MOBILE PLATFORM MONITORING (AND RELATED STUDIES) IN PORT-ADJACENT COMMUNITIES AND OTHER LOCATIONS IN THE SOUTH COAST AIR BASIN

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Chair's Air Pollution Seminar

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Outline of Presentation

- Introduction
- Mobile Platform Measurements During HCMS
- Counting HDDT in Port Communities
- Time-Location Study in Port Communities
- Discovery of Wide Impact Area in Pre-sunrise Hours Using the Mobile Platform (MP)
- MP Study of Aircraft Impacts on Particulate Pollution Downwind of Santa Monica Airport
- MP Measurements of Ultra-Fine Particles in Boyle Heights

Historical Focus on Los Angeles

Discovery of “new” type of air pollution, an oxidizing atmosphere, by Dr. Arie Haagen-Smit of Cal Tech

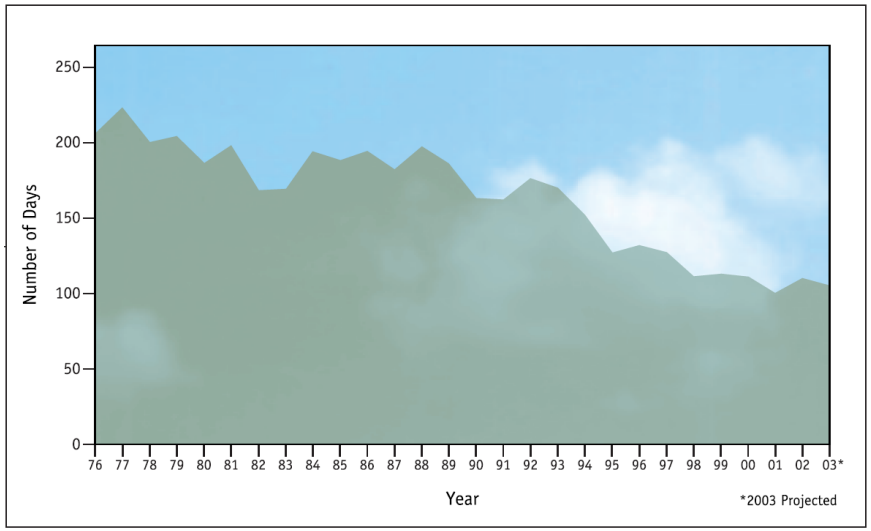
In 1960’s and 70’s
Los Angeles becomes
the “smog capital” of the world

Focus of air pollution research is on the **regional** problem of photochemical smog.

Remarkable Transformation by ~2000

LA became a “mega city” with 18 million residents and 10 million vehicles

Population doubled; vehicle miles traveled tripled



Yet ozone peak levels are reduced by more than two thirds and NAAQ standards for NO_2, CO, Pb and SO_2 are all met

Research Focus Changes in Past Decade

- Emphasis of research shifts from the **regional** photochemical smog problem
- To the exposures and health impacts due to **localized** transportation-related emissions
- This new focus results from
  - Paradigm shift in air pollutant exposure assessment
  - New measurements and health studies in close proximity to roadways & other transportation modes

Exposure Assessment Paradigm

- Measure air pollutants in the highly localized

  "*microenvironments*"

  where people spend their time

Examples of Transportation-Related Microenvironments

- Near-roadway outdoor environments (sidewalks, bus stops, parks, etc.)
- Near-roadway structures (schools, pre-schools, homes, shops, amenities)
- Proximity to ports, airports, rail-lines etc.
- Passenger vehicle compartments and school buses


L A Airport
Long Beach
Los Angeles
Santa Monica
Celebrity Foods
PENSKE

Research Questions

- What are the exposures from this roadway in adjacent residential neighborhoods?
- What variables most determine the duration and magnitude of those exposures?
- Are there disproportionate impacts of roadways, and other localized emission sources, on certain neighborhoods?

Near-Roadway Population Exposures

- Users of areas downwind of roadways are likely to experience exposure levels and health impacts beyond those associated with regional ambient air pollution.

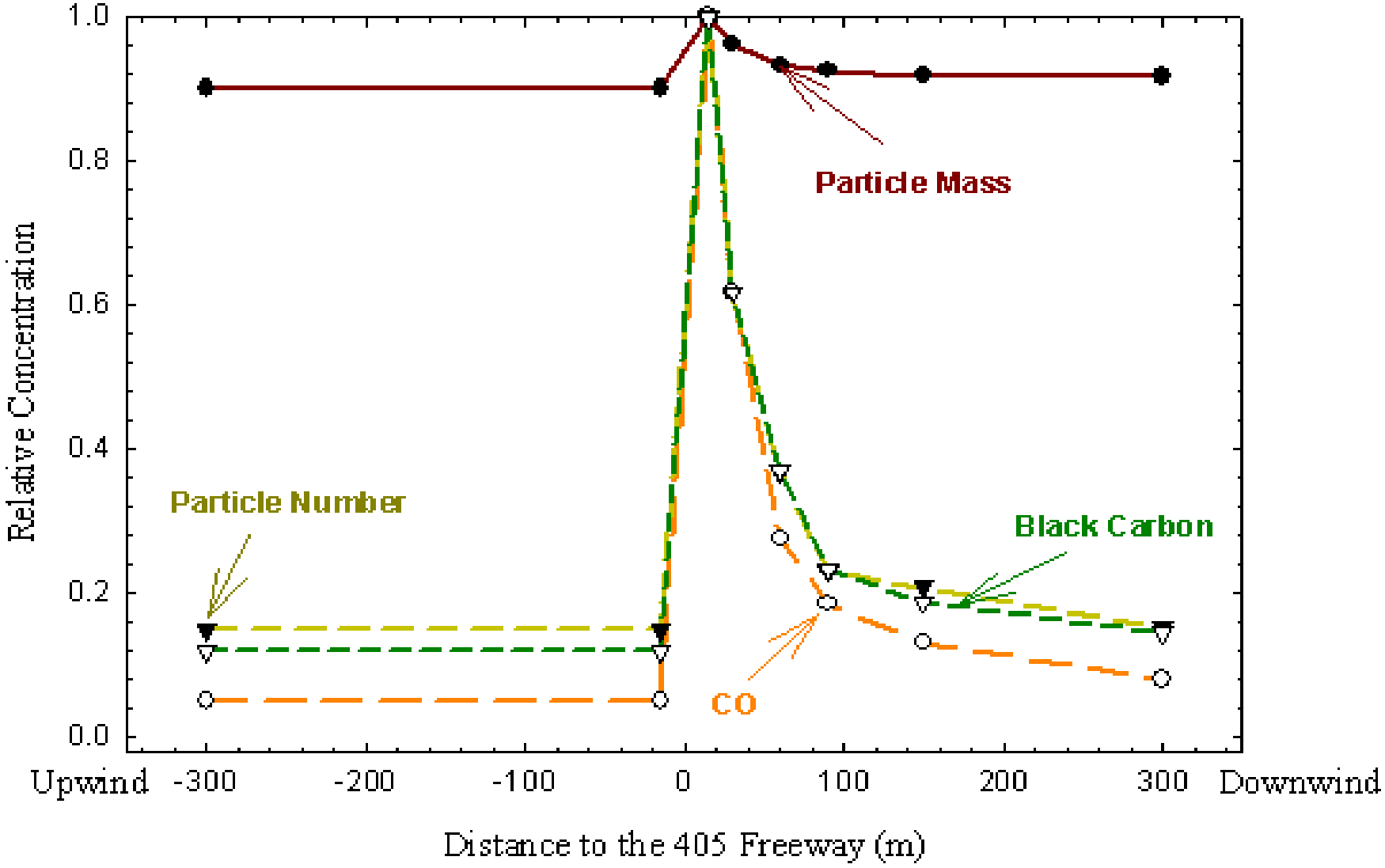
- Subjects who live near roadways with a high volume of diesel vehicles:

  - More likely to suffer from chronic respiratory ailments
  - More likely to have reduced lung function; higher mortality

Sources: Brunekreef et al. (1997); Janseen et al. (2003); Lin et al. (2002); Ryan et al. (2005); van Liet et al. (1997)

Relative Pollutant Concentrations vs Distance From the I-405 Freeway

(Zhu et al., 2002a)



GOODS MOVEMENT FROM THE PORTS

Exposures Along Transportation Corridors in Port-Adjacent Communities

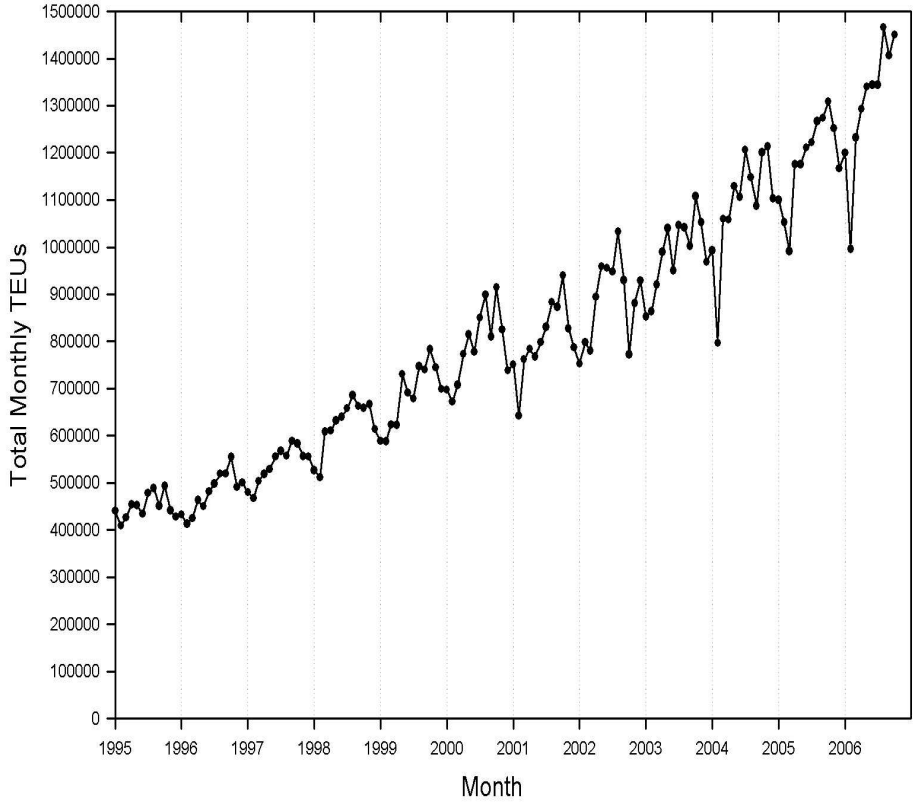
Statement of the Problem

Area near the Ports of LA/LB contains a wide range of pollution sources, especially heavy-duty diesel trucks (HDDT)

Goods movement tripled in past 15 years

16,000 HDDT on streets

Localized high concen-trations of pollutants



Where is this cargo going and how will it get there?

How Cargo Containers Leave the Ports

According to Alameda Corridor Transportation Authority (ACTA):

- 50% by big-rig diesel trucks directly to businesses or to distribution warehouses
  - Warehouses in Riverside & San Bernardino Counties where cargo is sorted and sent to other cities/states
- 25% by truck on I-710 to intermodal facilities where containers transfer to trains
  - Downtown L.A., East L.A., Commerce
- 25% onto Alameda Corridor, a 20-mile express railroad to downtown Los Angeles


Terminal
Island Fwy
Hudson
School
CHINA SHIPPING
Community Park

“Protecting” residents and students: A chain link fence!

Near-Road Air Pollution Impacts of Goods Movement in Communities Adjacent to the Ports of Los Angeles and Long Beach: Application of an EV Mobile Platform

Kathleen Kozawa[1,3], Scott Fruin[2], Arthur Winer[3]

[1]California Air Resources Board, [2]University of Southern California,
[3]UCLA School of Public Health

*ATMOSPHERIC ENVIRONMENT, 43: 2960-2970 (*2009)

Introduction

- Sources in the Harbor Communities
  - Freeways
  - Surface streets with high HDDT volumes
  - Ports: diesel yard equipment, locomotives, ships, etc.
  - Refineries and other industrial processes

- Utility of a Mobile Platform (MP)
  - High spatial resolution
  - Able to monitor large areas efficiently
  - Electric vehicle has no pollution of its own
  - Can investigate on-road, near-roadway, and neighborhood micro-environments

Objectives

- Use real-time instruments on a mobile platform to measure pollution concentrations with high spatial and temporal resolution to determine the:
  - Relative importance of various emission sources, especially HDDT, to exposures in the port-adjacent communities
  - Locations of high pollution impacts from local sources and conditions under which they occur.

Overview of Mobile Platform Methodology

- Electric vehicle mobile platform with real-time instruments (Toyota RAV-4)
- Travel along fixed routes to measure pollutant concentrations and gradients
- High temporal resolution (~ 1 sec sampling time)
- High spatial resolution (a few meters at low MP speeds)
- Investigate key variables


ELECTRIC VEHICLE
YAKIMA

Dr. Arie Haagen-Smit's "Mobile Platform" in 1947!

Mobile Platform Instruments

Instrument	Measurement Parameter
TSI Portable CPC, model 3007	**UFP Count 10 nm-1um**
TSI FMPS	**UFP Size 5.6-560 nm**
TSI Model 8520 DustTrak	**PM2.5**
Magee Scientific Aethalometer	**Black Carbon**
EcoChem PAS 2000	**Particle Bound PAH**
Teledyne API 300e CO Analyzer	**Carbon Monoxide (CO)**
LI-COR, LI-820 CO2 Gas Analyzer	**Carbon Dioxide (CO_2)**
Teledyne-API NO_x analyzer, model 200e	**Nitrogen Oxides (NO_x, NO, NO_2)**
Garmin GPSMAP 76CS	**GPS**
Vaisala Sonic Anemometer and Temperature/RH Sensor	**Local Wind Speed and Direction, Temp, RH**
Stalker LIDAR and Vision Digital System	**Traffic**

Important Variables

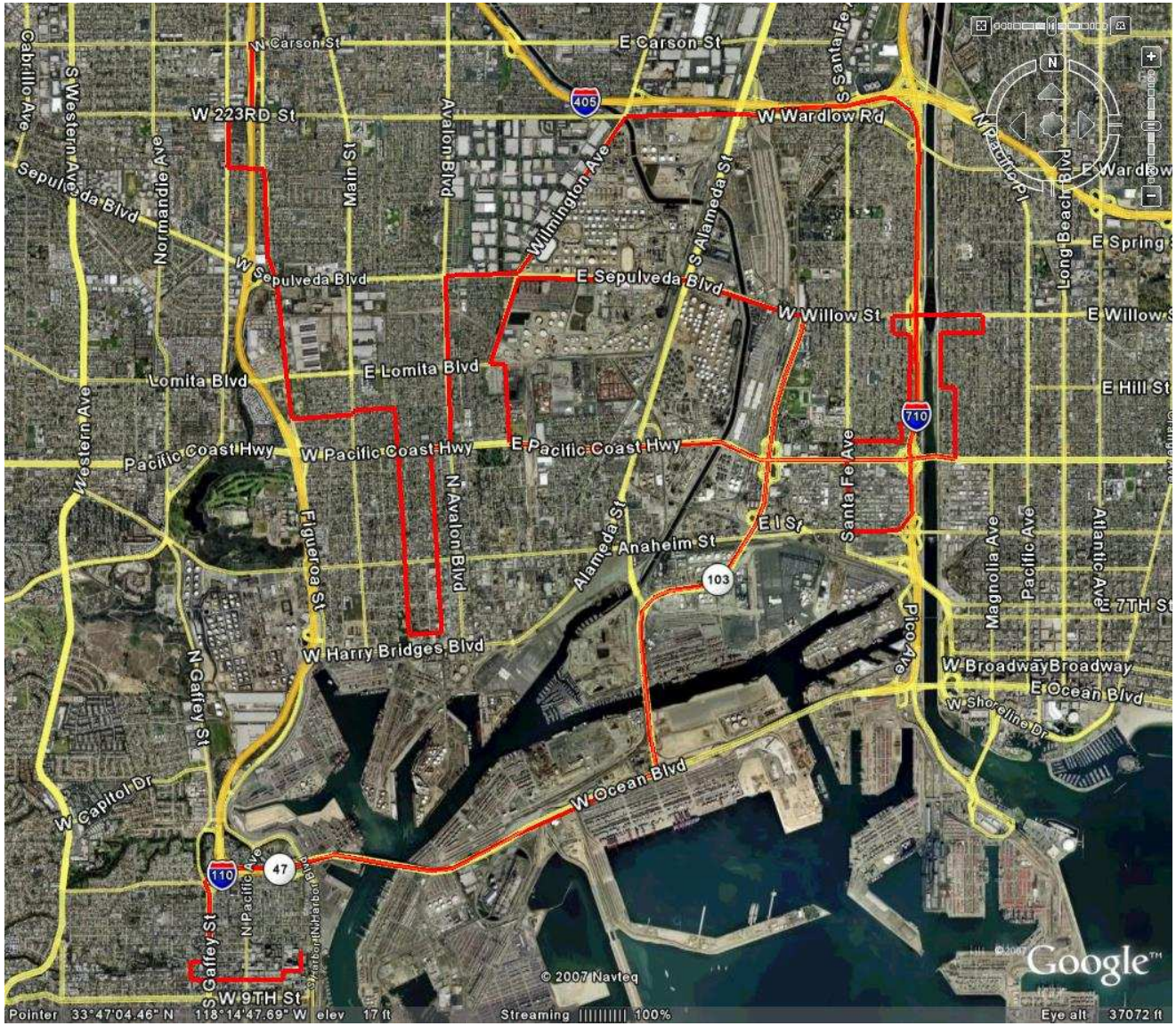
- Meteorology
- Heavy-Duty Diesel Truck (HDDT) Volumes
- Proximity to Roadways
- Road Type
- Time of Day
- Day of Week
- Season

Sampling Protocol

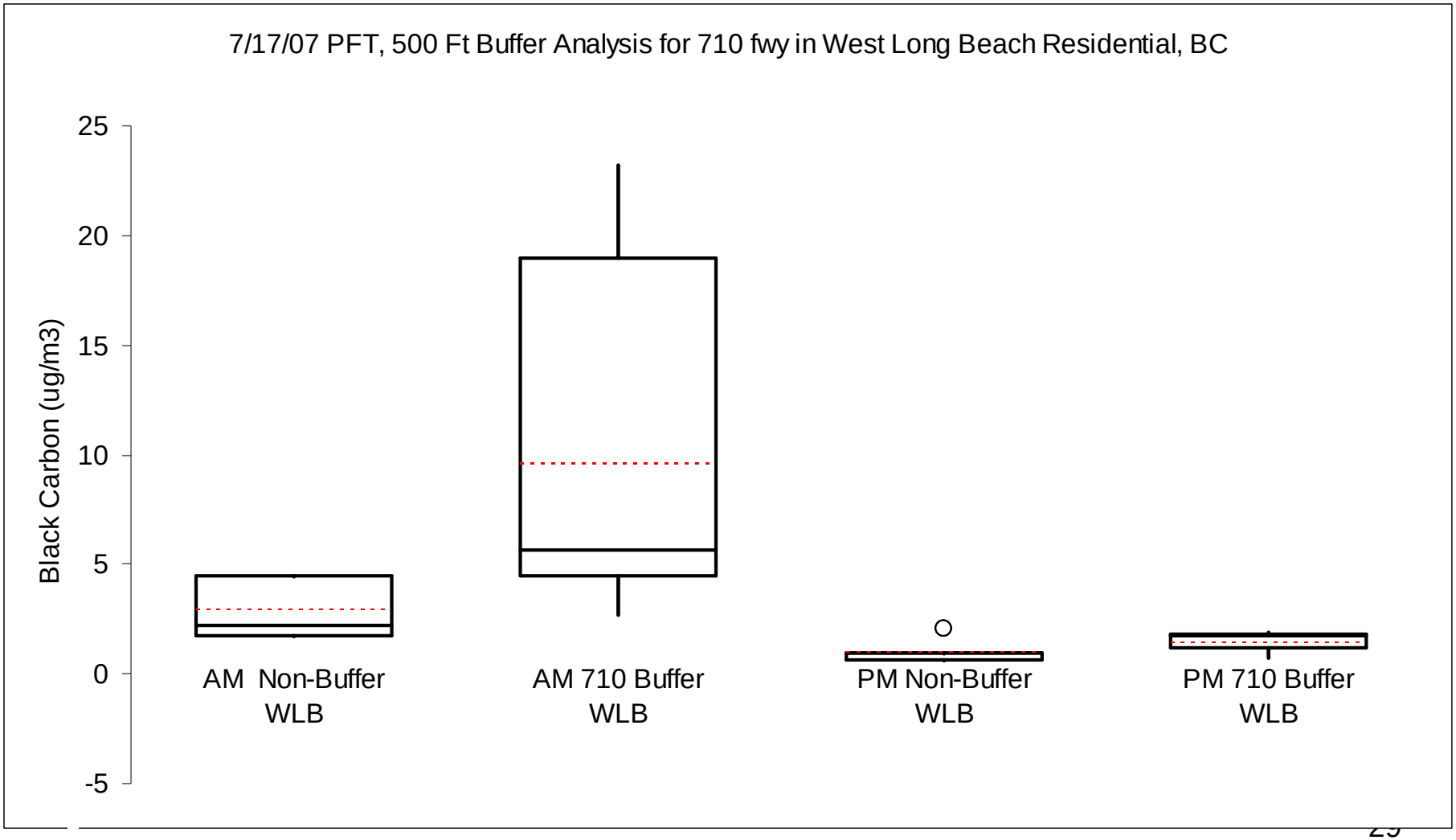
- Winter and Summer
- Two Routes (designed with community input)
  - Residential
  - Port-Freeway-Truck
- Morning and Afternoon
- Impact Zone/Reference Zone Sampling (150 m buffer)
- Stationary monitoring at busy intersections (e.g. PCH and Santa Fe; Anaheim and PCH)

Residential Route

Port/Freeway/Truck Route (PFT)



I-710 Impact Zone Analysis
Black Carbon

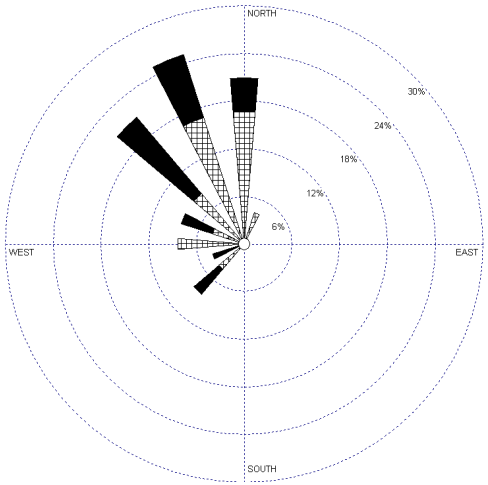


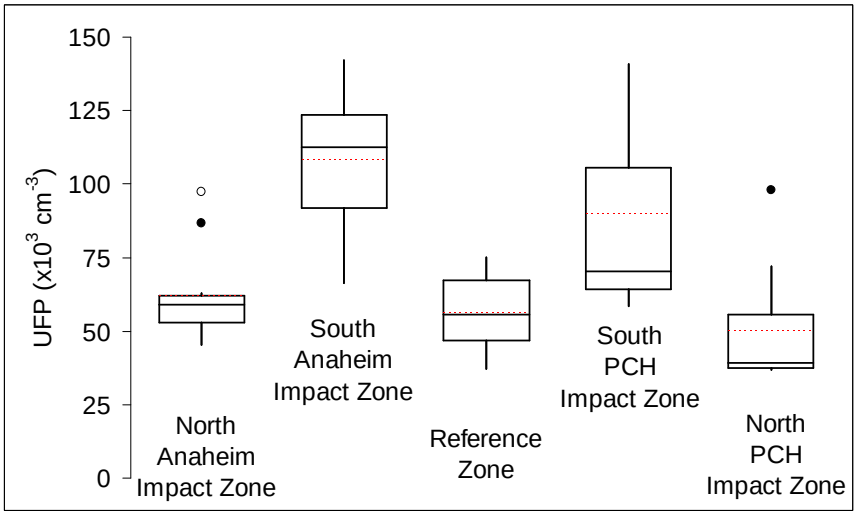
Impact Zones at Busy Arterials

North and South Impact Zones Traveling across PCH on Santa Fe

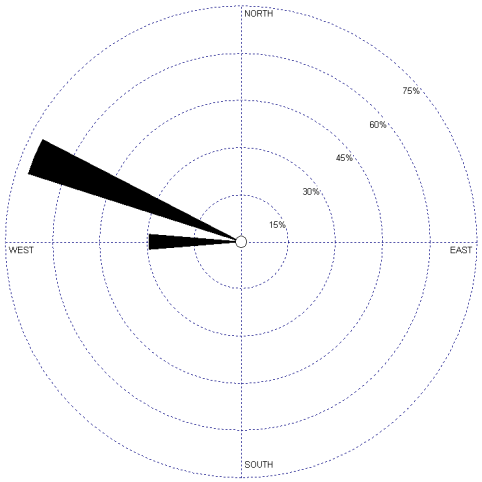
Impact Zones Near Busy Arterials

Morning

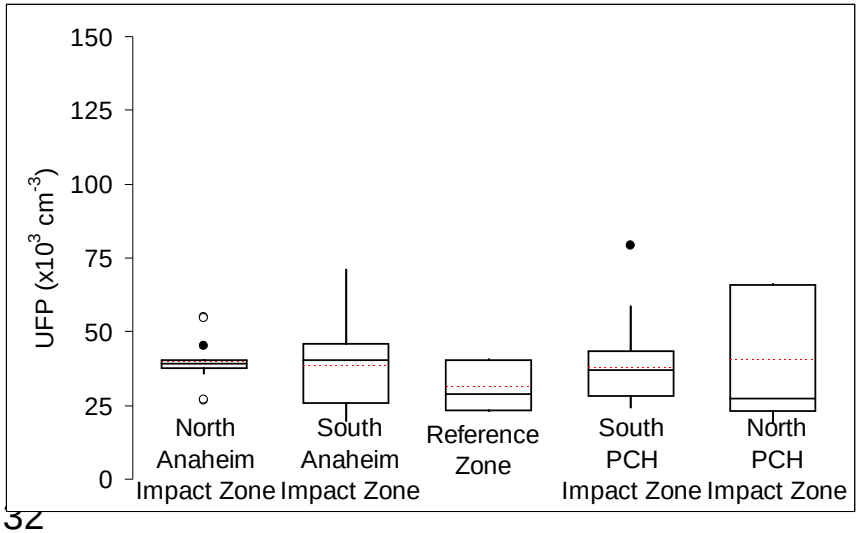




Afternoon



Wind Speed
m s^{-1}
>= 2.1
0.5 - 2.1



“Mobile Platform in Stationary Mode

“Fast Food” Site

“Stationary” Monitoring, NO

Summary

- Utility of mobile platform demonstrated for measuring in the dynamic near-road environment
- Pollutant concentrations (e.g. BC, UFP, NO) in Impact Zones near surface streets and freeways heavily traveled by HDDT in port-adjacent communities were ~2-5 times higher compared to Reference Zones away from such roadways
- Meteorology, including wind direction and season, is an important determinant of pollution concentrations in near-roadway microenvironments
- Results raise environmental justice issues given the low SES/ethnic population in this community

Measuring Diesel Truck Traffic Volumes on Surface Streets in Port-Adjacent Communities

Doug Houston, Margaret Krudysz & Arthur Winer
UCLA Schools of Public Health and Public Policy

J. TRANSP. RES. BOARD, No. 2067, 38-46 (2008)

Statement of the Problem and Hypothesis

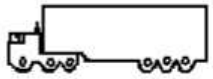
- Using traffic volumes as a proxy for exposure can lead to large uncertainties if traffic counts are inaccurate
- Paucity of current, reliable surface street counts
- Diesel/gasoline split often unknown for surface streets
- Hypothesis: Air pollutant exposure in port-adjacent communities will be driven predominately by heavy-duty diesel truck (HDDT) traffic emissions.

Study Design

August 15, 2006 to September 19, 2006, period with highest historic container volumes

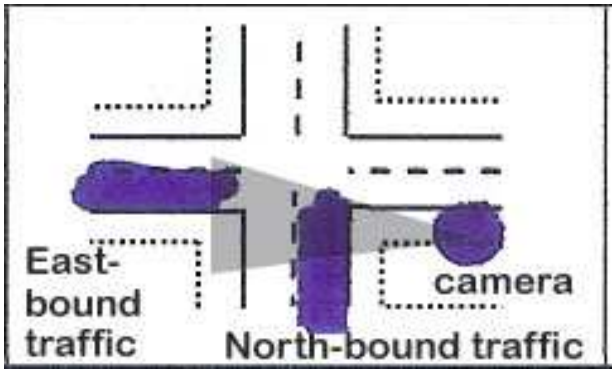
- 11 count locations (13 days)
- Videotaped intersection traffic 07:30 - 18:00 PDT from two directions at 30 min or 1 hr intervals
- Weekdays (T/W/TH) and one Saturday count
- Data Reduction: JAMAR electronic traffic counting boards, by direction and vehicle class.
- Bin into 10 vehicle classes by four major groupings
- Port Diesels: Bobtail-only, chassis-only truck, and container trucks



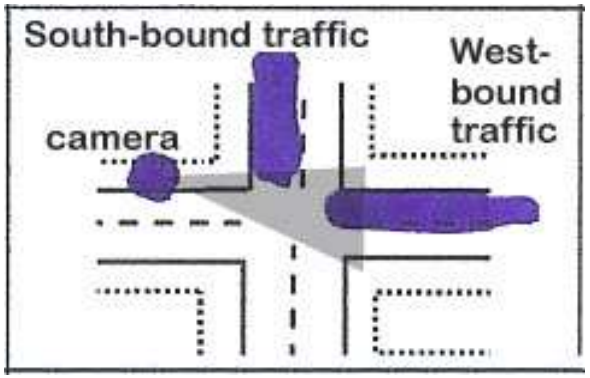


Count Collection Methods

Sample Video Camera Positions



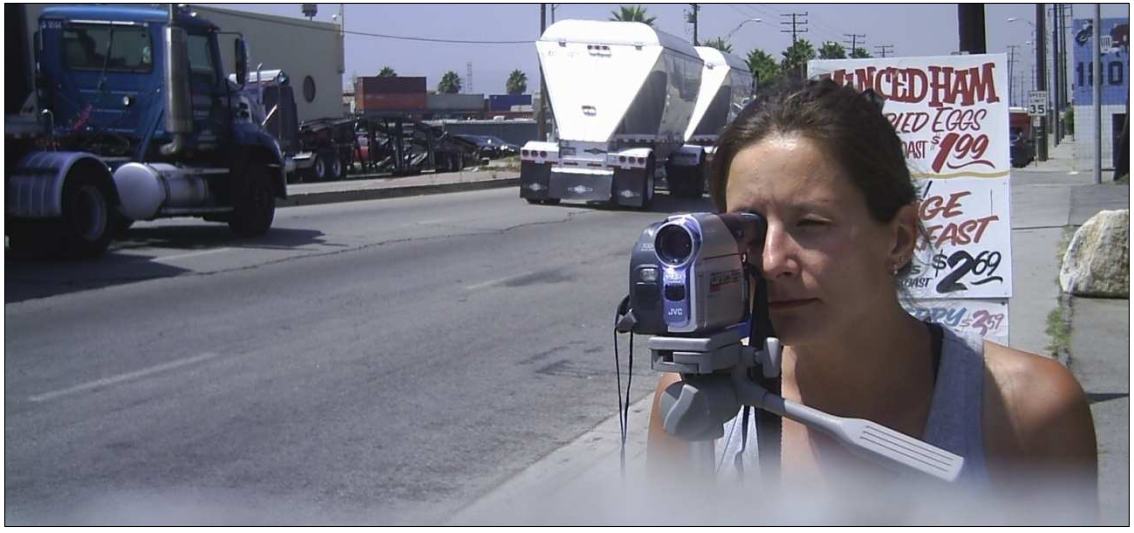
Camera #1Position



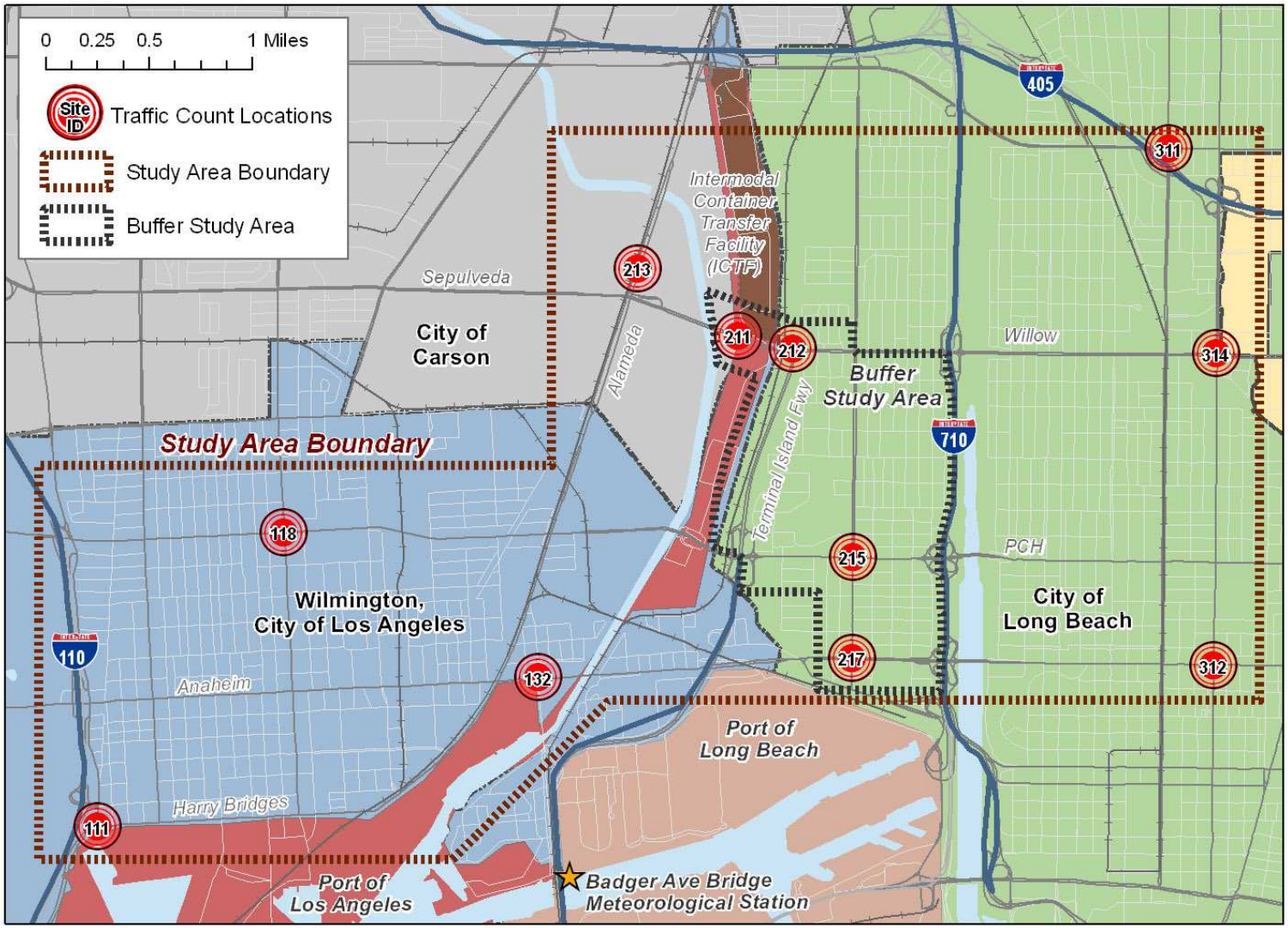
Camera #2 Position

JAMAR count board

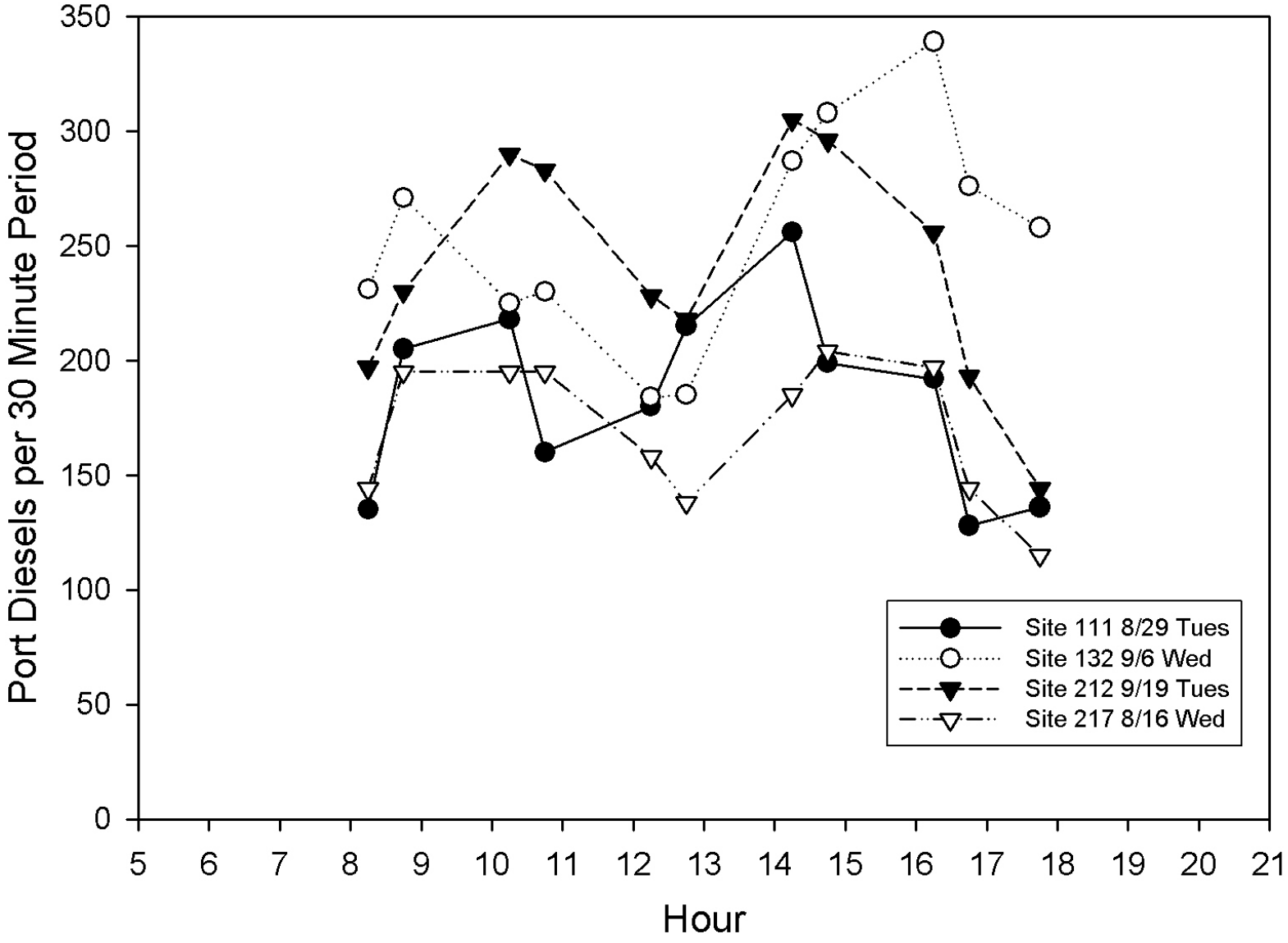
Data Collection



Study Area and Traffic Count Locations



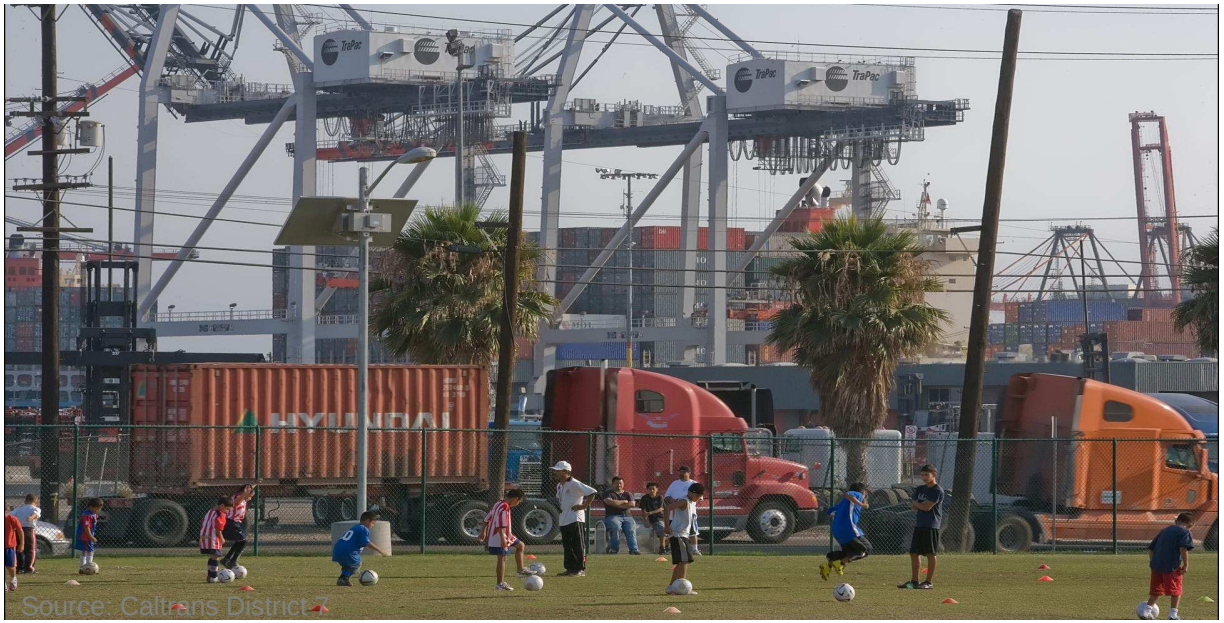
Diurnal Patterns of Port Diesel Traffic



Summary

- Up to 600-700 HDDT per hour pass through the most heavily impacted intersections and line segments
- Many HDDT were observed to be smoky
- HDDT travel on surface streets with substantial pedestrian traffic and numerous shops/facilities/amenities
- On-road, in-vehicle and near-roadway exposures are expected to be high for intersections and line segments we studied
- Significant environmental justice concerns raised

Harbor Community Time Location Study:
Diurnal Time-Location Patterns and Traffic Exposure Near the Ports of Los Angeles and Long Beach Using GPS-Enhanced Tracking Methods



Source: Caltrans District 7

Douglas Houston, Guillermo Jaimes, Paul Ong and Arthur Winer

UCLA Schools of Public Health and Public Affairs

Submitted for publication to American J. Public Health

Funded by The California Air Resources Board & the University of California Transportation Center

Objectives

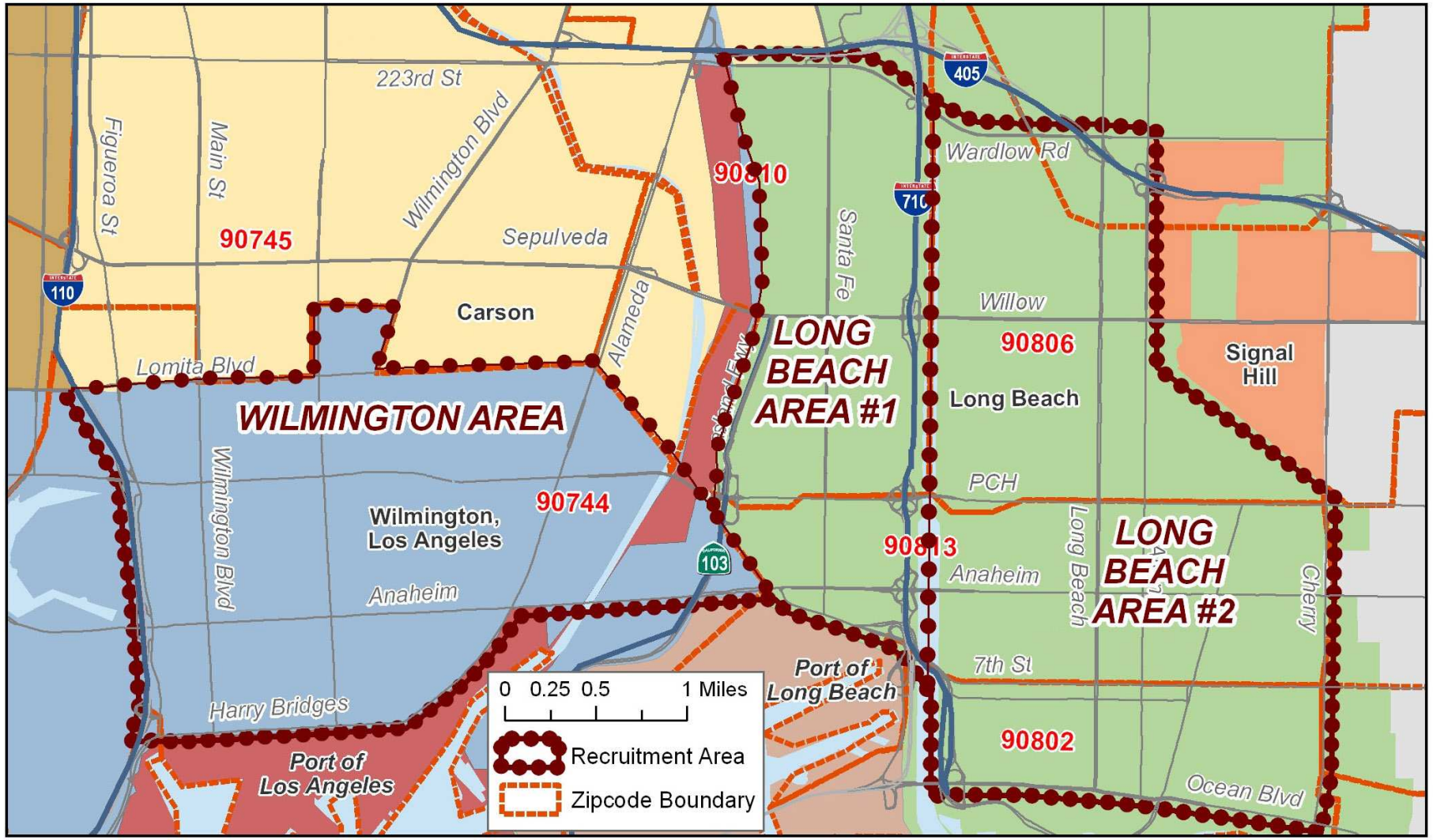
- To document the travel and activity patterns of residents living near the ports of Los Angeles and Long Beach.
- Where do residents spend time during the day?
  - Indoors, Outdoors, In-Vehicle, Near Roadways
- To compare accuracy of GPS monitored activity against traditional T-L recall diaries.
- To generate a time-location database that future studies can use to model the exposure of residents to air pollution.

Participant Requirements

- Residents must live in parts of Wilmington, Carson and West Long Beach or in the following zip codes:
  - 90744, 90802, 90806, 90810, and 90813

- Must be between 21-65 years old

Study Area


223rd St
Figueroa St
Main St
Wilmington Blvd
90745
Sepulveda
Carson
Alameda
Lomita Blvd
WILMINGTON AREA
Wilmington Blvd
Wilmington, Los Angeles
90744
Anaheim
Harry Bridges
Port of Los Angeles
90810
Santa Fe
LONG BEACH AREA #1
Wardlow Rd
Willow
90806
Long Beach
Signal Hill
PCH
90813
Anaheim
Long Beach
LONG BEACH AREA #2
Cherry
7th St
Port of Long Beach
90802
Ocean Blvd
405
710
110
103
0 0.25 0.5 1 Miles
Recruitment Area
Zipcode Boundary

Monitoring Schedule

Week 1

Sunday	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*
	TRAINING **BASELINE SURVEY** **IN-HOME PM MONITORING**					
		GPS MONITORING				
		TIME ACTIVITY LOG				

Week 2

Sunday	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*
GPS MONITORING						

Week 3

Sunday	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*
GPS MONITORING						

Week 4

Sunday	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*
				FOLLOW-UP SURVEY **IN-HOME PM MONITORING**		

Baseline Survey

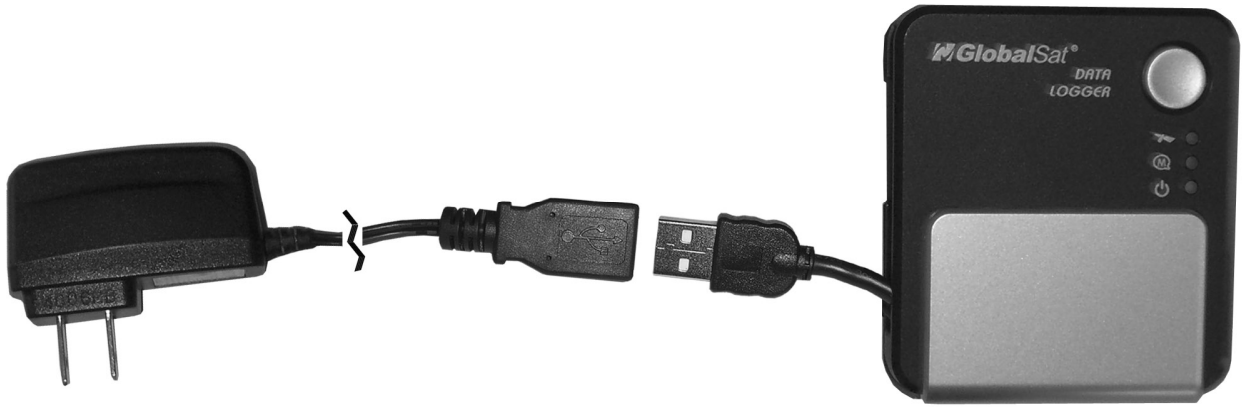
The Baseline Survey was conducted at the home of participants, and lasted about one hour.

- Types of questions:
  - Activity and Travel Patterns, Usual Destinations (Work, School, etc.)
  - Household transportation resources and demographic information
  - Details of house or apartment relating to the potential intrusion of air pollution
- Surveys were conducted in Spanish or English

Monitoring with GPS

Participants carry a Global Positioning System (GPS) device during their waking hours for a 2-week period.

Global Positioning System (GPS) Device



In-Home PM Measurements

In-Home measurements of particulate matter (PM) during:

- Baseline Survey
- Follow-up Survey

Portable monitors and measurements are confined to the room in which these interviews are conducted.

1 Condensation Particle Counter (CPC)

Particle counts, including UFP

2 Dustraks

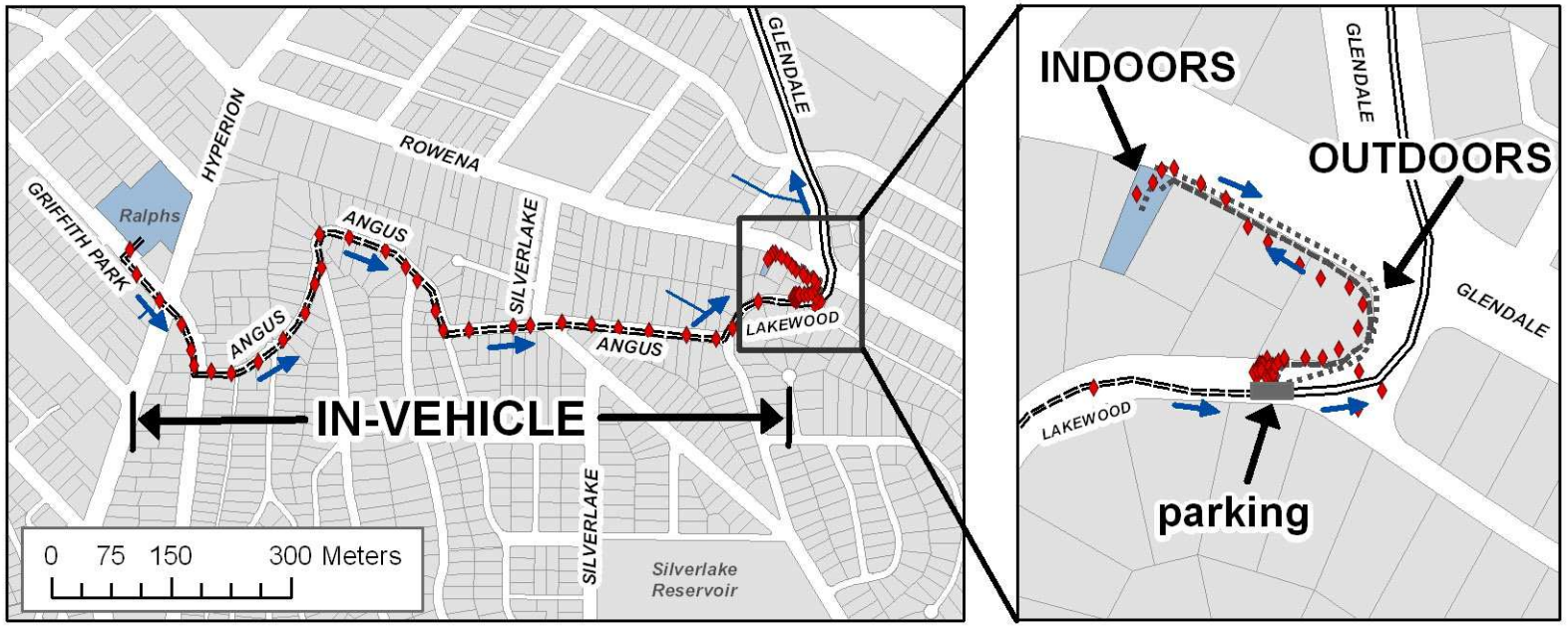
$PM_{2.5}$

Follow-Up Survey

The follow-up interview was conducted within 2-4 weeks of monitoring with GPS device.

Goal: To clarify unclear patterns or potential unreported trips

Sample analysis of GPS Data: In-Vehicle, Outdoors, Indoors



Confidentiality and Privacy

- Any information that can be identified with participants will remain confidential
- Participants were assigned an anonymous identifying code
- Survey and diary information were delivered by research staff soon after data collection to UCLA Secure Data Facility
- Only authorized researchers had access to the data for research purposes
- Data with subject identifiers will not be released
- Participants may refuse to answer any questions and still remain in the study

Incentives to Participate

Participants receive the satisfaction of participating in air pollution research that could influence air pollution policy.

Participants also receive $50 in grocery gift cards, which are provided in the following amounts:

- $15 upon completion of the Baseline Survey and In-home Particulate Matter (PM) Measurements
- $15 upon completion of the Time Activity Log and GPS Monitoring
- $20 upon completion of the Follow-up Interview

Recruitment Efforts

Phase 1: Worked with community organizations

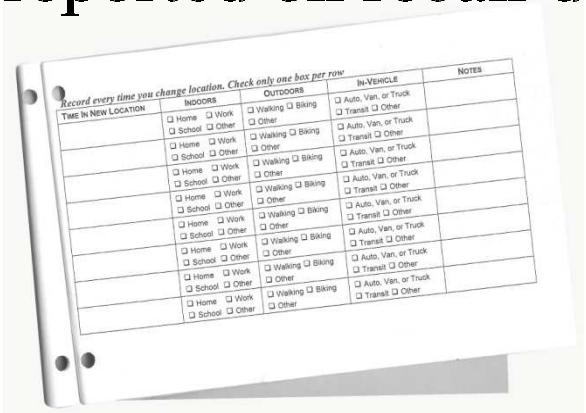
Phase 2: Drew upon past monitoring participation lists

Phase 3: Contacted potential participants through targeted mailing

Outcomes

- Tracked 47 adults in port-adjacent communities of Wilmington and Long Beach

- Integrated participant activity logs, GPS tracking, follow-up surveys
  - GPS significantly improved the amount, quality and resolution of data over recall diaries
  - As many as 44% of vehicle trips were not reported on recall diary logs



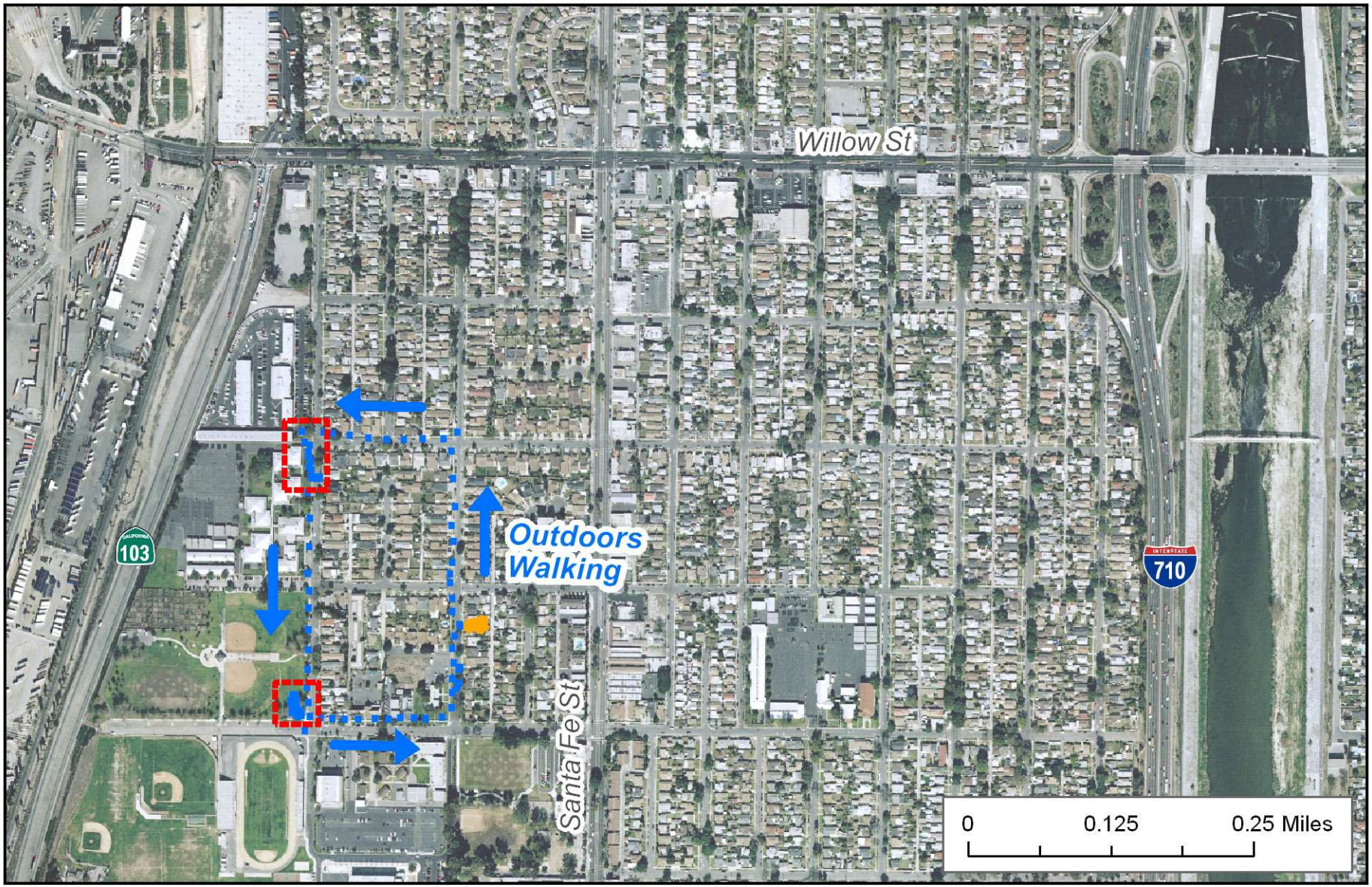
Harbor Community Time Location Study

Actual locations has been shifted to protect confidentiality.

Harbor Community Time Location Study

Actual locations has been shifted to protect confidentiality.

Harbor Community Time Location Study



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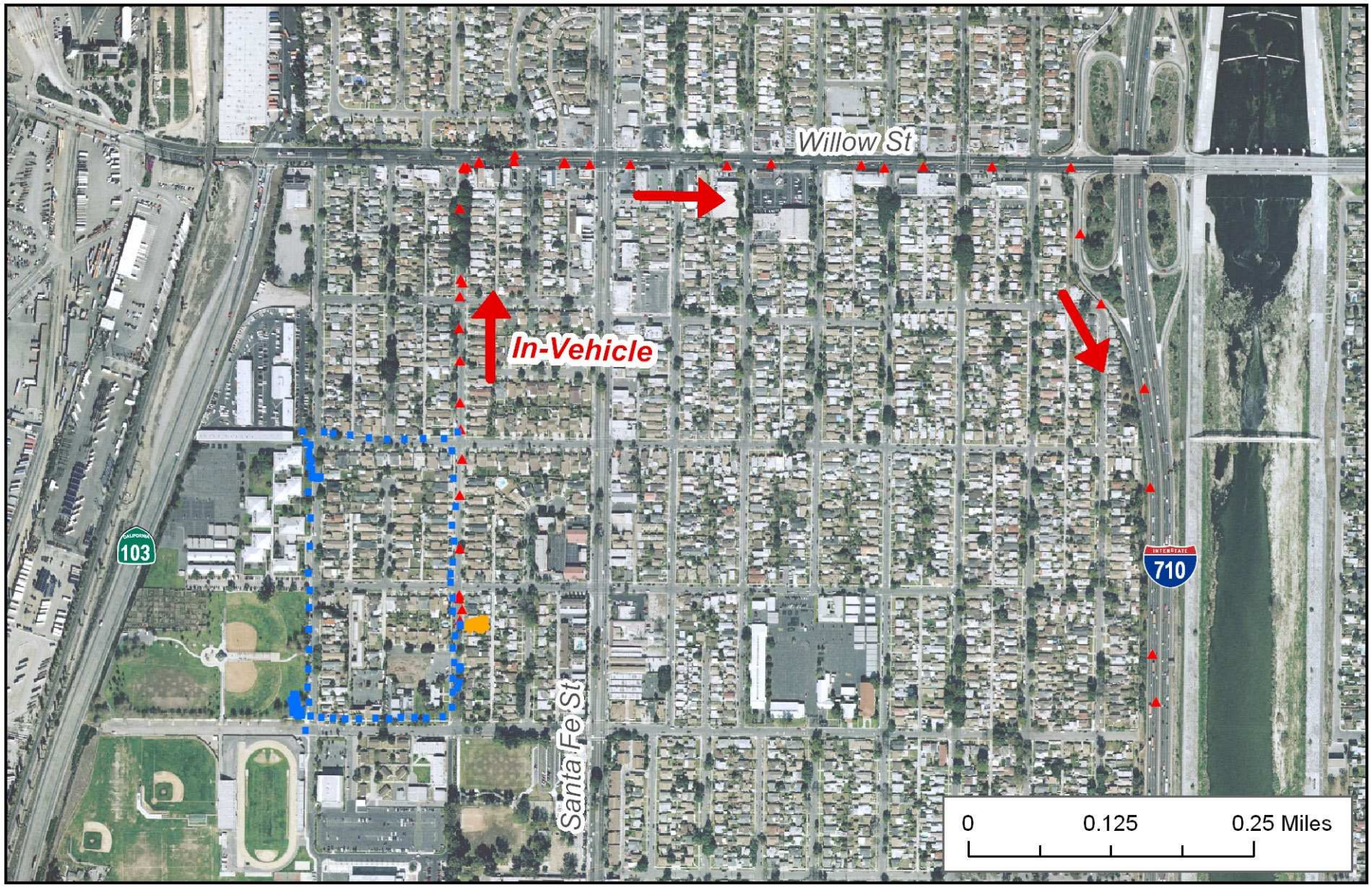
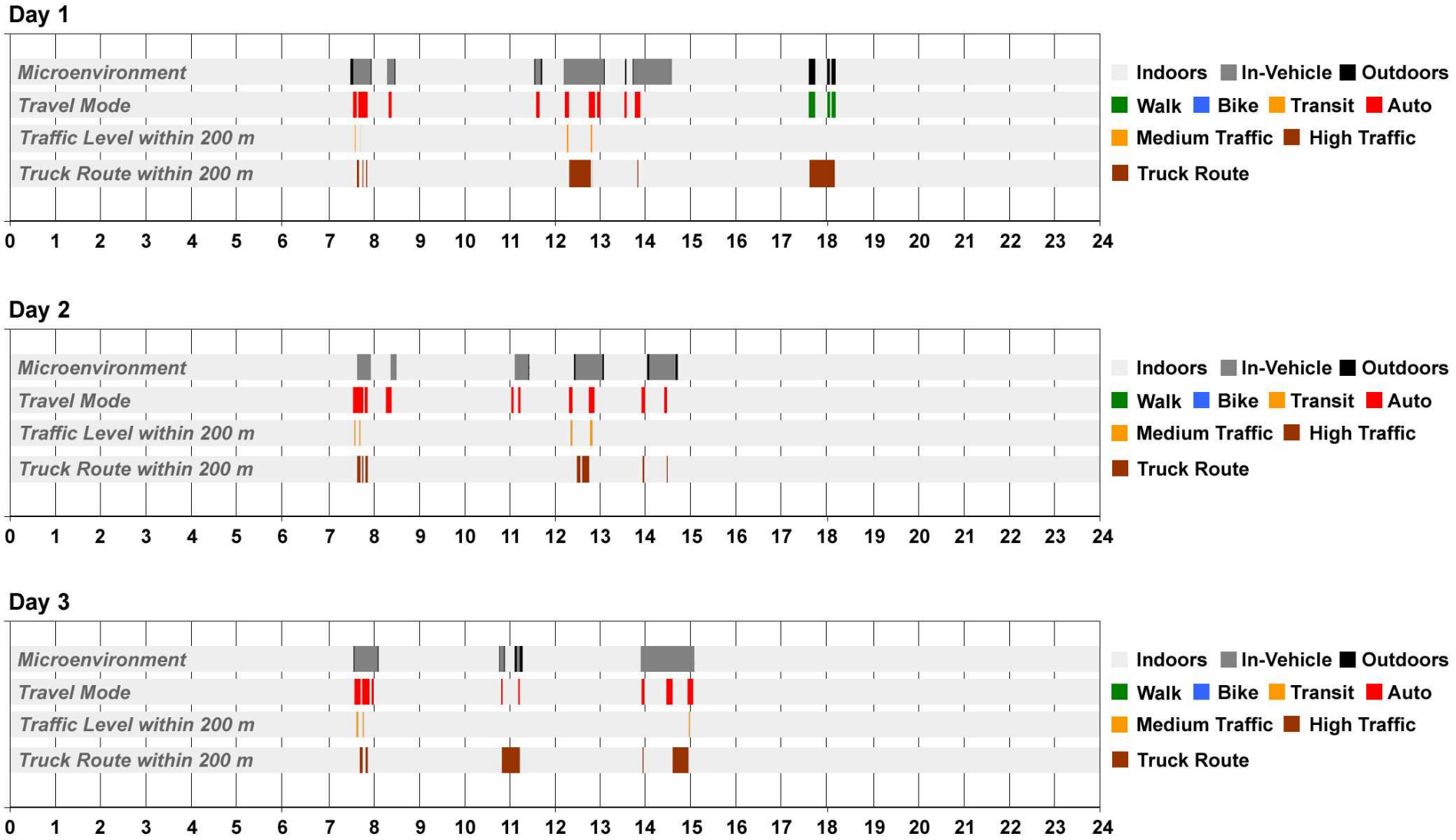
Harbor Community Time Location Study



Actual locations has been shifted to protect confidentiality.

Harbor Community Time Location Study

Human Time Activity Patterns



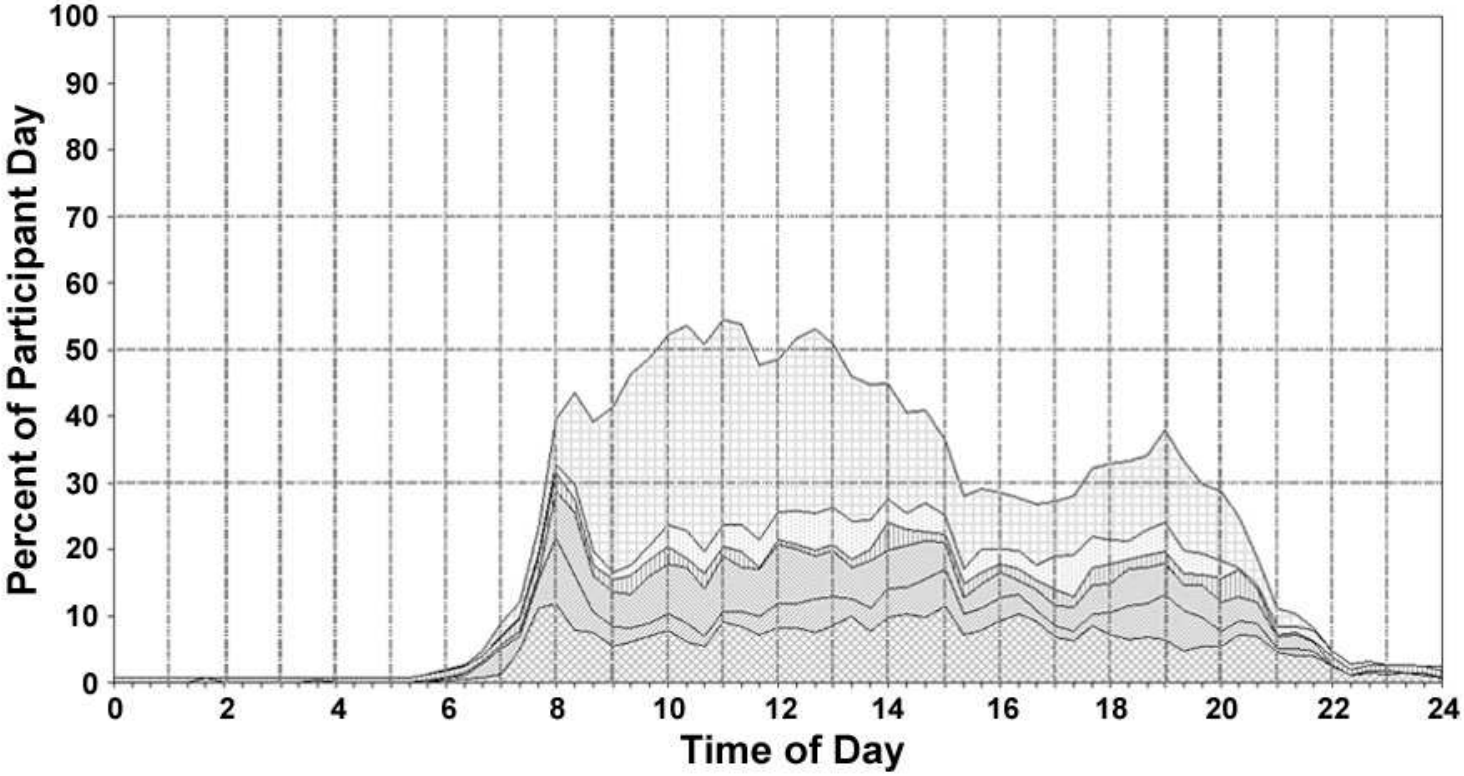
Source: Harbor Communities Time Location Study

Table 4. Mean percent of day (95% CI) in locations/activities, HCTLS and NHAPS, Age 21-65

Location type	HCTLS	NHAPS-Nation	NHAPS-CA
A. Time by location, All Adults Age 21-65	n=131	n=5,807	n=628
Indoors	**89.4 (88.1-90.6)*†**	**86.6 (86.2-87.0)***	**85.6 (84.5-86.8)†**
Residential	*77.5 (75.2-79.8)*†*	*65.6 (65.0-66.1)**	*66.1 (64.5-67.6)†*
Public, Services, School, Workplace	*9.9 (8.1-11.8)*†*	*16.0 (15.5-16.5)**	*14.6 (13.1-16.0)†*
Retail, Restaurant/Bar	*1.9 (1.5-2.4)*†*	*5.0 (4.8-5.3)**	*5.0 (4.3-5.7)†*
Outdoors	**5.9 (5.0-6.7)*†**	**7.1 (6.8-7.4)***	**8.1 (7.1-9.0)†**
Residential	*1.0 (0.8-1.3)*†*	*3.0 (2.9-3.2)**	*3.2 (2.6-3.8)†*
Other	*2.7 (2.0-3.4)*	*2.1 (1.9-2.3)*	*2.6 (2.0-3.2)*
Outdoors Traveling or Waiting[i]	*2.2 (1.7-2.6)*	*2.0 (1.8-2.2)*	*2.3 (1.8-2.9)*
Traveling or Waiting During Travel	**6.9 (6.1-7.8)*†**	**8.3 (8.0-8.6)***	**8.6 (7.8-9.4)†**
Outdoors Traveling or Waiting[i]	*2.2 (1.7-2.6)*	*2.0 (1.8-2.2)*	*2.3 (1.8-2.9)*
Enclosed Vehicle, Traveling or Waiting	*4.8 (3.9-5.7)*†*	*6.3 (6.1-6.5)**	*6.3 (5.7-6.9)†*

Source: Harbor Communities Time Location Study

Time Activity Patterns



a. Location type by time of day, HCTLS, Adults Age 21-65 (N=131 Days)

Location type

- Indoors - Residential
- Indoors - Public, Service, School, Work
- Indoors - Retail, Restaurant
- Outdoors - Residential
- Outdoors - Other
- Outdoors - Traveling/Waiting
- Enclosed Vehicle - Traveling/Waiting

Source: Harbor Communities Time Location Study

Summary

- The HCTLS is the first study to integrate traditional recall activity diary and passive GPS tracking with follow-up interviews to document the time-location of a low SES immigrant group in a major transportation and goods movement corridor.
- Participants were largely Hispanic women and homemakers who spent about 89% of their time indoors, ~5% in vehicles, and ~6% outdoors.

Summary (Con't)

- HCTLS participants were similar to adults nationwide in time spent indoors, in-vehicle and outdoors, but spent more time indoors at home (78% vs 66%).
- GPS tracking (especially with "prompts") more accurate than traditional recall diaries
- Participants may experience heightened exposures to vehicle pollution during the five hours on average spend near major roadways

Discovery of a Wide Impact Area Downwind of I-10 Freeway During Pre-Sunrise Hours

Shishan Hu[1], Kathleen Kozawa[1,2], Steve Mara[2]
Scott Fruin[3], Suzanne Paulson[1], Arthur Winer[1]

[1] University of California, Los Angeles
[2] California Air Resources Board
[3] University of Southern California

*Atmospheric Environment, 43: 2541-2549 (*2009)

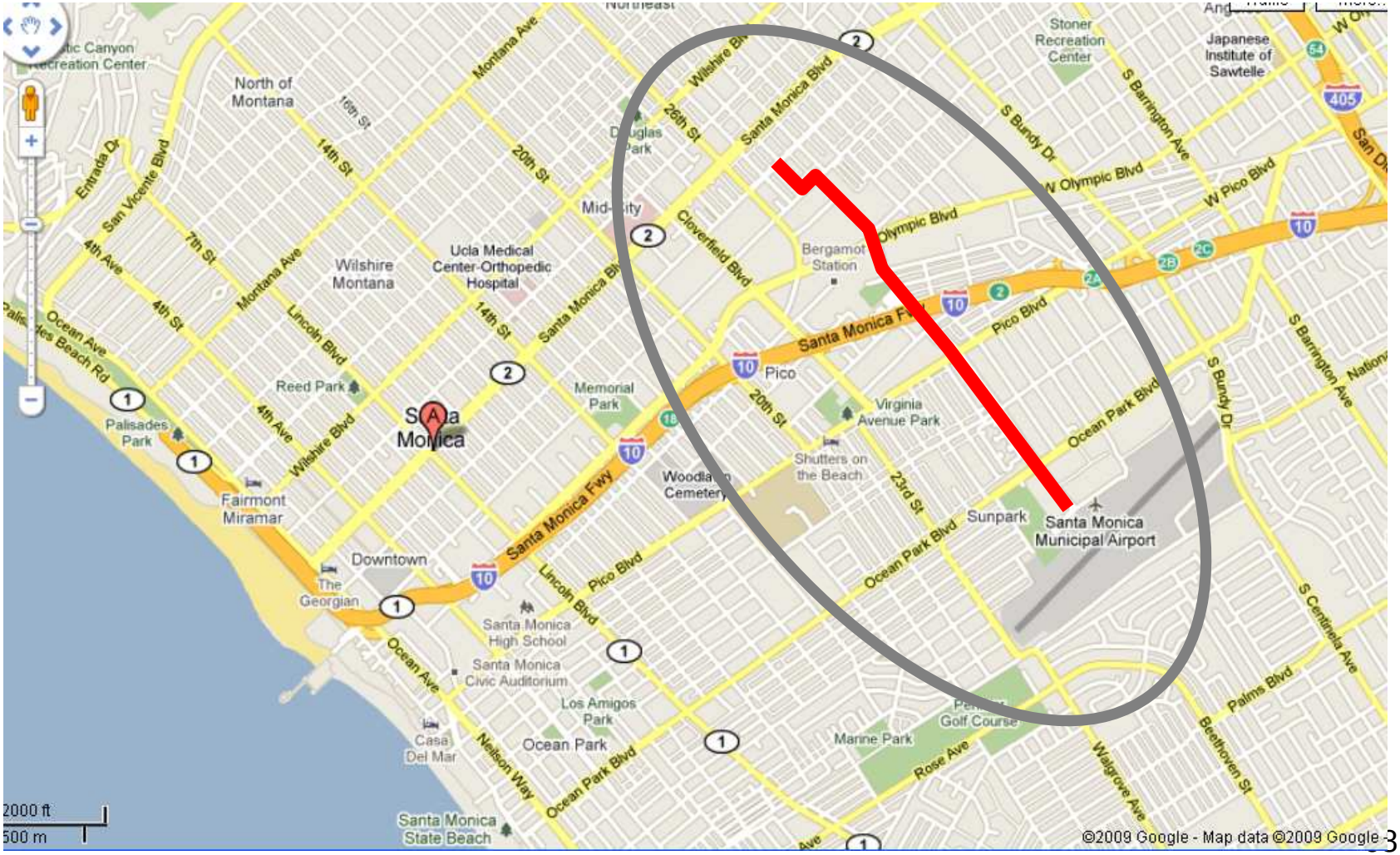
Pre-Sunrise Meteorological Conditions

Hypothesis: Under pre-sunrise meteorological conditions, pollutants from roadways may extend further from the roadway than during the day.

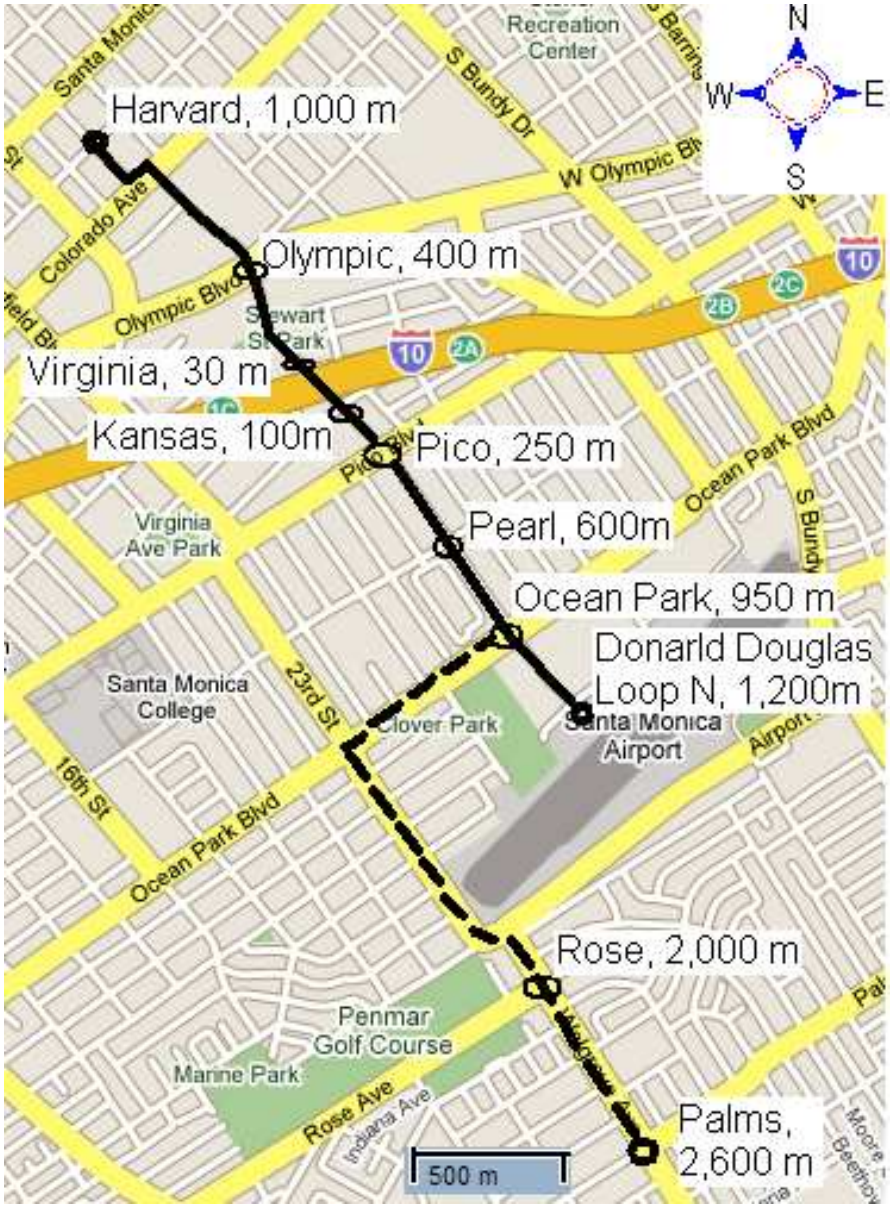
•Low wind speeds (*0-1.0m/s*)

- Cool to moderate temperatures
  - Winter *9-13^{o}C*
  - Summer *15-17^{o}C*
- Low nocturnal surface temperature inversions
- No significant turbulent mixing

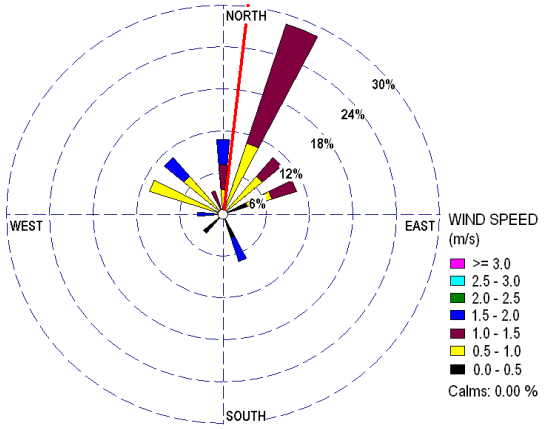
Route for Pre-Sunrise Measurements in West Los Angeles at I-10 Freeway



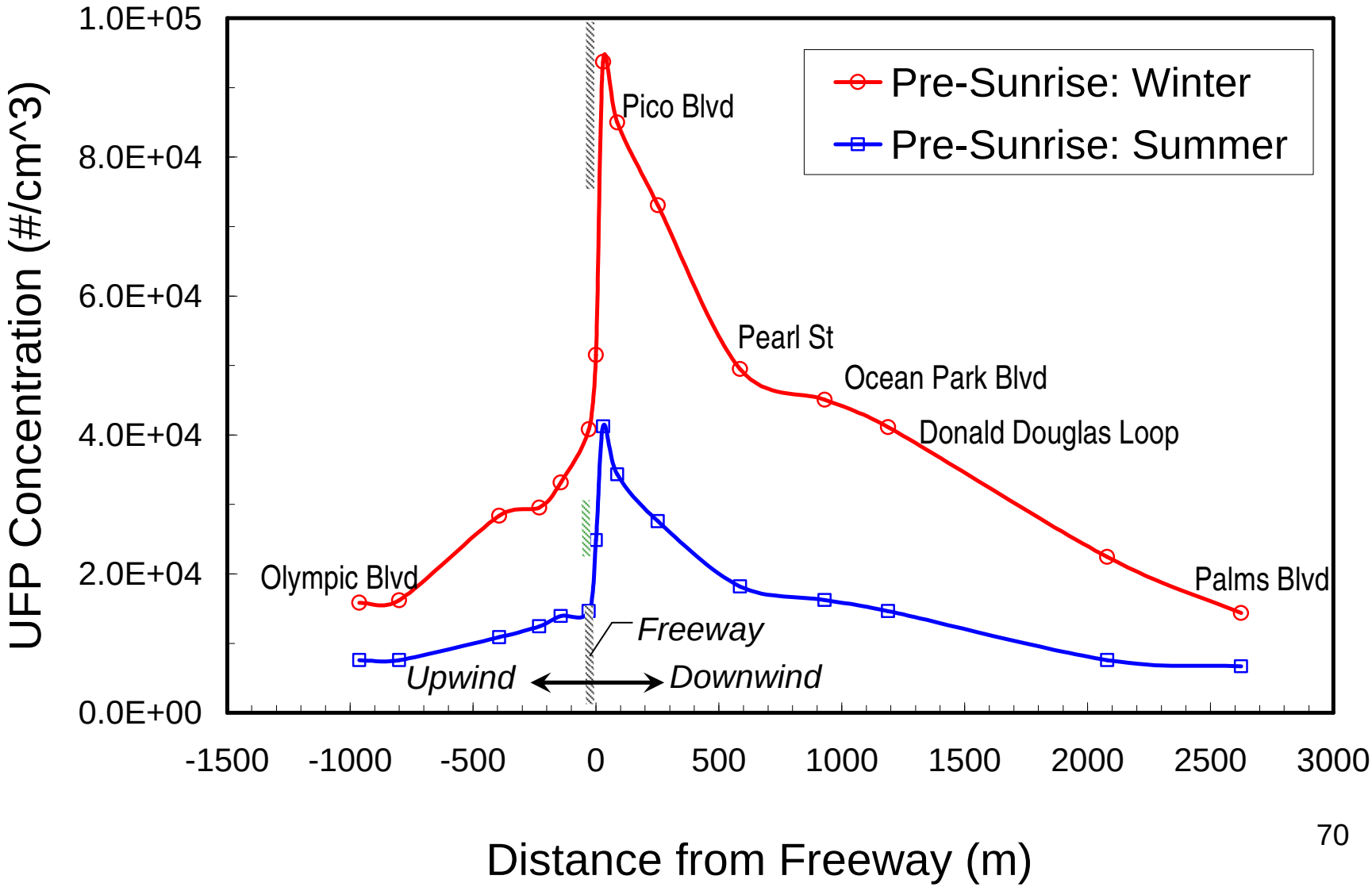
Route N and S of I-10 Freeway



Pre-sunrise wind direction

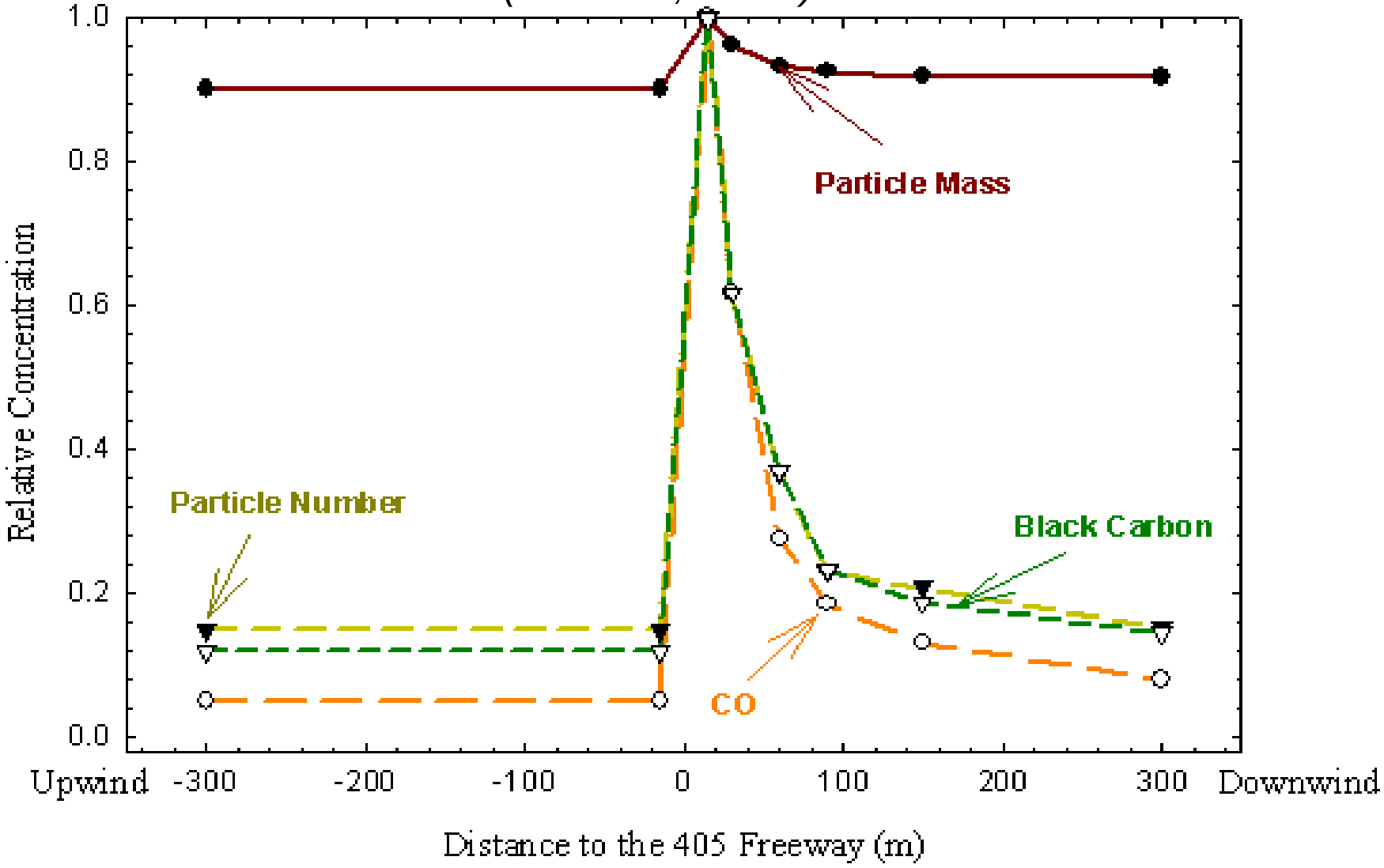


Wide Impact Area Downwind of I-10 Freeway During Pre-Sunrise Hours (> 2000 m)

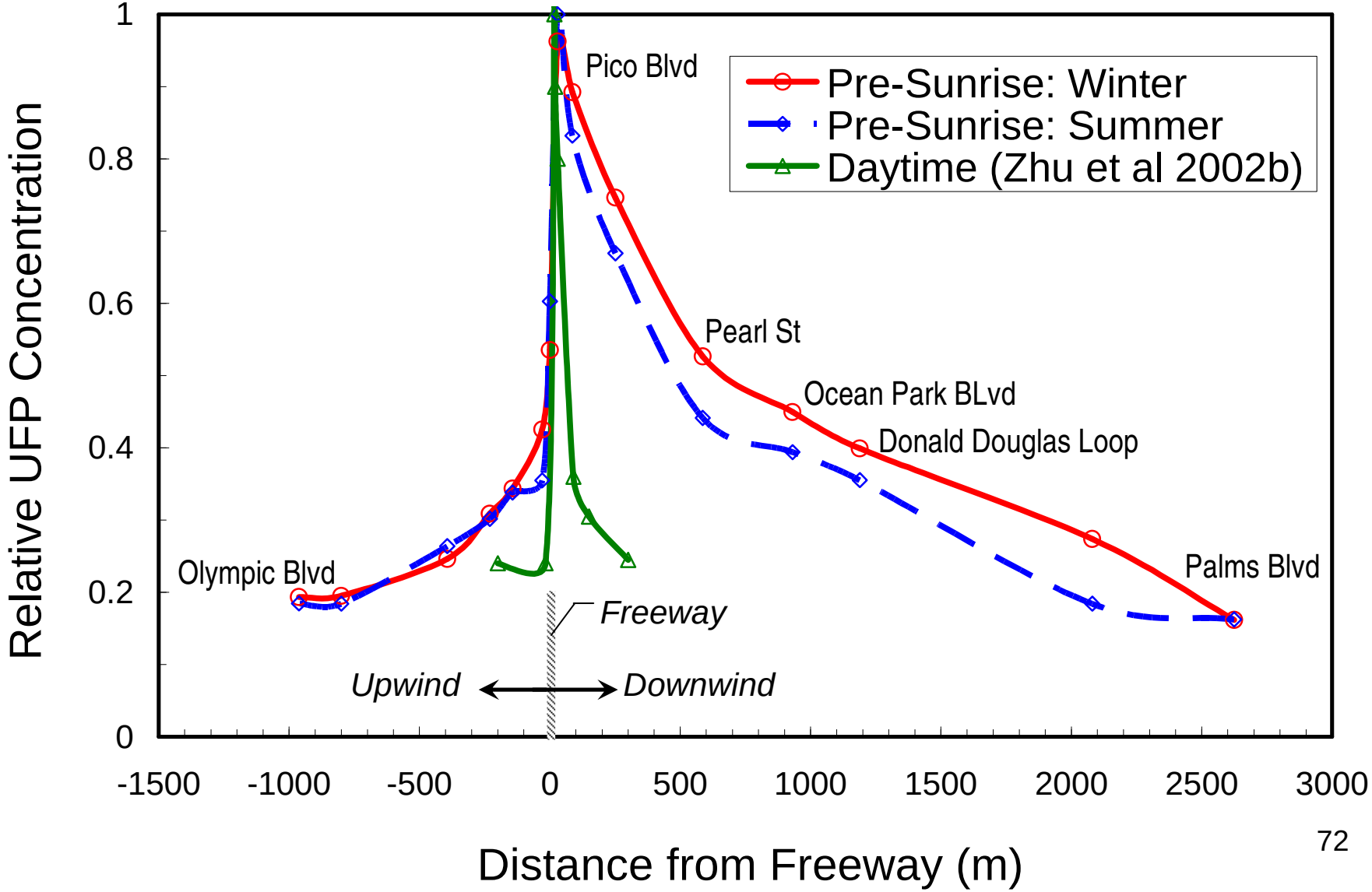


Relative Pollutant Concentrations vs Distance From the I-405 Freeway

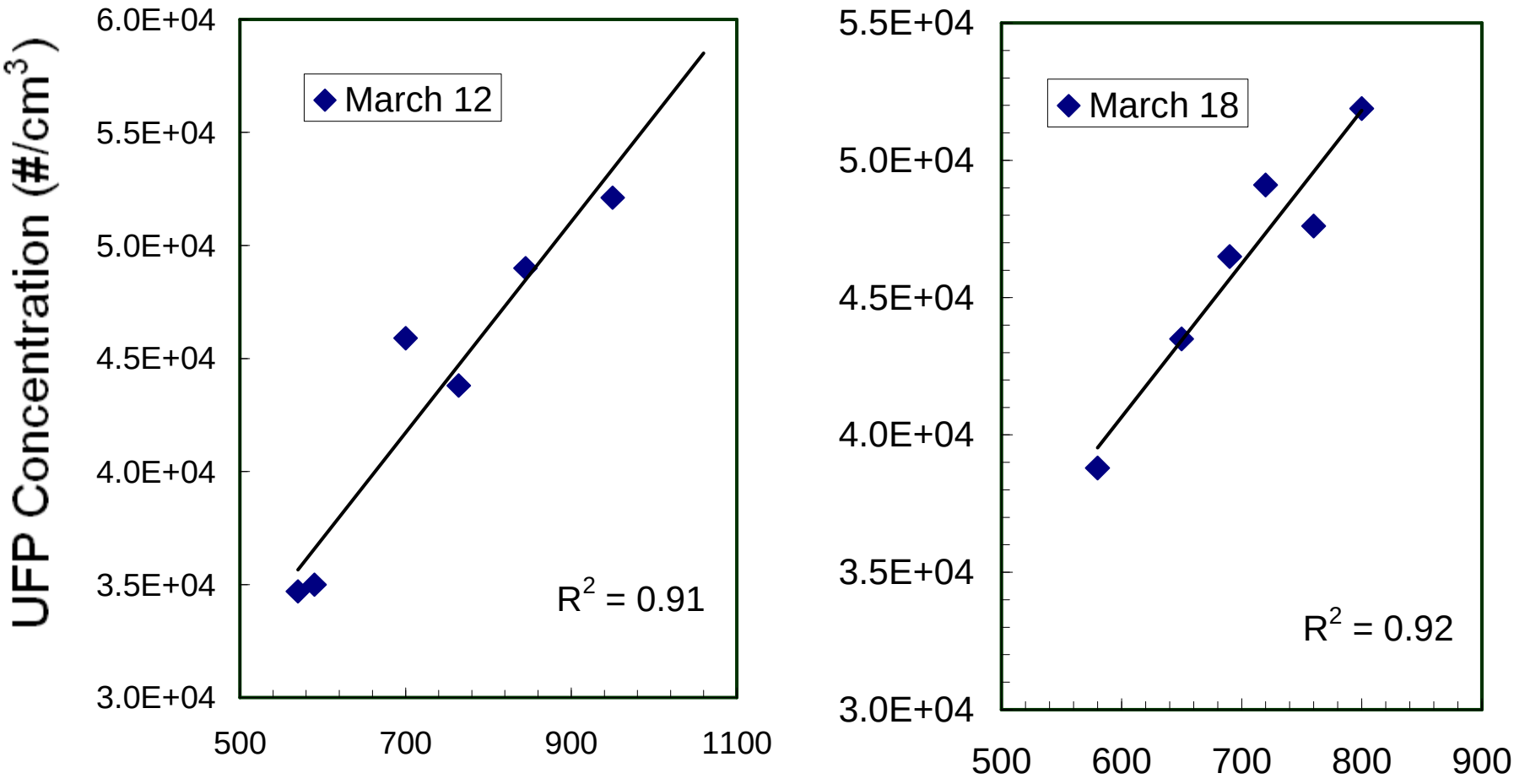
(Zhu et al., 2002a)



Relative UFP Concentration Pre-Sunrise Hours vs. Daytime Measurements of Zhu et al. (2002)



PSR Correlation between UFP *~1000m* Downwind and Traffic Counts on *I-10* Fwy



Summary

- We have discovered a wide impact area, up to *2,000 m* downwind and *600 m* upwind, of a major freeway during pre-sunrise hours

- Pollutant concentrations pre-sunrise are *higher* than daytime despite *lower* traffic volumes

- Results raise significant implications for human exposure and health given that most people are in their homes prior to sunrise and outdoor pollutants can penetrate indoor environments.

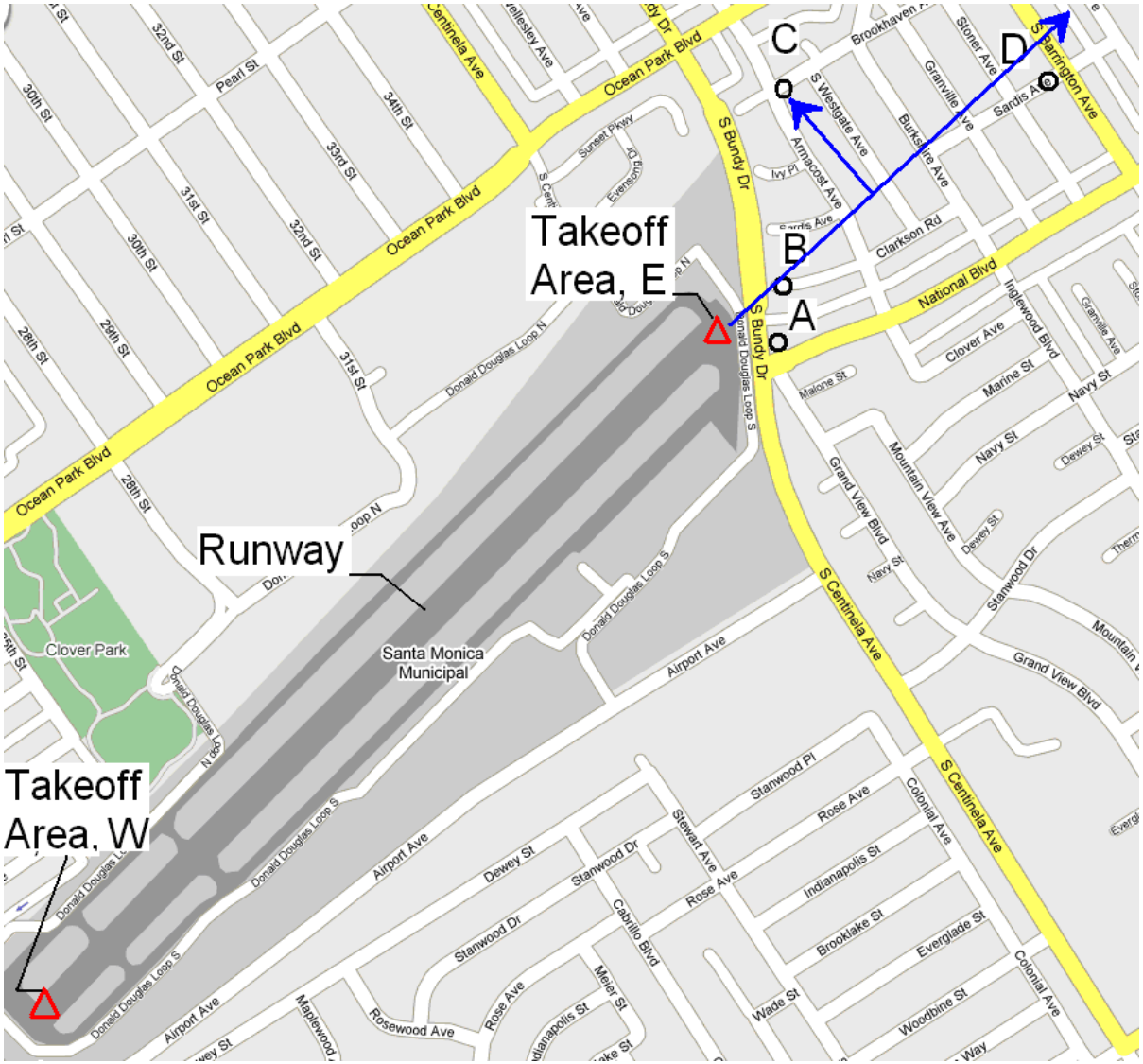
Aircraft Emission Impacts in a Neighborhood Adjacent to a Local Airport in Santa Monica, California

Shishan Hu[1], Scott Fruin[3], Kathleen Kozawa[1,2], Steve Mara[2]
Arthur Winer[1], Suzanne Paulson[1]

[1] University of California, Los Angeles
[2] California Air Resources Board
[3] University of Southern California

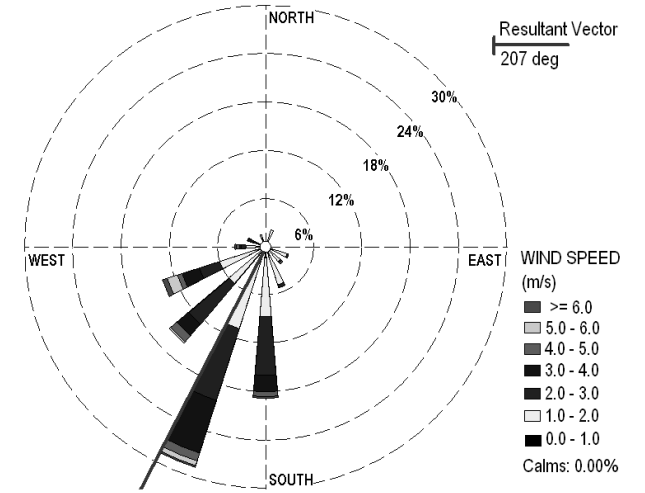
Environmental Science and Technology, 43: 8039-8045 (2009)

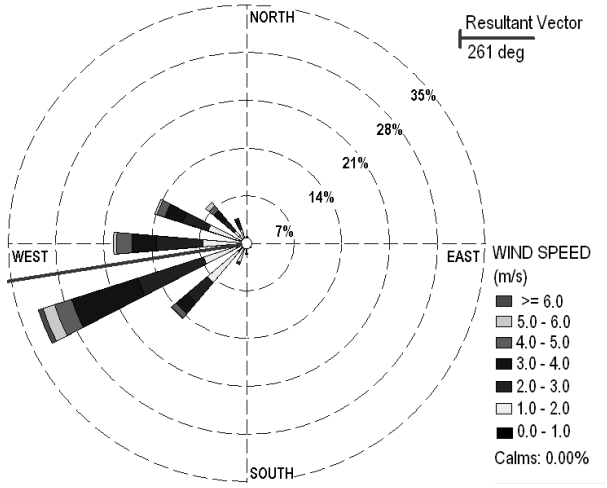
SMA and Neighborhood

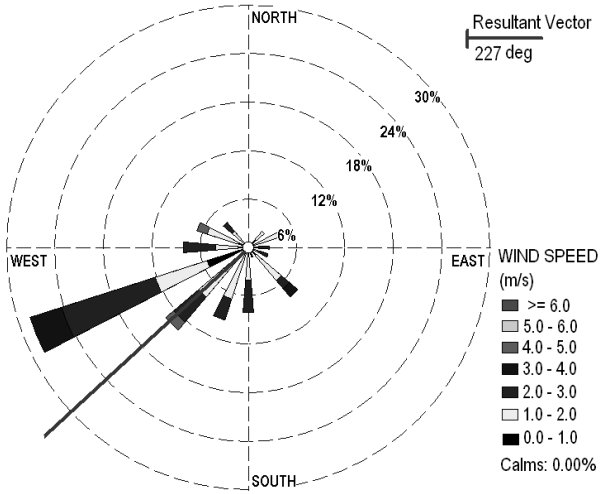


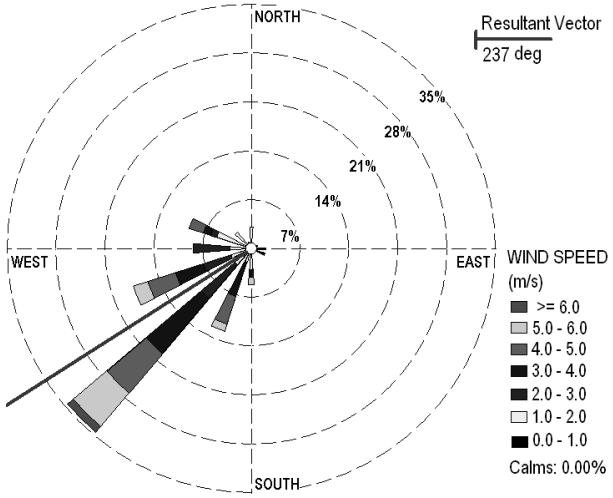
- SMA is a small local airport bounded by a residential neighborhood
- Predominant daytime wind direction is SW in this area
- Measurements were conducted on all sides of SMA

Wind Roses During Measurements on April 14, April 20, July 20 and August 8, 2008.







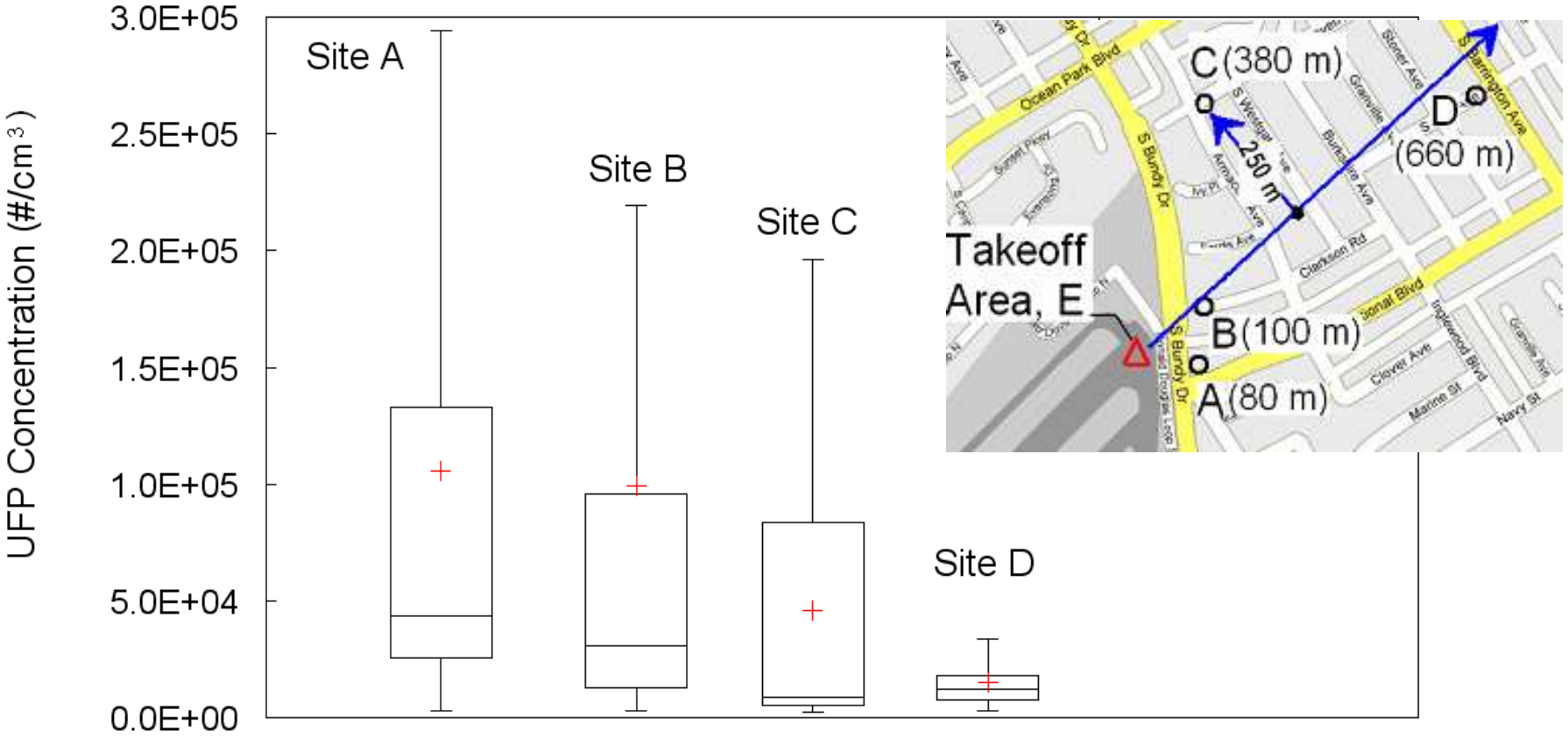


Map of Monitoring Sites

We were unable to detect a signature from the airport on the South, West or North sides of the airport.

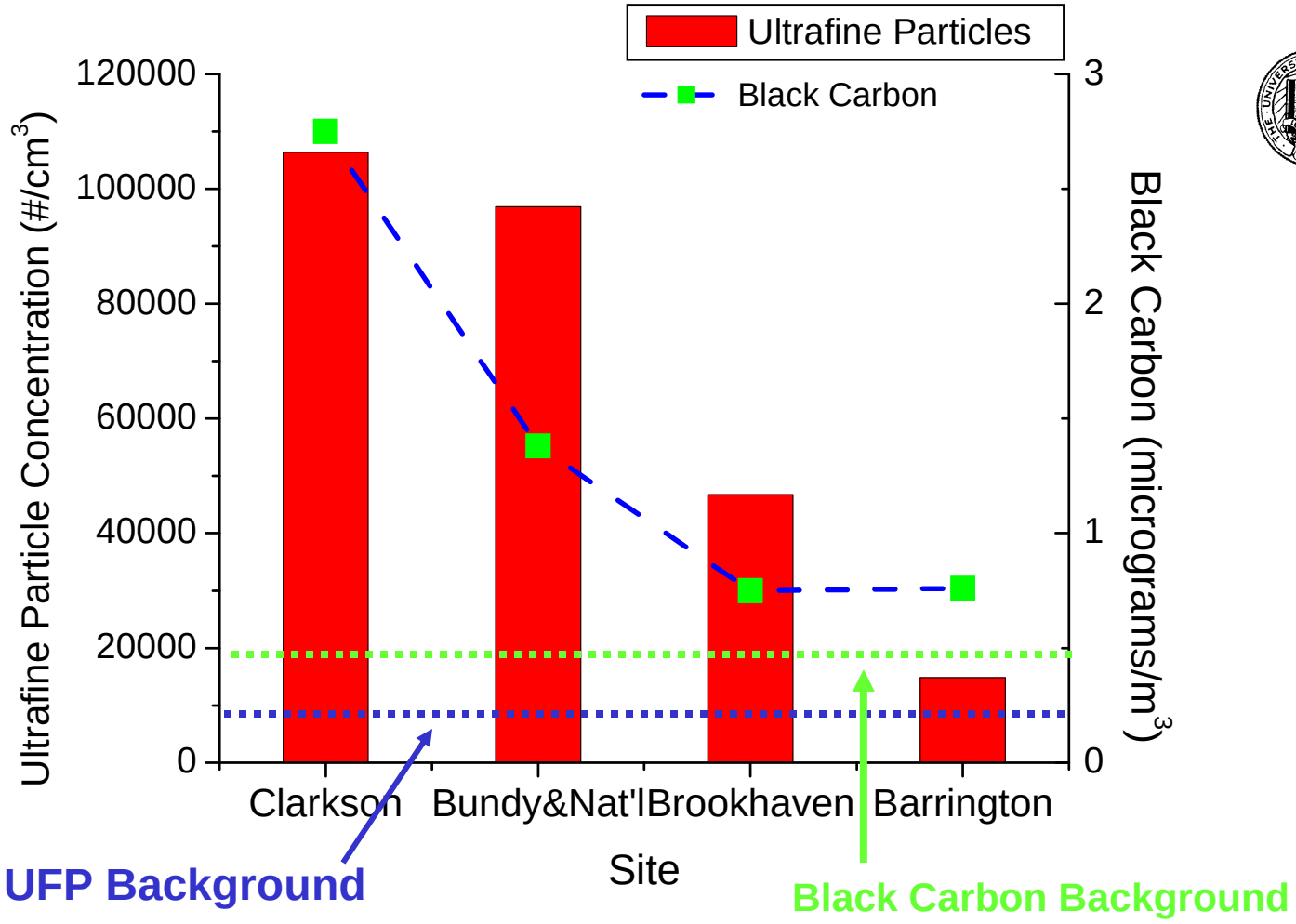
The signature downwind (east) of the airport was very clear.

UFP Downwind from SMA

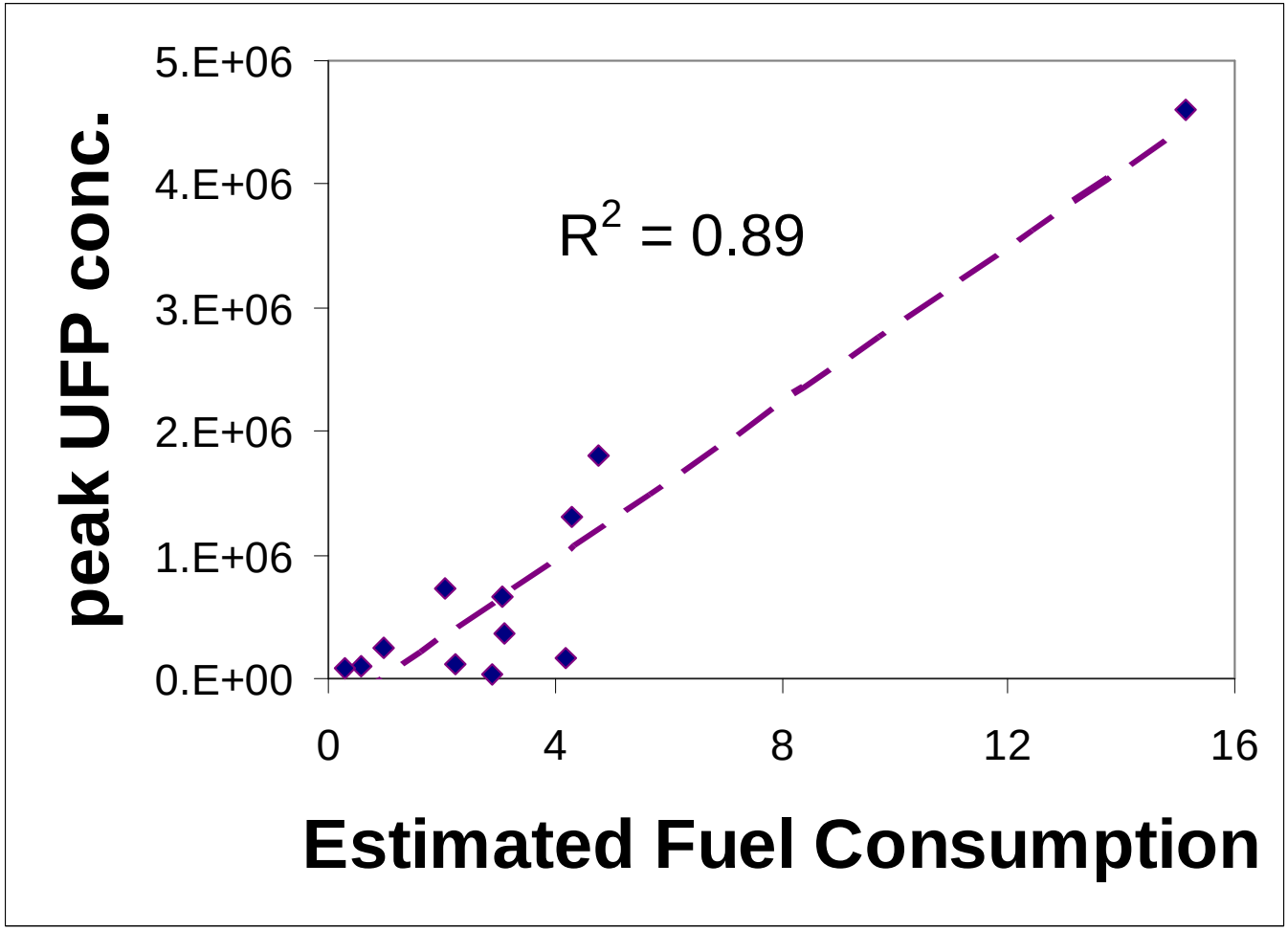


- Average UFP concentrations for A, B, C, and D were ~105K, ~100K, ~50K, and ~15K cm^{-3} (background UFP ~10K cm^{-3}).

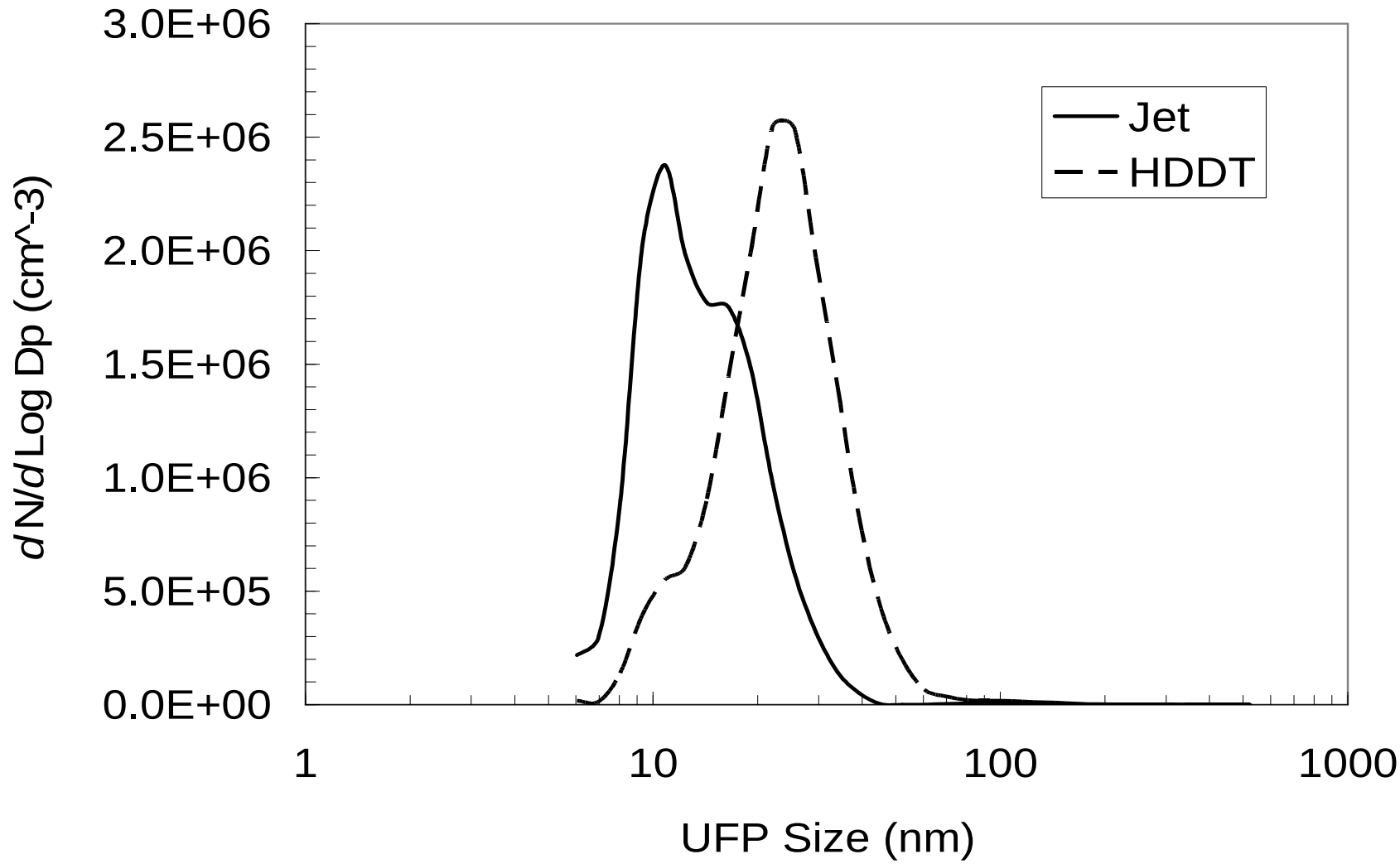
Black Carbon and Ultrafine Particles Were Elevated at All Downwind Sites



Higher ultrafine particle numbers are associated with higher estimated aircraft fuel consumption rates.



Aircraft particles are smaller than heavy duty diesel particles.



Summary

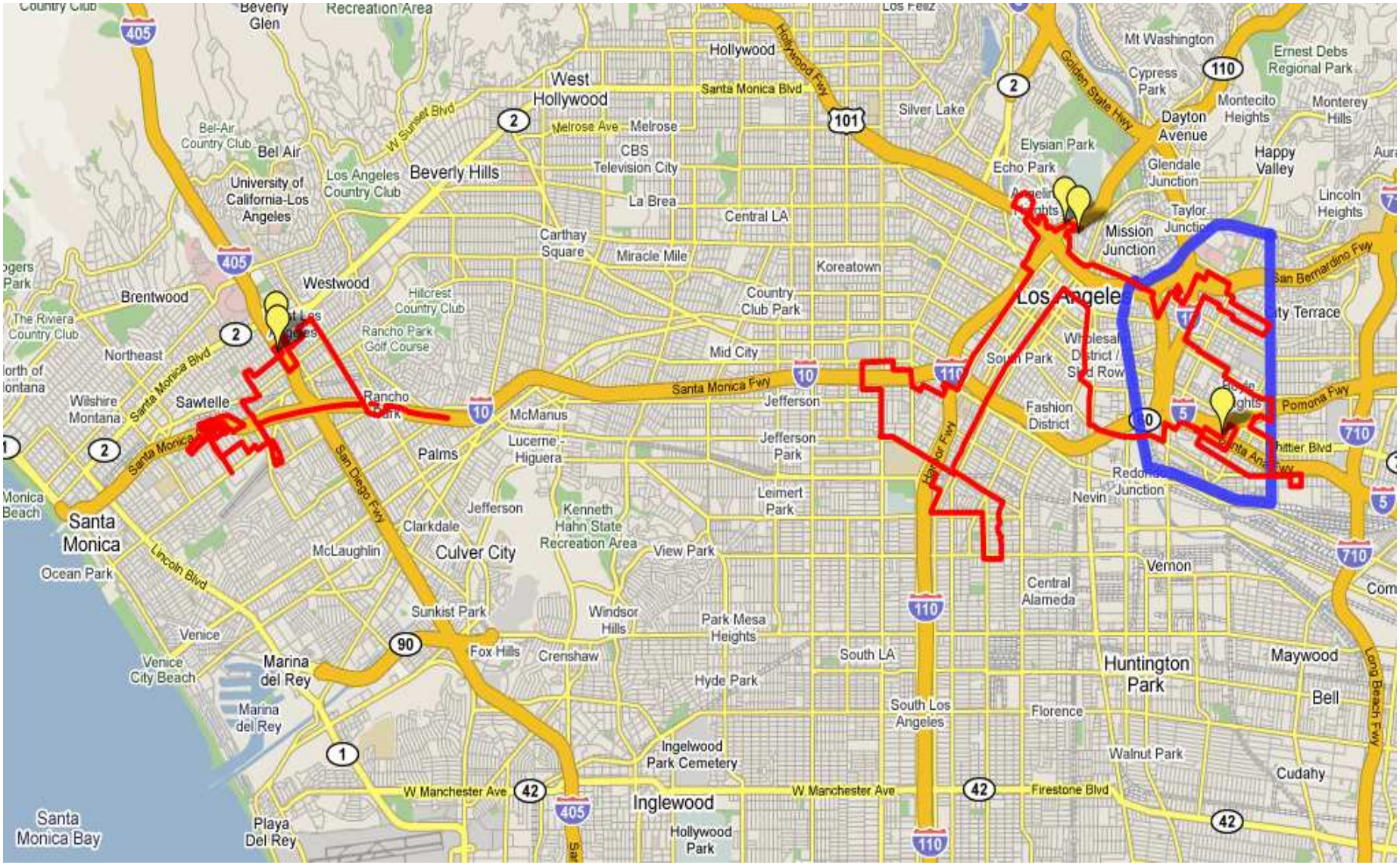
- Peak UFP, BC, and PAH concentrations observed downwind of the runway were, respectively, ~1000, 200, and 100 times neighborhood background levels (~1 km away).
- Pollutant concentrations remained elevated for several minutes at a time.
- Most of the pollutant spikes were associated with jet takeoffs.
- Impacts extended more than 600 m into the residential neighborhood.

Mobile Platform Measurements in DOLA and Boyle Heights

Shishan Hu[1], Suzanne Paulson[1], Kathleen Kozawa[1,2], Steve Mara[2] , Scott Fruin[3], Arthur Winer[1]

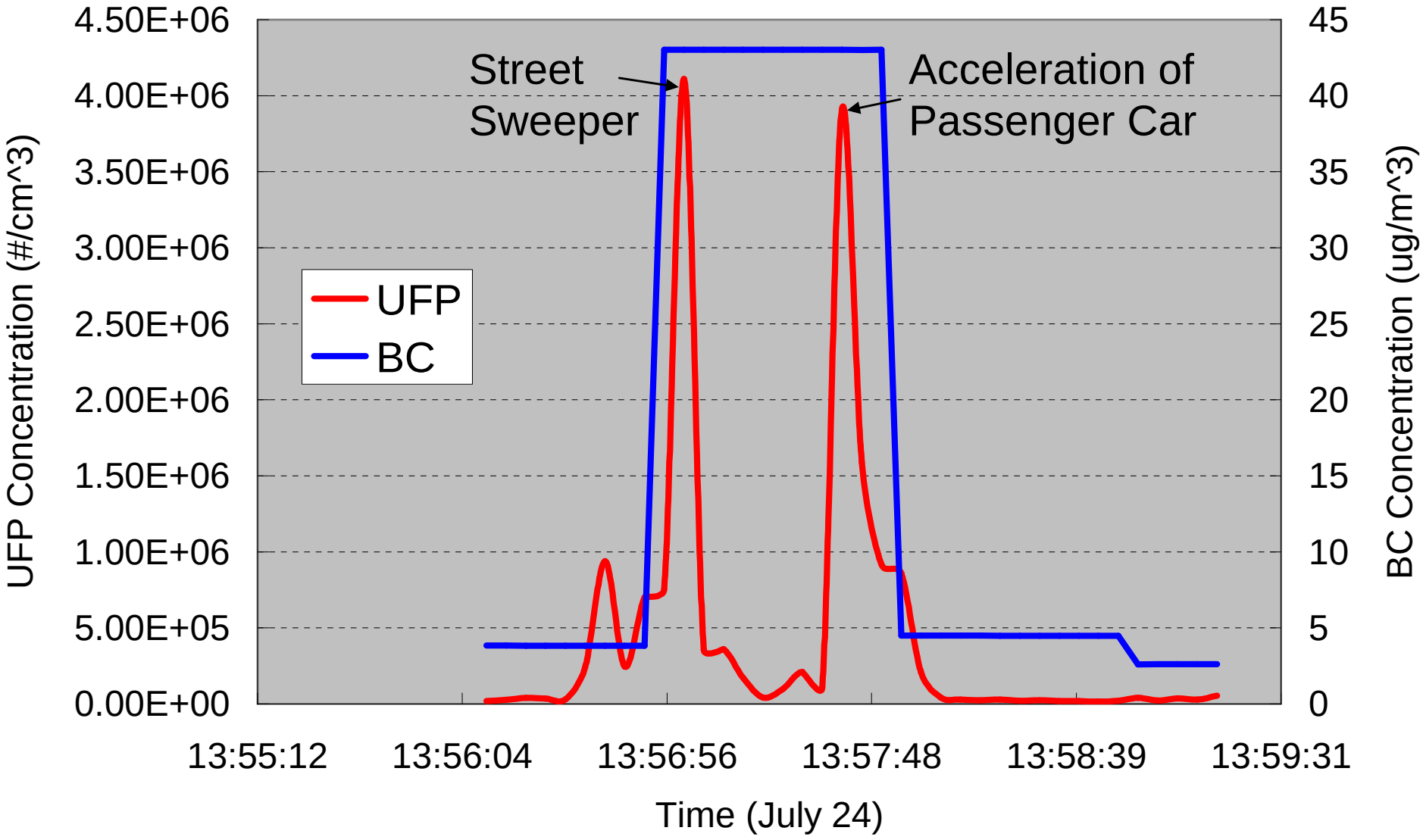
[1] University of California, Los Angeles
[2] California Air Resources Board
[3] University of Southern California

Manuscript in Preparation


Beverly Glen
Recreation Area
Hollywood
West Hollywood
Santa Monica Blvd
Melrose Ave
Melrose
Silver Lake
Elysian Park
Echo Park
Mt Washington
Ernest Debs Regional Park
Cypress Park
Montecito Heights
Monterey Hills
Dayton Avenue
Glendale Junction
Happy Valley
Lincoln Heights
Taylor Junction
Mission Junction
Bel-Air Country Club
Bel Air
University of California-Los Angeles
Los Angeles Country Club
Beverly Hills
CBS Television City
La Brea
Central LA
Carthay Square
Miracle Mile
Koreatown
Country Club Park
Westwood
Brentwood
Hillcrest Country Club
Rancho Park Golf Course
The Riviera Country Club
Northeast
Mid City
Wilshire Montana
Sawtelle
Rancho
McManus
Jefferson
Jefferson Park
Lucerne - Higuera
Palms
Fashion District
South Park
Wholesale District / Skid Row
Pomona Fwy
Santa Monica Fwy
San Diego Fwy
Harbor Fwy
Santa Ana Fwy
Whittier Blvd
Redondo Junction
Nevin
Leimert Park
Santa Monica
Ocean Park
Lincoln Blvd
Clarkdale
Jefferson
Kenneth Hahn State Recreation Area
McLaughlin
Culver City
View Park
Vernon
Central Alameda
Sunkist Park
Windsor Hills
Park Mesa Heights
Venice
Venice City Beach
Fox Hills
Crenshaw
South LA
Marina del Rey
Hyde Park
Huntington Park
Maywood
Bell
South Los Angeles
Florence
Walnut Park
Cudahy
Ingelwood Park Cemetery
W Manchester Ave
Inglewood
Firestone Blvd
Hollywood Park
Santa Monica Bay
Playa Del Rey
Long Beach Fwy
San Bernardino Fwy

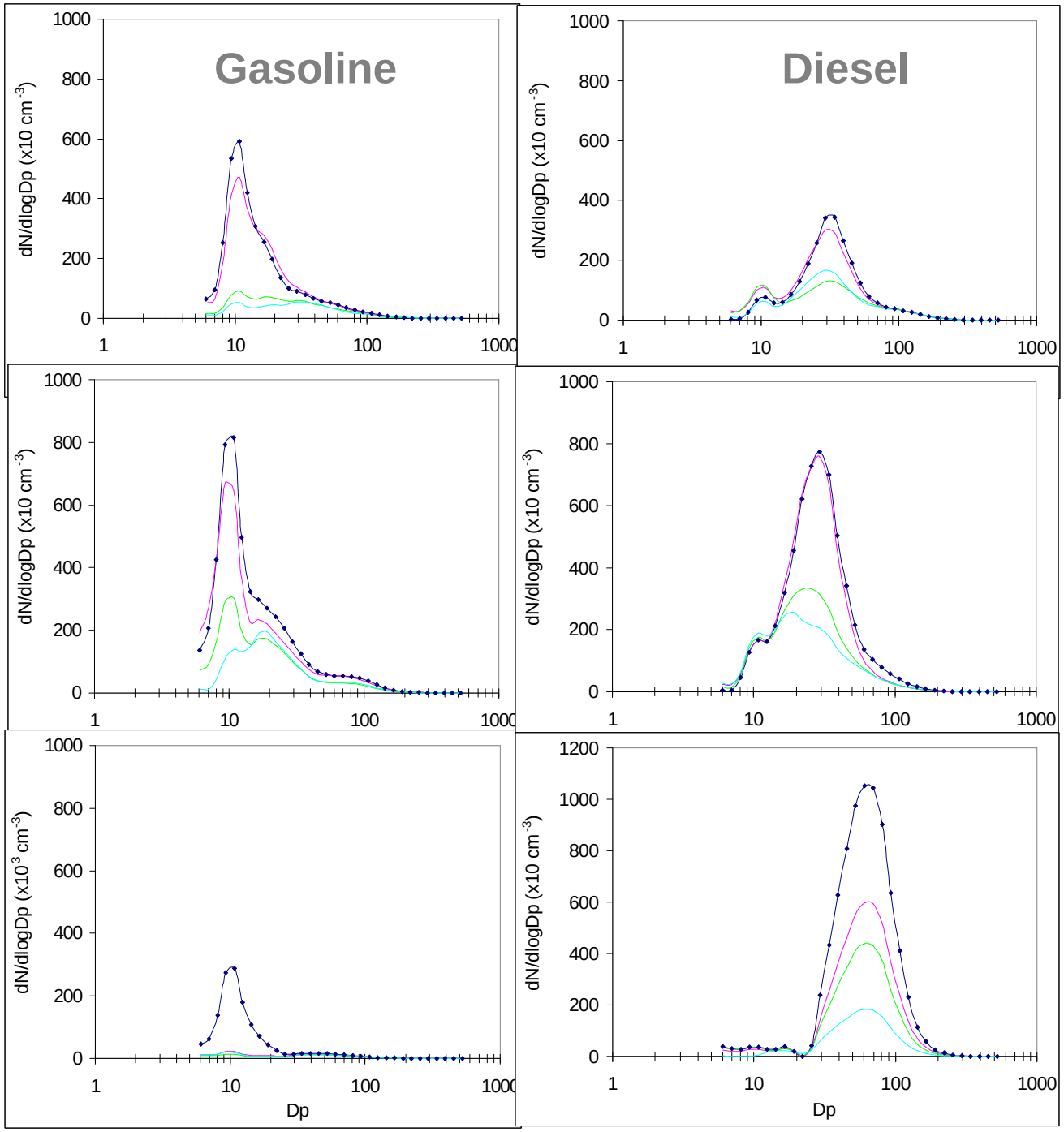

13:56:53 LOST GPS

Time series plot for UFP and BC



PAH peak: 2000 ng/m^3 (Background about 10 ng/m^3)

UFP Size Distributions from Gasoline and Diesel Vehicles Accelerating in front of Mobile Platform



Preliminary Conclusions for BH UFP

- High-emitting gasoline vehicles (HEGV), together with HDDT and other diesel vehicles, on surface streets within the community may produce elevated UFP concentrations throughout much of the community

- HEGV appear to contribute disproportionately to UFP concentrations observed in the community

- Strength of HDDT and HEGV emissions from the half dozen surrounding and intersecting freeways are also expected to contribute importantly.

- Secondary aerosol formation appears to contribute to UFP concentrations in the afternoon.

Overall Conclusions

- AQ problems occur at two distinct scales:
  - Regional smog vs localized vehicle impacts
- Addressing both poses new challenges for government, the private sector and the public:
  - We need to:
    - **Reduce diesel emissions from all sources**
    - **Develop effective strategies to reduce VMT**
    - **Eliminate gasoline “super emitters”**
    - **Create “Buffers” along major roadways**
    - **Address EJ issues posed by vehicle emissions**
  - Will require greater cooperation and integrated policy approaches across “disciplinary” agencies

Acknowledgements

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