

# Vegetation and Soundwalls around Freeways: Can trees help? Overview of CARB 13-306

Pollution Characterization:

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Supported by the  
California Air  
Resources Board

With meteorological characterization support by UCR  
(Amini, Ahangar, Venkatram)



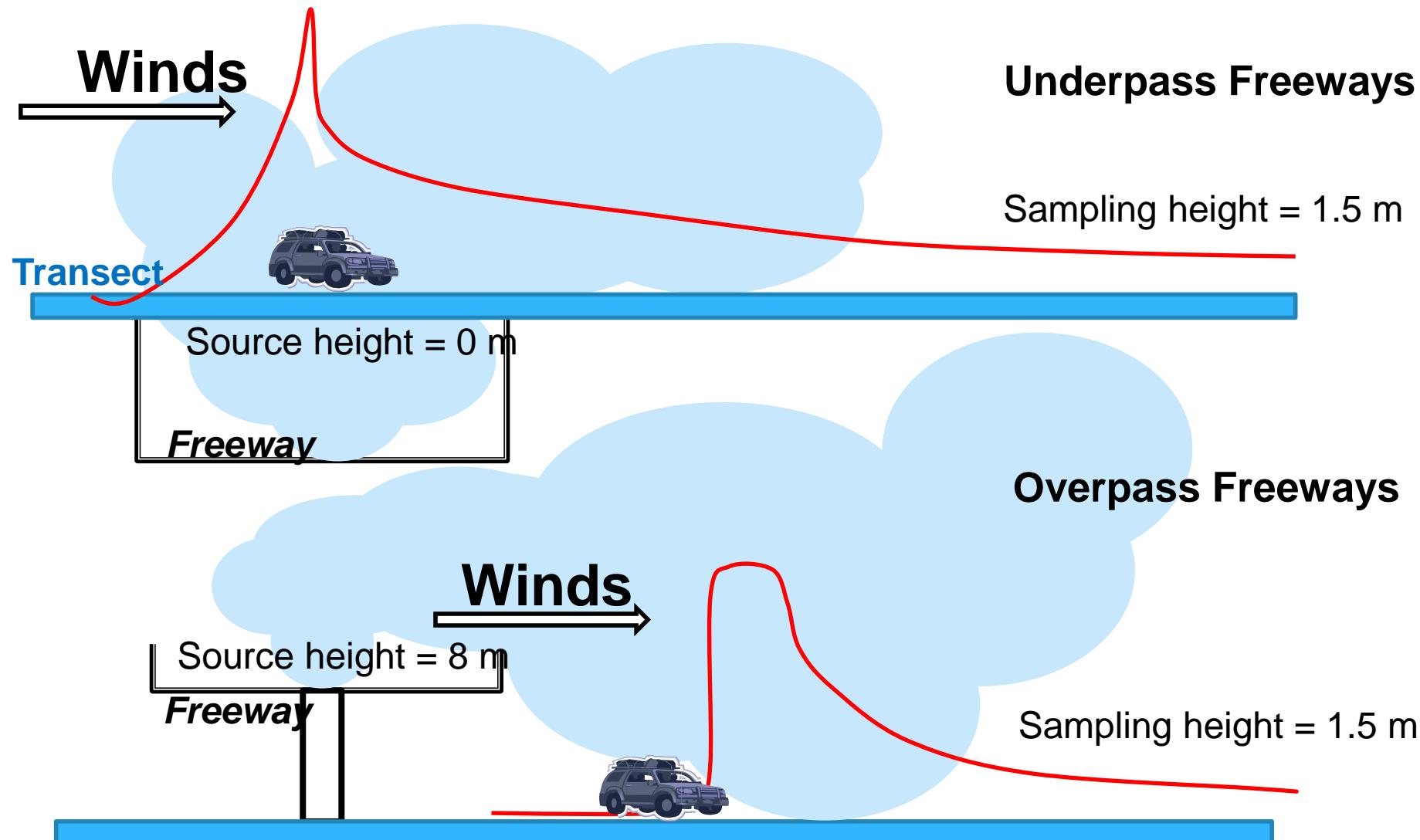
# OVERVIEW OF CARB 13-306

- Perform four soundwall measurement campaigns, at three sites; 2 in the South Coast Air Basin, 1 in the Sacramento area.
- Site conditions:
  - Four possible configurations
    - No Soundwall
    - Soundwall
    - Vegetation
    - Vegetation + Soundwall
  - Difficult to find good sites with even two of these conditions.

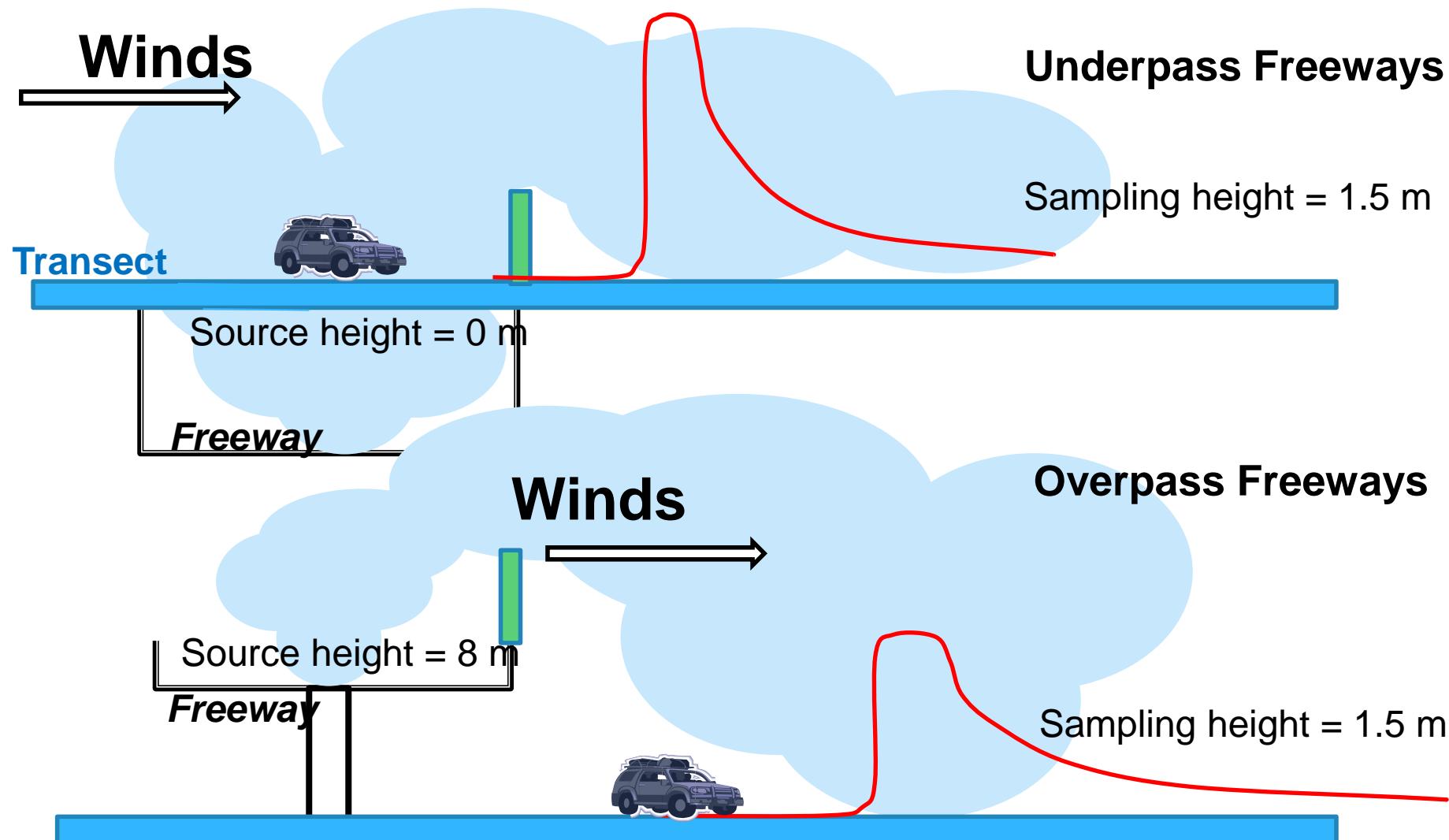
# OTHER CONSIDERATIONS

- Prefer winds that are ~ perpendicular to the roadway → larger, clearer effects, larger impact of the freeway on neighbors.
- Prefer flat terrain adjacent to the freeway → simpler to interpret.
- Soundwalls at roadways at or below grade will likely produce larger impacts and will be simpler to interpret. Rural freeways are often at grade.
- In dense urban areas, freeways are generally not at grade. Often they are elevated. What is the most relevant?

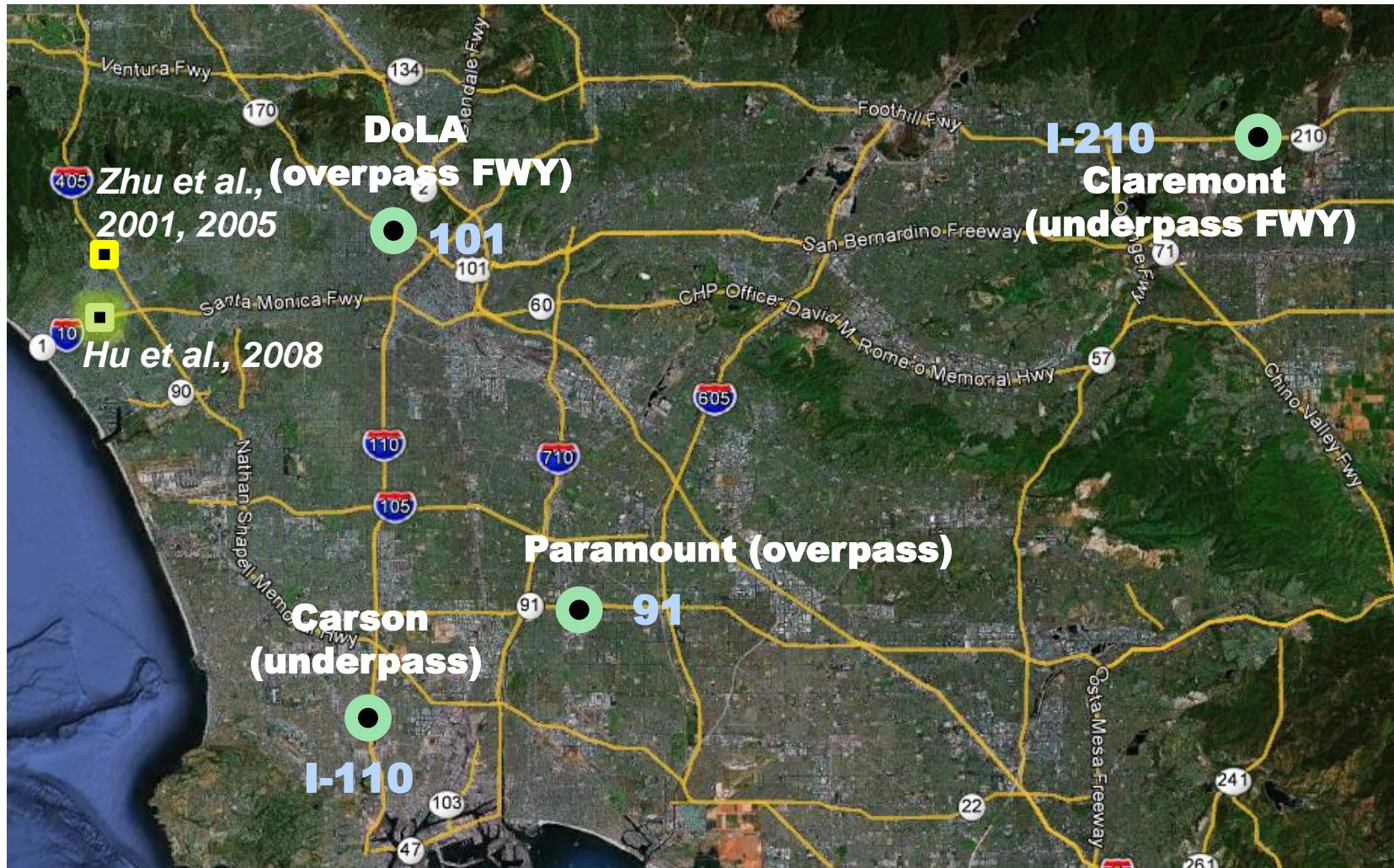
# AT, ABOVE OR BELOW GRADE?



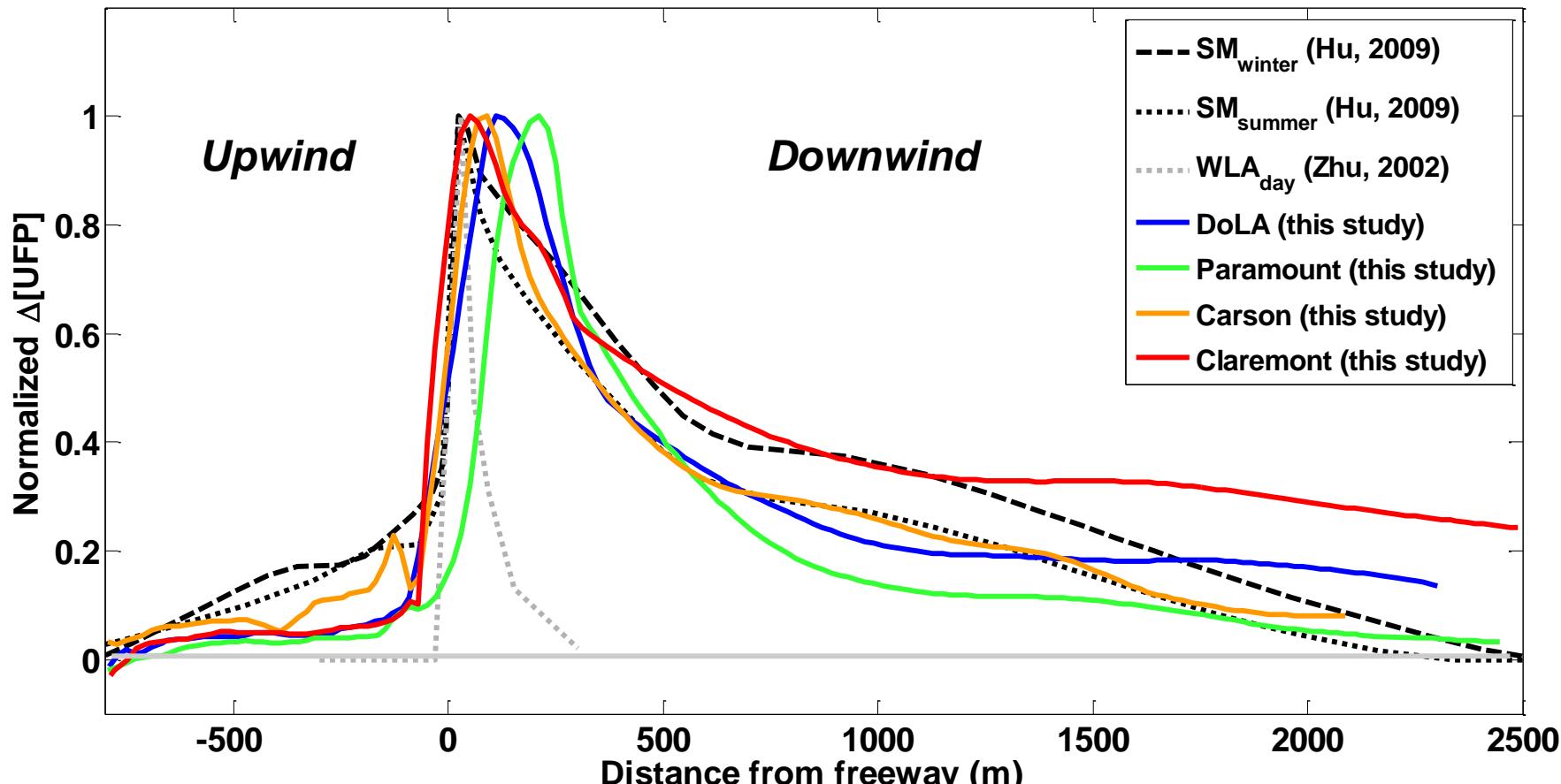
# AT, ABOVE OR BELOW GRADE?



# DAYTIME OR EARLY MORNING? Sampling Area and Transects



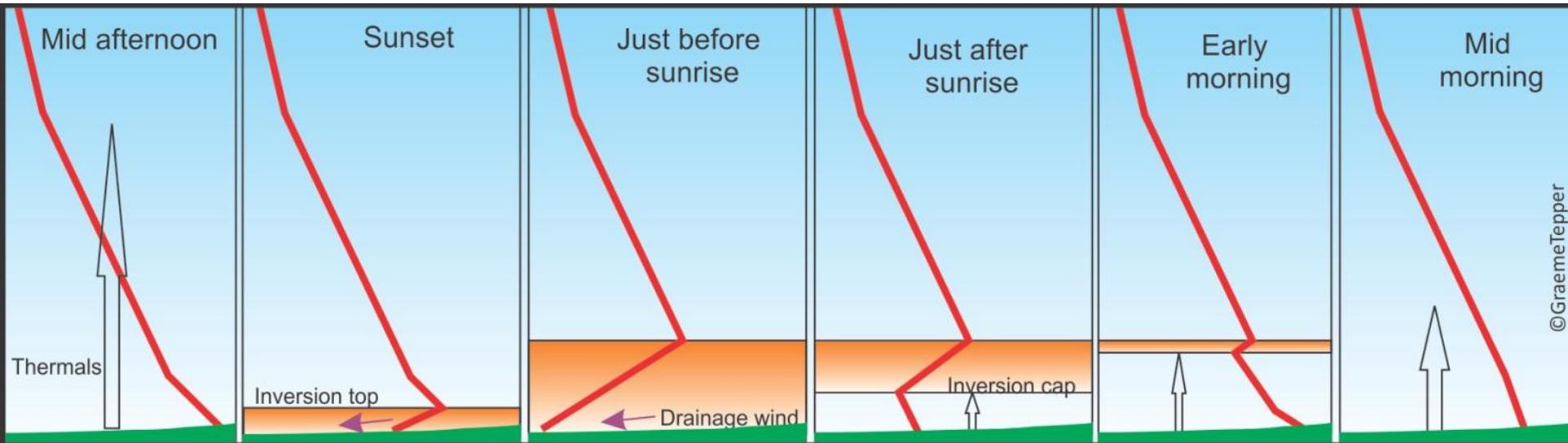
# Early Morning Freeway Plumes at Other Locations in Southern California



$$\Delta[UFP] = [UFP] - [UFP]_{bkgnd}$$

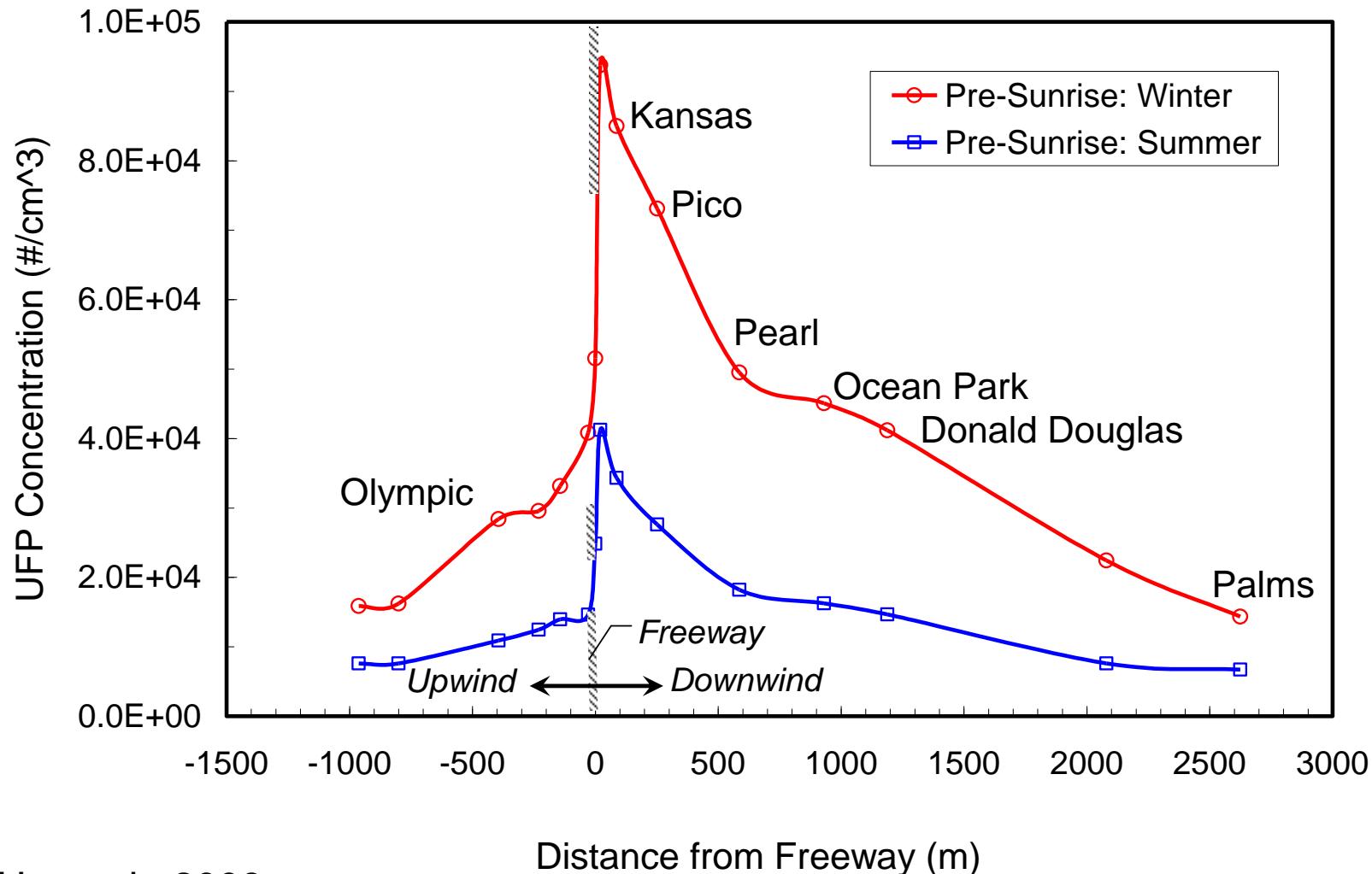
$$\text{Normalized } \Delta[UFP(x)] = \frac{\Delta[UFP(x)]}{\Delta[UFP]_{peak}}$$

# The Atmosphere Strongly Traps Pollution Near the Surface in the Early Morning

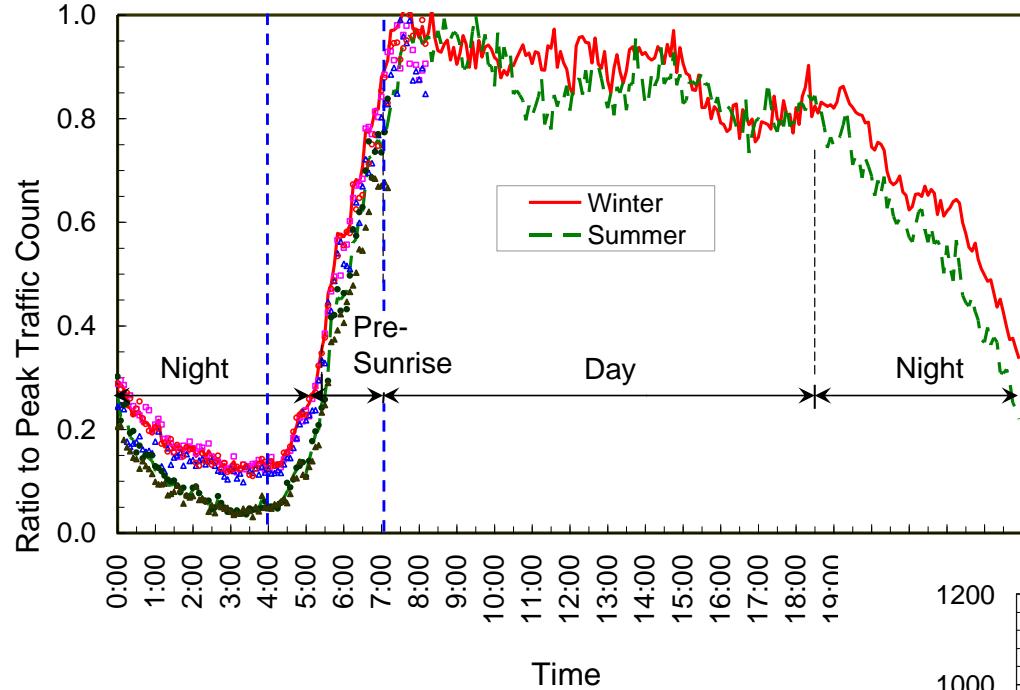


Red line indicates temperature profile

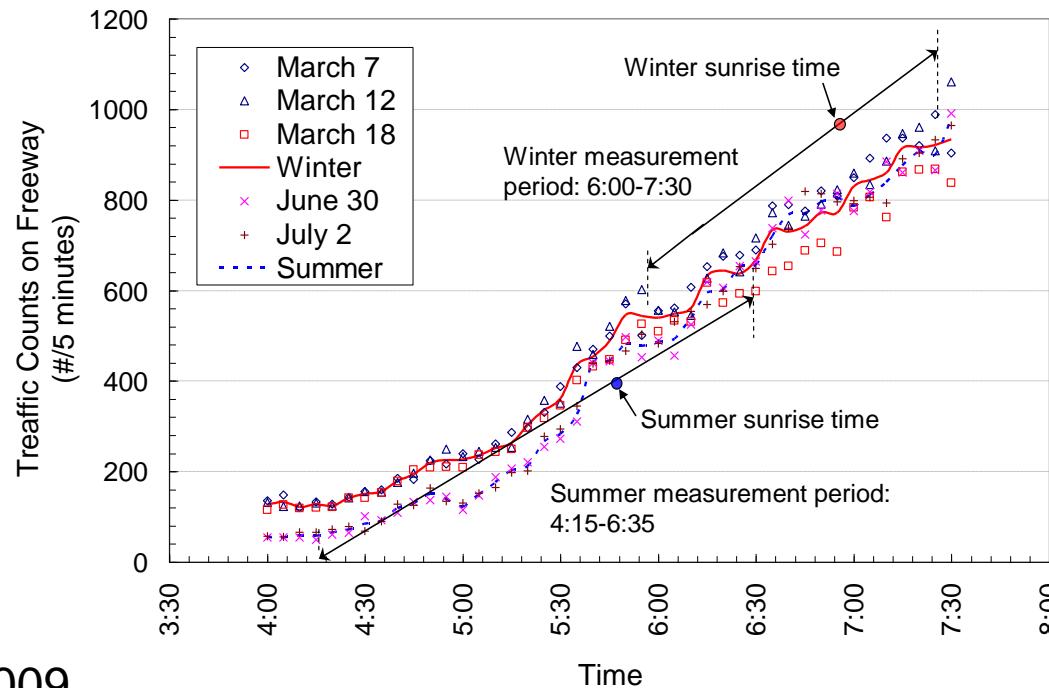
# Santa Monica: Summer is Cleaner; why?



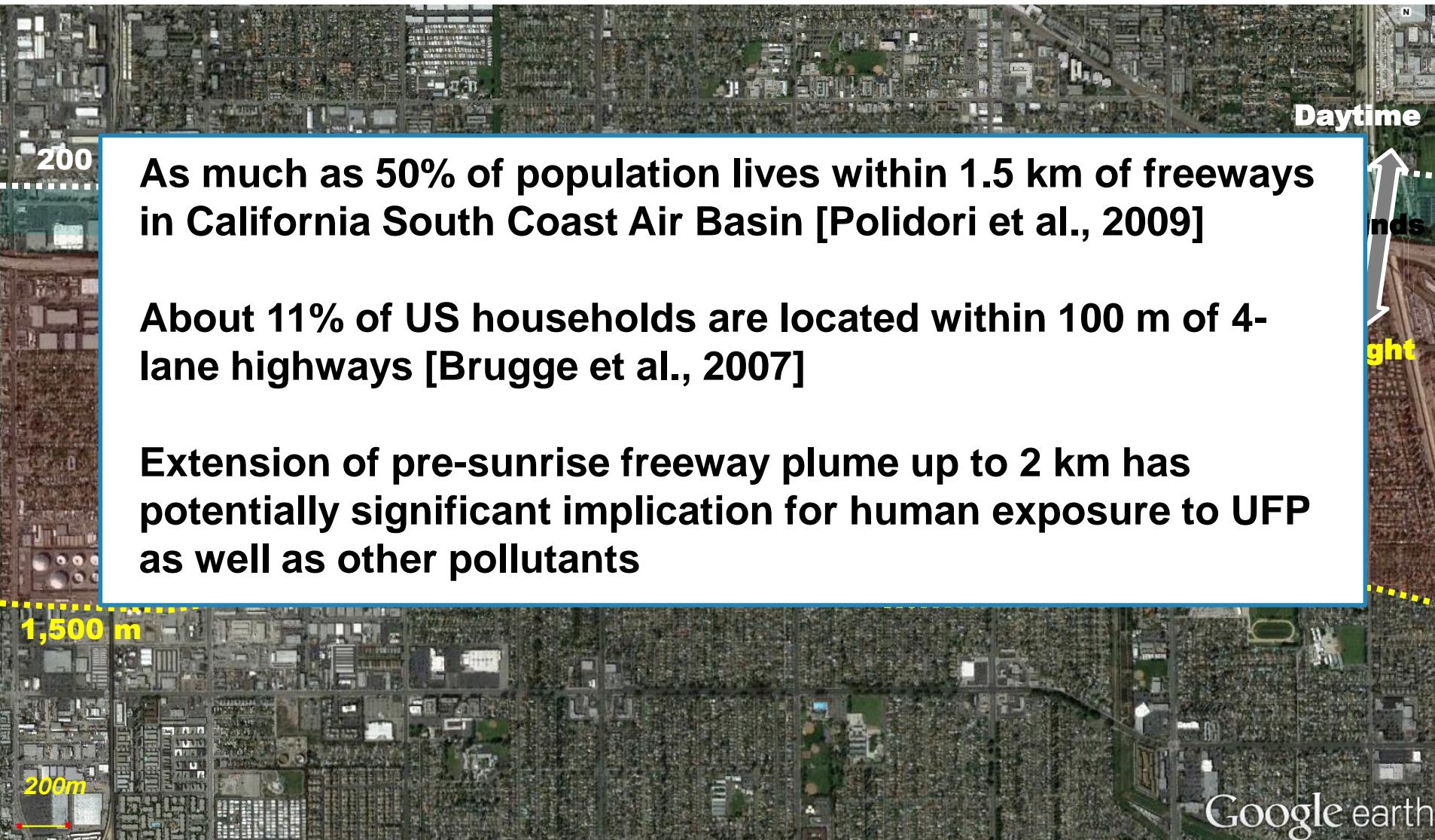
# Traffic Counts Increase Rapidly in the Early AM



Summer is cleaner because there is less traffic during the pre-sunrise period



# Night and Day



**As much as 50% of population lives within 1.5 km of freeways in California South Coast Air Basin [Polidori et al., 2009]**

**About 11% of US households are located within 100 m of 4-lane highways [Brugge et al., 2007]**

**Extension of pre-sunrise freeway plume up to 2 km has potentially significant implication for human exposure to UFP as well as other pollutants**

# CHALLENGES FINDING GOOD SITES

- Almost all residential areas in the South Coast Air Basin have a soundwall.
- Older freeway construction often has low barriers, newer construction taller barriers. Sometimes these are right next to each other.
- Almost all areas without a barrier are located near an interchange. Not good!
- Logistically, it is much easier to deploy stationary monitors in residential neighborhoods. Also need upwind stationary sites.
- But these almost always have walls—no controls!

# OVERVIEW OF CARB 13-306

- We have closely examined over 100 miles of freeway and considered about 15 sites so far. We finally have 3 sites that seem viable.
- 1. Santa Monica
- 2. El Monte
- 3. Sacramento

# Stationary Monitoring Instrumentation

Instrument and manufacturer	Time Resolution	Research Group
<b>UFP/Fine Particle Size Distribution</b>		
SMPSS (TSI) (3)	1 min	Zhu/Paulson
<b>Particle Number Concentration</b>		
Testo Discmini (4)	1 sec	Paulson
**CPC 3007	1 sec.	Zhu
WCPC 3785	1 sec.	Zhu
<b>PM2.5</b>		
DustTrak (2)	1 min	Zhu
Dylos (4)		Paulson/Zhu
<b>NO<sub>x</sub> and NO<sub>2</sub></b>		
Ogawa Passive Samplers (70)	1 day - few weeks	Zhu
<b>Noise</b>		
Quest 2900/MicroDaQ (3)	1 min	Paulson/Zhu
<b>Micro met</b>		
Sonic Anemometer CSAT3 (3)	1 – 60 Hz	Venkatram

## Measurement Parameter

Particle Number (10 nm ~ 1 $\mu\text{m}$ ), but dominated by **ultrafine particles**

Particle size distribution (5.6~560 nm)

PM<sub>2.5</sub> and PM<sub>10</sub> mass

Particle bound PAHs

Black Carbon

CO<sub>2</sub>

CO

NO, NO<sub>2</sub>

Temperature, Relative humidity, Wind speed/direction

GPS

Vertical profiles of temperature, RH, wind speed/direction

Video record

----- Wish List -----

Speciated Volatile Organics

Particle Chemical Composition

# Pollutants & Measurements



ARB's electric vehicle



SmartTether™

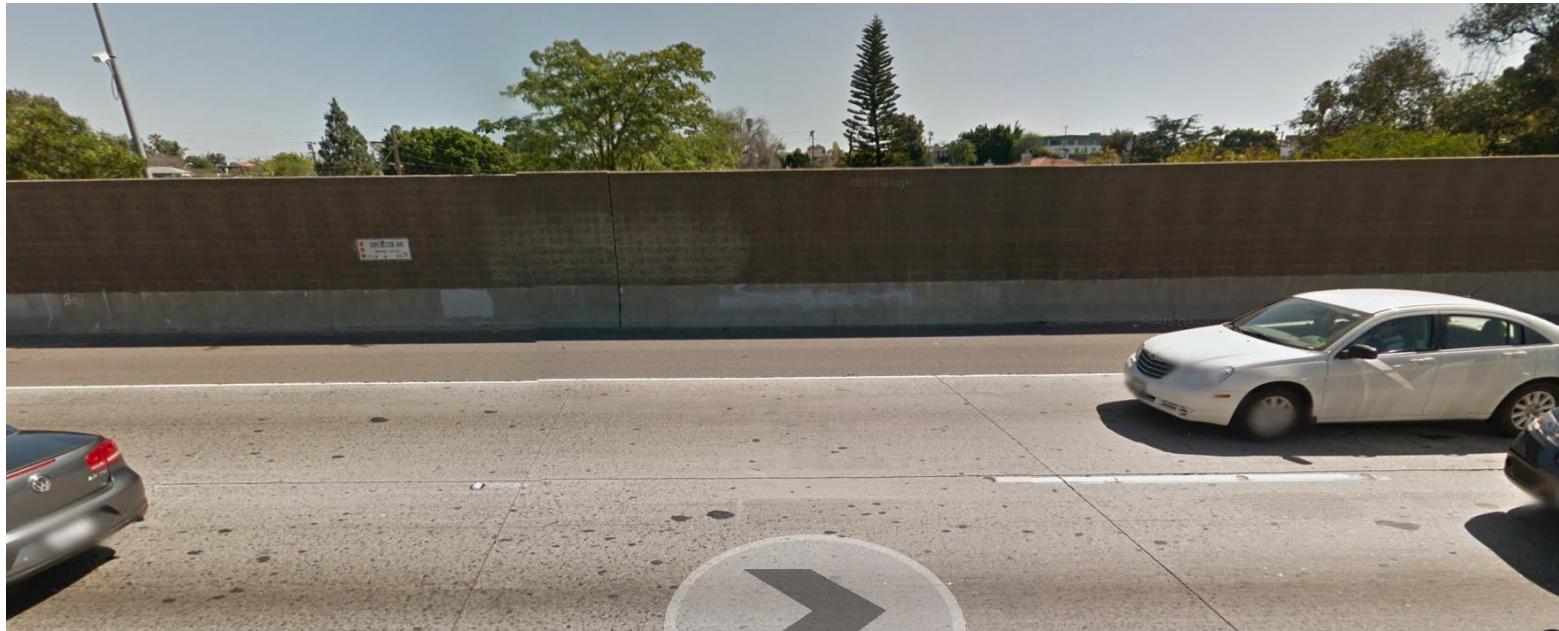
# VEGETATION

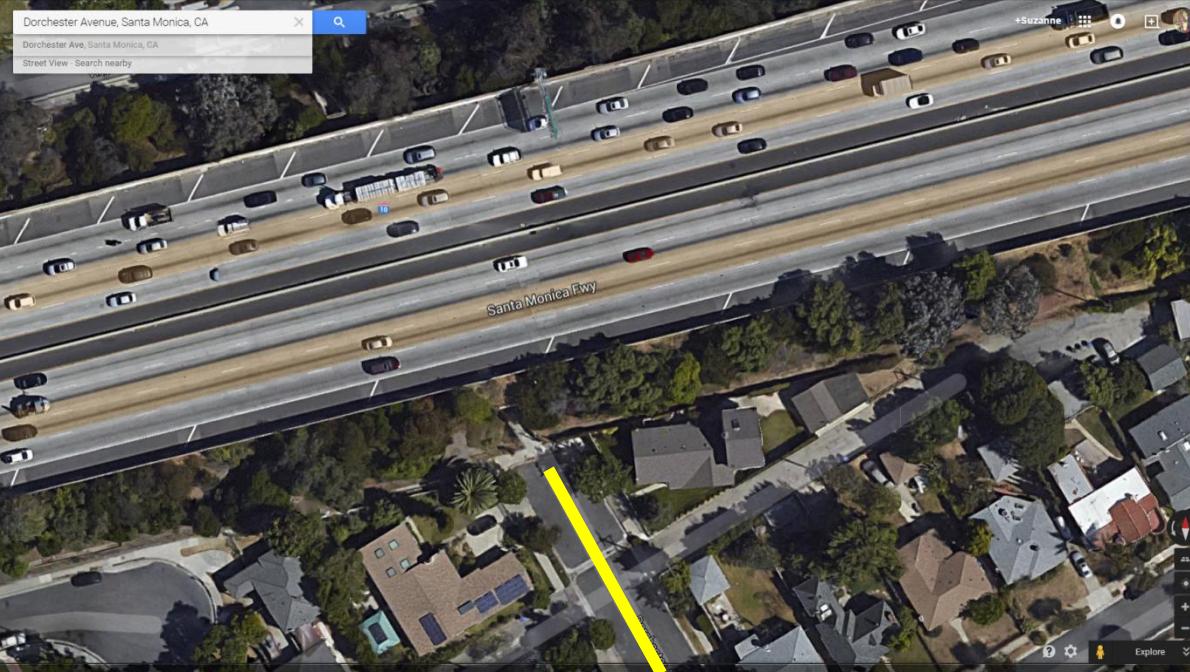
- With only three sites and so many other requirements in site selection we are not be able to find sites with an ideal selection of vegetation variables (i.e. control for height and geometry, vary leaf area index).
- Nonetheless, we hope to contribute to the understanding of the effectiveness of vegetation at mitigating pollution.

## Characterize the vegetation

- Physical characteristics control deposition and barrier activity:
  - genus and species, height, width, spacing,
  - optical porosity, leaf shape and clumping, leaf area index
  - Leaf area index is likely the dominant parameter governing particle deposition
- Activity characteristics:
  - genus and species, height, width, spacing,
  - leaf area index
  - stomatal conductance: presumably most important characteristic controlling impacts on gaseous pollutants

SANTA MONICA:  
WALL + VEGETATION  
VS. VEGETATION  
“MORNING SIDE”

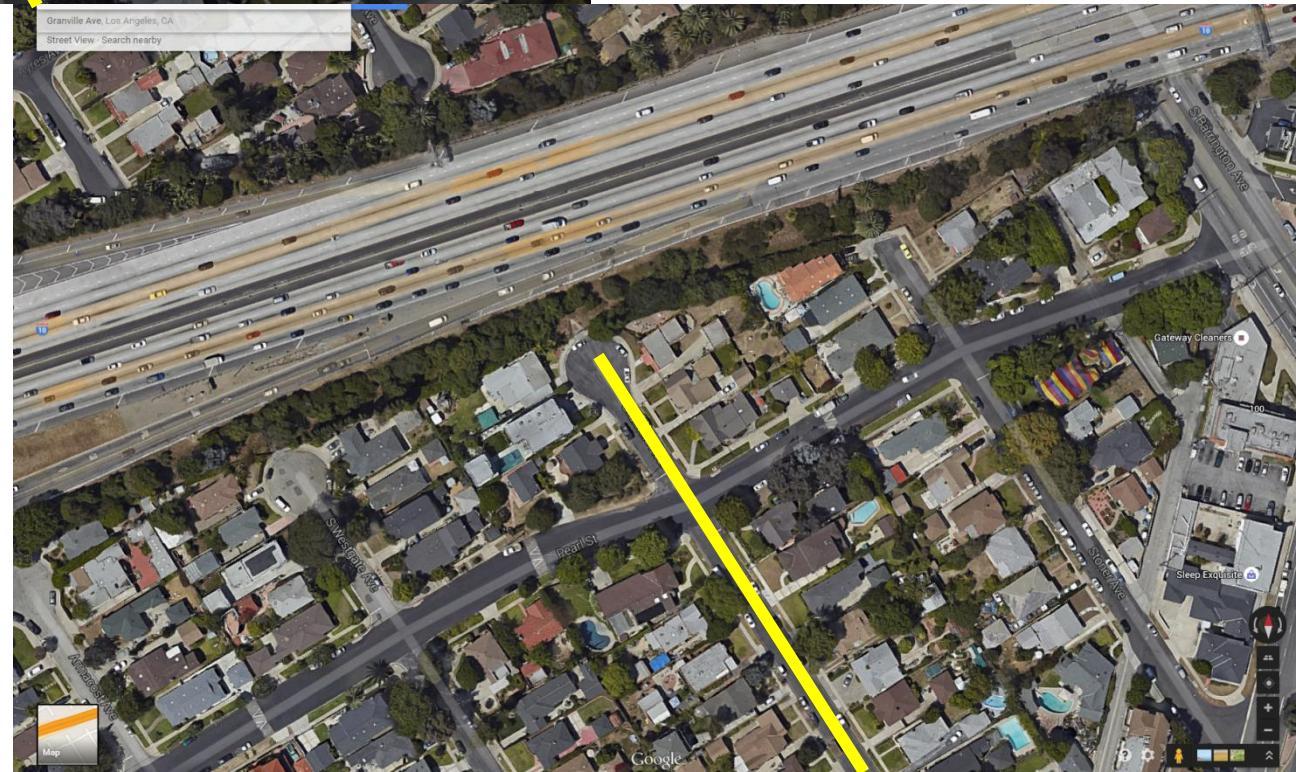




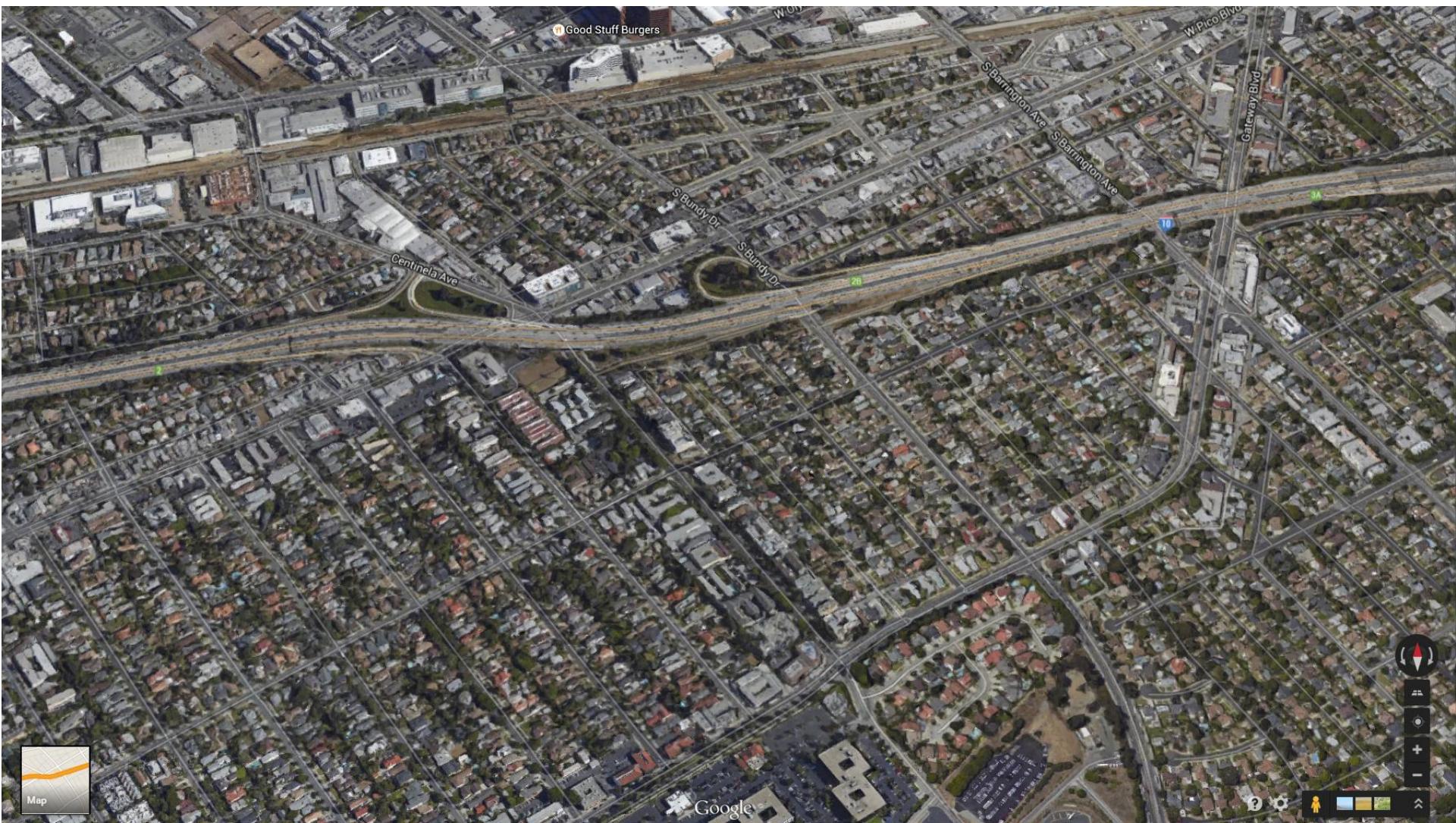
**Similar  
Vegetation**

**Similar but not  
identical  
elevation  
profile**

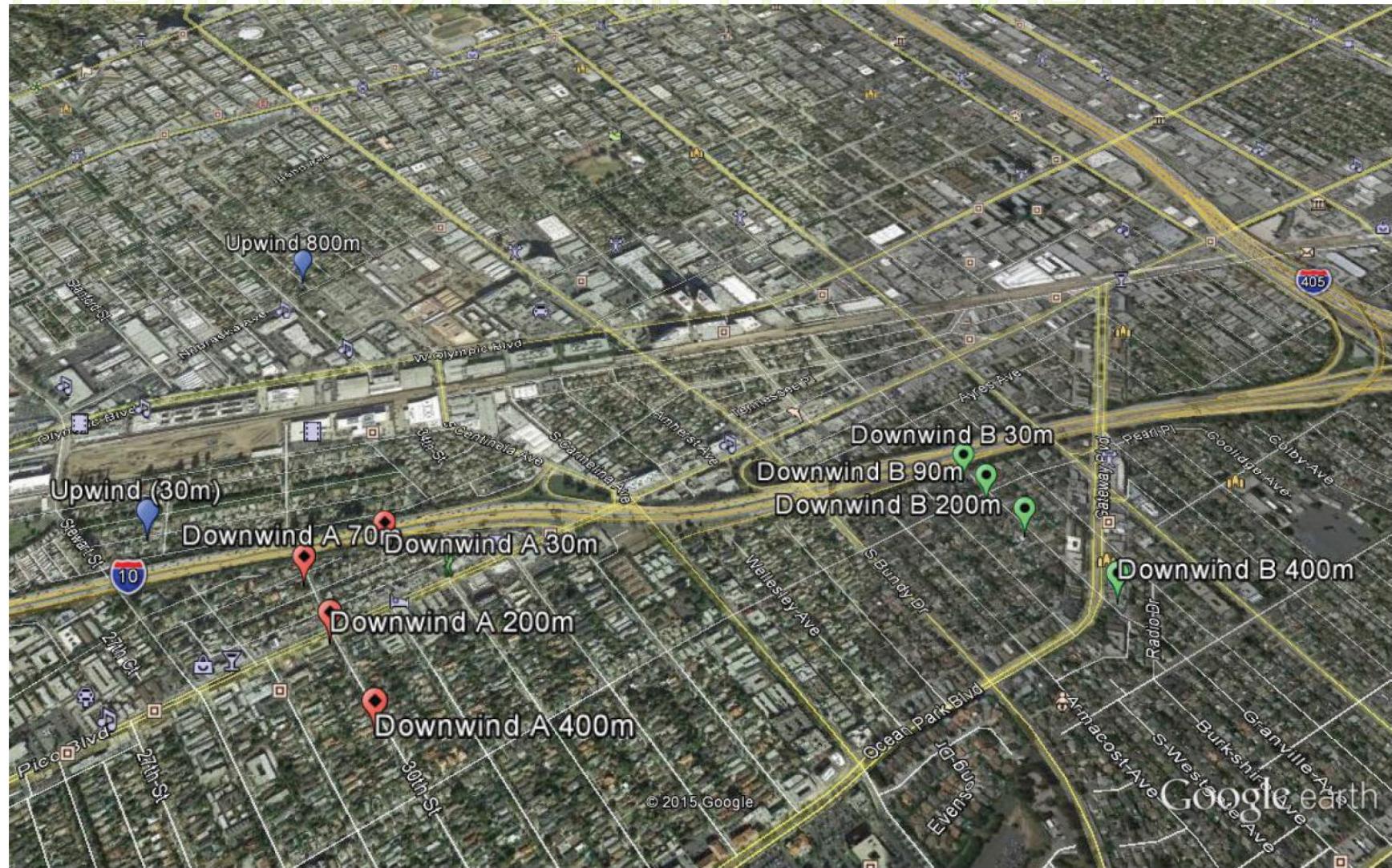
**Santa Monica  
Site:  
Freeway is  
elevated 5-6 m**



# Santa Monica Site: Both have vegetation, one has soundwall



# STATIONARY SAMPLER LOCATIONS



# Google earth

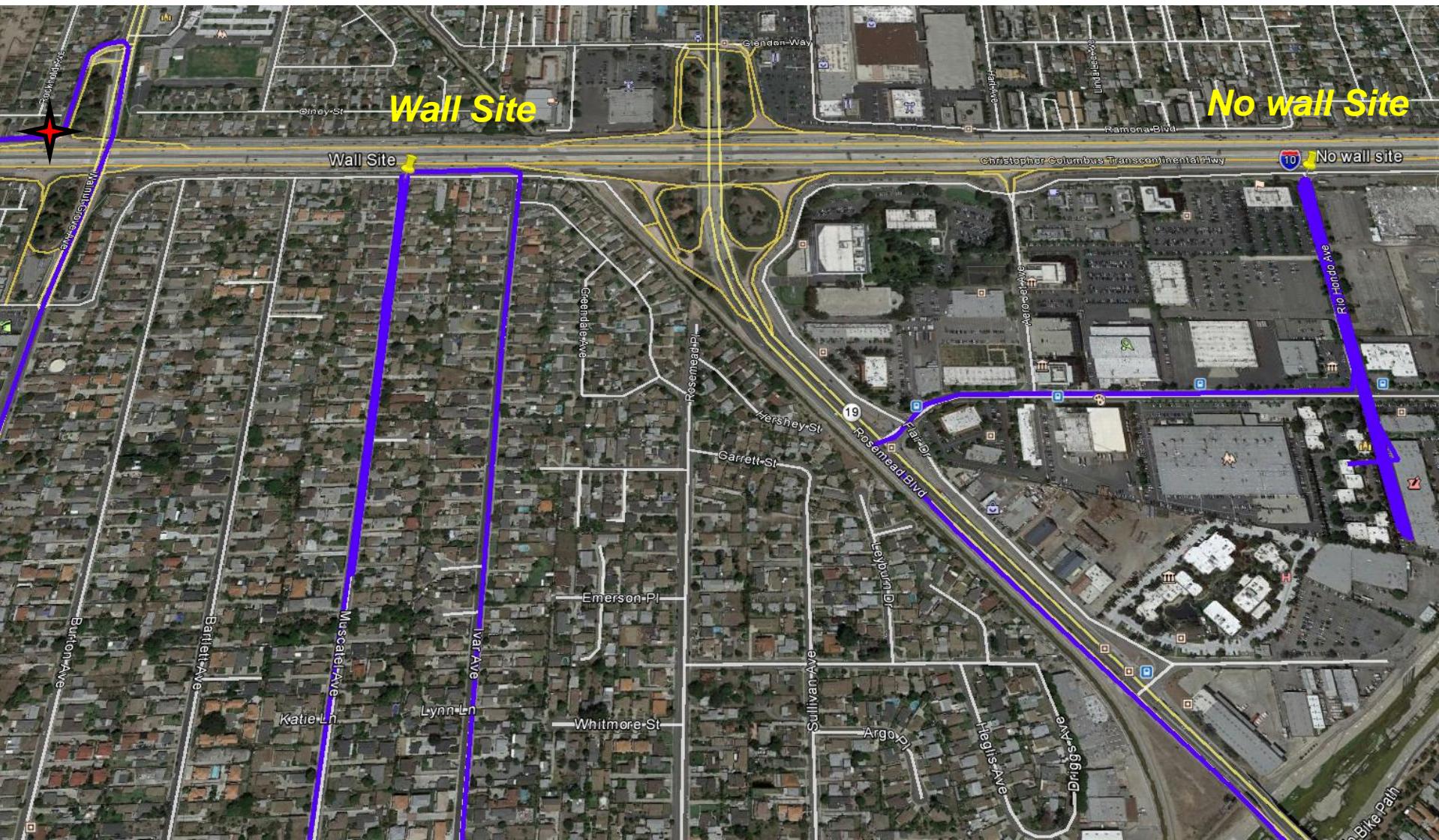
feet  
km

-3000-  
1



EL MONTE:  
WALL  
VS. NO WALL  
PRIMARILY AM

# EL MONTE WALL/NO WALL AM SITE





**No-Wall Site**



**Wall Site**

**SACRAMENTO:**  
**WALL + VEGETATION**  
**VS. NO WALL**  
**DAYTIME**

# Wall only site

Vegetation

26<sup>th</sup> Ave.

27<sup>th</sup> Ave.

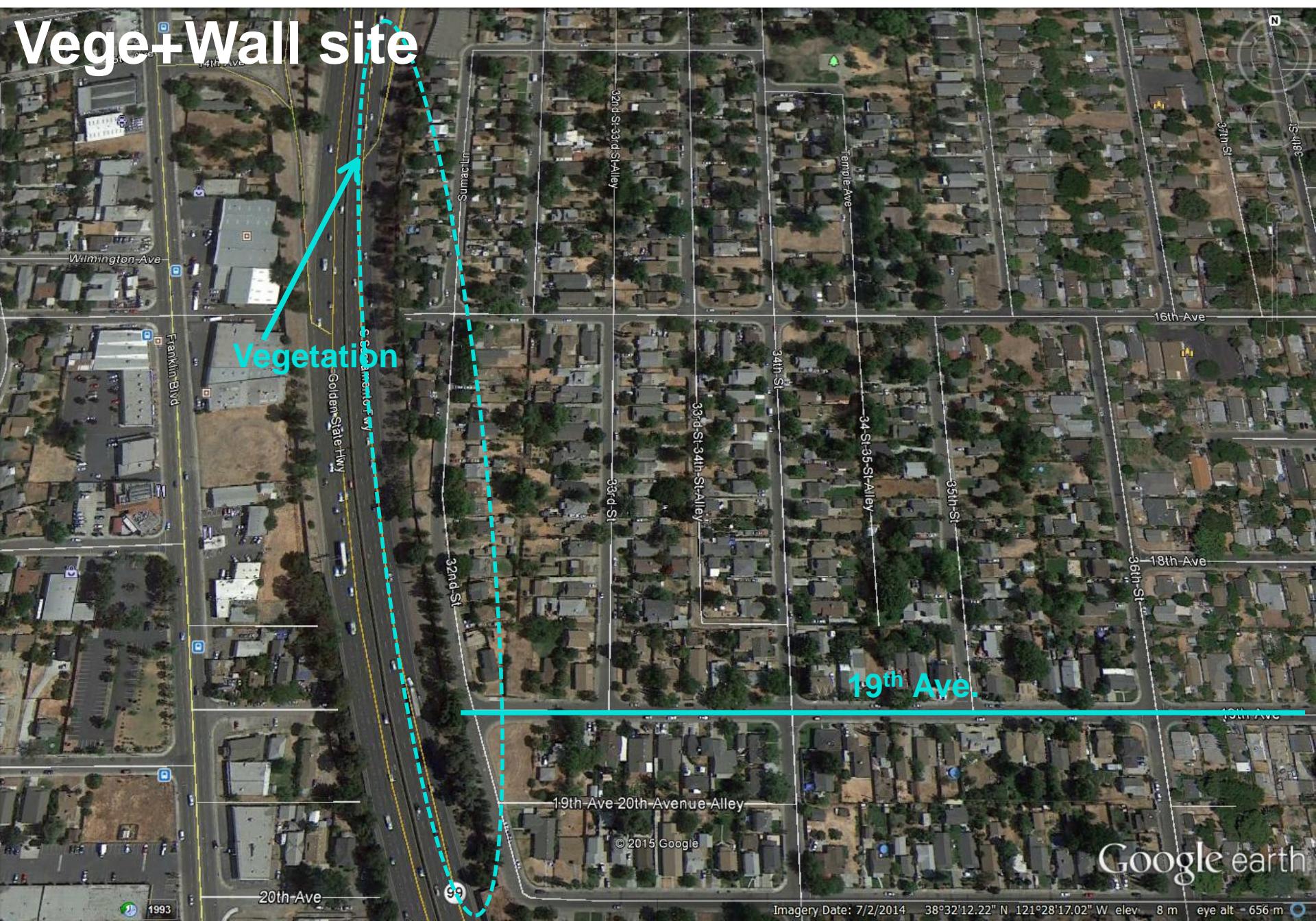
10m 40m 100m 150m

Distances perpendicular  
to the freeway

250m



# Vege+Wall site



**Thank you for your attention**



# The Credit is Really Due to:

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**Eon Lee**

**Yifang Zhu**

**Arthur Winer**

**\*California Air Resources Board**

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