Action: Mobile monitoring to identify air pollution hotspots and assess the impact of truck emissions on community exposure

Background & Objective

The Wilmington, Carson, West Long Beach (WCWLB) community is intersected by a multitude of public roads and freeways with high traffic volumes and a high fraction of diesel truck traffic due to the presence of the Port of Long Beach and Port of Los Angeles and the associated goods movement. The specific concerns related to truck traffic identified by the community steering committee (CSC) include emissions from idling and moving trucks operated on freeways, major roadways, intersections, local neighborhood streets, and their impact on local residents. The monitoring strategy to study and characterize this air quality priority consists of comprehensive mobile measurements and near-road monitoring for black carbon (BC), particulate matter (PM), ultrafine particles (UFP), nitric oxide (NO), and nitrogen dioxide (NO_2).

Mobile monitoring is first conducted in areas identified by the CSC with high density of moving and idling trucks within the local neighborhood streets and prioritized based on available truck density information. These measurements will extend to other areas within the WCWLB community to support implementation of emission reduction strategies and track their progress; identify air pollution hotspots; and assess the impact of truck emissions on community exposure.

These measurements complement the near-road measurements collected by the South Coast AQMD near the I-710 freeway that provide representative pollutant exposure information for people who live, work, or go to school adjacent to freeways or who spend significant time traveling on some of the busiest roadways in Southern California with a high fraction of diesel truck traffic.

Method

Mobile monitoring is conducted using a mobile platform capable of measuring a wide range of particulate and gaseous pollutants, including PM, BC, UFP, NO, and NO_2. Figure 1 shows the routes traversed by the mobile platforms (as of May 2020), with respect to the location of truck idling hotspots (shown as yellow circles) and truck traffic related air quality concerns (shown as red stars) within WCWLB. Truck traffic air quality concerns were identified by the CSC through a prioritization activity during the February 2019 CSC meeting, whereas the truck idling hotspots were identified by the CSC through a separate prioritization activity during the October 2019 CSC meeting.

The South Coast AQMD maintains [a near-road air monitoring station] downwind of the I-710 freeway (and within the WCWLB community) where some of the major diesel emission tracers (BC, NO_2, PM2.5 and UFP) are measured. This site has been operational since 2015 and will provide an opportunity to observe relatively long-term trends in pollution levels and track the progress of emissions reduction strategies.

Results

- As of May 2020, a total of 5 days of mobile monitoring has been carried out to study and characterize the truck idling hotspots and truck traffic air quality concerns identified by the CSC
- Mobile monitoring results indicated elevated concentrations of NO_2, UFP, and BC on major freeways and roadways (Attachment A)
- NO_2, UFP, and BC concentrations were found to be generally lower in residential communities as compared to those measured in and around major streets and freeways (Attachment A)
  Average NO_2 levels were comparable between measurements taken within truck idling locations/truck traffic air quality concerns and all mobile data (Attachment A)

Next steps

- Continue to assess mobile measurements and near-road fixed monitoring data/results to support implementation of emission reduction strategies and track their progress

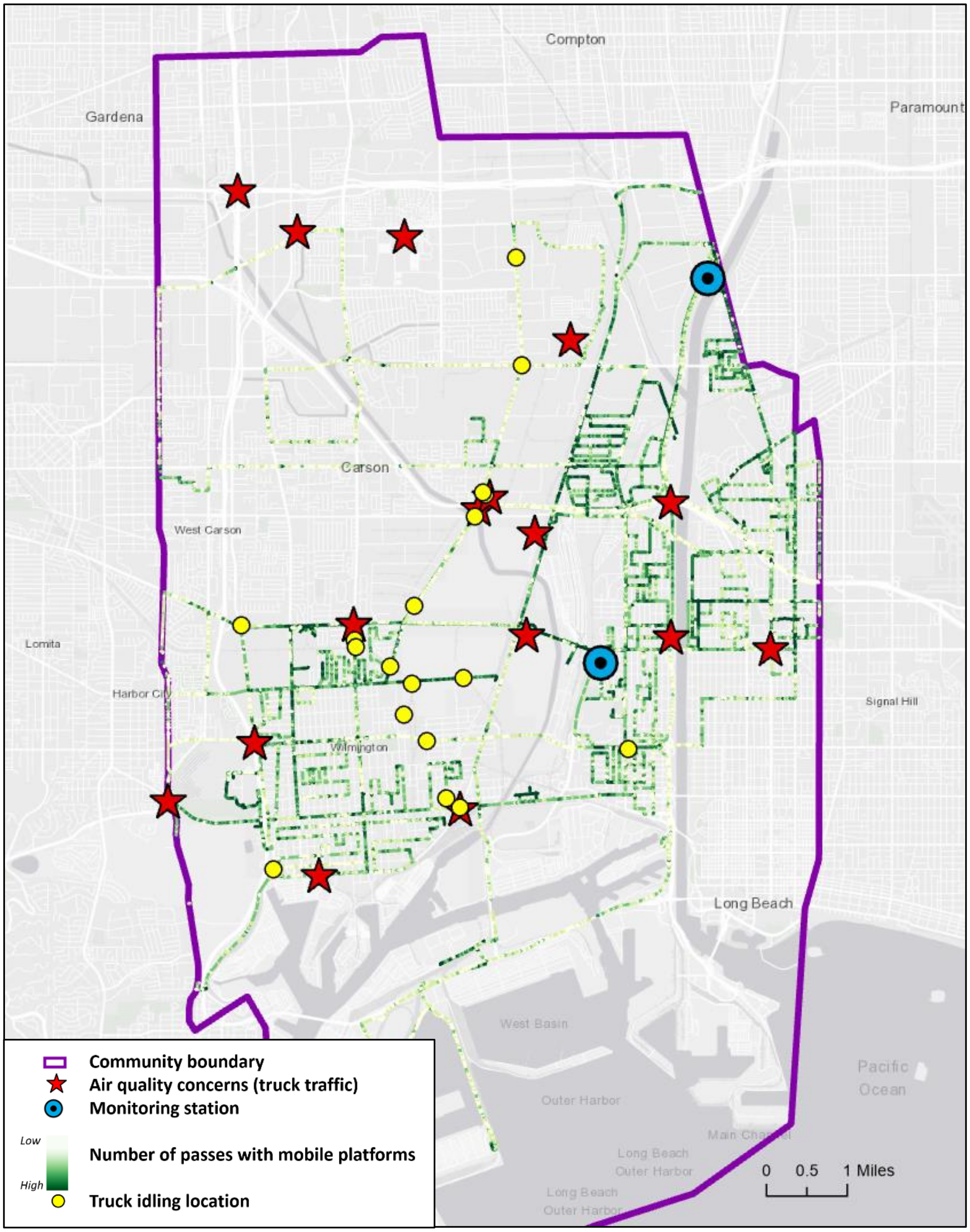


Figure 1. The routes traversed by the mobile platforms with respect to the locations of the truck idling hotspots and truck traffic-related air quality concerns. As of May 2020, a total of 5 days of mobile monitoring has been carried out in the WCWLB community

Attachment A

As of June 2020, a total of five mobile monitoring surveys have been conducted in the Wilmington, Carson, West Long Beach (WCWLB) community to measure diesel emissions. Diesel engines emit a complex mixture of air pollutants, including both gaseous and solid material. The solid material in diesel exhaust is known as diesel particulate matter (DPM), which is a component of PM2.5. There is no technique to directly measure DPM (a major contributor to health risk); therefore, indirect measurements based on surrogates for components of diesel exhaust are used, specifically black carbon (BC). DPM is typically composed of carbon particles ("soot", also called BC) and numerous organic compounds. Diesel exhaust also contains gaseous pollutants, including volatile organic compounds (VOC) and NOx. Measurements are conducted using a mobile platform capable of monitoring a wide range of particulate and gaseous pollutants, including particulate matter (PM), black carbon (BC), ultrafine particles (UFP), and nitrogen dioxide (NO_2), as part of the area-wide surveys.

The routes traversed by the mobile platform were defined in a way to perform monitoring in and around major roadways and freeways, as well as truck traffic and idling locations identified by the community steering committee (CSC) within the WCWLB community (Figure 1). The location of truck idling hotspots (shown as yellow circles) and truck traffic related air quality concerns (shown as red stars) within WCWLB were identified by the community steering committee (CSC) through a prioritization activity during the February 2019 CSC meeting, whereas the truck idling hotspots were identified by the CSC through a separate prioritization activity during the October 2019 CSC meeting.

Figure A-1 shows the duration and time window for the area-wide mobile measurements performed within the WCWLB community in and around freeways, major roadways, truck idling hotspots, and truck traffic-related air quality concerns. As shown in this figure, mobile monitoring was performed in different times of day during the five survey days. The starting time of the mobile monitoring surveys varied between 8 and 11:30 am PST (Pacific Standard Time), whereas the ending time ranged from 1 to 3 pm PST.

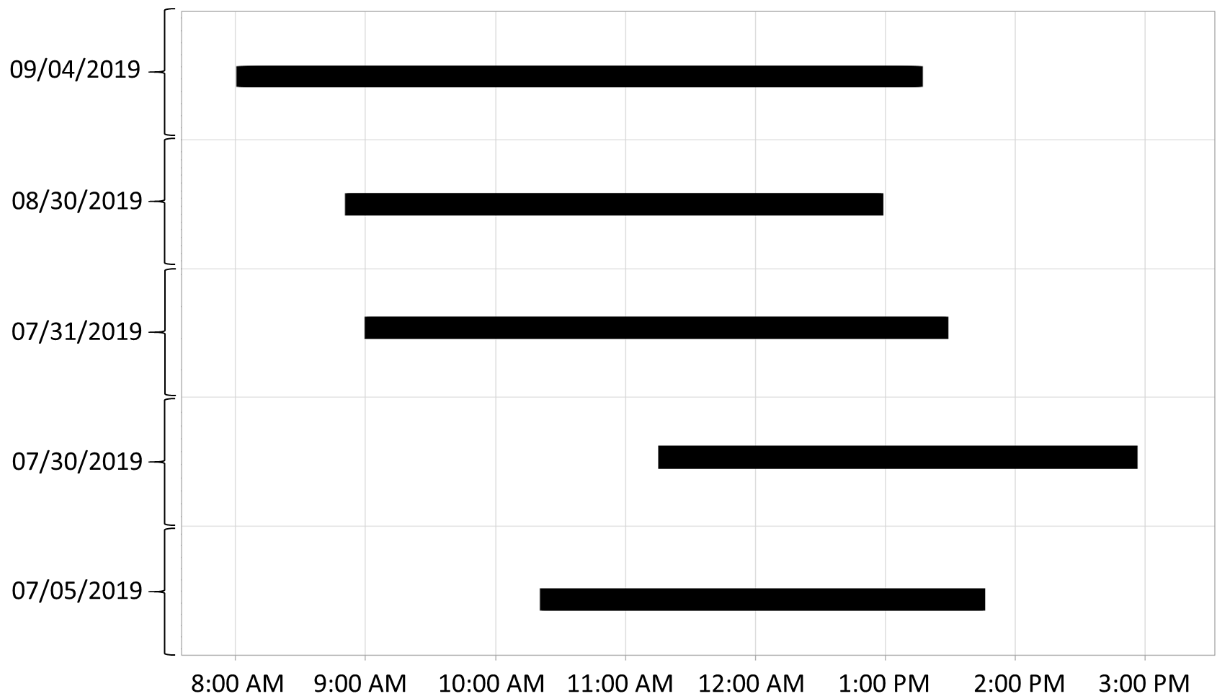


Figure A-1. The duration and time window for the area-wide mobile measurements performed in and around freeways, major roadways, truck idling hotspots, and truck traffic-related air quality concerns within the WCWLB community. The time windows only include hours of active mobile measurements within the community, excluding the commute time between the South Coast AQMD Headquarters and the community

Upon extensive screening and pre-processing of the data, NO_2 measurements were found to be the most robust and reliable set of diesel exhaust markers measured, with 5 (out of 5) valid days of measurements and minimum instrument down time, followed by UFP and BC measurements, with 3 and 1 valid day(s) of measurements, respectively. Figures A-2, A-3, and A-4 illustrate "aggregated" maps of the spatial patterns (or concentration gradients) of NO_2, UFP, and BC concentrations in and around freeways, major roadways, truck idling hotspots, and truck traffic-related air quality concerns within the WCWLB community, as measured by the mobile monitoring platform during those five days. To ensure that the concentration gradient map is representative of the variations in the pollutant concentrations, individual measurements taken within a 50-meter radius in different passes and on different days were "aggregated", by calculating their arithmetic average, and shown as colored hexagonal bins on the map. Therefore, each hexagon on the map represents multiple measurements taken at different passes. In addition, it should be noted that mobile measurements taken on different days and hours cannot be directly compared, mainly because of the day-by-day and diurnal (i.e., hour-of-the-day) variability in pollutant concentrations as a result of changes in meteorology and source emission strengths. Therefore, in order to account for the day-by-day as well as diurnal variability in the pollutant concentrations, the mobile monitoring data need to be normalized with stationary data from a fixed site monitoring station, according to a commonly used method in the literature. To achieve this, minutely data from the Hudson monitoring station was collected and hourly averages of pollutant concentrations were computed for the time period corresponding to the period when mobile monitoring was conducted (Figure A-1). For example, on September 4th, 2019, mobile monitoring was performed from 8 am PST to 1:08 pm PST, therefore, a total of 6 hourly averages were calculated for each pollutant from the Hudson monitoring station. Subsequently, the mobile monitoring data with 1-second time resolution was divided by the hourly averaged stationary data that corresponded to the hour in which that measurement was taken.

As shown in Figure A-2, the mobile monitoring results indicated elevated NO_2 concentrations on freeways, including the I-710 and I-405, and major roadways, including Alameda St., Wilmington Ave., Sepulveda Blvd., and W Anaheim St. These instantaneous elevations, lasting from seconds to minutes, were occasionally higher than the U.S. EPA's short-term (i.e., 1-hour) standard for NO_2 (i.e., 100 ppb). However, the comparison of instantaneous measured concentrations with hourly standard must be interpreted with caution, as instantaneous measurements conducted by the mobile platform represent concentration levels measured every few seconds, whereas the NO2 short-term standard is based on 1-hour average concentration. The purpose of this comparison here is to help with the identification of persistent elevated levels of NO_2 and the potential pollution hotspots. It can also be observed from the map that NO_2 concentrations were much lower in residential communities as compared to those measured in and around freeways and major roadways within the WCWLB community. Additionally, as shown in the map, while relatively high NO_2 concentrations were observed in some of the truck traffic air quality concerns and truck idling locations identified by the CSC, no significant elevations in NO_2 levels were observed for most of the truck traffic air quality concerns and truck idling locations.

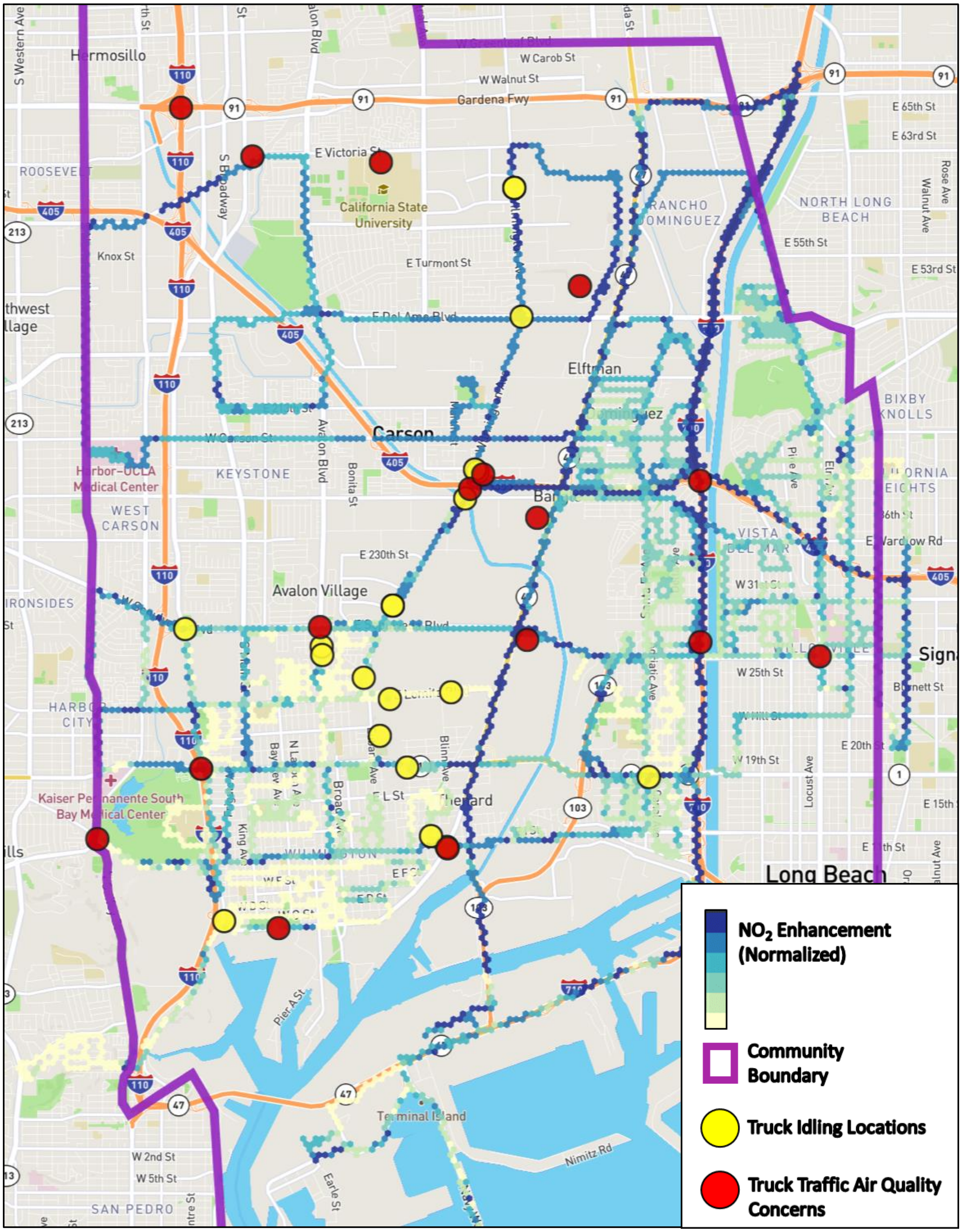


Figure A-2. Aggregated map of the spatial pattern of NO_2 concentrations in and around freeways, major roadways, truck idling hotspots, and truck traffic-related air quality concerns within the WCWLB community, as measured by the mobile monitoring platform on 07/05/2019, 07/30/2019, 07/31/2019, 08/30/2019, and 09/04/2019

For UFP (Figure A-3), the most elevated concentrations were observed on the I-710 freeway, followed by Santa Fe Ave and Alameda St. Expectedly, and similarly to NO_2, UFP concentrations were generally lower in residential communities compared to those measured in and around freeways and major roadways within the WCWLB community. As with NO_2, some of the truck traffic air quality concerns and truck idling locations exhibited somewhat elevated UFP levels, while the rest did not show any significant elevations. As shown in Figure A-4, BC concentrations also showed the highest elevations on the I-710 freeway and parts of Alameda Street. BC levels were also generally higher to the west of the I-710 freeway compared to those measured in the communities across the Los Angeles River to the east of the I-710. Since valid BC data were only limited to one measurement day, they spanned a smaller part of the WCWLB community, compared to NO_2 and UFP, and only covered a few of the truck traffic air quality concerns. It is also noteworthy that even though the spatial patterns of these DPM tracers did not exactly match, the general trends were expectedly consistent, showing elevated levels near and on major freeways and streets. This is an important observation since a large fraction of personal exposure to DPM occurs during travel on roadways. According to California Air Resource Board[1], although Californians spend a relatively small proportion of their time in enclosed vehicles (about 7% for adults and teenagers, and 4% for children under 12), 30 to 55% of daily DPM exposure typically occurs during the time people spend in motor vehicles.

[1] https://ww2.arb.ca.gov/resources/overview-diesel-exhaust-and-health

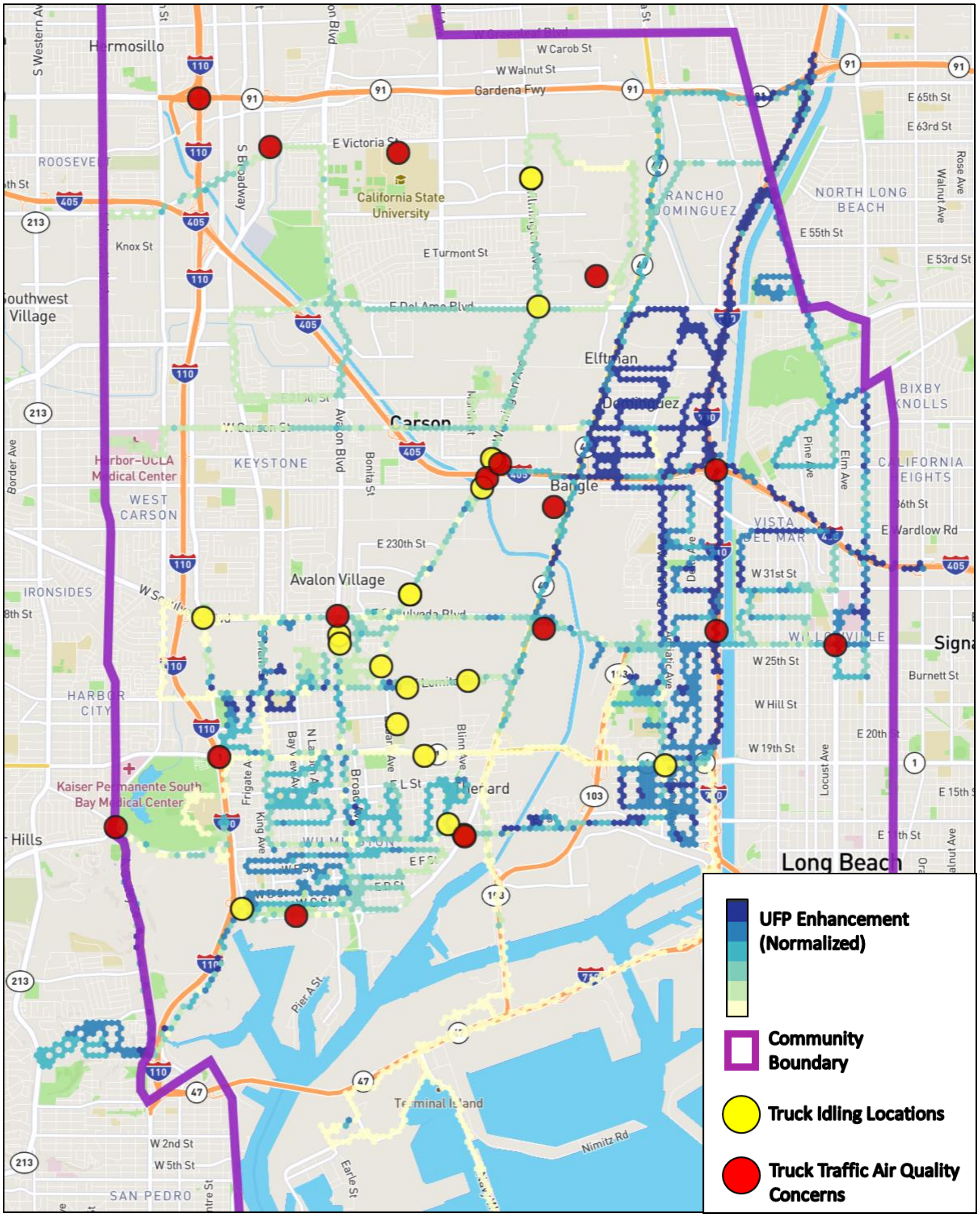


Figure A-3. Aggregated map of the spatial pattern of ultrafine particles (UFP) concentrations in and around freeways, major roadways, truck idling hotspots, and truck traffic-related air quality concerns within the WCWLB community, as measured by the mobile monitoring platform on 07/30/2019, 07/31/2019, and 09/04/2019

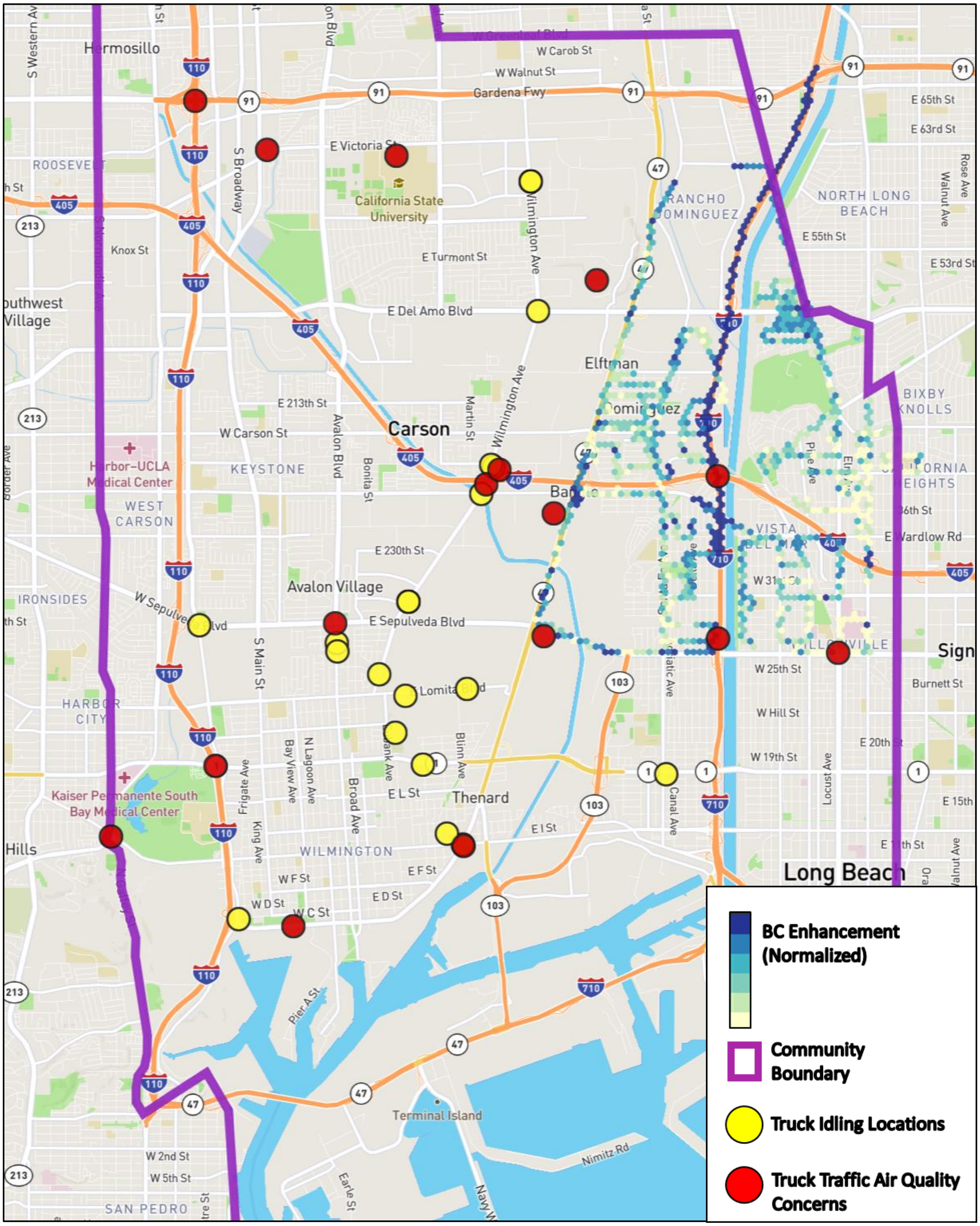
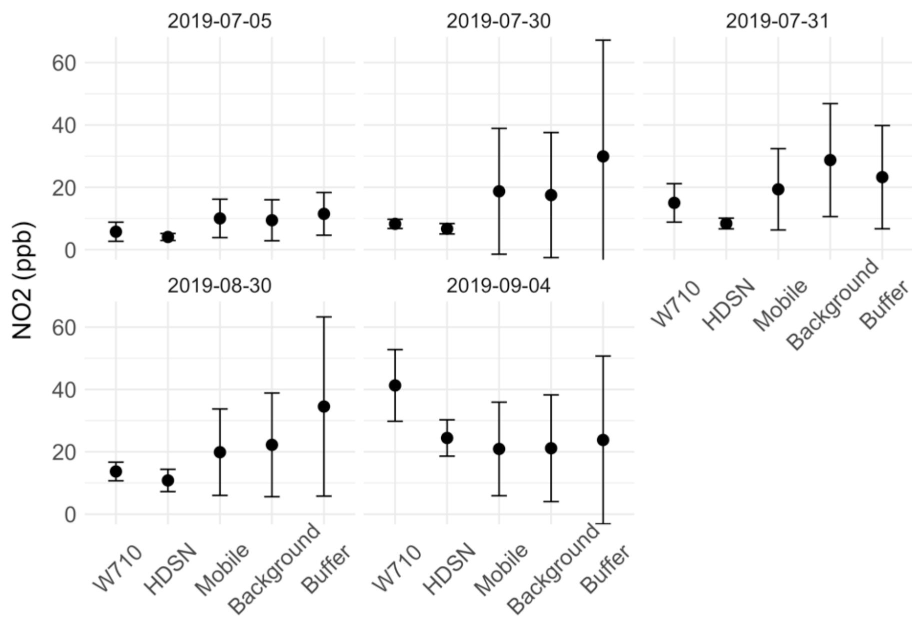


Figure A-4. Aggregated map of the spatial pattern of black carbon (BC) concentrations in and around freeways and major roadways within the WCWLB community, as measured by the mobile monitoring platform on 08/30/2019

In order to further investigate the NO_2 levels in and around truck traffic air quality concerns and truck idling locations, a 200-meter radius "buffer" zone was defined around each location to quantify pollution around these locations (regardless of how many trucks were observed at each identified location at the time of mobile monitoring). Additionally, a 500-m radius "background" zone (excluding the buffer zones) was also defined around each location to quantify air pollution further away from the truck traffic air quality concerns and truck idling locations. Mobile NO_2 measurements taken over the course of five days were then aggregated in these buffer and background zones and compared to all on-road "mobile" data taken within the WCWLB community and in the nearby stationary monitoring stations (i.e., Hudson monitoring station (HDSN) and I-710 near-road monitoring station (W710) (Figure A-5(a and b)). It should be noted that when comparing data from monitoring stations and mobile measurements, it is important to make comparisons for data measured within the same time period. Therefore, data from the monitoring stations were averaged for the period corresponding to the hours that the mobile measurements were conducted.

Average values for NO_2 over all days were comparable between measurements taken within background and buffer zones and all mobile data for both truck traffic air quality concerns and truck idling locations. On-road mobile data showed a higher average NO_2 concentration compared to the HDSN site (18.3 ppb vs. 12.4 ppb), but they were comparable to average NO_2 concentration measured at the near-road W710 site (19.0 ppb). It should be noted that mobile measurements represent variations in data both in time and space, whereas data from fixed monitoring stations characterize a single area over time. Therefore, direct comparisons of these data should be done with caution.

a)



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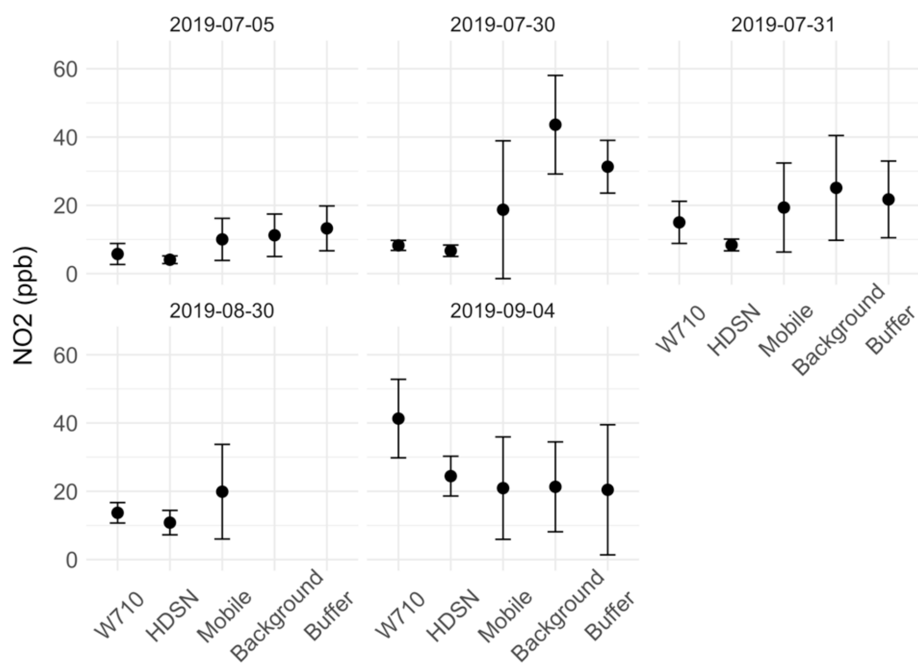

Figure A-5. Point plots of mobile-measured NO_2 levels within and outside of background and buffer zones for: a) truck traffic air quality concerns, and (b) truck idling locations, as compared to all on-road mobile data and those measured in Hudson and W710 fixed sites within the WCWLB community. The points represent the mean and errors correspond to one standard deviation

Attachment B

South Coast Air Quality Management District (South Coast AQMD) maintains a near-road air monitoring station downwind of the I-710 freeway within the WCWLB community (Figure 1) where some of the major diesel emission tracers, including black carbon (BC), nitrogen dioxide (NO_2), fine particulate matter (PM2.5), and ultrafine particles (UFP), are measured. This site has been operational since 2015 and provides an opportunity to observe relatively long-term trends in pollution levels and track the progress of emissions reduction strategies. These measurements provide representative pollutant exposure information for people who live, work, or go to school adjacent to freeways or who spend significant time traveling on some of the busiest roadways in Southern California with a high fraction of diesel truck traffic.

In this attachment, an overview of the temporal trends in the concentrations of these diesel emissions tracers are provided along with a comparison of the levels with those measured at the Hudson monitoring station, which also lies within the WCWLB community (Figure 1). In this report, we are focusing on data collected between 07/01/2019 and 07/13/2020. Figure B-1 illustrates the monthly variations in the concentrations of NO_2, UFP, BC, and PM2.5. As can be seen in the figure, for all the pollutants, higher levels are observed in the colder months of the year (i.e., October-February), due mainly to the impact of meteorology. PM2.5 and UFP also show somewhat elevated levels in July and August, which could be attributed to the impact of secondary aerosol formation enhanced during the warmer season. Particles are formed by photochemical reactions in the atmosphere, particularly in photochemically-active, sunnier seasons. This is often reflected in a mid-day peak associated with secondary particles and is common in the Los Angeles Air Basin.

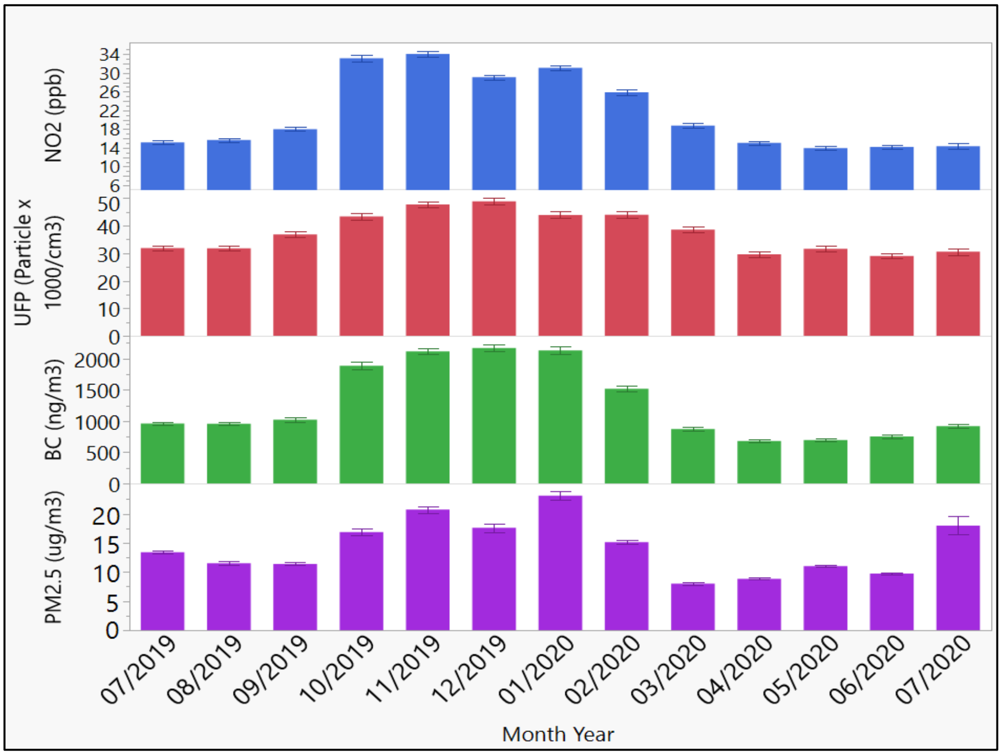

Figure B-1. Monthly variations in the concentrations of NO_2, UFP, BC, and PM2.5 at W710 monitoring station. Error bars correspond to one standard error (SE)

Figures B-2 and B-3 indicate the diurnal variations of NO_2, UFP, BC, and PM2.5 by season and day-of week, respectively. As shown in Figure B-2, in the cold season (i.e., October-February), the diurnal variation plots show sharp peaks for all diesel emission tracers during morning rush hours. Another peak is also observed in the late afternoon hours, which again coincides with traffic rush, particularly for NO_2 and UFP, and, to some extent, for PM2.5. This is an expected trend given the fact that the W710 site is located right next to the heavily congested I-710 freeway, with the highest percentage of truck traffic compared to other freeways in the Los Angeles Basin. In the warm season (i.e., March-September), the peaks during traffic rush hours can still be observed, but they are much less pronounced compared to the cold season, mainly due to the impact of meteorology. A major mid-day peak is also observed in UFP levels in the warm season, which is attributed to secondary aerosol formation due to enhanced photochemistry, which is typical in Los Angeles Air Basin.

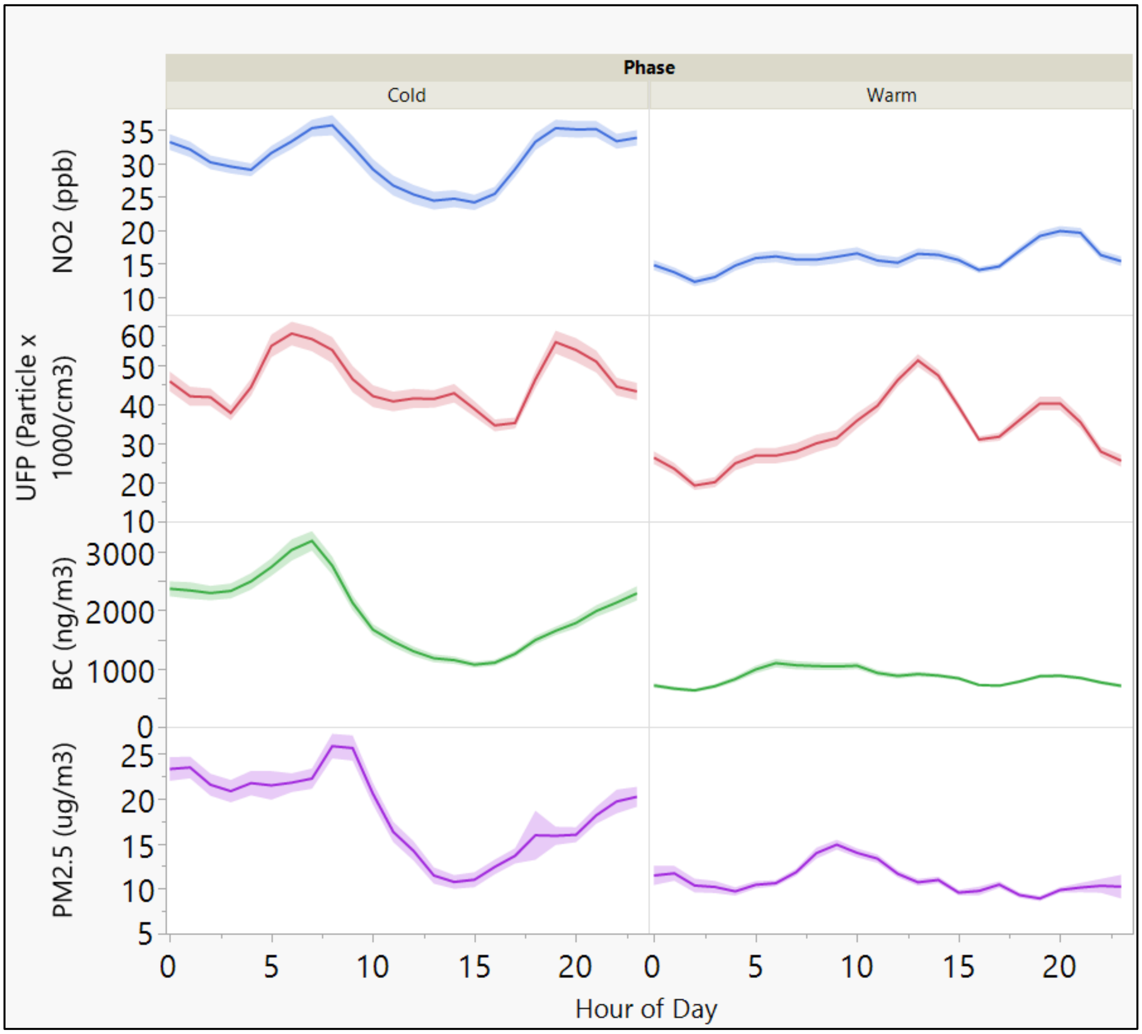

Figure B-2. Diurnal variations in the concentrations of NO_2, UFP, BC, and PM2.5 at the W710 monitoring station in different seasons. Cold phase corresponds to Oct- Feb, while warm phase corresponds to Mar-Sep. The error bands represent one standard error (SE)

Figure B-3 also shows the diurnal trends in the concentrations of NO_2, UFP, BC, and PM2.5 by day-of-the-week. As can be seen in the figure, NO_2, UFP, and BC show clearly higher levels during the weekdays, as compared to the weekends. This trend is the result of lower traffic volume on the weekends on the I-710 freeway. It is noteworthy that a similar trend is not observed for PM2.5, and levels are comparable between weekdays and weekends, most likely because PM2.5 is a regional pollutant and its concentrations are driven by other sources as well. PM2.5 also seems to be showing elevated nighttime levels on Saturday nights, which has been previously reported in the literature and associated, at least partly, with people's intra-city trips and activities during the weekend nights.

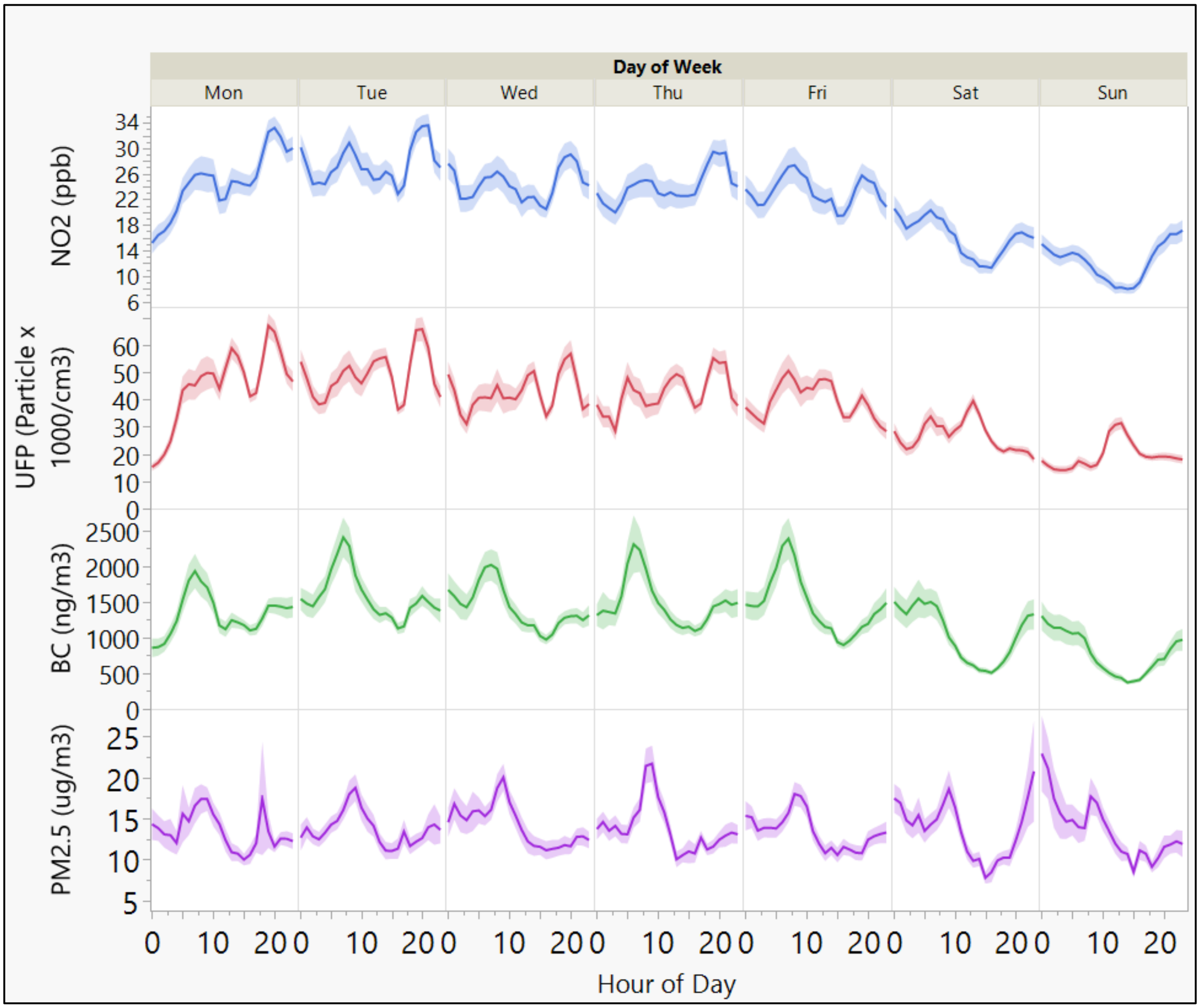

Figure B-3. Diurnal variations in the concentrations of NO_2, UFP, BC, and PM2.5 at the W710 monitoring station in different days of the week. The error bands represent one standard error (SE)

Figure B-4 indicates a comparison of the BC, UFP, and NO_2 levels measured in W710 and HDSN monitoring stations. It should be noted that when comparing data from different monitoring stations, it is important to make comparisons for data measured within the same time period. For BC, data were available at both sites for the entire time period of interest for this analysis (i.e., 07/01/2019 through 07/13/2020). However, this was not the case for NO_2 and UFP. For NO_2, HDSN data were only available from 07/01/2019 through 12/13/2019, so only NO_2 data measured within this time period were compared between the two monitoring stations. For UFP, HDSN data were only available from 07/01/2019 through 12/20/2019, so only UFP data measured within this time period were compared between the two monitoring stations.

As can be seen in Figure B-4, levels of BC, UFP, and NO_2 were higher in the W710 station, as compared to those measured at the HDSN monitoring station. Expectedly, the higher levels at the W710 monitoring station are due to the immediate vicinity of this site to the I-710 freeway with heavy traffic, while HDSN is located further away from major roads and streets, although still impacted.

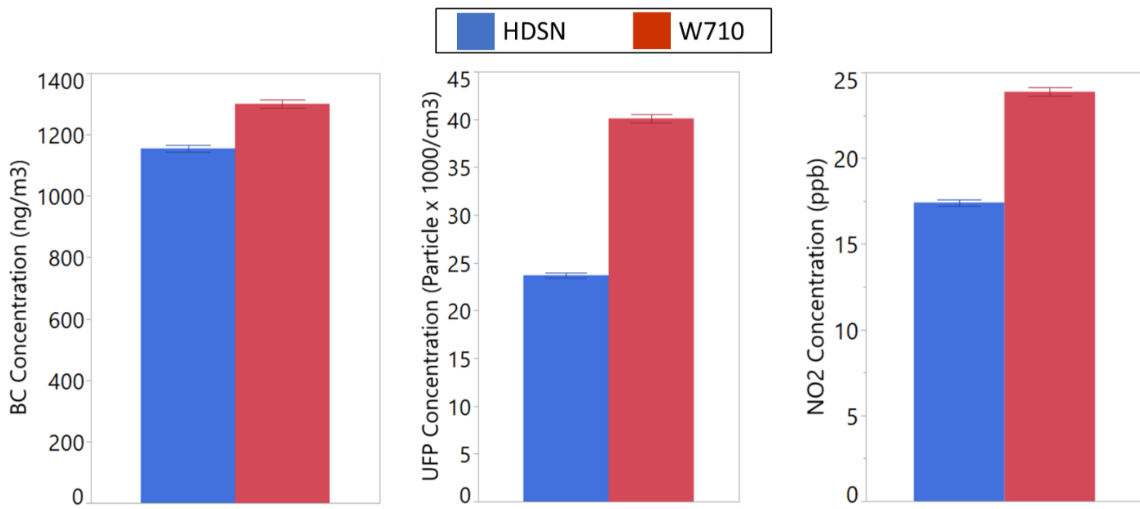

Figure B-4. Comparison of diesel emission tracer levels between W710 and HDSN monitoring stations. Error bars correspond to one standard error (SE). BC plot corresponds to data from 07/01/2019 through 07/13/2020, while NO_2 and UFP plots correspond to data measured from 07/01/2019 through 12/13/2019 and from 07/01/2019 through 12/20/2019, respectively