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Roadside Hot-Spot Anaylsis in Urban Areas:

A Comparison Study of the Proposed Replacement of CALINE3 with AERMOD in U.S. Regulatory Guidance

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Harmo 17
Budapest, Hungary
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Context: Appendix W Revisions

- Main U.S. ambient air quality modeling guideline
- Proposed revisions pending (proposed July 2015)
- Included: replace CALINE3 with AERMOD for mobile source applications (particulate and CO hot-spot modeling)

What is CALINE3?

- Developed in late 1970's
  - Steady-State
  - P-G stability classes

- U.S. EPA preferred model for modeling mobile sources
  - CALINE4, CAL3QHC, and CAL3QHCR
  - Quantitative hot-spot analyses
  - CO, PM, NO_2, SO_2 and lead

Why replace CALINE3?

- No major updates since 1995
- Simplistic/unrealistic boundary layer characterization
  - P-G stability classes
  - Insensitive to mixing height
- Unable to model non-road sources (parking areas)
- Lack of up-to-date met data
  - 1-minute wind data

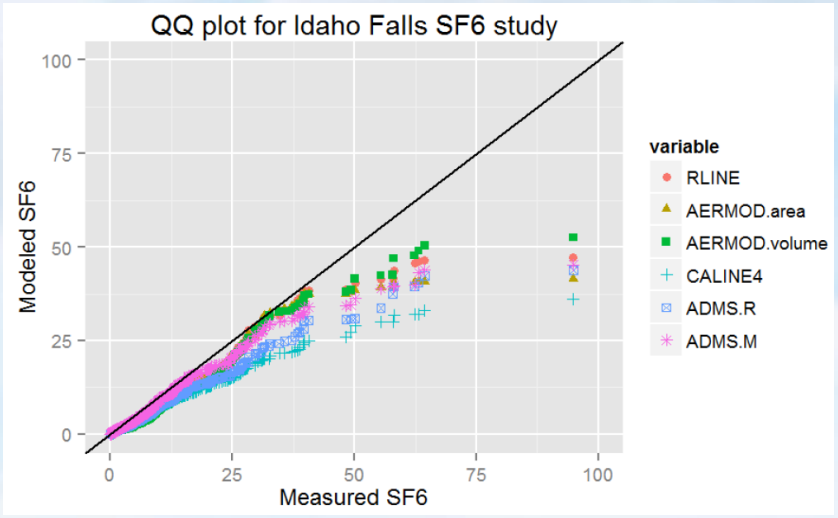
Why AERMOD?

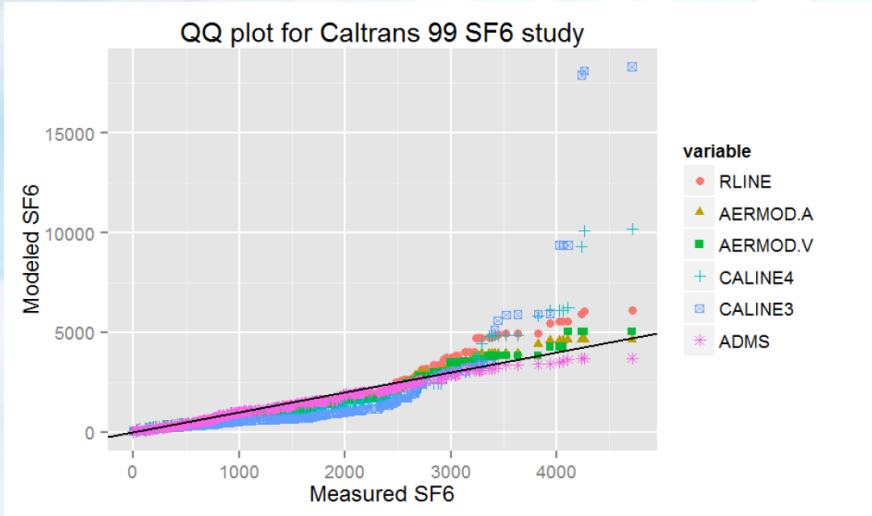
- M-O similarity theory
- Simple and complex terrain
- Line and area source options
- Latest meteorological data
- Continuous update since 2005, ongoing

- U.S. EPA: model should be listed as preferred when “a single model is found to perform better than others…”

Supporting Studies by U.S. EPA

- Idaho Falls
  - Barrier between the roadway emissions and receptors
- Caltrans 99
  - Highway 99 outside Sacramento





Heist et al. 2013, cited by U.S. EPA 2015

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Urban Roadways

- Not addressed in U.S. EPA replacement analysis
- Challenging environment for Gaussian models

Downtown Los Angeles

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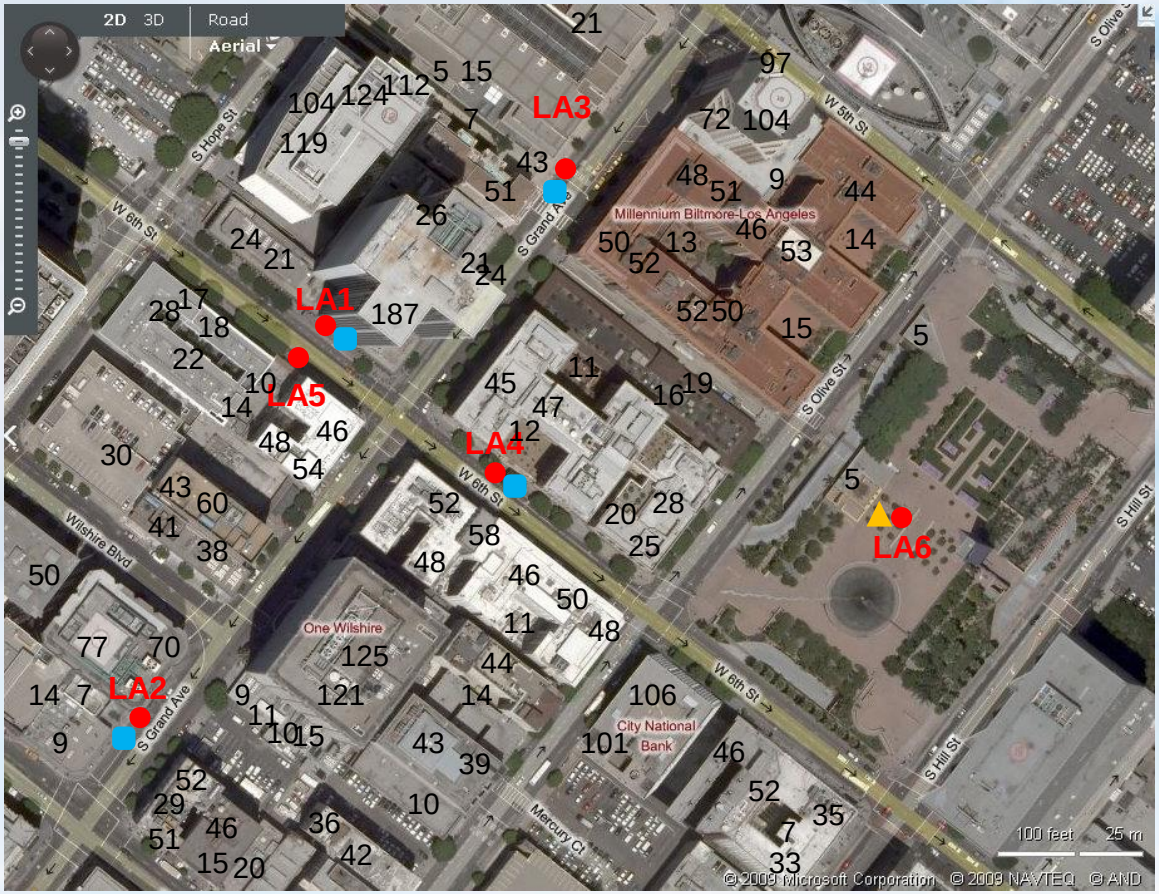
AERMOD Urban Road Considerations

- Steady-state meteorology
- Building effects limited to point sources
  - Only meteorological and land use data can account for urban environment

Field Study



● DustTrak ▲ Sonic Anemometer ■ Camera

- Downtown LA
  - 3 days in June, 2008
- Building Height
  - 5 – 187 m
- Roadways
  - 3-lane one way
- Met data
  - 7 am – 7 pm
- PM2.5 data
  - Morning 7 am – 9 am
  - Midday 11 am – 1 pm
  - Afternoon 5 pm – 7 pm
- Traffic
  - Digital camera

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On-Site Meteorological Data

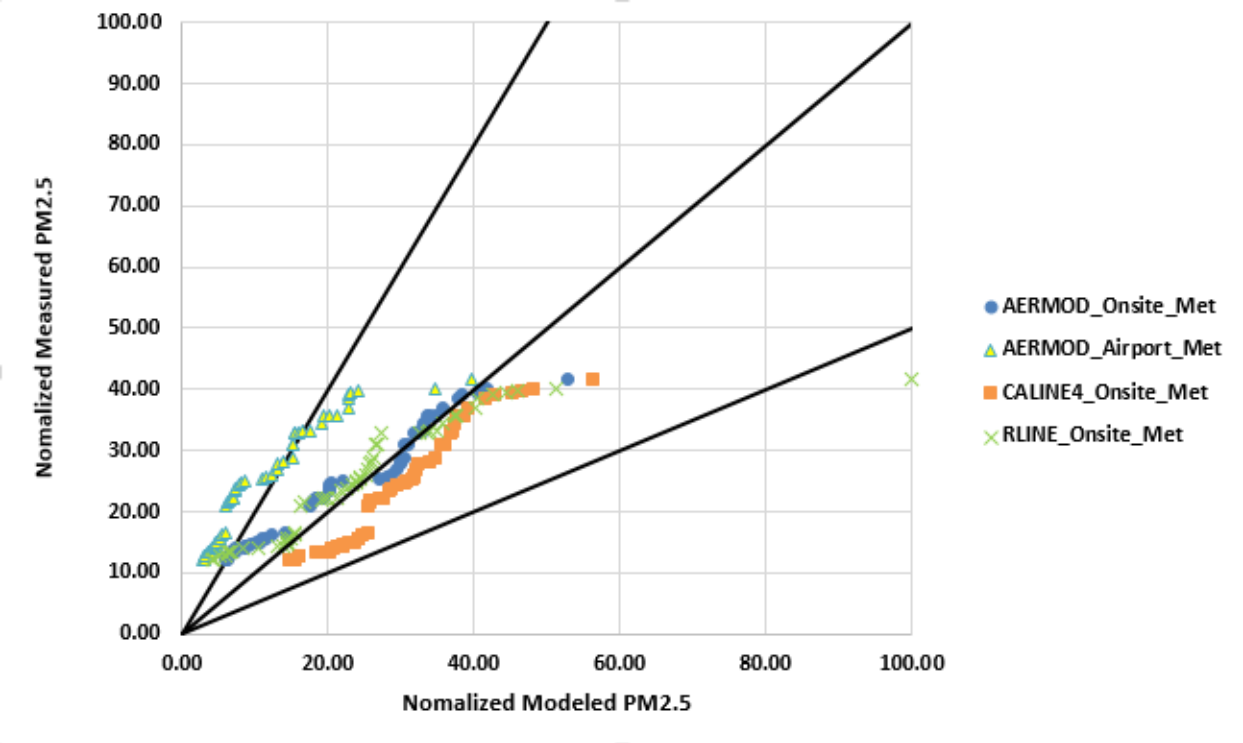
- On-site meteorological data (LA6 sonic anemometer)
  - Low wind speeds (0.66-1.18 m/s)
  - SSW prevailing wind
  - σ_W measured
  - M-O Length -35.9 to -0.9
- Upper air data: San Diego, CA (~170 km)
- AERMOD with airport weather data (LAX) also considered

$PM_{2.5}$ Emission Rates

- Vehicle $PM_{2.5}$ emissions
  - EMFAC 2014 data for LA
- Fugitive $PM_{2.5}$ emissions
  - CARB's methodology 7.9
- Resulting $PM_{2.5}$ emission rate
  - 0.16 g/km

Model Performance

> Q-Q Plot for Downtown LA Field Study



- CALINE: vertical mixing is not enough? No σ_w input
- AERMOD onsite met is closet to 1:1 line
- RLINE similar to AERMOD
- AERMOD with airport met has worst performance

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Meteorological Data Considerations

- Airport meteorological data widely used
  - Low z_o + coastal location = high wind speed (0.66 vs. 1.30 m/s)
  - Pre-processed data availability cited as cause for model switch
- Real-world on-site data
  - Turbulence parameters needed?
  - AQ monitoring sites: can this be routinely collected in urban areas?

Summary

- This data supports the recently proposed replacement of CALINE3 with AERMOD
- Onsite meteorological data is essential for AERMOD when modeling urban road sources
- For regulatory purposes, model validation and/or implementation guidance should consider real-world data

Acknowledgement

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Questions

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