



# Community Air Quality Research

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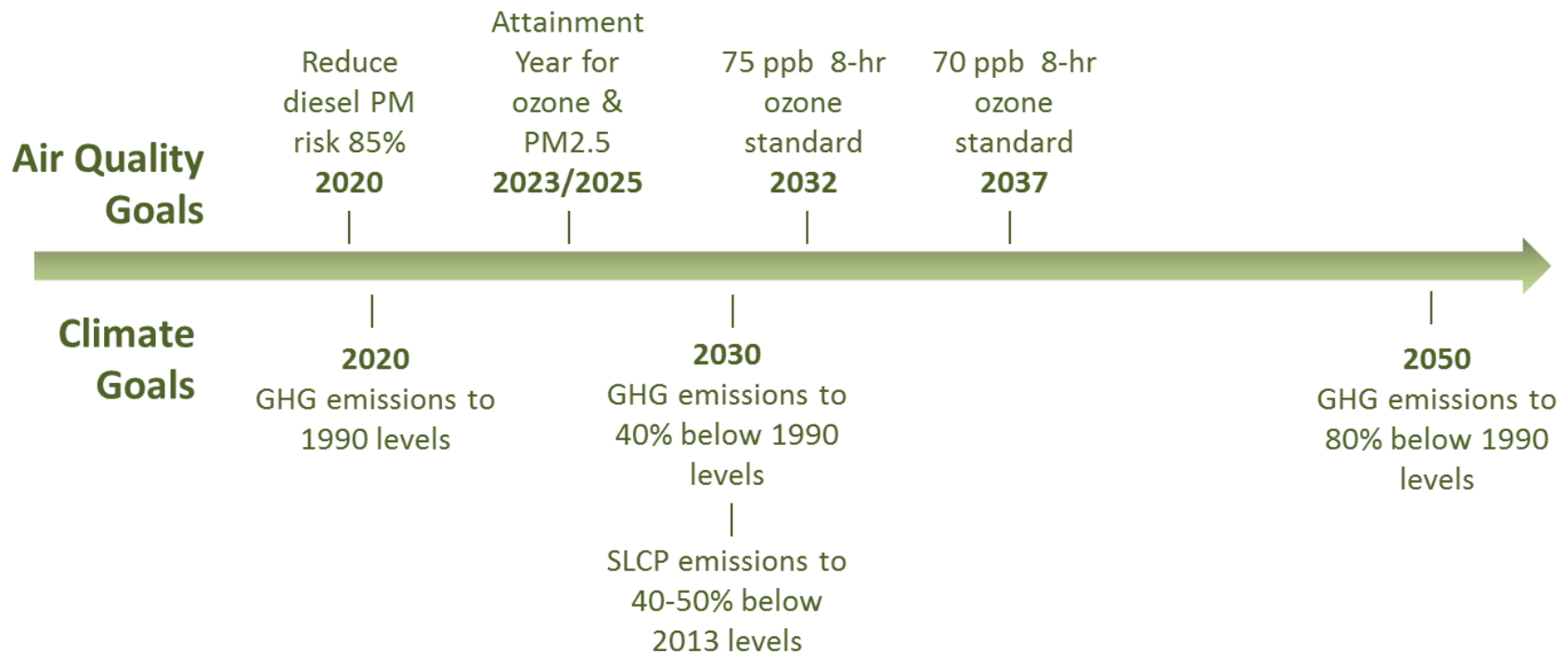


“Making Sense of Sensors”  
September 27-28, 2017



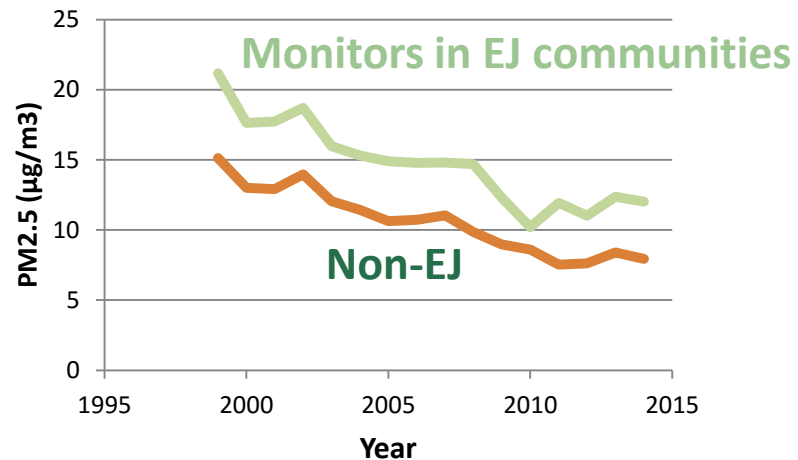
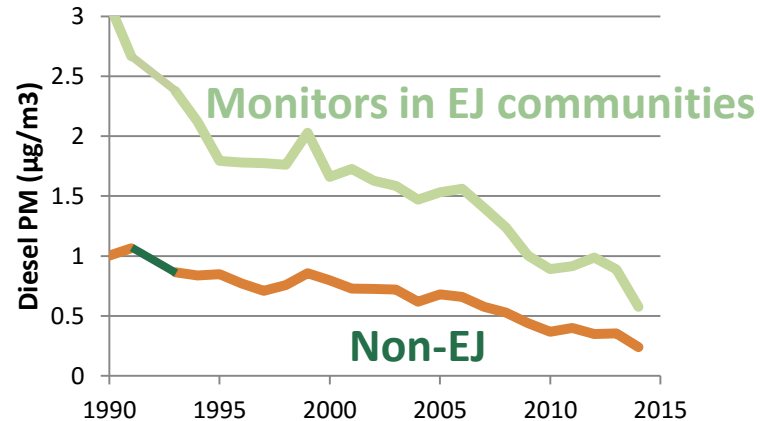
CALIFORNIA  
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# California Goals



# Environmental Justice Challenges

- Why diesel PM and PM2.5 levels at monitors in EJ communities are higher than those in non-EJ communities
- Quickly finding air pollution hotspots
- Determining the contributing sources
- Measuring progress

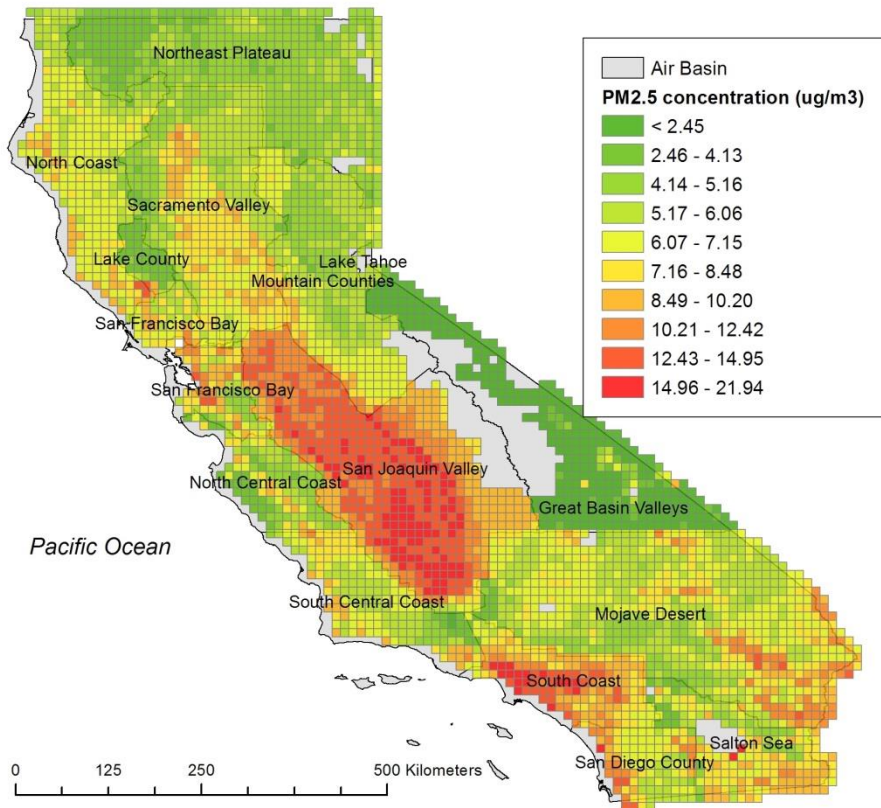


# Approach

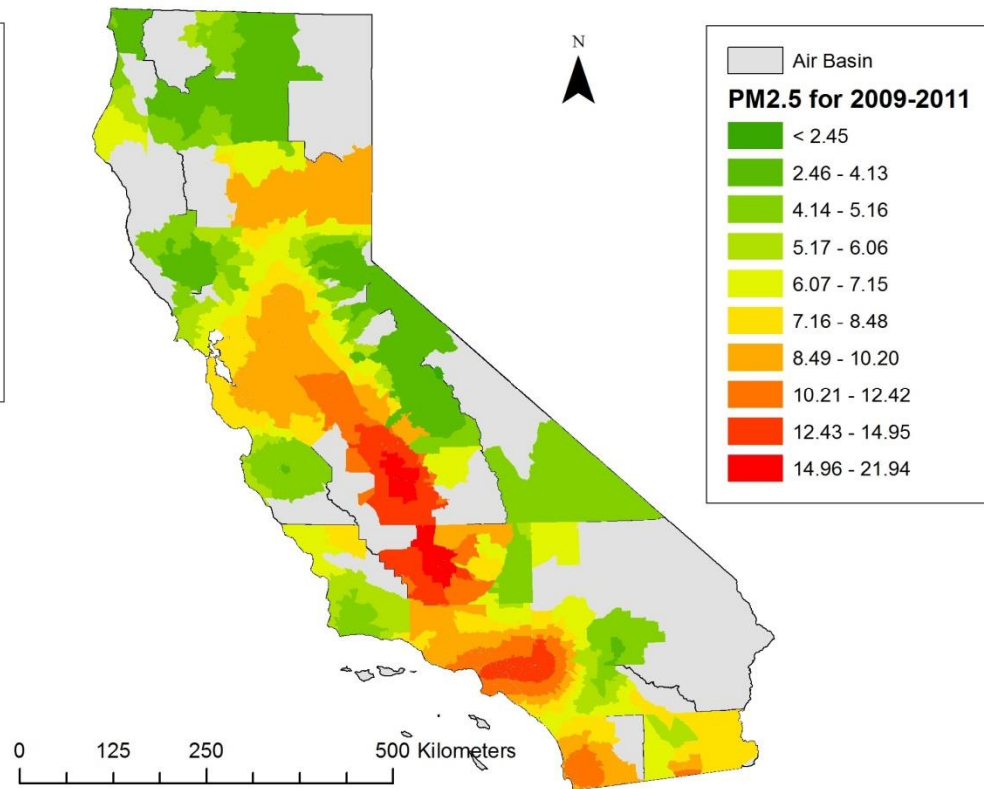
- Build on past successes
  - EV Mobile Monitoring Platform (2005)
  - Harbor Communities Monitoring Study (2007)
- Fill air quality data gaps using multi-scale data
  - Satellite data to map state-level air quality (PM2.5, CO, HCHO)
  - Airborne remote sensing (methane super-emitters)
  - Regional modeling and ambient monitoring maps
  - Community-based and source-oriented fixed monitoring
  - Street-level mobile monitoring and source follow-up
  - Personal monitoring for complete exposure analysis
- Mapping and data analysis to identify local hotspots and their sources
- Intake fraction approach for health-weighted source impacts

# Satellite Remote Sensing

## 10-km resolution (1-km for 2016 in progress)



PM2.5 for 2006-2012  
(satellite-based estimates)

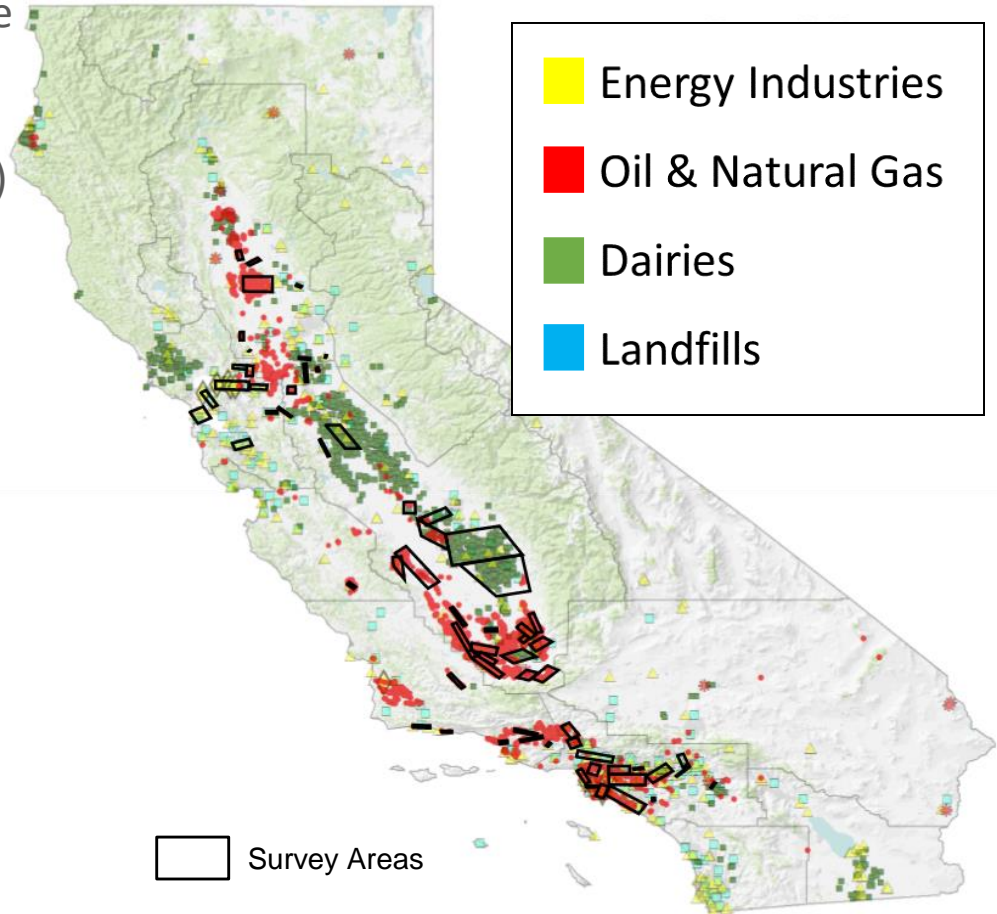


PM2.5 for 2009-2011  
(interpolation estimates)

# Airborne Remote Sensing

## California Statewide Methane Survey

- >350,000 possible methane sources in California
- CARB and CEC funded under AB 1496 (Thurmond)
  - Airborne methane imaging by NASA/JPL
  - Point source detection method within meters for large sources (>10 kg/hr)
  - Snapshot so ground verification needed
- Timeline
  - Phase 1 (CARB funded) complete
  - Phase 2 (CEC funded) started August 2017
  - Emission quantification (NASA funded) in 2018

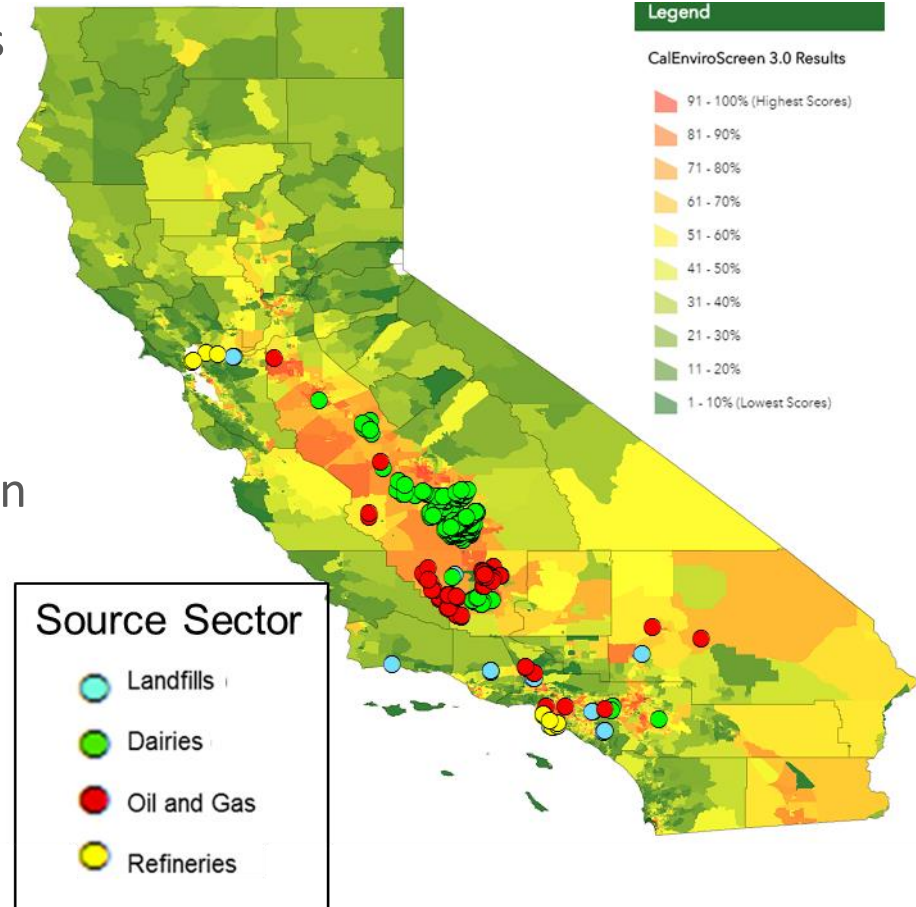




# Phase 1 Results

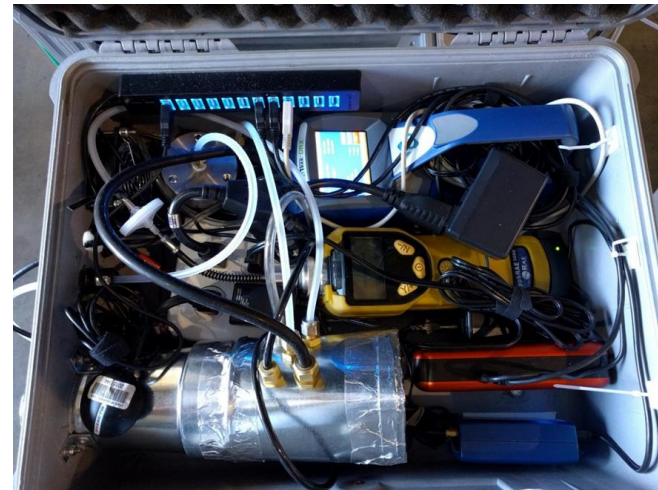
*329 high-emitting point sources identified*

- 180,000 individual facilities surveyed over 15,000 km<sup>2</sup>
- Follow-up research to measure co-emitted toxics and screen for community impacts
- Inform community selection for Oil and Gas Community Monitoring efforts



# Mobile Monitoring Technologies

- Three tiers of measurements
  - Small-scale research grade analyzers in quickly deployable CARB Mobile Hat systems
  - CARB vehicle for air toxics using state-of-the-science FTIR
  - FluxSense van for vertically integrated source emission rate estimation
- Pollutants
  - Black carbon, ultrafine particles, and PM<sub>10</sub>, PM<sub>2.5</sub>, PM<sub>1.0</sub>
  - NO<sub>x</sub>/NO<sub>2</sub> and CO<sub>2</sub>
  - Total and speciated VOC
  - Methane, ethane





# Data Analysis Tools

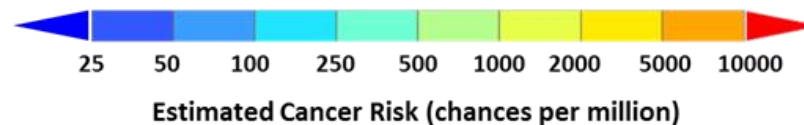
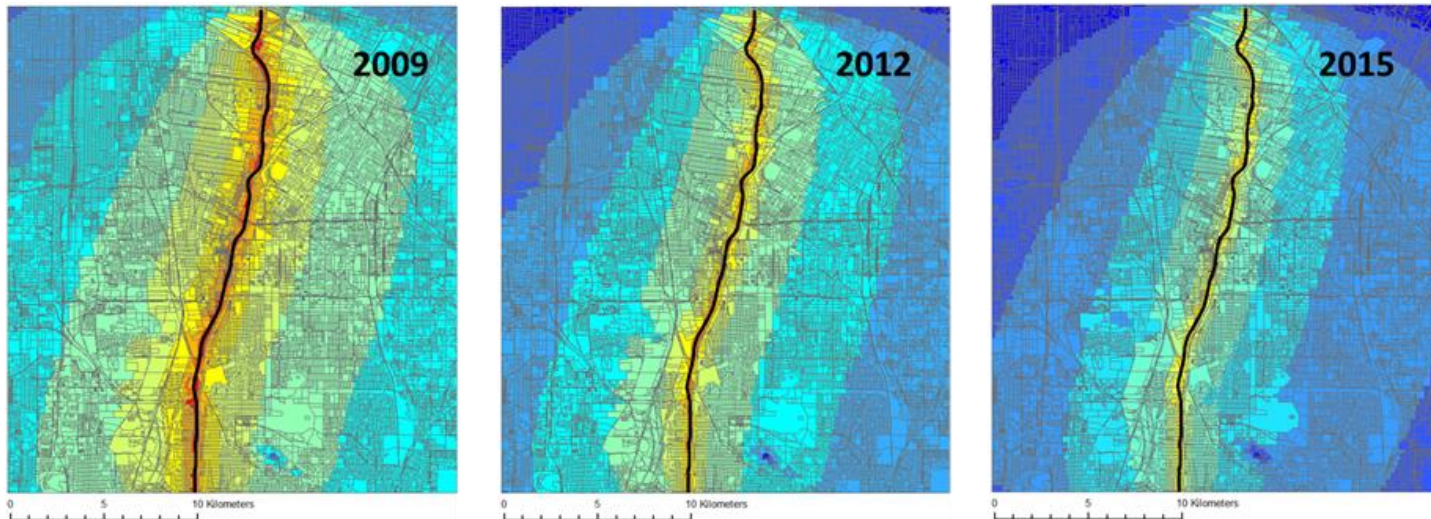
- Spatial concentration mapping to identify local hotspots
  - Automated data checks, display, and statistics
- Identify disproportionate impacts from sources
  - Source tracers (e.g., CO vs. BC and NO<sub>x</sub>)
  - Multi-pollutant factor analysis
  - Emission factors and dispersion modeling



# Community Modeling

## *Heavy-Duty Vehicle Emission Reductions*

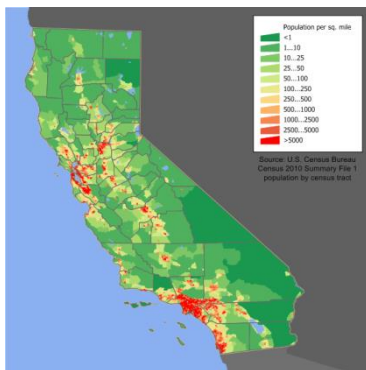
- Real-world vehicle activity and emissions being measured on freeways, Caldecott Tunnel, and at ports
- Modeled diesel PM cancer risk along I-710 freight corridor



# Intake Fraction Framework

*Fraction of pollutant emitted that is inhaled*

## Population

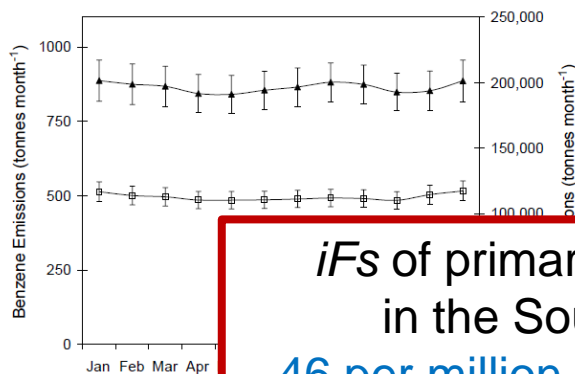


## Exposure

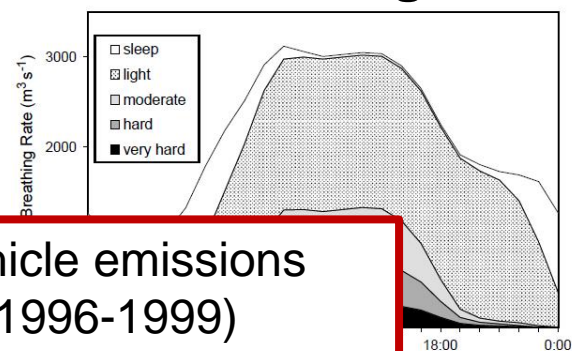
- Ambient or modeling
- Microenvironments
- Time-activity patterns

$$iF = \frac{\text{Exposure} \times \text{Breathing Rate}}{\text{Total Emissions}}$$

## Emissions



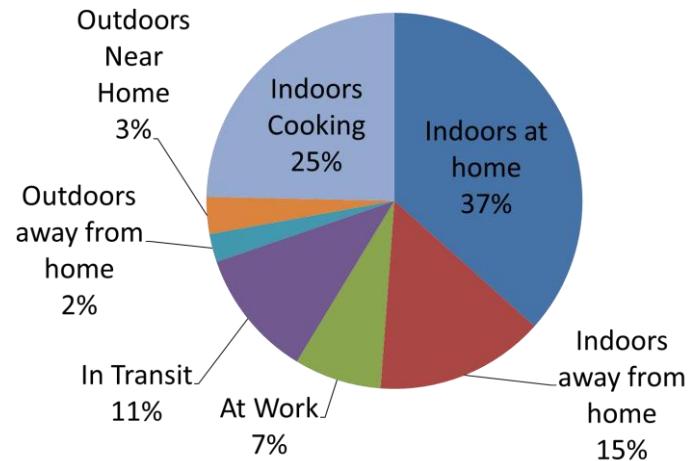
## Breathing Rate



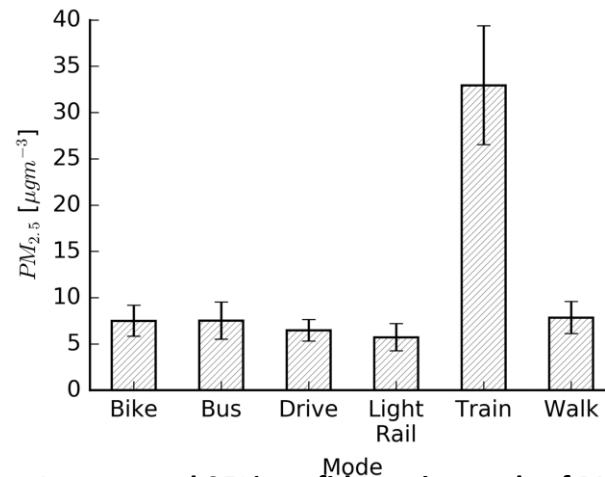
*iF*s of primary pollutants from vehicle emissions  
in the South Coast Air Basin (1996-1999)  
46 per million for CO and 48 per million for benzene

# Personal Exposure

- CARB backpacks to measure pollution levels during personal activities
  - Indoors and other microenvironments
  - Various commute modes



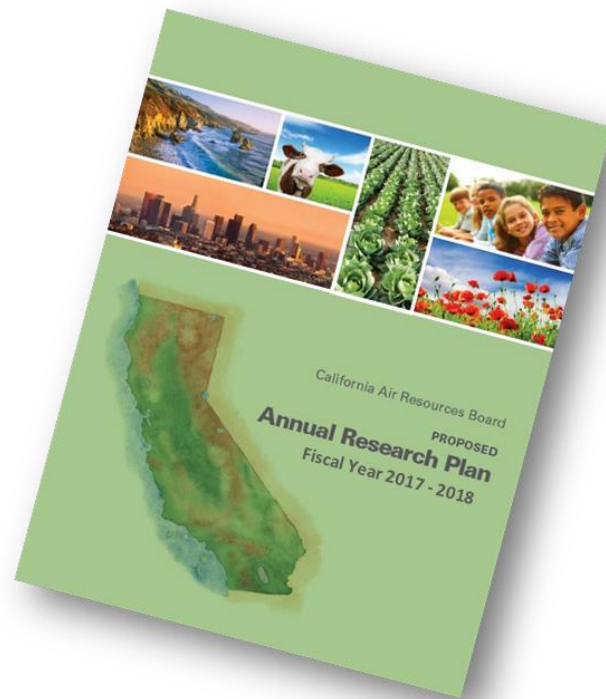
**UFPM exposure profile for all participants**



**Average and 95% confidence intervals of PM2.5 in different Sacramento commute modes**

# New Research Projects

- Facility-level methane and air toxics emissions in disadvantaged communities (FluxSense)
- Sources contributing to higher levels of PM2.5 in disadvantaged communities (U. of Texas-Austin and U. of Washington)
- Development of real-time, portable monitoring methods for toxic metals (tbd)





# Collaborators

- CARB Research Division
  - Commuter Exposure: **Nico Schulte**
  - EJ Mapping: Álvaro Alvarado, Cynthia Garcia
  - Methane Hotspots: Matthias Falk, Abhilash Vijayan
  - Mobile Monitoring: Yanju Chen, Steve Mara, **Nico Schulte**, Abhilash Vijayan
  - Personal Exposure: Jeff Williams, Quanfang (Zoe) Zhang, Peggy Jenkins
  - Satellite: Hyung Joo Lee
  - Spatial Analysis: **Longwen (Owen) Gong**, Toshi Kuwayama, Jin Xu
  - Original Development: Dane Westerdahl, Scott Fruin, Philip Fine, Walter Ham, Kathleen Kozawa, Todd Sax, Constantinos Sioutas
  
- Jet Propulsion Laboratory
  - Riley Duren
  - Andrew Thorpe