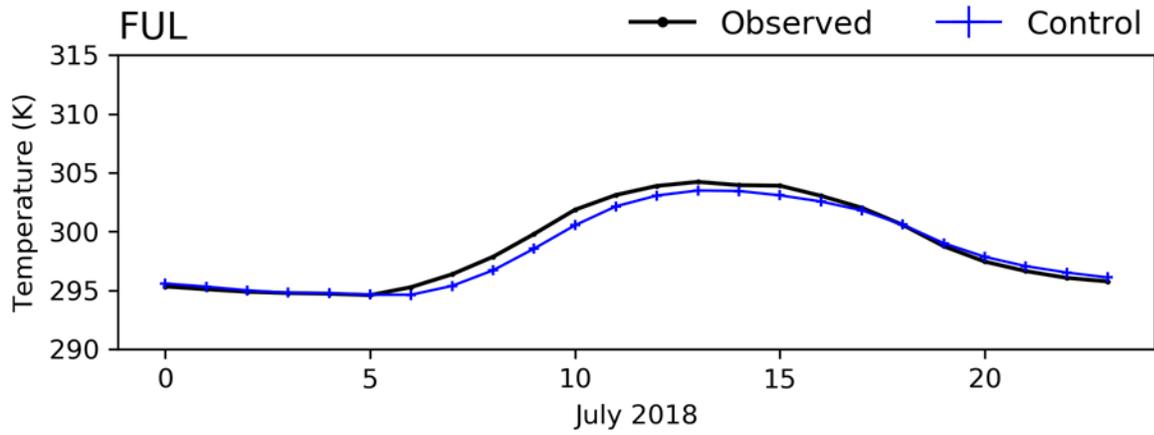
Figure IX-3-20

Time series of hourly water vapor mixing ratio from measurements and WRF control simulations at Hawthorne (HHR) station for July 2018 and January 2019

**IX.3.5 Model Performance Evaluation of Meteorological fields – Diurnal variations**

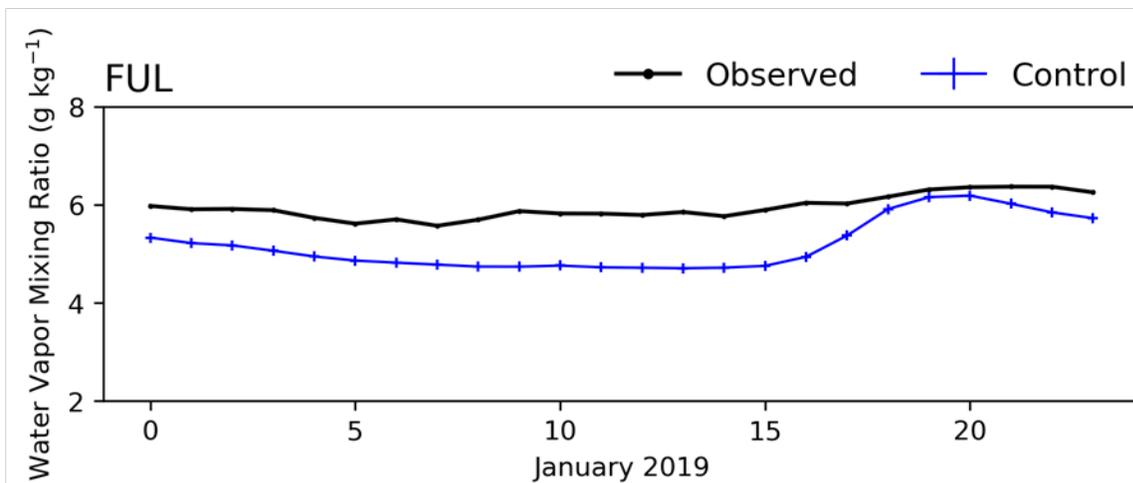
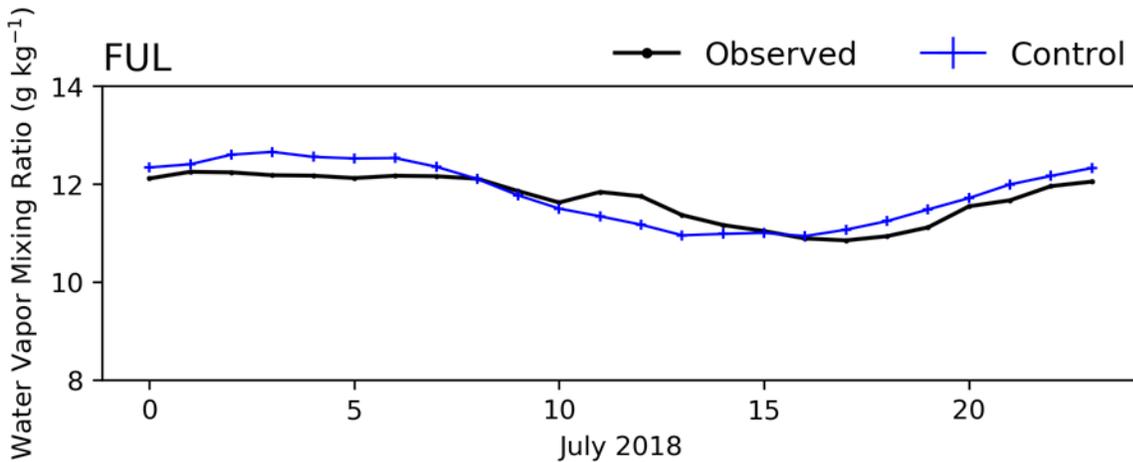
Monthly average diurnal variations of simulated temperature and water vapor mixing ratio were compared against measurements at three locations as provided in Figures IX-3-21 - IX-3-22. The seasonal differences between summer and winter, as represented by July and January, respectively, and the diurnal variations were well reproduced in the WRF control simulation. For example, the daily highest temperature occurs at around 14:00 local time for both summer (~305 K) and winter (~292 K). The water vapor mixing ratio does not exhibit distinct

diurnal variation as does the temperature, but it does show a slight dryness in the early afternoon such as between 13:00 – 15:00 local time during summer.



**Figure IX-3-21**

Measured vs simulated composite diurnal temperature variation at Fullerton (FUL) station for July 2018 and January 2019

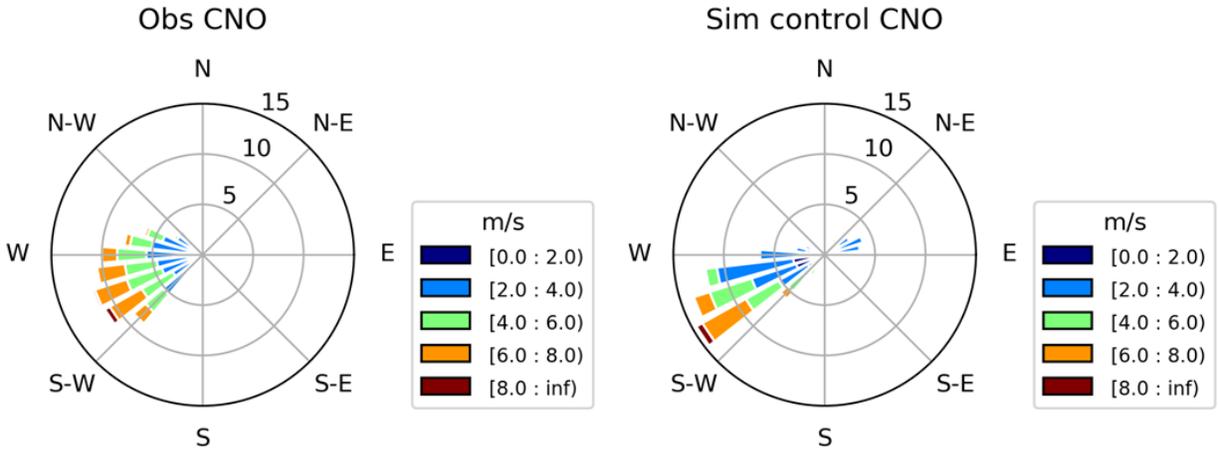


**Figure IX-3-22**

Water vapor mixing ratio at Fullerton (FUL) station from measurement and WRF control simulation for July 2018 and January 2019

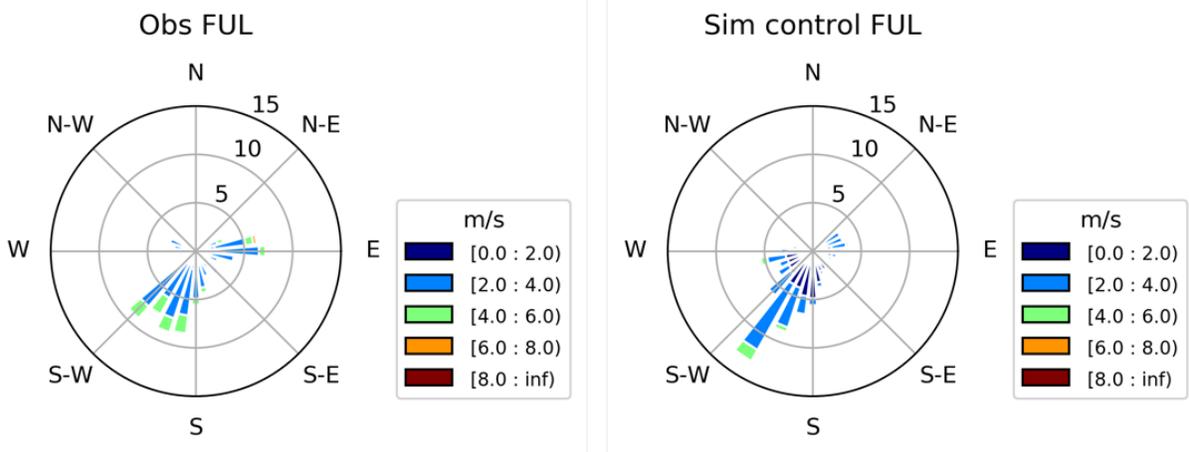
**IX.3.6 Meteorological Model Performance – Wind Rose**

The measured and WRF control simulated wind rose at each station for 1-year period of May 2018– April 2019 are shown in Figure IX-3-23 – Figure IX-3-27. The wind rose plots for 5 stations are presented. In general, the control simulations reproduce the dominant wind direction as the measurement at each station. For example, the station of CNO, FUL, HHR and ONT all have southwest wind as prevailing wind direction showed from both observations and simulations. The wind direction is mostly from the southeast at the BUR station, as presented in both observations and simulations. For the wind speed, among the five stations, the FUL and BUR stations have calm winds, mostly under 6 m/s, while other stations showed stronger wind between 6 - 8 m/s. In general, the WRF control simulation underestimates the observed wind speed at HHR and ONT stations.



**Figure IX-3-23**

Wind rose from measurement and WRF control simulation at Chino (CNO) station during MATES V



**Figure IX-3-24**

Wind rose from measurement and WRF control simulation at Fullerton (FUL) station during MATES V

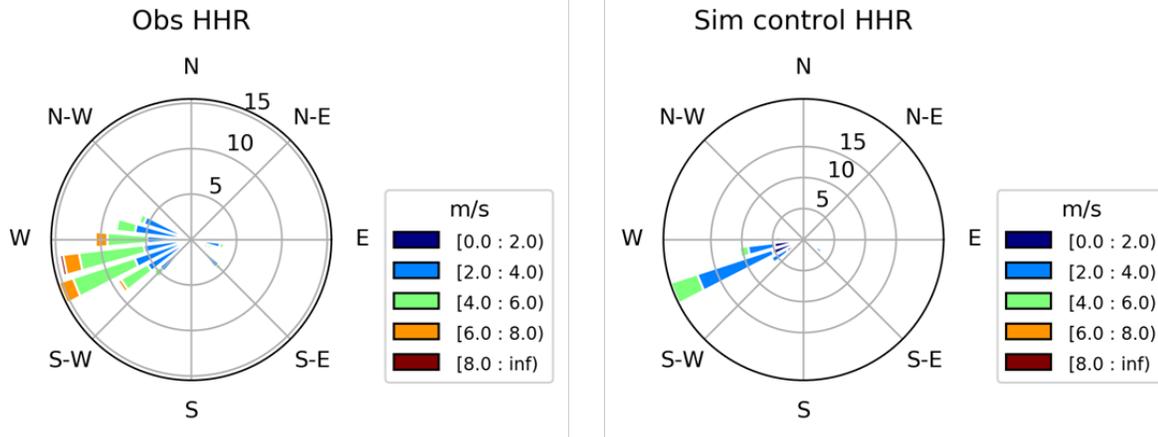


Figure IX-3-25

Wind rose from measurement and WRF control simulation at Hawthorne (HHR) station during MATES V

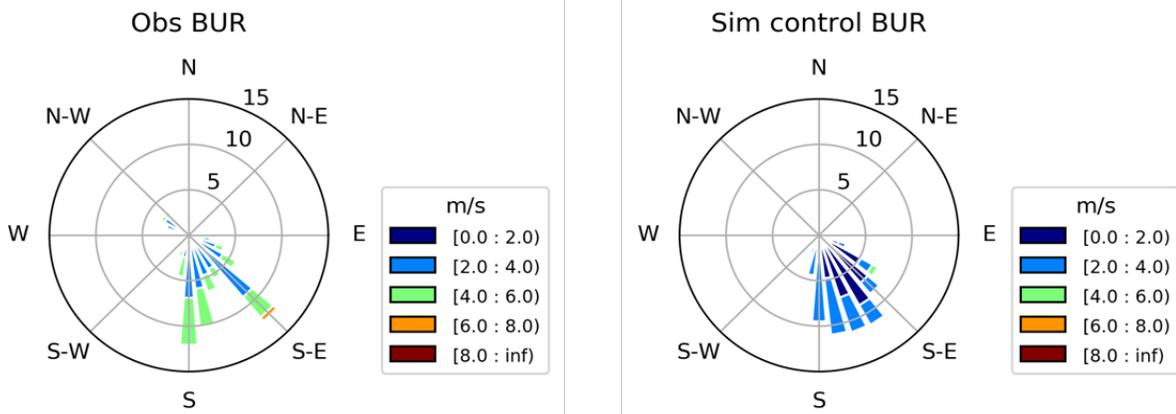
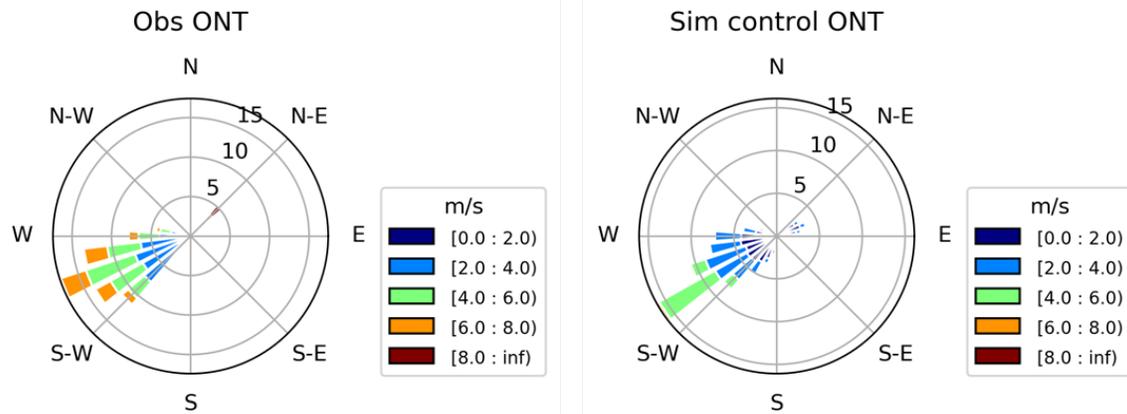


Figure IX-3-26

Wind rose from measurement and WRF control simulation at Burbank (BUR) station during MATES V



**Figure IX-3-27**

Wind rose from measurement and WRF control simulation at Ontario (ONT) station during MATES V

### IX.3.7 Meteorological Model Performance – Planetary Boundary Layer Height (PBLH)

Time series of hourly PBLH from Ceilometer measurements and WRF control simulations for July 2018 at ONT and IRV are shown in Figure IX-3-28. The simulations match very well with the Ceilometer PBL height in general except the Ceilometer reported several very high values such as values higher than 2 km. The very high PBL values from the Ceilometer might be caused by some contamination from clouds. Time series of seasonal composed PBLH diurnal variation from measurement and the WRF control simulations for summer season (June, July and August of 2018) at ONT and IRV shown in Figure IX-3-29. The PBL height development processes from midnight through daytime toward late night are well captured by the simulations. For example, at ONT, the PBL height is lowest (~200 m) during early morning and develops to

higher values of ~800 m around noon time because convection and vertical mixing are stronger, then slowly decays to the lower heights during the late afternoon and early night.

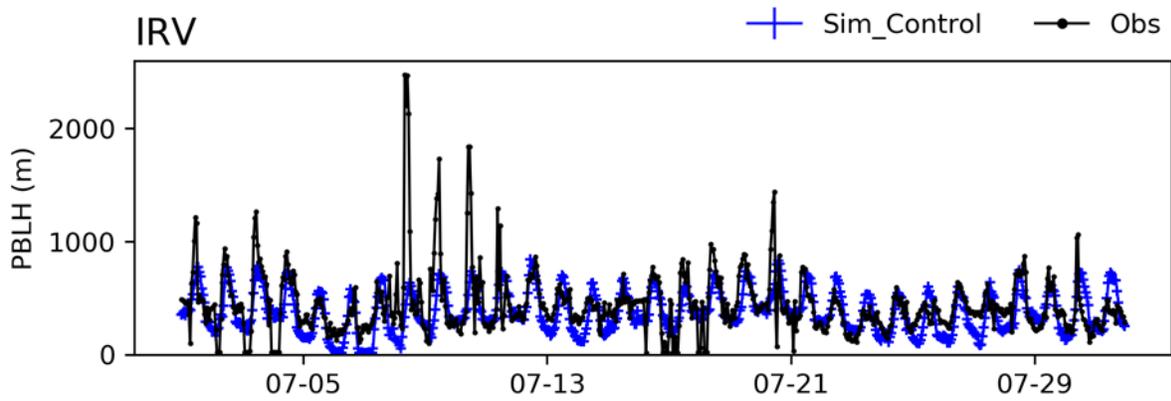
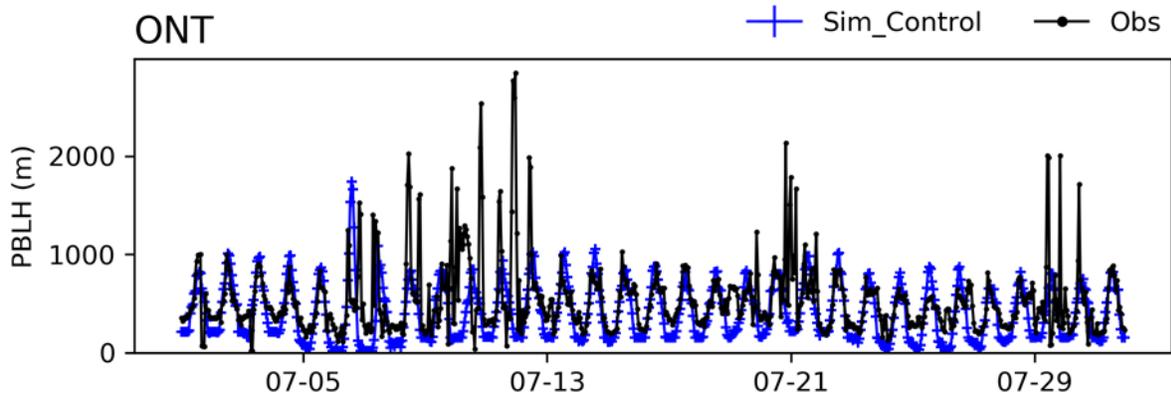
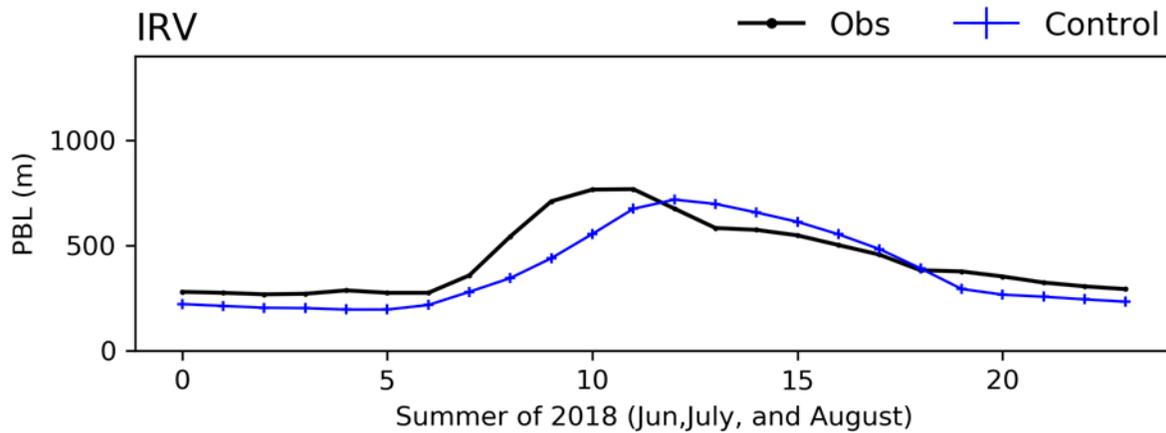
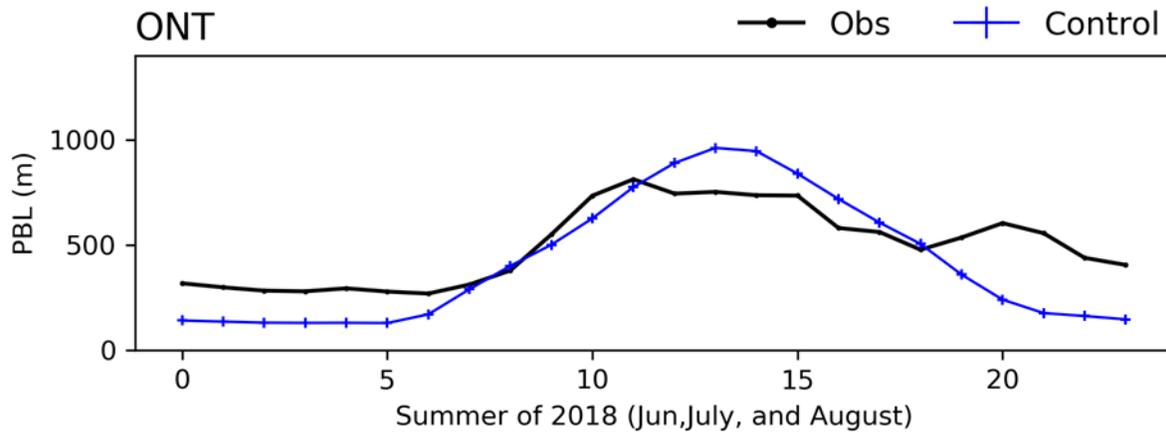


Figure IX-3-28

Time series of hourly PBLH from ceilometer measurement and WRF control simulations for July of 2018 at Ontario (ONT) station and at Irvine (IRV) station



**Figure IX-3-29**

Time series of seasonal composed PBLH diurnal variation from ceilometer measurement and WRF control simulations for summer season (Jun, July and August of 2018) at Ontario (ONT) station and Irvine (IRV) station

**IX.3.8 Vertical Dispersion**

The WRF output was converted to the CAMx reactive tracer (RTRAC) format using ‘wrfcamx\_v.7’ software. Vertical diffusivity ( $K_v$ ), which is critical in vertical dispersion, was computed using CMAQ vertical diffusivity scheme with a minimum value of 1.0 m<sup>2</sup>/sec. The number of vertical layers was reduced to 18 layers from the 30-layer configuration used in the WRF. The layers whose height was below 2 km from the ground level were remained unchanged. The layers above 2 km were collapsed to four layers in order to reduce computation cost. The vertical structure was chosen carefully to optimize computational efficiency and numerical accuracy based on an extensive sensitivity study evaluating the impact of vertical layer structure using various numbers of computational layers.

There are three  $K_v$ -patch options: 1) Land use-based patch to enhance mixing over urban areas; 2) the OB70 patch applies the O'Brien 70 [OB70] (O'Brien, 1970) profile through a user specified surface layer depth. Its purpose is to maintain higher vertical diffusivity during nighttime hours to help reduce over predictions in the buildup of NO<sub>x</sub>; 3) the cloud patch extends the daytime PBL vertical diffusivity profile through capping cloud tops as a means to prohibit artificial collapse of the boundary layer when convection develops and to include convective venting to the free troposphere. Since the SoCAB is mostly under stable atmosphere especially during pollution episodes, it is recommended to avoid using the cloud patch. In all, after careful evaluation of various sensitivity analyses, the vertical dispersion profile used in the final MATES V CAMx RTRAC simulations relied on a 16-layer structure using the CMAQ diffusivity scheme overlaid with the  $K_v$ -patch option. The land use-based patch and OB79 patch are applied with the minimum vertical diffusivity of 1.0 m<sup>2</sup>/sec. In the current study, the first and second computational layers, which are centered approximately 20 m and 40 m above ground level, respectively, were subject to the direct modification of the  $K_v$  through the  $K_v$  patch.

#### **IX.4 MATES V CAMx Modeling Emissions**

An updated version of the 2016 AQMP emissions inventory for the year 2018 provided mobile and stationary source input for the MATES V CAMx RTRAC simulations. On-Road mobile source emissions were updated based the most recent CARB model, EMFAC2017 (CARB, 2017) and adjusted for time-of-day and day-of-week travel patterns based on CalTrans Performance Monitoring System (PeMS) and weigh-in-motion data profiles. The updated inventory also included 2018 reported point source emissions and updated OGV emissions. Table IX-4-1 lists the annual average day emissions for 2018. (A comprehensive breakdown of the planning VOC, NO<sub>x</sub>, CO, SO<sub>2</sub> and particulate emissions for 2018 used in the MATES V simulation is provided in Chapter 3 and Appendix VIII). Table IX-4-1 also includes the MATES IV total suspended particulate matter (TSP) and PM<sub>2.5</sub> diesel emissions for 2012 for comparison.

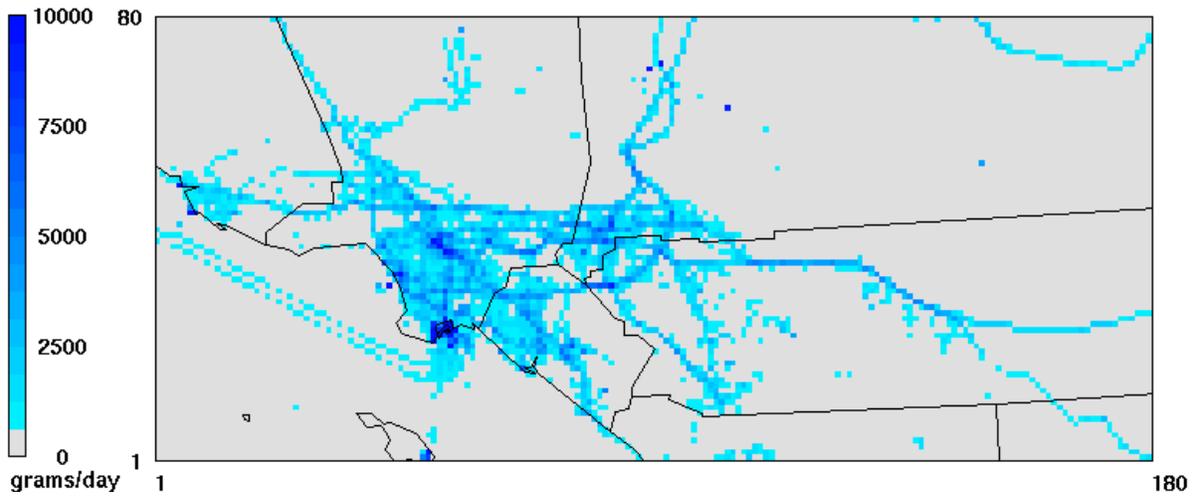
**Table IX-4-1**  
Annual Average Diesel/EC Emissions in the SCAB (TPD)

Compound	MATES IV 2012		MATES V 2018	
	PM <sub>2.5</sub>	TSP	PM <sub>2.5</sub>	TSP
EC	11.58	14.74	5.05	7.85
Total Diesel Particulate Matter (DPM)	9.43	10.24	4.53	4.85
DPM per Major Source Category				
On-road	4.97	5.40	2.00	2.11
Off-road	2.94	3.20	1.81	1.98
Ships	0.74	0.78	0.29	0.31
Trains	0.56	0.61	0.30	0.32
Stationary	0.22	0.25	0.14	0.14
Total DPM	9.43	10.24	4.53	4.85

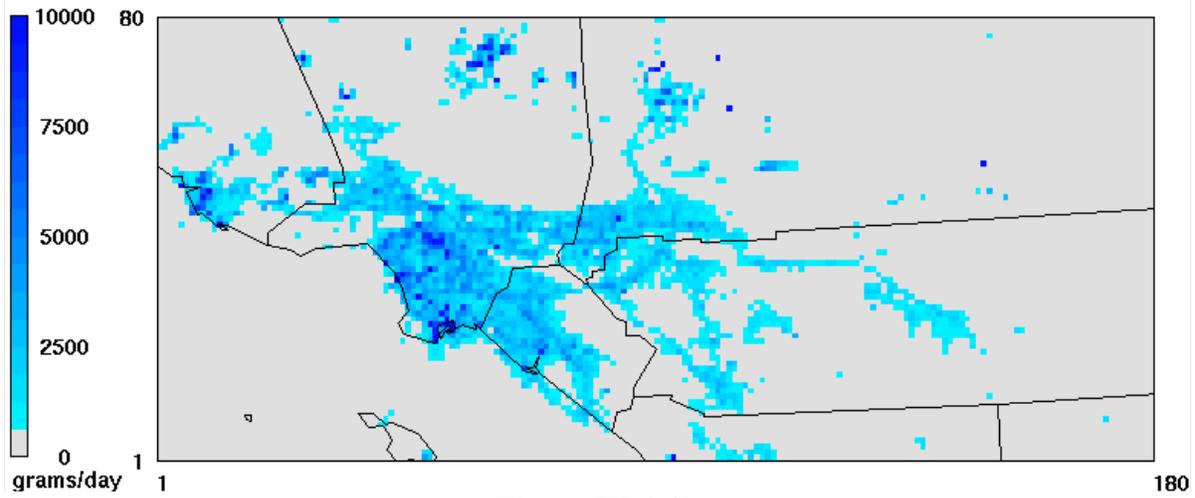
A comparison of the MATES V 2018 PM<sub>2.5</sub> diesel emissions shows a 52% reduction in emissions from the 2012 emissions used in MATES IV. The most significant area of diesel particulate matter emissions reduction occurs in the on-road categories due to significant DPM reductions from CARB's Truck and Bus Regulation.

Figures IX-4-1a through IX-4-1x provide the grid-based average modeling emissions for selected toxic pollutant and precursor emissions categories.

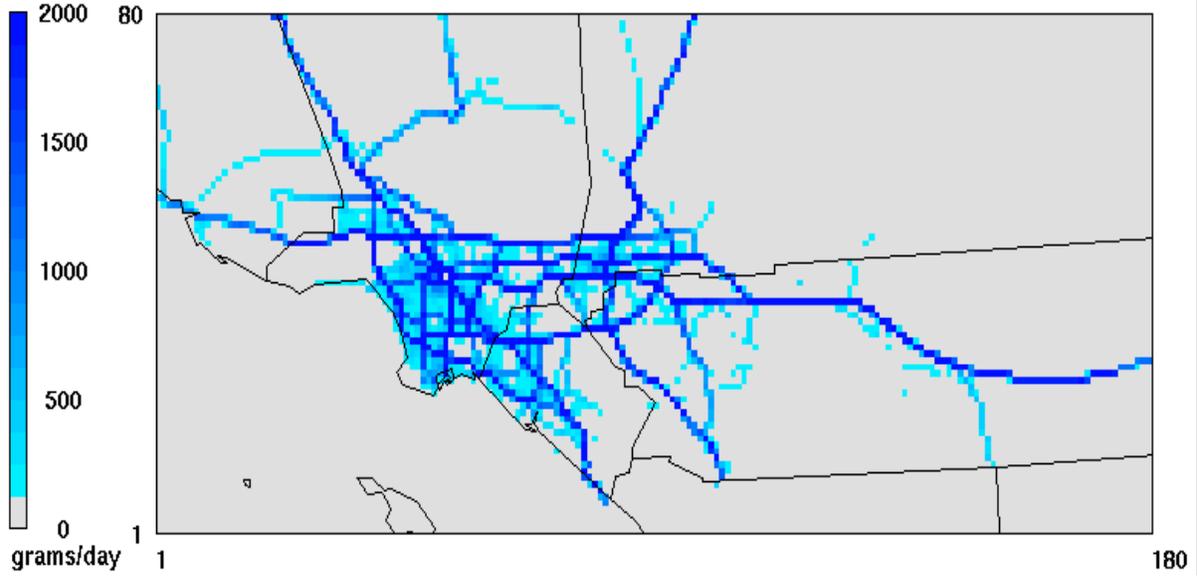
The MATES V modeling used the latest available emissions data. For major point sources, reported annual emissions were used. For area and off-road mobile sources, although annual emissions were based on projection in 2016 AQMP, the latest updated spatial surrogates were used to allocate county total emissions to a specific grid in the modeling domain. The EMFAC2017 emission factors along with SCAG's transportation modeling for 2018 developed for the 2016 RTP/SCS, CalTrans Performance Measurement System (PeMS) and Weigh-in-Motion (WIM) data, and ambient conditions from WRF modeling were used to generate spatially and temporally resolved on-road modeling emissions. The projected annual emissions from ocean-going vessels (OGV) for 2018 from the CARB 2018 SIP update (CARB, 2018) were also used. Emissions from OGV and commercial harbor craft (CHC) were spatially and temporally resolved using Automatic Identification System (AIS) data. OGV emissions are released through stacks, which result in the emissions penetrated to the computational layer 2 and higher, while CHC emissions were assumed to be released at the sea level due to the lower profile of a typical harbor craft. The latest biogenic emission model, Model of Emissions of Gases and Aerosols from Nature 3 (MEGAN3), together with WRF outputs were used to generate day-specific biogenic emissions.



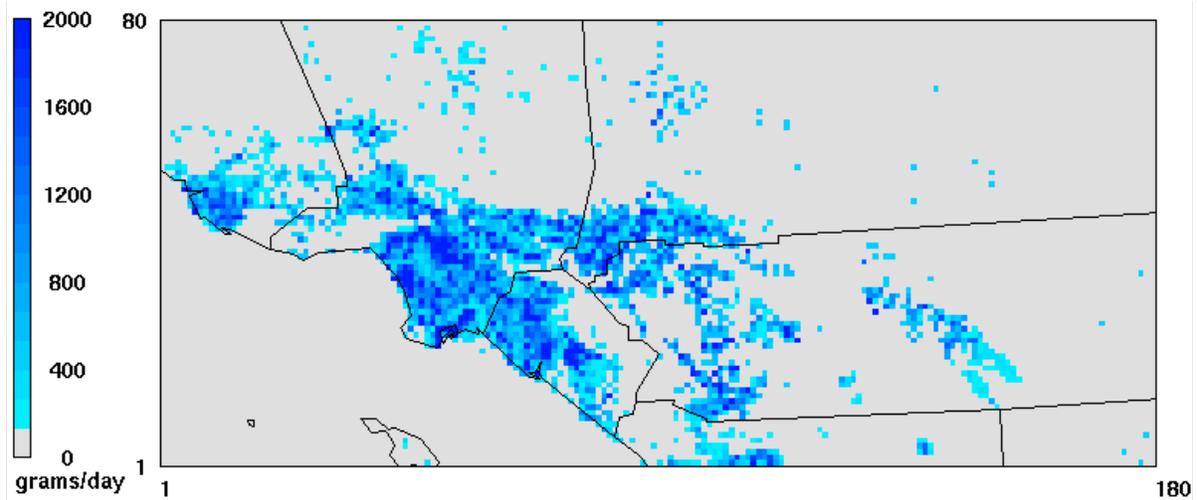
**Figure IX-4-1a**  
Average emissions pattern for diesel PM from all source categories



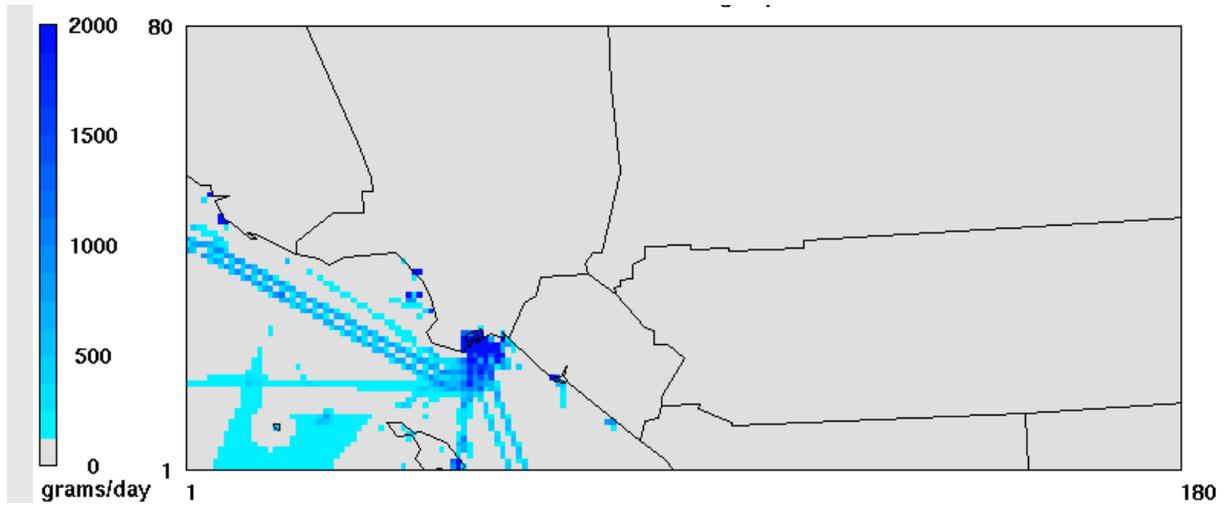
**Figure IX-4-1b**  
Average emissions pattern for elemental carbon



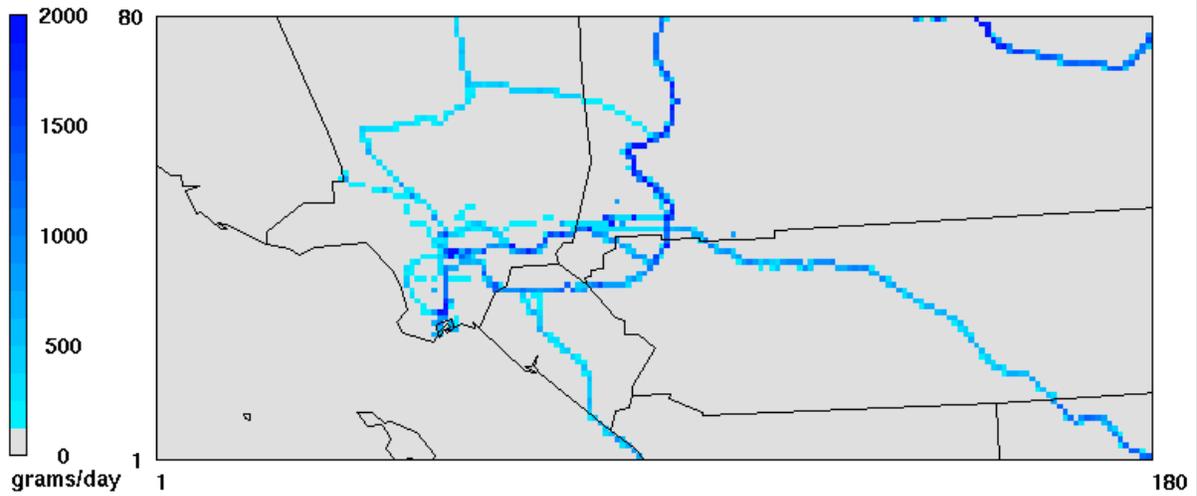
**Figure IX-4-1c**  
Average emissions pattern of on-road diesel PM



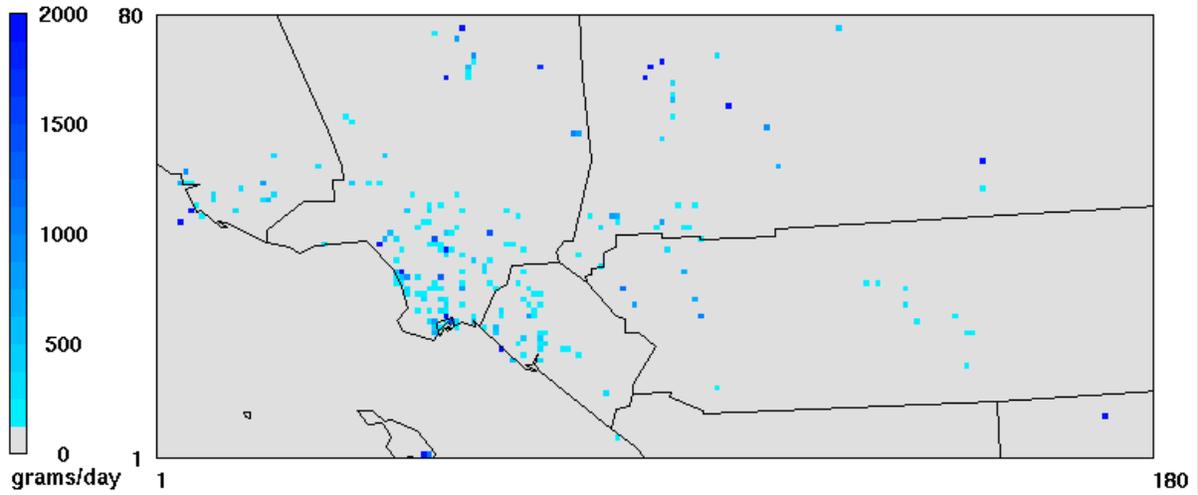
**Figure IX-4-1d**  
Average emissions pattern of off-road diesel PM



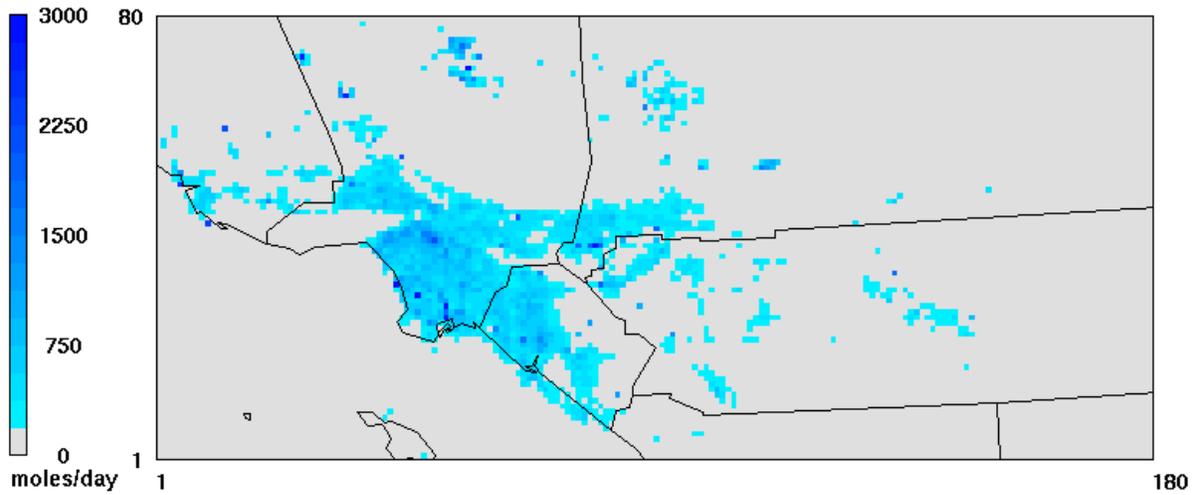
**Figure IX-4-1e**  
Average emissions pattern of diesel PM from OGV and CHC.



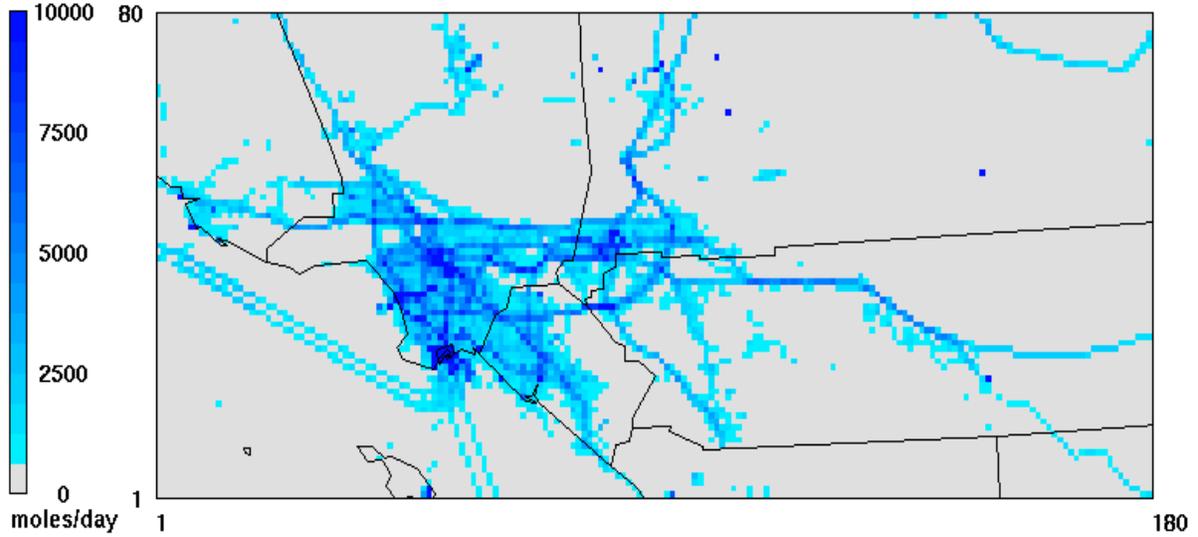
**Figure IX-4-1f**  
Average emissions pattern of diesel PM from trains



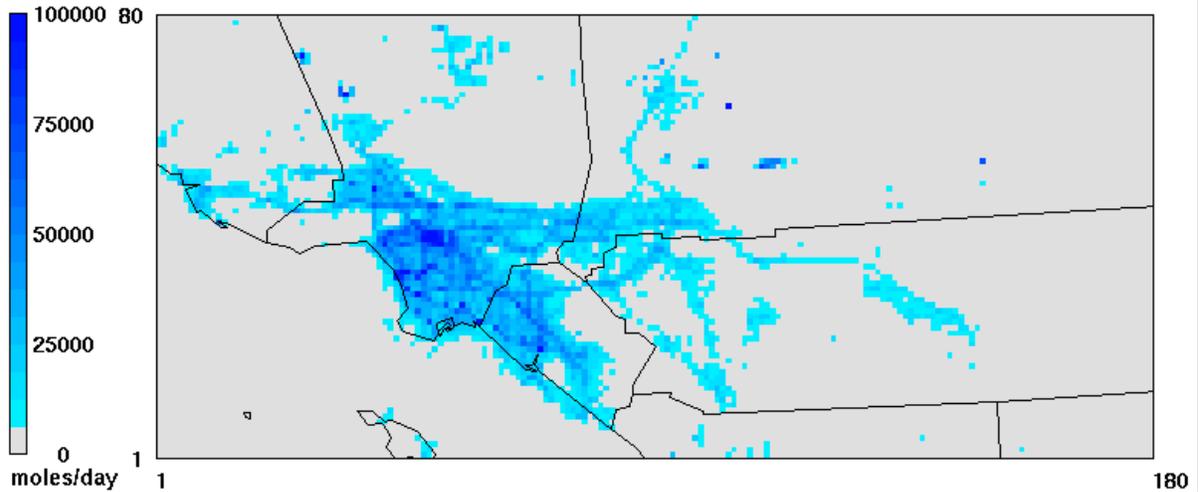
**Figure IX-4-1g**  
Average emissions pattern Diesel PM from stationary sources



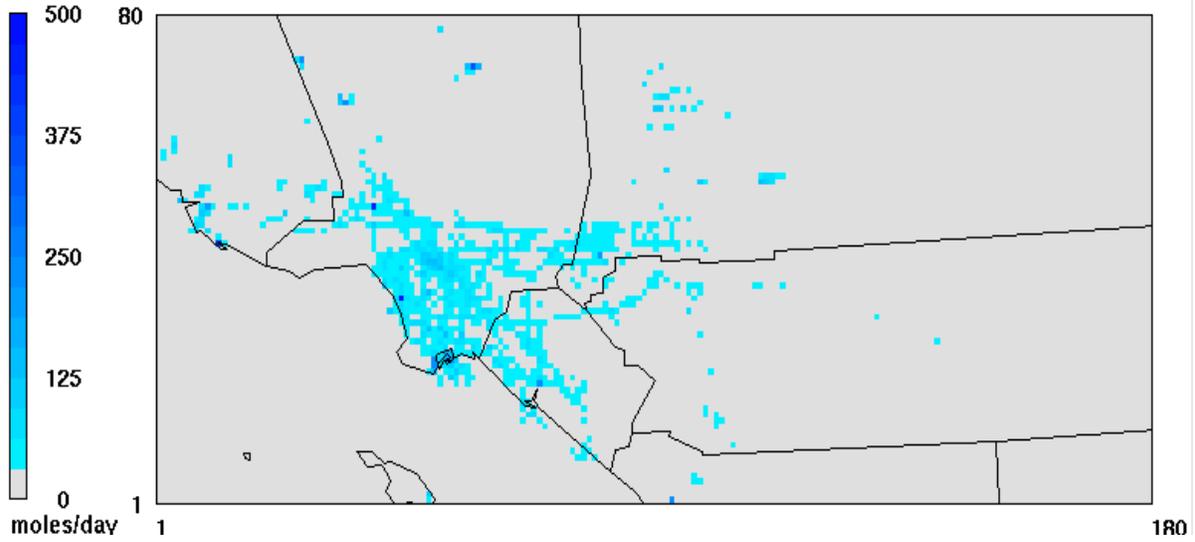
**Figure IX-4-1h**  
Average VOC emissions pattern from all source categories



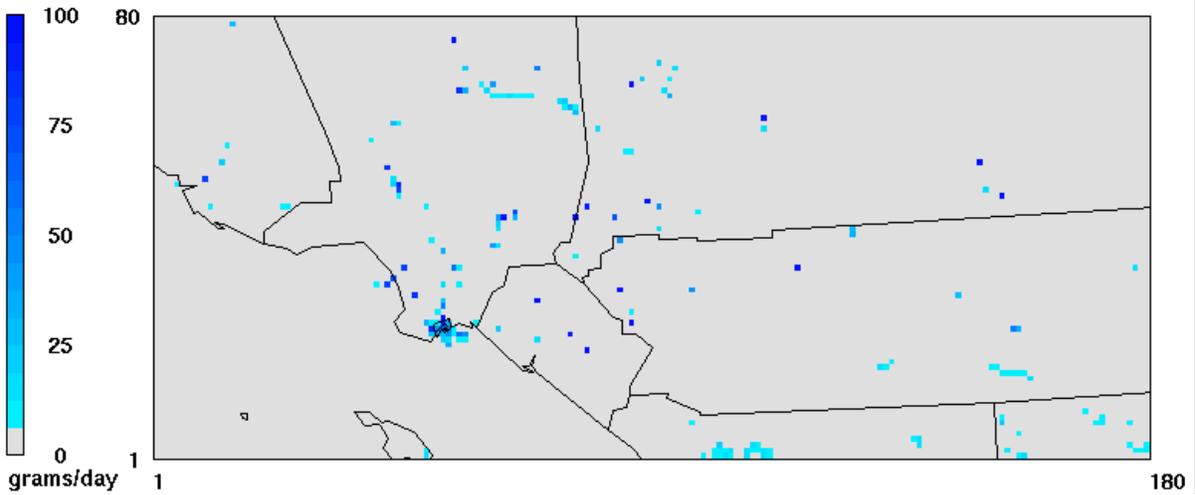
**Figure IX-4-1i**  
Average NOx emissions pattern from all source categories



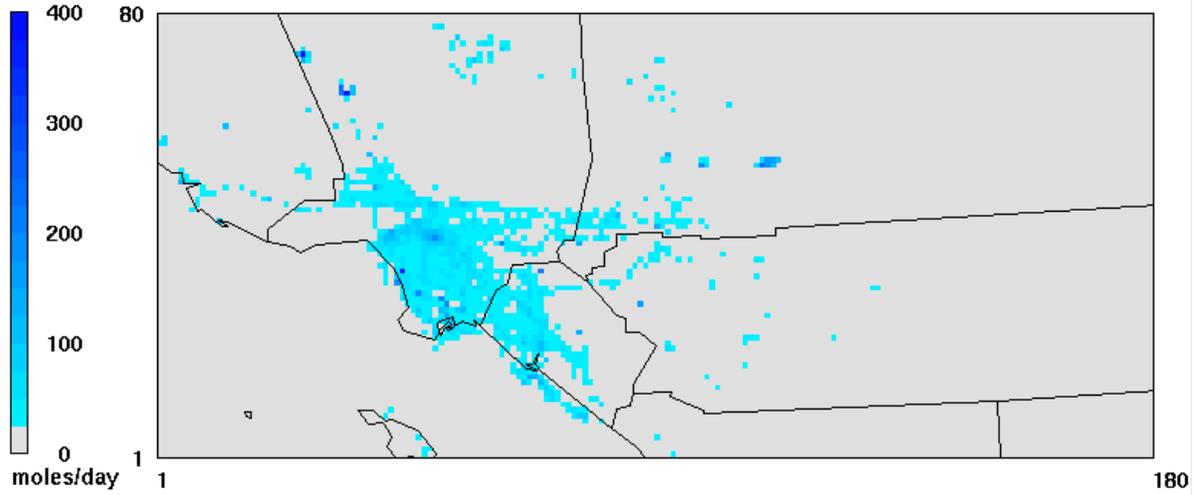
**Figure IX-4-1j**  
Average CO emissions pattern from all source categories



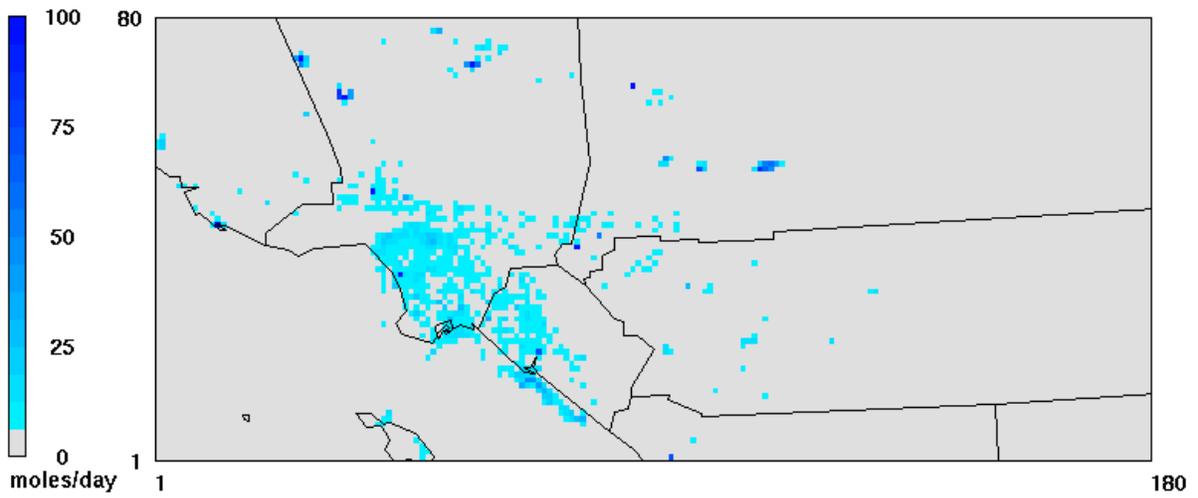
**Figure IX-4-1k**  
Average emissions pattern for Acetaldehyde from all source categories



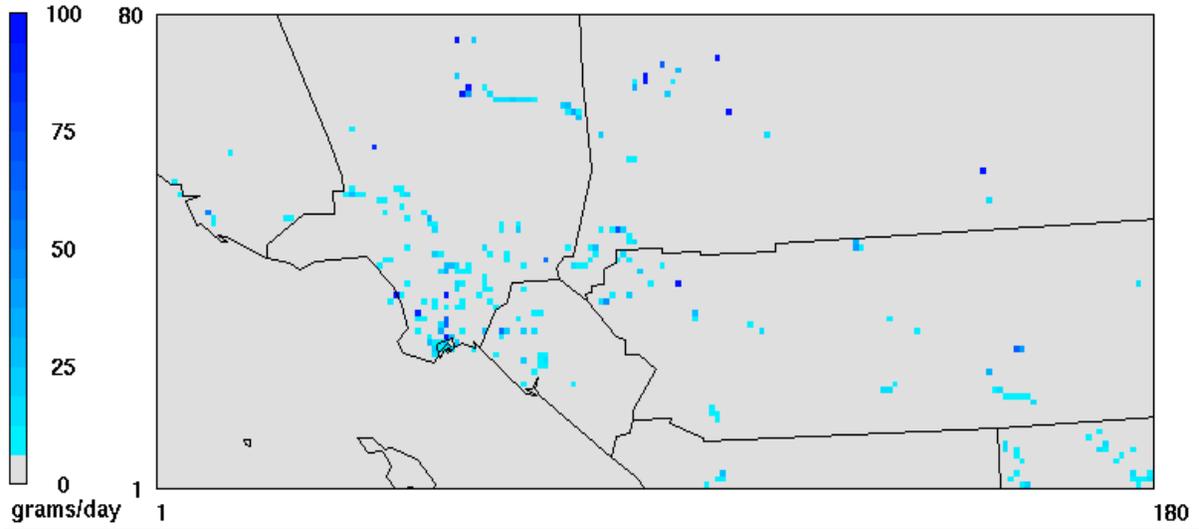
**Figure IX-4-1l**  
Average Arsenic emissions pattern from all source categories



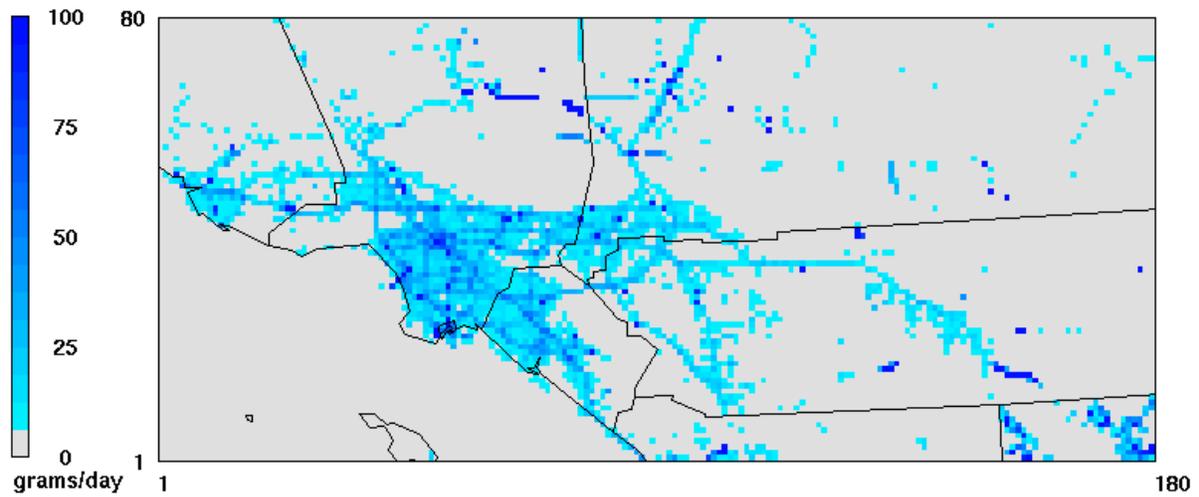
**Figure IX-4-1m**  
Average Benzene emissions pattern from all source categories



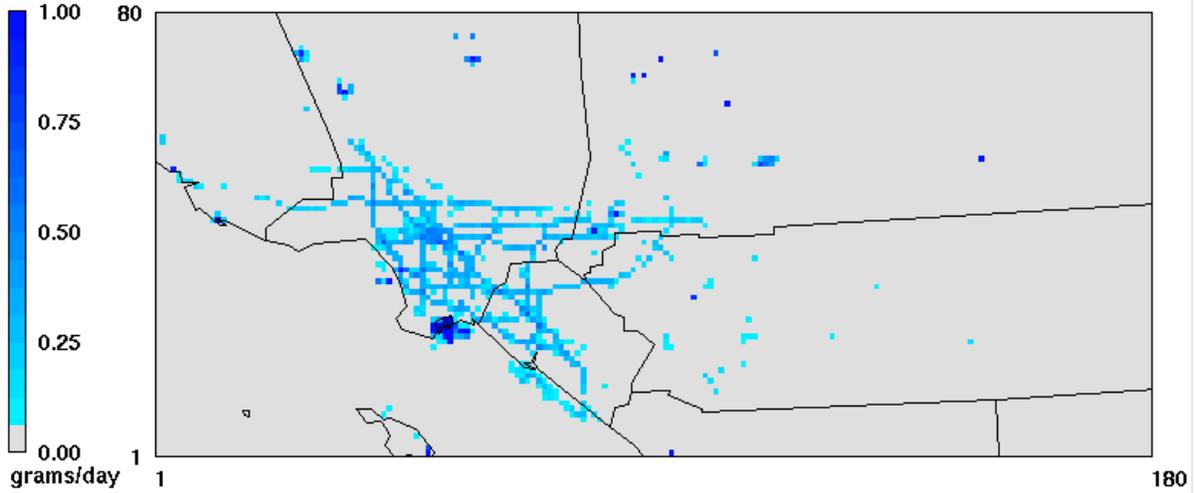
**Figure IX-4-1n**  
Average 1,3-Butadiene emissions pattern from all source categories



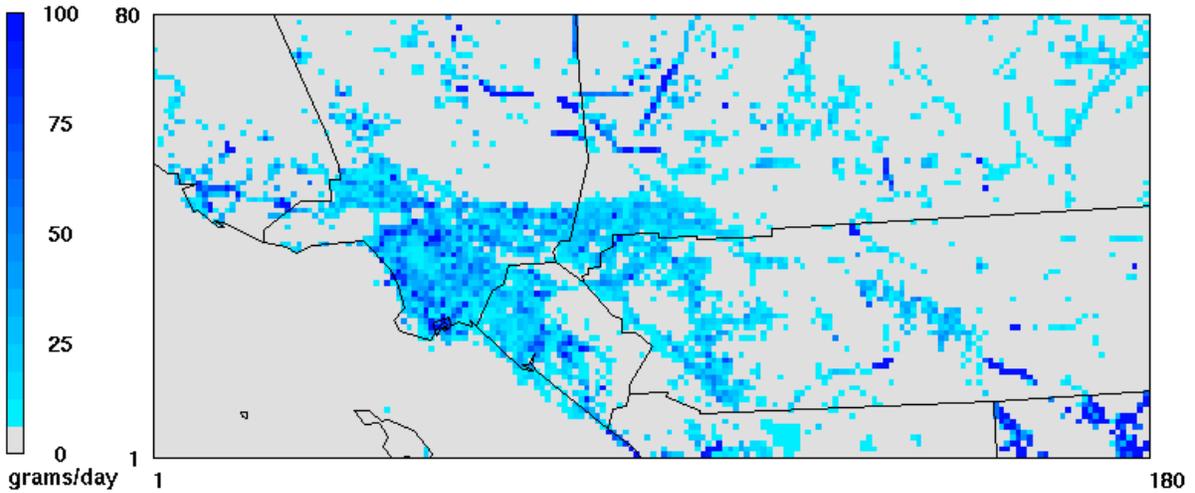
**Figure IX-4-1o**  
Average Cadmium emissions pattern from all source categories



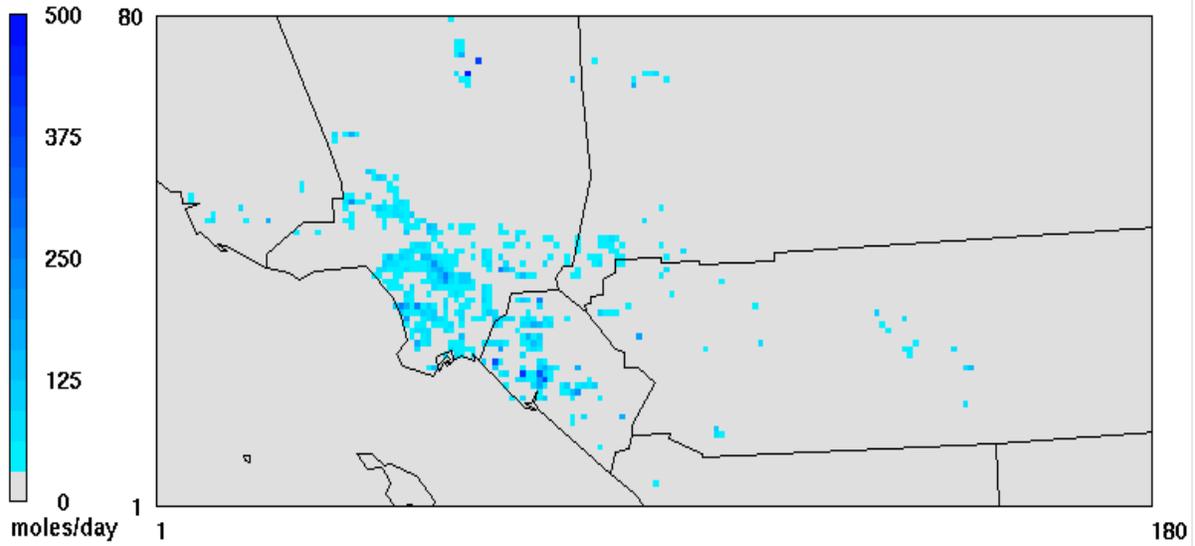
**Figure IX-4-1p**  
Average Total Chromium emissions pattern from all source categories



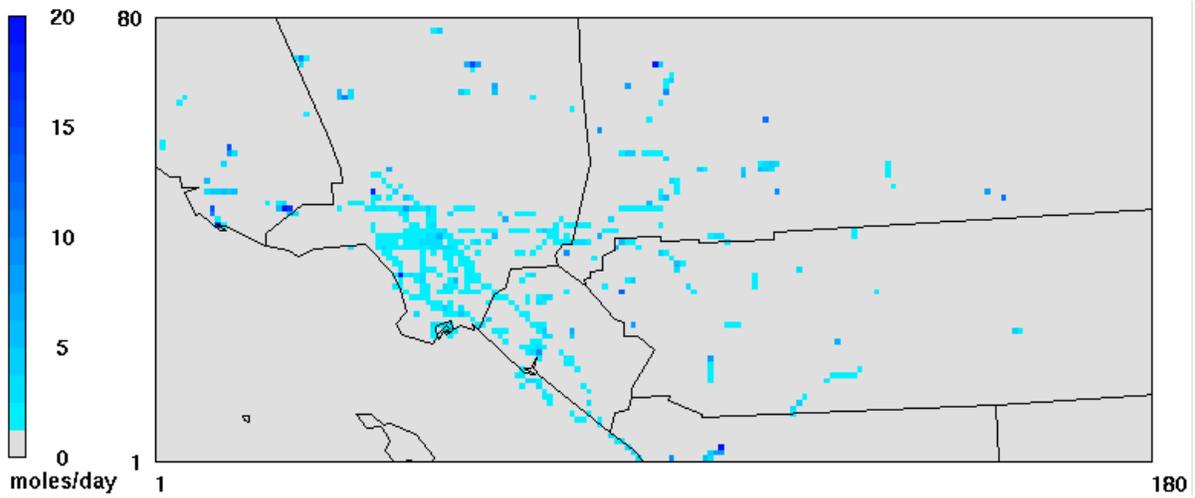
**Figure IX-4-1q**  
Average Hexavalent Chromium emissions pattern from all source categories



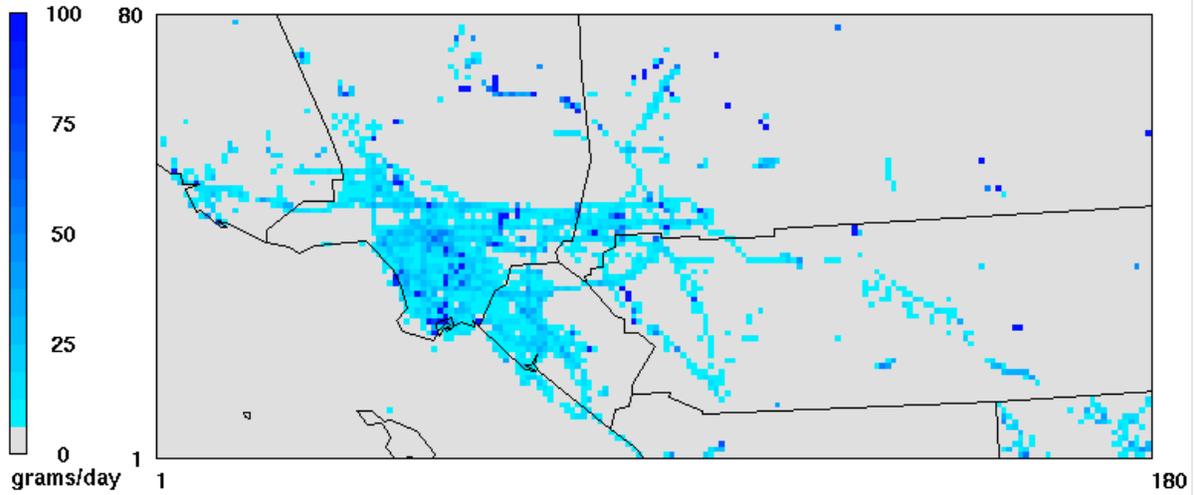
**Figure IX-4-1r**  
Average Lead emissions pattern from all source categories



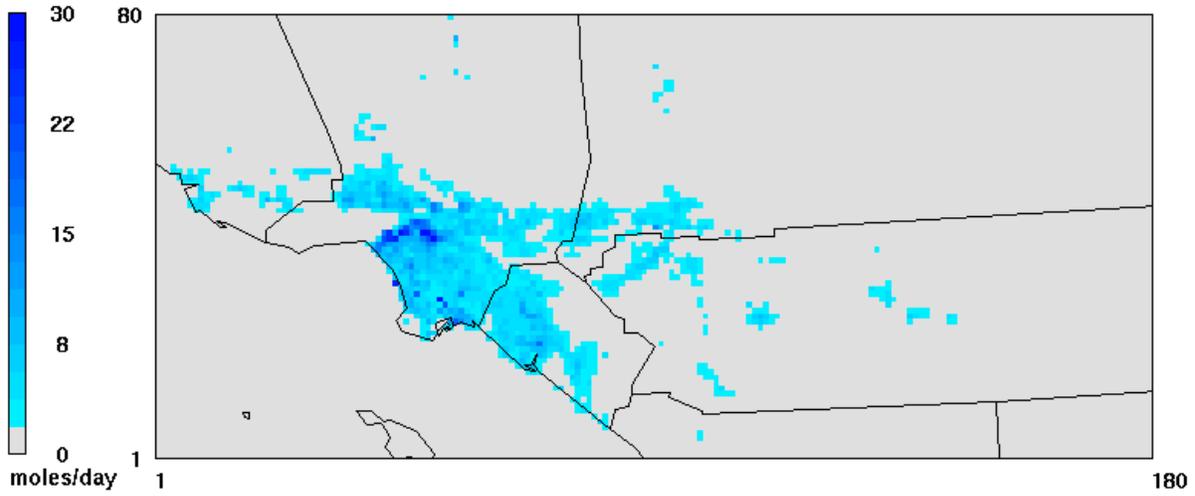
**Figure IX-4-1s**  
Average Methylene Chloride emissions pattern from all source categories



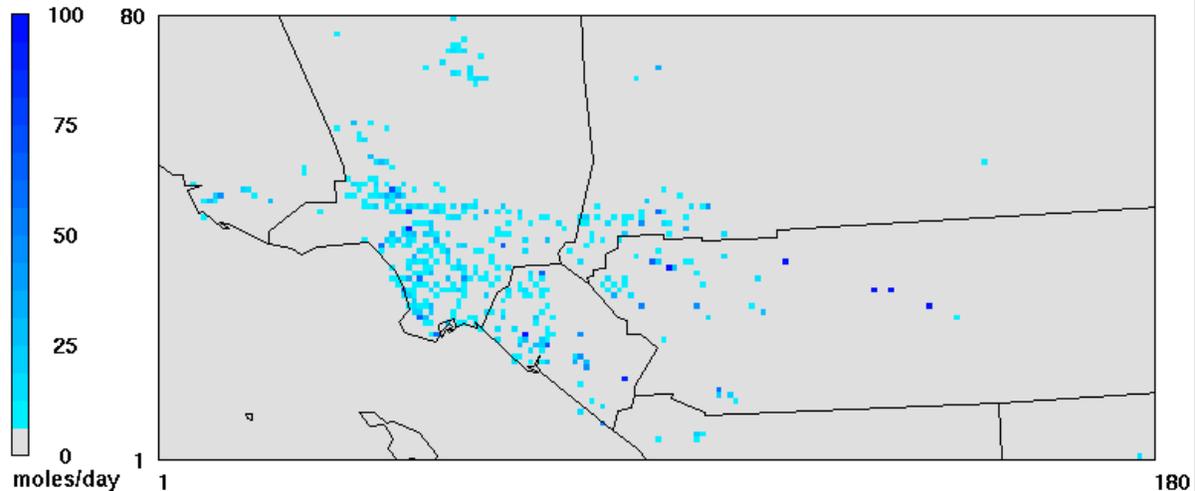
**Figure IX-4-1t**  
Average Naphthalene emissions pattern from all source categories



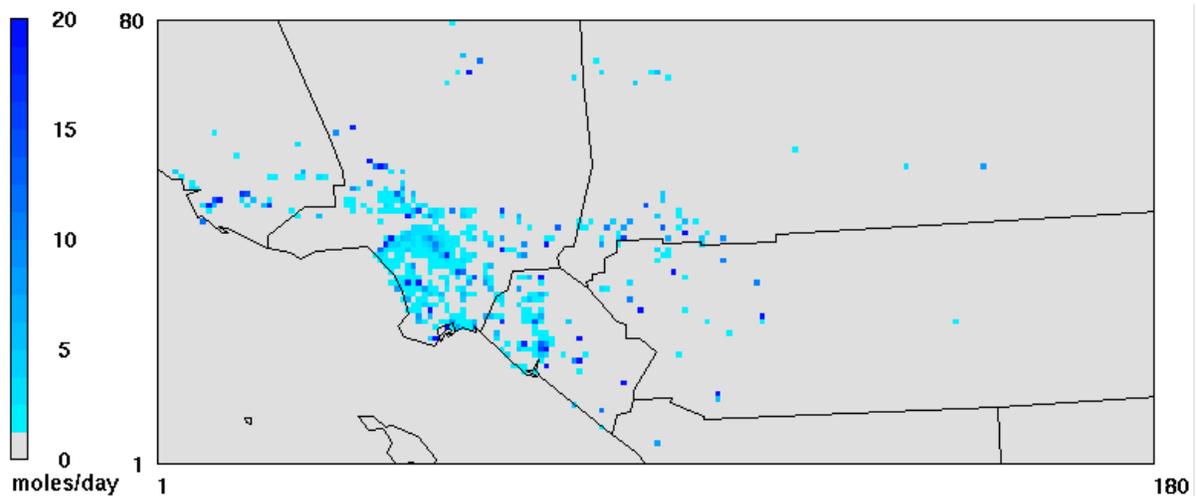
**Figure IX-4-1u**  
Average Nickel emissions pattern from all source categories



**Figure IX-4-1v**  
Average p-Dichlorobenzene emissions pattern from all source categories



**Figure IX-4-1w**  
Average Perchloroethylene emissions pattern from all source categories



**Figure IX-4-1x**  
Average Trichloroethylene emissions pattern from all source categories

## IX.5 Modeling Setup

The MATES V regional modeling analyses relies on the CAMx RTRAC model to simulate annual impacts of both gaseous and aerosol toxic compounds. The accuracy of the modeling analyses depends on the accuracy of region-wide emissions of air toxic compounds, temporal and spatial resolutions of these emissions, accurate representation of meteorological conditions and quality of modeling tools used. The South Coast AQMD staff strives to use the best information and modeling tools available at the time for its MATES modeling analyses. Table IX-5-1 summarizes the major components in the air toxics modeling and provides a comparison between the MATES V and MATES IV analyses.

**Table IX-5-1**  
Summary and Comparison of Key Modeling Considerations Between  
MATES IV and MATES V

Parameter	MATES IV	MATES V
Meteorological Modeling Year	July 2012 - June 2013	May 2018 - April 2019
Model Platform / Chemistry	CAMx RTRAC (5.30)	CAMx RTRAC (6.50)
Meteorology Model / Vertical Layers	WRF with 30 layers/ CAMx: 16 layers	WRF with 30 layers/ CAMx: 16 layers
On-Road mobile Emissions	EMFAC2011/2012 RTP Caltrans/SCAG Model Uniform day of week and hourly distributions by Caltrans District	EMFAC2017/2016 RTP Caltrans PeMS/WIM data and SCAG model Day-specific spatial and temporal distributions
OGV and CHC Emissions	2012 AQMP for 2012 OGV; Emissions spread through mostly layers 1 and 2; uniform spatial and temporal distributions	2018 SIP Update for OGV; Emissions spread through mostly layers 1 and 2; day-specific temporal and spatial distributions
Point Source Emissions	2012 Projection from 2008 (2012 AQMP)	2018 Annual Emissions Reports
Area Source Emissions	2012 Projection from 2008 (2012 AQMP)	2018 Projection from 2012 (2016 AQMP)
Off-Road Emissions except OGV	2012 Projection from 2008 (2012 AQMP)	2018 Projection from 2012 (2016 AQMP)

## IX.6 Boundary and Initial Conditions

The day-specific boundary condition files were prepared by extracting values at boundary grids from the 2016 AQMP modeling domain, which spans 90 by 40 grids in the east-west and the north-south direction, respectively, with 4 km grid space (2016 AQMP, Appendix V, Figure V-2-2). The CMAQ modeling domain covers the South Coast Air Basin as well as adjacent counties in Southern California. SAPRC07 were chosen as the gaseous species mechanism and AERO6 were chosen as aerosol module in the CMAQ modeling (South Coast AQMD, 2020). In total, 171 modeled gaseous and aerosol species were extracted from the CMAQ hourly simulation outputs using the BCON m3conc utility. For the unmodeled toxic gaseous and metal components required in the MATES V modeling, the boundary values were scaled based on the resolved CMAQ surrogate concentrations. The corresponding days in the 2018 CMAQ modeling values were used for the boundary conditions extraction during the January to April 2019 MATES modeling period. In order to minimize the impact of the unrealistic low CMAQ simulated

benzene concentrations to MATES V domain, a fixed value as 0.1 ppbV were replaced for the lateral boundary condition.

The initial condition files were prepared using the *icbcp* utility included in the CAMx standard package. The utility prepares uniform boundary and initial conditions with prescribed values. The initial values turn out to be not significant in the annual modeling, since the footprint of the initial values typically disappear in approximately 7 to 10 days of time integration, depending on grid size and chemical mechanism. In the MATES V simulations, 7 days were used as initial spin-up.

## IX.7 CAMx Modeling Results

CAMx modeling results, CAMx modeling performance evaluation, and cancer risk estimation based on model predicted air toxics concentrations, OEHHA's cancer potency factor and population were presented in this section. The estimated cancer risk based on CAMx modeling results were compared with measurement-based cancer risk and those from MATES IV to evaluate the progress in improving air quality for the South Coast Air Basin and Coachella Valley.

### IX.7.1 Overall Model Performances

The performance of the CAMx regional modeling simulation is summarized through statistical and graphical analysis, including time series of key pollutant concentrations. Summarized in Table IX-7-1 are the measurements and model predictions of toxic components during the sampling period. Prediction Accuracy (PA), defined as the percentage difference between the mean observed and simulated concentrations, is given as an indicator for the model performance.

For the MATES V period, the model simulated concentrations of particulate matter species, such as EC<sub>2.5</sub>, and TSP metals, compared favorably with measurement results. Concentrations of some air toxic species, such as perchloroethylene, p-dichlorobenzene, trichloroethylene, and naphthalene have become low enough that model performances for those pollutants are immaterial. Concentrations of 1,3-butadiene was underpredicted by the modeling. Emissions of 1,3-butadiene are primarily from gasoline combustion. Recently, CARB updated emissions from small off-road engines (CARB, 2020). This update is expected to increase 1,3-butadiene emissions marginally and to help reduce some of the underprediction, and is not incorporated in this modeling. Benzene and methylene were relatively well-simulated. Compared to MATES IV, ambient concentrations of formaldehyde and acetaldehyde increased in MATES V. These increases were incongruent with the expected emission decreases between the two MATES periods. Consequently, the model underpredicted the formaldehyde and acetaldehyde concentrations.

Simulated annual average EC<sub>2.5</sub> was used to assess overall model performance for the MATES V period. Tables IX-7-2 summarizes the MATESV EC<sub>2.5</sub> performance.

EPA guidance (U.S. EPA, 2006) recommends evaluating gaseous and particulate modeling performance using measures of prediction bias and error. PA goals of  $\pm 20\%$  for ozone and  $\pm 30\%$

for individual components of PM<sub>2.5</sub> or PM<sub>10</sub> have been used to assess simulation performance in previous modeling attainment demonstrations.

As shown in the Tables IX-7-2, eight of the 10 MATES V sites meet the PM<sub>2.5</sub> PA goal. In general, the model underpredicts annual average concentrations at the Rubidoux, Inland Valley San Bernardino, Compton and Pico Rivera stations, consistent with what was observed in our past modeling effort. Concentrations in locations such as Burbank Area, Long Beach and Anaheim are overpredicted. Overall, modeled EC<sub>2.5</sub> concentrations were 5% lower than the measurements, which were likely driven by the CAMx not being able to predict extreme high events (See Figures IX-7-1).

Table IX-7-3 provides the CAMx RTRAC performance for benzene at the 7 MATES V monitoring sites. Benzene model performance is included in the evaluation because of the confidence in the benzene measurement data based on the long-term monitoring conducted in the Basin and throughout California. With the exception of the Burbank Area site (25% over), the annual average benzene concentrations are underpredicted with Compton showing the largest low bias (36%). Overall, the model underpredicted benzene concentrations by 13%. Therefore, the overall model performance for benzene is reasonable.

The time series fit of the simulated EC<sub>2.5</sub> concentrations to measurements for each station is depicted in Figures IX-7-1a through IX-7-1j. As evident in the plots, variations of modeled concentrations matched well with measurements. As expected, the model has difficulty in predicting extreme high and low concentrations.

**Table IX-7-1**  
Station Observed and CAMx Simulated MATES V Average Concentrations

Compound	Units	Anaheim			Burbank Area			Compton			Inland Valley San Bernardino		
		Obs	Model	PA	Obs	Model	PA	Obs	Model	PA	Obs	Model	PA
1,3-Butadiene	ppb	N/A	-	N/A	0.036	0.018	-50	0.095	0.017	-82	0.051	0.014	-72
Acetaldehyde	ppb	N/A	-	N/A	1.77	0.70	-61	1.48	0.55	-63	2.15	0.65	-70
As (2.5)	ng/m <sup>3</sup>	N/A	0.17	N/A	N/A	0.13	N/A	N/A	0.28	N/A	N/A	0.22	N/A
As (TSP)	ng/m <sup>3</sup>	0.36	0.31	-14	0.46	0.33	-28	0.44	0.59	34	0.89	0.52	-42
Benzene	ppb	N/A	-	N/A	0.22	0.27	23	0.38	0.24	-36	0.23	0.22	-4
Cd (2.5)	ng/m <sup>3</sup>	N/A	0.43	N/A	N/A	0.39	N/A	N/A	0.80	N/A	N/A	0.59	N/A
Cd (TSP)	ng/m <sup>3</sup>	0.24	0.49	104	0.19	0.47	147	0.25	0.86	244	0.31	0.78	151
Cr6 (TSP)	ng/m <sup>3</sup>	0.038	0.022	-42	0.032	0.028	-13	0.061	0.029	-52	0.038	0.081	125
EC <sub>2.5</sub>	µg/m <sup>3</sup>	0.47	0.55	17	0.50	0.67	34	0.80	0.66	-18	0.78	0.63	-19
Formaldehyde	ppb	N/A	-	N/A	3.73	1.72	-54	2.47	1.48	-40	4.47	1.67	-63
Methylene Chloride	ppb	N/A	-	N/A	0.16	0.22	36	0.19	0.17	-10	0.19	0.15	-21
Naphthalene	ppb												
Ni (2.5)	ng/m <sup>3</sup>	N/A	1.77	N/A	N/A	1.96	N/A	N/A	3.55	N/A	N/A	3.55	N/A
Ni (TSP)	ng/m <sup>3</sup>	2.17	2.62	20	2.01	3.26	62	2.93	5.02	71	6.31	5.14	-19
Pb (2.5)	ng/m <sup>3</sup>	N/A	1.11	N/A	N/A	1.56	N/A	N/A	1.36	N/A	N/A	2.24	N/A
Pb (TSP)	ng/m <sup>3</sup>	2.72	2.46	-10	6.98	3.93	-44	4.81	3.12	-53	7.66	4.93	-36
p-Dichlorobenzene	ppb	N/A	-	N/A	0.023	0.037	61	0.030	0.023	-23	0.020	0.018	-10
Perchloroethylene	ppb	N/A	-	N/A	0.021	0.032	52	0.049	0.023	-53	0.052	0.024	-54
Trichloroethylene	ppb	N/A	-	N/A	0.024	0.019	-21	0.020	0.012	-40	0.018	0.015	-17

**Table IX-7-1 (Continued)**  
Station Observed and CAMx Simulated MATES V Annual Average Concentrations

Compound	Units	Huntington Park			North Long Beach			Central Los Angeles			Pico Rivera		
		Obs	Model	PA	Obs	Model	PA	Obs	Model	PA	Obs	Model	PA
1,3-Butadiene	ppb	0.074	0.022	-70	0.051	0.017	-67	N/A	-	N/A	0.055	0.012	-78
Acetaldehyde	ppb	1.63	0.62	-62	1.24	0.50	-60	N/A	-	N/A	1.39	0.64	-54
As (2.5)	ng/m <sup>3</sup>	N/A	0.24	N/A	N/A	0.46	N/A	N/A	0.20	N/A	N/A	0.18	N/A
As (TSP)	ng/m <sup>3</sup>	0.45	0.46	2	0.38	0.69	82	0.42	0.43	2	0.66	0.41	-39
Benzene	ppb	0.31	0.26	-16	0.32	0.24	-23	N/A	-	N/A	0.25	0.23	-6
Cd (2.5)	ng/m <sup>3</sup>	N/A	0.82	N/A	N/A	0.58	N/A	N/A	0.43	N/A	N/A	0.41	N/A
Cd (TSP)	ng/m <sup>3</sup>	0.46	0.90	96	0.09	0.66	633	0.15	0.52	246	0.14	0.49	250
Cr6 (TSP)	ng/m <sup>3</sup>	0.057	0.024	-58	0.034	0.029	-15	0.044	0.036	-18	0.035	0.023	-34
EC <sub>2.5</sub>	µg/m <sup>3</sup>	0.68	0.66	-3	0.52	0.61	17	0.71	0.78	10	0.74	0.62	-16
Formaldehyde	ppb	2.56	1.61	-37	2.08	1.42	-32	N/A	-	N/A	3.00	1.56	-48
Methylene Chloride	ppb	0.17	0.27	59	0.16	0.14	-14	N/A	-	N/A	0.16	0.17	4
Naphthalene	ppb							0.013	0.007	-46			
Ni (2.5)	ng/m <sup>3</sup>	N/A	3.01	N/A	N/A	2.91	N/A	N/A	2.94	N/A	N/A	2.47	N/A
Ni (TSP)	ng/m <sup>3</sup>	2.64	4.25	61	3.64	4.23	16	2.00	4.50	125	3.00	3.81	27
Pb (2.5)	ng/m <sup>3</sup>	N/A	1.41	N/A	N/A	1.56	N/A	N/A	1.64	N/A	N/A	1.36	N/A
Pb (TSP)	ng/m <sup>3</sup>	4.42	3.56	-19	3.19	3.18	0	5.09	4.53	-11	4.73	3.35	-29
p-Dichlorobenzene	ppb	0.033	0.028	-15	0.029	0.025	-14	N/A	-	N/A	0.026	0.021	-19
Perchloroethylene	ppb	0.032	0.028	-13	0.023	0.017	-26	N/A	-	N/A	0.031	0.021	-32
Trichloroethylene	ppb	0.022	0.015	-32	0.020	0.011	-45	N/A	-	N/A	0.014	0.012	-14

**Table IX-7-1 (Continued)**  
Station Observed and CAMx Simulated MATES V Average Concentrations

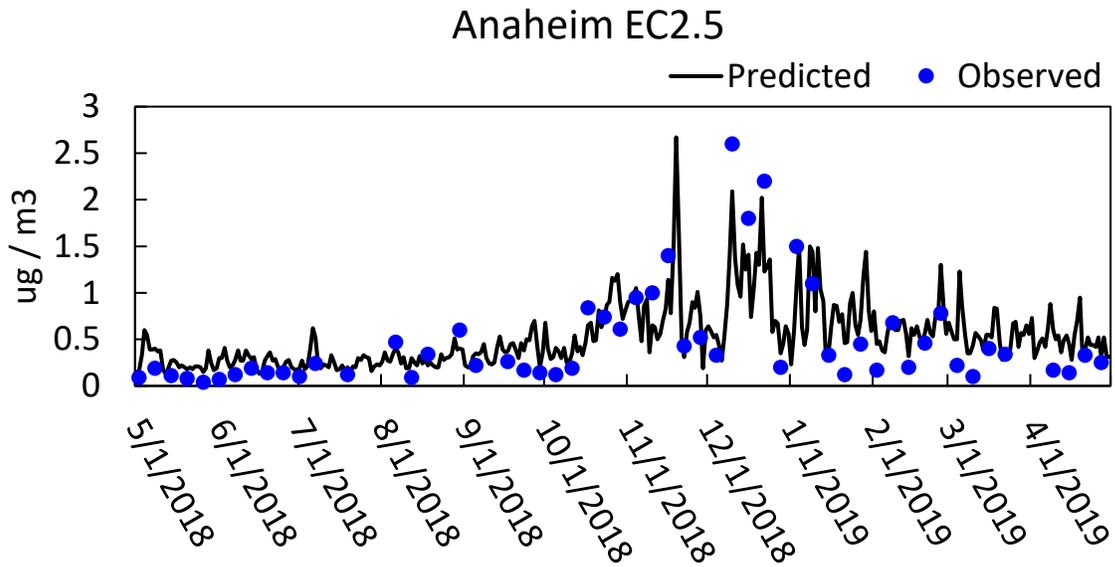
Compound	Units	Rubidoux			West Long Beach		
		Obs	Model	PA	Obs	Model	PA
1,3-Butadiene	ppb	N/A	-	N/A	0.062	0.022	-65
Acetaldehyde	ppb	N/A	-	N/A	1.16	0.51	-56
As (2.5)	ng/m <sup>3</sup>	N/A	0.09	N/A	N/A	0.80	N/A
As (TSP)	ng/m <sup>3</sup>	0.67	0.26	-61	0.47	1.11	136
Benzene	ppb	N/A	-	N/A	0.30	0.27	-10
Cd (2.5)	ng/m <sup>3</sup>	N/A	0.22	N/A	N/A	0.88	N/A
Cd (TSP)	ng/m <sup>3</sup>	0.59	0.30	-49	0.77	0.94	22
Cr6 (TSP)	ng/m <sup>3</sup>	0.026	0.012	-54	0.035	0.037	6
EC <sub>2.5</sub>	µg/m <sup>3</sup>	0.69	0.42	-39	0.72	0.71	1
Formaldehyde	ppb	N/A	-	N/A	2.33	1.64	-30
Methylene Chloride	ppb	N/A	-	N/A	0.16	0.13	-19
Naphthalene	ppb	0.008	0.003	-100			
Ni (2.5))	ng/m <sup>3</sup>	N/A	1.11	N/A	N/A	4.64	N/A
Ni (TSP)	ng/m <sup>3</sup>	2.41	1.88	-22	4.32	6.84	58
Pb (2.5)	ng/m <sup>3</sup>	N/A	0.88	N/A	N/A	1.87	N/A
Pb (TSP)	ng/m <sup>3</sup>	4.47	2.63	-41	4.14	3.50	-15
p-Dichlorobenzene	ppb	N/A	-	N/A	0.026	0.024	8
Perchloroethylene	ppb	N/A	-	N/A	0.024	0.017	-29
Trichloroethylene	ppb	N/A	-	N/A	0.030	0.012	-60

**Table IX-7-2**  
MATES V EC<sub>2.5</sub> Model Performance

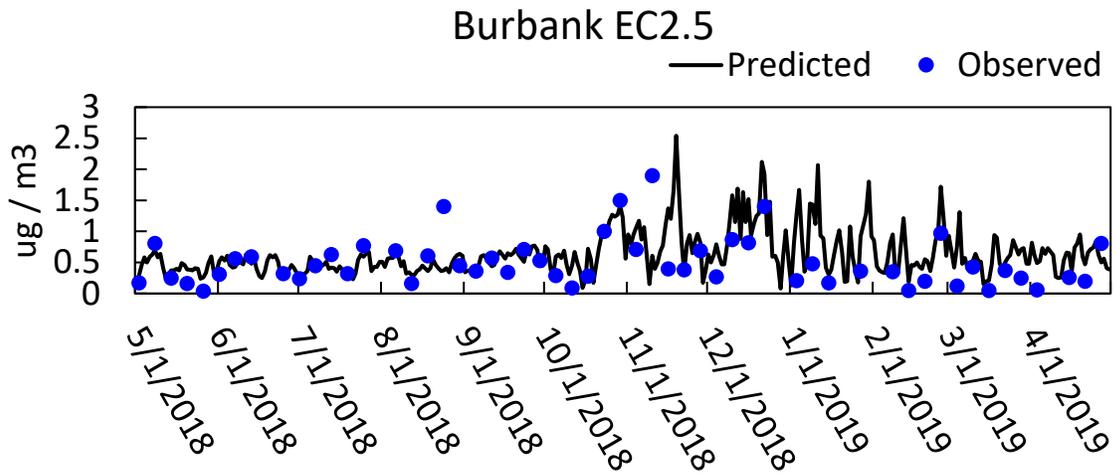
Location	Observed ( $\mu\text{g}/\text{m}^3$ )	*Modeled ( $\mu\text{g}/\text{m}^3$ )	Prediction Accuracy	Mean Bias ( $\mu\text{g}/\text{m}^3$ )	Mean Error ( $\mu\text{g}/\text{m}^3$ )	Normalized Mean Bias	Normalized Mean Error
Anaheim	0.47	0.55	16	0.08	0.21	0.78	0.89
Burbank Area	0.50	0.67	33	0.17	0.33	1.06	1.22
Compton	0.80	0.66	-17	-0.14	0.42	0.59	0.86
Inland Valley San Bernardino	0.78	0.63	-20	-0.15	0.33	0.05	0.48
Huntington Park	0.68	0.66	-2	-0.02	0.32	0.74	0.97
Long Beach	0.52	0.62	19	0.10	0.28	1.53	1.67
Central L.A.	0.71	0.78	9	0.07	0.27	0.63	0.76
Pico Rivera	0.74	0.62	-16	-0.13	0.25	0.11	0.41
Rubidoux	0.69	0.42	-40	-0.27	0.35	0.06	0.60
West Long Beach	0.72	0.71	-2	-0.01	0.38	0.89	1.16
All Stations	0.66	0.63	-5	-0.03	0.31	0.64	0.90

**Table IX-7-3**  
MATES V Simulation Performance Statistics for Benzene

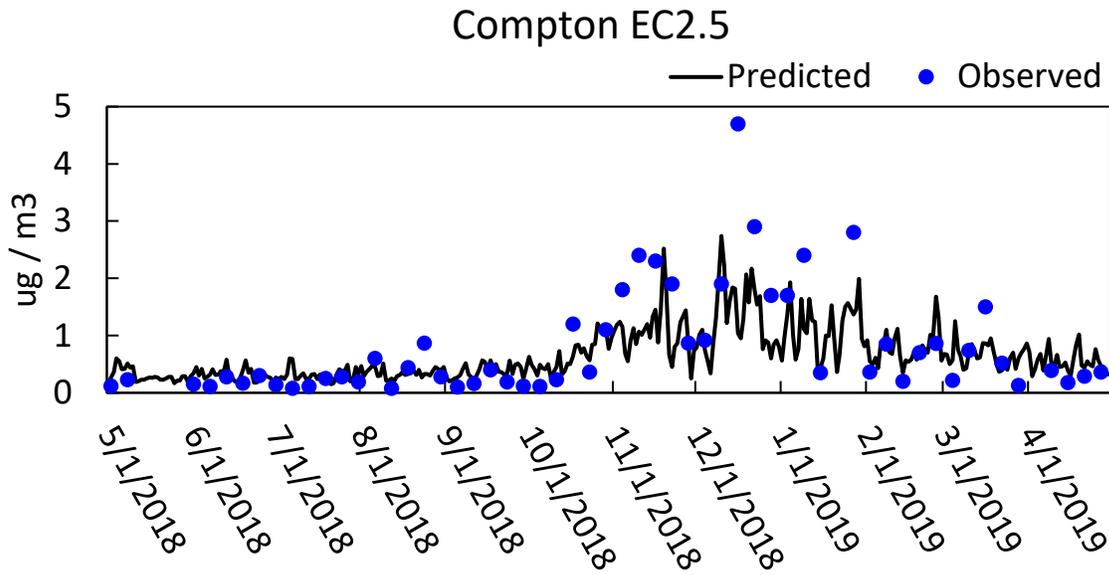
Location	Observed (ppb)	Samples	Predicted (ppb)	PA	Mean Bias (ppb)	Mean Error (ppb)	Normalized Mean Bias	Normalized Mean Error
Anaheim								
Burbank Area	0.22	60	0.27	23	-0.06	0.08	0.33	0.41
Compton	0.38	61	0.24	-36	-0.14	0.20	0.09	0.52
Inland Valley San Bernardino	0.23	61	0.22	-4	-0.01	0.06	0.07	0.27
Huntington Park	0.31	60	0.26	-17	-0.05	0.11	0.08	0.35
North Long Beach	0.32	58	0.24	-24	-0.08	0.15	0.28	0.61
Central L.A.								
Pico Rivera	0.25	53	0.23	-8	-0.02	0.08	0.14	0.37
Rubidoux								
West Long Beach	0.30	58	0.27	-8	-0.03	0.13	0.35	0.61
All Stations	0.29	411	0.25	-13	-0.04	0.12	0.19	0.45



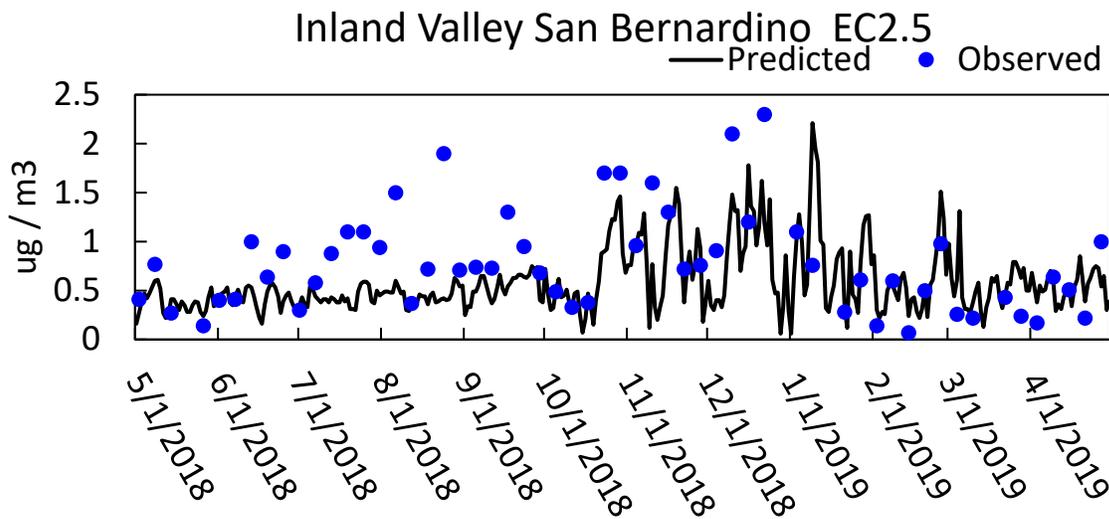
**Figure IX-7-1a**  
EC<sub>2.5</sub> Time Series: Simulated vs. Measured at Anaheim



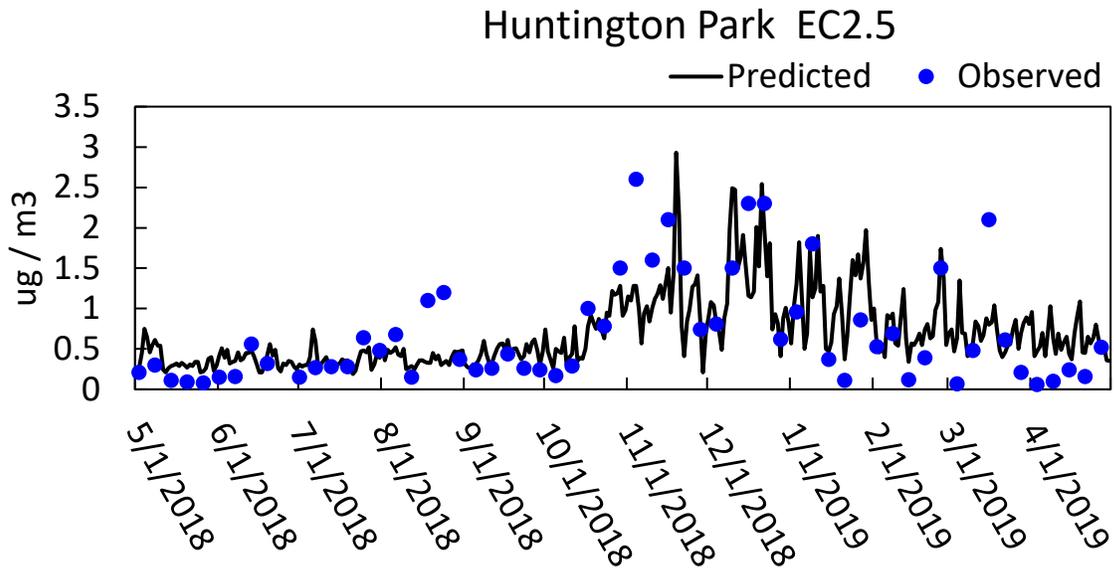
**Figure IX-7-1b**  
EC<sub>2.5</sub> Time Series: Simulated vs. Measured at Burbank Area



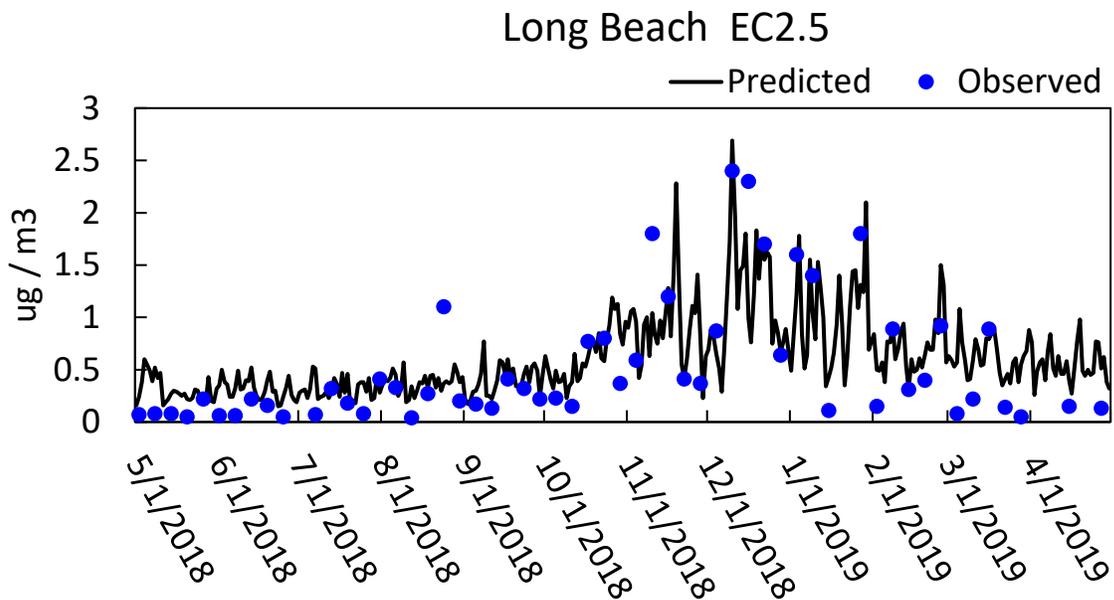
**Figure IX-7-1c**  
EC<sub>2.5</sub> Time Series: Simulated vs. Measured at Compton



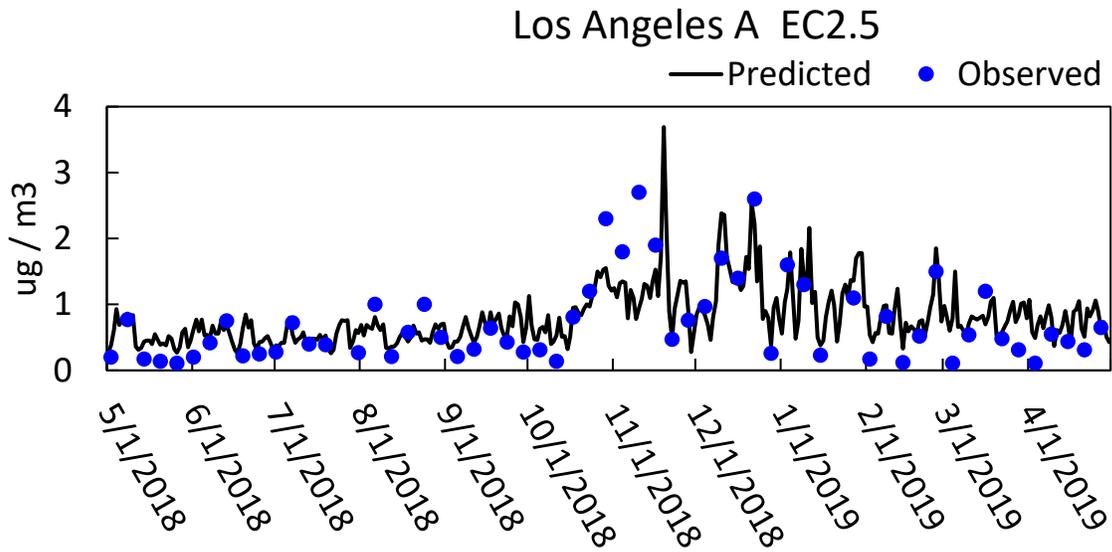
**Figure IX-7-1d**  
EC<sub>2.5</sub> Time Series: Simulated vs. Measured at Inland Valley San Bernardino



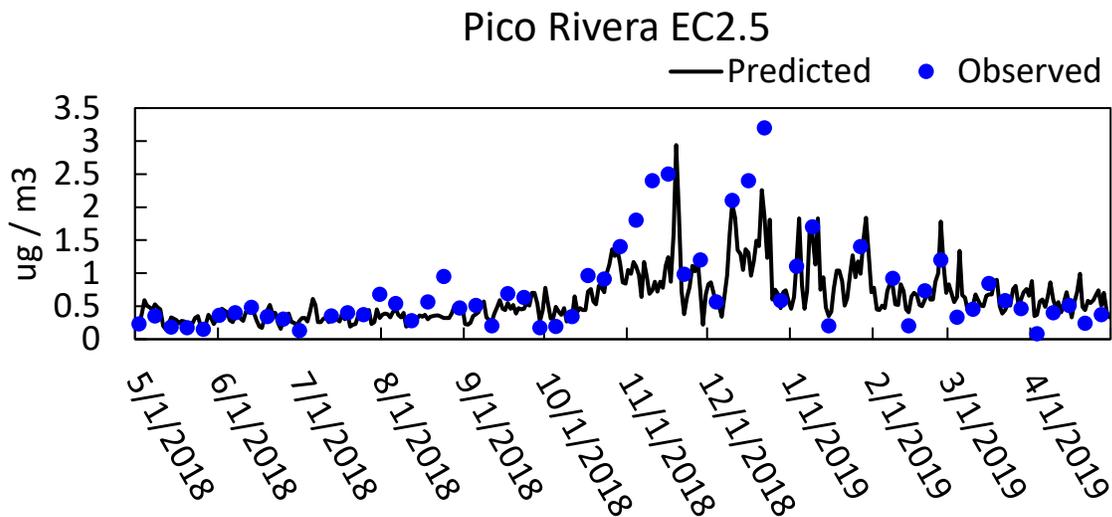
**Figure IX-7-1e**  
EC<sub>2.5</sub> Time Series: Simulated vs. Measured at Huntington Park



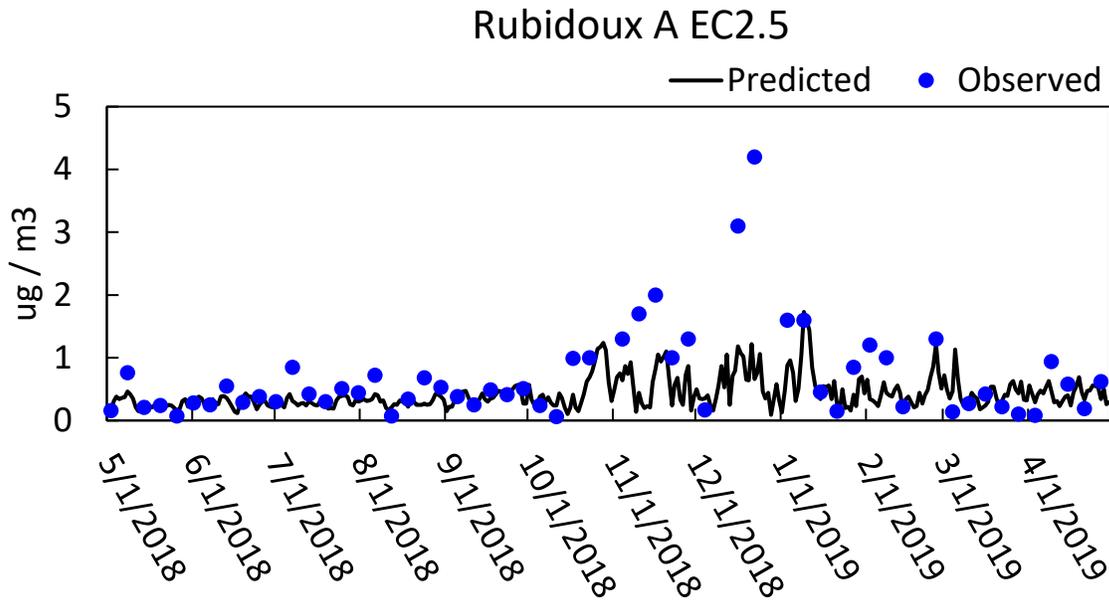
**Figure IX-7-1f**  
EC<sub>2.5</sub> Time Series: Simulated vs. Measured at Long Beach



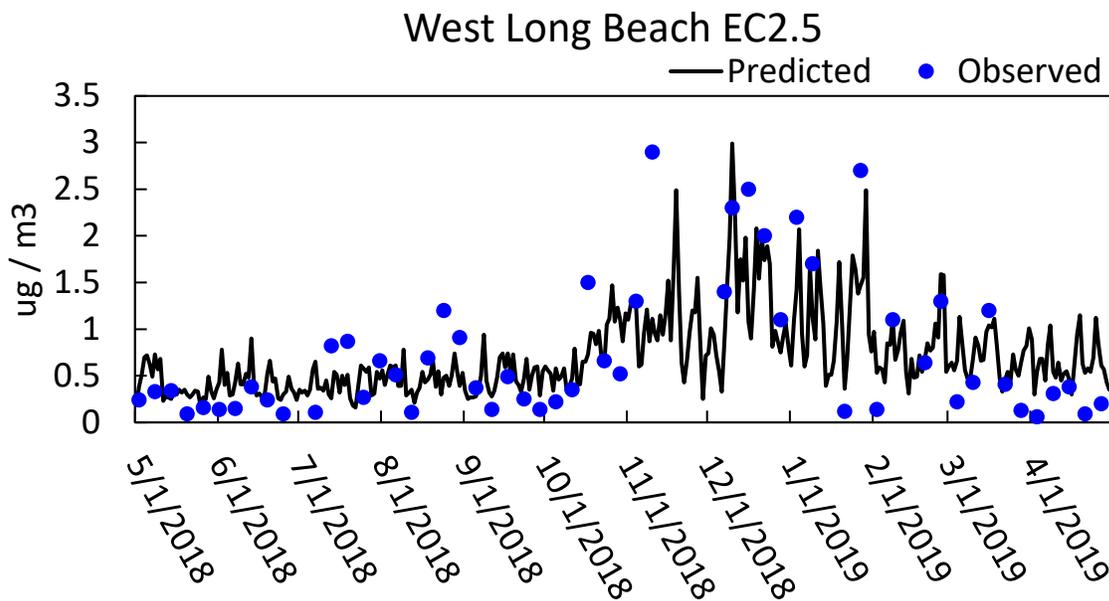
**Figure IX-7-1g**  
EC<sub>2.5</sub> Time Series: Simulated vs. Measured at Central Los Angeles



**Figure IX-7-1h**  
EC<sub>2.5</sub> Time Series: Simulated vs. Measured at Pico Rivera



**Figure IX-7-1i**  
EC<sub>2.5</sub> Time Series: Simulated vs. Measured at Rubidoux



**Figure IX-7-1j**  
EC<sub>2.5</sub> Time Series: Simulated vs. Measured at West Long Beach

### **IX.7.2 Comparison with MATES IV Simulation**

Tables IX-7-4 and IX-7-5 provide a comparison of the 2018-2019 MATES V and 2012-2013 MATES IV model performance for EC<sub>2.5</sub> and benzene, respectively. Listed in each table are PA, bias, and mean error. As presented in tables, compared to MATES IV modeling, where modeling exhibited an overall tendency to overpredict EC<sub>2.5</sub>. MATES V modeling does not show a significant under or over prediction tendencies. Historically, regional modeling in the SCAB showed under predictions in the Rubidoux and Burbank areas, as evidenced by the MATES IV results. MATES V modeling, while still shows underprediction in the Rubidoux area, it no longer underpredicts the Burbank Area, indicating changes in the behavior of meteorological modeling. Overall, the MATES V model performance is on par or better compared to MATES IV.

**Table IX-7-4**  
Comparative Simulation Performance Statistics for EC<sub>2.5</sub>

Location	MATES IV (2012-2013)					MATES V (2018-2019)				
	Observed Days (µg/m <sup>3</sup> )	Modeled Sampling Days (µg/m <sup>3</sup> )	PA	Bias (µg/m <sup>3</sup> )	Mean Error (µg/m <sup>3</sup> )	Observed Days (µg/m <sup>3</sup> )	Modeled Sampling Days (µg/m <sup>3</sup> )	PA	Bias (µg/m <sup>3</sup> )	Mean Error (µg/m <sup>3</sup> )
Anaheim	0.90	1.10	22	0.20	0.56	0.47	0.55	16	0.08	0.21
Burbank Area	1.32	1.19	-9	-0.12	0.64	0.50	0.67	33	0.17	0.33
Compton	1.06	1.48	39	0.42	0.76	0.80	0.66	-17	-0.14	0.42
Inland Valley San Bernardino	1.38	1.13	-18	-0.25	0.46	0.78	0.63	-20	-0.15	0.33
Huntington Park	1.30	1.70	31	0.40	0.67	0.68	0.66	-2	-0.02	0.32
Long Beach	0.91	1.45	59	0.53	0.80	0.52	0.62	19	0.10	0.28
Central L.A.	1.23	1.81	47	0.58	0.70	0.71	0.78	9	0.07	0.27
Pico Rivera	1.39	1.30	-6	-0.09	0.48	0.74	0.62	-16	-0.13	0.25
Rubidoux	1.11	0.98	-12	-0.13	0.40	0.69	0.42	-40	-0.27	0.35
West Long Beach	1.13	1.88	67	0.75	1.00	0.72	0.71	-2	-0.01	0.38

**Table IX-7-5**  
Comparative Simulation Performance Statistics for Benzene

	MATES IV (2012-2013)					MATES V (2018-2019)				
Location	Observed Days (ppb)	Modeled Sampling Days (ppb)	PA	Bias (ppb)	Mean Error (ppb)	Observed Days (ppb)	Modeled Sampling Days (ppb)	PA	Bias (ppb)	Mean Error (ppb)
Anaheim	0.33	0.28	-14	-0.05	0.16					
Burbank Area	0.46	0.28	-38	-0.17	0.22	0.22	0.27	23	-0.06	0.08
Compton	0.50	0.28	-43	-0.21	0.26	0.38	0.24	-36	-0.14	0.20
Inland Valley San Bernardino.	0.29	0.22	-24	-0.07	0.09	0.23	0.22	--4	-0.01	0.06
Huntington Park	0.53	0.33	-38	-0.20	0.22	0.31	0.26	-17	-0.05	0.11
Long Beach	0.33	0.30	-10	-0.03	0.10	0.32	0.24	-24	-0.08	0.15
Central L.A.	0.40	0.37	-8	-0.03	0.12					
Pico Rivera	0.35	0.27	-21	-0.07	0.12	0.25	0.23	-8	-0.02	0.08
Rubidoux	0.28	0.21	-24	-0.07	0.10					
West Long Beach	0.36	0.41	15	0.05	0.20	0.30	0.27	-8	-0.03	0.13

### IX.7.3 Simulation Evaluation Averaged Over the Monitoring Network

For this comparison, the monitored data for ten stations are combined to provide an estimate of average Basin-wide conditions for the two sampling periods. Table IX-7-6 summarizes the network average measured and predicted pollutant concentrations. For gaseous species concentrations, measurement data from Anaheim, Central Los Angeles and Rubidoux were missing, so only the data from the remaining seven monitoring sites were presented. Measured concentrations of naphthalene were available for Central Los Angeles, and Rubidoux. Each of the four counties is represented by at least one station. The stations' measured and simulated average concentrations provide an estimate of the regional profile but with a bias towards impacts to the coastal communities in the heavily transited areas of the Basin. Moreover, the assessment provides a direct comparison for model performance evaluation.

For MATES V, the model simulated concentrations of particulate matter species, such as EC<sub>2.5</sub> and TSP metals were consistent with measured data. The model was unable to predict the increased carbonyl concentrations, formaldehyde and acetaldehyde, compared to MATES IV. Concentrations of perchloroethylene, p-dichlorobenzene, trichloroethylene, 1,3-butadiene and naphthalene have become low enough that model performances for those pollutants are immaterial. Benzene and methylene concentrations were well simulated.

**Table IX-7-6**

Toxic Compounds Simulated and Measured Ten-Station Annual Average Concentrations  
For MATES IV and MATES V periods using CAMX RTRAC

Compound	Units	2012-2013 MATES IV		2018-2019 MATES V	
		Measured Annual Average	Simulated Annual Average***	Measured Annual Average	Simulated Annual Average***
EC <sub>2.5</sub>	µg/m <sup>3</sup>	0.96	1.39	0.66	0.63
Cr 6 (TSP)	ng/m <sup>3</sup>	0.05	0.18	0.040	0.032
As (2.5)	ng/m <sup>3</sup>	N/A	0.66	N/A	0.27
As (TSP)	ng/m <sup>3</sup>	0.44	1.07	0.52	0.51
Cd (2.5)	ng/m <sup>3</sup>	N/A	0.38	N/A	0.55
Cd (TSP)	ng/m <sup>3</sup>	0.13	0.56	0.32	0.64
Ni (2.5))	ng/m <sup>3</sup>	N/A	4.58	N/A	2.83
Ni (TSP)	ng/m <sup>3</sup>	2.98	6.64	3.14	4.15
Pb (2.5 )	ng/m <sup>3</sup>	N/A	2.10	N/A	1.52
Pb (TSP)	ng/m <sup>3</sup>	4.69	5.26	4.80	3.51

Benzene*	ppb	0.33	0.29	0.29	0.25
Perchloroethylene*	ppb	0.03	0.08	0.03	0.02
p-Dichlorobenzene*	ppb	0.02	0.04	0.03	0.03
Methylene Chloride*	ppb	0.46	0.24	0.17	0.18
Trichloroethylene*	ppb	0.02	0.04	0.02	0.01
1,3-Butadiene*	ppb	0.09	0.04	0.06	0.02
Formaldehyde*	ppb	1.78	1.91	2.95	1.59
Acetaldehyde*	ppb	0.71	0.95	1.55	0.60
Naphthalene**	ppb	0.02	0.01	0.01	0.01

\* Seven station average

\*\* Two station average

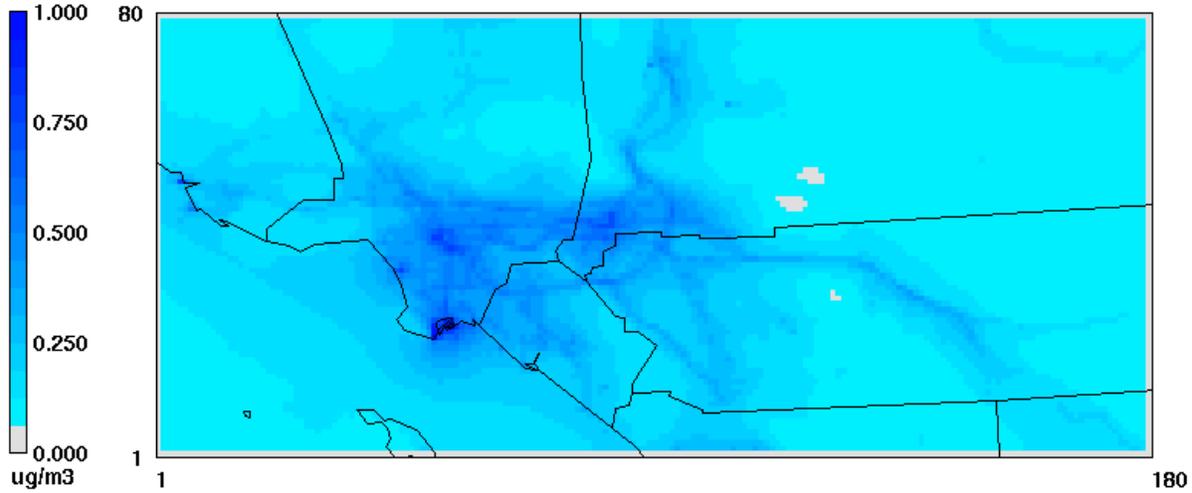
\*\*\* Average of days with measurements

#### IX.7.4 Simulation Estimated Spatial Concentration Fields

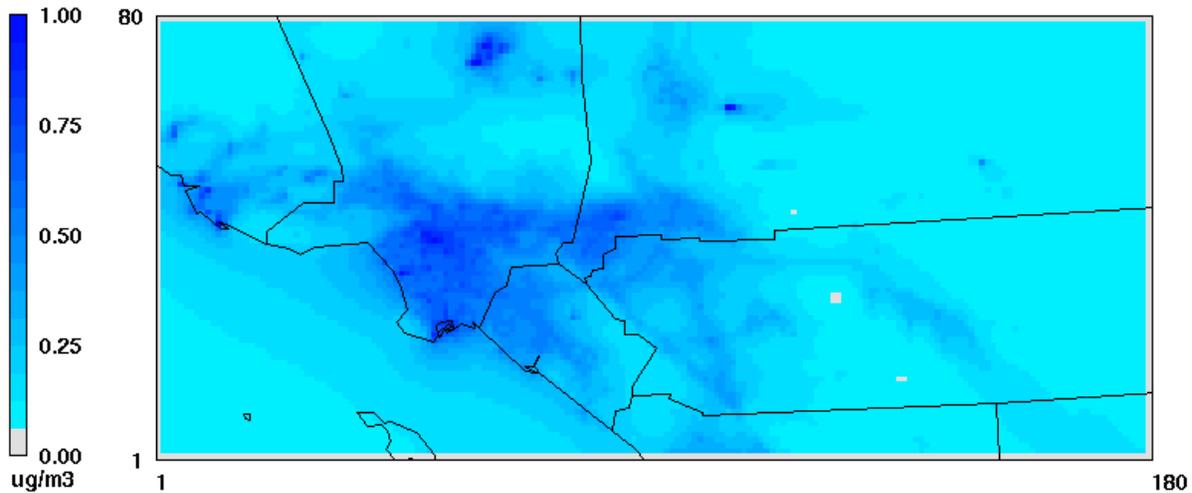
Figures IX-7-2a through IX-7-2u depict the CAMx projected annual average concentration distributions of selected toxic compounds as well as the impacts of five emissions categories of diesel particulates in the Basin. The highest concentration ( $1.13 \mu\text{g}/\text{m}^3$ ) was simulated to occur around the Ports of Los Angeles and Long Beach. In general, the distribution of diesel particulates is aligned with the transportation corridors including freeways, major arterials and rail rights-of-way. The peak diesel concentration is much lower than the previous MATES, due in a large part to emission reductions in various categories of on-road and other mobile sources. Figures IX-7-2h and IX-7-2i provide the distributions of benzene and 1,3-butadiene, respectively, whereby the toxic compounds are almost uniformly distributed throughout the Basin, reflecting patterns of light-duty vehicles fuel consumption since benzene and 1,3-butadiene emissions are mostly from gasoline combustion. Benzene emissions are primarily from on- and off-road mobile sources, with some portions emitted from refineries located near the coast. The modeled benzene concentrations mostly reflect patterns of the mobile sources with marginal enhancement near the coastal area. The 7 monitoring stations (Burbank Area, Compton, Huntington Park, Inland Valley San Bernardino, Long Beach, Pico Rivera and West Long Beach) showed the measured annual concentrations for benzene ranging from 0.22 ppb (at Burbank Area) to 0.38 ppb (at Compton), with a 7-station average of 0.29 ppb. Model prediction at those stations ranges from 0.21 to 0.28 ppb with a 7-station average of 0.25 ppb, which are in reasonable agreement with the measurements.

The ambient concentrations of formaldehyde in the Basin are attributed to direct emissions, combustion sources, and secondary formation in the atmosphere. The formaldehyde concentrations shown in Figure IX-7-2j depict a spatial distribution indicative of its sources, with measurable concentrations in the heavily-traveled western and central Basin, with additional elevated levels in the downwind areas of the Basin that are impacted by higher levels of photochemistry and ozone formation. While the emissions from primary combustion sources decreased by approximately 8% since MATES IV, the MATES V measurements indicated the ambient formaldehyde concentrations increased compared to MATES IV. This increase means

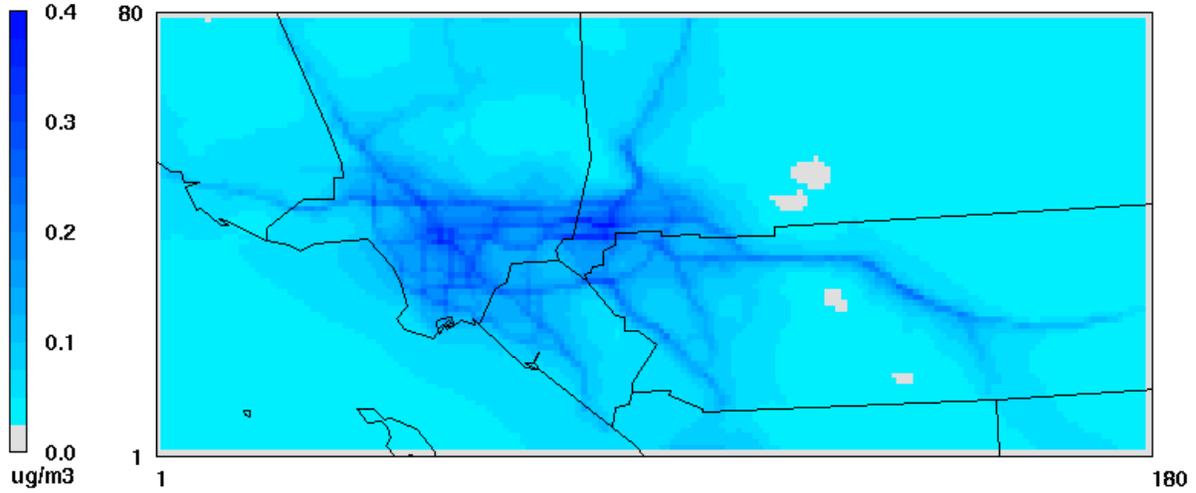
that the formaldehyde concentrations are being driven by secondary formation instead of direct emissions, indicating a complex chemistry involved in formaldehyde formation and depletion. It is also possible that uncertainties in emissions inventory and air quality modeling could contribute to the discrepancy. The modeled concentrations from the 7 monitoring stations averaged at 1.61 ppb, lower than the measured values averaged at 2.95 ppb.



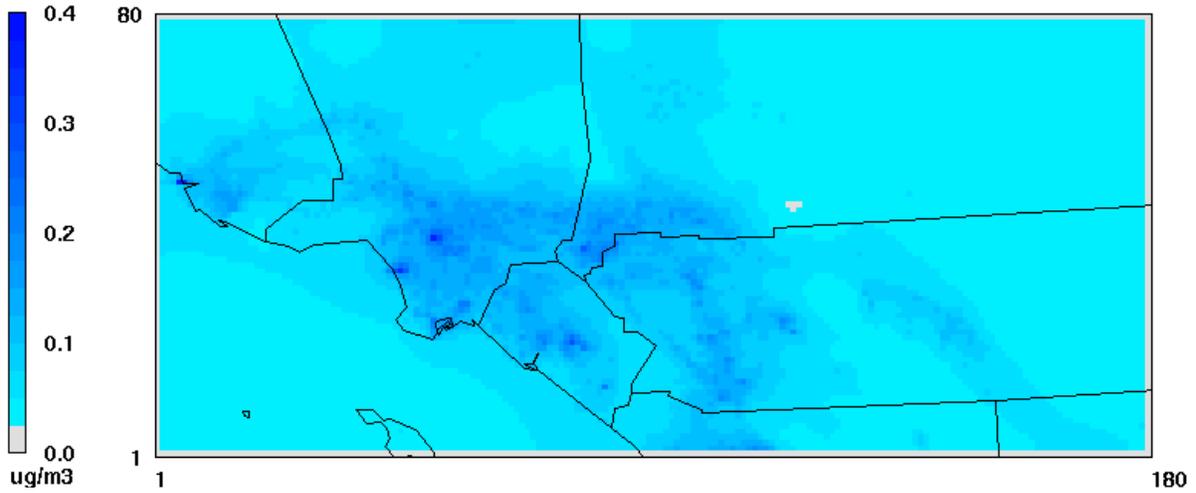
**Figure IX-7-2a**  
CAMx simulated 2018 annual average Diesel PM



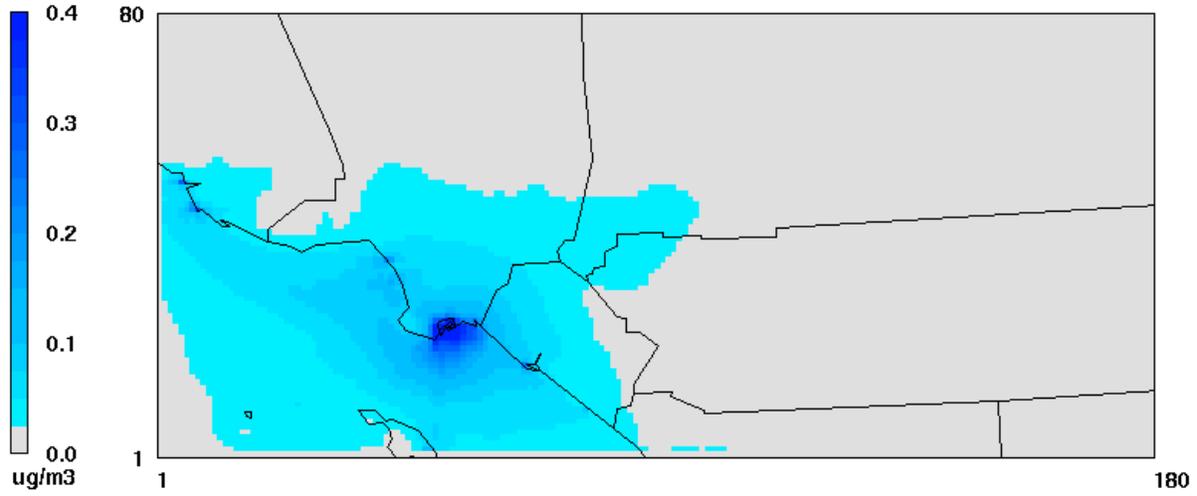
**Figure IX-7-2b**  
CAMx simulated 2018 annual average Elemental Carbon  $\text{PM}_{2.5}$



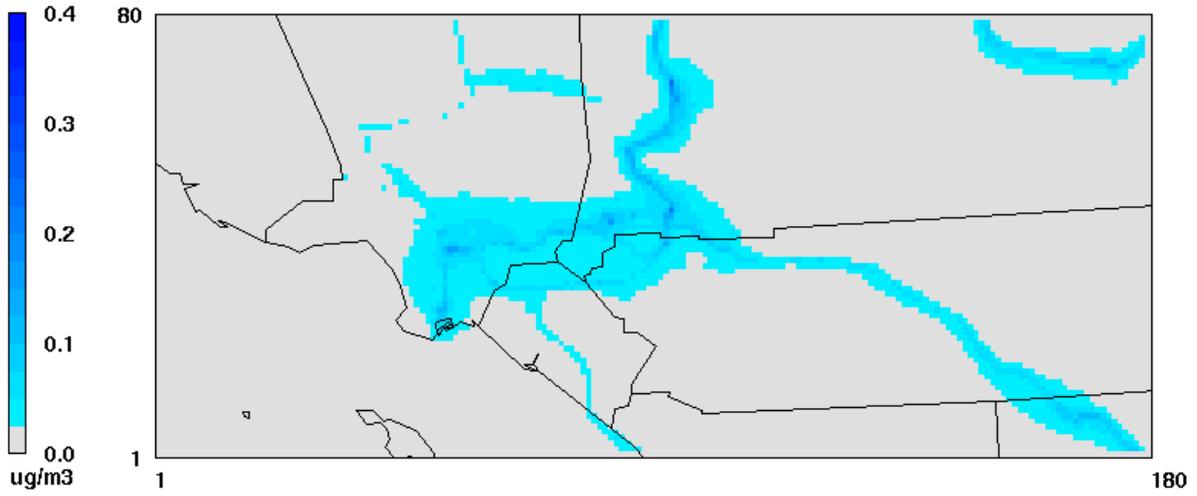
**Figure IX-7-2c**  
CAMx simulated 2018 annual average On-Road Diesel PM



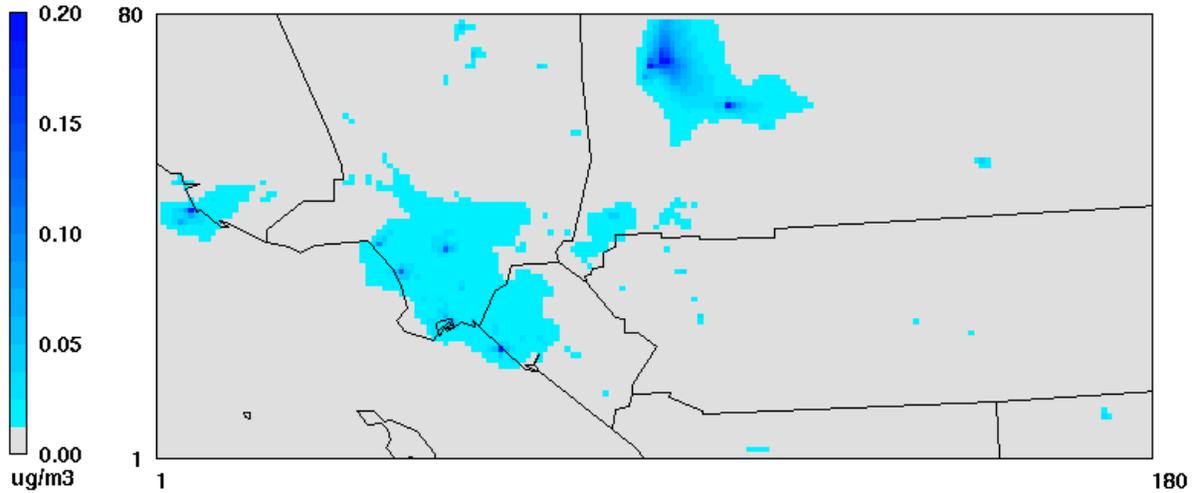
**Figure IX-7-2d**  
CAMx simulated 2018 annual average Off-Road Diesel PM



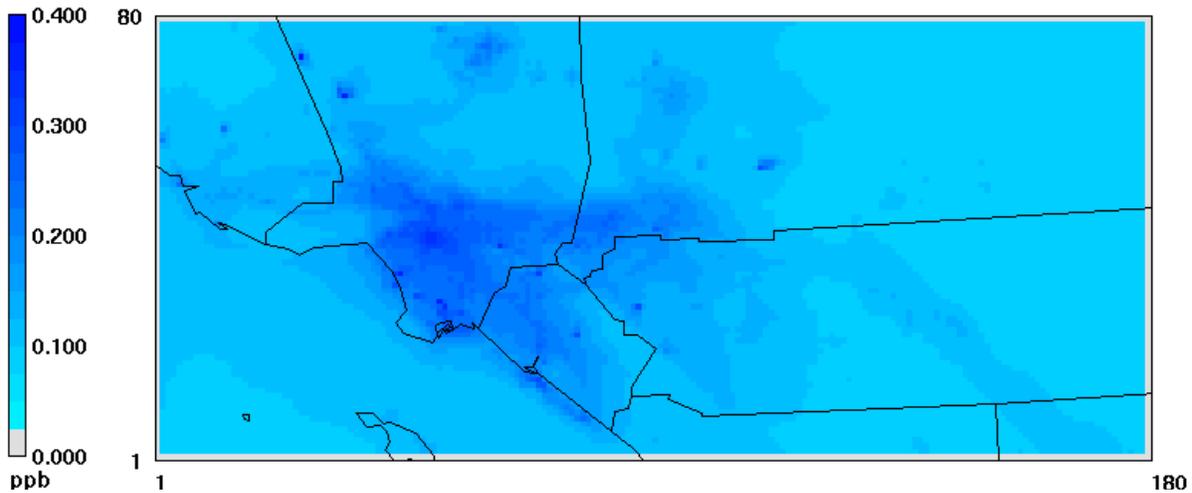
**Figure IX-7-2e**  
CAMx simulated 2018 annual average Diesel PM from OGV and CHC



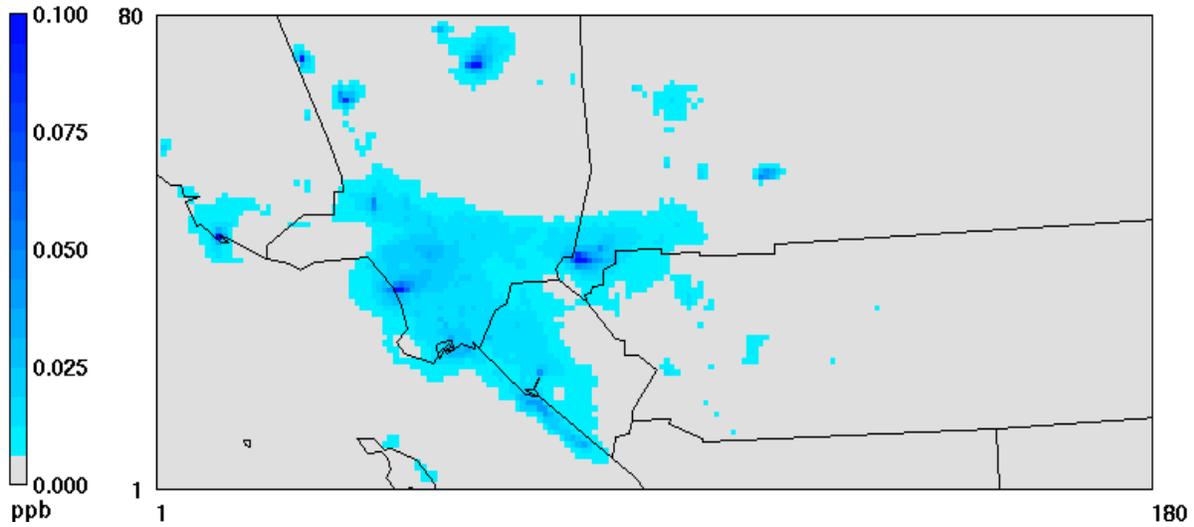
**Figure IX-7-2f**  
CAMx simulated 2018 annual average Diesel PM from Trains



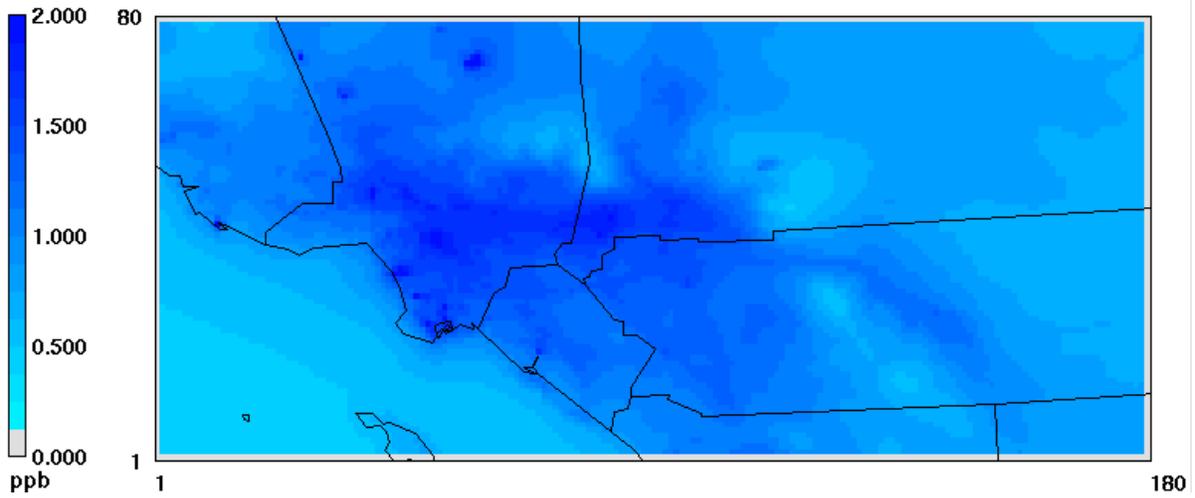
**Figure IX-7-2g**  
CAMx simulated 2018 annual average diesel PM from stationary sources.



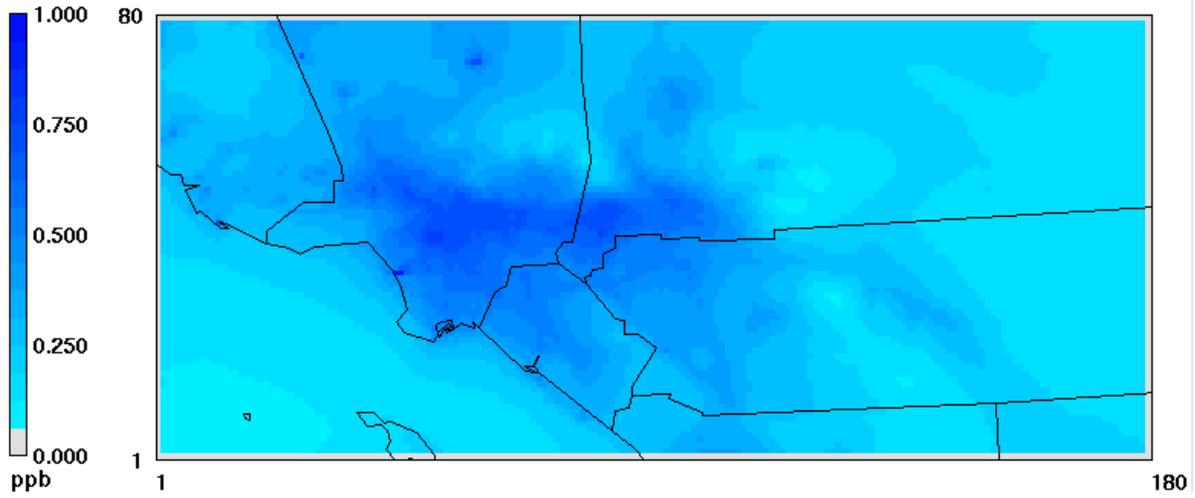
**Figure IX-7-2h**  
CAMx simulated 2018 annual average benzene



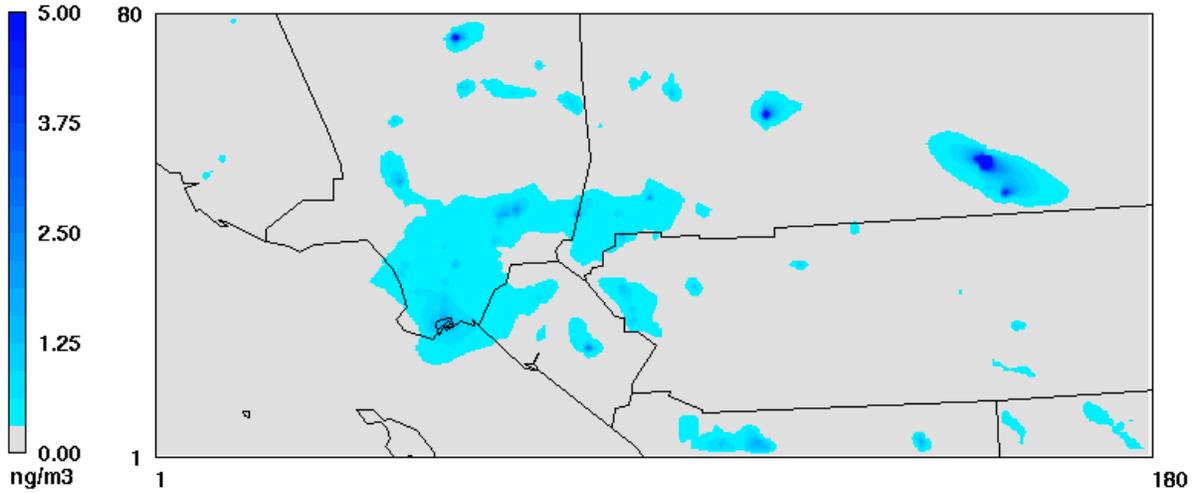
**Figure IX-7-2i**  
CAMx simulated 2018 annual average 1,3-butadiene



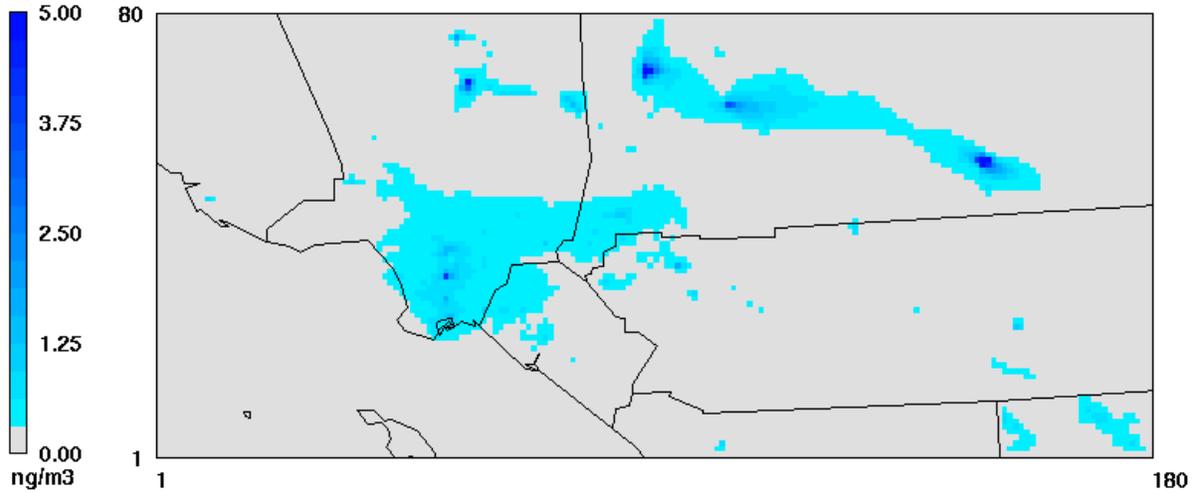
**Figure IX-7-2j**  
CAMx simulated 2018 annual average for total formaldehyde



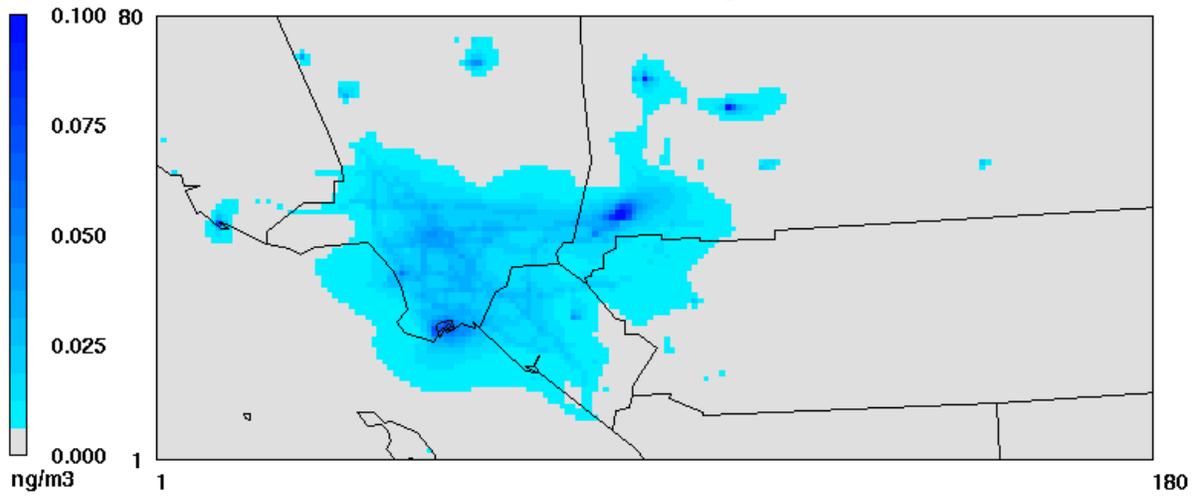
**Figure IX-7-2k**  
CAMx simulated 2018 annual average acetaldehyde



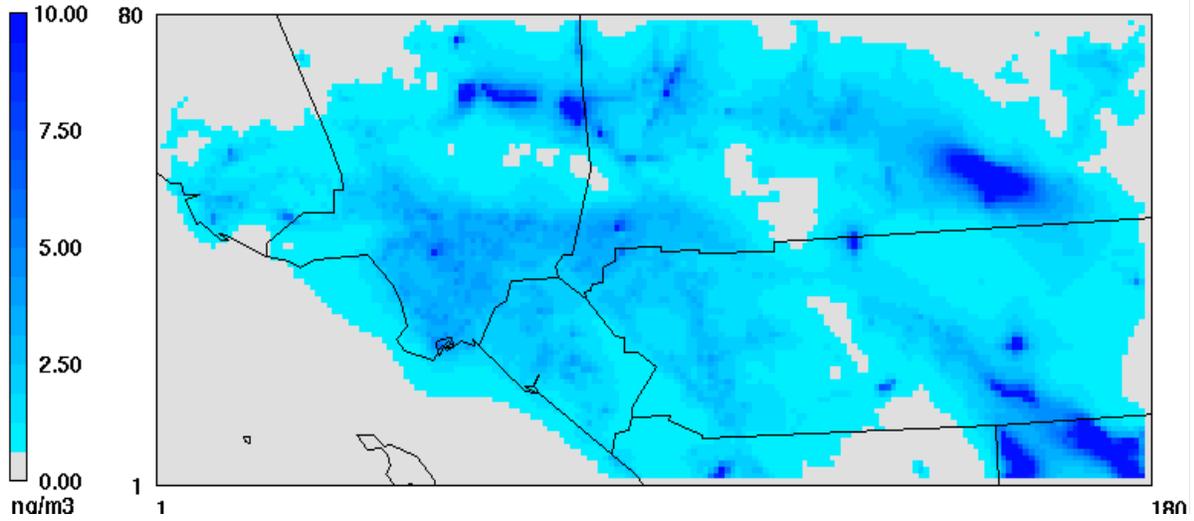
**Figure IX-7-2l**  
CAMx simulated 2018 annual average arsenic TSP



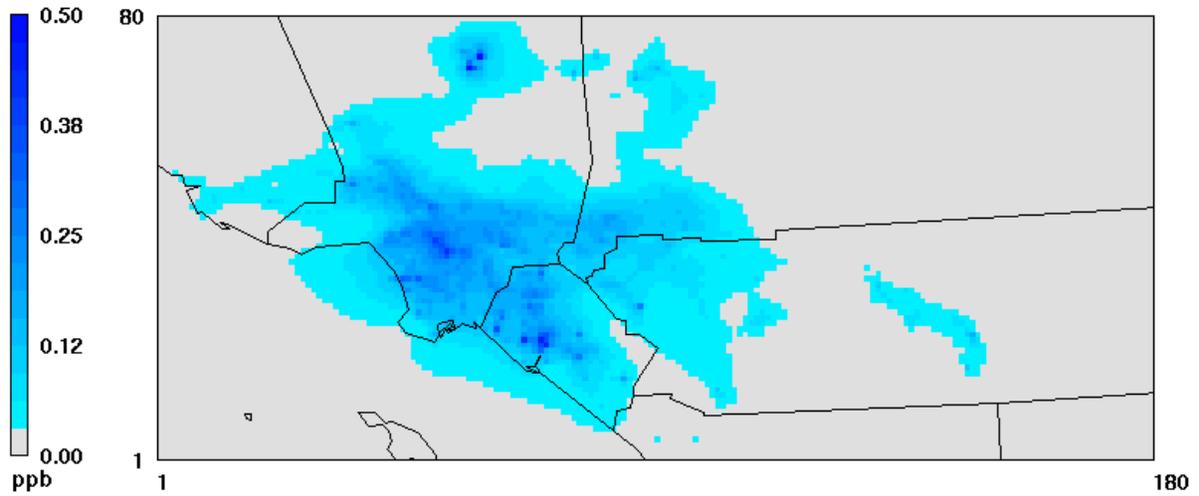
**Figure IX-7-2m**  
CAMx simulated 2018 annual average cadmium TSP



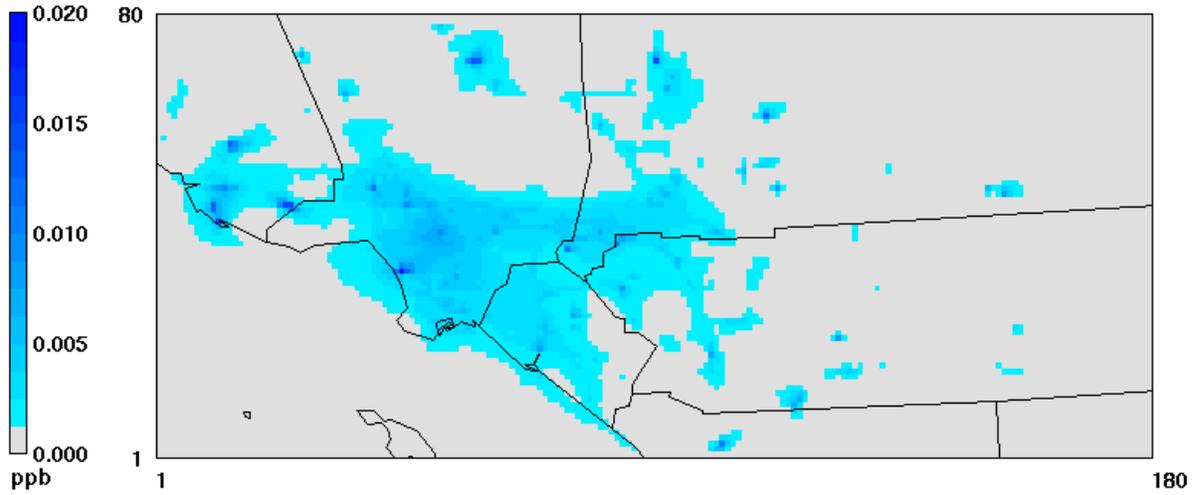
**Figure IX-7-2n**  
CAMx simulated 2018 annual average hexavalent chromium TSP



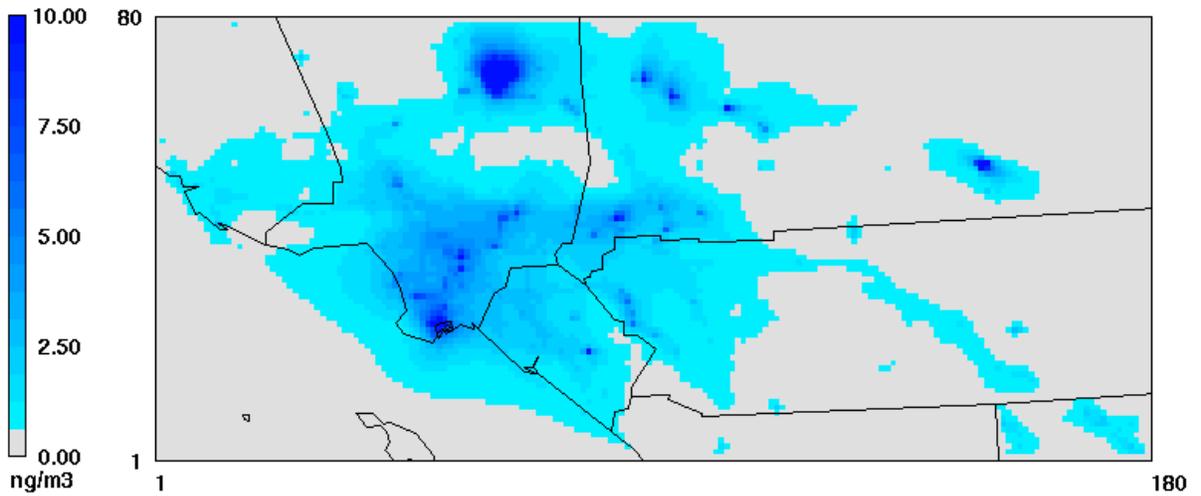
**Figure IX-7-2o**  
CAMx simulated 2018 annual average lead TSP



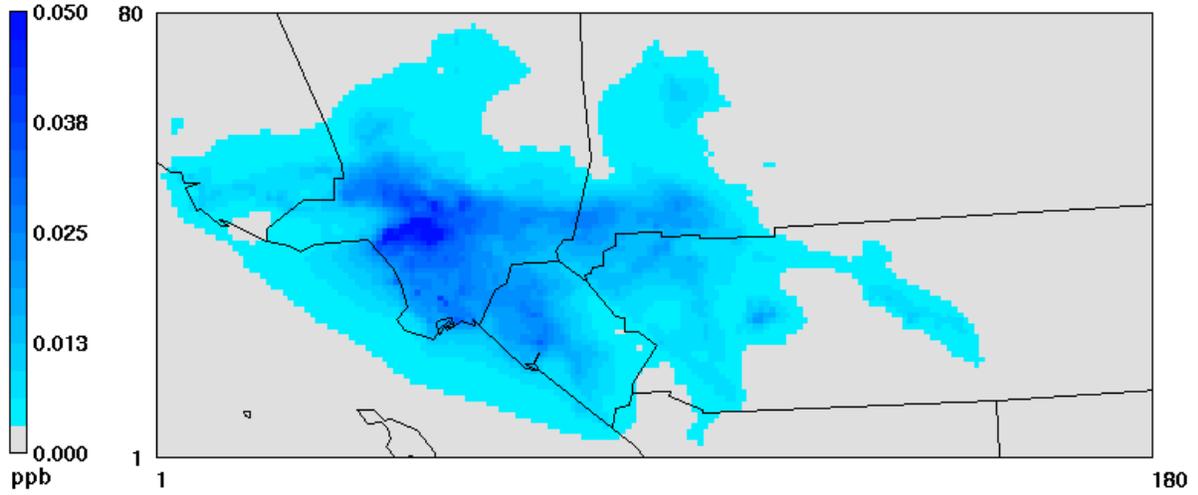
**Figure IX-7-2p**  
CAMx simulated 2018 annual average methylene chloride



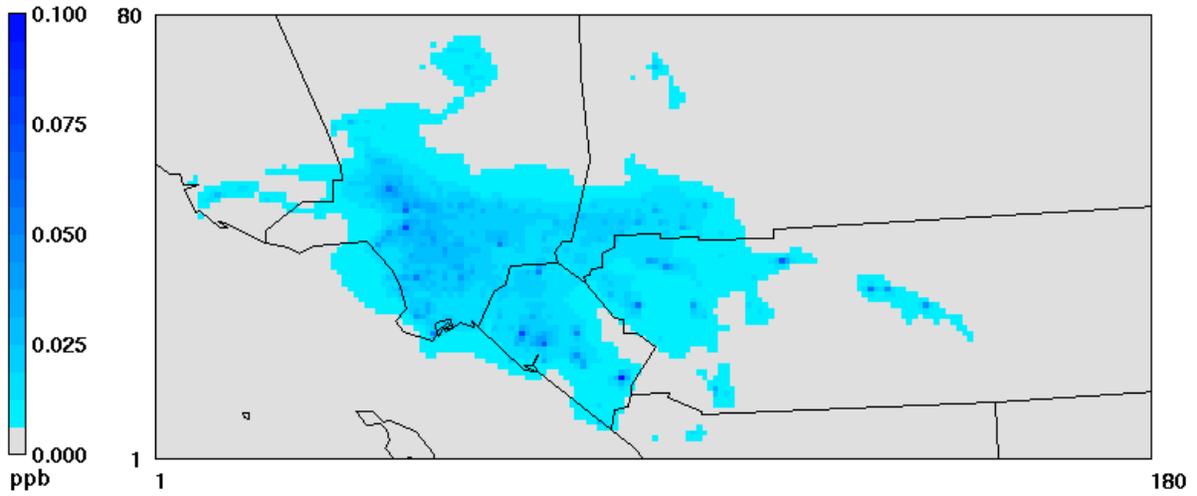
**Figure IX-7-2q**  
CAMx simulated 2018 annual average naphthalene



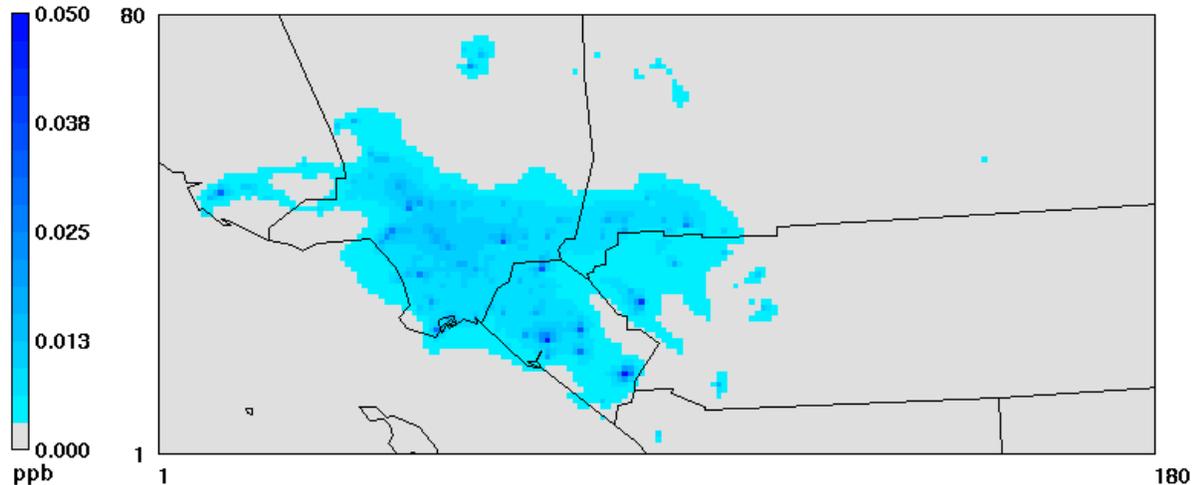
**Figure IX-7-2r**  
CAMx simulated 2018 annual average nickel TSP



**Figure IX-7-2s**  
CAMx simulated 2018 annual average p-dichlorobenzene



**Figure IX-7-2t**  
CAMx simulated 2018 annual average perchloroethylene



**Figure IX-7-2u**  
CAMx simulated 2018 annual average trichloroethylene

### IX.7.5 Estimation of Risk

Figure IX-7-3 depicts the distribution of risk estimated from the predicted annual average concentrations of the key toxic compounds. Risk is calculated for each grid cell as follows:

$$\text{Risk}_{ij} = \sum \text{Concentration}_{ij,k} \times \text{Risk Factor}_{ij,k},$$

Where  $i,j$  is the grid cell (easting, northing) and  $k$  is the toxic compound. The risk factor for a given compound is derived from its inhalation slope factor following the 2015 OEHAA risk assessment guidelines. In addition to the inhalation exposure, which was the method to estimate cancer risk in the previous MATES, a multiple pathway factor was incorporated in the current cancer risk estimation. The multiple pathway factors include additional cancer risk from oral and dermal exposures from toxic metals.

The grid cell having the highest simulated cancer risk of 990-in-a-million was located near the Ports of Los Angeles and Long Beach. Another grid cell with a high risk value (963-in-a-million) was the grid where the Los Angeles International Airport is located. In addition to the clusters of cells around the seaports and the airport with high risk, a third cluster of high-risk area is centered around a railyard southeast of downtown Los Angeles. In general, as in the past studies, the higher-risk areas tend to be along transportation and goods movement corridors.

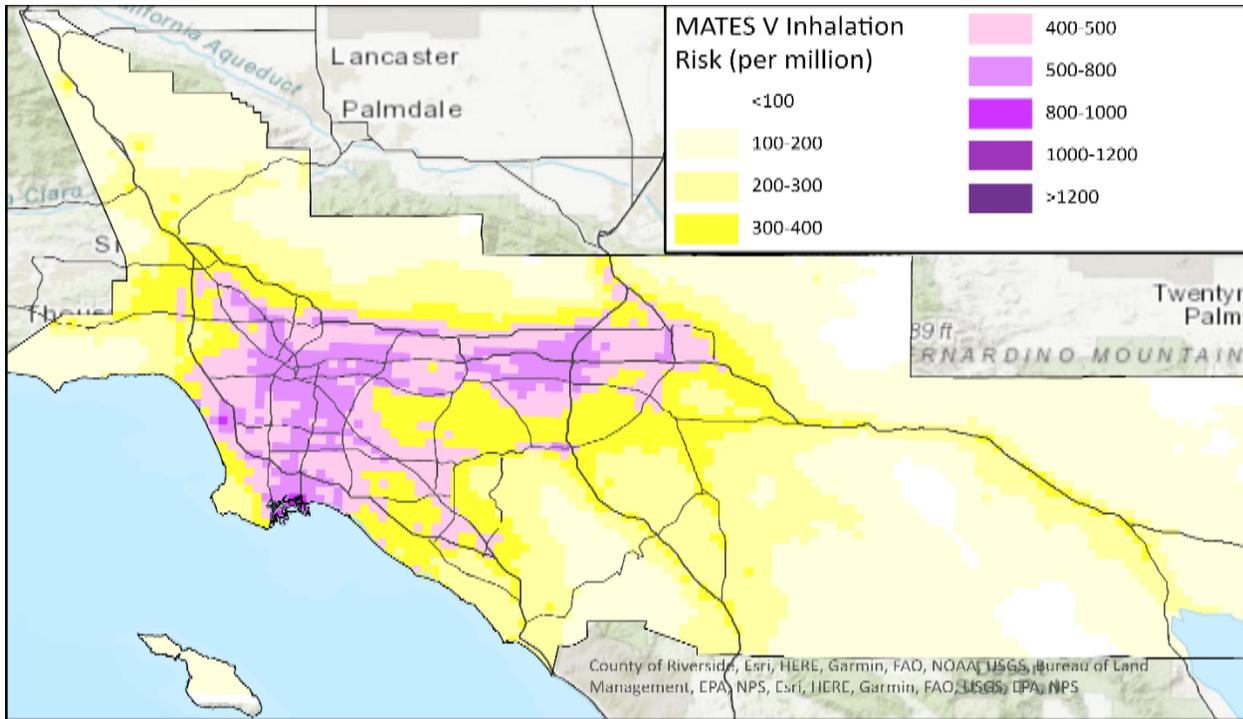
Figure IX-7-4 provides the CAMx RTRAC simulated air toxics risk for the MATES IV period. Figure IX-7-5 depicts the changes in risk from MATES IV (2012-2013) to MATES V (2018-2019) estimated from the CAMx RTRAC simulations. The greatest decrease in risk occurred in the ports area, where the peak risk value changed from 2,607 to 990, reflecting the emission reductions from OGV, CHC and other port operations including cargo handling equipment, port

trucks and locomotives. Overall, air toxics risk improved significantly, consistent with air toxic emissions reductions that occurred over the period.

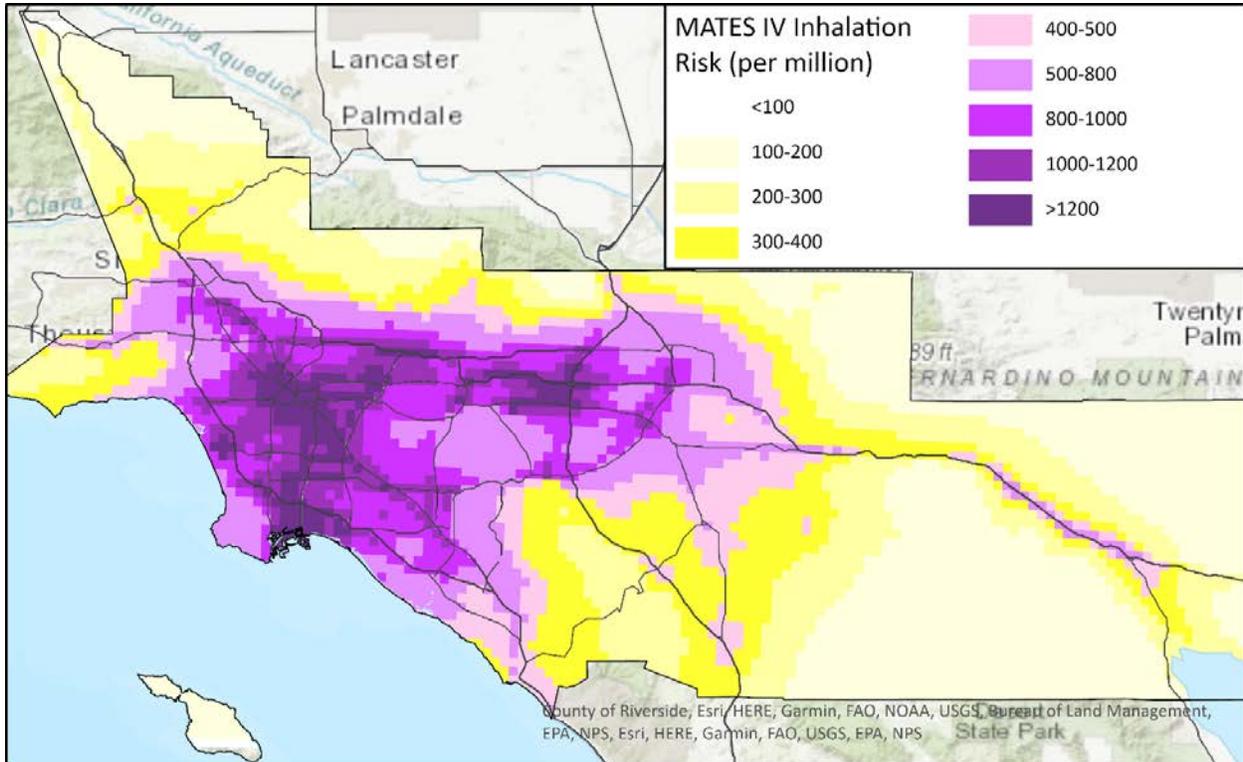
The MATES V period Basin-average population-weighted inhalation-only cancer risk summed for all the toxic components yielded a cancer risk of 424 in a million. The average risk included all populated land cells that reside within the Basin portion of the modeling domain. The MATES IV Basin average inhalation-only risk was 897 per million. Between the MATES IV and MATES V periods, the simulated risk decreased by 53%. The 53% reduction in Basin risk can be attributed to several factors, most notably, changes in diesel emissions between 2012 and 2018. As shown in Chapter 3, the toxic emissions between the two MATES periods decreased by 46%, including the on-road source emissions decreasing by 59% and the off-road source emissions decreasing by 39%. Modeling using the MATES IV emissions with the MATES V meteorology indicates that, under the same meteorological conditions, the risk reduction based on the changes in the emissions between MATES IV and MATES V would have been 49%. Therefore, a small portion of the modeled risk reduction is due to the difference in the meteorological dispersion potential.

Figures IX-7-6a through IX-7-6f depict risk associated with diesel and its specific emissions categories. Figure IX-7-7 provides the risk excluding the contribution of diesel PM. On and off-road diesel impacts are spread throughout the Basin following the transportation corridors and off-road facilities such as the intermodal transfer sites. The shipping impacts are concentrated in the vicinity of the Ports of Los Angeles and Long Beach and the adjacent downwind communities.

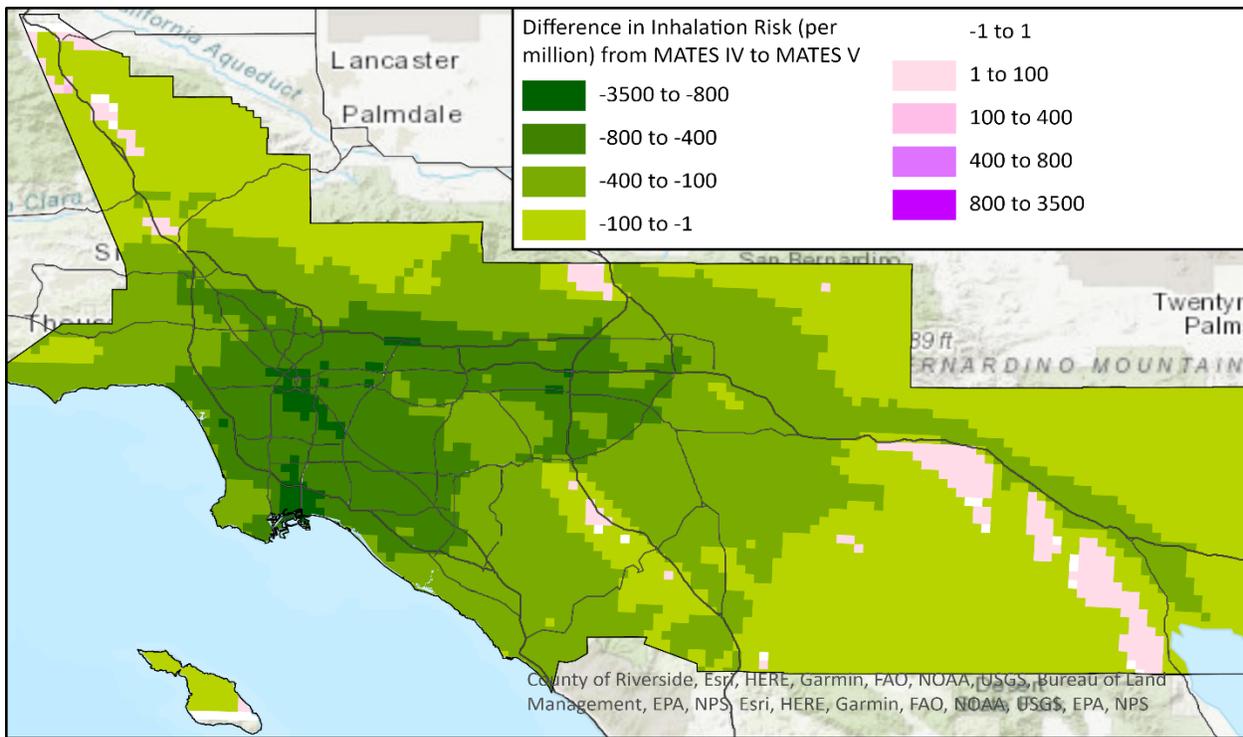
Regional risk from non-diesel sources (Figure IX-7-7) is also uniformly distributed throughout the Basin with values typically around 100 -200 in one million, with only a few selected cells showing values exceeding 200 in one million risk.



**Figure IX-7-3**  
2018 MATES V CAMx RTRAC Simulated Inhalation Air Toxics Cancer Risk

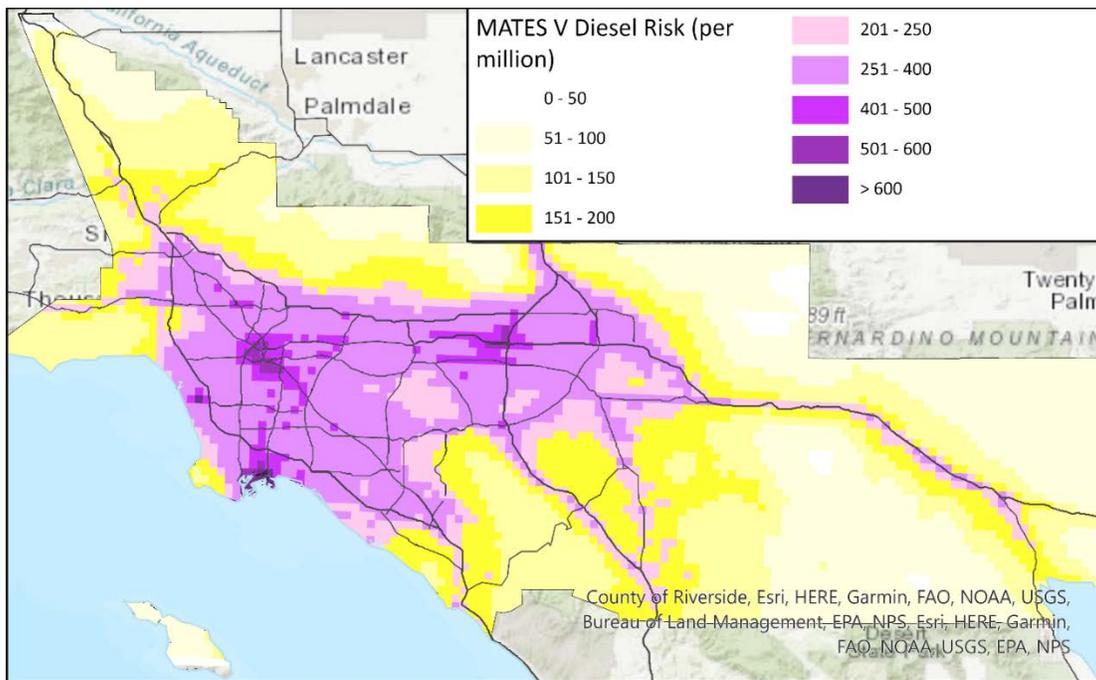


**Figure IX-7-4**  
2012 MATES IV CAMx RTRAC Simulated Inhalation Air Toxics Cancer Risk.



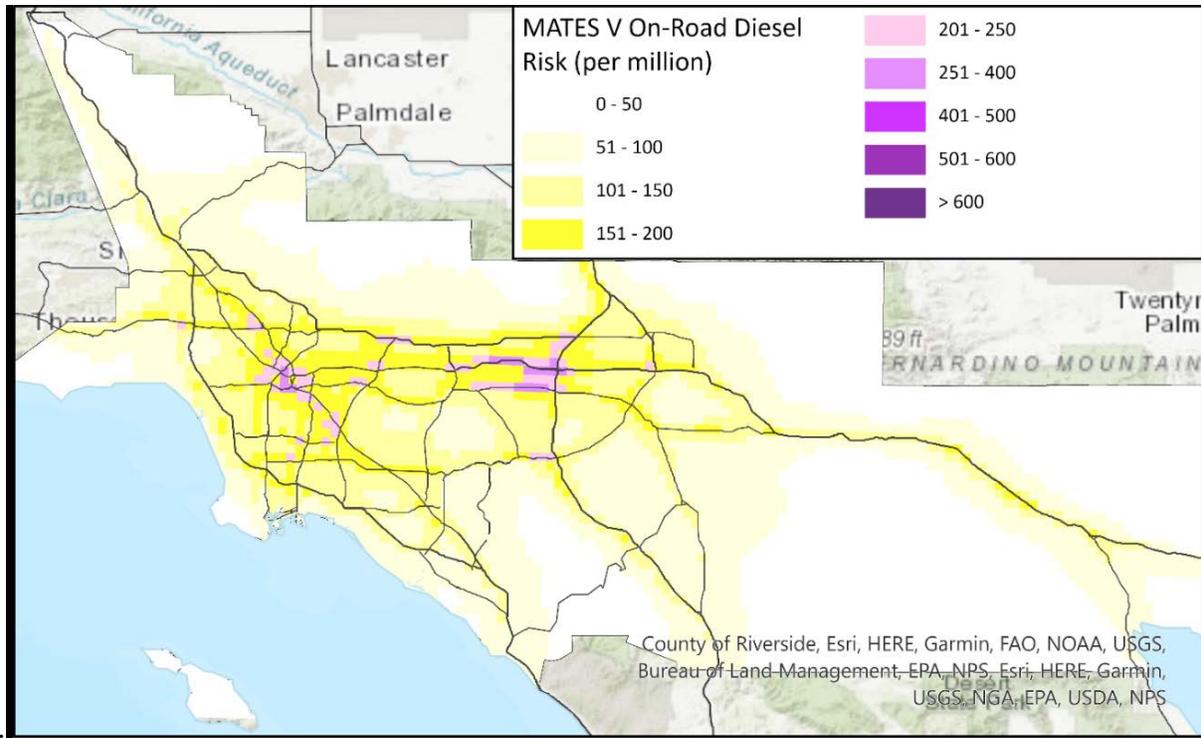
**Figure IX-7-5**

Change in CAMx RTRAC simulated Inhalation Air Toxics Cancer Risk from 2012 to 2018

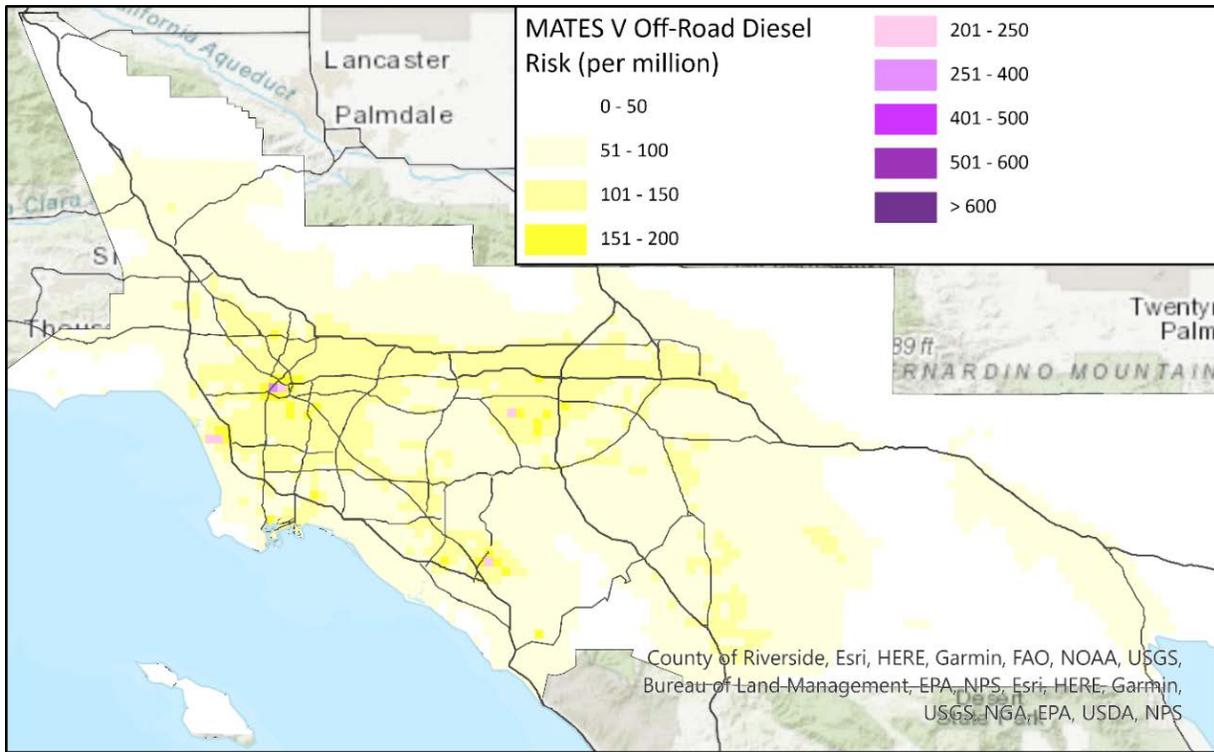


**Figure IX-7-6a**

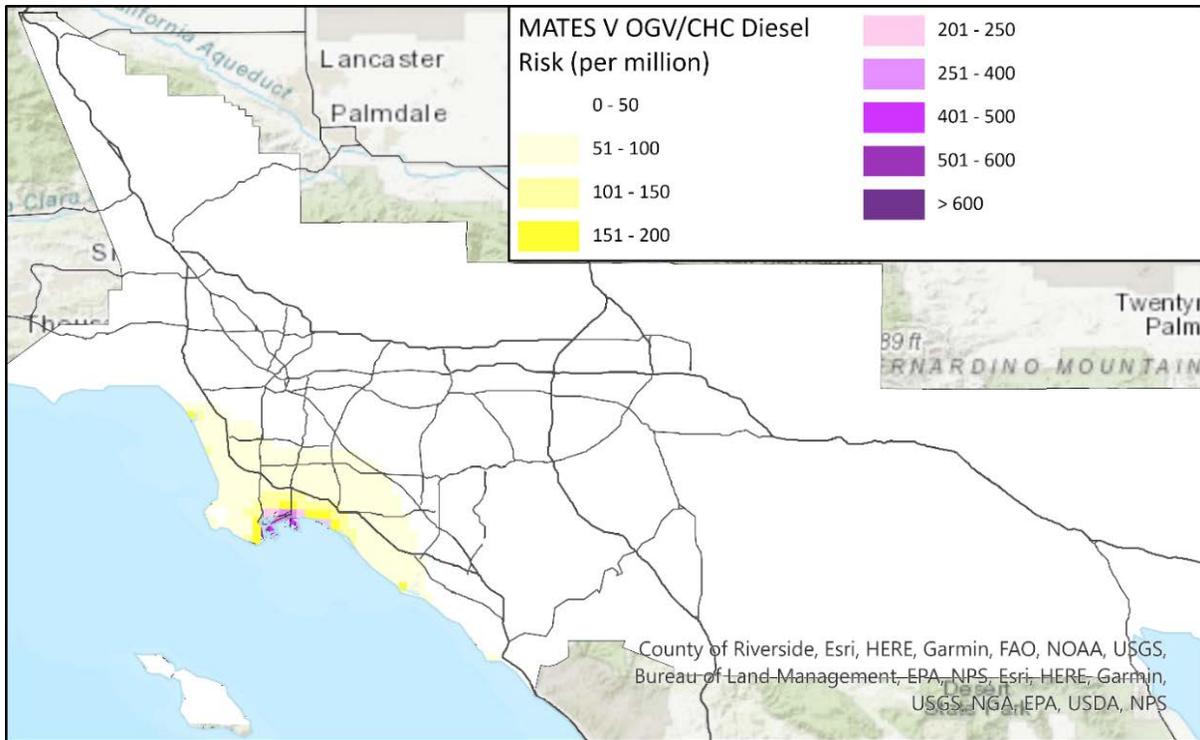
MATES V Inhalation Cancer Risk from Diesel PM from All Categories



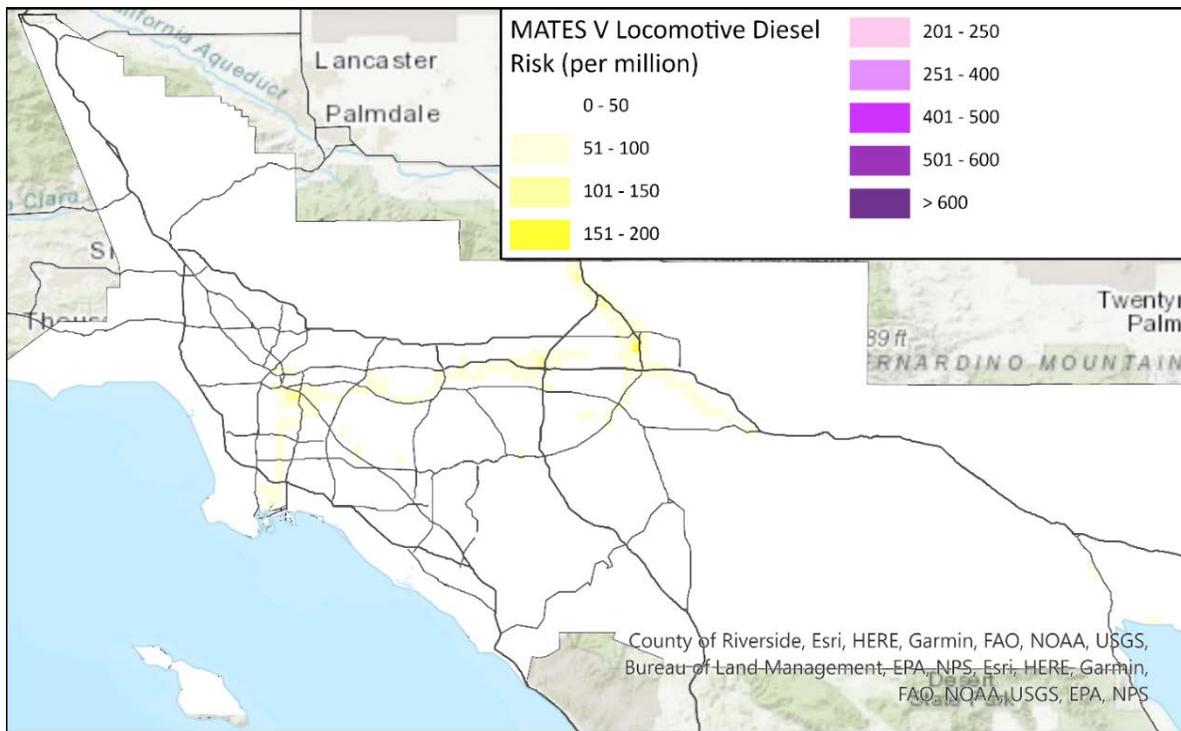
**Figure IX-7-6b**  
 MATES V Simulated Inhalation Cancer Risk from On-Road Diesel PM.



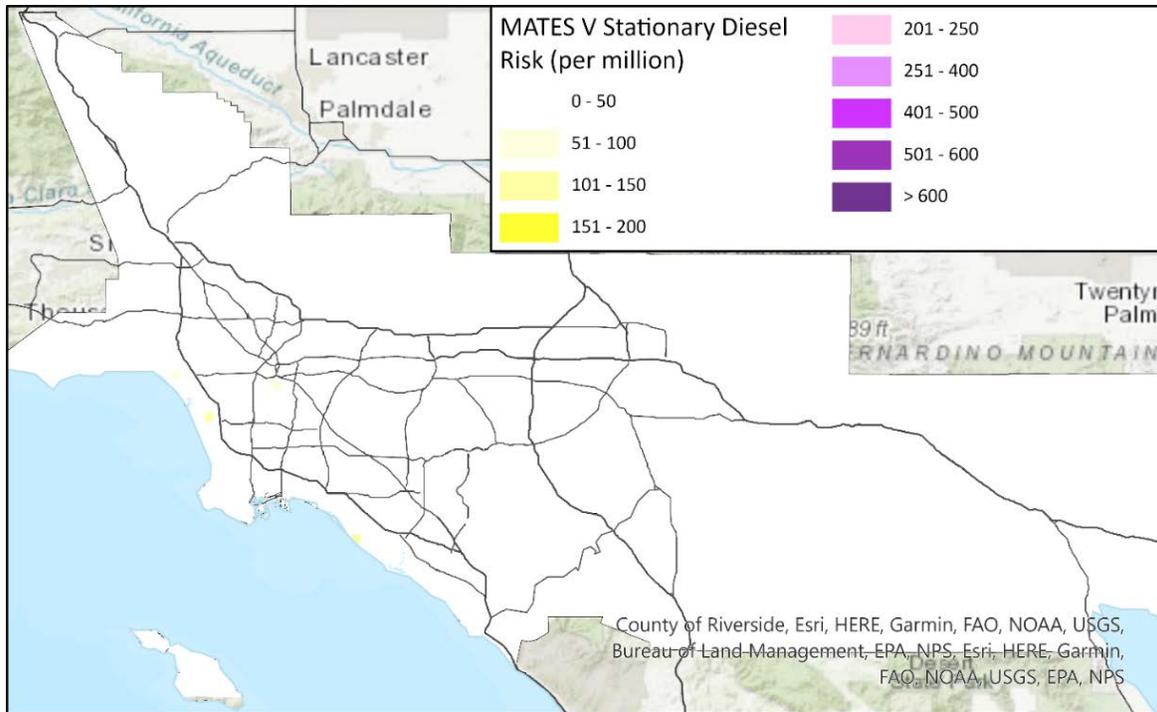
**Figure IX-7-6c**  
 MATES V Simulated Inhalation Risk from Off-road Diesel (including railyards but excluding trains and ships).



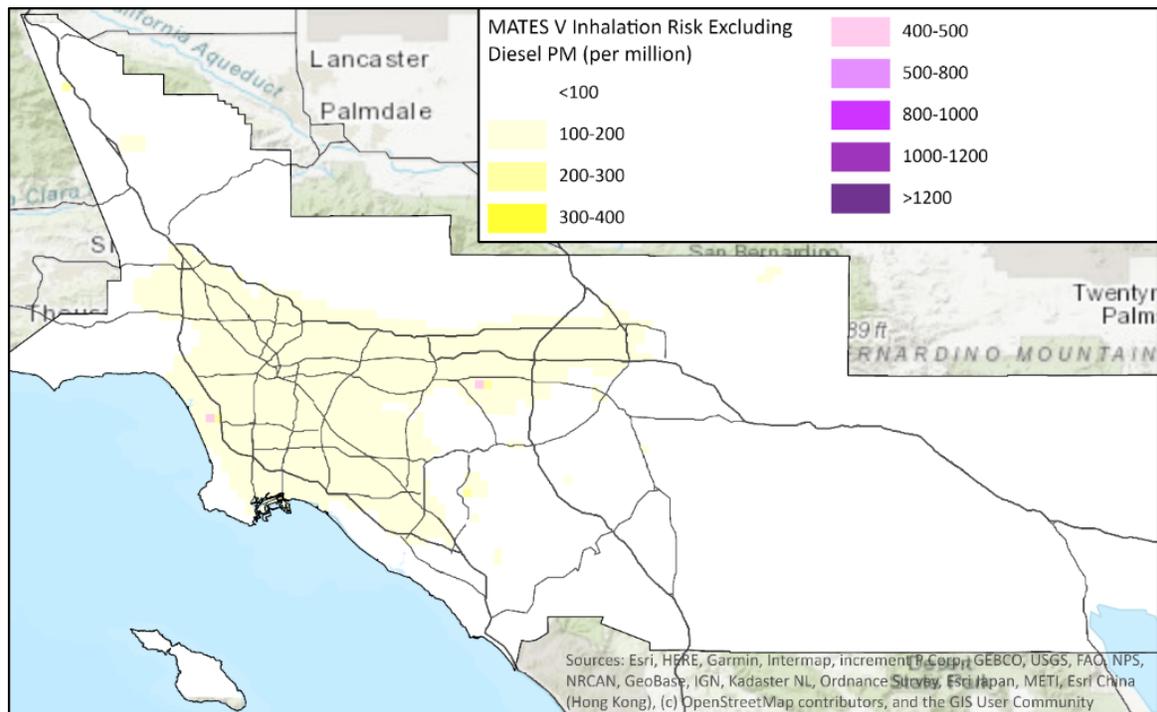
**Figure IX-7-6d**  
MATES V Simulated Inhalation Cancer Risk from Ship Diesel PM.



**Figure IX-7-6e**  
MATES V Simulated Inhalation Cancer Risk from Locomotive Diesel PM (Excluding Rail yard Equipment).

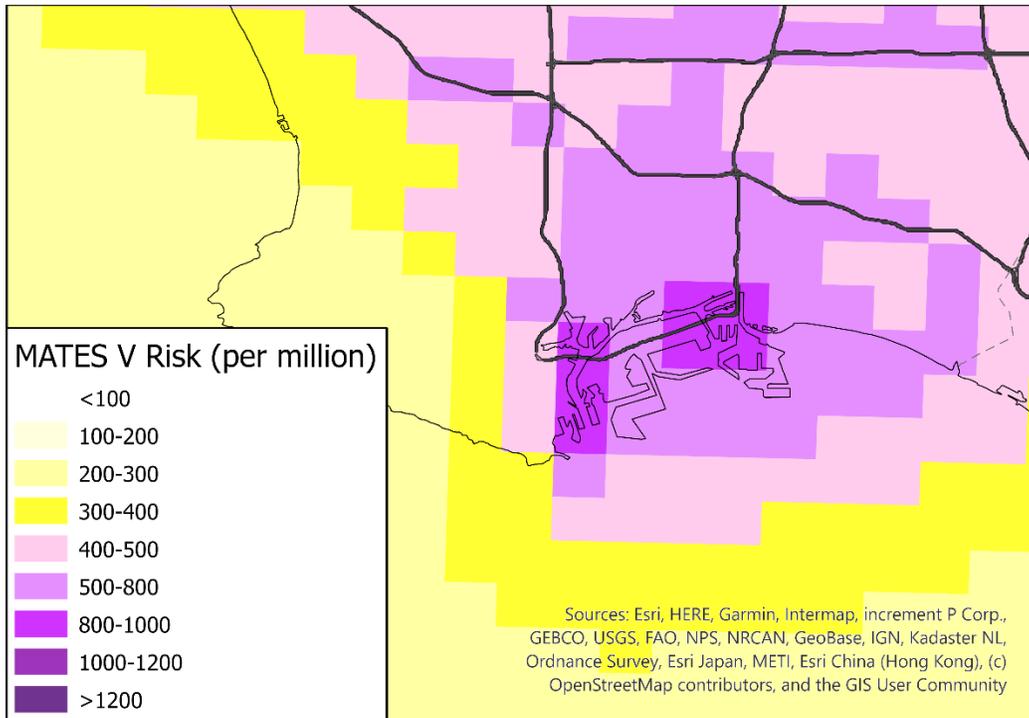


**Figure IX-7-6f**  
MATES V Simulated Inhalation Cancer Risk from Stationary Diesel PM.



**Figure IX-7-7**  
MATES V Simulated Inhalation Cancer Risk from all air toxics excluding diesel emissions

Figure IX-7-8 provides a close-up plot of the air toxics cancer risk in the Ports area. Table IX-7-7 provides a summary of the air toxics cancer risk estimated for the Basin, for the Ports area, and for the Basin excluding the Ports area. For this assessment, the Ports area includes the populated cells roughly bounded by the Interstate 405 to the north, San Pedro to the west, Balboa Harbor to the east, and Pt. Fermin to the south. The MATES V average population-weighted air toxics risk in the Ports area (as defined above) was 504 in one million. The Basin average population-weighted air toxics risk, excluding the grid cells in the Ports area, was 418 in one million. The downwind impacts resulting from Port area activities are still reflected in the toxics risk estimates for the grid cells categorized as “Basin minus Ports.” Similarly, the MATES IV simulations indicated that the Ports area air toxics risk was 1,177 in one million; and the Basin minus the Ports area was 879 in one million. Overall, the Ports area experienced an approximate 57% decrease in risk, while the average population-weighted risk in other areas of the Basin decreased by about 52%.



**Figure IX-7-8**  
2018 Ports area MATES V Simulated Inhalation Air Toxics Cancer Risk

**Table IX-7-7**  
Basin and Port Area Population Weighted Inhalation Air Toxics Cancer Risk

Region	MATES IV		MATES V		Average Percentage Change in Risk
	2012 Population	Average Risk (Per Million)	2018 Population	Average Risk (Per Million)	
Basin	15,991,150	897	16,599,786	424	-53
Ports Area	998,745	1,177	1,004,938	504	-57
Basin Excluding Ports Area	14,992,806	879	15,994,848	418	-52

### IX.7.6 County Risk Assessment

Table IX-7-8 provides the county-by-county air toxics risk to the affected population. As presented in the spatial distribution, the Basin portion of Los Angeles County bears the greatest average cancer risk at 470 per one million. The Basin portion of San Bernardino County has the second highest projected risk at 449 per one million. The estimated risk for Orange County is 379 per million, and the Basin portion of Riverside County was estimated to have the lowest population-weighted risk at 321 per million. As expected, the Coachella Valley portion of Riverside County, which is outside of the Basin, has the lowest toxic risk at 241 per million. It should be noted that these are county-wide averages, and individual communities could have higher risks than the average if they are near emissions sources, such as railyards or intermodal facilities.

Comparison of the county-wide population-weighted risk shows that the greatest reduction occurred in Los Angeles County, with the amount of risk reduction per county being similar. Reductions in emissions from mobile sources including benzene, 1,3-butadiene, and diesel particulate are the primary contributors to the improved county-wide risk.

**Table IX-7-8**  
County-Wide Population-Weighted Air Toxics Cancer Risk (Inhalation Only)

Region	MATES IV		MATES V		Average Percentage Change in Risk
	2012 Population	Average Risk (Per Million)	2018 Population	Average Risk (Per Million)	
Los Angeles*	9,578,586	1015	9,846,922	462	-54
Orange	3,067,909	770	3,223,763	365	-53
Riverside*	1,784,872	543	1,912,855	313	-42
San Bernardino*	1,560,183	827	1,616,247	439	-47
Basin	15,991,550	897	16,599,786	424	-53
Coachella Valley	465,064	339	479,055	239	-30

\* Including the Basin portion only

### IX.7.7 Risk from Key Compounds

Table IX-7-9 provides the Basin average breakdown of risk associated with each of the key compounds simulated in the analysis. Diesel particulate ranked highest (70%) as the toxic compound contributing to the overall inhalation cancer risk to the population. The next three highest contributors included benzene, 1,3-butadiene and formaldehyde. The four top toxic pollutants contribute over 90% toxic risk. Formaldehyde (primary and secondary) and acetaldehyde (primary and secondary) contribute 6% and 1.6%, respectively, while the remaining compounds combined accounted for less than 7% of the total.

**Table IX-7-9**  
MATES V Inhalation Cancer Risk from Simulated Individual Toxic Air Contaminants

Toxic Compound	Risk Factor ( $\mu\text{g}/\text{m}^3$ )	Max Annual Average Concentration	Population Weighted Annual Average Concentration	Units	Risk (per million)	% Contribution
DPM	7.40E-04	1.13	0.41	$\mu\text{g}/\text{m}_3$	306.30	72.3
Benzene	6.80E-05	0.42	0.14	ppb	46.87	11.1
Formaldehyde	1.40E-05	3.60	1.49	ppb	25.78	6.1
1,3- Butadiene	4.10E-04	0.44	0.03	ppb	12.90	3.0
Hexavalent Chromium	3.50E-01	0.00025	2.01E-05	$\mu\text{g}/\text{m}_3$	7.13	1.7
Acetaldehyde	6.80E-06	1.02	0.55	ppb	6.82	1.6
Cadmium	1.00E-02	0.019	4.69E-04	$\mu\text{g}/\text{m}_3$	4.08	1.0
p-Dichlorobenzene	2.70E-05	0.07	2.37E-02	ppb	3.86	0.9
Arsenic	8.10E-03	0.029	5.89E-04	$\mu\text{g}/\text{m}_3$	3.00	0.7
Perchloroethylene	1.40E-05	0.10	2.06E-02	ppb	1.97	0.5
Nickel	6.20E-04	0.18	2.82E-03	$\mu\text{g}/\text{m}_3$	1.78	0.4
Naphthalene	8.10E-05	0.025	3.46E-03	ppb	1.48	0.3
Methylene Chloride	2.40E-06	0.77	0.15	ppb	1.29	0.3
Trichloroethylene	4.70E-06	0.08	8.34E-03	ppb	0.21	<0.1
Lead	2.80E-05	0.038	3.21E-03	$\mu\text{g}/\text{m}_3$	0.08	<0.1

### IX.7.8 Network Risk Evaluation

Table IX-7-10 provides the simulated air toxics risk at each of the 10 stations for the top three toxic compounds and the remaining aggregate contributing to the overall risk. Risk is calculated using each toxic component concentrations predicted for the specific monitoring station location. The model prediction comparison used the nine-cell average at the grid corresponding to a monitoring station and its surrounding 8 grid cells using an inverse distance squared weighting factor. The summary also provides the comparison between simulated average risk for the 10 stations and the average risk calculated using the annual toxic compound measurements. Since diesel PM cannot be measured directly, measurement-based risk is calculated using an EC<sub>2.5</sub> to diesel PM conversion as described in Chapter 2 to estimate the diesel PM contributions. The comparison to measured risk was conducted with the 7 stations which are listed in the previous section

Among the monitored locations, the highest risk was simulated in Central Los Angeles followed by West Long Beach and Huntington Park. The lowest modeled risk was simulated at Rubidoux. With diesel PM reductions in port operations, the West Long Beach is no longer the highest risk site as it was in the previous MATES. Additionally, the modeled risk at the Long Beach station is below the overall average risk across all stations, although the location of the Long Beach station was relocated from an area near the I-710 to a mostly residential location southeast of the previous location. The MATES V monitoring with the highest air toxics cancer risk was Inland Valley San Bernardino. This inland location is located in an area near major goods movement land uses.

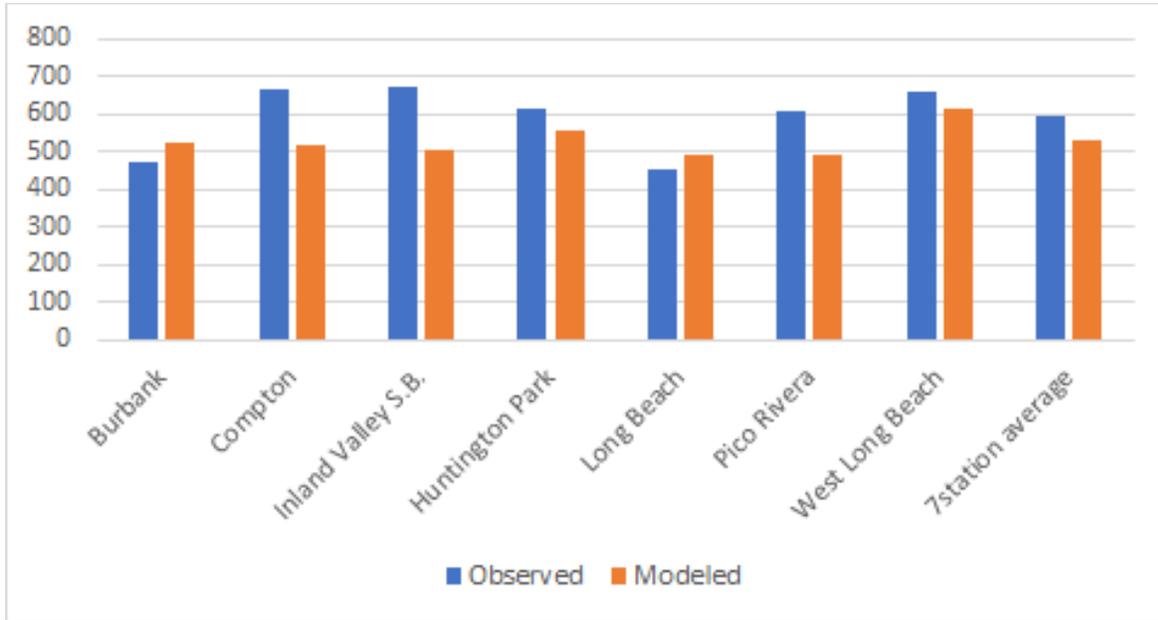
**Table IX-7-10**  
Modeled Inhalation Cancer Risk at Monitoring Locations and Measured Risk

Location	MATES V CAMX RTRAC Simulation				
	Benzene	1,3-Butadiene	Diesel	Others	Total
Anaheim	49	14	307	56	426
Burbank Area	58	16	381	72	526
Central Los Angeles	65	21	499	82	667
Compton	53	15	381	70	519
Inland Valley San Bernardino	46	12	362	86	506
Huntington Park	57	20	408	75	559
Long Beach	52	16	359	65	492
Pico Rivera	50	11	368	63	492
Rubidoux	39	9	295	48	390
West Long Beach	60	20	455	80	615
10-Station Average Modeled	53	15	382	70	519
7-station+ Averaged Modeled	54	16	387	73	530
7-Station+ MATES V Average Measured*	62	56	362	114	593

\*Including modeled species only, Risk from some measured species, such as carbon tetrachloride, chloroform and PAHs are excluded. Measured EC<sub>2.5</sub> was converted diesel PM as described in the Chapter 2.

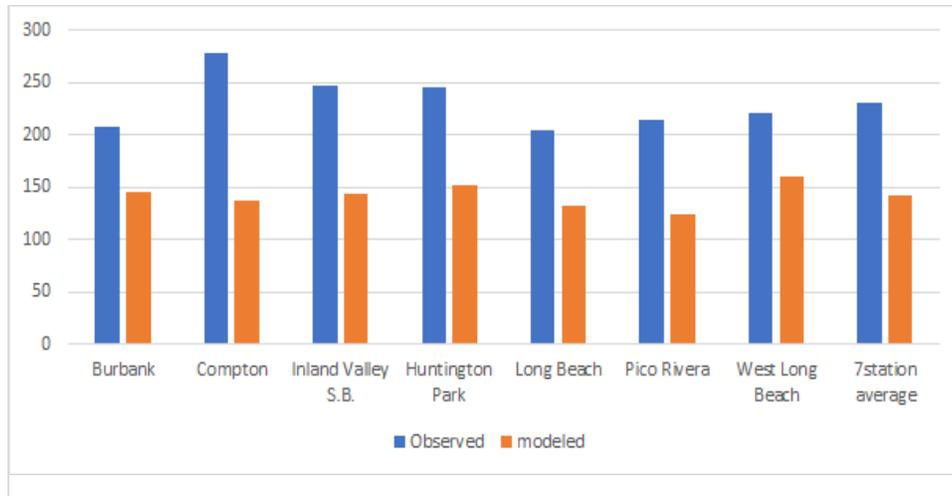
+ Among the 10 monitoring stations, 3 stations, Anaheim, Los Angeles and Rubidoux do not have complete data. Therefore 7-station averages are used.

Based on modeled concentrations, the inhalation-only air toxics cancer risk averaged over the 7 stations is 530-in-a-million, which is approximately 11% lower than the measurement-based risk as shown in Figure IX-7-9a.



**Figure IX-7-9a**  
 MATES V Modeled vs. Measured Inhalation Air Toxics Cancer Risk (Per Million)

The portion of the simulated cancer risk attributed to air toxics other than diesel PM can be directly compared to risk calculated from the toxic compound measurements. Figure IX-7-9b presents a comparison of the model simulated and measurement-based non-diesel risk at each monitoring site, as well as the 7-station average. The modeled non-diesel risk at each station is 27 to 50% lower than the risk calculated based on measurement data, with the modeled 7-station average cancer risk being 39% lower than the measurement-based risk. This difference in non-diesel risk is primarily due to underprediction of concentrations of formaldehyde, acetaldehyde and 1,3-butadiene and, to a lesser extent, benzene.



**Figure IX-7-9b**  
**MATES V Simulated vs. Measured Non-Diesel Air Toxics Risk (per million)**

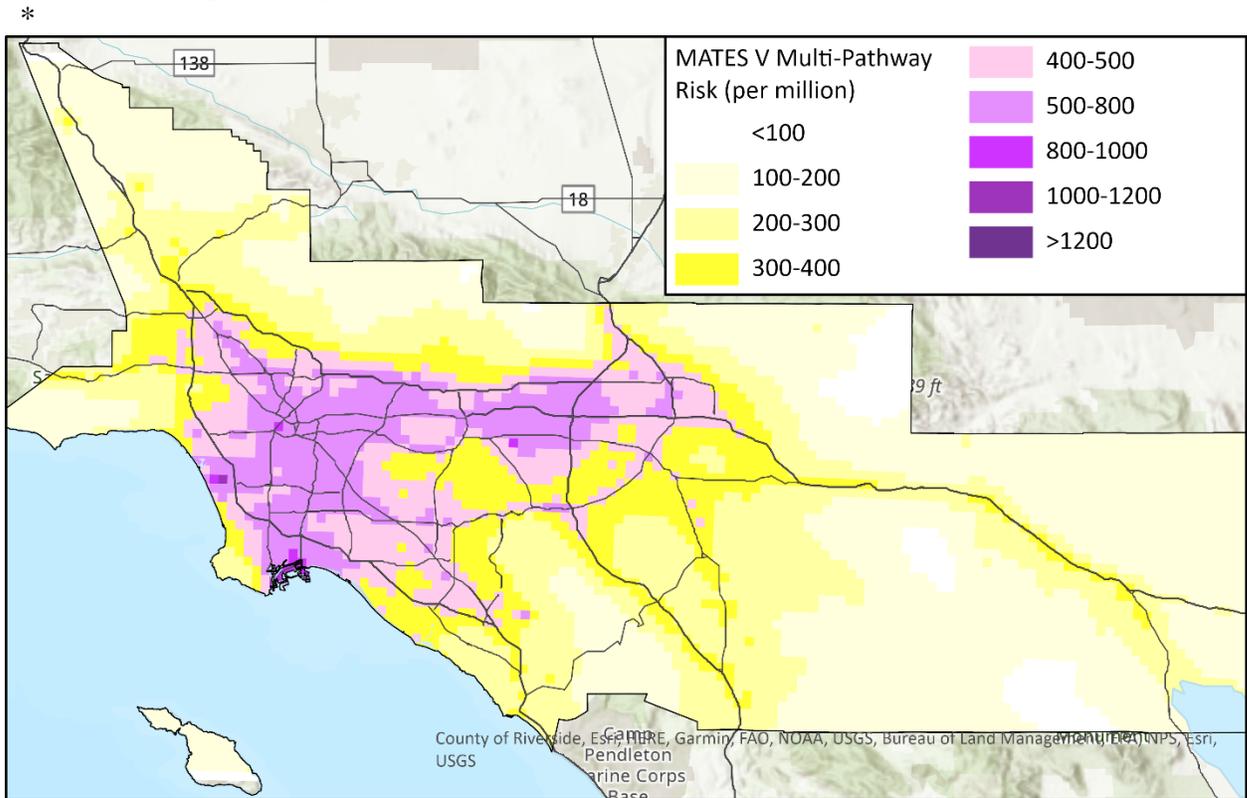
**IX.7.9 Multiple-Pathway Cancer Risk**

The cancer risk discussed in the previous section was based on inhalation exposure only, which was the practice used in previous MATES studies. Among the toxic species included in the modeling, arsenic, hexavalent chromium and lead have associated cancer risks from non-inhalation exposures. This additional cancer risk can be assessed by a multiple-pathway factor. For arsenic, hexavalent chromium and lead, the multiple-pathway factors are 9.71, 1.6 and 11.41, respectively. These factors account for oral and dermal exposures for these toxic metals. The overall multiple-pathway risk due to the inclusion of the three metals was estimated to be 455 per million, which is approximately 7.3% higher than the inhalation-only risk. Table IX-7-11 lists average risks for individual county and Coachella Valley. Figure IX-7-10 depicts the MATES V distribution of multiple-pathway cancer risk estimated from the predicted annual average concentrations of the modeled toxic compounds. Compared to Figure IX-7-3, where only inhalation toxic risk is depicted, additional risk from oral exposure of arsenic, hexavalent chromium and lead elevated the overall risk in some areas. County-wide and air basin level population weighted cancer risks are compared to MATES IV modeling results in Table IX-7-12. The reduction in the multiple-pathway risk is similar to the inhalation-only risk trends as shown in Table IX-7-8.

**Table IX-7-11**  
 County-Wide Population-Weighted Air Toxics Cancer Risk for Inhalation-Only and for  
 Multiple-Pathway Factors

Region	2018 Population	Inhalation-Only	Multiple-Pathway
		Average Risk (Per Million)	Average Risk (Per Million)
Los Angeles*	9,846,922	462	497
Orange	3,223,763	365	390
Riverside*	1,912,855	313	332
San Bernardino*	1,616,247	439	471
Basin	16,599,786	424	455
Coachella Valley	479,055	239	250

\* Data for these counties reflects the South Coast Air Basin portion only. Please note that all of Orange County is within the South Coast Air Basin.



**Figure IX-7-10**  
 MATES V CAMx RTRAC Simulated Multiple-Pathway Air Toxic Cancer Risk

**Table IX-7-12**  
County-Wide Population-Weighted Multiple-Pathway Cancer Risk

Region	MATES IV		MATES V		Average Percentage Change in Risk
	2012 Population	Average Risk (Per Million)	2018 Population	Average Risk (Per Million)	
Los Angeles*	9,578,586	1143	9,846,922	497	-57%
Orange	3,067,909	829	3,223,763	390	-53%
Riverside*	1,784,872	586	1,912,855	332	-43%
San Bernardino*	1,560,183	905	1,616,247	471	-48%
Port Area	998,745	1293	1,004,938	559	-57%
Basin Excluding Port Area	14,992,806	978	15,994,848	448	-54%
South Coast Air Basin	15,991,550	997	16,599,786	455	-54%
Coachella Valley	465,064	357	479,055	250	-30%

\* Data for these counties reflects the South Coast Air Basin portion only. Please note that all of Orange County is within the South Coast Air Basin.

### IX.8 Summary and Conclusions

A regional photochemical modeling system including CAMx with RTRAC algorithm, WRF, MEGAN and mobile source emissions model was employed to simulate air toxics cancer risk for the MATES V study. The population-weighted average Basin air toxics cancer risk is simulated to be 424 per million for inhalation-only risk and 455 per million for multi-pathway risk. The areas of the Basin that are exposed to the higher risk continue to be along the goods movement corridors. The MATES V inhalation-only cancer risk is estimated to be 53% lower than the corresponding risk during the MATES IV period, which was 897 in a million. Much of the risk reduction was due to the reductions of diesel particulate emissions which showed a 51% reduction from 2012 to 2018. The changes of other toxic compounds emissions marginally contribute to the overall reduction in the MATES V simulated risk. Overall carcinogenic emissions during the MATES V period are lower than the MATES IV by 46%. The simulated risk showed a greater rate of reduction than the corresponding risk derived from measurements, which showed 31% reduction since MATES IV.

## IX.9 References

- Byun, D.W., and Ching, J.K.S. (1999). Science Algorithms of the EPA Models-3 Community Multiscale Air Quality (CMAQ) Modeling system, U.S. Environmental Protection Agency, EPA/600/R-99/030
- California Air Resources Board (CARB) (2017). Emission FACtor (EMFAC) 2017 model and its documentation can be obtained at the following link: <http://www.arb.ca.gov/msei/modeling.htm>
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**APPENDIX X**  
**MATES V**  
**FINAL REPORT**

**Spatial and Temporal Trends of PM<sub>2.5</sub> and TSP Components in the South  
Coast Air Basin**

## Appendix X

### Spatial and Temporal Trends of PM<sub>2.5</sub> and TSP Components in the South Coast Air Basin (An Update from MATES IV)

#### X.1. Overview

While particulate pollution has decreased significantly over the past decades in the South Coast Air Basin (Basin), exposure to airborne particulate matter and toxic species within particulate matter continues to pose significant health risks for South Coast residents. In order to better understand long-term trends in particulate matter concentration and composition, fine particulate matter (PM<sub>2.5</sub>) and total suspended particulate (TSP) samples were collected and analyzed at ten MATES V sites throughout the Basin as in previous MATES campaigns. This appendix discusses findings from MATES V PM<sub>2.5</sub> and TSP analysis with particular attention to trends between MATES IV (2012-2013) and MATES V (2018-2019).

PM<sub>2.5</sub> mass reconstructions at five MATES V sites showed similar patterns to results from MATES IV, with organic matter making up the largest fraction (45-48%) of PM<sub>2.5</sub> mass, followed by the combined secondary inorganic ion fraction (ammonium sulfate and ammonium nitrate, 37-41%). Seasonal trends in reconstructed PM<sub>2.5</sub> component concentrations were also largely consistent with those observed in MATES IV, with fall/winter maxima in elemental carbon and ammonium nitrate, summer maxima in ammonium sulfate, and less seasonally distinct or more complex patterns in other components. Elemental carbon levels throughout the Basin dropped substantially between MATES IV and MATES V, with 31-64% reductions at all ten MATES V sites. Ambient toxic metal concentrations measured in TSP samples showed mixed trends by metal and site. Hexavalent chromium and lead concentrations decreased at most sites between MATES IV and MATES V (29 and 21% decreases in basin averages, respectively), while cadmium levels increased at most sites (114% increase in basin average). Trends for other toxic metals, including arsenic, nickel, manganese, antimony, chromium, and cobalt, were more spatially variable with more muted changes in overall basin averages.

#### X.2. Mass Reconstruction of PM<sub>2.5</sub>

PM<sub>2.5</sub> consists of a wide range of inorganic and organic species, reflecting diverse sources and complex aerosol chemical processes. PM<sub>2.5</sub> can be broadly grouped into five major components: elemental carbon (EC), organic matter (OM), secondary inorganic ions (ammonium, nitrate, and sulfate), sea salt, and crustal/soil material. Mass reconstruction of PM<sub>2.5</sub> from estimated contributions of these components is commonly performed to evaluate consistency between different chemical analyses as well as to assess temporal and spatial variability in PM<sub>2.5</sub> composition. In the MATES IV study, mass reconstruction calculations showed generally similar PM<sub>2.5</sub> composition across the Basin, with organic matter and secondary inorganic ions as the dominant fractions (42-46% and 34-38% of average reconstructed mass across all sites,

respectively) (South Coast AQMD 2015). To assess changes in PM<sub>2.5</sub> composition since the MATES IV period (July 2012-June 2013), this exercise was repeated for the five MATES V sites (Anaheim, Central Los Angeles, Inland Valley San Bernardino, Long Beach, and Rubidoux) where the full suite of PM<sub>2.5</sub> measurements was available.

Mass reconstruction calculations were performed for PM<sub>2.5</sub> samples collected on a 1-in-6 day schedule from May 2018 through April 2019. Since reconstructed masses were calculated for each MATES V sample (i.e., single observations), concentrations were used as reported without any detection limit censoring. Estimated contributions of each PM<sub>2.5</sub> component were calculated according to guidance for the EPA Chemical Speciation Network (Air Quality Research Center, University of California, Davis 2019). The only deviation from this guidance was to estimate ammonium sulfate from sulfate ion data measured by ion chromatography (IC) instead of sulfur measured by X-Ray Fluorescence (XRF). Staff made this substitution was due to possible negative bias in XRF data caused by instrumental issues during analysis of MATES V samples.

Two of the components, secondary inorganic ions and sea salt, were calculated with different formulas than those used in MATES IV (see Table 1). The change in the secondary inorganic ions formula resulted in minimal differences in calculated fractions (1-6% difference in site averages). However, the change in sea salt formula did result in significantly lower sea salt fractions (reductions of 0.18-0.55  $\mu\text{g}/\text{m}^3$ , 39-64% in calculated site averages). Calculating sea salt from only chloride ion data may underestimate total sea salt due to chlorine loss from sea salt aerosols during transport (Chow, et al. 2015). However, the alternative formula (sum of sodium and chloride ions) was not used in this study due to uncertainty associated with relatively high sodium concentrations measured on field blank filters. For consistency in comparing MATES IV and MATES V results, MATES IV inorganic ion and sea salt fractions were recalculated with the updated formulas in Table X-1.

Overall, reconstructed and measured filter PM<sub>2.5</sub> masses for all MATES V samples showed good agreement ( $r^2 = 0.84$ ,  $n = 289$ ). The average ratio of reconstructed mass to measured mass for all samples was  $0.99 \pm 0.20$  ( $1\sigma$ ), with the lowest average ratio at Long Beach ( $0.88 \pm 0.21$ ) and highest at Inland Valley San Bernardino ( $1.09 \pm 0.20$ ). As discussed extensively in Chow et al. (2015), the largest sources of uncertainty in the mass reconstruction calculation include sampling artifacts, analytical uncertainty, and scaling factors used to calculate component contributions, particularly the organic matter/organic carbon scaling factor. There is also some uncertainty associated with using concentrations below detection limits in mass reconstruction calculations. In order to assess the size of this effect, potential concentration ranges for each component were calculated by substituting zero and minimum detection limit concentrations for non-detects to calculate lower and upper limits, respectively. These calculations showed that uncertainty in non-detect concentrations had a very minimal effect on average reconstructed mass (less than 2% or  $0.15 \mu\text{g}/\text{m}^3$ ). The effect of non-detects was most pronounced for sea salt, where calculated five-site averages for zero-substituted, uncensored, and MDL-substituted data were 0.18, 0.29, and  $0.34 \mu\text{g}/\text{m}^3$ , respectively.

Figure X-1 shows mass balances by site for both MATES IV and MATES V. Site to site comparisons between MATES IV and MATES V are also provided in Table X-2. As in MATES IV, OM was the largest fraction of reconstructed mass at all sites (45-48%), followed by the combined secondary inorganic ion fraction (37-41%). The most notable changes from MATES IV to MATES V were the reductions in ammonium sulfate and EC fractions. Average sulfate concentrations decreased from MATES IV to MATES V at all five sites by 18-23%. Since sulfate aerosols in the Basin are mostly derived from burning of sulfur-containing fuels, including both land-based and ocean-going vessel fuel combustion, the uniform reduction in PM<sub>2.5</sub> sulfate points to reduced sulfur emissions from these sources. EC concentrations dropped substantially at all five sites (40-49% decrease from MATES IV concentrations), also pointing to reduced emissions from diesel and other fuel combustion. EC trends throughout the Basin are discussed in further detail in Section X.3. Average OM also decreased slightly at all five sites (4-17% decrease from MATES IV concentrations), while ammonium nitrate, crustal material, and sea salt fractions generally remained at similar levels to those calculated in MATES IV.

Seasonal PM<sub>2.5</sub> concentration and composition patterns are controlled by a combination of meteorological conditions (e.g., temperature, wind direction and speed, solar radiation/actinic flux, atmospheric mixing height) and source changes (e.g., winter wood burning, vegetation growth, wildfires). Figure X-2a shows monthly averages for each PM<sub>2.5</sub> component, reconstructed mass, and measured mass for the five sites across the MATES V measurement period. Both reconstructed and measured mass showed similar temporal trends, with generally higher values from June to December.

The variable seasonal patterns of calculated PM<sub>2.5</sub> components were generally consistent with trends observed in MATES IV (Figure X-2b). EC showed clear fall/winter maxima at all sites, likely due to favorable meteorological conditions for particle accumulation, as well as contributions from winter wood burning. OM had a less pronounced seasonal cycle, with inland sites (Inland Valley San Bernardino and Rubidoux) showing summer maxima, OM at Central LA peaking in fall, and Anaheim and Long Beach OM peaking in winter. The variable OM seasonal signals reflect the balance between complex meteorological and source effects at different sites through the year, including increased secondary organic aerosol formation in the summer, cooler temperatures and meteorological conditions favorable for increased particle accumulation in the winter, and seasonal sources of organic matter (e.g., winter wood burning, see Appendix XII). It is important to note that two wildfire events may have had significant effects on OM monthly averages. As evidenced by elevated levoglucosan concentrations and High Resolution Rapid Refresh (HRRR) smoke model forecasts, a smoke plume from wildfires in northern California likely contributed to the highest basin-wide OM concentration of the MATES V period on August 24, 2018, while smoke from the Woolsey/Hill Fires likely contributed to high OM in November 10, 2018 samples.

Ammonium nitrate and ammonium sulfate fractions showed distinct but opposing seasonal signals. The calculated ammonium nitrate fraction peaked in the fall/winter at all five sites (average winter concentrations: 3.03-4.11  $\mu\text{g}/\text{m}^3$ , 1.5-3.2x summer concentrations), while

ammonium sulfate peaked in the summer (average summer concentrations: 2.48-2.86  $\mu\text{g}/\text{m}^3$ , 3.5-5.8x winter concentrations). These seasonal trends largely reflect meteorological controls on sulfate and nitrate particle chemistry: increased actinic flux during the summer drives photochemical oxidation of sulfur dioxide and sulfate particle formation, while cooler winter temperatures favor nitrate particle formation from gaseous nitric acid (Seinfeld and Pandis 2016).

Both sea salt and crustal material showed generally muted seasonal variability. Seasonal differences in crustal material were more pronounced at inland sites, with summer/fall (June-November) averages (Rubidoux 1.36  $\mu\text{g}/\text{m}^3$ , Inland Valley San Bernardino: 1.39  $\mu\text{g}/\text{m}^3$ ) nearly double the winter/spring (December-May) averages (Rubidoux: 0.76  $\mu\text{g}/\text{m}^3$ , Inland Valley San Bernardino: 0.78  $\mu\text{g}/\text{m}^3$ ). Unlike in MATES IV where calculated sea salt fractions peaked in the summer, sea salt concentrations were slightly lower in the summer compared to the rest of the year. However, this difference was driven by the change in sea salt formula, as recalculated MATES IV data do not show higher summer values. In general, the true sea salt contribution to  $\text{PM}_{2.5}$  is difficult to estimate due to uncertainty in calculation parameters, as well as the high fraction of chloride results near or below instrument detection limits.

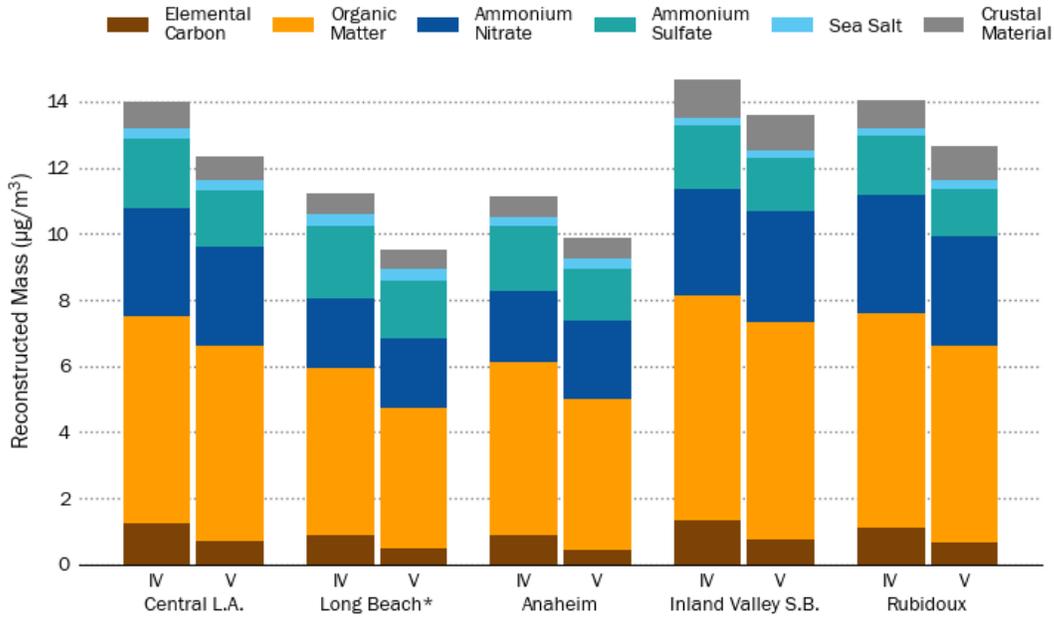
**Table X-1.** Summary of mass balance reconstruction calculations in MATES IV and MATES V. MATES V formulas are based on current guidance for EPA Chemical Speciation Network (Air Quality Research Center, University of California, Davis 2019). Differences between the studies are highlighted in bold.

<b>Component</b>	<b>MATES IV</b>	<b>MATES V</b>
Elemental carbon	As reported	As reported
Organic matter	1.4 × organic carbon	1.4 × organic carbon
<b>Secondary inorganic ions</b>	<b>Ammonium + sulfate + nitrate</b>	<b>Ammonium nitrate = 1.29 × nitrate</b> <b>Ammonium sulfate = 1.375 × sulfate</b>
<b>Sea salt</b>	<b>Sodium + chloride</b>	<b>1.8 × chloride</b>
Crustal material	2.2 × aluminum + 2.49 × silicon + 1.63 × calcium + 2.42 × iron + 1.94 × titanium	2.2 × aluminum + 2.49 × silicon + 1.63 × calcium + 2.42 × iron + 1.94 × titanium

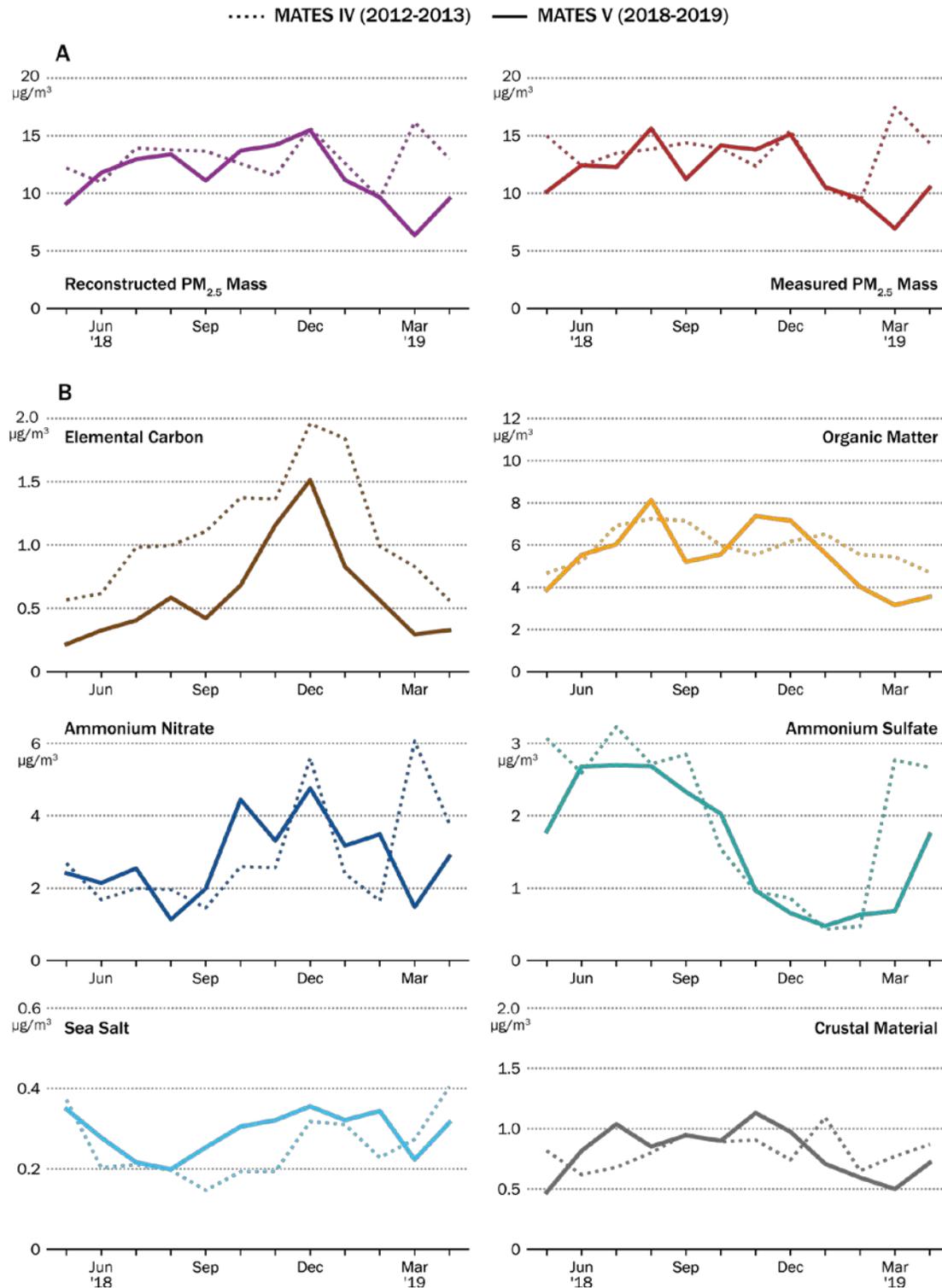
**Table X-2.** Site comparisons of annual average concentrations of calculated PM<sub>2.5</sub> components, reconstructed mass, and measured mass between MATES IV (July 2012 – June 2013) and MATES V (May 2018 – April 2019). The contribution of each component to overall average reconstructed mass is shown in parentheses. Note that MATES IV ammonium nitrate, ammonium sulfate, and sea salt concentrations were recalculated with updated formulas. All concentrations are in  $\mu\text{g}/\text{m}^3$ .

Component	Central Los Angeles		Long Beach*		Anaheim		Inland Valley S.B.		Rubidoux	
	IV	V	IV	V	IV	V	IV	V	IV	V
Elemental carbon	1.23 (9%)	0.71 (6%)	0.90 (8%)	0.48 (5%)	0.90 (8%)	0.46 (5%)	1.36 (9%)	0.73 (5%)	1.11 (8%)	0.66 (5%)
Organic matter	6.25 (45%)	5.97 (48%)	5.03 (45%)	4.23 (45%)	5.24 (47%)	4.48 (45%)	6.77 (46%)	6.50 (48%)	6.47 (46%)	5.81 (47%)
Ammonium nitrate	3.27 (23%)	3.00 (24%)	2.13 (19%)	2.12 (22%)	2.11 (19%)	2.44 (25%)	3.23 (22%)	3.37 (25%)	3.58 (25%)	3.18 (26%)
Ammonium sulfate	2.12 (15%)	1.75 (14%)	2.20 (20%)	1.74 (18%)	2.01 (18%)	1.55 (16%)	1.94 (13%)	1.56 (12%)	1.82 (13%)	1.45 (12%)
Sea salt	0.29 (2%)	0.31 (2%)	0.32 (3%)	0.38 (4%)	0.26 (2%)	0.31 (3%)	0.20 (1%)	0.22 (2%)	0.20 (1%)	0.24 (2%)
Crustal material	0.84 (6%)	0.71 (6%)	0.63 (6%)	0.56 (6%)	0.62 (6%)	0.64 (6%)	1.17 (8%)	1.10 (8%)	0.86 (6%)	1.05 (8%)
Reconstructed PM <sub>2.5</sub> Mass	14.01	12.44	11.20	9.50	11.14	9.88	14.67	13.48	14.05	12.38
Measured PM <sub>2.5</sub> Mass	14.14	12.43	12.95	10.88	12.37	10.60	14.33	12.55	13.83	12.50

\*Station location moved from MATES IV to MATES V.



**Figure X-1.** Average reconstructed PM<sub>2.5</sub> compositions at five sites in the South Coast Air Basin during MATES IV (July 2012-June 2013) and MATES V (May 2018-April 2019). Asterisk indicates station location moved between MATES IV and V campaigns.



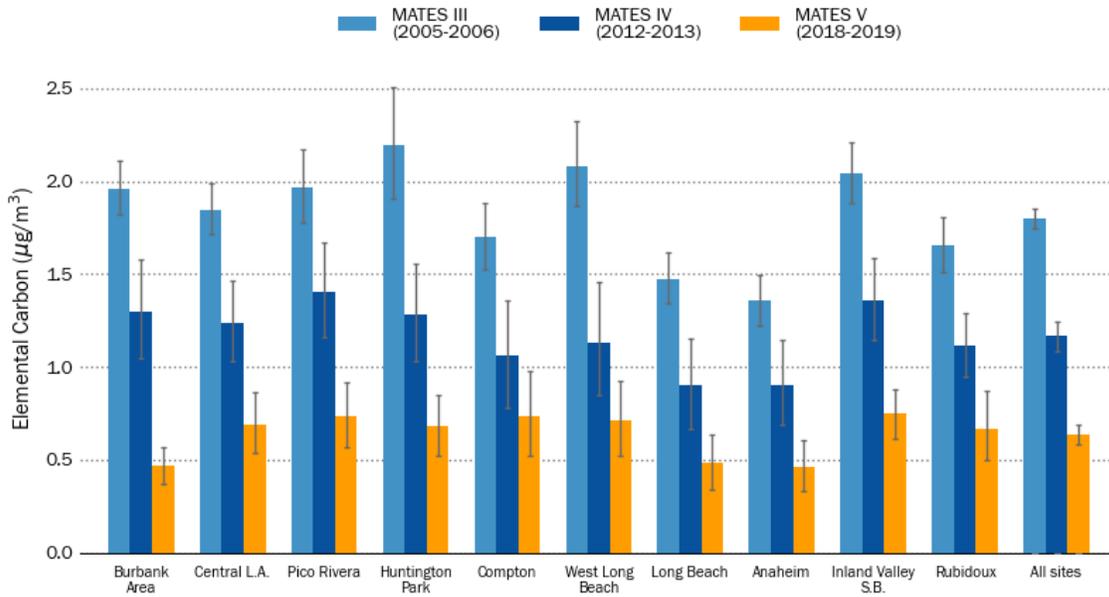
**Figure X-2.** a. Monthly averages of reconstructed and measured PM<sub>2.5</sub> mass during MATES V. b. Monthly averages of calculated PM<sub>2.5</sub> components during MATES V. Bold lines show MATES V five-site (Anaheim, Central L.A., Long Beach, Inland Valley San Bernardino, Rubidoux) averages and dotted lines show MATES IV five-site averages.

### X.3. Elemental Carbon in PM<sub>2.5</sub>

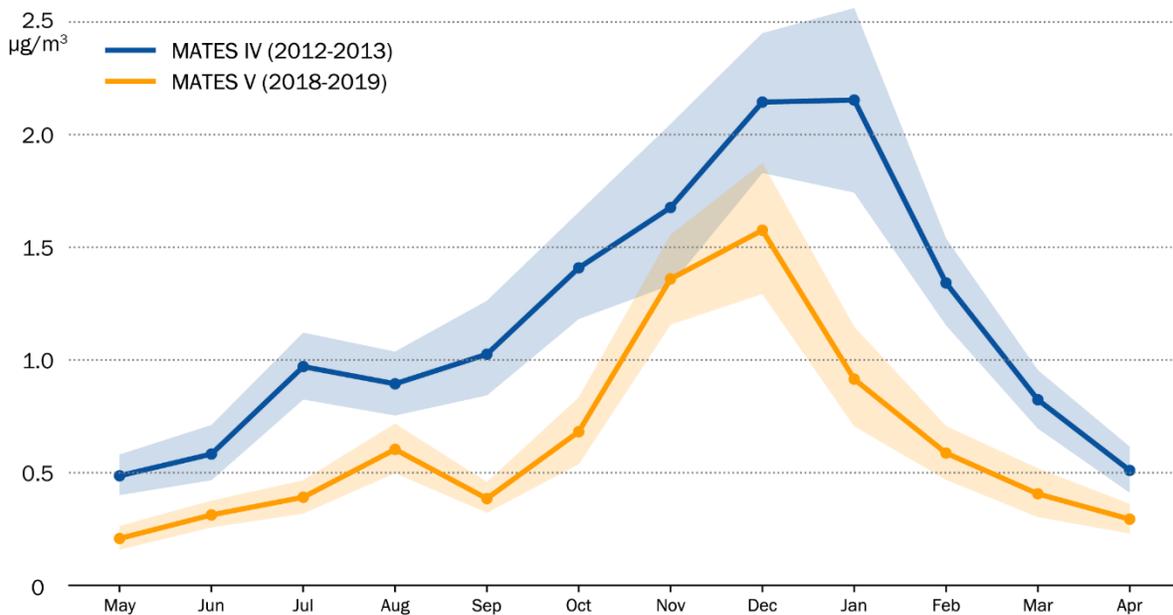
Elemental carbon (EC) is a byproduct of combustion processes, including diesel and gasoline engine combustion, wildfire, and residential wood burning. Critically, PM<sub>2.5</sub> EC concentrations are currently used to estimate diesel particulate matter, which is the largest contributor to air toxics cancer risk in the Basin (67.3% of total MATES V population-weighted average cancer risk). EC concentrations were measured in PM<sub>2.5</sub> samples collected on 1-in-6 day schedule at all ten fixed MATES V sites. Black carbon (BC), a closely related but distinct species from EC, was also measured on a continuous basis at all sites and is discussed in more detail in Chapter 5 and Appendix VI.

The average PM<sub>2.5</sub> EC concentration across all monitoring stations during MATES V was  $0.64 \pm 0.05 \mu\text{g}/\text{m}^3$ , which was 45% lower than the MATES IV basin-wide station average. Average EC concentrations at each site ranged from  $0.46 \mu\text{g}/\text{m}^3$  at Anaheim to  $0.75 \mu\text{g}/\text{m}^3$  at Inland Valley San Bernardino. Figure X-3 shows EC concentrations decreased at each individual site compared to MATES IV levels, ranging from a 31% drop at Compton to a 64% drop at the Burbank Area station, although the Burbank Area station was relocated between MATES IV and V. Furthermore, basin-wide monthly average concentrations were consistently lower in MATES V (Figure X-4). As observed in MATES IV, EC concentrations at all sites were generally higher in fall/winter compared to spring/summer due to a combination of meteorological conditions and some contribution from residential wood burning. The relative magnitude of the seasonal cycle also remained similar between MATES IV and MATES V, with a ratio of average winter (December-February) basin-wide EC concentration to average summer (June-August) concentration of 2.3 in MATES IV and 2.4 in MATES V.

The uniform spatial and temporal decreases in EC concentrations in the Basin between MATES IV and MATES V point to continued reductions in EC emissions across the basin, which is consistent with a 56% reduction in total PM<sub>2.5</sub> EC emissions in the MATES V (2018) emissions inventory compared to the MATES IV (2012) inventory (see Appendix VIII). The overall reduction in EC emissions was driven by large reductions across stationary sources (-58%), on-road vehicles (-69%), and other mobile sources (-38%).



**Figure X-3.** Kaplan-Meier mean  $\text{PM}_{2.5}$  elemental carbon concentrations from MATES III to MATES V. Error bars indicate 95% confidence intervals.



**Figure X-4.** Comparison of basin-wide station average  $\text{PM}_{2.5}$  concentrations by month during MATES IV (2012-2013) and MATES V (2018-2019). Shading indicates 95% confidence intervals.

#### X.4. Metals in TSP

As in previous MATES studies, ambient toxic metal concentrations in the Basin were assessed by analysis of total suspended particulate (TSP) samples, which incorporate both coarse and fine particulate matter fractions. Figures X-5 through X-13 show average MATES V TSP metal concentrations compared to MATES IV levels. Station and basin-wide concentration trends for all metal air toxics from MATES IV to MATES V are also summarized in Figure X-14. Overall, metal air toxics contribute to approximately 10.4% of the MATES V population-weighted average multi-pathway cancer risk in the Basin. The metal species with the largest contributions to total population-weighted MATES V air toxics cancer risk are arsenic (6.4% of total risk) and hexavalent chromium (2.5%). Other metal air toxics that contribute to overall population-weighted cancer risk include cadmium (0.9%), nickel (0.4%), and lead (0.2%). Given the relatively small contribution of each of these metal air toxics to the overall air toxics cancer risk, small changes in the measured levels would not have a large impact on the cancer risk contribution from that pollutant. However, in the exploratory analysis of chronic non-cancer risk based on the measurement data, arsenic was identified as contributing to about half of total risk (Chapter 2). Therefore, changes in arsenic levels may impact the overall chronic non-cancer risk.

The ten-station average arsenic concentration decreased slightly from MATES IV, with increases in average concentration observed at two sites, Anaheim and Pico Rivera, and similar or decreased concentrations at other sites. An analysis of arsenic concentrations from monitoring locations throughout the US showed that the concentrations detected in the MATES V sites were similar to concentrations elsewhere in the US (see Appendix IV, Figure IV-75). Arsenic concentrations were strongly correlated with a number of other metal species at all sites, including manganese ( $r^2$  range of 0.60-0.94, N = 58-61), titanium ( $r^2 = 0.61-0.92$ , N = 57-60), vanadium ( $r^2 = 0.61-0.90$ , N = 35-45), chromium ( $r^2 = 0.52-0.86$ , N = 58-61), and barium ( $r^2 = 0.54-0.81$ , N = 51-56).<sup>1</sup> These correlations are consistent with mixed sources of arsenic in the Basin, including crustal material, abrasive vehicle emissions, and industrial emissions, as found in Pakbin et al. (2011). Arsenic, manganese, titanium, and vanadium all showed higher concentrations in the summer/fall at inland sites compared to other sites, which is consistent with increased crustal dust during warmer and drier months.

Hexavalent chromium concentrations decreased at most sites, with a 29% decrease in the basin-wide average from MATES IV to MATES V. The only substantial increase was at Anaheim where average concentrations increased from 0.027 to 0.038 ng/m<sup>3</sup> (+43%) but remained below the MATES V basin-wide average of 0.040 ng/m<sup>3</sup>. As observed in MATES IV, average hexavalent chromium concentrations were highest at Compton (0.061 ng/m<sup>3</sup>) and Huntington Park (0.057 ng/m<sup>3</sup>), although average concentrations decreased substantially compared to MATES IV (-46% at both sites). Compared to other MATES stations, these two stations are located closer to a number of metal-processing facilities that handle hexavalent chromium. South Coast AQMD has conducted special monitoring investigations and enforcement efforts in

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<sup>1</sup> All  $p \ll 0.001$ .

communities where a large number of hexavalent chromium emitting facilities are located and continue to develop and/or amend regulations to control these types of metal emissions. Hexavalent chromium concentrations did not show any strong correlation with other measured TSP metals, which is consistent with distinct or highly variable sources in the Basin.

Average cadmium concentrations increased at most sites, with very large increases at West Long Beach (+ 506%), Rubidoux (+348%), and Burbank Area (+415%). At the Burbank Area station, this increase was largely driven by one extremely high sample (30 ng/m<sup>3</sup>) on December 22, 2018, but increases in average concentrations at other sites could not be attributed to any one outlier. Similar to hexavalent chromium, cadmium concentrations did not show strong correlations with any other measured metals across the basin, pointing to distinct or heterogeneous sources.

Basin-wide average concentrations of nickel and lead both declined from MATES IV to MATES V, but trends at individual sites varied. While average nickel concentrations decreased substantially at some sites, the average concentration at Inland Valley San Bernardino rose by 55% compared to MATES IV. Much of the observed increase at Inland Valley San Bernardino was driven by a series of high concentration samples during the summer (June-August). Nickel is also of interest as a tracer of emissions from heavy fuel oil combustion by ocean-going vessels (OGV) (Agrawal, et al. 2009). The usage of heavy fuel oil fuel should have been phased out by OGVs with the low sulfur fuel requirements implemented by the California Air Resources Board<sup>2</sup> and the International Maritime Organization<sup>3</sup> over the past decade. At the two sites near the ports, West Long Beach and Long Beach, nickel concentrations showed virtually no change from levels observed in MATES IV. Nickel concentrations at these sites were only weakly correlated ( $r^2 = 0.26$ ,  $p < 0.001$ ), pointing to the importance of local sources and meteorological patterns. Lead concentrations decreased across the Basin from MATES IV to MATES V by 20-39%, with the exception of Anaheim and Burbank Area stations, where average lead concentrations increased by 28% and 30%, respectively. Average lead concentrations at every site (2.72-7.66 ng/m<sup>3</sup>) were well below the National Ambient Air Quality Standard for lead (150 ng/m<sup>3</sup> average over 3 months). Furthermore, every sample measured during MATES V remained below this standard, with the highest individual sample concentration (106.4 ng/m<sup>3</sup>) recorded at Huntington Park on April 15, 2019.

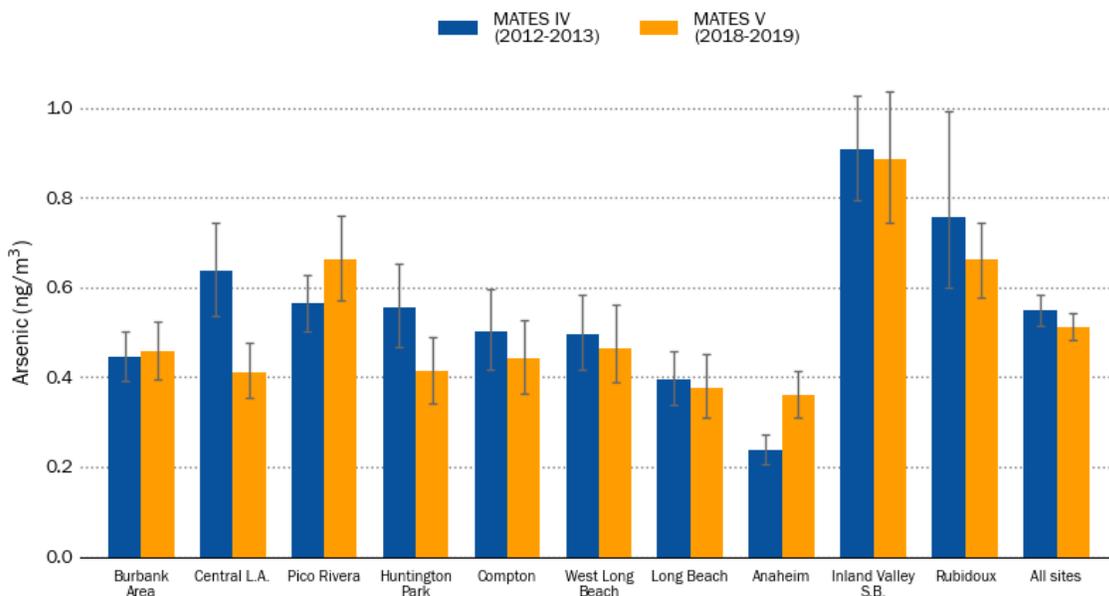
Other metals designated as Hazardous Air Pollutants by the EPA and measured as part of MATES V include manganese, antimony, chromium, cobalt, beryllium, and selenium. Temporal trends in these metals, except for beryllium and selenium, are shown in Figures X-10 through X-13 and Figure X-14. Selenium and beryllium concentrations were generally too low to be reliably quantified (77% of MATES V samples were below detection limit for selenium, and 76% were below detection limit for beryllium), so true ambient trends were difficult to discern.

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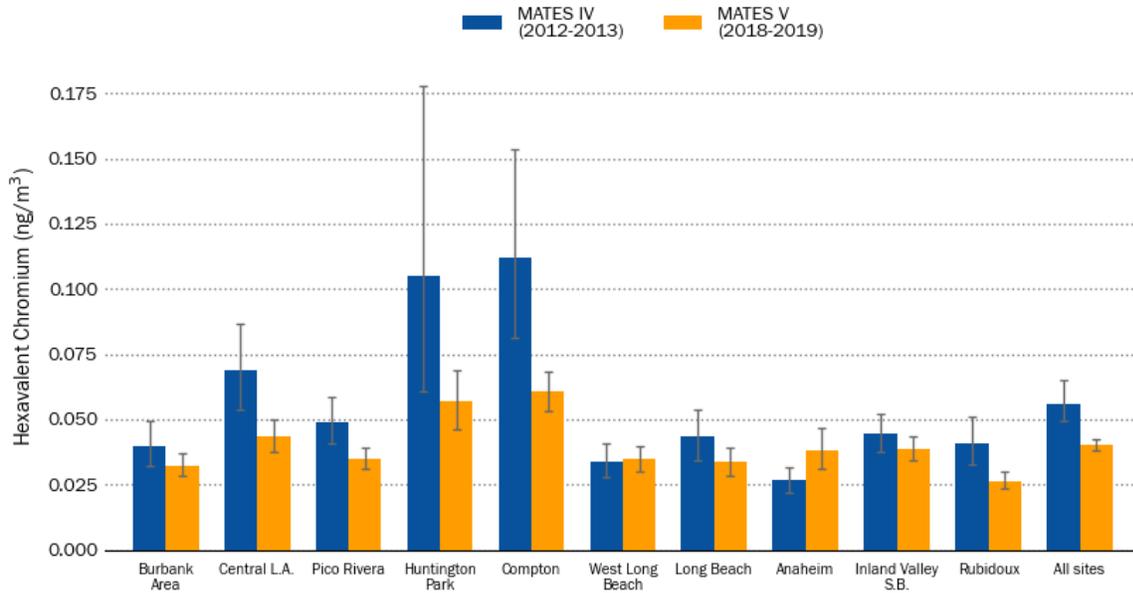
<sup>2</sup>For more information, see <https://ww2.arb.ca.gov/our-work/programs/ocean-going-vessel-fuel-regulation>

<sup>3</sup>For more information, see <https://www.imo.org/en/MediaCentre/PressBriefings/Pages/34-IMO-2020-sulphur-limit.aspx>

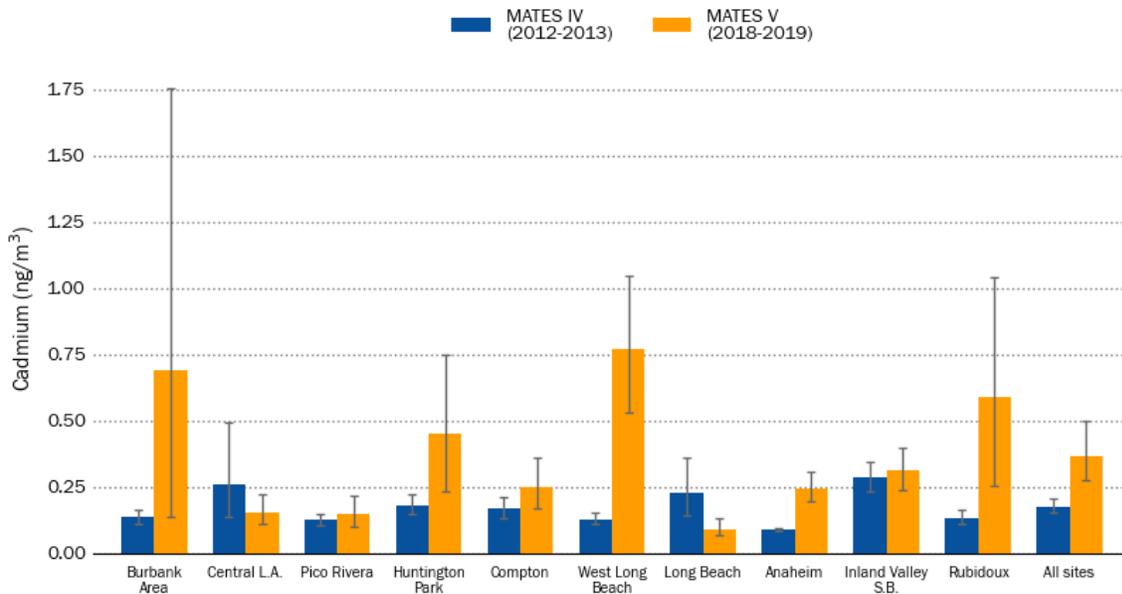
Basin-wide average concentrations of manganese, antimony, and cobalt increased slightly from MATES IV averages (+3, 4, 13%, respectively), while average chromium concentration declined slightly (-9%). Trends at individual sites varied considerably. While concentrations of these metals uniformly decreased at Central Los Angeles and Huntington Park, concentrations uniformly increased at Anaheim. In general, concentrations of nearly every measured TSP metal increased at Anaheim from MATES IV to MATES V. Since the Anaheim station location and sampling method did not change between the two studies, this trend could be the result of changes in local sources and/or particle transport to this site. Other noteworthy increases include the average cobalt concentration at Long Beach, which doubled between MATES IV (0.37 ng/m<sup>3</sup>) to MATES V (0.75 ng/m<sup>3</sup>). This increase was primarily driven by high winter concentrations and could reflect closer proximity to a local cobalt source due to the change in the Long Beach station location between MATES IV and MATES V sampling campaigns. Cobalt concentrations at Long Beach were strongly correlated with nickel ( $r^2 = 0.93$ ) and chromium ( $r^2 = 0.79$ ), suggesting a possible common source of these metals at this site.



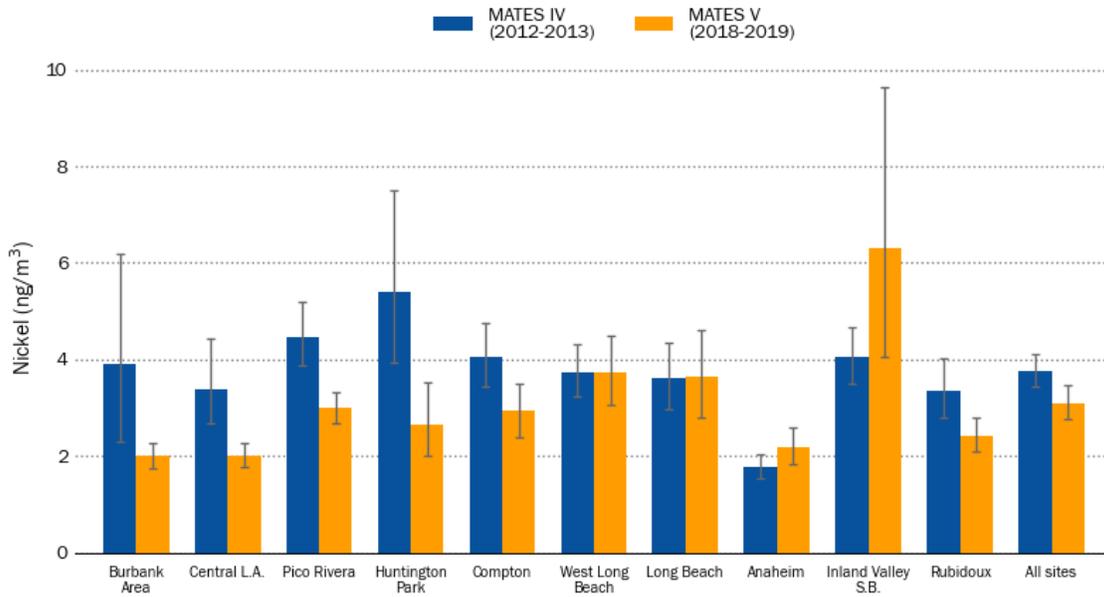
**Figure X-5.** Kaplan-Meier mean TSP arsenic concentrations by site during MATES IV (2012-2013) and MATES V (2018-2019). Error bars indicate 95% confidence intervals.



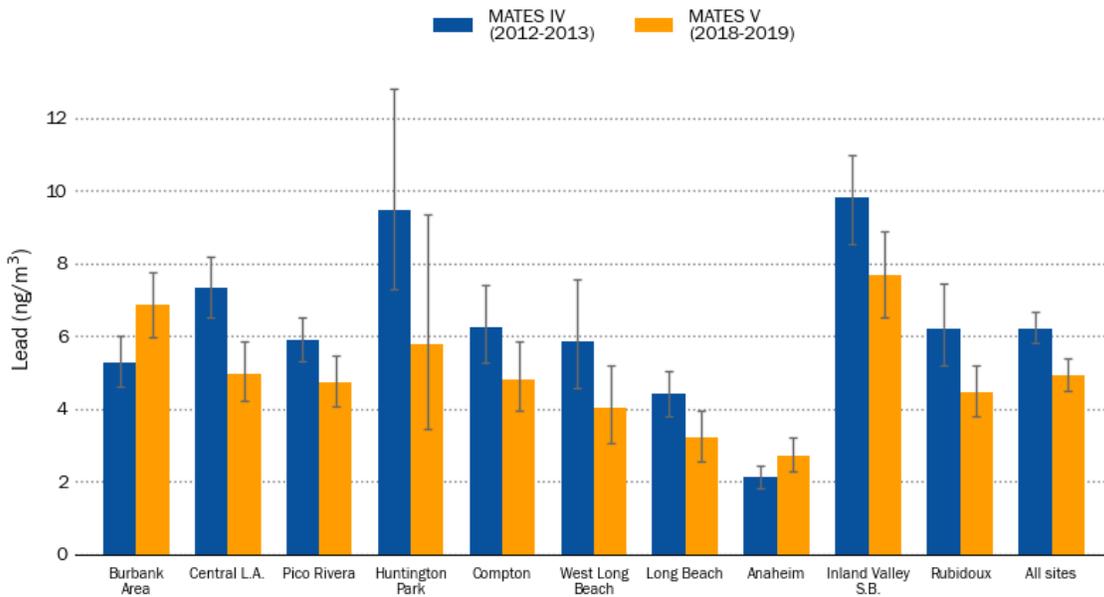
**Figure X-6.** Kaplan-Meier mean TSP hexavalent chromium concentrations by site during MATES IV (2012-2013) and MATES V (2018-2019). Error bars indicate 95% confidence intervals.



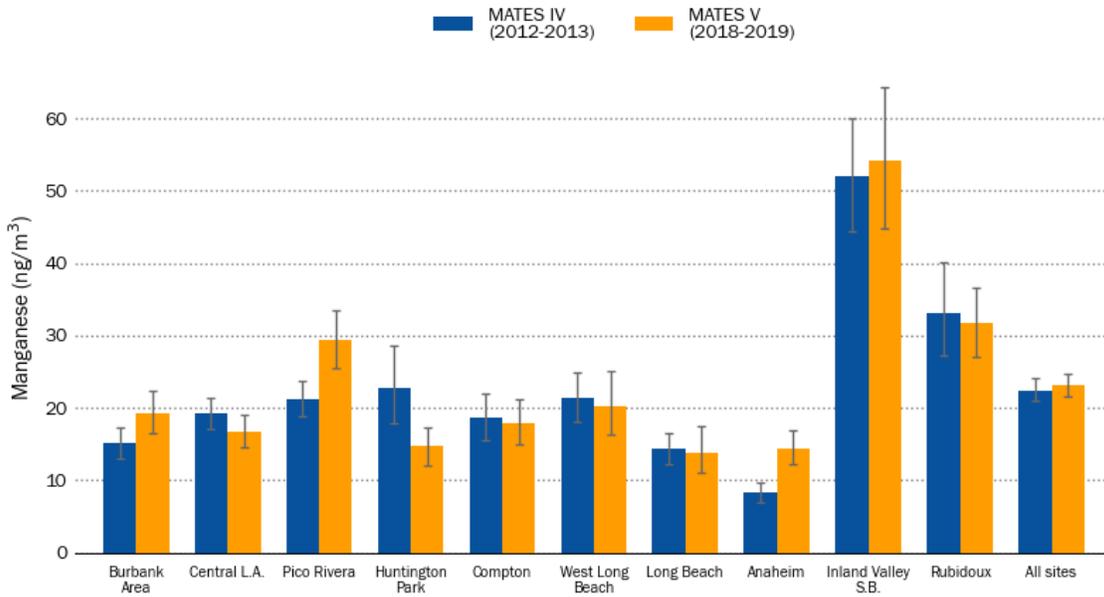
**Figure X-7.** Kaplan-Meier mean TSP cadmium concentrations by site during MATES IV (2012-2013) and MATES V (2018-2019). Error bars indicate 95% confidence intervals.



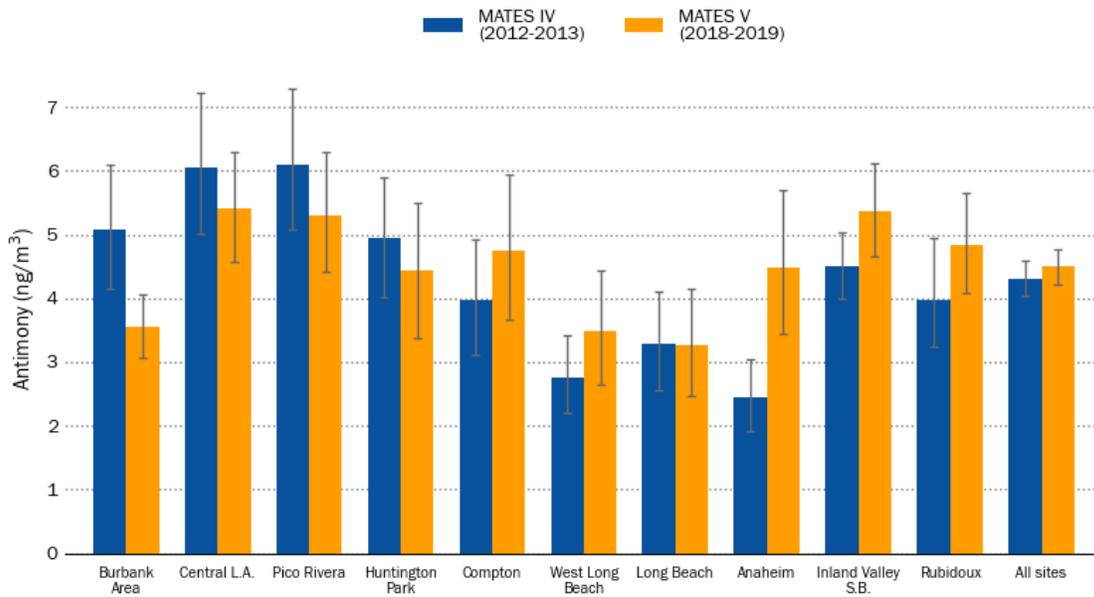
**Figure X-8.** Kaplan-Meier mean TSP nickel concentrations by site during MATES IV (2012-2013) and MATES V (2018-2019). Error bars indicate 95% confidence intervals.



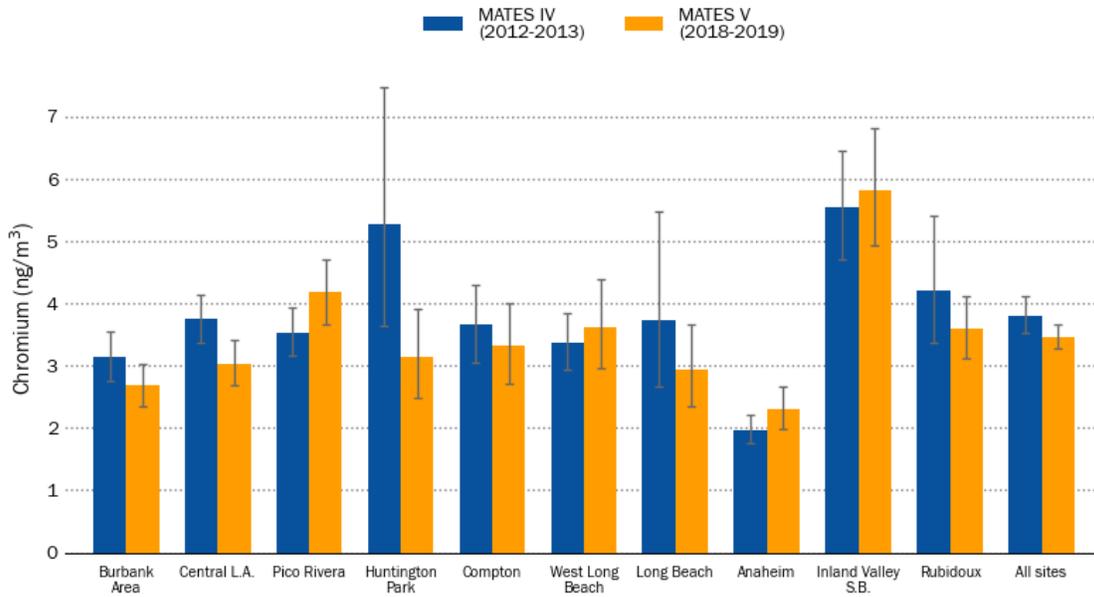
**Figure X-9.** Kaplan-Meier mean TSP lead concentrations by site during MATES IV (2012-2013) and MATES V (2018-2019). Error bars indicate 95% confidence intervals.



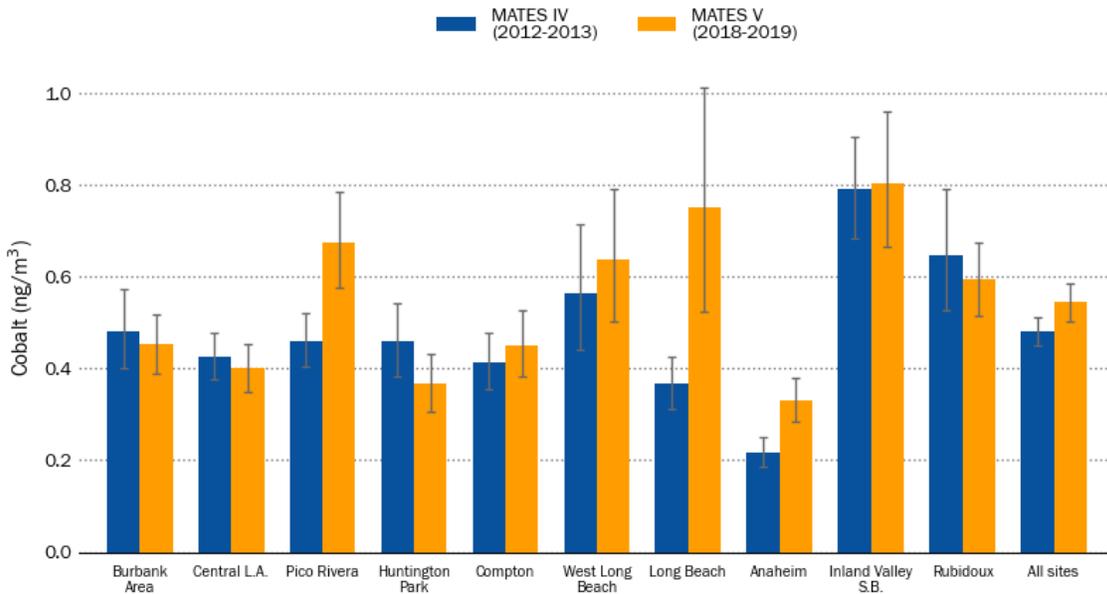
**Figure X-10.** Kaplan-Meier mean TSP manganese concentrations by site during MATES IV (2012-2013) and MATES V (2018-2019). Error bars indicate 95% confidence intervals.



**Figure X-11.** Kaplan-Meier mean TSP antimony concentrations by site during MATES IV (2012-2013) and MATES V (2018-2019). Error bars indicate 95% confidence intervals.



**Figure X-12.** Kaplan-Meier mean TSP total chromium concentrations by site during MATES IV (2012-2013) and MATES V (2018-2019). Error bars indicate 95% confidence intervals.



**Figure X-13.** Kaplan-Meier mean TSP cobalt concentrations by site during MATES IV (2012-2013) and MATES V (2018-2019). Error bars indicate 95% confidence intervals.

	Burbank Area*	Central L.A.	Pico Rivera	Huntington Park*	Compton	West Long Beach	Long Beach*	Anaheim	Inland Valley S.B.	Rubidoux	All sites
Arsenic	3	-35	17	-26	-12	-6	-5	51	-3	-12	-6
Hexavalent Chromium	-19	-37	-29	-46	-46	2	-23	43	-13	-35	-29
Cadmium	415	-42	16	149	48	506	-61	179	10	348	114
Nickel	-48	-41	-33	-51	-28	0	1	22	55	-28	-18
Lead	30	-32	-20	-39	-23	-31	-27	28	-22	-28	-21
Manganese	27	-13	39	-35	-5	-5	-4	72	4	-4	3
Antimony	-30	-11	-13	-11	20	26	-1	83	20	22	4
Chromium	-15	-19	18	-41	-9	8	-21	17	5	-14	-9
Cobalt	-6	-6	46	-20	9	13	105	52	1	-8	13

**Figure X-14.** Percent change in Kaplan-Meier mean TSP metal concentrations at each station from MATES IV to MATES V. Asterisks indicate station locations that moved between MATES IV and MATES V.

### V. Conclusion

The wide range of particulate measurements at fixed sites during MATES V allowed for the evaluation of changes in patterns of particulate pollution in the six years since MATES IV. In general, spatial and seasonal trends in PM<sub>2.5</sub> composition in the South Coast Air Basin remained similar to those observed in MATES IV. One key change in PM<sub>2.5</sub> composition was the substantial reduction in average elemental carbon concentrations throughout the basin. On a basin scale, toxic metal concentrations generally decreased or remained at similar levels to those measured in MATES IV, with the exception of a significant increase in average cadmium concentration. However, the overall contribution of cadmium to average population-weighted air toxics cancer risk is less than 1%, and contributions from cadmium to chronic non-cancer risk calculated at each monitoring station are also minimal (basin-wide average of 0.6%). Targeted control measures of both local and regional sources of particulate matter will lead to continued improvement in air quality and reduced health risks in the South Coast Air Basin.

## VI. References

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**APPENDIX XI**  
**MATES V**  
**FINAL REPORT**

**Monitoring Data Treatment Methodologies**

## Appendix XI

### Monitoring Data Treatment Methodologies

Measuring pollutants at low concentrations is more difficult than measuring pollutants at higher concentrations. Occasionally, the concentrations are so low that they are below the method detection limit (MDL). When this happens, we are only confident that the concentration could be as low as zero or as high as the MDL and is probably somewhere in between those two values. However, we cannot give a specific estimate of the concentration with any confidence when it is below the MDL. Every observation has a corresponding MDL. Laboratory technologies typically improve over time, and more recent observations tend to have lower MDLs than older observations. For example, the MDLs in the MATES V data are generally much lower than the MDLs in the MATES II data, see Appendix IV. Data with observations below the MDL are common in environmental data [1] and occur throughout the MATES data. Data below the detection limit are referred to as “nondetects” while data at or above the MDL are referred to as “detects”. Statistical methods are available to perform calculations on data that include nondetects, in order to draw appropriate conclusions regarding spatial or temporal trends.

As laboratory technologies have improved over time, the statistical methods for handling data with nondetects have also improved and the improved methods are becoming more widely used in the environmental sciences. The MATES V analyses follow the guidance provided in Singh et al. (2006) [2] and Helsel (2012) [1]. Singh et al., 2006 [2] is an in-depth U.S. EPA-commissioned report on the topic of handling environmental data below detection limits, the authors of which consulted Dennis Helsel, the author of multiple textbooks describing methods to handle environmental data with nondetects, including Helsel (2012) [1]. General guidance from Helsel (2012) for handling data with nondetects recommends not deleting or ignoring the data below the detection limit and avoiding substitution<sup>1</sup> (e.g.,  $0.5 \times \text{MDL}$ ) [1]. The analysis methods combine information about the proportions of nondetects with the numerical values of the data at or above the detection limit(s) [1].

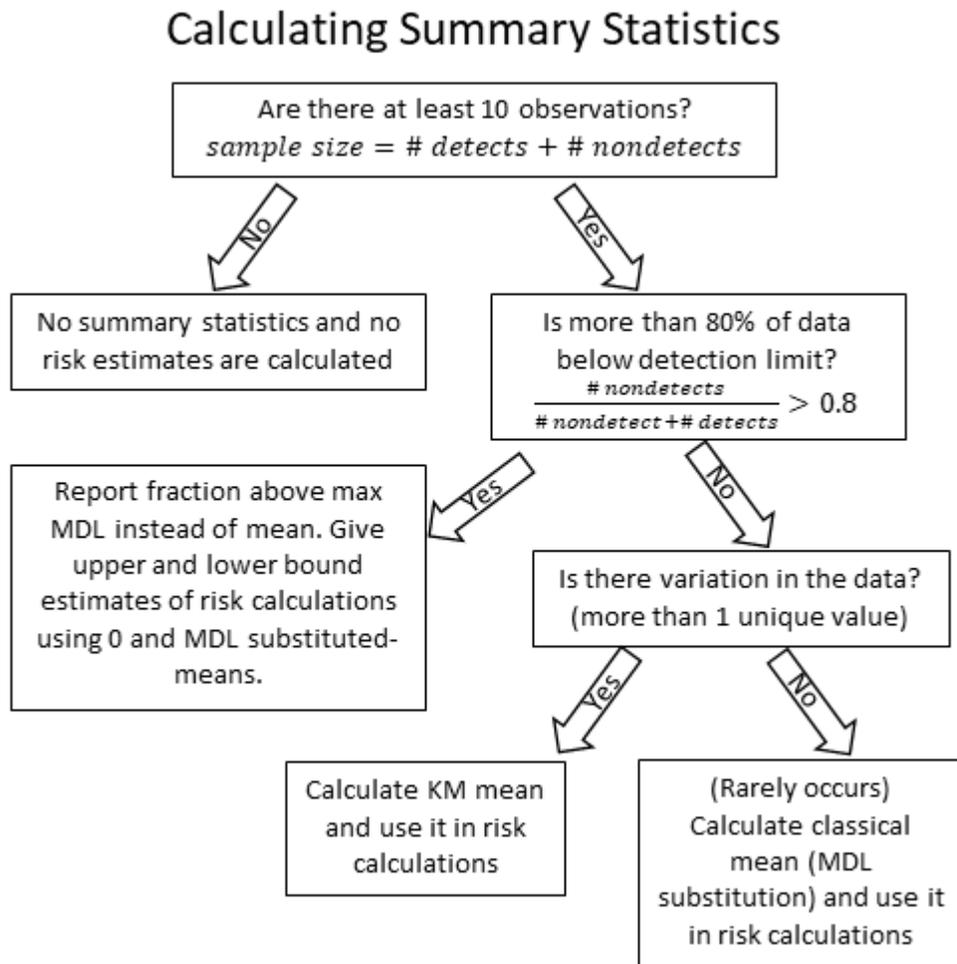
The analyses for MATES II, conducted in 2000, used  $0.5 \times \text{MDL}$  substitution to handle nondetects [3, pp. ES-7]. This approach was quite common and was endorsed by the U.S. EPA at the time [4]. Consistent with another EPA report [5], the analyses for MATES III (2008) and MATES IV (2015) reported specific values for data between the MDL and the Limit of Detection (LoD) and reported data below the LoD as zero [6, pp. Appendix VI-1, 7, pp. Appendix IV-1]. We updated our statistical methods for the MATES V measurement data analysis to make use of advancements in the science that are becoming more widely used for handling environmental data with nondetects. To be able to make direct comparisons of pollutant concentrations over time, MATES II through IV data are being re-analyzed alongside the MATES V data using these improved statistical methods.

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<sup>1</sup> Substitution is only recommended for averaging points in cases where all data points have the same MDL [1, p. xix].

Helsel (2012) outlines three broad approaches to handling data with nondetects: 1) Maximum Likelihood Estimation (MLE), 2) nonparametric methods with a single MDL (applying the highest MDL to all observations if there are multiple MDLs), or 3) nonparametric survival analysis methods [1]. The MLE methods require that the data fit an assumed distribution and either have a small percent of the data be nondetects or have outside knowledge with which to determine the distribution [1]. MLE methods have been shown to perform poorly for skewed data with sample sizes smaller than 70 [1, p. 65]. The MATES data does not consistently meet the requirements of the MLE methods, so the two nonparametric approaches, 2 and 3, are used in analyzing the MATES data.

Summary statistics were generally calculated using the Kaplan-Meier method with Efron's bias correction (from nonparametric survival analysis methods) since it is the most generally applicable of the methods presented in Helsel (2012) [1, p. 85] (See Figure 1). A minimum sample size (number of detects plus the number of nondetects) of 10 is required, otherwise no statistics are calculated [2, p. 91]. Mean concentrations were, in most cases, calculated using the Kaplan-Meier Mean (KM mean) equations in Section 3.11 of Singh et al. (2006) [2] with Efron's bias correction [1, pp. 74-75, 8, pp. 100, 118]. The first exception was when more than 80% of observations were nondetects. In this case, a single estimate of the mean cannot be made for risk calculations, and therefore, we report the percent of data above the maximum MDL instead of calculating an estimate of the mean [1, p. 93]. For the purposes of giving upper and lower bound estimates for the risk calculations, zero substitution and MDL substitutions were used to calculate classical means of concentrations for use in the risk calculations, analogous to the method mentioned in Helsel (2012) [1, p. 94]. The classical mean is used in the rare occurrence when all concentrations were identical because the algorithm in Section 3.11 of Singh et al. (2006) [2] breaks down if there is no variation in the data. This can occur when all concentrations are above the MDL and have the same value or when less than 80% of the data are nondetects and all detects have values equal to the MDL, both of which are rare occurrences. When all data are above their respective MDLs, the KM mean yields the same numerical value as the classical mean.



**Figure XIV-1:** Flow chart for determining how to calculate summary statistics and risk calculations for MATES data.

Calculations of confidence intervals follow guidance from Helsel (2012) [1] and Singh et al. (2006) [2]. Standard deviations and standard errors were calculated according to the equations in Singh et al. (2006) [2, pp. 31, 47]. The 95% confidence intervals were calculated using bootstrapping [1, pp. 103, 136-140]. Briefly, the KM mean is computed from a random sample of the data that is the same size as the data set. The random sampling is taken with replacement from the measurements, so that some measurements may be sampled multiple times while others may not have been sampled. This procedure is repeated 1000 times to give a distribution of KM mean estimates from 1000 random samples of the data. The 2.5<sup>th</sup> and 97.5<sup>th</sup> percentiles of the distribution of 1000 KM mean estimates provides the 95% confidence interval [1, pp. 103, 136-140]. The bootstrap 95% confidence intervals are only calculated if the data sample met the requirements to allow a KM mean to be calculated (See Figure 1). If a random sample had more than 80% of the data below the detection limit, then the KM mean cannot be calculated for that iteration and the classical mean using MDL substitution is used for that iteration instead of the KM mean. If none of the random samples used MDL substitution and the average of all of the KM mean estimates did not match the original non-boot-strapped KM mean within three

significant digits, then the bootstrap algorithm was run again with progressively larger number of random samples (up to a maximum of 50,000) until convergence was achieved, if possible. In the situation where the original data set had more than 80% below the detection limit and MDL and zero substitution were used to give upper and lower estimates as described in the paragraph above, bootstrapping was performed on the classical means for each the MDL and zero-substituted data sets to get the 95% confidence intervals for each.

For some MATES iterations (i.e., MATES II, III, IV, or V), some or all stations operated for more than a year. To calculate annual mean concentrations, the analysis was limited to data within the time periods shown in Table 1. MATES III was initially intended to collect observations during April 2004 through March 2005 and was extended for a second year due to heavy rainfall and concerns that the measurements would not represent typical meteorology. The MATES III final report presented annual averages for eight of the sites over the two-year monitoring period. Because the Huntington Park and Pico Rivera sites did not have a full second year of data, only data from the first year of measurements at these sites were used to calculate annual statistics [9, pp. ES-2, 10, pp. 1-1]. The current analysis uses the same averaging periods for each of the MATES III sites. In cases when there were multiple observations at a given station on a given day, the observations were merged by taking the (classical) mean of the replicate measurements prior to analyzing the data.

**Table XIV-1:** Date ranges for data included in this analysis.

<b>MATES Iteration</b>	<b>Start of data used</b>	<b>End of data used</b>
MATES II [11, pp. 1-2]	April 1998	March 1999
MATES III [9, pp. ES-2]	April 2004	March 2006
MATES IV [12, pp. Appendix X-1]	July 2012	June 2013
MATES V	May 2018	April 2019

## References

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**APPENDIX XII**

**MATES V**

**FINAL REPORT**

**Biomass Burning Contribution to PM<sub>2.5</sub> (Levoglucosan Data Analysis)**

## Appendix XII

### Biomass Burning Contribution to PM<sub>2.5</sub> (Levoglucosan Data Analysis)

#### XII.1. Introduction

MATES is a study that focuses on the measurement and modeling of ambient air toxics for the primary purpose of evaluating health risks due to air pollution. As part of MATES V, levoglucosan, a key tracer of wood smoke, was measured alongside other particulate species at all ten fixed monitoring sites. The addition of levoglucosan measurements provided insight into pollution sources that influence both basin-wide and localized health risks and also allowed for improvement to pollution forecast models to help residents minimize their exposures to air pollution.

Wood smoke from residential wood burning is an important source of wintertime fine particulate matter (PM<sub>2.5</sub>) in the South Coast Air Basin (South Coast Air Quality Management District, 2008) and concentrations are influenced by both meteorology and human behavior. Levoglucosan is a component of PM<sub>2.5</sub> produced during wood burning (Fine, et al., 2001) and was measured in the months leading up to and throughout the MATES V campaign from January 2018 to April 2019. The acquisition of levoglucosan data provided staff with the opportunity to create a forecasting tool specifically tailored to residential wood burning patterns in the Basin. Machine learning techniques were used to create a forecasting model for residential wood smoke based on levoglucosan observations during the MATES V period. The levoglucosan observations are referred to as the ‘training data’ for the model. The influence of meteorology on wood smoke concentrations is represented in the model by meteorological forecast data from the North American Mesoscale (NAM) model (National Centers for Environmental Information, 2020). The influence of human behavior on wood smoke concentrations is represented in the model by calendar-based patterns such as day of week and holidays. Levoglucosan concentrations are modeled with these predictor variables and then conversion factors are used to estimate the PM<sub>2.5</sub> concentrations due to wood smoke.

This forecast tool can be used to both estimate wood smoke concentrations on days without MATES V measurements and to predict concentrations on any day with NAM meteorological forecast data—up to three days into the future. South Coast AQMD staff issue a daily air quality forecast for the entirety of Los Angeles, Orange, San Bernardino, and Riverside counties, which takes into account forecasted concentrations of ozone, PM<sub>2.5</sub>, PM<sub>10</sub>, carbon monoxide, and nitrogen dioxide. Air quality forecasting models used by South Coast AQMD staff to issue the daily forecast do not completely account for the strong dependence of wood smoke PM<sub>2.5</sub> on calendar and meteorological parameters. However, the levoglucosan model can be used to improve PM<sub>2.5</sub> predictions during the winter months in the Basin as part of the daily air quality forecast.

## **XII.2. Background**

Levoglucosan (1,6-anhydro- $\beta$ -D-glucopyranose), a thermal degradation product of cellulose and hemicellulose, is a widely used tracer of biomass burning contributions to atmospheric particulate loading (Simoneit, 2002). Levoglucosan has been shown to be present at very high concentrations in fine particulate (PM<sub>2.5</sub>) emissions from both residential wood combustion (Schauer, et al., 2001; Fine, et al., 2002) and wildland biomass combustion (Sullivan, et al., 2008; Hosseini, et al., 2013), making it a robust indicator for key biomass burning processes in the Basin. Although particulate levoglucosan concentrations may be reduced by photochemical oxidation (Hennigan, et al., 2010; Hennigan, et al., 2011; Hoffmann, et al., 2010), this effect is mitigated by the dominance of local pollution sources and relatively short distances between monitors within the Basin (South Coast Air Quality Management District, 2016). Additionally, levoglucosan is more stable at cooler temperatures observed in winter (Pratap, et al., 2019) when residential wood burning is most common (South Coast Air Quality Management District, 2008). To date, several studies have incorporated levoglucosan into receptor modeling studies to better characterize the contribution of biomass burning/wood smoke to total PM<sub>2.5</sub> mass or PM<sub>2.5</sub> organic carbon in the Basin (South Coast Air Quality Management District, 2008; Heo, et al., 2013; Shirmohammadi, et al., 2016).

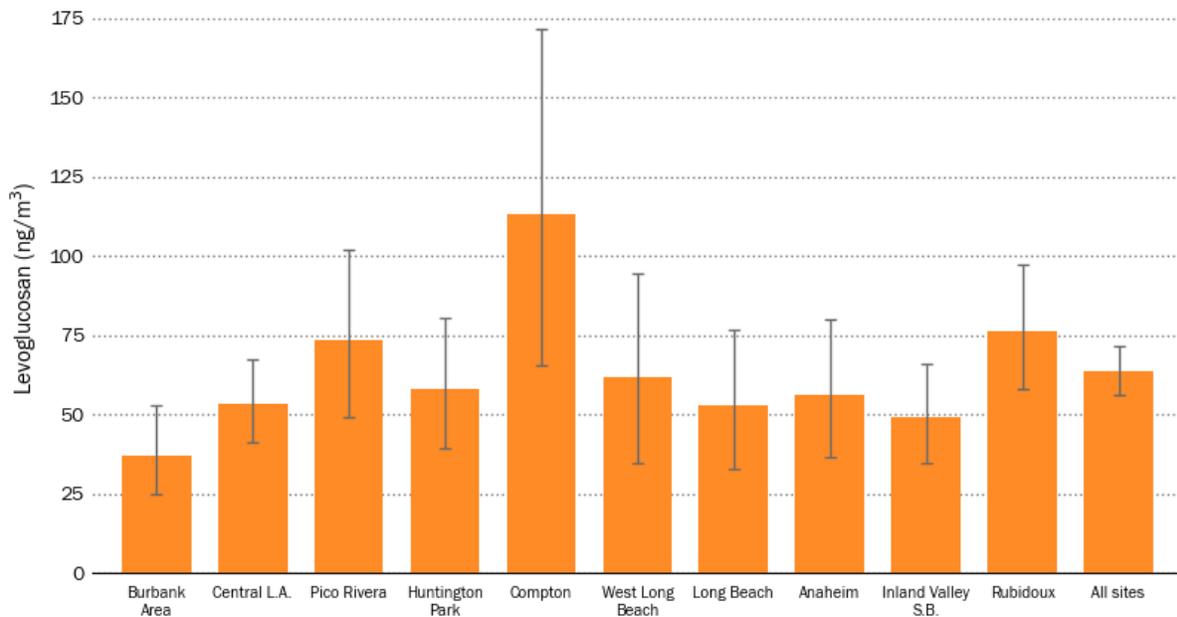
In addition to levoglucosan, other minor monosaccharide anhydrides produced during hemicellulose pyrolysis can provide further insight into the predominant biomass fuel type. The relative yields of levoglucosan and its isomers mannosan (1,6-anhydro- $\beta$ -D-mannopyranose) and galactosan (1,6-anhydro- $\beta$ -D-galactopyranose) have been shown to be characteristic of burns of different vegetation types (e.g., hardwood, softwood, grass, etc.) (Sullivan, et al., 2008; Fine, et al., 2004). Metrics such as the levoglucosan/mannosan ratio in particulates can thus be used to distinguish different biomass burning sources provided sources are derived from sufficiently distinct vegetation types.

## **XII.3. Levoglucosan Measurement Methods**

Levoglucosan and other monosaccharide anhydrides were analyzed using a method adapted from procedures described in (California Air Resources Board, 2015; Cordell, et al., 2014; Schauer & Sioutas, 2012). Fine particulate matter (PM<sub>2.5</sub>) for levoglucosan analysis was collected by ambient air filtration onto quartz fiber filters on a dedicated channel of a speciated air sampling system (SASS) PM<sub>2.5</sub> sampler at each site. Samples were collected on a 1-in-6 day schedule at all ten fixed MATES V sites except for Central L.A. and Rubidoux, where sampling frequency was increased to a 1-in-3 day schedule to better characterize temporal variability. Prior to analysis, filters were spiked with an internal standard (<sup>13</sup>C<sub>6</sub>-levoglucosan) and extracted by ultrasonication in acetonitrile. Extracts were then derivatized with a silanizing reagent to convert monosaccharide anhydrides to trimethylsilyl (TMS) derivatives suitable for gas chromatography-mass spectrometry (GC-MS) analysis. Samples were analyzed by GC-MS using a simultaneous selective ion monitoring (SIM)/full scan method and quantified by comparison to authenticated standards for each compound of interest. Further sampling and analytical details can be found in Appendix III.

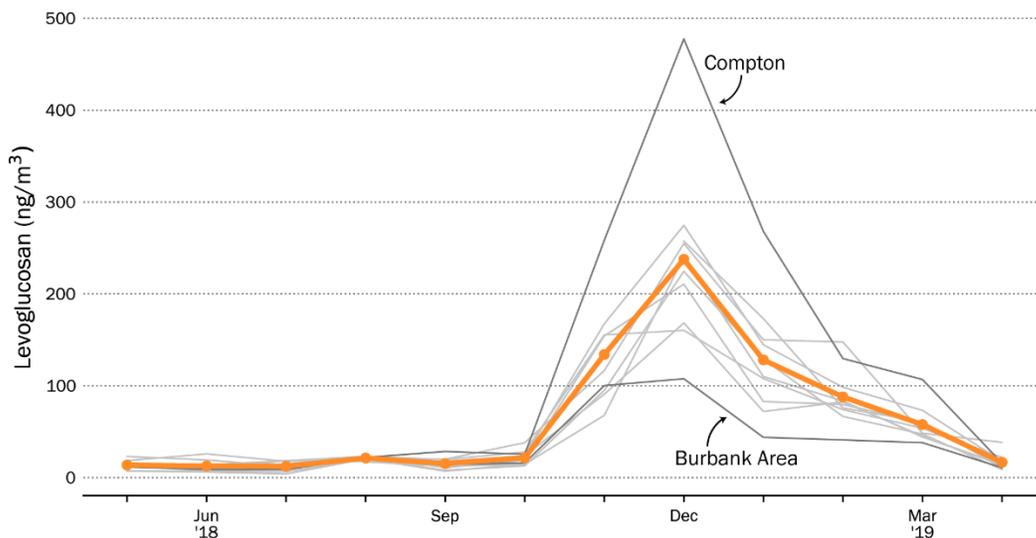
#### XII.4. Levoglucosan Observations

Average levoglucosan concentrations measured at each station over the MATES V analysis period (May 2018-April 2019) are shown in Figure XII-1. With the exception of Compton, average MATES V levoglucosan concentrations at all sites were generally comparable to site averages of 45-60 ng/m<sup>3</sup> measured during the second year of MATES III from May 2005 – April 2006 (South Coast Air Quality Management District, 2008).<sup>1</sup> As expected, levoglucosan concentrations at all sites were much higher during late fall/winter due to increased residential wood burning during cooler months (Figure XII-2). Late fall/winter levoglucosan concentrations at Compton were generally higher than concentrations measured at other sites, which could reflect increased wood burning in this area or closer proximity to a local biomass burning source. Average winter (December-February) mannosan/levoglucosan ratios ranged from 5.5 to 6.3 across the basin, which is consistent with softwood-dominated or mixed hardwood/softwood burning based on reported ranges in the literature ( Fabbri, et al., 2009) and references therein).



**Figure XII-1.** Kaplan-Meier mean levoglucosan concentrations measured at MATES V sites from May 2018 to April 2019. Error bars represent 95% confidence intervals of averages. The station name Inland Valley San Bernardino is abbreviated as Inland Valley S.B.

<sup>1</sup> Results from three sites (Huntington Park, Long Beach, and Pico Rivera) with incomplete levoglucosan MATES III Year 2 datasets are not included in this range.



**Figure XII-2.** Monthly average levoglucosan concentrations during MATES V monitoring period. Gray lines show monthly averages at individual sites, and bold orange line shows Basin (ten site) average.

Outside of the winter wood burning season, several peaks in levoglucosan concentrations coincided with local wildfires or smoke plumes from wildfires outside the Basin, although the magnitude of these peaks was variable. These events included transport of smoke into the basin from northern California wildfires on August 24, 2018 and from the Woolsey/Hill Fires in Ventura County and western Los Angeles County on November 10, 2018. Both events were marked by higher levoglucosan concentrations at sites in the western and coastal portions of the Basin, consistent with westerly transport of smoke into the SCAB. The Euclid Fire south of Chino also may have contributed to an elevated levoglucosan concentration of 108 ng/m<sup>3</sup> at Rubidoux on June 13, 2018 compared to a summer station average of 21 ng/m<sup>3</sup>.

### XII.5. Conversion Factors

Observed and model forecasted levoglucosan concentrations at each station were scaled by a conversion factor, defined as the ratio of wood smoke PM<sub>2.5</sub> to levoglucosan, to estimate total PM<sub>2.5</sub> mass due to wood smoke. This conversion factor is a major source of uncertainty for wood smoke PM<sub>2.5</sub> estimates since it depends on the fuel burned, the characteristics of the burn (e.g., combustion temperature, combustion efficiency), the age of the smoke, ambient temperature, and actinic flux (Fine, et al., 2001; Fine, et al., 2002; Fine, et al., 2004; Schauer, et al., 2001; Sullivan, et al., 2008; Kuo, et al., 2011; Hennigan, et al., 2011; Hoffmann, et al., 2010; Sang, et al., 2016; Pratap, et al., 2019). This uncertainty is represented in the variety of conversion factors ranging from 8.33 to 41.7 that were either reported in studies or calculated from several studies, see Table XII-1. To empirically constrain the wide range of conversion factors found in the literature, levoglucosan observations with co-located speciated PM<sub>2.5</sub> data

were analyzed. Several conversion factors reported in the literature produced calculated wood smoke PM<sub>2.5</sub> concentrations that were larger than the measured total PM<sub>2.5</sub>. A maximum empirical conversion factor could be determined by assuming that all of the PM<sub>2.5</sub> mass with the exception of soil, ammonium nitrate, and ammonium sulfate was wood smoke PM<sub>2.5</sub>. The smallest of these empirical conversion factors was used as the new upper-bound estimate of the conversion factors. The lowest conversion factor from the literature (Table XII-1) was used as a lower-bound estimate of the PM<sub>2.5</sub> due to wood smoke. The levoglucosan forecast model outputs a lower-bound estimate of the PM<sub>2.5</sub> due to wood smoke using the smallest conversion factor from the literature (8.33, see Table XII-1) and an upper-bound estimate of PM<sub>2.5</sub> due to wood smoke using the smallest empirical conversion factor (16.39).

Applying this conversion factor range to measured winter levoglucosan concentrations illustrates the potential significance of wood smoke contributions to total PM<sub>2.5</sub> mass in the SCAB. From December 2018-February 2019, the period during MATES V when residential wood burning would be expected to reach peak levels, levoglucosan alone constituted an average of 0.8-1.9% of total PM<sub>2.5</sub> mass measured at each site (Table XII-1). Winter levoglucosan/PM<sub>2.5</sub> mass ratios did not show any clear spatial trend, with average levoglucosan concentrations remaining relatively close to 1% of total mass at most sites. The only exception was at Compton, where levoglucosan represented a larger fraction of average winter PM<sub>2.5</sub> mass (1.9%). After applying the range of conversion factors determined above, observed levoglucosan concentrations would translate to wood burning contributions ranging from 7-32% (0.5-4.8  $\mu\text{g}/\text{m}^3$ ) of total winter PM<sub>2.5</sub> mass at individual sites, with a basin average of 11-21% (1.3-2.5  $\mu\text{g}/\text{m}^3$ ). These levoglucosan-based estimates are somewhat higher than estimated winter biomass burning contributions at Central L.A. and Rubidoux from 2002-2007 determined using a Positive Factorization Matrix (PMF) receptor model (Central L.A.: 1.7  $\mu\text{g}/\text{m}^3$ /8.3% PM<sub>2.5</sub> mass, Rubidoux: 1.0  $\mu\text{g}/\text{m}^3$ /5.0% PM<sub>2.5</sub> mass (Hasheminassab, et al., 2014)). However, this finding is consistent with a decrease in emissions from non-wood smoke PM<sub>2.5</sub> sources relative to wood smoke PM<sub>2.5</sub> sources.

**Table XII-1:** Conversion factors derived from literature for use in wood smoke model.

Conversion Factor	Citation	Notes
8.3333	(Fine, et al., 2001)	Calculated from numbers in the paper: "The results in Table 3 also indicate that almost all of the emitted fine particulate mass consists of organic compounds. Organic carbon contributes over 80% of the fine particle mass in the emissions from every wood species studied." "Between 3% and 12% of the fine particulate organic compound emissions are accounted for by levoglucosan"
9.01	(Busby, et al., 2016)	"We used a combination of the experimental and published values for $L_A$ , $L_B$ and $L_S$ to establish a low and a high estimate of the conversion factor. Using only the most relevant published results (Fine et al., 2004a) gives a [conversion factor] = 9.01, which is used here as a lower limit" " $L_A$ , $L_B$ , and $L_S$ are the levoglucosan mass fractions for aspen, birch, and spruce woodsmoke respectively."
10.4	(Busby, et al., 2016) (citations therein)	"Piazzalunga et al. (2011) generated conversion factors of 10.4 using literature values and 16.9 using [positive matrix factorization] in Italy."
10.4167	(Fine, et al., 2001)	Calculated from numbers in the paper: "The results in Table 3 also indicate that almost all of the emitted fine particulate mass consists of organic compounds. Organic carbon contributes over 80% of the fine particle mass in the emissions from every wood species studied." "Between 3% and 12% of the fine particle organic compound emissions are accounted for by levoglucosan"
10.7	(Busby, et al., 2016) (citations therein)	"Schmidl et al. (2008) and Caseiro et al. (2009) measured, reported and used a conversion factor of 10.7 to calculate wood smoke particulate from levoglucosan."
10.7	(Busby, et al., 2016) (citations therein)	"Herich et al. (2014) compared results for multiple studies in alpine regions of Europe and found that wood smoke PM to levoglucosan ratios varied from 10.7 to 25.2."
10.72	(Busby, et al., 2016)	"Using all data and the minimum and maximum wood smoke PM <sub>2.5</sub> estimates from the [carbon-14 analysis methods] data yielded [conversion factor] = $10.72 \pm 0.61$ and $12.91 \pm 0.74$ , respectively."
11.31	(Busby, et al., 2016)	slope of [carbon-14 analysis methods] vs levoglucosan, removing the highest point
11.45	(Busby, et al., 2016)	"Another approach is to calculate and average the ratios of wood smoke PM <sub>2.5</sub> to levoglucosan for each sample. Using minimum and maximum estimates for wood smoke PM <sub>2.5</sub> from the

		[carbon-14 analysis methods] data yielded mean [conversion factor] values of $11.45 \pm 0.89$ and $13.8 \pm 1.1$ , respectively."
11.46	(Busby, et al., 2016)	slope of [carbon-14 analysis methods] vs levoglucosan, removing the 4 highest points
11.82	(Busby, et al., 2016)	"analyses. Fig. 2(b) demonstrates a high correlation between the levoglucosan and [carbon-14 analysis methods] measures with a slope ([conversion factor]) of $11.82 \pm 0.67$ ( $r^2 = 0.97$ , $F = 1257$ , $n = 40$ )."
12.2	(Busby, et al., 2016)	"device type data by zip code was utilized together with wood species survey data to generate site-specific [conversion factor] values weighted for both wood species and device type. These conversion factors, calculated using LB and LS from Table 3 and the published value for LA, ranged from 12.2–12.4. There was significant concern about these site-specific results because of the combined uncertainties in L values, wood species usage, and stove type usage. Because of this, and because they are bracketed by [lower and upper bound conversion factors], they were not used for additional calculations."
12.4	(Busby, et al., 2016)	"device type data by zip code was utilized together with wood species survey data to generate site-specific [conversion factor] values weighted for both wood species and device type. These conversion factors, calculated using LB and LS from Table 3 and the published value for LA, ranged from 12.2–12.4. There was significant concern about these site-specific results because of the combined uncertainties in L values, wood species usage, and stove type usage. Because of this, and because they are bracketed by [lower and upper bound conversion factors], they were not used for additional calculations."
12.91	(Busby, et al., 2016)	"Using all data and the minimum and maximum wood smoke PM2.5 estimates from the [carbon-14 analysis methods] data yielded [conversion factor] = $10.72 \pm 0.61$ and $12.91 \pm 0.74$ , respectively."
13.3	(Busby, et al., 2016)	"An upper limit [conversion factor] was calculated using the average experimental values for LB and LS from Table 3 over all burn conditions and the published value of LA. The resulting [conversion factor] = 13.3 is strongly influenced (43%) by the published value for aspen."
13.8	(Busby, et al., 2016)	"Another approach is to calculate and average the ratios of wood smoke PM2.5 to levoglucosan for each sample. Using minimum and maximum estimates for wood smoke PM2.5 from the [carbon-14 analysis methods] data yielded mean [conversion factor] values of $11.45 \pm 0.89$ and $13.8 \pm 1.1$ , respectively."
15.12	(Busby, et al., 2016)	"wood smoke PM2.5 concentration estimated from [chemical mass balance] is plotted vs the measured levoglucosan levels ..."

		"Separate regression of the results at the three sites yields slopes of $15.12 \pm 0.39$ ( $r^2 = 0.96$ , $F = 1470$ , $n = 57$ ), $23.3 \pm 2.2$ ( $r^2 = 0.89$ , $F = 464$ , $n = 58$ ) and $19.8 \pm 2.5$ ( $r^2 = 0.84$ , $F = 245$ , $n = 46$ ) at the North Pole, Peger Rd., and State Building sites, respectively. The slopes are estimates of the [conversion factor] values assuming that [chemical mass balance] modeling provides an accurate estimate of wood smoke PM <sub>2.5</sub> ."
16.9	(Busby, et al., 2016) (citations therein)	"Piazzalunga et al. (2011) generated conversion factors of 10.4 using literature values and 16.9 using [positive matrix factorization] in Italy."
18.3	(Busby, et al., 2016) (citations therein)	"Zhang et al. (2010a) used [positive matrix factorization] to obtain a conversion factor of 18.3 for the southeastern US"
19.8	(Busby, et al., 2016)	"wood smoke PM <sub>2.5</sub> concentration estimated from [chemical mass balance] is plotted vs the measured levoglucosan levels ... "Separate regression of the results at the three sites yields slopes of $15.12 \pm 0.39$ ( $r^2 = 0.96$ , $F = 1470$ , $n = 57$ ), $23.3 \pm 2.2$ ( $r^2 = 0.89$ , $F = 464$ , $n = 58$ ) and $19.8 \pm 2.5$ ( $r^2 = 0.84$ , $F = 245$ , $n = 46$ ) at the North Pole, Peger Rd., and State Building sites, respectively. The slopes are estimates of the [conversion factor] values assuming that [chemical mass balance] modeling provides an accurate estimate of wood smoke PM <sub>2.5</sub> ."
23.3	(Busby, et al., 2016)	"wood smoke PM <sub>2.5</sub> concentration estimated from [chemical mass balance] is plotted vs the measured levoglucosan levels ... "Separate regression of the results at the three sites yields slopes of $15.12 \pm 0.39$ ( $r^2 = 0.96$ , $F = 1470$ , $n = 57$ ), $23.3 \pm 2.2$ ( $r^2 = 0.89$ , $F = 464$ , $n = 58$ ) and $19.8 \pm 2.5$ ( $r^2 = 0.84$ , $F = 245$ , $n = 46$ ) at the North Pole, Peger Rd., and State Building sites, respectively. The slopes are estimates of the [conversion factor] values assuming that [chemical mass balance] modeling provides an accurate estimate of wood smoke PM <sub>2.5</sub> ."
25.2	(Busby, et al., 2016) (citations therein)	"Herich et al. (2014) compared results for multiple studies in alpine regions of Europe and found that wood smoke PM to levoglucosan ratios varied from 10.7 to 25.2."
33.3333	(Fine, et al., 2001)	Calculated from numbers in the paper: "The results in Table 3 also indicate that almost all of the emitted fine particulate mass consists of organic compounds. Organic carbon contributes over 80% of the fine particle mass in the emissions from every wood species studied." "Between 3% and 12% of the fine particulate organic compound emissions are accounted for by levoglucosan"

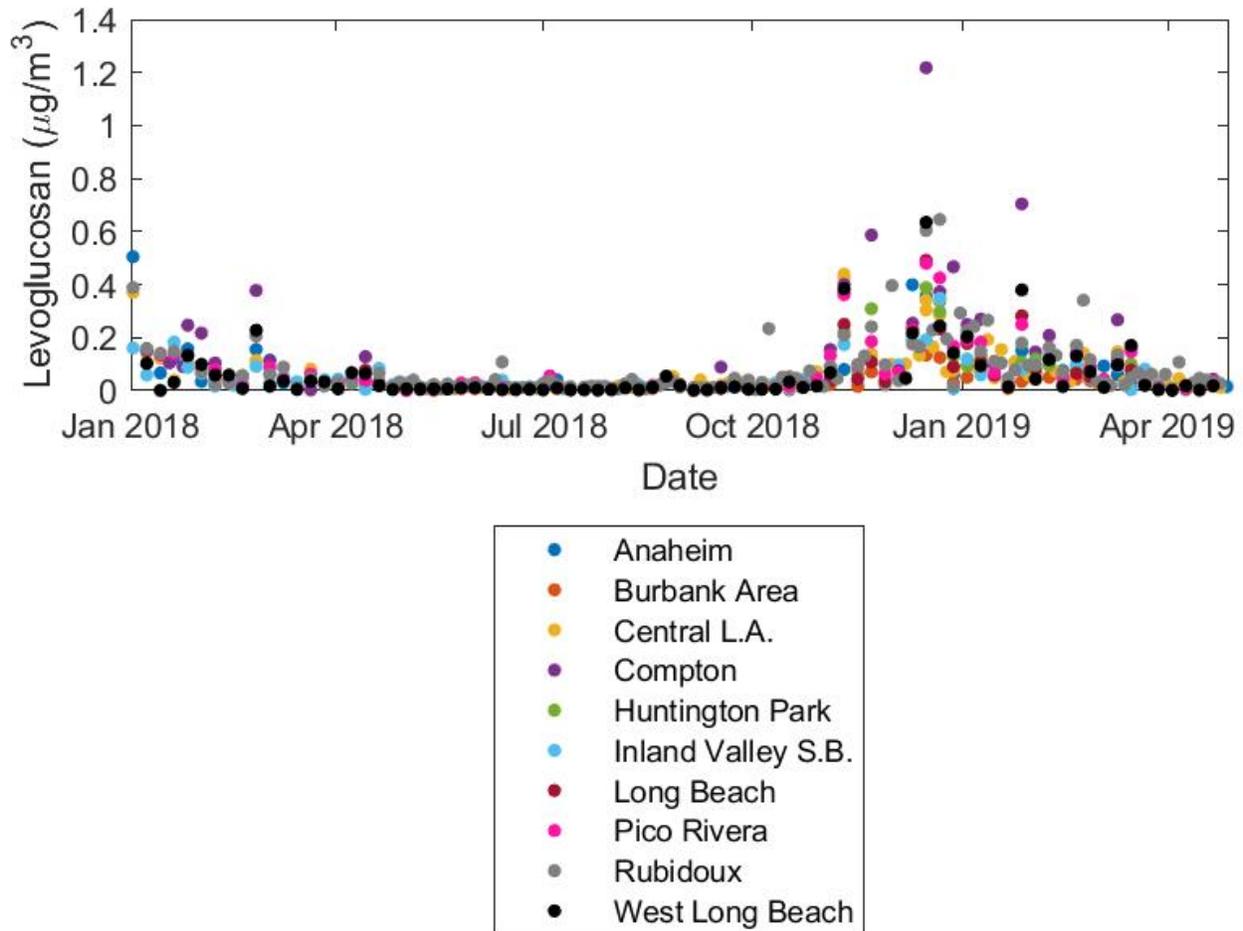
35.25	(Villalobos, et al., 2017)	Calculated from numbers in the paper: "wood burning is responsible for 84.6%", "The mean levoglucosan/PM2.5 ratio (0.021) is similar to the ratio found in Santiago (0.024)". $Lev/PM2.5_{tot} = 0.024$ , $PM2.5_{wood}/PM2.5_{tot} = 0.846$ , solve for $PM2.5_{wood}$ , which gives a conversion factor of $0.846/0.024 = 35.25$
40.29	(Villalobos, et al., 2017)	Calculated from numbers in the paper: "wood burning is responsible for 84.6%", "The mean levoglucosan/PM2.5 ratio (0.021) is similar to the ratio found in Santiago (0.024)". $Lev/PM2.5_{tot} = 0.021$ , $PM2.5_{wood}/PM2.5_{tot} = 0.846$ , solve for $PM2.5_{wood}$ , which gives a conversion factor of $0.846/0.021 = 40.29$
41.6667	(Fine, et al., 2001)	Calculated from numbers in the paper: "The results in Table 3 also indicate that almost all of the emitted fine particulate mass consists of organic compounds. Organic carbon contributes over 80% of the fine particle mass in the emissions from every wood species studied." "Between 3% and 12% of the fine particulate organic compound emissions are accounted for by levoglucosan"

**Table XII-2.** Average winter (December 2018-February 2019) PM<sub>2.5</sub> and levoglucosan concentrations and estimated biomass burning contributions to total PM<sub>2.5</sub> at MATES V sites. Low and high estimates were calculated with levoglucosan-PM<sub>2.5</sub> conversion factors of 8.33 and 16.4, respectively.

Station	PM <sub>2.5</sub> mass (μg/m <sup>3</sup> )	Levoglucosan (ng/m <sup>3</sup> )	Levoglucosan/PM <sub>2.5</sub> (%)	Estimated biomass burning PM <sub>2.5</sub> (μg/m <sup>3</sup> )		Estimated biomass burning contribution to total PM <sub>2.5</sub> (%)	
				Low	High	Low	High
Burbank Area	7.76	64	0.83	0.53	1.1	6.9	14
Central L.A.	10.71	127	1.18	1.1	2.1	9.8	19
Pico Rivera	13.53	178	1.31	1.5	2.9	11	22
Huntington Park	12.55	124	0.99	1.0	2.0	8.3	16
Compton	15.10	292	1.93	2.4	4.8	16	32
West Long Beach	13.82	168	1.22	1.4	2.8	10	20
Long Beach	11.94	140	1.17	1.2	2.3	9.8	19
Anaheim	12.48	145	1.16	1.2	2.4	9.6	19
Inland Valley S.B.	10.82	108	0.99	0.90	1.8	8.3	16
Rubidoux	12.66	188	1.48	1.6	3.1	12	24
Basin Average	12.14	153	1.26	1.3	2.5	11	21

**XII.6. Model Training Data**

Levoglucosan observations included the measurements made at 10 stations from May 2018 through April 2019, and additional measurements during the lead-up period to MATES V (January-April 2018). All of these measurements were incorporated into a training set for a new wood smoke forecasting model. Four levoglucosan observations were removed from the training set because they were impacted by smoke according to Hazard Mapping System (HMS) smoke plume data (National Oceanic and Atmospheric Administration Office of Satellite and Product Operations, 2020; NOAA OSEPO, 2020), and thus not representative of residential wood burning. Three additional observations were removed due to missing data from the NAM weather model (National Centers for Environmental Information, 2020). The data for 9% of randomly-selected dates with observations were separated as a held-out data set to be used for model verification. The held-out data set contained 57 observations. The final training data set contained 854 observations. Figure XII-3 shows the time series of levoglucosan measurements by station.



**Figure XII-3:** Time series of levoglucosan measurements by station.<sup>2</sup> The station name Inland Valley San Bernardino is abbreviated as Inland Valley S.B.

### XII.7. Model Configuration

Matlab's Regression Learner<sup>®</sup> software (MathWorks, 2020) was used to train the model. First, several built-in algorithms were implemented with all predictor variables to help identify the best performing algorithm. The exponential Gaussian Process Regression (Exponential GPR) algorithm had the lowest root mean squared error (RMSE). After determining the best performing algorithm, the number of predictor variables was reduced empirically from an initial list of 33 predictor variables by removing one at a time and re-training the Exponential GPR algorithm. Removing variables can improve model performance due to collinearities among predictor variables or predictor variables not being strongly related to levoglucosan concentrations. If the RMSE improved without a variable, that variable was permanently left out

<sup>2</sup> One data point (Rubidoux on 10/8/2018) was invalidated after the model was operational for the 2019-2020 winter season. The invalidation of one data point in the training data is likely to cause only a minor change in the model.

of the training and the next variable was tried. This process led to a final list of 21 predictor variables included in the training (see Table XII-3).

### **XII.8. Predictor Variables**

The model is trained to create forecasts for the 10 stations that were in the training data using 21 predictor variables, see Table XII-3 and Figure XII-4 - Figure XII-5. Station is a categorical variable indicating the name of the monitoring station, and the levoglucosan forecasts are made only at the stations with levoglucosan measurements. This variable serves as a proxy for characteristics and emission patterns of the area around each monitor. The remaining predictor variables are either calendar-based (determined by day of week, proximity to holiday, etc.) or meteorologically-driven, based on the North American Mesoscale Forecast System at a resolution of 12 km (12 km NAM) (National Centers for Environmental Information, 2020). Since the 12 km NAM model provides a forecast out to 84 hours, the levoglucosan model can be used to create a 3-day forecast.

The meteorological forecast data for the station locations were extracted by using data in the grid cell in which each monitor is located. The naming convention for the meteorological variables is that “TodayEve” variables describe a summary of the weather during 4 PM – 11 PM of the evening before the forecasted date. This is because the weather variables that promote an accumulation of PM<sub>2.5</sub> (such as low planetary boundary height and calm winds) the evening before the forecasted date will promote higher PM<sub>2.5</sub> concentrations the next day. “Tomorrow” in variable names indicates that the variable is a summary of the forecasted weather for the date of the forecast.

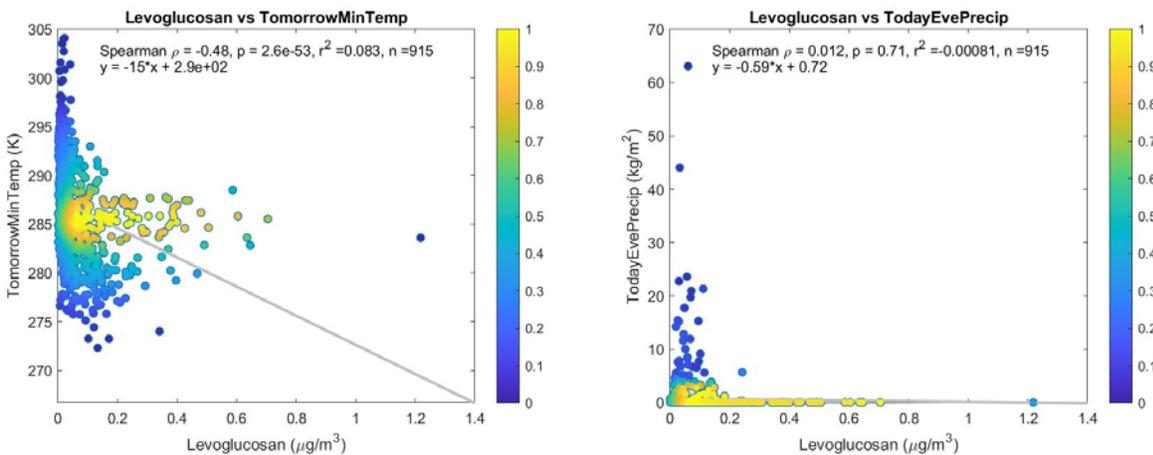
The variables used in the final version of the model and their descriptions are presented in Table XII-3. The following variables were empirically removed as predictor variables for the levoglucosan model: DayOfWeekName, Eve, TodayEveMinTemp, TodayEveMaxTemp, TodayEveRH, TodayEveUwind, TodayEveVent, TomorrowDSWRF, TomorrowMaxTemp, TomorrowPBH, TomorrowPrecip, and CumulativePM25Factors. These variables follow the naming conventions established in Table XII-3. The variable “Eve” is a categorical (binary) variable indicating if the date to be forecasted was December 24 or December 31 (‘Yes’) or any other day (‘No’). “CumulativePM25Factors” is analogous to “CumulativeFactors,” except that it is based on PM<sub>2.5</sub> instead of levoglucosan.

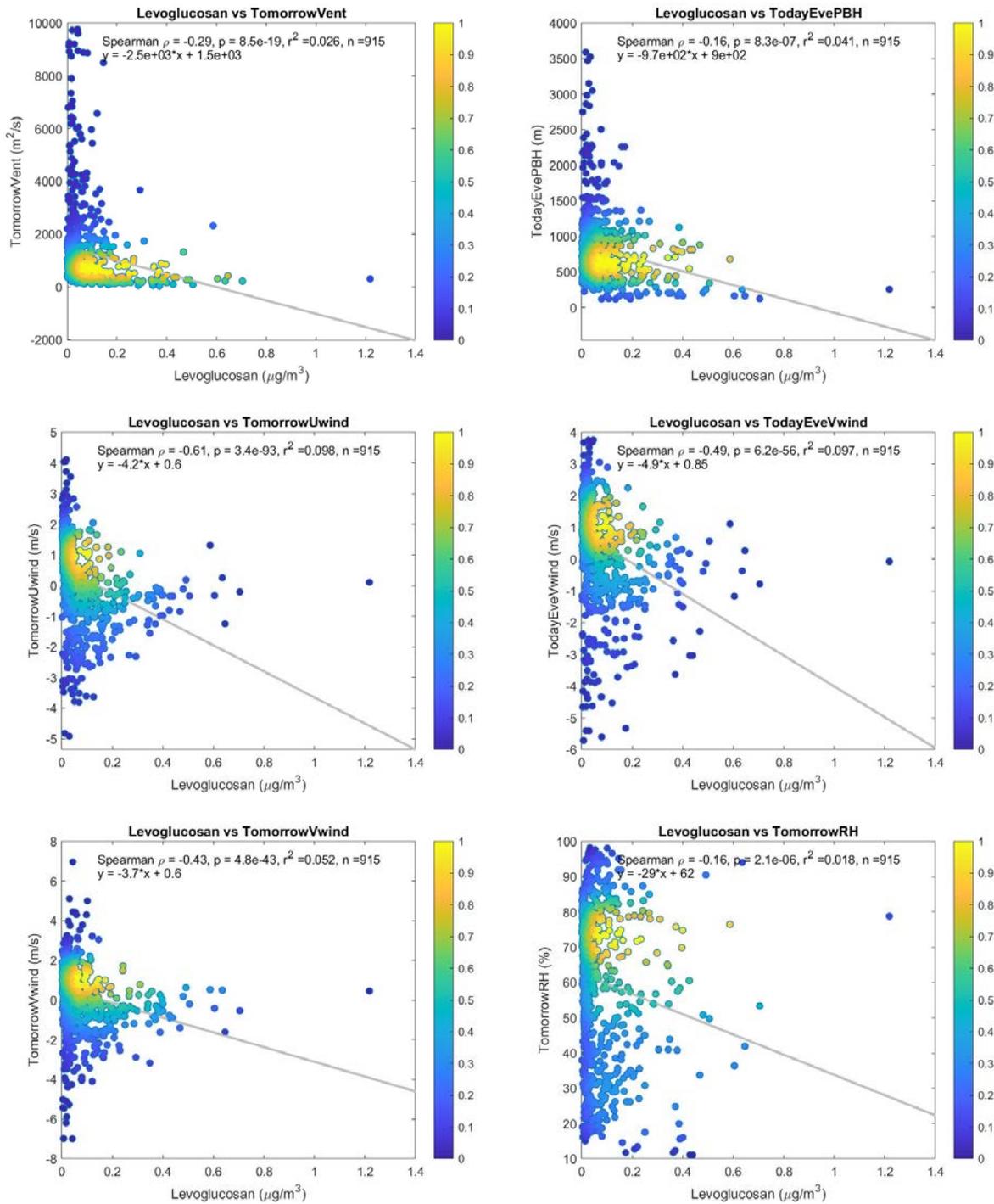
**Table XII-3:** Predictor Variables for Levoglucosan Forecast Model.

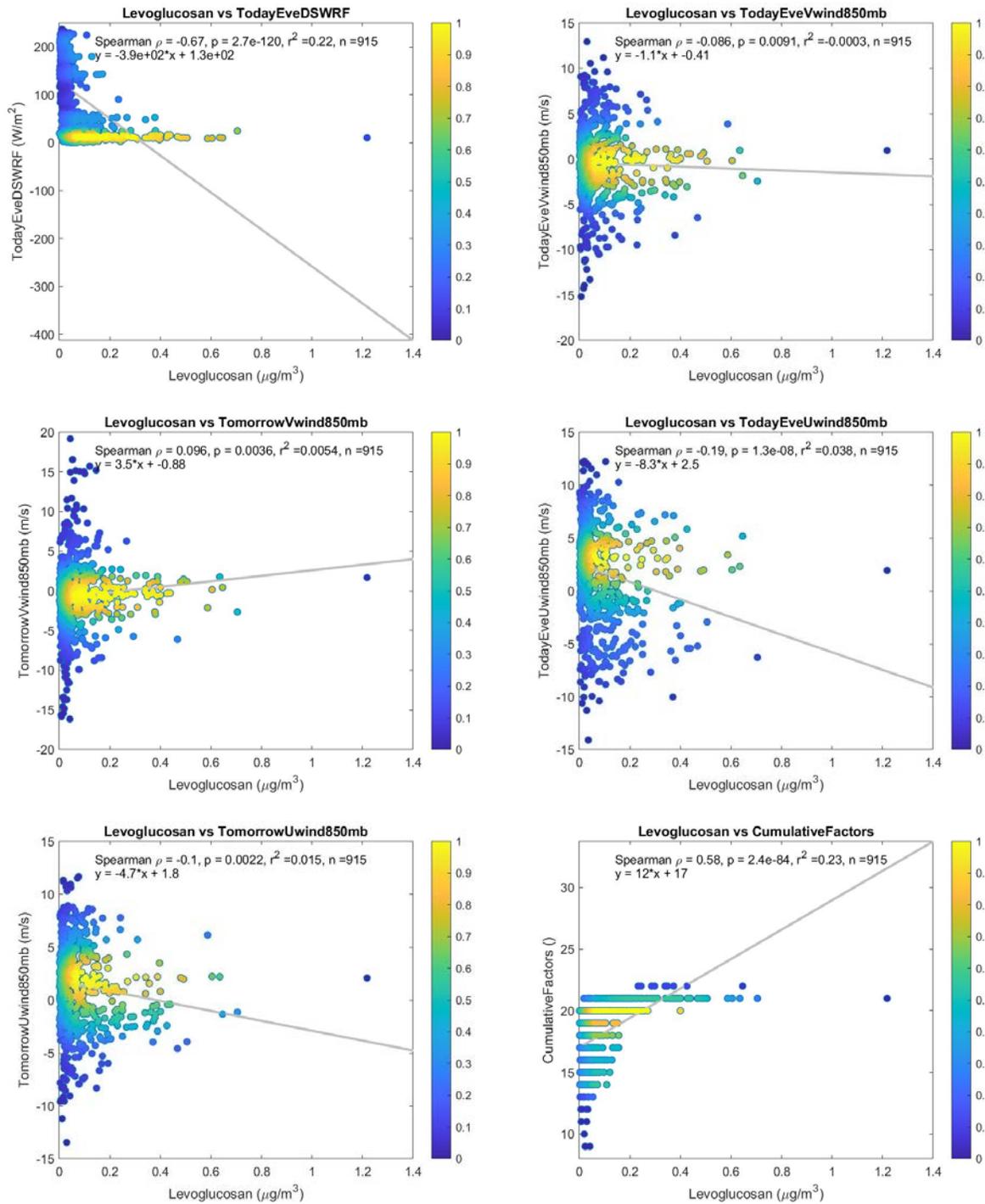
<b>Variable</b>	<b>Description</b>
Station	Station is a categorical variable indicating the name of the monitoring station. This variable serves as a proxy for characteristics and emission patterns of the area around each monitor.
TomorrowMinTemp	TomorrowMinTemp indicates the minimum temperature at 2 m above ground forecasted during the day of the forecast in the NAM 12 km model grid cell containing the station.
TodayEvePrecip	TodayEvePrecip is a summation of forecasted precipitation during 4 PM – 11 PM on the day before the forecast.
TomorrowVent	TomorrowVent is the average ventilation rate of the planetary boundary layer for the forecasted date.
TodayEvePBH	TodayEvePBH is the maximum planetary boundary height during 4 PM – 11 PM the day before the forecasted date.
TomorrowUwind	TomorrowUwind is the average of the east/west component of the wind at a height of 10 m above ground level for the forecasted date.
TodayEveVwind	TodayEveVwind is the average of the north/south component of the wind at height of 10 m above ground level during 4 PM – 11 PM the day before the forecasted date.
TomorrowVwind	TomorrowVwind is the average of the north/south component of the wind at a height of 10 m above ground level for the forecasted date.
TomorrowRH	TomorrowRH is the average relative humidity at a height of 2 m above ground level for the forecasted date.
TodayEveDSWRF	TodayEveDSWRF is the average downwelling shortwave radiation flux (i.e., sunlight) during 4 PM – 11 PM the day before the forecasted date.
TodayEveVwind850mb	TodayEveVwind850mb is the average north/south component of the wind at an altitude of 850 mb during 4 PM – 11 PM the day before the forecasted date.
TomorrowVwind850mb	TomorrowVwind850mb is the average north/south component of the wind at an altitude of 850 mb for the forecasted date.
TodayEveUwind850mb	TodayEveUwind850mb is the average east/west component of the wind at an altitude of 850 mb during 4 PM – 11 PM the day before the forecasted date.
TomorrowUwind850mb	TomorrowUwind850mb is the average east/west component of the wind at an altitude of 850 mb for the forecasted date.
TodayEveMinTempCat	TodayEveTempCat is a categorical variable with value ‘cold’ if TodayEveMinTemp is at or below 288 K and warm otherwise.
TomorrowMaxTempCat	TomorrowMaxTempCat is a categorical variable with value ‘cold’ if TomorrowMaxTemp is at or below 297 K and warm otherwise.

MonthName	MonthName is a categorical variable indicating the month.
Weekend	Weekend is a categorical variable indicating if a day is a weekday or part of the weekend.
HolidayType	HolidayType is a categorical variable indicating if a day was a major holiday, minor holiday, or not a holiday.
ProximityToMajorHoliday	ProximityToMajorHoliday is 0 on major holidays, -1 the day before and after a major holiday, -2 two days before or after a major holiday, or -3 three days before or after a major holiday. All other days are -4 with the assumption that holiday-related activities only influence residential wood burning patterns within three days before or after a holiday.
CumulativeFactors	CumulativeFactors is an integer variable that indicates how closely the meteorological conditions resemble aggregate descriptions of the weather conditions corresponding to the highest 10% levoglucosan concentrations. For example, if TomorrowMinTemp for a date of interest was less than the highest TomorrowMinTemp corresponding to the highest 10% of levoglucosan measurements, CumulativeFactors would be increased by 1. CumulativeFactors is increased by 1 if ProximityToMajorHolidays is greater than -4. CumulativeFactors is also increased by 1 for weekends. The maximum value for CumulativeFactors would be 22.

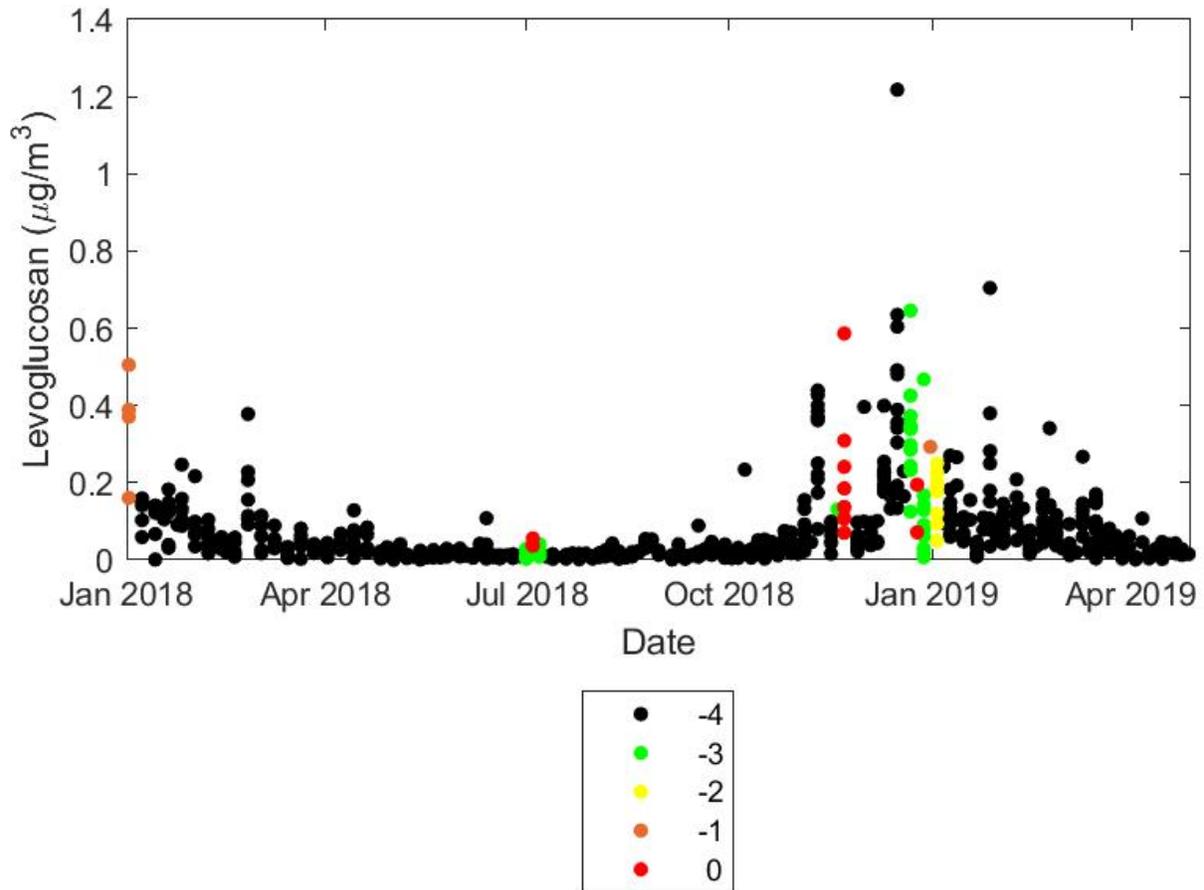
Figure XII-4 illustrates how each of the non-categorical predictors vary with levoglucosan concentration. Figure XII-5 shows the time series of levoglucosan concentration and the ProximityToMajorHoliday variable.







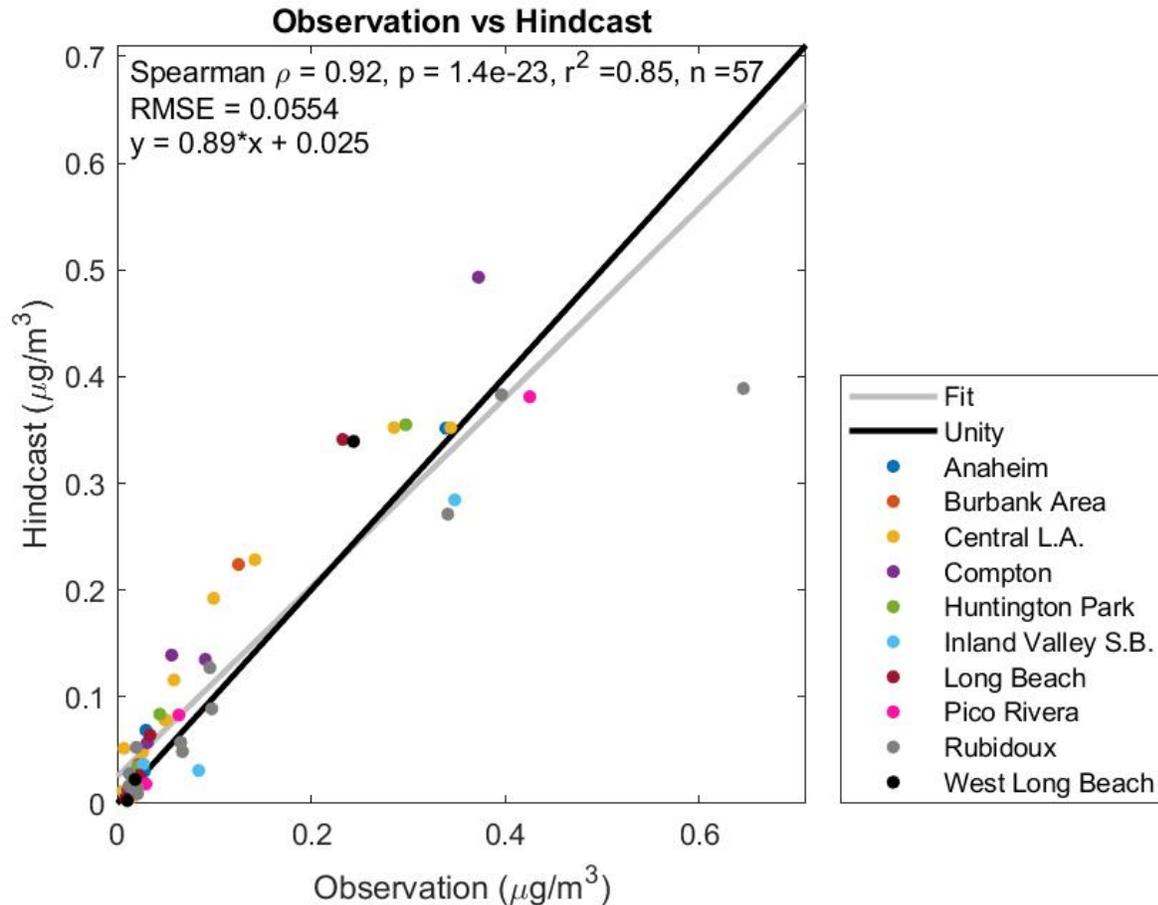
**Figure XII-4:** Density scatter plots of levoglucosan and the weather variables in Table XII-3. The color bars indicate the relative density of data points next to each other, as data can be plotted on top of each other in scatter plots.



**Figure XII-5:** Time series of Proximity to Major Holiday variable. The different colored dots represent the number of days before or after a major holiday, with 0 being the holiday date, -1, -2, and -3 being one, two, or three days before or after a major holiday, respectively. All other days are considered “-4”, with the assumption that holiday-related activities only influence residential wood burning patterns within three days before or after a holiday.

### XII.9. Model Performance

The training used 10-fold cross validation, and the Regression Learner application calculated an RMSE of 0.049  $\mu\text{g}/\text{m}^3$  and an R-squared of 0.73. Figure XII-6 shows the scatter plot of the 57 held-out data points and the corresponding prediction from the model (hindcast). The RMSE and R-squared for the held-out data set are 0.0554 and 0.85, respectively.



**Figure XII-6:** Scatter plot of held-out observations and corresponding predictions (hindcast). The station name Inland Valley San Bernardino is abbreviated as Inland Valley S.B.

### XII.10. Application to Daily Air Quality Forecasts

While residential wood smoke may contribute significantly to PM<sub>2.5</sub> concentrations on certain days in the winter months, emission inventories for PM<sub>2.5</sub> chemical transport forecasting models apportion wood smoke based on a static temporal profile that is not dependent on meteorology. Wood smoke PM<sub>2.5</sub> predictions from other forecasting models used by South Coast AQMD staff to issue daily forecasts also have high levels of uncertainty because of their inability to capture the human behavioral influence on burning patterns. In order to improve winter-time predictions of total PM<sub>2.5</sub>, the midpoint of the upper- and lower-bound estimates of wood smoke PM<sub>2.5</sub> from the levoglucosan model is used in a weighted ensemble of PM<sub>2.5</sub> forecast models to improve predictions of total PM<sub>2.5</sub> when widespread residential wood burning occurs.

### **XII.11. Multi-Year Time Series**

The levoglucosan model predictions can be generated for any day for which the predictor variables can be calculated, i.e., any day for which the NAM data is available. Residential wood burning patterns may gradually change over the course of several years, which means that the model will need to be trained with new levoglucosan measurement data. However, residential wood burning patterns are unlikely to change substantially over the course of a few years. As such, staff has run the levoglucosan model backward in time to create retrospective forecasts starting on January 1, 2017 through the start of the on-going operational model runs, resulting in a time series from January 1, 2017 through January 1, 2021.

This multi-year time series of levoglucosan model predictions has been used to help guide outreach efforts for the Check Before You Burn Initiative related to Rule 445 (South Coast Air Quality Management District, 2013; South Coast Air Quality Management District, 2020). To achieve this goal, we used levoglucosan model wood smoke PM<sub>2.5</sub> predictions during the 2020-2021 and 2019-2020 Check Before You Burn seasons (November to February) to estimate the impact of wood burning on the annual mean PM<sub>2.5</sub> concentration and the 98<sup>th</sup> percentile of daily PM<sub>2.5</sub> concentrations—two important statistics for the PM<sub>2.5</sub> federal standards. Outreach was prioritized in communities with higher PM<sub>2.5</sub> concentrations along with a larger contribution from residential wood smoke.

### **XII.12. Conclusion**

Analysis of measured levoglucosan concentrations has provided critical insight into the spatial and temporal trends of wood smoke throughout the South Coast Air Basin. Development of a machine learning model with the levoglucosan measurements has improved the accuracy of wintertime forecasts and allowed for prioritization of outreach for the Check Before You Burn program in communities most impacted by residential wood smoke.

### **XII.13. References**

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**APPENDIX XIII**  
**MATES V**  
**FINAL REPORT**

**Black Carbon and Elemental Carbon Comparison**

## Appendix XIII

### Black Carbon and Elemental Carbon Comparison

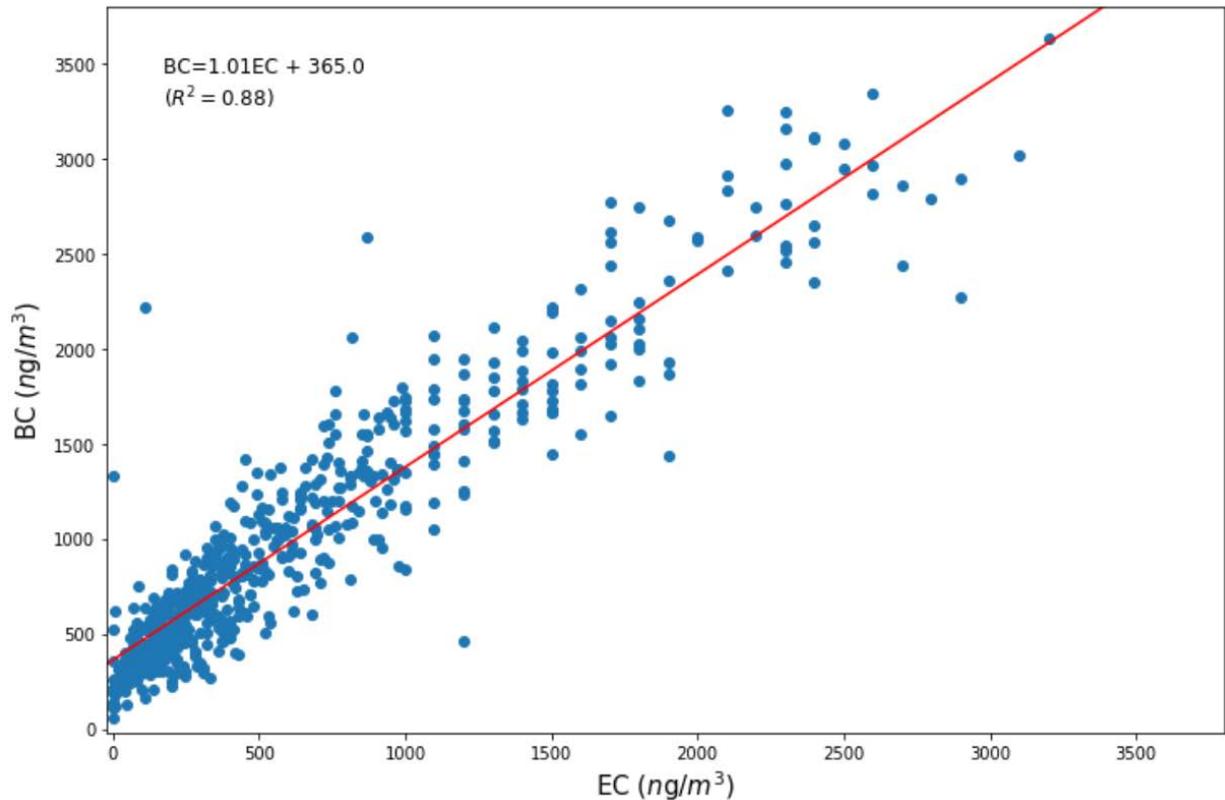
#### XIII.1 Introduction

During MATES V, continuous black carbon (BC) monitors (i.e. AE33 Aethalometers) and 24-hr integrated speciation samplers (i.e. SASS; used to collect the particle samples that were then analyzed for EC and other major components of  $PM_{2.5}$ ) were operated at all sites. Both samplers were operated in air-conditioned trailers through  $PM_{2.5}$  inlets, approximately 10 m above the ground level and subsequently, the quartz-fiber filters were analyzed for organic carbon (OC) and elemental carbon (EC). More information about sampling procedures is available in Appendix VI.

BC concentrations are derived through a light absorption process correlated with the deposited soot particles on the filter while EC represents a thermally refractory portion of the carbon measured based on the preferential oxidation. Although EC and BC are operationally defined based on the measurement method used and are not considered measurements of the same species, they are generally highly correlated (Lack et al., 2014). A few studies have directly compared BC and EC measurements and investigated the relationship between them (Cesari et al., 2018; Jeong et al., 2004; Mousavi et al., 2018; Sharma et al., 2004). Such comparisons usually indicate satisfactory correlation coefficients but various degrees of bias (slope). This is probably related to the choice of the coefficients used to convert absorption measurements to BC estimates or to assumptions inherent in the thermal-optical methods used to measure EC and different instruments used in each study. In this appendix, the results from simultaneous EC and BC measurements are compared with each other and their correlation is investigated.

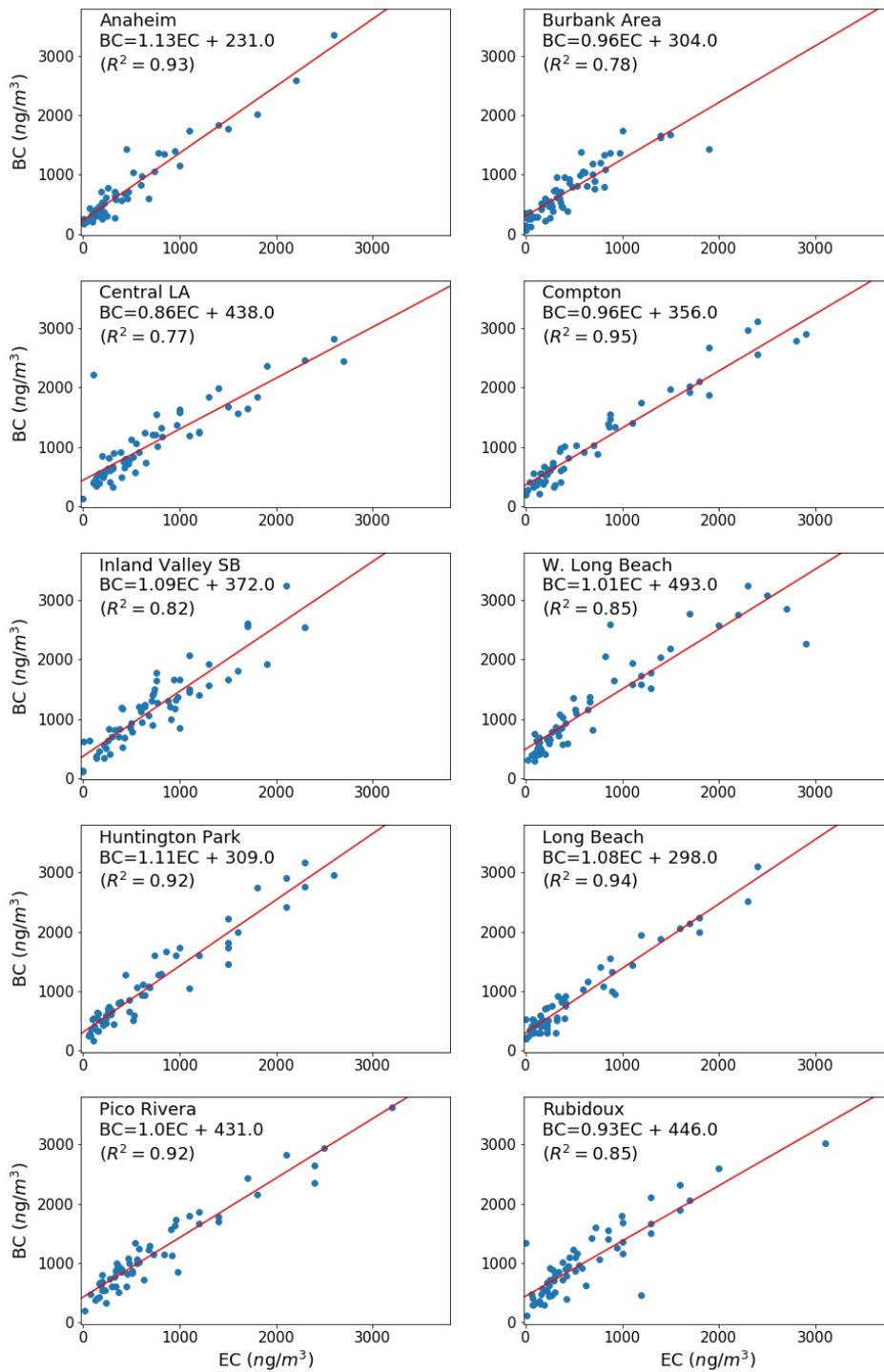
#### XIII.2 Results

As shown in Figure XIII-1, a comparison between the 24-hr average BC concentrations and the corresponding EC levels for all MATES V sites shows a good correlation ( $r^2 = 0.88$ ). The plot also shows that there is an intercept of  $365 \text{ nm}/m^3$  on the fitted line which shows that when the filter-based EC measurements are zero or near zero, aethalometers are measuring higher BC values. This might be due to the fact that Aethalometers are continuous monitors and have higher sensitivity at low concentrations compared to filter-based EC measurements.



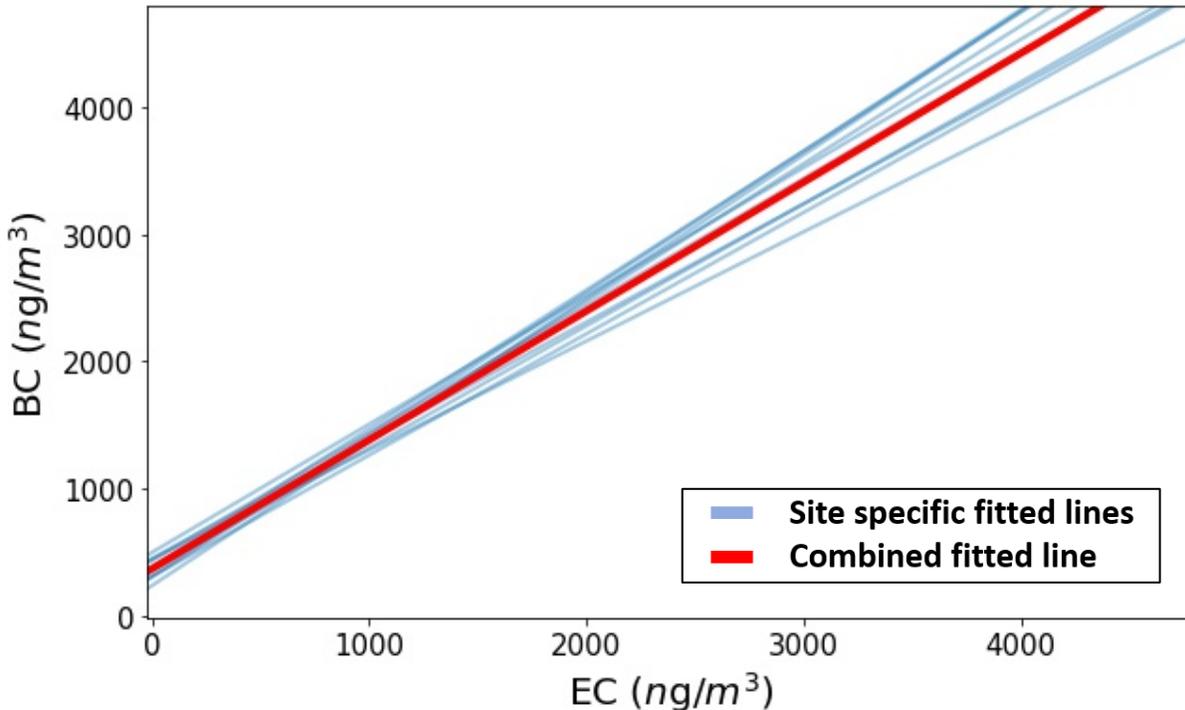
**Figure XIII-1.** Comparison of daily average BC and EC concentrations, measured at all stations during MATES V

Previous research has indicated that the correlation between EC and BC can be site-specific (Jeong et al., 2004). Figure XIII-2 shows the regression analysis between BC and EC measurements at each site. High correlation coefficients ( $0.77 < r^2 < 0.94$ ) show good agreement between the two measurements at each site. The slope changes from 0.86 to 1.13 while a positive intercept is observed at each site between 231 to 493  $ng/m^3$ . A site-specific correction factor is calculated based on actual measurements to convert the optical BC measurements to thermal-optical EC equivalents. EC is a required PM component in an attainment regional modeling approach in an Air Quality Management Plan/State Implementation Plan. However, EC measurements require a time-consuming and relatively expensive method, whereas BC measurements can be performed relatively cheaply, continuously (i.e. higher time resolution), and with much less required maintenance. Therefore, such conversions are useful information to substitute EC or to use as supporting data to substantiate EC measurements.



**Figure XIII-2.** Comparison of daily average BC and EC concentration at each MATES V site

It should be noted that the calculated fitted lines for all stations are close to the overall fitted line shown in figure VI-7 which allows applying a universal correction factor, without causing a significant deviation from unity as is shown in Figure XIII-3.



**Figure XIII-3.** Comparison of fitted lines between site-specific analysis (blue) and all the combined data (red) for MATES V BC and EC data correlations

Generally, particulate BC measured by the Aethalometer is a reliable surrogate for particulate EC measured by subsequent chemical analysis on the filter, especially in cases where the trends and changes of ambient BC concentrations are of interest, or in large air quality monitoring networks. The concurrent measurement of BC and EC with both optical and thermal-optical methods, however, provides additional information for identifying emission sources.

### XIII.3 Summary

One of the major areas of interest in air monitoring is to evaluate continuous monitoring technologies in order to reduce the frequency and amount of filter-based technologies that are expensive and time-consuming. Aethalometers offer a tremendous opportunity to move towards more desired continuous, higher time resolution sampling (as short as 1-minute) and supplement or reduce the need for more expensive, time-consuming filter-based sampling. The comparison between filter-based EC and continuous BC concentrations measured by Aethalometer shows good agreement between the two measurements at each site and suggests that continuous BC measurement can be a reliable surrogate for particulate filter-based EC while providing higher temporal resolution and better detection limits at lower concentrations.

### XIII.4 References

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**APPENDIX XIV**  
**MATES V**  
**FINAL REPORT**

**Comments Received on MATES V Report**

## **Comment Letter A from Delbert Eatough**

To: Dr. Jo Kay Ghosh  
Health Effect Officer  
South Coast Air Quality Management District

Report on the MATES V Technical Advisory Group Meeting  
April 14, 2021

From: Dr. Delbert J. Eatough  
Professor of Chemistry, Emeritus  
Brigham Young University

### **Scope of Comments**

I appreciate the opportunity you gave me to participate as a Technical Advisor in the April 14 meeting. As I am a chemist and have no background in the health effect evaluation, which is the heart of MATES V, I will limit these comments to the areas where I have some expertise. MATES has consistently shown that the major contributor to cancer risk to inhabitants of the South Coast Air Basin is exposure to diesel PM because of the fine particulate black carbon present in these emissions. Over the years I have been involved in three studies in cooperation with the South Coast Air Quality Management District on the determination of the source of this diesel PM. The Results of these studies shed light on assumption made in the MATES health evaluations. I will briefly review the studies and results which I think are most pertinent to the topic of this report and have attached the publications resulting from those studies. I will then relate those results to the presentation made at the April 14 meeting.

I would like to emphasize that each of these studies was a PM<sub>2.5</sub> source apportionment study based on hourly averaged data. The use of hourly averaged data allows the identification of sources of PM<sub>2.5</sub> based on diel changes in the presence of the species included in the analysis at the sampling site and allows details to be identified which are not identifiable from 24 hour every few days data sets.

A-1

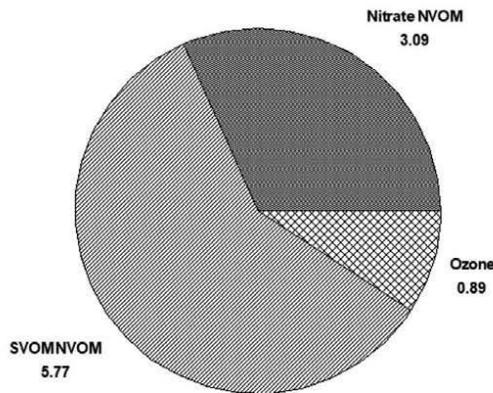
### **Apportionment of PM<sub>2.5</sub> adjacent to the I-710 Harbor Freeway in Long Beach, CA (August – September 2012)**

During August and September 2012, a study was conducted to determine the sources of PM<sub>2.5</sub> adjacent to the I-710 Long Beach Freeway. The site is directly affected by the emissions from heavy diesel traffic flowing from major container ports about 10 km south of the sampling site. The site is just south of the 2012 MATES Compton site. Hourly average data were obtained for particulate species including PM<sub>2.5</sub>, black carbon and UV absorbing carbon, EC, fine particulate nonvolatile and semi-volatile organic material (NVOM and SVOM), sulfate, nitrate, chloride, ammonium ion, and Na ion, and for related factors including O<sub>3</sub>, CO, NOX, SO<sub>2</sub>, and total traffic flow on the I-710. A total of 520 hourly averaged data sets with 15 measured variables were

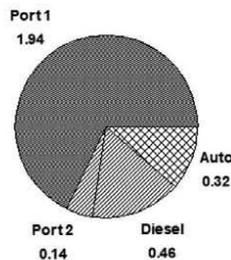
analyzed by EPA-PMF v5.0. The key features of the results are shown in the following Figure from the publication.

Pie charts of the contribution of the three factors contributing to secondary related factors, the four factors contributing to transportation-related factors and the three factors contributing to the refinery-related factors to total PM<sub>2.5</sub>. The area of each graph and pie section are related to the contribution of each to total PM<sub>2.5</sub>.

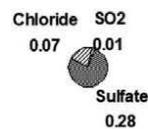
**Secondary Related, 9.75 µg/m<sup>3</sup>**



**Transportation Related, 2.86 µg/m<sup>3</sup>**



**Refinery Related, 0.36 µg/m<sup>3</sup>**



As indicated in the above figure, Secondary Related PM<sub>2.5</sub> was responsible for 75% of the PM<sub>2.5</sub> and 3% was from Refinery Related emissions. The later came from upsets at a nearby refinery. The remainder, 22%, was from traffic related emissions.

The major objective of the study was to determine the impact of traffic from the ports at the monitoring site. Factors related to both diesel traffic originating from the ports and diesel traffic from non-port origins were identified. The diesel traffic originating from the ports was

A-1 cont.

responsible for 9% of the total traffic and 95% of the BC measured at the sampling site. The non-port diesel traffic was responsible for 15% of the total traffic and 5% of the BC. While the Port 1 diesel traffic coming from the ports contributed a large fraction of the BC, this source contributed only 2% of the CO and 5% of the NO<sub>x</sub> at the sampling site. The Port 2 sources was associated with traffic from the Ports which were high emitters of CO and NO<sub>x</sub>. An important point in these results for the MATES program is that essentially all BC measured in the study was associated with diesel traffic emissions.

### **Source apportionment of 1 h semi-continuous data during the 2005 Study of Organic Aerosols in Riverside (SOAR) using positive matrix factorization (July-August, Riverside)**

Positive matrix factorization (PMF2) was used to elucidate sources of fine particulate material (PM<sub>2.5</sub>) for a study conducted during July and August 2005, in Riverside, CA. One-hour averaged semi-continuous measurements were made with a suite of instruments to provide PM<sub>2.5</sub> mass and chemical composition data. Total PM<sub>2.5</sub> mass concentrations (non-volatile plus semi-volatile) were measured with an R&P filter dynamic measurement system (FDMS TEOM) and a conventional TEOM monitor was used to measure non-volatile mass concentrations. PM<sub>2.5</sub> chemical species monitors included a dual-oven Sunset monitor to measure both non-volatile and semi-volatile carbonaceous material, an ion chromatographic-based monitor to measure sulfate and nitrate and an Anderson Aethalometer to measure black carbon (BC). Gas phase data including CO, NO<sub>2</sub>, NO<sub>x</sub> and O<sub>3</sub> were also collected during the sampling period. In addition, single-particle measurements were made using aerosol time-of-flight mass spectrometry (ATOFMS).

A-1 cont.

All the data except for the ATOFMS and ToF-AMS data were used in an initial evaluation of sources at Riverside during the study. PMF2 was able to identify six factors from the data set corresponding to both primary and secondary sources, primarily from automobile emissions (0% of BC), diesel emissions (78% of BC), secondary nitrate formation (7% of BC), a secondary photochemical associated source (0% of BC), organic emissions (7% of BC) and Basin transported pollutants (8% of BC). Again, diesel emission account for the bulk of the BC.

### **Source Apportionment of One-Hour Semi-Continuous Data Using Positive Matrix Factorization with Total Mass (Nonvolatile plus Semi-Volatile) Measured by the R&P FDMS Monitor (July 2003, Rubidoux)**

Semi-continuous monitoring data have been shown to greatly improve the power of receptor models to determine sources because the data include information on diurnal changes in the atmosphere. Such variation assist in the factor analysis identification of sources (or atmospheric processes) which vary diurnally. In this first study by us in the South Coast Air Basin, PMF2 was used to deduce source contributions from a sampling campaign conducted at the SCAQMD station in Rubidoux, CA during July 2003. Semi-continuous measurements (1-h average) were made using an FDMS TEOM (total fine particulate mass), a conventional TEOM (nonvolatile fine particulate mass), an R&P 5400 Carbon monitor (elemental and organic carbon), an Aethalometer (black carbon), and

an R&P 8400N nitrate monitor. Hourly average CO, NO<sub>x</sub>, and NO gas phase data were also available.

PMF2 analysis of the data yielded a six factor solution with sources attributed to automobile emissions (1.5 μg/m<sup>3</sup>), diesel emissions (4.3 μg/m<sup>3</sup>), secondary nitrate (17.0 μg/m<sup>3</sup>), photochemistry (5.7 μg/m<sup>3</sup>), organic aerosol (6.2 μg/m<sup>3</sup>), primary emissions (2.8 μg/m<sup>3</sup>). 94% of the EC was associated with the diesel emissions factor and 3% each with the secondary nitrate and primary emissions factors.

The common thread through each of these studies is that the great bulk of BC associated with fine particles in the South Coast Air Basin are associated with diesel traffic emissions.

I would again emphasize that common factor in each of the studies reported is the use of a one-hour averaged data and the extensive characterization of the PM<sub>2.5</sub> composition and other factors which might contribute to the source characterization analysis. Not specifically highlighted in the discussion, but also evident in the analysis, was the importance of including highly time resolved measurements of the major PM<sub>2.5</sub> constituents. When data are available on a diel basis, factors can be identified which cannot be elucidated from 24-hour averaged data,

A-1 cont.

## Comments on the MATES V Technical Report.

### 1. Black Carbon

The pertinent conclusion given in the previous section that is based on PMF analyses of hourly average data in three different studies in the South Coast Air Basin, black carbon in the Basin is essentially all from emissions from diesel traffic.

This conclusion is counter to assumptions which have been made through the past MATES program that the black carbon sources include On-road, Off-road, Point and Area sources with the emissions estimates being derived from:

On -Road. Emission were determined using factors deemed most current and vehicle emission data and vehicle activity data (Section 3.5).

Off-Road. Emissions were determined using an update of the 2016 AQMP off-road emissions estimate (Section 3.6), If the conclusions drawn in the previous section are correct, these emissions should be small to negligible.

Point. These estimates were based on reported emissions data from facilities emitting four tons or more of VOC, NO<sub>x</sub>, SO<sub>x</sub>, or PM or emitting 100 tons or more of CO per year. The pertinent species here would be the emission of PM. Details are not given on the specific speciation profile for the PM. However, if the conclusions drawn in the previous section are correct, the black carbon in the emitted PM should be small to negligible.

A-2

Area. Since the area source estimates are based on the above outline emission types, again the conclusions based on results in the first section would be that are associate black carbon is small to negligible.

The actual distribution for sources of black carbon given in Table 3.4 of the MATES V report is

On-road	Off-road	Point	Area
25%	26%	6%	>1%

A-2 cont.

If the conclusions given in the previous section are correct, then the Off-road contribution to black carbon is way over estimated and assumptions will be made about future controls on potential Off-road sources which are not needed for black carbon control and the effort to improve diesel traffic emission might be somewhat reduced. In this connection, the I710 study outlined in the previous section looked specifically for evidence of black carbon at the sampling site from ships at sea or ships entering the harbor and could not find evidence for these two sources being important in that road-side study.

I suggest that SCAQMD consider modifying the MATES V report to reflect the probable overriding important of black carbon from diesel traffic on the overall cancer health impacts identified in the program.

**2. Benzene**

I have one observation in connection with possible sources of benzene. We recently conducted a source apportionment study in cooperation with the State of Utah Division of Air Quality on sources of dichloromethane at a sampling site in Bountiful, Utah, just north of several oil refineries. We identified the refineries as the probable primary source of the dichloromethane, with an important parameter in the PMF analysis being BTEX, the combination of benzene, toluene, ethylbenzene, and xylene.

Among chemical industries, petroleum refineries have been identified as large emitters of a wide variety of pollutants. Benzene, toluene, ethylbenzene, and xylene (BTEX) form an important group of aromatic volatile organic compounds (VOCs) emitted from petroleum refineries because of their role in the troposphere chemistry and the risk posed to human health.

A-3

It would be expected that refineries in the South Coast Air Basin will emit this group of compounds. Toluene was a second compound in this group routinely measured in MATES. It might be worthwhile to look at the correlation between benzene and toluene to see if they are related at sites closer to refineries, such as the Compton site and to consider adding the other two members of this group to the next MATES effort. This may give clues as to the possible importance of benzene from petroleum refineries.

The commenter also submitted the following publications as part of the comment. Since these publications are copyrighted materials, these copyrighted materials are not reprinted here, and instead, we are providing a list of the publications received and links to websites where such materials may be available for viewing and download.

Grover BD and Eatough DJ. (2006). Source Apportionment of One-Hour Semi-Continuous Data Using Positive Matrix Factorization with Total Mass (Nonvolatile plus Semi-Volatile) Measured by the R&P FDMS Monitor. *Aerosol Science and Technology*, Volume 42, 2008 (1), 28-39. <https://www.tandfonline.com/doi/full/10.1080/02786820701787910>

Eatough DJ, Grover BD, Woolwind WR, Eatough NL, Long R, Farber R. (2008). Source apportionment of 1 h semi-continuous data during the 2005 Study of Organic Aerosols in Riverside (SOAR) using positive matrix factorization. *Atmospheric Environment*, Volume 42 (11), 2706-2719. <https://www.sciencedirect.com/science/article/abs/pii/S1352231007006516>

Eatough DJ, Cropper P, Keeton W, Burrell E, Hansen JC, Farber R. (2020). Apportionment of PM<sub>2.5</sub> adjacent to the I-710 Harbor Freeway in Long Beach, CA. *Journal of the Air & Waste Management Association*, Volume 70, 2020 (3), 260-282. <https://www.tandfonline.com/doi/full/10.1080/10962247.2019.1705436>

**Comment Letter B from Scott Fruin**

Keck School  
of Medicine  
of USC

Scott Fruin  
Assistant Professor



May 31, 2021

Jo Kay Ghosh, PhD, MPH  
Health Effects Officer/Director of Community Air Programs  
South Coast AQMD

Dear Dr. Ghosh,

Thank you for including me as a member of the Technical Advisory Group. The following are my comments and suggestions regarding the draft report of the MATES V results.

It is impressive that pollutant concentrations have once again shown such large and important decreases. The technical quality of the MATES V campaign and analysis is excellent, and this comes across well in the report. It is clear the modeling has made big strides, further improving agreement between measured and modeled pollutants as well as weather. Demonstrations of sampling day meteorological representativeness and comparability of meteorology between campaigns IV and V were also quite well done.

My suggestions are primarily where I think the results presentation and interpretation can be enhanced and where uncertainty can be better appreciated. A detailed list is given under "Specific Suggestions" below. However, there are some important suggestions for the Executive Summary that I think are worth emphasizing, as it is by far the most commonly read. These are as follows:

- The large risk reductions from MATES IV to V should be featured more prominently. | B-1
- The risk of premature mortality from PM2.5 should be mentioned up front, to help put the cancer risks in context of overall air pollution health risk. | B-2
- The new hazard index calculations need more interpretation, especially since they are well above thresholds of concern. | B-3
- The uncertainty of diesel PM risk should have more detail (ditto for Chapters 1 and 2. See specific comments below). There are large uncertainties in the cancer potency factor multiplier and still relatively large uncertainties in the EC-to-DPM conversion, and this is important for the reader to appreciate. For example, the large drop in the EC-to-DPM conversion factors from MATES III to IV (shown in Table O-4 in Chapter 1) may be contributing to the large drop in calculated cancer risk shown in Figure ES-3. (Concurrently, it can be pointed out that the decreases in actual concentrations such as EC2.5, for example, are less uncertain because they do not rely on any conversions or multipliers.) | B-4
- The air basin maps should remove the density of port boundaries as this sometimes makes the ports appear to be an area of exceptionally high impact, such as Figure ES-6. (This occurs throughout the report.) | B-5

# Keck School of Medicine of USC

Scott Fruin  
Assistant Professor

More specific comments are listed below.

Please feel free to contact me if you would like any further information or clarification.

Sincerely,



Dr. Scott Fruin, P.E.  
Environmental Health Sciences  
Department of Preventative Medicine  
USC Keck School of Medicine  
University of Southern California, 2001 N Soto Street  
Los Angeles, CA 90032

## SPECIFIC COMMENTS

Executive Summary:

- Page 1, paragraph 2: Suggest pointing out “toxic air contaminants” are those pollutants without regulatory standards.  
Suggest including mention of premature mortality risk due to PM2.5 as an additional major health risk in the SoCAB.
- Page 5, paragraph 2: Define “non-inhalation pathways” (i.e., oral and dermal and what these entail). Briefly say how important they are such as adding 5 to 7% to overall cancer risk. Might add that they likely have higher uncertainty than inhalation risk estimates.
- Page 5: “Results” should be a major heading.
- Page 5, first paragraph in Results: suggest citing the risk numbers here and defining how calculated. Suggest separate paragraphs on current risks and trends.  
Suggest defining “secondary formation.”
- Page 8, paragraph 1: the introduction to hazard indices needs more explanation, such as why added, why important, how to interpret, etc.  
Some of these details here are rather obscure and belong deeper in the report.
- Page 8, figure ES-4. Font size is too small.
- Page 8, paragraph 2: Some guidance on interpretation of HIs belongs here. Also point out here that HI is calculated separately by organ.
- Figure ES-6: Port boundaries are dense and look like high risk since dark colors are highest risk. These should be removed. (This occurs throughout the report.)

B-6

Keck School  
of Medicine  
of USC

Scott Fruin  
Assistant Professor

<p>Page 11, first paragraph: the changes due to non-inhalation risk cancer additions are not important compared to the uncertainty in the cancer risk. These details probably do not belong in the ES or need to go in Table ES-2.</p> <p>Page 12, Figure ES-7: Presenting risk reduction by % reduction may be more effective or it may be a good additional figure.</p> <p>Page 12, Caveats, paragraph 2: the uncertainty around BC/DPM should be included when cancer risk is first presented. Suggest including here that uncertainty is markedly reduced when comparing trends in actual concentrations, especially EC2.5, where the diesel PM conversion uncertainty and cancer potency uncertainty are yet to be added in. An additional caveat is that the sampling and modeling design does not capture near-source exposures such as living near freeways.</p> <p>“Conclusions” and “Policy Implications”: some of these key highlights deserve to also be presented earlier in the Executive Summary.</p>	<p>B-6 cont.</p>
<p>Chapter 1:</p> <p>Page 6: suggest adding to “Dose Response Assessment” another paragraph giving more detail about uncertainties in the cancer potency factor for diesel PM, as this uncertainty likely dominates the total cancer risk uncertainty of the study.</p> <p>Page 8, in “Source of Uncertainty”: I suggest having a paragraph that explains how the changes in EC2.5 concentration reflect a less uncertain risk reduction estimate from diesel PM than estimates of diesel PM cancer risk (since it is a direct measure and not reliant on conversion factors or potency factors). A comparison table of EC2.5 versus diesel PM concentrations, measured and modeled, for MATES IV versus V would be a useful addition here.</p>	<p>B-7</p>
<p><b>Chapter 2:</b></p> <p>Figure 2-3 illustrates there is still likely high uncertainty in the early EC to DPM conversions where MATES II used a 1.95 factor (Table 0-4) while all factors in MATES IV and V ranged from 0.7 to 0.9. This “step change” from III to IV may exaggerate the diesel PM risk reduction from III to IV, as shown by comparing diesel PM results in Figure 2-3 to measured EC in Figure 2-4. This also affects graphs like 0-47 of total cancer risk trends and ES-3 in the Exec Summary.</p> <p>An uncertainty analysis based on the variability of these conversion factors might be a useful addition here.</p>	<p>B-8</p>
<p><b>Chapter 4:</b></p> <p>Figures 4-18 to 4-21: recommend also including a horizontal line showing basin wide cancer risk level for MATES IV</p> <p>Appendices should have titles.</p>	<p>B-9</p>

**Comment Letter C from Ken Davidson**

**From:** [Davidson, Ken](#)  
**To:** [Jo Kay Ghosh](#)  
**Subject:** MATES V Comments  
**Date:** Tuesday, June 1, 2021 4:32:24 PM

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Hi Jo Kay,

My apologies for not getting these to you before COB yesterday. My comments are pretty minor and certainly not showstoppers. My main comment is, once again, great work on the study. Though burdened with some of the most challenging air quality issues in the country, the MATES analysis continues to be an amazing resource for the SCAB and for stakeholders both local and nationally. I especially appreciated the work to update the previous MATES data for consistency and comparability, as well as the addition of risks from multiple pathways. Here are my other comments:

- Suggest pulling some of the EJ results from Chapter 4 into the Executive Summary. | C-1
- In the discussion of uncertainty in both the ES and Chapter 1, it might be good to acknowledge unquantified health risks from air toxics omitted from the analysis (both monitored and modeled). | C-2
- Chapter 1 first paragraph: The sentence “Unlike the common ‘criteria air pollutants,’ there are not state or federal standards for air toxics.” As written, this statement is actually false since both EPA and CARB develop standards for controlling air toxics from sources in an industry group (NESHAPs & ATCMs), though there aren’t ambient standards for air toxics concentrations. | C-3
- EPA has heard from different sources that there’s a preference to move away from labeling communities “EJ communities.” I wonder if you’ve heard the same. “Communities with EJ concerns” is one way to rephrase. Just a thought. | C-4
- In Section 1.3, I think the only human activity pattern data I noted in the exposure and risk characterization was fraction of time spent at home. Is that correct? | C-5

Again, great work. Thanks for the opportunity to review – I look forward to sharing these results with my colleagues in R9, OAQPS, and OTAQ. Best,

Ken

## Comment Letter D from John Budroe

### John Budroe – Comments on MATES V Report

#### Content Comments

##### 2.9 Chronic Non-Cancer Risk Estimates

Chronic non-cancer risks are long-term non-cancer health impacts from exposure to toxic air contaminants that have a defined Reference Exposure Levels (REL). A REL is defined as the concentration at which no adverse non-cancer health effects are anticipated for one or more target organ systems (reference: OEHHA Hot Spots, section 8.3). Similar to cancer risks, risks from both inhalation and non-inhalation pathways were calculated and reported for this study.

A cancer inhalation unit risk (IUR) is used to calculate a cancer risk resulting from a specific carcinogen air concentration. In that case, the cancer IUR is calculated from the slope of a non-threshold dose-response for that carcinogen.

However, a comparison of an air toxic concentration to a chronic REL would generally not be used to derive a probabilistic noncancer risk estimate. Unlike cancer IUR derivations, chronic REL derivation methodology assumes the existence of a threshold for adverse health effects. Additionally, this methodology uses uncertainty factors (UFs) to extrapolate from chemical adverse health effect data to a chronic REL. The magnitude of these UFs differs between chronic RELs. An air toxic concentration that results in a Hazard Quotient (HQ) of two may not produce twice the risk of causing an adverse health effect compared to a concentration resulting in a HQ of one. The likelihood that a concentration of an air toxic will result in an adverse health effect does increase as the HQ increases, but that increase cannot be depended upon to display linearity.

Section 8.3.1 (Calculation of Noncancer Inhalation Hazard Quotient and Hazard Index) of the 2015 Hot Spots Guidance Manual states: "An HQ of 1.0 or less indicates that adverse health effects are not expected to result from exposure to emissions of that substance. As the HQ increases above one, the probability of human health effects increases by an undefined amount. However, it should be noted that a HQ above one is not necessarily indicative of health impacts due to the application of uncertainty factors in deriving the RELs." It should be noted that this section of the Guidance Manual discusses "adverse health effects" and "health impacts", not risks.

It would be more accurate to say that HQs were calculated for air toxics which have existing chronic RELs, and the likelihood of experiencing an adverse health effect increases as the HQ increases.

These comments also generally apply to **Estimates of Chronic Non-Cancer Risk based on Monitoring Data**, starting on page 2-64.

D-1

**Proofreading Comments**

**Executive Summary**

Figures ES-6, 7 and 9 need to have the text at the bottom of the figure cleaned up. Also, ES-9 should be renumbered to ES-8.

D-2

**Chapter 1**

Page 1-9: and Helsel (2012)<sup>6</sup> for handling this type of data (see Appendix XI for details).

D-3

**Chapter 2**

Page 2-14: The revised methodology includes utilizing age sensitivity factors to weigh early life exposure; higher, as well as updated assumptions on breathing rates, and length of residential exposures.

Chronic non-cancer risks are long-term non-cancer health impacts from exposure to toxic air contaminants that have a defined Reference Exposure Levels (REL).

Page 2-16:

**Diesel PM**

Diesel Exhaust estimates are shown in Figure 2-3, and the continuation of a trend of decreasing diesel exhaust over time at all stations.

D-4

This is a bit unclear – possibly what was meant was “and illustrate the continuation of a trend of decreasing diesel exhaust over time at all stations”?

Page 2-18: Delete benzene graph (redundant, shown on page 2-19).

Figure 2-5 and Figure 2-46 present levels for benzene and 1,3-butadiene, which are emitted

Formatted: Font: 12 pt

Page 2-30: Figure 2-18, 2-19. Average Concentrations of Bromomethane – upon examination, it became apparent that the two graphs were showing the same data set, with different y-axis scales between the two figures. However, it would make it easier for the reader if the difference between the two figures was explicitly described in the text and/or the figure legend. This comment holds for all chemicals in the report where the same data set was displayed in two figures with different y-axis scales.

**Comment Letter E from Janet Whittick****California Council for Environmental and Economic Balance**

101 Mission Street, Suite 1440, San Francisco, California 94105  
 415-512-7890 phone, 415-512-7897 fax, [www.cceeb.org](http://www.cceeb.org)

June 7, 2021

Dr. Jo Kay Ghosh  
 Health Effects Officer and Director of Community Air Programs  
 South Coast Air Quality Management District  
 Submitted Electronically to [jghosh@aqmd.gov](mailto:jghosh@aqmd.gov)

RE: MATES V Draft Report

Dear Dr. Ghosh,

On behalf of the California Council for Environmental and Economic Balance (CCEEB), we appreciate the opportunity to comment on the fifth and most recent iteration of the Multiple Air Toxics Exposure Study (MATES V) and accompanying draft report. CCEEB has been an active stakeholder at the South Coast Air Quality Management District (SCAQMD) for many years, and has seen the progress made by the District and its partners since the first MATES was conducted in 1986. We believe MATES V is a major achievement, both in terms of the technical and scientific rigor of monitoring and modeling by District staff, but also, most importantly, the significant reductions in toxic emissions and exposures that have occurred throughout the air basin. The draft MATES V report shows a 54 percent reduction in cancer risk since MATES IV in 2012, along with decreases in on-road, off-road, and point source carcinogenic emissions of 59 percent, 39 percent, and 49 percent, respectively, over the same time period.

Use MATES V to Help Inform AB 617 and Other Community-based Actions

CCEEB believes MATES V marks an important milestone in the District's clean air and public health history; while a 454-in-a-million cancer risk is still unacceptably high, it is roughly half the risk from MATES IV in 2012, and 82 percent lower than MATES II in 1998. Alongside these critical risk reductions, MATES V shows similar rates of reduction in diesel particulate matter (DPM) emissions. Over the same period and, in part, as a result of outreach and community discussions stemming from MATES, the District's understanding of localized impacts and environmental injustices has grown. CCEEB appreciates the analysis shown in Chapter 4 that quantifies benefits in SB 535 and AB 617 communities, and believes that data and lessons from MATES V can and should augment the District's community-specific investigations and engagement. Particularly for AB 617, understanding the drivers of risk can help communities formulate targeted actions that achieve even greater reductions. MATES V also helps us understand what areas – both in terms of geography and sources – call for more attention, and suggests which programs and policies have contributed most to success.

E-1

Include an Abbreviated Discussion of “Estimates of Risk” in the Executive Summary

CCEEB also appreciates the discussion of risk assessment and risk characterization in Chapter 1.3. We ask staff to include a shortened version in the Executive Summary to help provide context and meaning for risk estimates. In particular, the section explaining potential cancer risk on page 1-7 and the following section on “Perspectives of Risk” could be adapted to simply explain how to interpret cancer risk estimates like 454-in-a-million or 1,141-in-a-million.

E-2

Project Anticipated Further Reductions in DPM for 2023 and 2030

While the release of the draft MATES V report is timely and important, it is also somewhat limited and already outdated as it only depicts data from 2018. Significant reductions in air toxics, in particular DPM, have occurred since then. For example, a review of EMFAC2017 indicates that DPM emissions are expected to decrease by 79 percent between 2018 and 2023. Since the District and its agency and public partners are updating future year emissions inventories as part of the 2022 Air Quality Management Plan (AQMP), and since cancer risks associated with DPM are based on emission inventories and modeling rather than on measured concentrations, we ask staff to include in MATES V projected DPM cancer risk for 2023 and 2030, and include this information in the final report. If the District is unable to analyze and show these future year DPM reductions in cancer risk, then we ask that the following statements, or something similar, be added to the final report.

Page ES-5.

“...and 86% lower since MATES II based on monitored data. In addition, an analysis of EMFAC2017 indicates that DPM emissions are projected to be reduced by an additional 79% between 2018 and 2023. These reductions reflect ongoing efforts to further reduce DPM from rules already adopted by the District, the state air board, and the federal Environmental Protection Agency”

E-3

Page 2-60

“... approximately 50% of the cancer risk, see Figure 0-49. While future year cancer risks from DPM were not included in this report, we expect that cancer risk associated with DPM will continue to decrease since, based on an analysis of EMFAC2017, DPM emissions are projected to be reduced by an additional 79% between 2018 and 2023. These reductions reflect ongoing efforts to further reduce DPM from rules already adopted by the District, the state air board, and the federal Environmental Protection Agency”

Page 3-9

Please insert the following after Table 3-4

“An analysis of EMFAC2017 indicates that DPM emissions are projected to be reduced by an additional 79% between 2018 and 2023. These reductions reflect ongoing efforts to further reduce DPM from rules already adopted by the District, the state air board, and the federal Environmental Protection Agency”

Page 4-6

“... impacting in various categories of on-road and other mobile sources. And these diesel concentrations are expected to decrease an additional 79% between 2018 and 2023, based on an analysis of EMFAC2017. These reductions reflect ongoing efforts to further reduce DPM from rules already adopted by the District, the state air board, and the federal Environmental Protection Agency”

E-3 cont.

In addition, in the interest of clarity, we ask that the figures in the final MATES V report clearly identify in the title whether the information shown is population weighted or not.

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Transparency in data is the cornerstone of sound science, which in turn supports effective and actionable public policies and air quality rules. CCEEB commends the SCAQMD for its work on MATES V, and thanks staff for its efforts and ongoing commitment to this important effort.

Sincerely,



Janet Whittick  
CCEEB Vice President and South Coast Air Project Manager

cc: Mr. Bill Quinn, CCEEB president  
Members of the CCEEB South Coast Air Project

## Additional Comment Letters Received After the Comment Deadline

### Comment Letter from Michael Benjamin

#### **Summary of CARB's comments on SCAQMD's MATES V**

Thanks for sharing the links to the updated MATES work also providing time to provide feedback. Below are comments from the California Air Resources Board staff. Please feel free to reach out to us to have further discussion on the points below.

**Consideration of New and Emerging Chemicals and Noncancer Impacts:** CARB staff appreciate the updated toxics and monitoring data for the top TACs. However, in future studies, it will be important to include new and emerging chemicals (e.g., PFAS, etc.), additional health analysis and quantification of PM mortality as well as other noncancer impacts like hospital visits, cardiovascular, asthma, etc. SCAQMD should consider assessing acute REL's (max hourly concentrations) in future MATES studies.

**Adding Community Monitors:** The current MATES structure is able to capture pollutant levels at the regional scale, but not community. Given the focus of AB 617, consider adding a few community-specific monitors to check on the progress within these communities.

**Outlining the Process for Handling High Risk:** We recommend having some statements throughout the document that discuss how SCAQMD handles situations where certain emission levels result in elevated. For example, if there is elevated risk due to methyl bromide emissions due to fumigation operations.

**Focus on Stationary Sources:** As the particulate matter concentrations continue to decline, it will be important to understand the breadth of emissions (particularly from new and emerging chemicals) from stationary sources and their impact on this modeling effort. Particularly important at the localized level, it is also important to evaluate the impacts from stationary sources that may be near road ways or clustered together near local receptors.

**Air Toxics Monitoring Comments and Recommendations:** These comments are grouped into 3 general categories and designed to address the current document but also future considerations:

1) What thoughts or concerns do you have in terms of monitoring for toxics (e.g., new approaches to monitoring, use of new technologies, limitations of current techniques, sampling frequencies and locations, could a MATES type program be deployed statewide, etc.)?

- In the Mates V draft section 2.7, *Sampling Issues*, SCAQMD discussed a problem with their carbonyl sampler and VOC canister. In general, the district invalidated data from those instruments due to leaks in connections. The leak involved 3 of their 10 monitoring stations, but still a good amount of data was invalidated. This underscores the importance of regular functional checks for instruments. This will avoid the unnecessary invalidation of data, which may diminish the study's purpose and informational returns. Fortunately, SCAQMD has taken steps to prevent similar occurrences in the future.

- The reference to a 2000 CARB citation/webpage on limitations for acrolein measurements from stationary sources is confusing. There are certainly more recent efforts to acknowledge limitations of traditional analytical approaches, as well as offer alternative approaches. Given the emerging interest in acrolein, it is recommended that a parallel comparison be made with butadiene. Does methacrolein present the same health effects concerns as acrolein? If so, are those relevant to comparisons of risk from butadiene and those of isoprene?
  - At some point more intensive monitoring of POPs (e.g. PFAS, PFOS, PCBs, PBDEs, Dioxins, etc.) are likely going to be needed from the extraction and analysis of PM as we continue to drive down the main volatile/semi-volatile 'bad actors' for air pollution health risks. Spatial variability for these types of compounds will be a challenge both from an exposure assessment perspective, but also from assessing regulatory phase-out effectiveness. They may be best assessed via biomarkers related to environmental exposures.
  - There are several references to advanced monitoring techniques that will be discussed in a separate report. It would be interesting to know if SCAQMD investigated using continuous GC measurements for hourly VOC concentrations to assess temporal trends in toxicity? For example, a thermal desorption pre-concentration unit coupled to a GC-MS system. The USEPA has a method using a system of this manner for fugitive and area source emissions (Method 325B). The inclusion of high-temporal resolution measurements – even if the number of compounds does not change – using a thermal desorption system in line with a GC-MS would provide useful insights to exposure pathways in heavily impacted areas.
- 2) What thoughts or concerns do you have in terms of laboratory operations or impacts (e.g., analytical methods, method development, detection limits, sampling media, etc.)?
- MDL and how to handle data below MDL are critical in assessing overall toxics exposure. The approach used in MATES V is reasonable (Kaplan-Meier nonparametric method combined with bootstrapping). When more than 80% of data are below MDL, substituting such data with zero values to get a lower bound and substituting with MDL to get an upper bound is an improvement over previous practice of simply substituting with half times the MDL for data below MDL. However, the report did not discuss consideration of other resampling techniques such as the jackknife instead of "bootstrapping" since bootstrapping essentially is resampling with replacement, which could lead to the same values being sampled repeatedly. It would be nice to have some sensitivity analysis done to justify the method chosen.
  - In Appendix XI (Monitoring Data Treatment Methodologies), it was stated that Helsel (2012) refers to three approaches for handling data with non-detects: MLE, nonparametric with a single MDL, and nonparametric survival analysis. It was justified that the underlying assumptions for MLE were not sound, so nonparametric survival analysis was chosen (page Appendix XI-3); however, it was not clear how the second approach, nonparametric with a single MDL, was dropped.
-

- Data completeness requirements are said to be included in the monitoring QAPPs. For greater transparency, we would suggest showing the total number of samples and overall data completeness for each of the species and methods sampled as a supporting figure. This would apply both to South Coast in this report as well as any future toxics based report CARB may lead.
- There is a definite emerging need for more reliable methods to accurately quantify acrolein. A sensitive real-time method overcomes many of the existing limitations, but it comes with a hefty price or more intensive sampling/analytical approaches.
- Need to better quantify the uncertainties associated with different methods used to estimate diesel PM. Are we biasing the current surrogate methodologies based on correlations to attributes relevant to on-road emissions, if off-road emissions are substantially different from the on-road profiles and the regulatory cycles grow farther apart?

3) What thoughts or concerns do you have in terms of data management/validation (e.g., quality assurance/quality control, data storage, data messaging)?

- One suggestion is to include the process on how data was collected from instruments (i.e., a data logger, commercial software application, manually, etc., and how they stored it for later analysis (in-house database, commercial vendor, spread sheets, etc.)). Setting up instruments in a station is one hurdle and collecting the data from instruments is another. For instance, getting instrument data to a network or connecting an air monitoring station to the internet "in the middle of nowhere" is not a trivial task.
- In Chapter 2 regarding manifold leakage issue, which was also mentioned above, it is not clear how the data before 5/1/2018 was verified. If a leak check was performed that day, it should be stated in the document. It would also be helpful to mention what might cause the leakage at three locations at the same time (i.e., operation error, calibration, etc.).

**Acetaldehyde and Formaldehyde:** The increase of formaldehyde and acetaldehyde is interesting (CARB's iADAM statewide data also shows an increase in the formaldehyde concentration). Emissions from combustion sources are clearly decreasing as evident from the decrease in aromatics and PAHs emissions. Are there any indications from ambient data that secondary formation is somehow enhanced over the last few years (i.e., photochemical reaction pathways have shifted to form more aldehydes due to the reduction of NO<sub>x</sub> in air, or climate change has contributed to enhanced photochemistry due to high average temp)? It would be beneficial to state in Chapter 2 (2-22) whether there is any seasonal difference in the rate of increase (summer vs. winter) or if there is any spatial difference. Has the use of any consumer products that release aldehydes increased over the last several years?

**Black Carbon, Elemental Carbon, Diesel PM:**

Diesel exhaust vs Diesel PM: Throughout the document there are numerous references to diesel exhaust (Table 0-4 in Chapter 2) and diesel PM (Figures 0-44-0-47, Chapter 2), are these two considered to be the same? For example, does the

diesel exhaust include gaseous or semi-volatile species as well as PM? If so, how were these chemicals separated in the health risk or monitoring?

Black Carbon vs Elemental Carbon: EC and BC is measured at all of the 10 fixed sites as part of MATES V monitoring. EC is stated to be used in the diesel exhaust/PM calculation, but there is not a discussion of the relationship between EC and BC at the same stationary site. A comparison between the two measurement techniques at the same site may provide insight into using BC measurements, rather than EC, in future toxics analysis.

Elemental Carbon to Diesel PM Ratio, Chapter 2, page 2- 9: The method in which the modeled EC:DieselPM is unclear. How is the modeled EC:DieselPM calculated at each site? Specifically, the methods to calculate the individual modeled EC and modeled diesel PM values to calculate the ratios in Table 0-4.

**Edits and Clarifications:** Below are minor edits and clarifications needed to improve the clarity of the document:

*Overall:*

in the text discussion, Roman numerals are used to differentiate MATES I, II, III, IV and V; however, in graphics, the numbers 1, 2, 3, 4, and 5 are used. There should be some consistency with the use of numerals or a statement correlating the uses. Also, page 2-13, Table 0-4 should be corrected to be 2-4; page 2-48 and subsequent pages, Figures 0-36 through 0-55 should be corrected to be Figures 2-36 through 2-55.

*Executive Summary*

Page ES-3: "cancer risks in *tall* these...": Typo, should read "all"

Page ES-5: "CEQA": Acronym introduced without description

Page ES-6: Figure ES-2: Odd pie-chart drawing I was unable to understand

For clarity, the data labels above the columns illustrating the risk trends in Figures ES-3 and ES-5 should use Roman numerals II to V (instead of Arabic numbers 2 to 5) to be consistent with the designations of the MATES studies they represent.

The discussion preceding Table ES-2 cites numbers that are slightly inconsistent with those presented in the table. Specifically, the discussion cites a 51% reduction in population weighted risk in the basin and 33% reduction in the Coachella Valley, but the table shows reductions of 54% and 30% (respectively) for multi-pathway exposure assessments, and 53% and 30% (respectively) for inhalation pathway only.

*Chapter 1*

Page 1-7: "Risk Management Policy (RMP) *Using* the Derived...": typo, should be "using"

Page 1-7: "e.g. experiences of racism": Sensitive wording, should probably be put in another form to reflect the intended meaning

Page 1-9: "state-of-the-science": Unusual/uncommon word, per online Google/dictionary search; could be replaced with "state-of-the-art" (catch-all term) Recommend checking throughout report.

### *Chapter 2*

Inconsistent labeling of Tables and Figures. The tables in Chapter 2 are all labeled with a "0" prefix preceding the table number (e.g., "Table 0-1"), but the text referencing those tables uses a combination of "0" and "2" prefixes when citing them (e.g. "Table 2-1"). Similarly, a number of the figures in the chapter use the prefix "0", but other figures use the prefix "2".

Figures 0-47 and 0-48: the data labels above the columns illustrating the risk trends should use roman numerals II to V (instead of Arabic numbers 2 to 5) to be consistent with the designations of the MATES studies they represent.

Page 2-7, section 2.3: "for real-time measurements of *BC* was...": Acronym meaning should be introduced in context here, instead of afterwards

Page 2-7, section 2.3: "DPM": Acronym not explained  
"black carbon": For consistency, Black Carbon should be stated either capitalized, or not, throughout the entire report

### *Chapter 3*

The discussion preceding Table 3-5 (p. 3-9) should introduce the concept of DPM equivalent emissions, since the term is used later in the same section when discussing increases in the DPM equivalent emissions of vinyl chloride, cadmium and methylene chloride.

### *Chapter 4*

Page 4-18, Table 4-6: Risk Factor ( $\mu\text{g}/\text{m}^3$ )-1: ambiguous measuring unit expression (due to incorrect text formatting?)

## Comment Letter from Dennis Fitz

**From:** [Dennis Fitz](#)  
**To:** [Jo Kay Ghosh](#)  
**Subject:** Section 2 Comments on Draft Report Section 2Structure  
**Date:** Wednesday, June 16, 2021 9:08:29 PM

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Hi Jo:

I know it's way past the deadline for comments, but I finally sat down to read section 2 carefully. There are some problems in the structure that reflect compilation errors. Maybe they have been corrected in later versions, but certainly should be in the final document. Here are the most noticeable:

Tables are labeled 0-1 to 0-4. There are two Tables 0-4 and one should be Table 5. This looks like a cut and paste that wasn't corrected. Shouldn't these be Tables 2-1 thru 2-5?

Figure 2-4: Where are the results for MATES III and V?

Page 2-18: This is a cut and paste mess. The first Figure (Benzene) does not have a caption and is actually a duplicate of Figure 2-5 that comes later. It should be removed. The paragraph starts with "Figure 2-5 and Figure 2-4" but should start with "Figure 2-5 and Figure 2-6".

Toluene data are presented in Figure 2-7 and not 2-5 as stated in the text.

Pages 2-30 and 2-31: Figures 2-17 and 2-18 both show Bromomethane data, which is correct? No mention of Figure 2-18 in the text.

Figure 2-25 & 2-26; 2-27 & 2-28; 2-30 & 2-31: For clarification, it would help to mention in the text that the second figure of each set is at higher resolution.

Naphthalene and other PAH compounds (and following sections): The figures are labelled as 0-XX when they should be 2-XX.

I hope this helps make for a better document. I look forward to our meeting.

Dennis

**APPENDIX XV**  
**MATES V**  
**FINAL REPORT**

**Response to Comments on MATES V Report**

## Appendix XV

### Response to Comments on MATES V Report

#### Responses to Comment Letter A from Delbert Eatough

##### **Response to Comment A-1:**

Staff appreciate the commenter providing the information derived from the source apportionment studies.

##### **Response to Comment A-2:**

While it is true that the MATES studies have consistently showed that diesel PM is a major contributor to air toxics cancer risk, neither South Coast AQMD nor CARB specifically attributes this risk to the black carbon (BC) present in the diesel PM emissions. CARB has determined that total diesel exhaust, including both gaseous and particulate emissions, was carcinogenic while diesel PM was designated as a surrogate to total diesel exhaust.

Staff disagree with the assertion that off-road and stationary sources have negligible contributions to the overall BC emissions in the South Coast Air Basin. The studies cited by the commenter were unable to identify a contribution from ships near the Ports of Long Beach and Los Angeles at a sampling site near I-710 and Long Beach Blvd. The inability of those studies to identify contribution of ship emissions to measured PM<sub>2.5</sub> or BC concentration at a site downwind of the ports does not in itself indicate those emissions from ships do not travel on land.

While BC measurements were performed during MATES studies, these measurements were not factored in our risk analyses because the OEHHA risk assessment guidance does not have health risk assessment values for BC. In our analyses, we tracked PM emissions from diesel engines for each source category without regard to the speciation of the emissions. Emissions were inventoried from the top-down approach based on reported or estimated activity, vehicle/equipment population, or fuel consumption data, and established emission factors. For example, the diesel PM emissions from point sources were reported by facilities based on the hours of operations and engine size or diesel fuel consumption; the emission factors for this equipment were then applied to calculate the pollutant emissions. As the regulatory agency with primary authority over mobile sources, CARB has developed various tools to calculate mobile source emissions, based on their wealth of data on mobile source engines in California. The emissions inventory employed in MATES V is consistent with a regulatory inventory included in an AQMP/SIP which were developed via public process by multiple agencies, including CARB. While new data and methodology will likely continue to improve the accuracy of emissions inventories, any changes in the inventory and the underlying assumptions would need to go through an appropriate public process.

##### **Response to Comment A-3:**

We note that all BTEX compounds (benzene, toluene, ethylbenzene, o-xylene, m+p-xylenes) were measured in MATES V and previous MATES. During MATES V, benzene and toluene were generally well-correlated at all MATES sites ( $r^2 = 0.62-0.94$ ), with linear regression slopes (toluene/benzene) ranging from 1.7-3.9. The toluene/benzene ratio has been used to differentiate between key BTEX sources such as vehicle exhaust and refinery emissions in some regions (e.g., Halliday et al., 2016), but assessing the refinery signal in the MATES V BTEX data is very difficult due to the location of refineries within a major urban area with other large sources of these compounds, including gasoline-powered mobile sources. However, the MATES V Advanced Monitoring report expected to be released within the next year will include results from targeted studies of toxic emissions from refineries. Furthermore, South Coast AQMD currently has several monitoring programs focused on characterizing refinery emissions and impacts, including the Rule 1180 (continuous fence-line monitoring) and AB 617 (community monitoring) programs. These higher spatial and temporal resolution datasets will be used in conjunction with baseline MATES V BTEX data to understand the impact of refineries on community and regional scales.

Reference:

Halliday, H. S., A. M. Thompson, A. Wisthaler, D. R. Blake, R. S. Hornbrook, T. Mikoviny, M. Müller, P. Eichler, E. C. Apel, and A. J. Hills. "Atmospheric benzene observations from oil and gas production in the Denver-Julesburg Basin in July and August 2014." *J. Geophys. Res. Atmos.* 121 (2016): 11,055-11,074.

### **Responses to Comment Letter B from Scott Fruin**

#### **Response to Comment B-1:**

The executive summary states that "The carcinogenic risk from air toxics in the Basin, based on the average concentrations at the 10 monitoring sites, is approximately 38% lower than the monitored average in MATES IV and 82% lower than the average in MATES II." and describes the changes in chronic HI from IV to V. In order to keep the executive summary at a reasonable length, staff believe that this level of detail is sufficient to highlight the large reductions in cancer risk.

#### **Response to Comment B-2:**

In Chapter 1, staff have added a description of the links between PM<sub>2.5</sub> exposures and risk of premature mortality. In future work, staff may consider adding information to the Data Visualization Tool to highlight the impact of PM<sub>2.5</sub> on premature mortality.

#### **Response to Comment B-3:**

Staff have added text in the chapters to provide additional interpretation of the hazard indices.

#### **Response to Comment B-4:**

The air toxics cancer risk associated with diesel PM was calculated using both the modeling results as well as the monitoring results. Uncertainties in the risk estimates stemming from the uncertainties in the cancer potency factor are noted in the Executive Summary and Chapter 1.

*Uncertainties in Modeled Air Toxics Cancer Risk Associated with Diesel PM*

The modeling-based cancer-risk used CAMx-predicted diesel PM to calculate cancer risk. The air toxics cancer risks presented in the MATES III and IV reports also used model-based predictions that did not rely on a conversion factor. However, the EC-to-diesel PM ratio was used in the measurement-based risk calculations in MATES V as well as earlier iterations. While there is uncertainty in the monitoring-based calculation of cancer risks from diesel PM, arising from the conversion factor, these risk estimates also showed similar significant reductions in diesel PM risk. This indicates that, despite the uncertainties in estimating this risk, the model-derived EC-to-diesel PM conversion factor served the risk calculation reasonably well.

The uncertainties in modeled EC concentrations were from the individual model components, i.e., emissions inputs and air quality and meteorological models. The CAMx model used for the MATES analysis is a state-of-the-art, comprehensive 3-dimensional model that utilizes 3-dimensional meteorological models, complex chemical mechanisms that accurately simulate ambient reactions of pollutants, and sophisticated numerical methods to solve complex mathematical equations that lead to the prediction of ambient air quality concentrations. While air quality models progressively became more sophisticated in employing improved chemical reaction modules that more accurately simulate the complex ambient chemical reaction mechanisms of the various pollutants, such improved modules are still based on limited experimental data that carry associated uncertainties. In order to predict ambient air quality concentrations, air quality models rely on the application of sophisticated numerical methods to solve complex mathematical equations that govern the highly complex physical and chemical processes that also have associated uncertainties. Layer averaging of model output reduces the sensitivity of the model to changing patterns in the vertical structure.

While significant improvements have been realized in mobile source emissions models, uncertainties continue to exist in the mobile source emissions inventory estimates. EMFAC2017 on-road mobile source emission estimates have improved with each new EMFAC release. On-road mobile source emissions have inherent uncertainties with the current methodologies used to estimate vehicle miles traveled and the impacts of fuel additives such as ethanol. Stationary (or point) source emission estimates generally have less associated uncertainty compared to area source emission estimates. Major stationary point sources report emissions annually whereas minor stationary and area source emissions are, in general, estimated based on a top down approach that relies on state-total to county-total production, usage or activity information. Area source emissions including paved road dust and fugitive dust have significant uncertainties in the estimation of particulate (PM<sub>2.5</sub>) emissions due to the methodologies used for estimation, temporal loading and weather impacts. In addition to uncertainties in PM emissions, EC emissions relied on speciation profiles and large uncertainties in those profiles were expected. Nevertheless, the modeled EC concentrations compared reasonably well with the measured EC concentrations throughout MATES II to MATES V. The model performance for EC provides reasonable confidence for both the EC emissions inventory and the modeling system.

Since diesel PM behaves similarly to EC in the atmosphere and diesel PM comes from fewer sources than EC and its modeling inventory does not need to be speciated, it is expected that the

uncertainties in the modeled diesel PM concentrations are less than the modeled EC concentrations.

*Uncertainties in Air Toxics Cancer Risk Associated with Diesel PM Calculated with Measured EC*

Uncertainties in estimating diesel PM risk from the measured EC concentrations are related to uncertainties in measured EC concentrations and uncertainties in the ratio of modeled EC and diesel PM. Additional text has been added in Chapter 2 to better describe these uncertainties. In addition, staff added error bars to the monitor-based calculation of diesel risk, which were based on uncertainties inherent in deriving the ratio of modeled diesel PM and EC along with uncertainties in the EC measurements. Although there are uncertainties in converting ambient EC concentrations into ambient diesel PM concentrations, it is worth noting that converted diesel PM concentrations compared reasonably well with modeled diesel PM concentrations.

Staff also added a figure showing the EC2.5 trend to Chapter 2; EC2.5 shows a steady decrease in concentrations from MATES III through MATES V.

**Response to Comment B-5:**

Staff reduced the density of basin boundaries in risk maps throughout the report to avoid misinterpretation of risk in the port area.

**Response to Comment B-6:**

(part 1) Staff have added text in this paragraph to clarify that air toxics are those pollutants that do not have ambient regulatory standards. However, federal, state, and local agencies do have regulatory standards that do control emissions of air toxics.

(part 2) Chapter 1 includes an explanation of the exposure pathways. Staff have added text to describe that the estimated multi-pathway cancer risk is ~8% higher than the inhalation-only estimate. The multi-pathway non-cancer chronic HI is approximately twice the inhalation-only estimate. Staff added text in Chapter 1 to describe the uncertainties in estimating health impacts from non-inhalation exposure pathways.

(part 3) Staff added "Results" to the "Fixed Monitoring" and "Modeling" headings.

(part 4) The risk results included in this section have been moved toward the beginning of the paragraph, along with a brief description of the basis of these calculations and the interpretation. Chapter 1 includes a more detailed description of how these cancer risks were calculated. A definition of secondary formation has been added.

(part 5) Staff have added text to the Executive Summary as well as Chapter 2 to provide more explanation and interpretation of the chronic HI.

(part 6) Staff fixed the font size in Figure ES-4.

(part 7) Staff have added clarifying text to the Executive Summary.

(part 8) Staff reduced the density of basin boundaries in risk maps throughout the report.

(part 9) Because previous MATES iterations utilized inhalation-only exposure pathways to calculate risk, and because a reader may be looking for the same information in the MATES V report, staff believe it is important to keep this information in the Executive Summary. Staff also concur that there is uncertainty in the calculation of cancer risks and discuss these uncertainties in the Executive Summary and Chapter 1.

(part 10) Although staff agree that presenting risk reduction by percentage may be useful, there is also value in consistently showing the change in absolute cancer risk across MATES iterations. However, the percentage reductions are described within the text of the report. Error bars have been added to the plot for diesel PM for MATES IV and V.

(part 11) Staff added text to the Caveats section of the Executive Summary to note that the conversion of BC to diesel PM is a source of uncertainty. This section also includes comments about the analysis not being designed to reflect near-source exposures. The analysis of the EC2.5 concentrations is included in Chapter 2. See also Response to Comment B-4.

(part 12) In an effort to keep the Executive Summary as short as possible, staff prefer to keep the conclusions at the end of the Executive Summary. However, staff will highlight such conclusions in infographics and outreach presentations.

**Response to Comment B-7:**

Uncertainties in the estimation of diesel PM health risks are addressed in the Executive Summary and Chapter 1. See Response to Comment B-4. Error bars have been added to the figure for diesel PM for MATES IV and V to help convey some uncertainties in these estimates.

**Response to Comment B-8:**

MATES IV and V diesel PM estimates were calculated with station-specific EC to diesel PM ratio calculated from modeled concentrations. As discussed above, uncertainties in the station-specific conversion factors were calculated for MATES IV and V and were combined with the EC measurement uncertainty to capture the diesel PM estimation uncertainty. MATES II and III diesel PM estimates were calculated with a basin-wide conversion factor calculated from modeled emissions. While it is not possible to calculate the uncertainty of these emission-based conversion factors, staff derived them for MATES IV and V to ensure that the methodology did not contribute to the large apparent decrease in diesel PM. Using these emission-based conversion factors led to a very similar trend in diesel PM throughout each MATES study. A paragraph was added to Chapter 2 to address this point.

**Response to Comment B-9:**

We have added horizontal lines showing the MATES IV average risk in the basin and Coachella Valley to figures 4-18 through 4-21. Appendix titles are shown on the cover pages of the appendices and in the List of Appendices.

**Responses to Comment Letter C from Ken Davidson**

**Response to Comment C-1:**

Staff added text to the Executive Summary detailing the change in population-weighted cancer risk within the SB535 designated communities compared to the rest of the Basin in MATES IV and MATES V.

**Response to Comment C-2:**

Staff added a couple of sentences acknowledging that unmeasured air toxics could contribute to health risks, but that the MATES studies have included the known air toxics that primarily drive health risks from air pollution.

**Response to Comment C-3:**

Staff added "ambient concentrations" for clarification.

**Response to Comment C-4:**

Staff revised the report so that the term "EJ Community" is first defined as "communities experiencing environmental injustices". The term "EJ Community" is subsequently used for the remainder of the chapter or appendix.

**Response to Comment C-5:**

Per OEHHA guidelines, residential health risks are calculated assuming that 100% of the time is spent at home. This is a conservative estimate of the impacts in a single location.

**Responses to Comment Letter D from John Budroe**

**Response to Comment D-1:**

Staff have incorporated additional language in the Executive Summary, Chapter 1 and Chapter 2 to clarify the terminology and interpretation of chronic non-cancer health impacts.

**Response to Comment D-2:**

Staff have made the suggested revisions.

**Response to Comment D-3:**

Staff have made the suggested revision.

**Response to Comment D-4:**

Page 2-14: Staff have made the suggested revisions.

Page 2-16: Staff have made the suggested revision.

Page 2-18: Staff have deleted the redundant graph and fixed the figure numbering.

Page 2-30: Staff have added text explaining that the two bromomethane figures show the same data with different vertical axes. Staff have added similar clarification for similar figure pairings throughout Chapter 2.

**Responses to Comment Letter E from Janet Whittick**

**Response to Comment E-1:**

Staff appreciate the comments about using MATES data to enhance our understanding of air toxics risk drivers, especially in environmental justice communities. The MATES data have already been used to inform AB 617 community efforts. For example, the MATES IV data was one of the main technical data sources that was used to inform community identification and prioritization efforts for AB 617. Additionally, the emissions inventory is a key part of the Source Attribution analysis portion of the AB 617 Community Emissions Reduction Plans (CERPs). These data, along with community knowledge and other information (e.g. near-source monitoring studies, other data sources), help to inform the priorities and actions of the CERPs. Staff intend to use MATES V data for similar purposes once the data are finalized.

**Response to Comment E-2:**

In order to keep the Executive Summary at a reasonable length and minimize redundancy, staff prefer not to include a discussion of the perspectives on risk that is currently described in Chapter 1. However, staff added text in the Executive Summary explicitly defining cancer risk and chronic non-cancer health impacts to improve clarity.

**Response to Comment E-3:**

Staff agree that it is reasonable to expect future trends of decreasing air toxics emissions, since criteria pollutants such as NOx, VOC and combustion-related PM emissions are also expected to decrease due to various regulations by the District, State and Federal agencies. These planning projections can already be found in other South Coast AQMD publications, such as the Air Quality Management Plans. For example, 2016 AQMP includes projected diesel PM emissions in the future year (2016 AQMP Appendix III). The Source Attribution analyses completed for the designated AB 617 communities also show significant decreases in air toxics emissions (including diesel emissions) from the 2017 baseline year to the target years 2024 and 2029 ([source-attribution-methodology.pdf](#)). Given that the MATES analysis has always been anchored on measurement data and serves as a platform to measure the progress in air toxics and associated health risks, staff do not believe that an analysis of projected future emissions and associated health risks would be a good fit. Staff have added text to the Executive Summary and Chapters 2, 3, and 4 to cite the existing data from the 2016 AQMP and the AB 617 source attribution analysis.

Staff have added text to clarify when information shown in figures is based on population-weighted data.