MODELING EXPOSURE OF
DIESEL PARTICULATE MATTER IN CALIFORNIA

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CMAS Conference
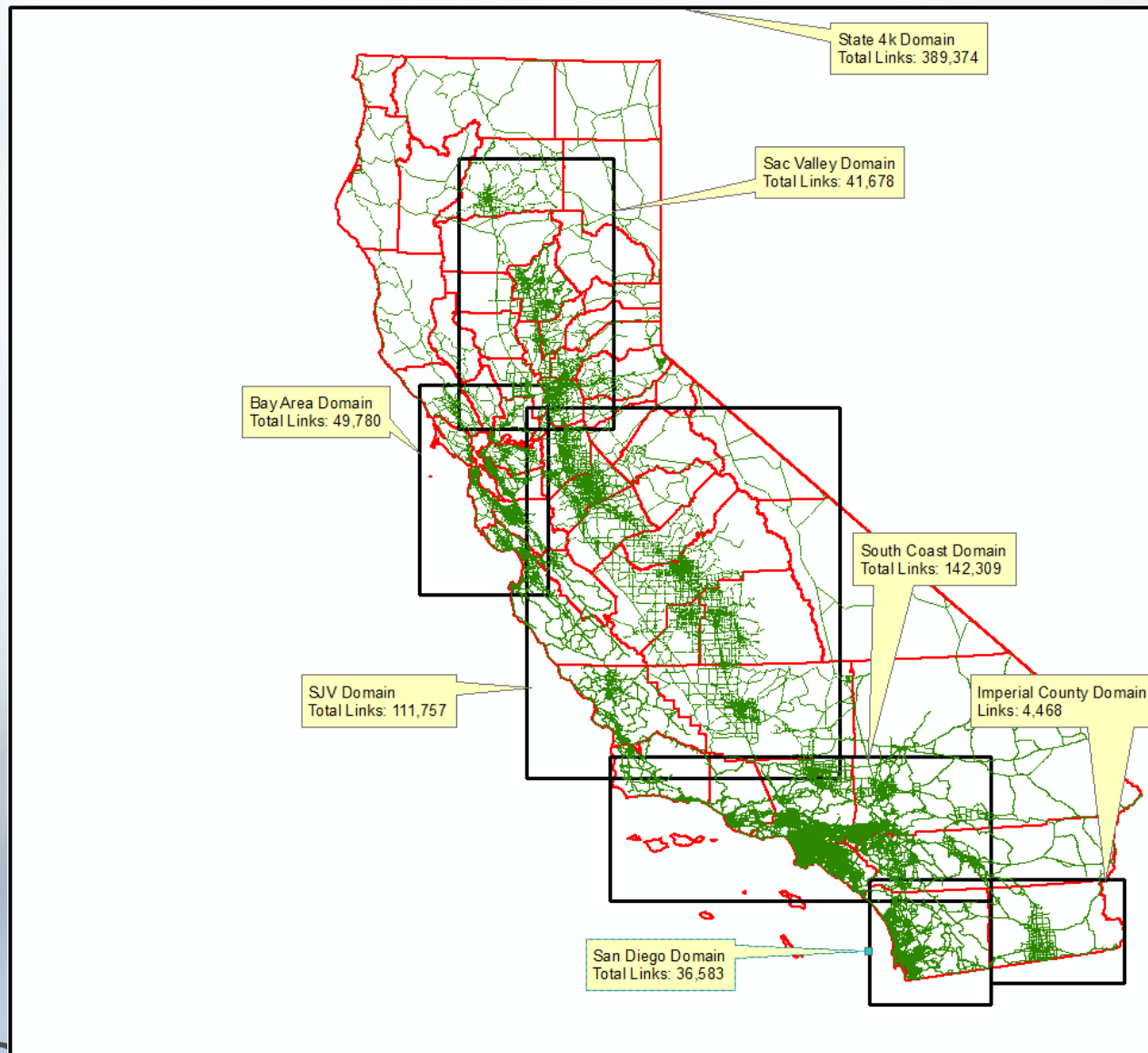Nov 1-5, 2021 (Virtual)

Motivation

- State of California's Air Toxics Programs
  - ➢ Identify and control emissions of toxic air contaminants
  - ➢ Inform the public of the significant toxic exposures
  - ➢ Make regulations and policy to reduce the risks of these exposures
- AB 617: Community Air Protection Program
  - ➢ Identify and prioritize impacted communities for emissions and health risk reductions
- Existing studies
  - ➢ Nationwide: NATA (U.S. EPA)
  - ➢ Regional: MATES study (SCAQMD); CARE program (BAAQMD)
  - ➢ Local scale: various HRAs
- There is a need to develop an integrated modeling system to bridge the gap between local (community level) and regional scale (air-basin-wide) or statewide to serve multiple purposes

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Modeling Approach: Modeling Domains (Statewide)

State 4k Domain
Total Links: 389,374

Sac Valley Domain
Total Links: 41,678

Bay Area Domain
Total Links: 49,780

South Coast Domain
Total Links: 142,309

SJV Domain
Total Links: 111,757

Imperial County Domain
Links: 4,468

San Diego Domain
Total Links: 36,583

Number of links shown for each domain are the number of traffic links being modeled as individual emission sources

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Modeling Approach: Model Selection

TACs/Emission categories	CALPUFF	CMAQ

DPM
  On-road major traffic links
  On-road-centroid connectors
  Off-road mobile
  Area sources
  Point sources
	Explicit links (line sources)
	1 x 1 km area sources
	Explicit links (line/area/point)
	1 x 1 km area sources
	Points	

Heavy metals (Hexavalent Chromium, Lead, Arsenic, Cadmium, Nickel, etc.)
  On-road major traffic links
  On-road - centroid connectors
  Off-road mobile
  Area sources
  Point sources
	Explicit links (line sources)
	1 x 1 km area sources
	Explicit links (line/area/point)
	1 x 1 km area sources
	Points	

PM2.5 & O3		Gridded 2 x 2 km
VOCs (Benzene, 1,3-Butadiene, Formaldehyde, Acetaldehyde, Acrolein, Perchloroethylene, p-Dichlorobenzene, etc.)		Gridded 2 x 2 km

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Modeling Approach: Emission Categories

| Source Type	Source Categories	Source Sectors
Point sources	Off-road mobile Stationary	• OGV at berth • Stationary Toxics – Hotspots program
Line sources	On-road mobile Off-road mobile	• On-road major traffic • OGV (maneuvering / transit) • Aircraft 3D • Locomotives (in progress)
Area sources (1km x 1km)	Off-road mobile Area sources Mexico sources	• Commercial harbor craft, cargo handling equipment, aircraft (military), locomotive (current), OGV (military), TRU • Ag burn, agriculture activities, construction, managed burns, residential wood combustion, structural burns, wildfires / prescribed burn, charbroil • Others: off-road equipment such as forklifts, generator sets, pumps, air compressors, food and agricultural processing, manufacturing and industrial equipment, etc. • Mexico (on-road, off-road, point and areas)

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Focuses of This Presentation

- Modeling System
  - ➤ Domain: South Coast Air Basin
  - ➤ Year: 2017 (both meteorology and emissions)
  - ➤ Models: CALPUFF and CMAQ
  - ➤ TACs: Diesel PM (DPM)
  - ➤ Emissions: All emission sources
  - ➤ Meteorology: WRF data
- Annual average DPM concentration/exposure was simulated with CALPUFF
- As a comparison, DPM was also simulated with CMAQ
- Model evaluation with EC2.5 measurement data
- Feasibility of using CALPUFF to simulate inert TACs at scales ranging from community level to air basin wide

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Modeling Approach: Receptors (SC domain)

CALPUFF

Census blocks
(179,378)

Sensitive receptors
(10,400)
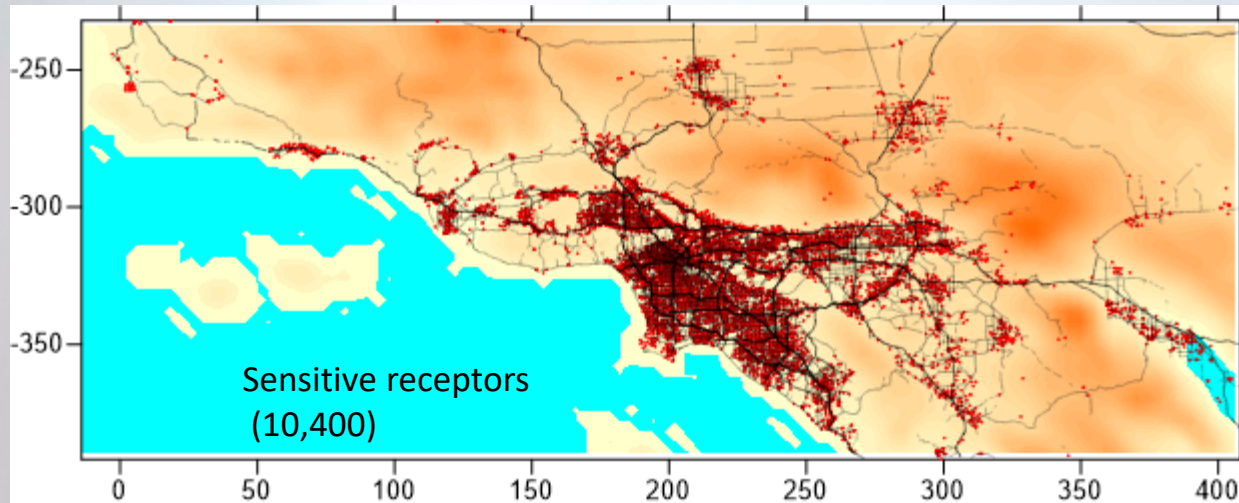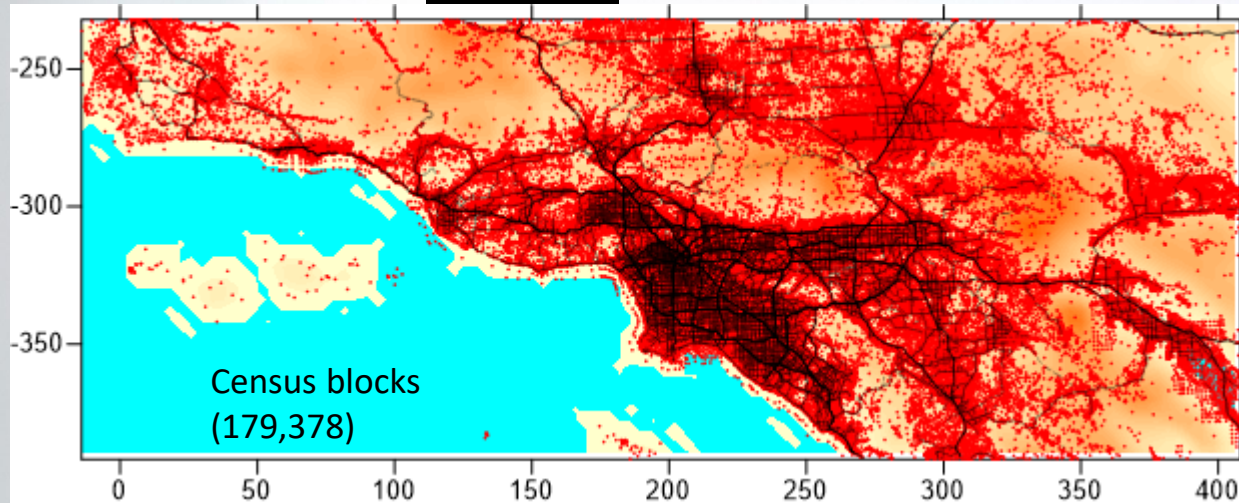
CMAQ

2km x 2km resolution
Grid Cells: 12,640

Modeling Results for DPM in the South Coast Air Basin

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Model Evaluation with EC2.5 data*

* The EC2.5 measurement data are provided by the SCAQMD
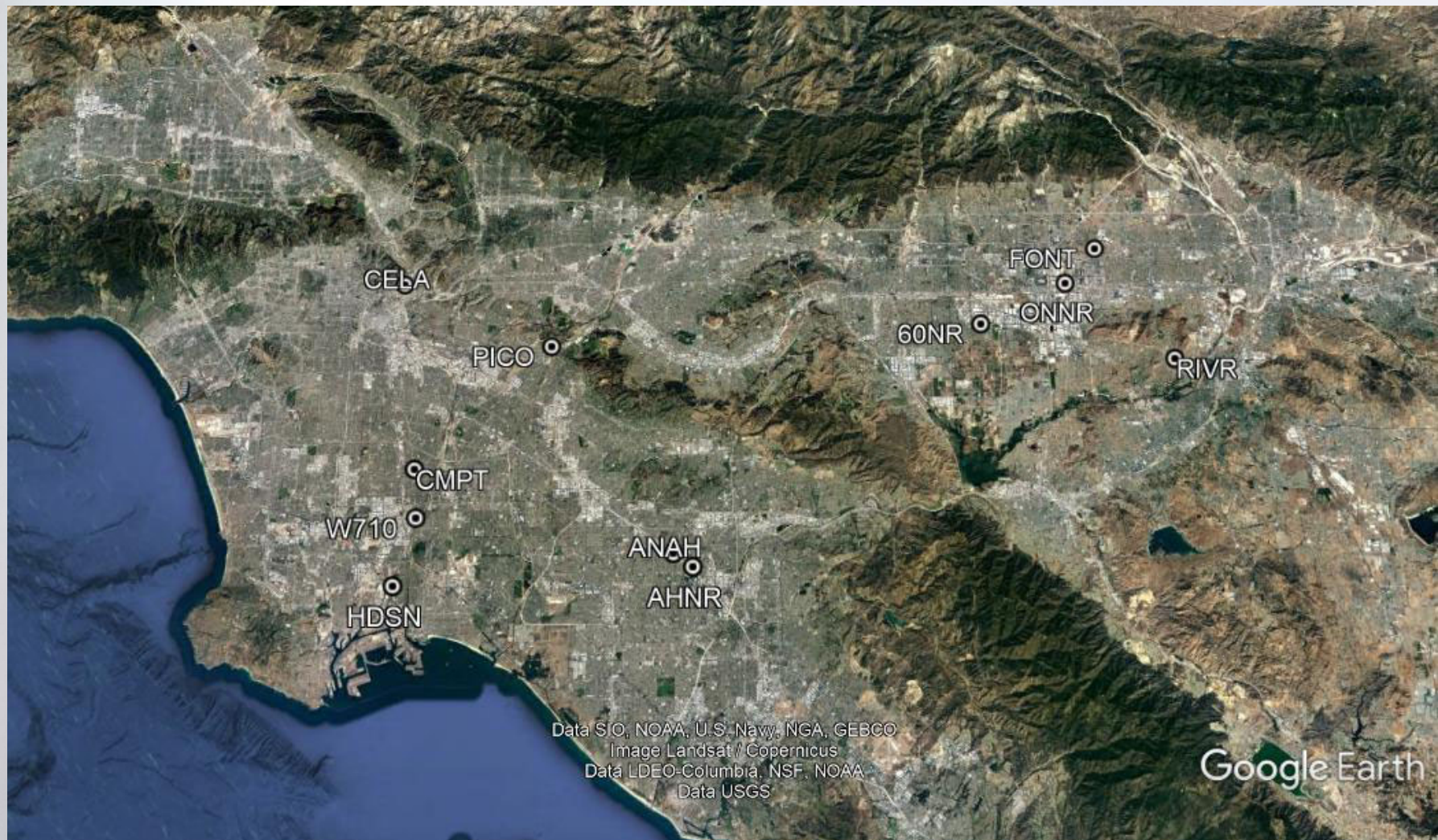
Model Evaluation with EC2.5 data (in µg/m³)
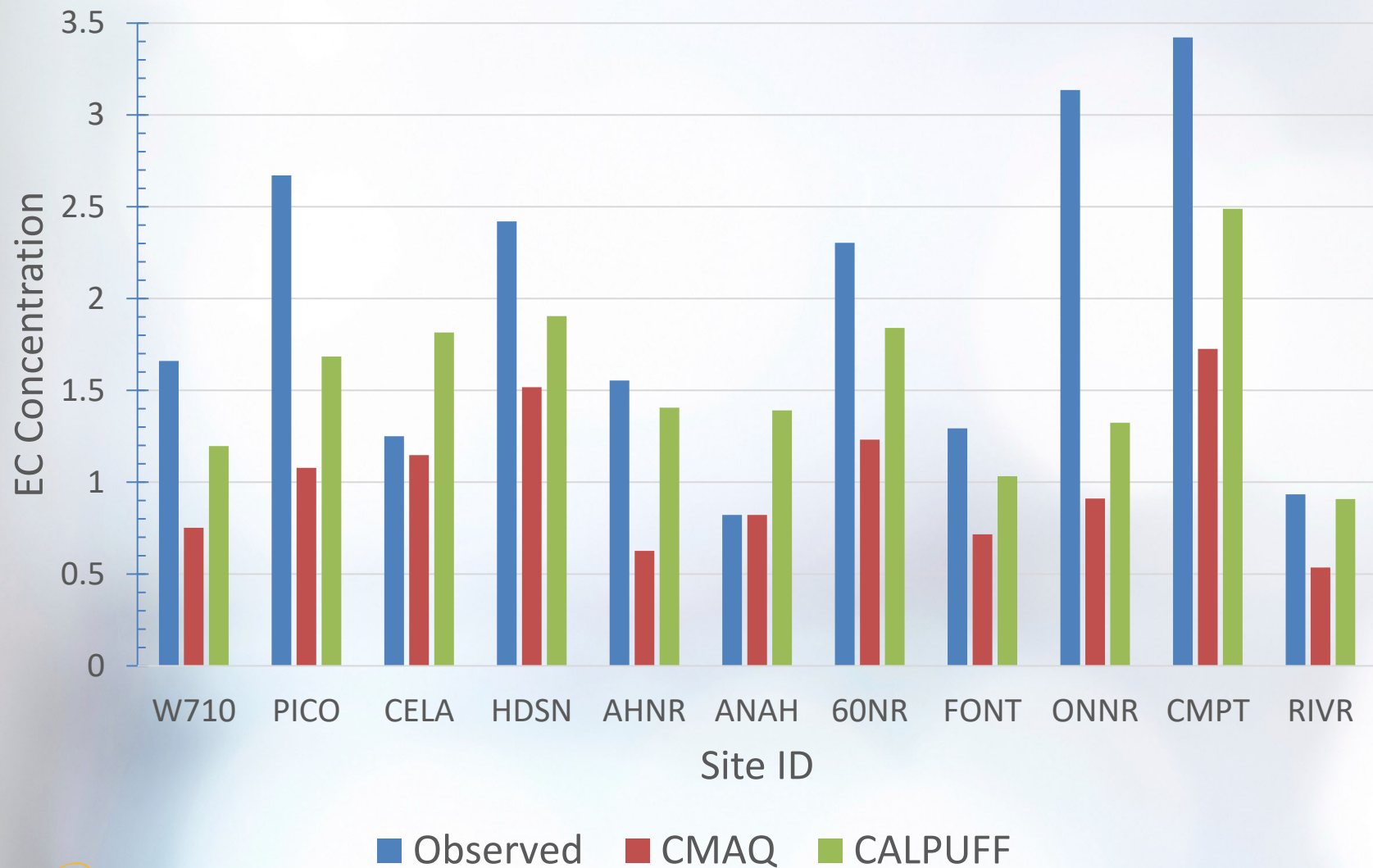
Total DPM Concentrations (μg m⁻³) CMAQ (2km x 2km), CALPUFF (census blocks)

On-road & off-road DPM Concentrations in Census Blocks (µg m^{-3})
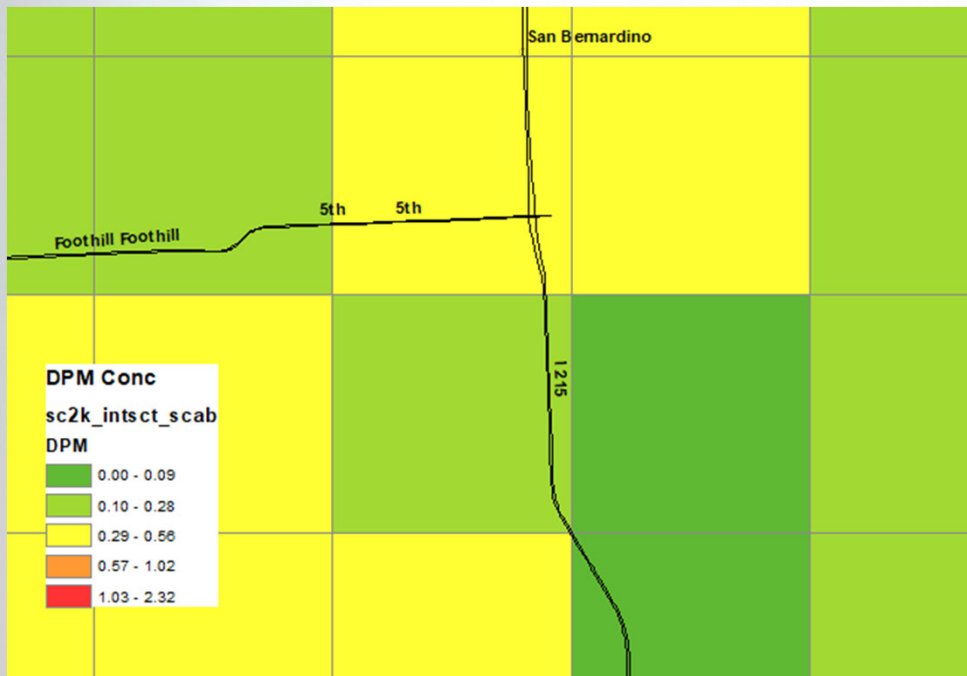
On-Road (CALPUFF)
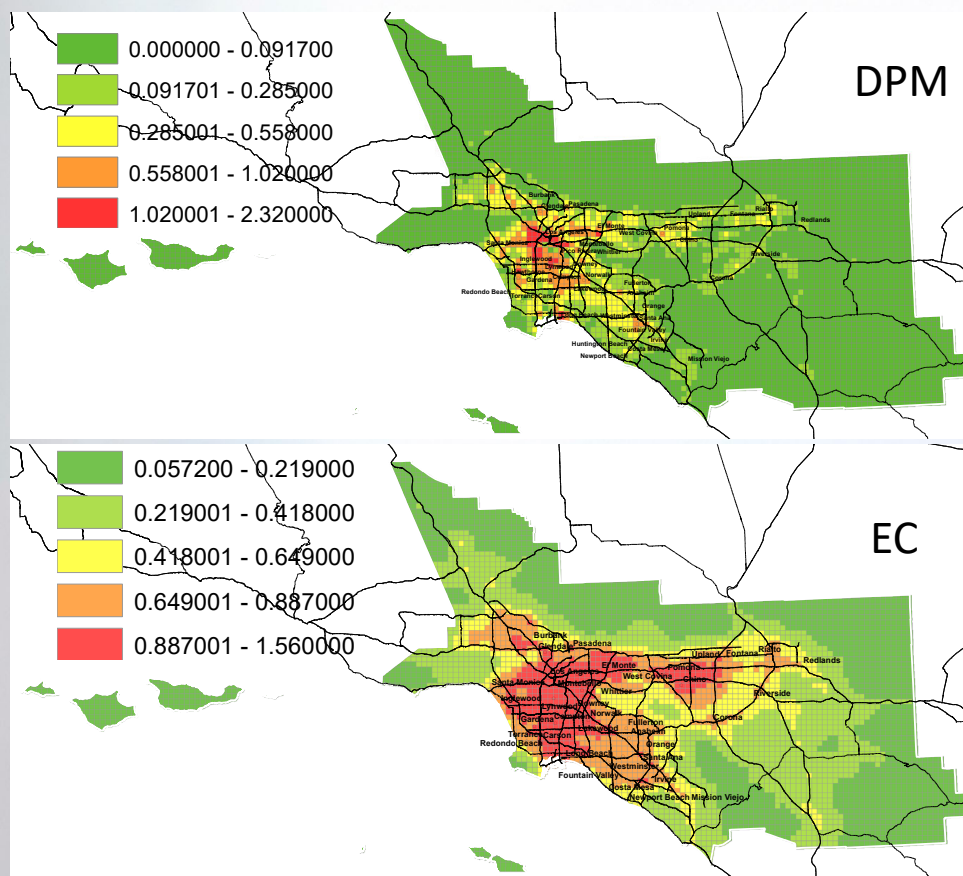
Off-Road (CALPUFF)
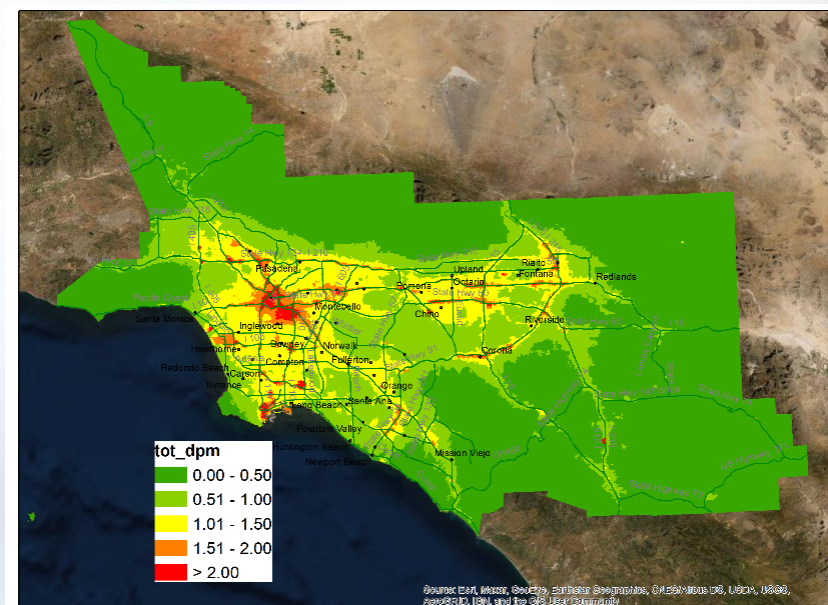
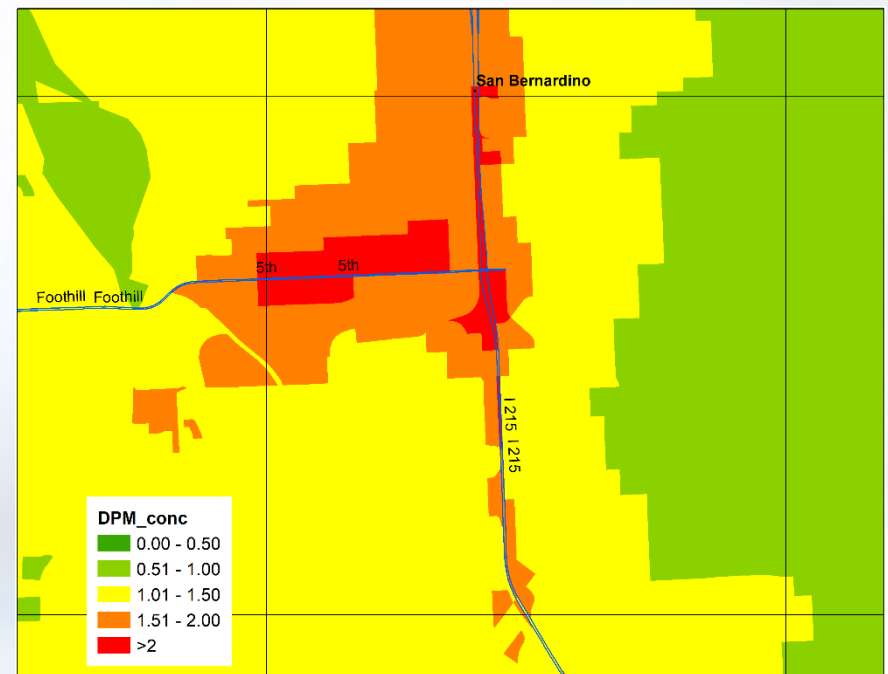# A Comparison at the Community Level: CMAQ vs CALPUFF

The Muscoy community in San Bernardino, CA

Conclusions

- Both CMAQ and CALPUFF can capture spatial DPM exposure pattern from the prospective of regional scale (air basin)
- CALPUFF results compare better with field measurement data
- CALPUFF can resolve strong gradients of concentrations, such as those along major freeways and transportation corridors, and within local communities. Thus, CALPUFF has been used to
  - identify disadvantaged commuties statewide (per AB617)
  - apportion contribution from each emission category (source apportionment)
  - assist the effort of mitigating toxic air emissions from community level to regional and statewide

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