TRAKER: A Method for Fast Assembly and Update of Paved and Unpaved Road Dust Emission Inventories

V. Etyemezian, H. Kuhns, G. Nikolich, A. Gertler
Desert Research Institute , Las Vegas, NV

D. Fitz, K. Bumiller
CE-CERT, Riverside, CA

R. Merle, and R. Langston
Clark County DAQEM, Las Vegas, NV

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Outline

- Road Dust Introduction
- Mobile Platform for Road Dust Measurement
  - The TRAKER Concept
  - TRAKER Characteristics and Calibration
- Examples of completed TRAKER Applications
  - Las Vegas, NV
  - Lake Tahoe, NV/CA
  - Treasure Valley (Near Boise), ID
- Conclusions and Plans for Future Work

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Road Dust Emissions

- PM emissions of fugitive dust from paved and unpaved roads due to vehicle travel
- Road Dust Emission Measurement
  - Towers upwind and downwind of road segment
  - Silt loading/content
    - Calibrated against upwind/downwind measurements
  - Vehicle-based technologies (DRI, CE-CERT)

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Road Dust Measurement

- Planning agencies largely use silt loading (paved roads) and silt content (unpaved roads) to determine emission factors (AP-42 guidance document)
- Silt loading (paved roads)
  - Lane closure
  - Vacuum/sweep material
  - Use sieves to determine silt
  - Per Sample/Location ~ 10 labor hours + planning + hazards

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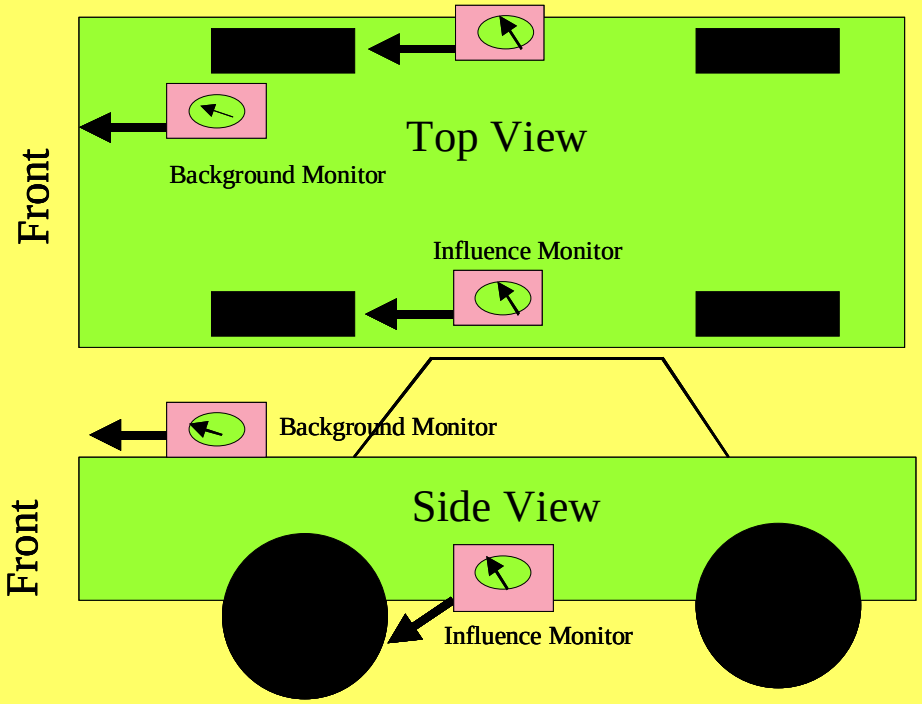
Testing Re-Entrained Aerosol Kinetic Emissions from Roads (TRAKER)



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TRAKER

- Particle Sensors
  - TSI DustTrak 5820
  - Grimm Particle Size Analyzer 1.108
- GPS

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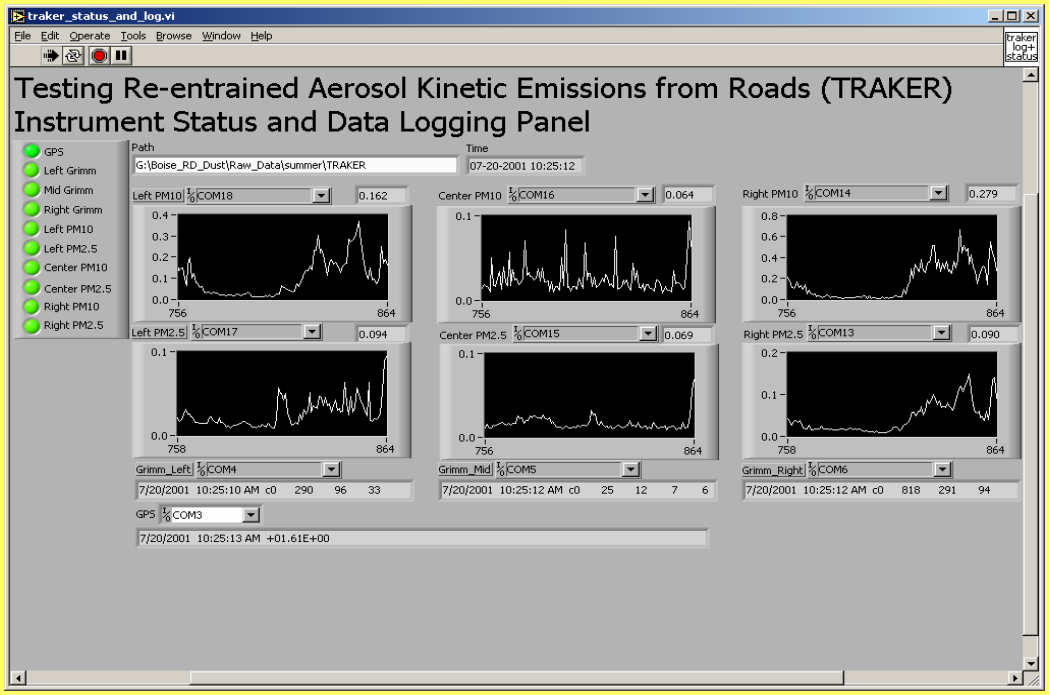
Data Acquisition and Processing

- Lab View program displays and logs data from
  - 6 DustTraks
  - 3 Grimms
  - 1 GPS
- Uniform time stamp applied to all data for synchronization
- Data tables are loaded into MS Access for processing and analysis



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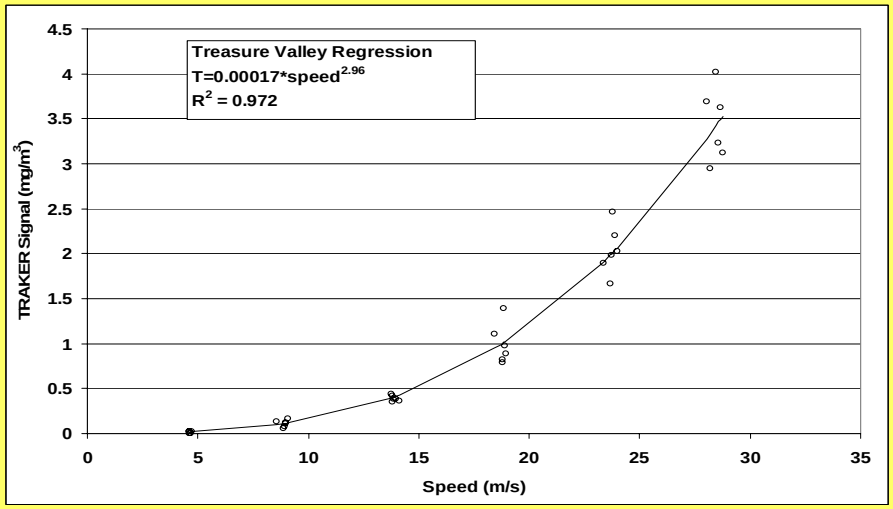
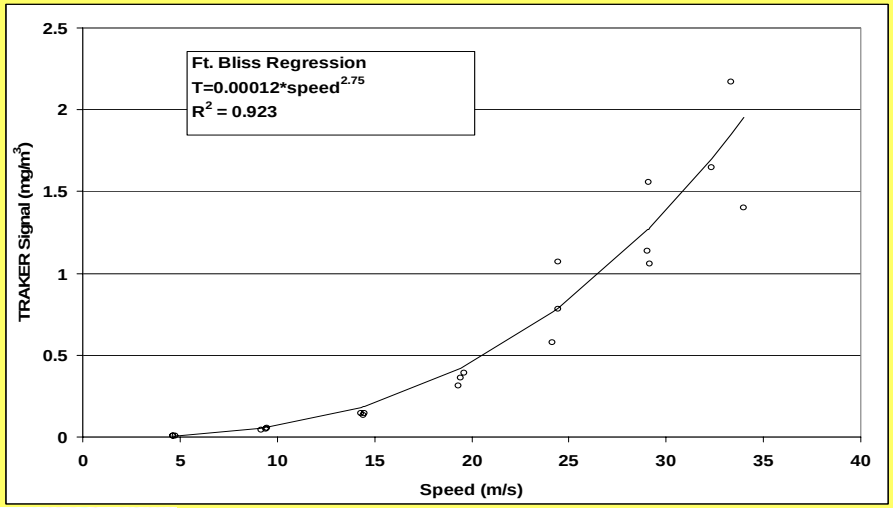
TRAKER Signal vs Vehicle Speed





- $T = C_{tire} - C_{bkgrnd}$
- $T = a\ S^3$

- On the same paved road the TRAKER signal increases with the speed cubed

- Factoring out speed leaves a signal proportional to the emission potential of the road.

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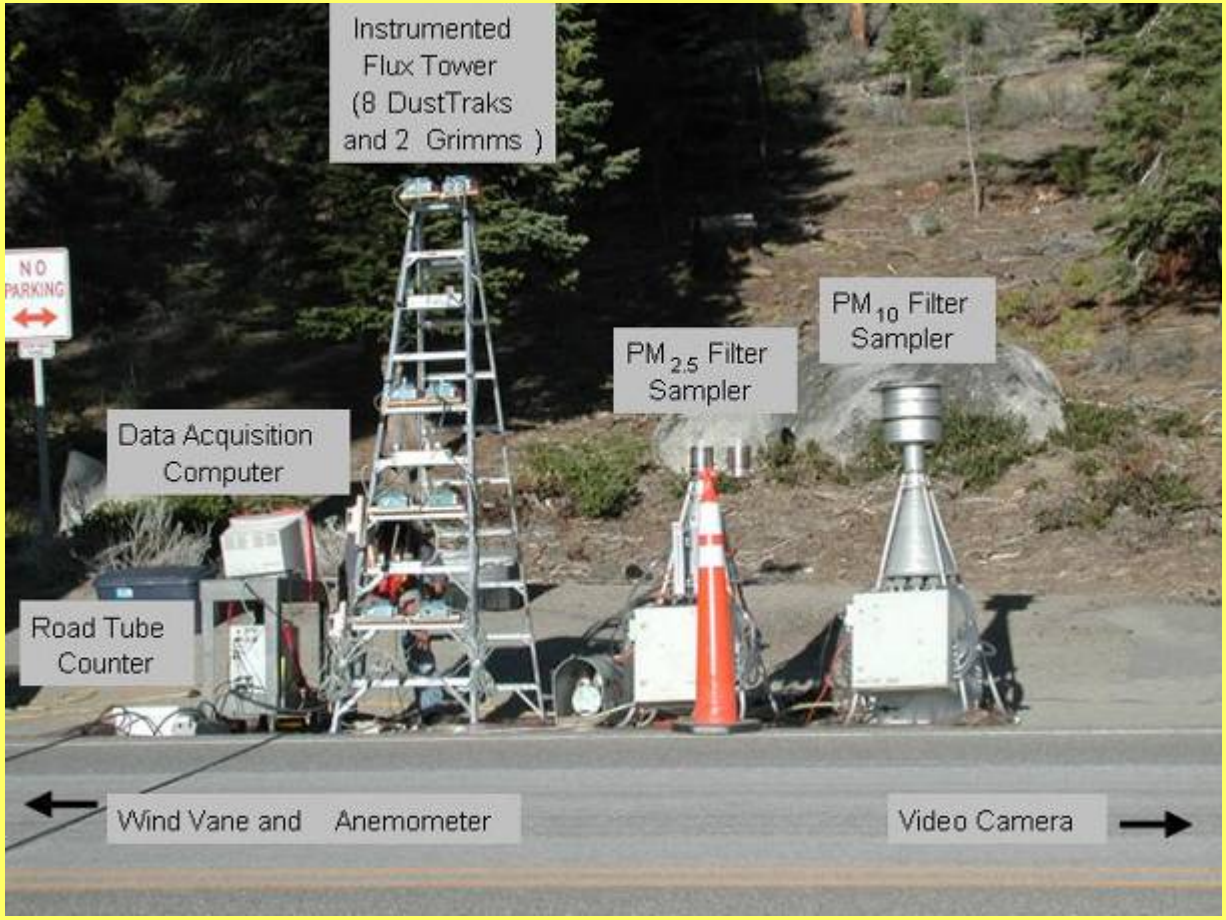
TRAKER Calibration with Upwind/Downwind Flux Towers



$T = T_T - T_B$

Unpaved Road EMF (g/veh-km) $= 8.36\ T^{1/3}$

Paved Road EMF (g/veh-km) $= 0.33\ T^{1/3}$

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Example TRAKER Use: Las Vegas

- 150 km loop in Las Vegas Valley
- Covering Road Types, Locations, Construction Influence
- TRAKER operated:
  - 6/30/04, 7/1/04 (Loop 1)
  - 2/14/05 – 2/17/05 (Loop 2)

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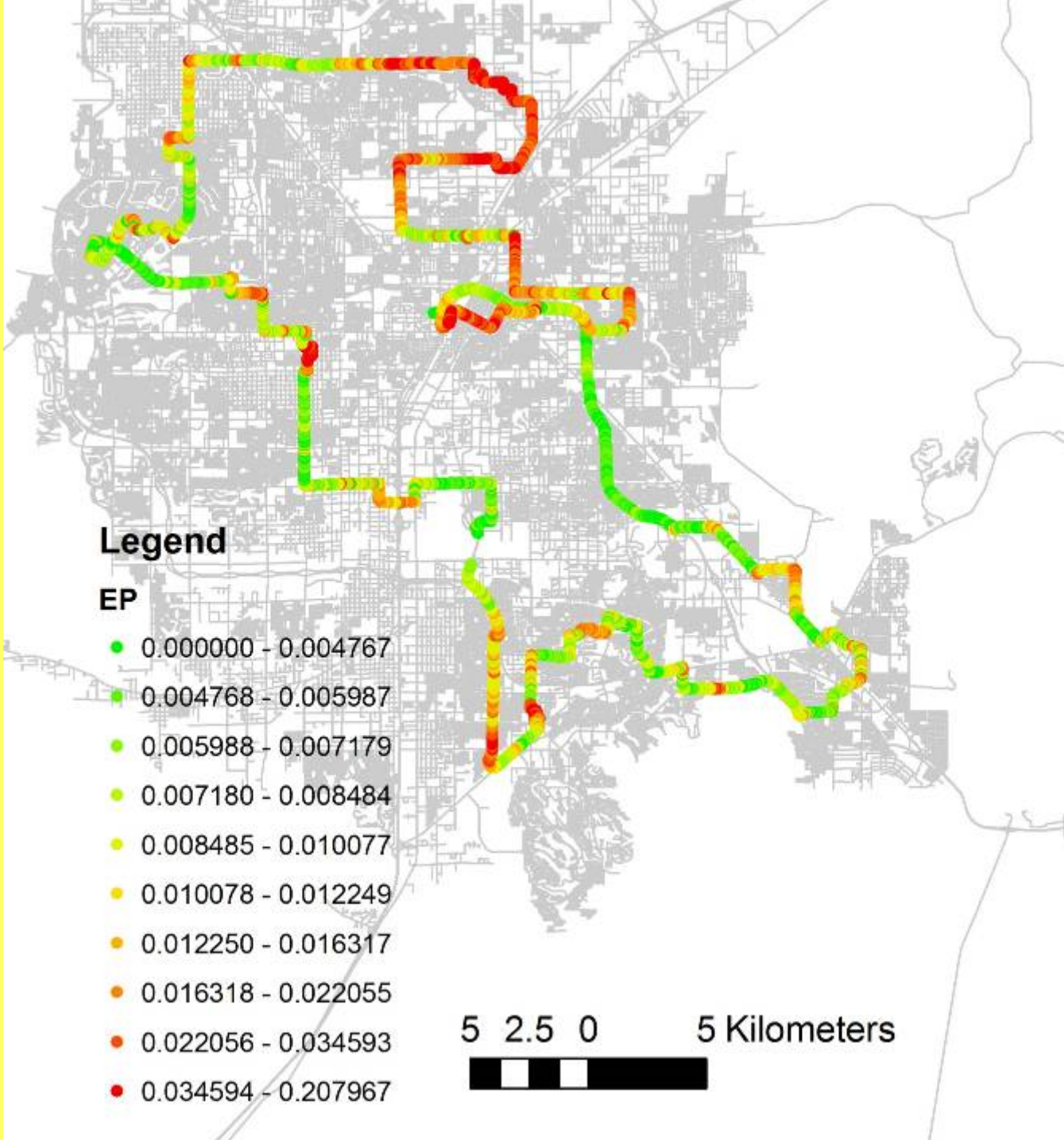
Emission Potentials (g/veh-km) on 2/14/05



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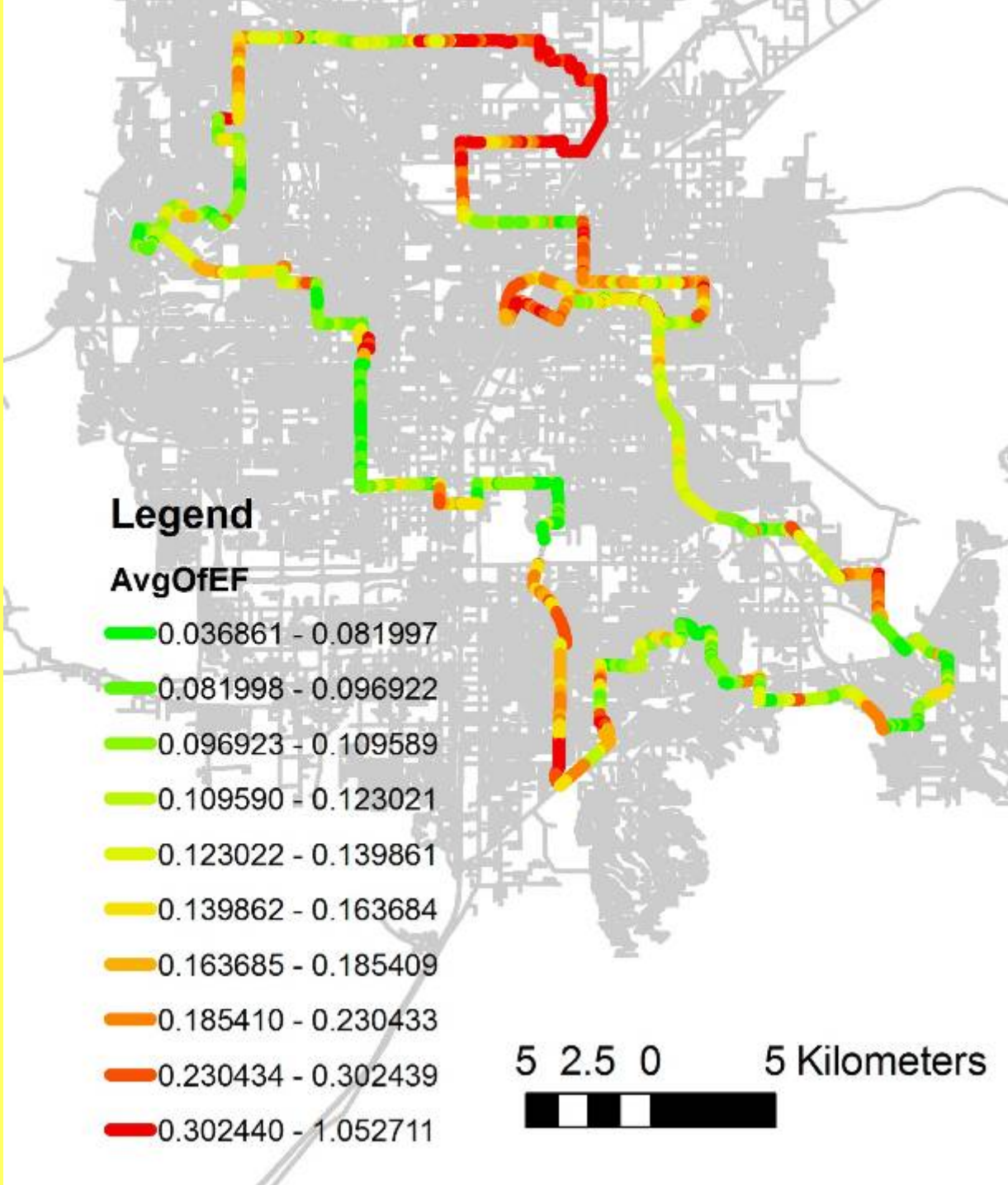
Average of PM_{10} Emission Factor (g/vkt) on a road link basis for all 4 days of sampling (2/14/05 – 2/17/05)



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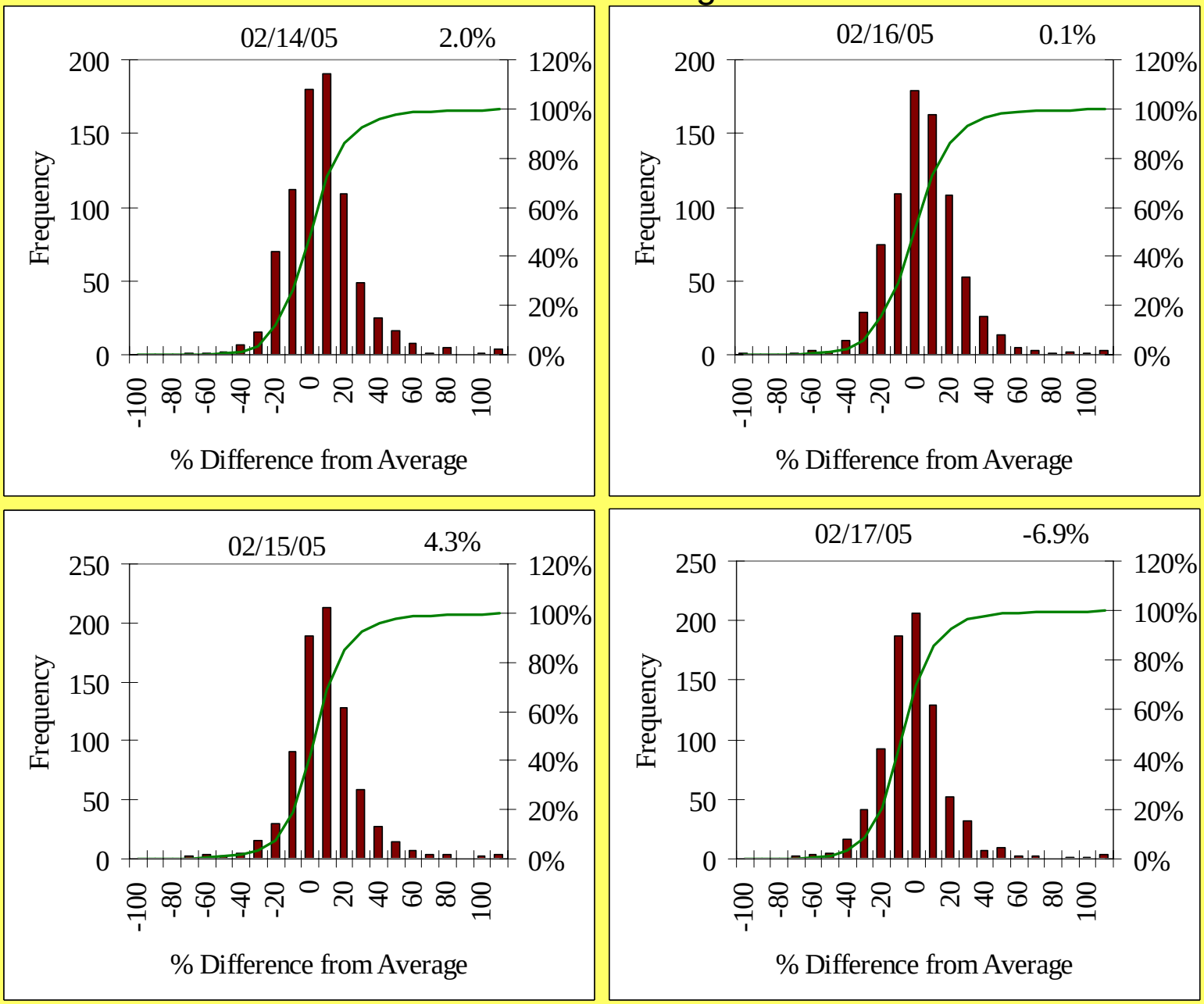
Comparison of Link-averaged emissions potentials from 4 consecutive days of TRAKER measurement in Las Vegas



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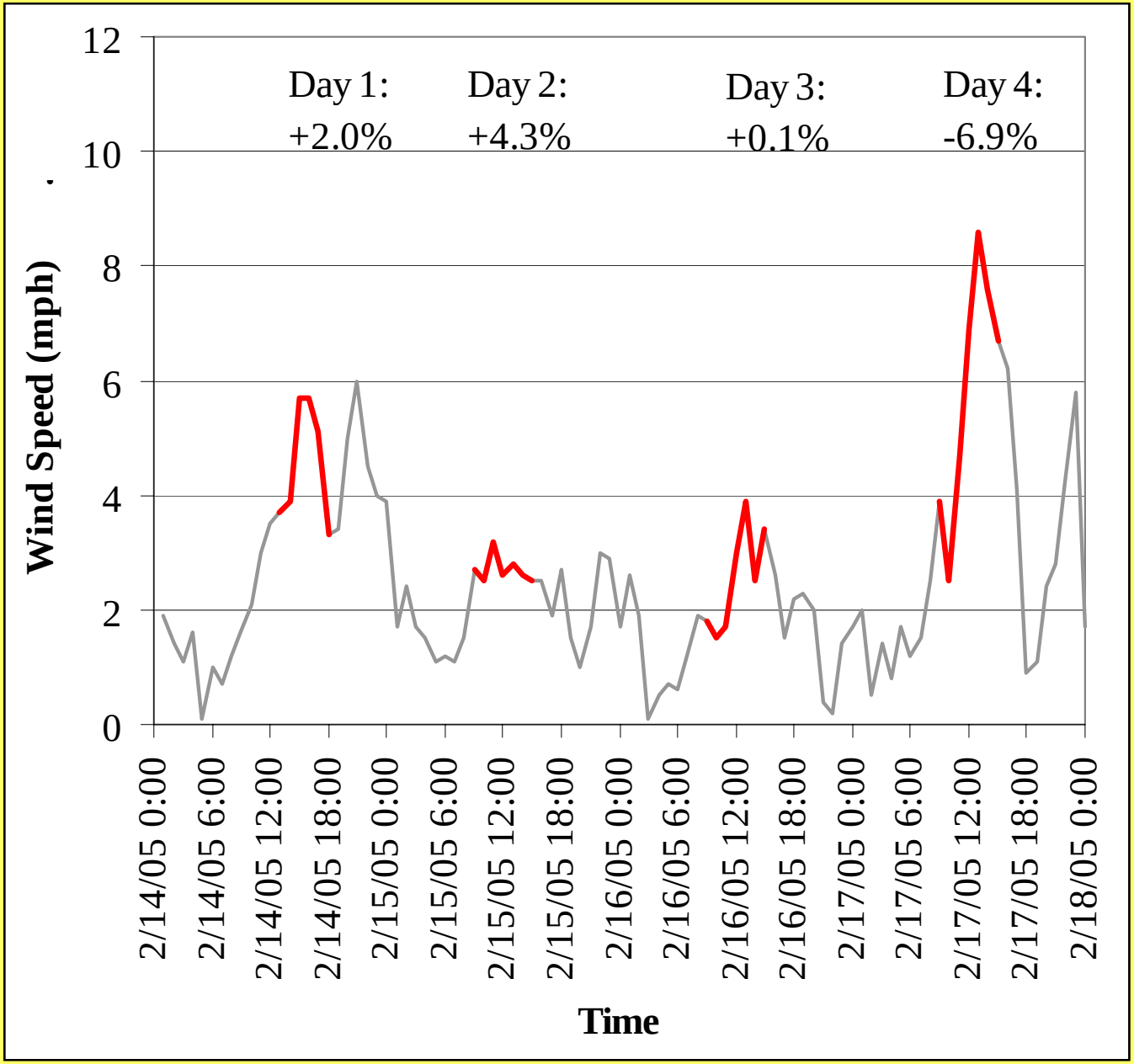
What about wind effects?



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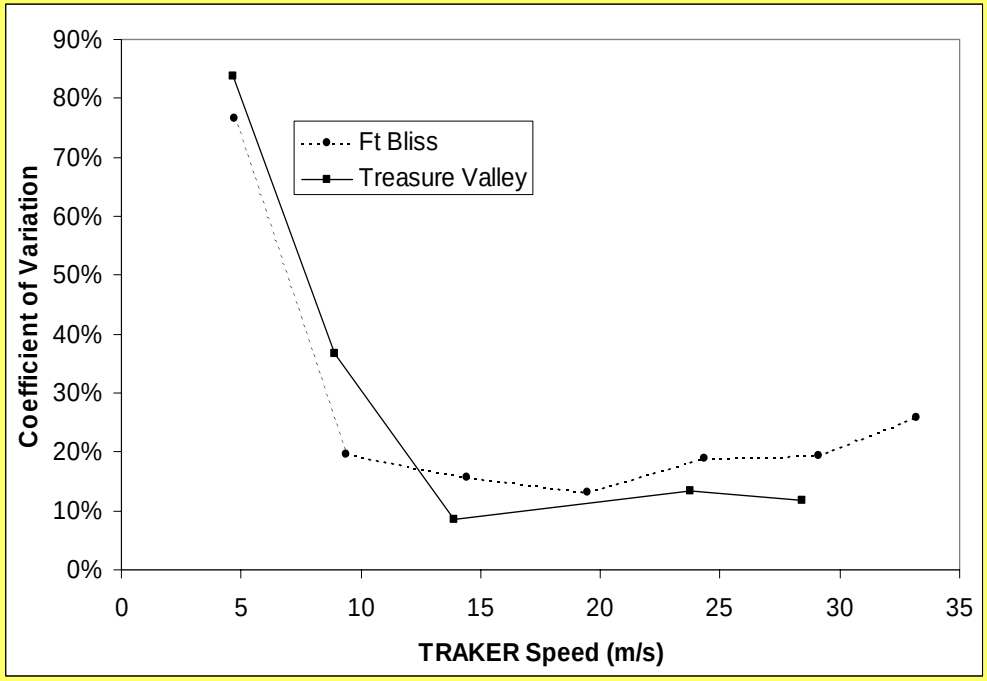
Correction for Cross-winds



Avoid cross-wind effects by considering data where TRAKER speed > 10 mph

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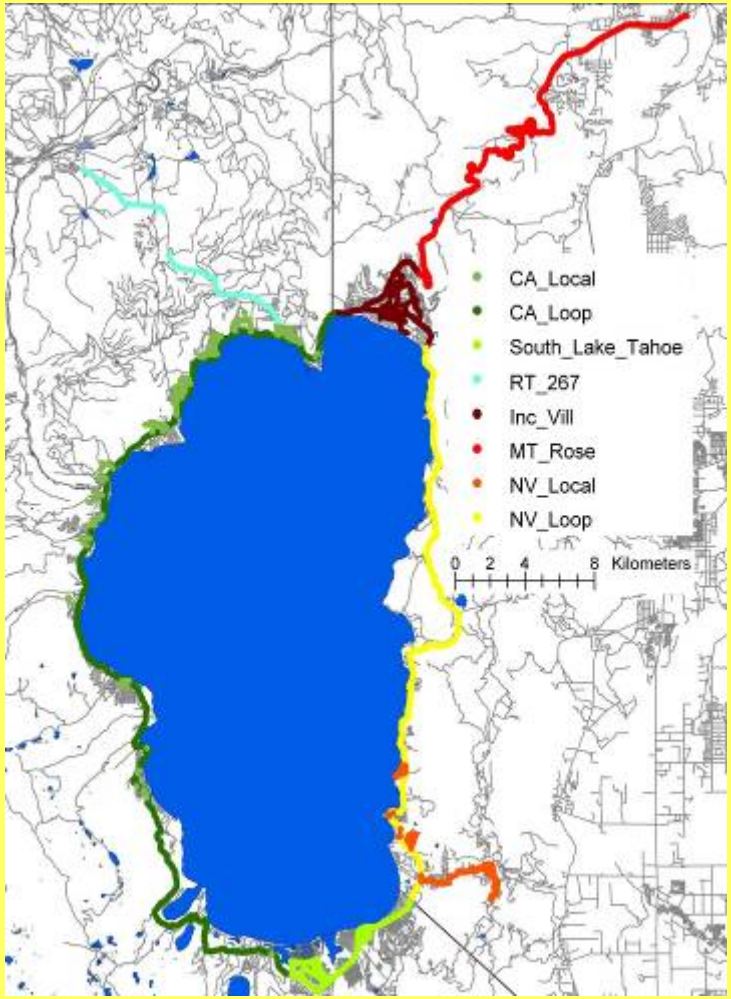
Example TRAKER Use: Lake Tahoe

- 13 runs over a mountain pass
- 9 circuits around the lake
- Comparison with flux tower measurements



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Emission Factors Using Stationary Flux Tower

Sampling Period	Condition	$PM_{2.5}$ EMF (mg/km)	PM_{10} EMF (mg/km)
1	Baseline	76	229
2	After salting	99	310
3	1st dry day after storm	112	612
4	2nd dry day	133	660
5	After sweeping	211	735

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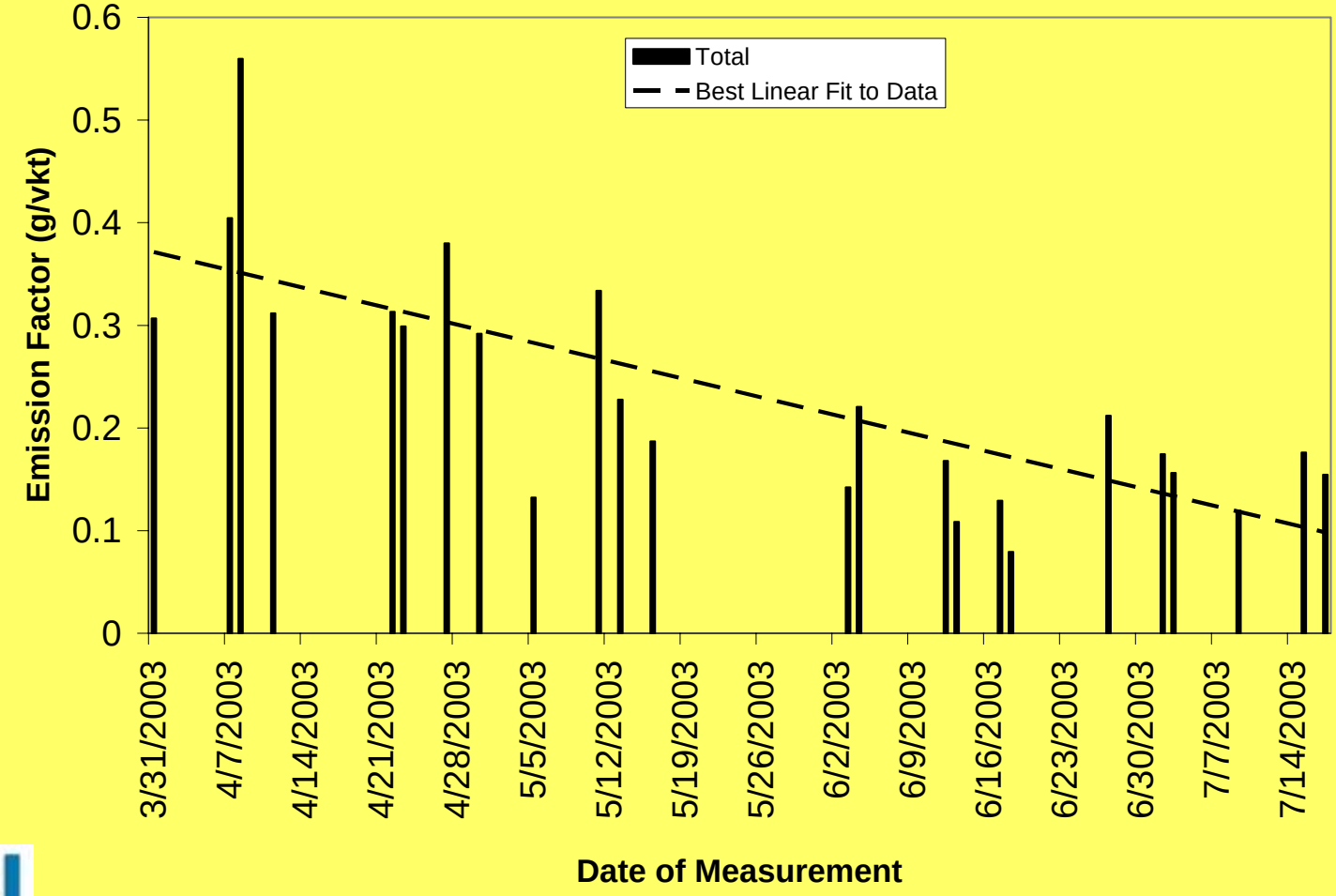
Emission Factor Using TRAKER



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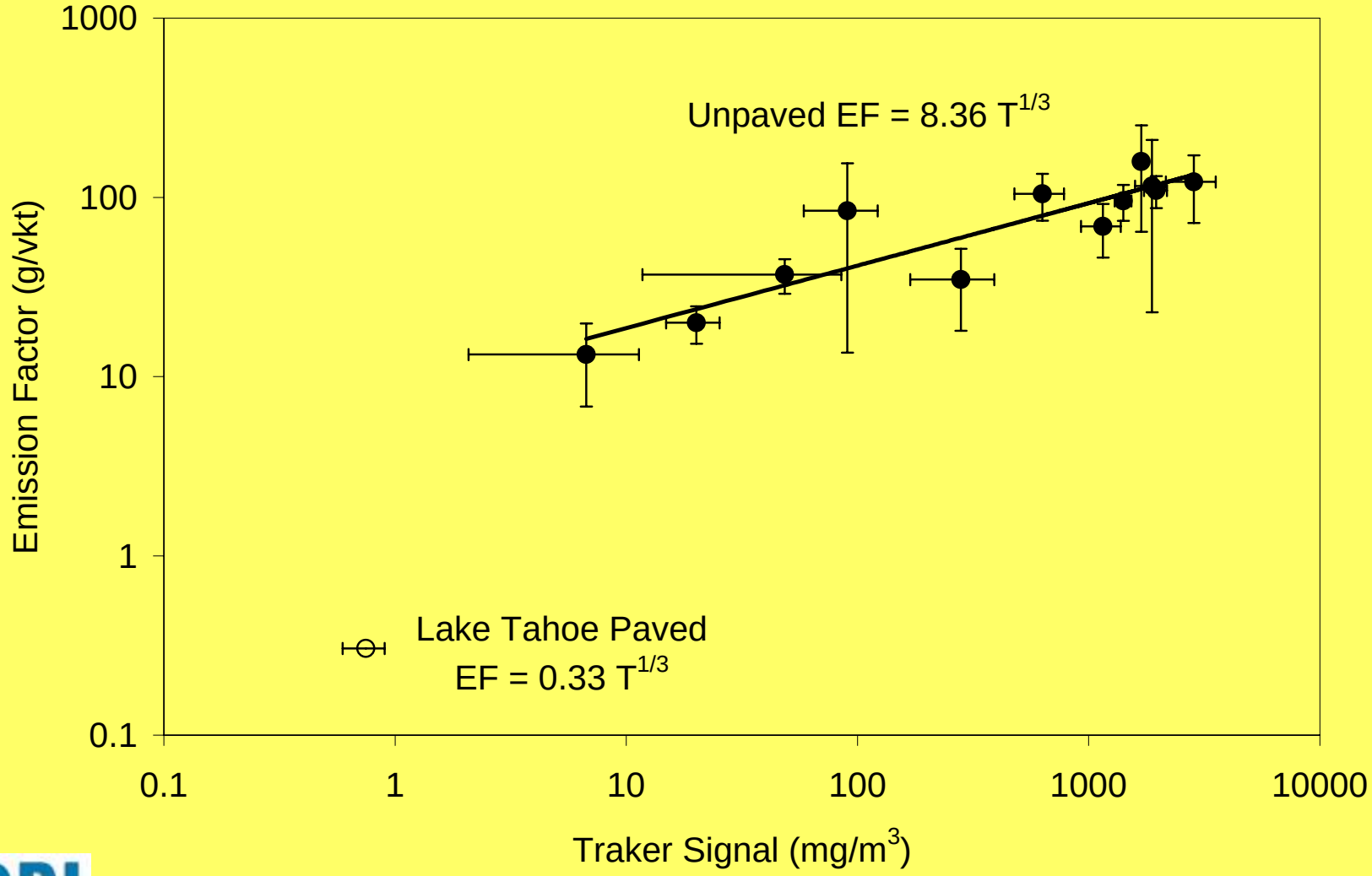
Paved Road Calibration



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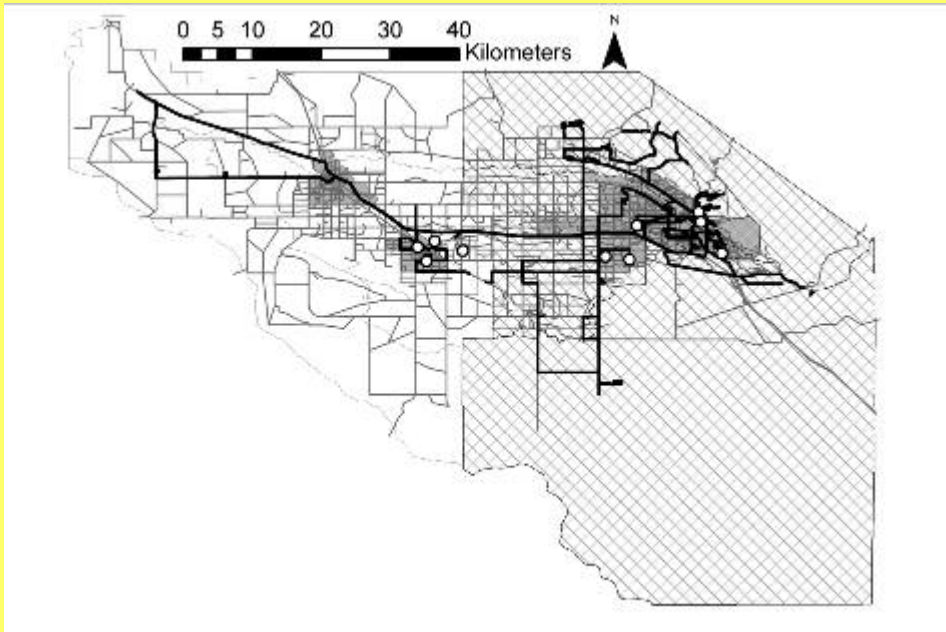
Example TRAKER Use: Treasure Valley, ID

- Winter/Summer TRAKER measurements over a closed loop
- Develop emission inventories based on road characteristics and traffic speeds/volumes
- Assess effect of road sanding, street sweeping, seasons



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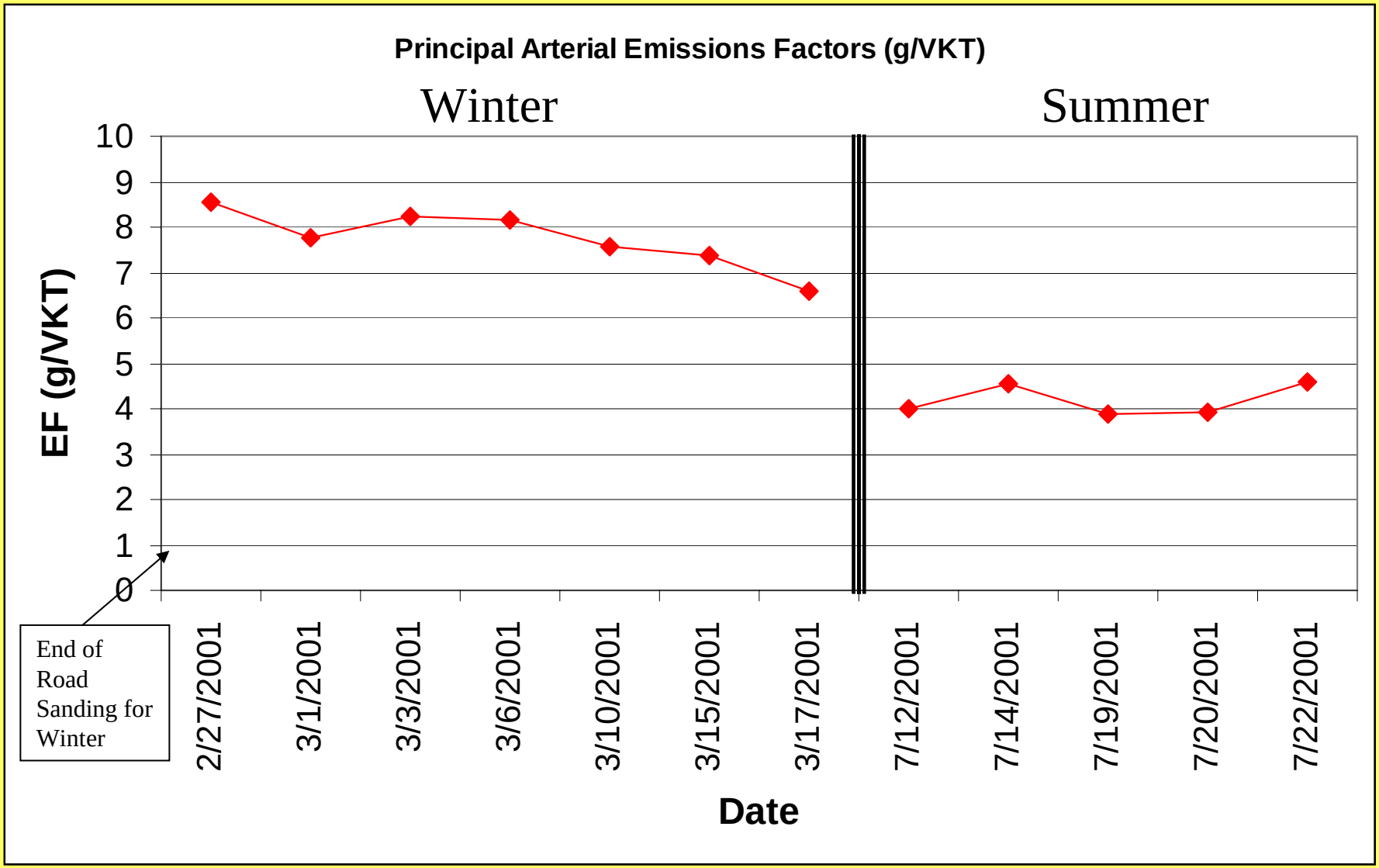
Time Series of Emissions from Roads



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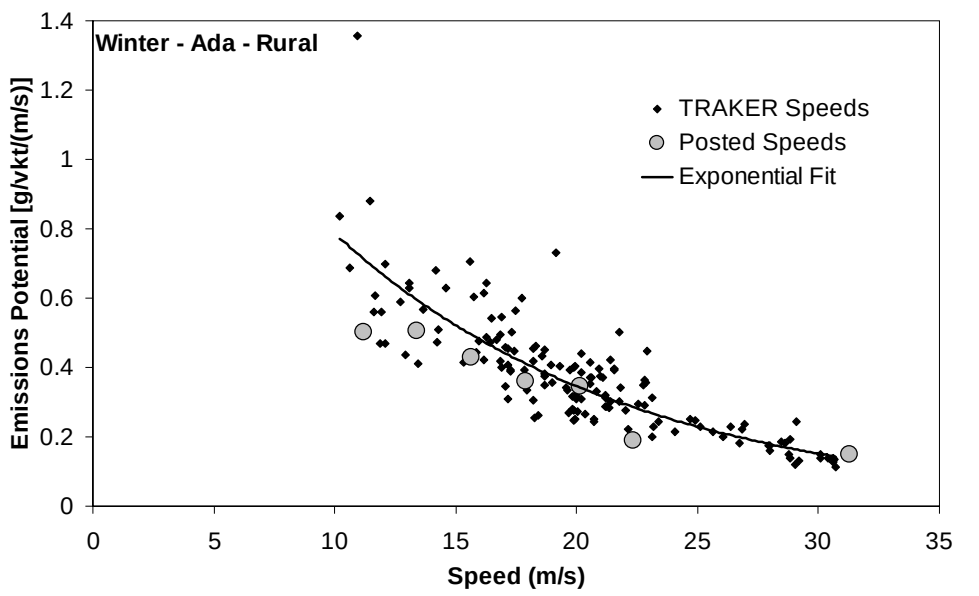
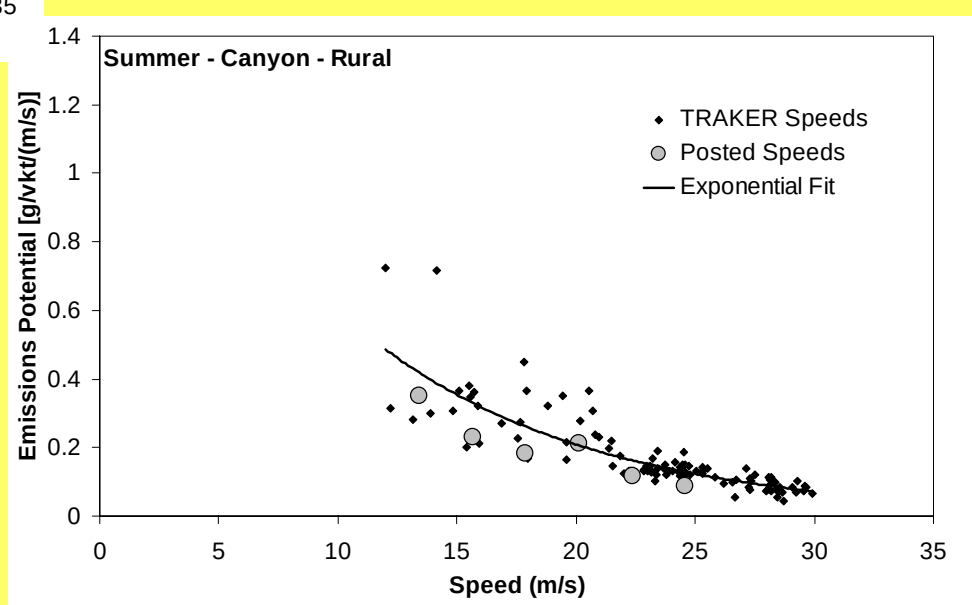
Use Roadway Properties To Extend TRAKER Results to Entire Network



Statistically significant differences found based on Season, County, Setting (urban/Rural), and Road Speed.



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Use Traffic Demand Model to Obtain Link-level Emission Inventory

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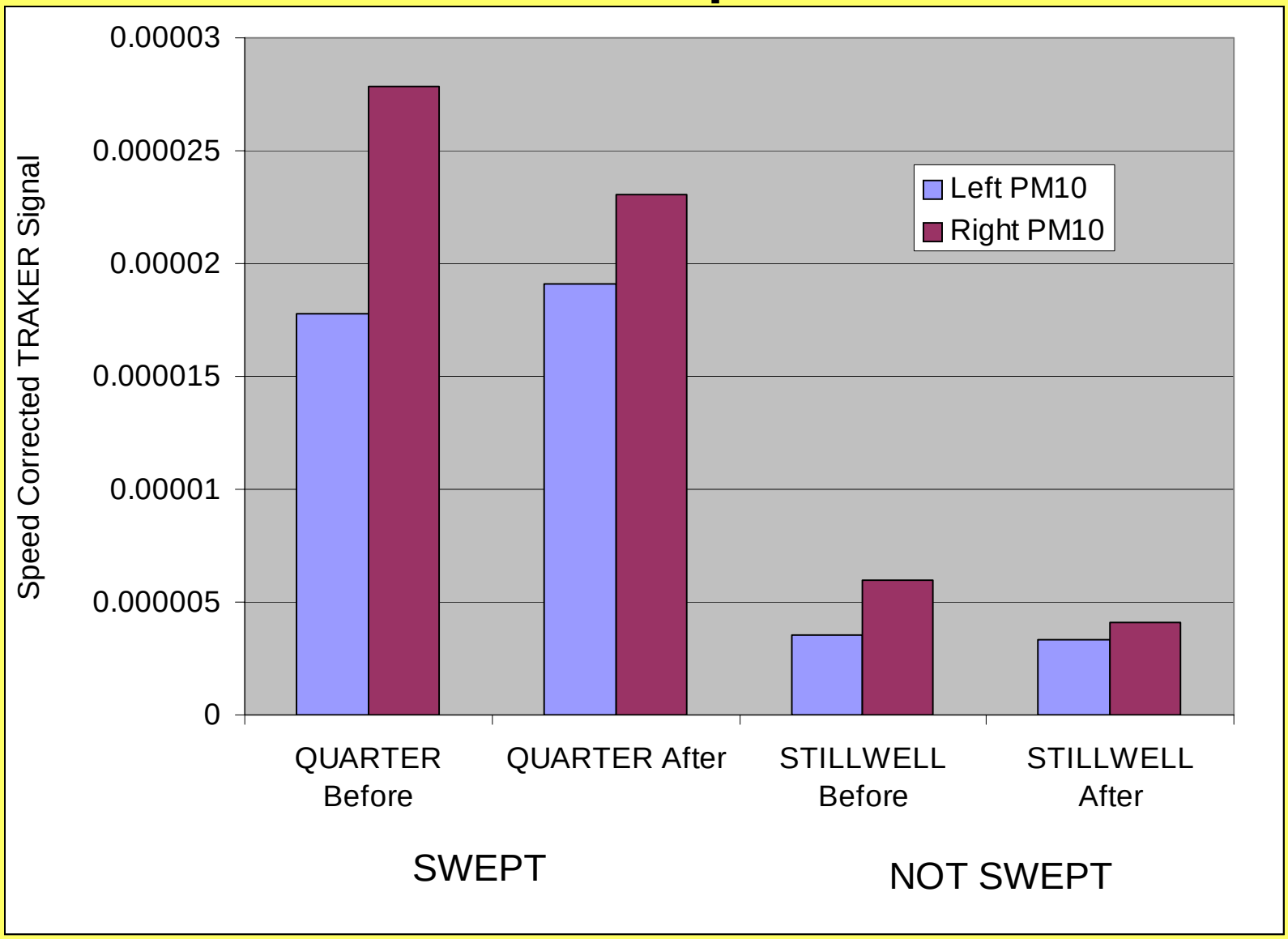
Another Interesting Finding About Street Sweepers



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Conclusions

- Vehicle-based methods for road dust emissions measurement are efficient and comparatively fast
  - Cover 100's of mile of road
  - No need to worry about "picking" representative sections of road
- For TRAKER
  - Las Vegas Study shows day to day differences (precision) is on the order of 5% overall and generally better than 20% on a link by link basis
  - Important to recognize the effect of cross-winds
  - Can use to
    - Efficiently assemble emission inventories for road dust
    - Test effects of parameters : sweeping, sanding, season, location, construction, traffic volume, etc
- Technology has been around for 6 years and multiple studies

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Planned Future Work

- Increase # calibration data points for paved roads using upwind/downwind technique (Las Vegas, summer 2005)
- Quantitatively compare with CE-CERT SCAMPER (summer 2005)
- Redesign towards achieving turnkey application (Winter, 2006). Features for TRAKER III will include:
  - New Platform: Dodge Sprinter
  - On-the-fly span and zero for DustTraks onboard
  - On-the-fly switching between paved and unpaved road sampling
  - Real-time mapping of dust emission potentials and factors

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Acknowledgements

- Clark County Department of Air Quality and Environmental Management
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