

Vehicle Based Road Dust Emission Measurements

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Outline

- AP-42 Road Dust Emission Estimation Methods
- TRAKER Road Dust Measurement Method
- TRAKER Calibration with PM_{10} Flux
- TRAKER Results
 - Seasonal Changes in Emission Potential
 - Effects of Sanding and Street Sweeping
 - Emissions Inventory Development

AP-42 Road Dust Emissions Estimation

Silt content and silt loading are surrogates for road dust emissions potential.

Paved Road:

- $EF \text{ (g/vkt)} = f(\textit{silt loading, vehicle weight})$

Unpaved Road:

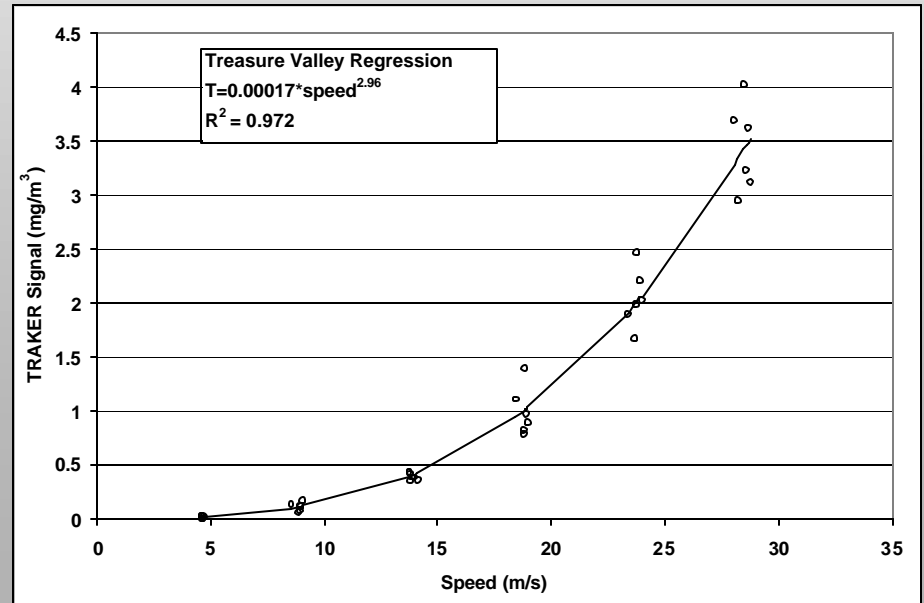
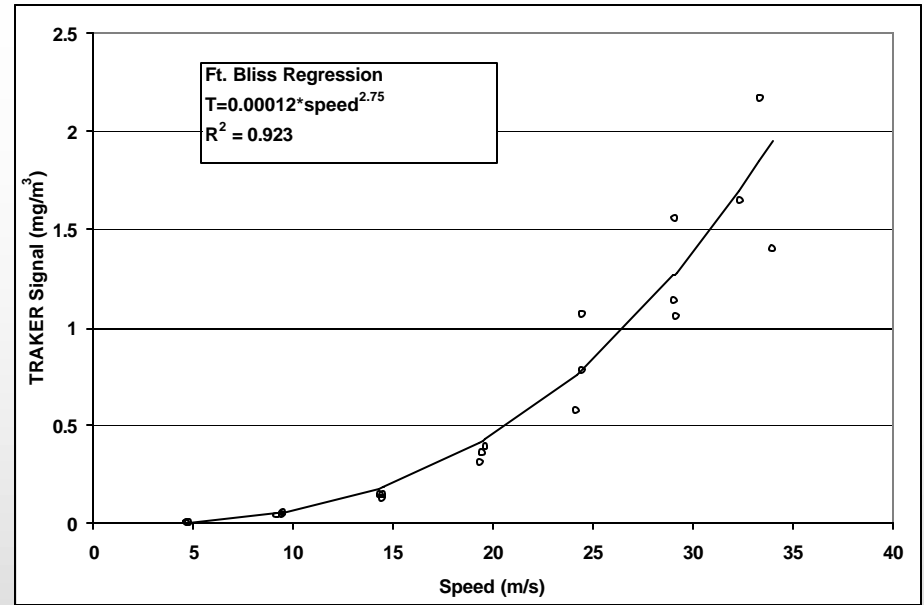
- $EF \text{ (g/vkt)} = f(\textit{silt content, vehicle weight, soil moisture/speed})$



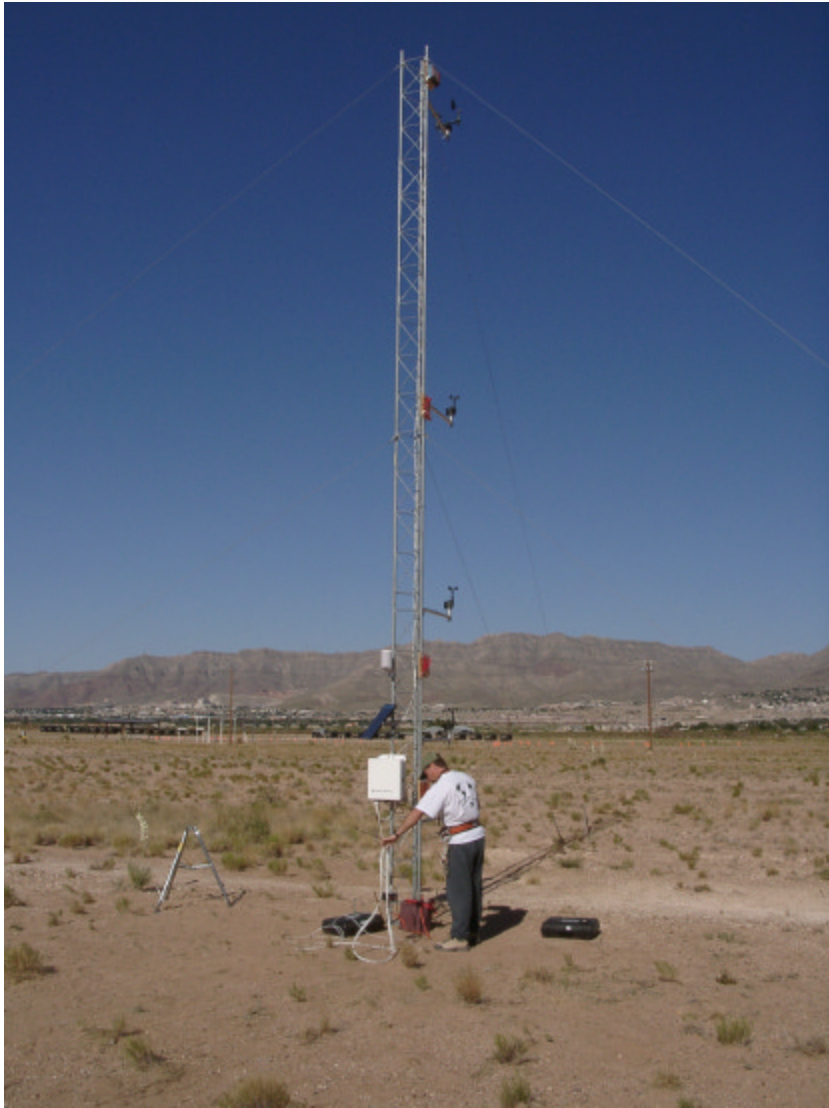
- Particle Sensors
 - TSI DustTrak 5830
 - Grimm Particle Size Analyzer 1.108
- GPS
 - Ashtech/Magellan Promark X

TRAKER Signal vs Vehicle Speed

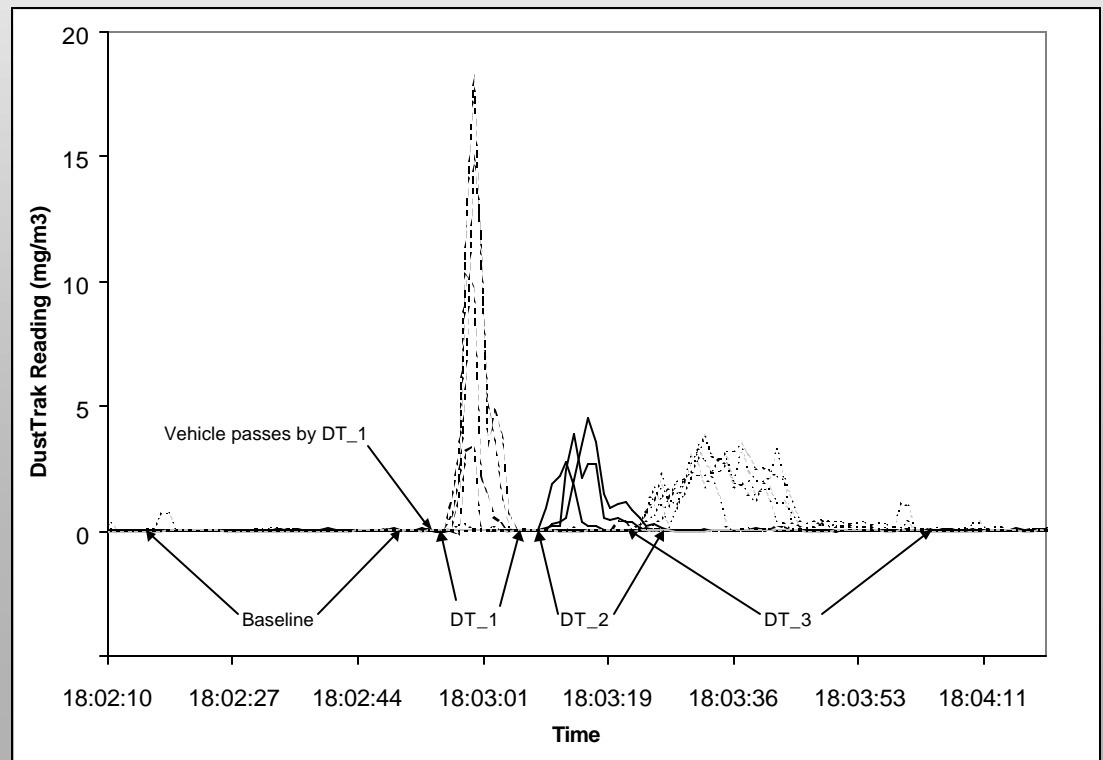
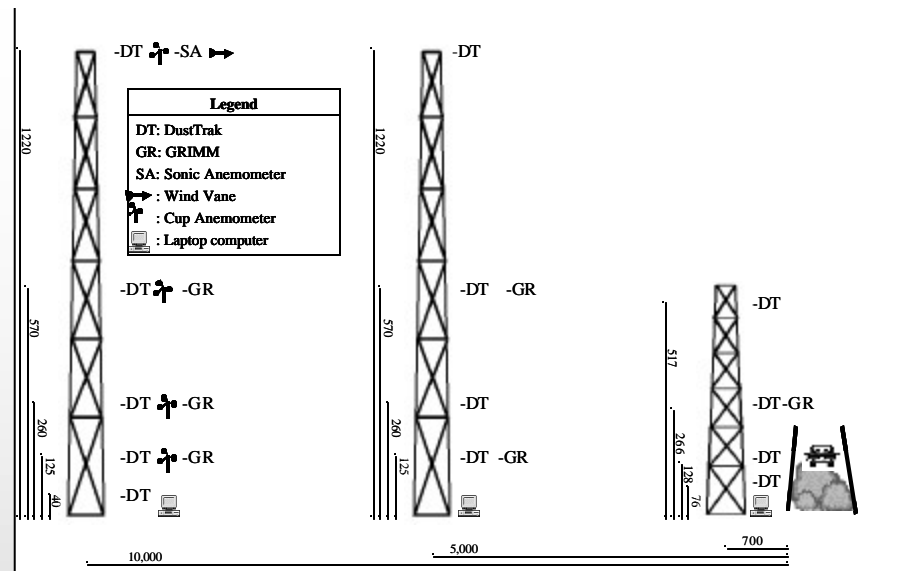
- $T = C_{\text{tire}} - C_{\text{bkgrnd}}$
- $T = a S^3$
- On the same paved road the TRAKER signal increases with the speed cubed
- Factoring out speed leaves a signal proportional to the emission potential of the road.



Upwind-Downwind Flux Measurements



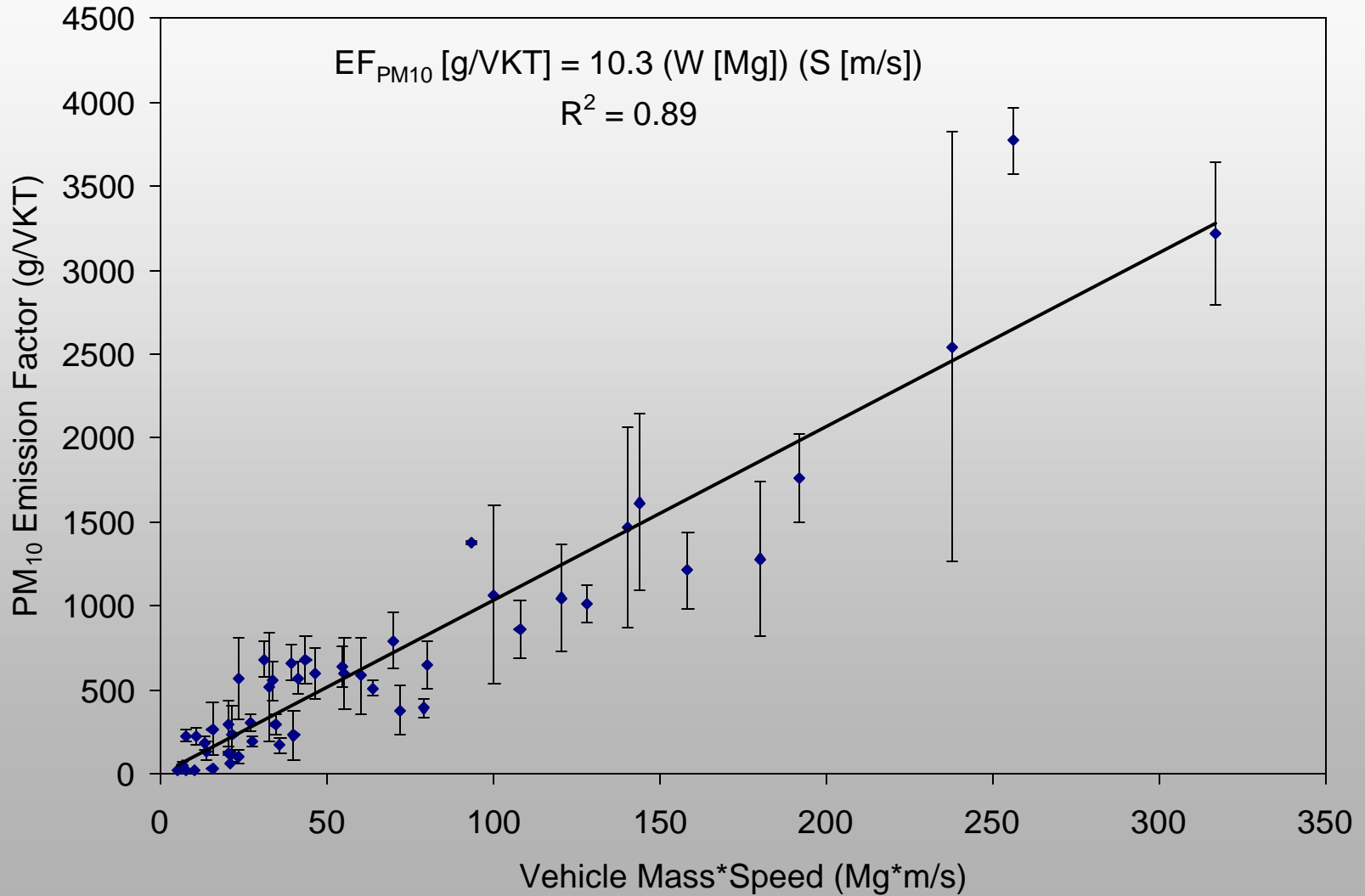
Emission factor
calculated as
horizontal
flux of PM_{10}
passing
instrumented
towers



Unpaved Emissions Measured on Flux Towers in Ft. Bliss TX (April 2002)

Vehicle	Weight (kg)	# Wheels
Dodge Neon	1,176	4
Ford Taurus	1,516	4
Dodge Caravan	1,759	4
HUMVEE	2,445	4
TRAKER (Chevy Van)	3,100	4
26' UHAUL Truck	5,227	6
LMTV	8,060	4
Freightliner (Tractor)	8,982	22
HEMMET	17,727	8
5-ton Truck	14,318	6

$$EF_{PM10} = b W S$$

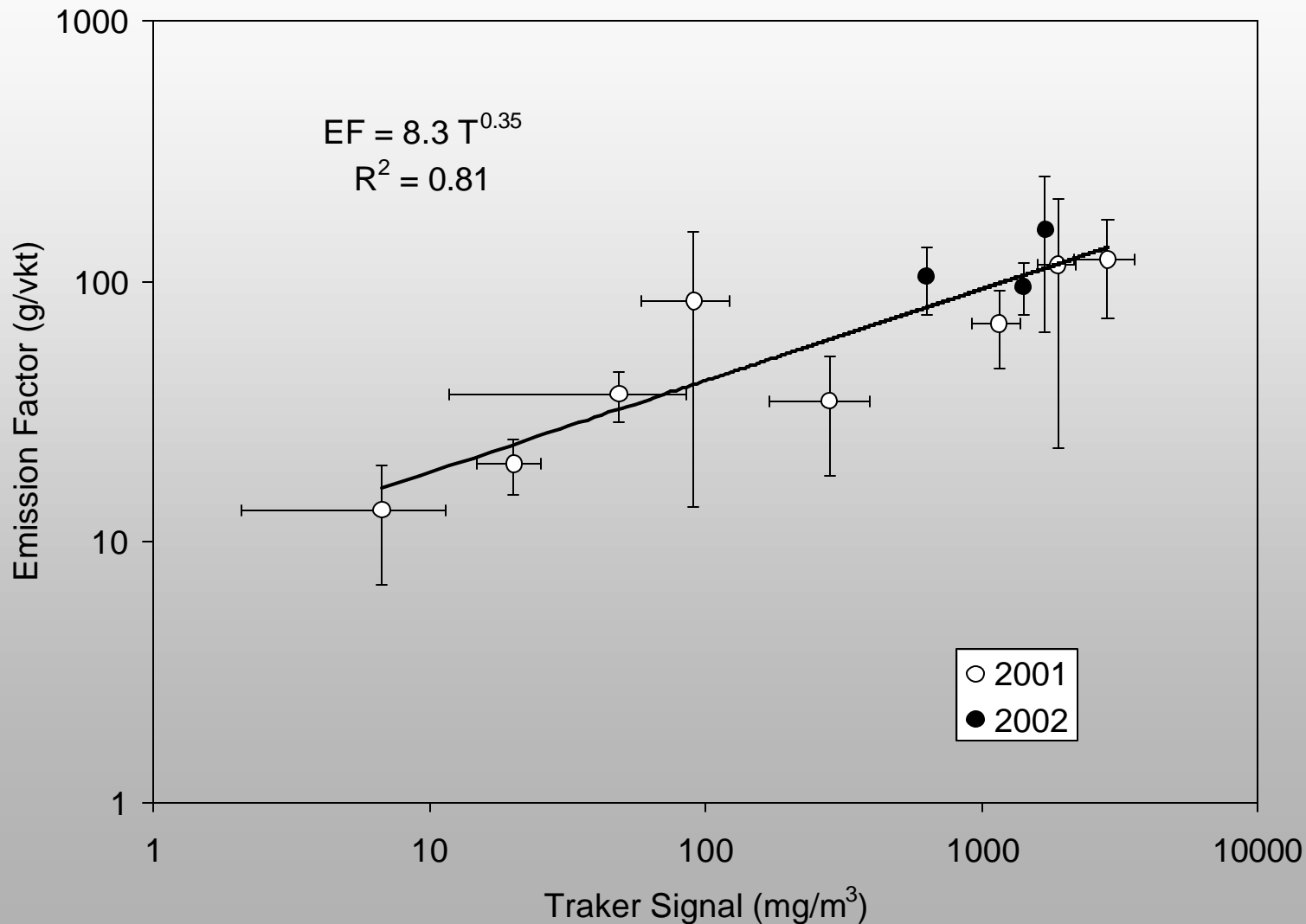


Calibrating TRAKER with Emissions Factors from Tower Measurements

- $T = a S^3$ (TRAKER Measurements)
- $EF_{PM10} = b W S$ (Tower Measurements)
- $EF_{PM10} = k T^?$ (Tower Calibrated TRAKER)

where a, b, and k are empirical constants

Relationship b/w TRAKER and Emissions Factor

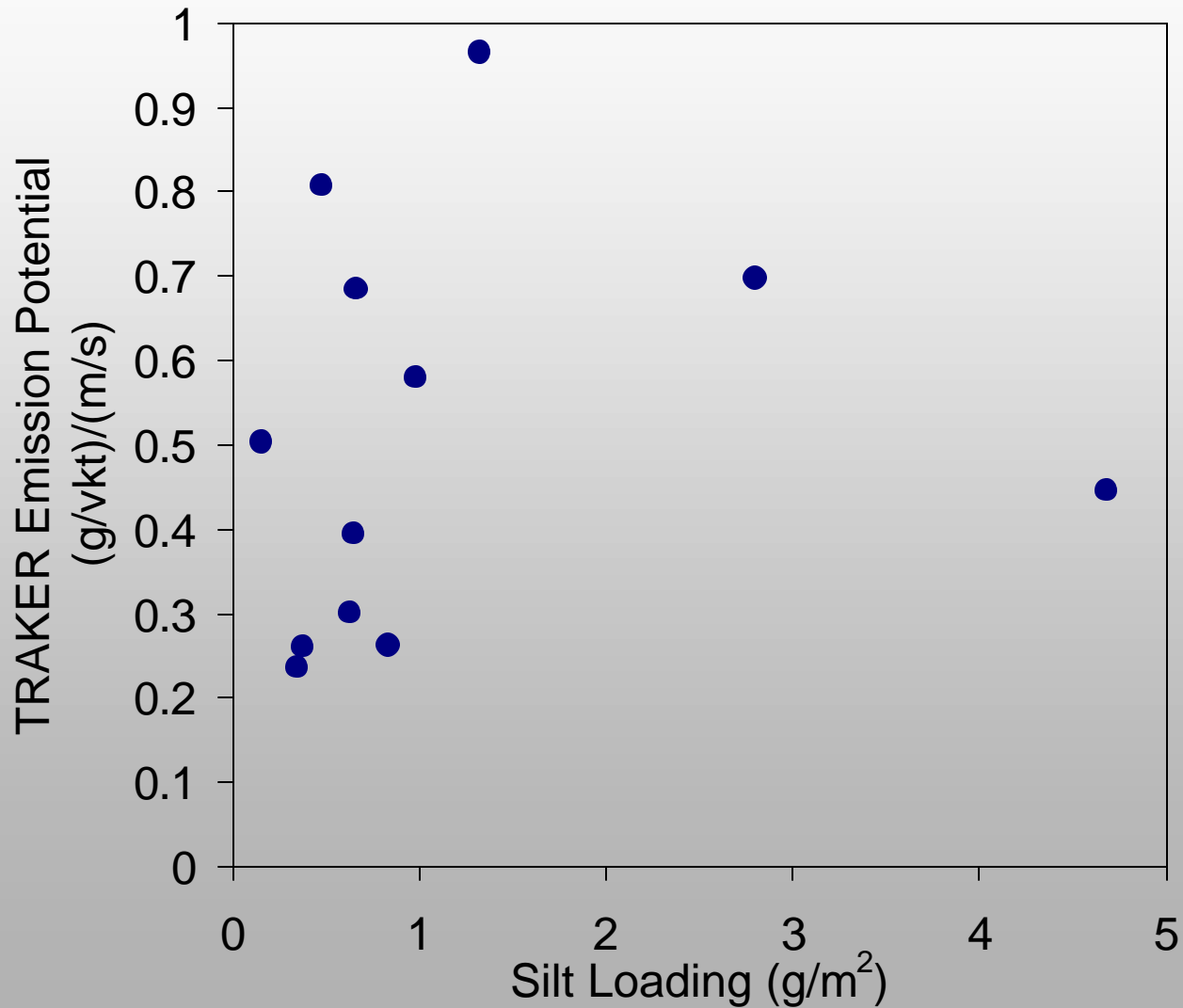


Emission Potential

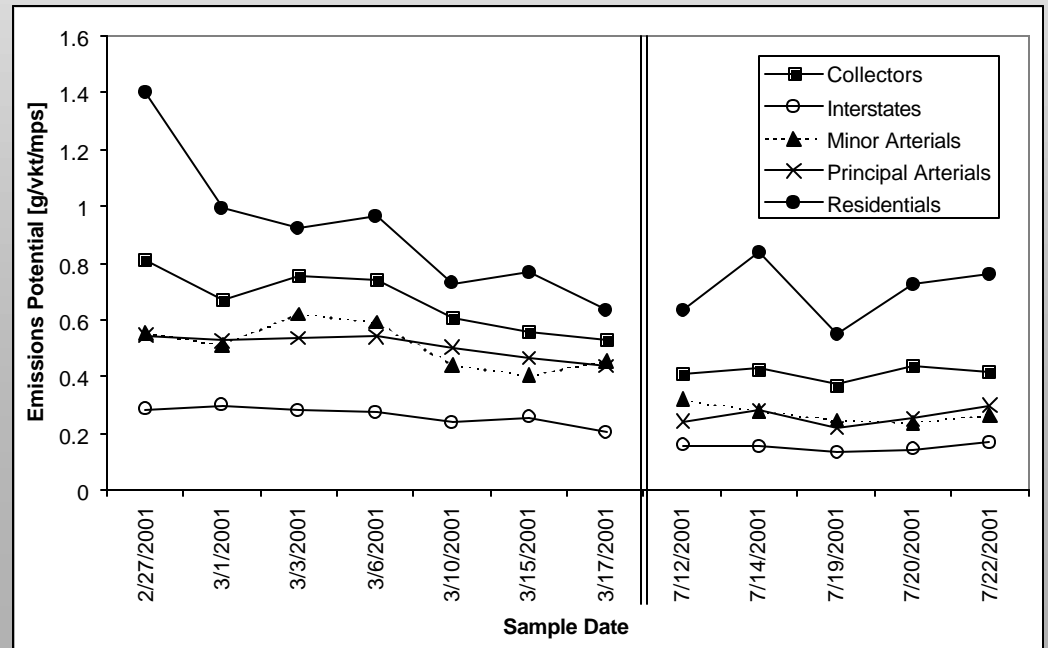
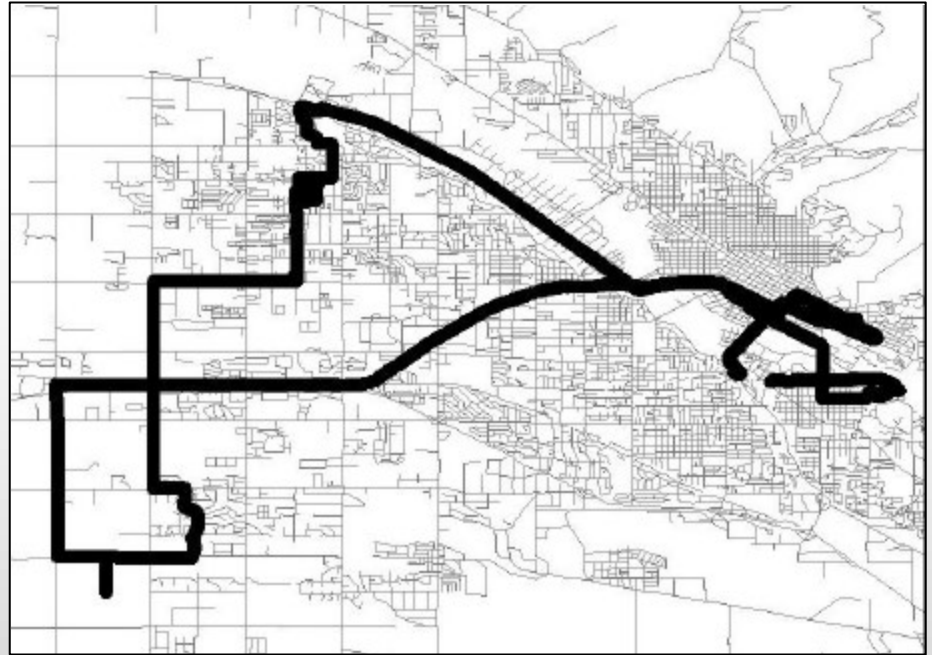
- Roads emit PM based on:
 - Weight of vehicle
 - Speed of vehicle
 - Dirtiness of the road (i.e. Emission Potential)
- Emission Potential is a property of the road only:

$$EP_{PM10} \left[\frac{\left(\frac{g}{VKT} \right)}{\left(\frac{m}{s} \right)} \right] = \frac{EF_{PM10}}{S} = \frac{kT^{1/3}}{S}$$

Comparison of TRAKER Emission Potential with Silt Loading



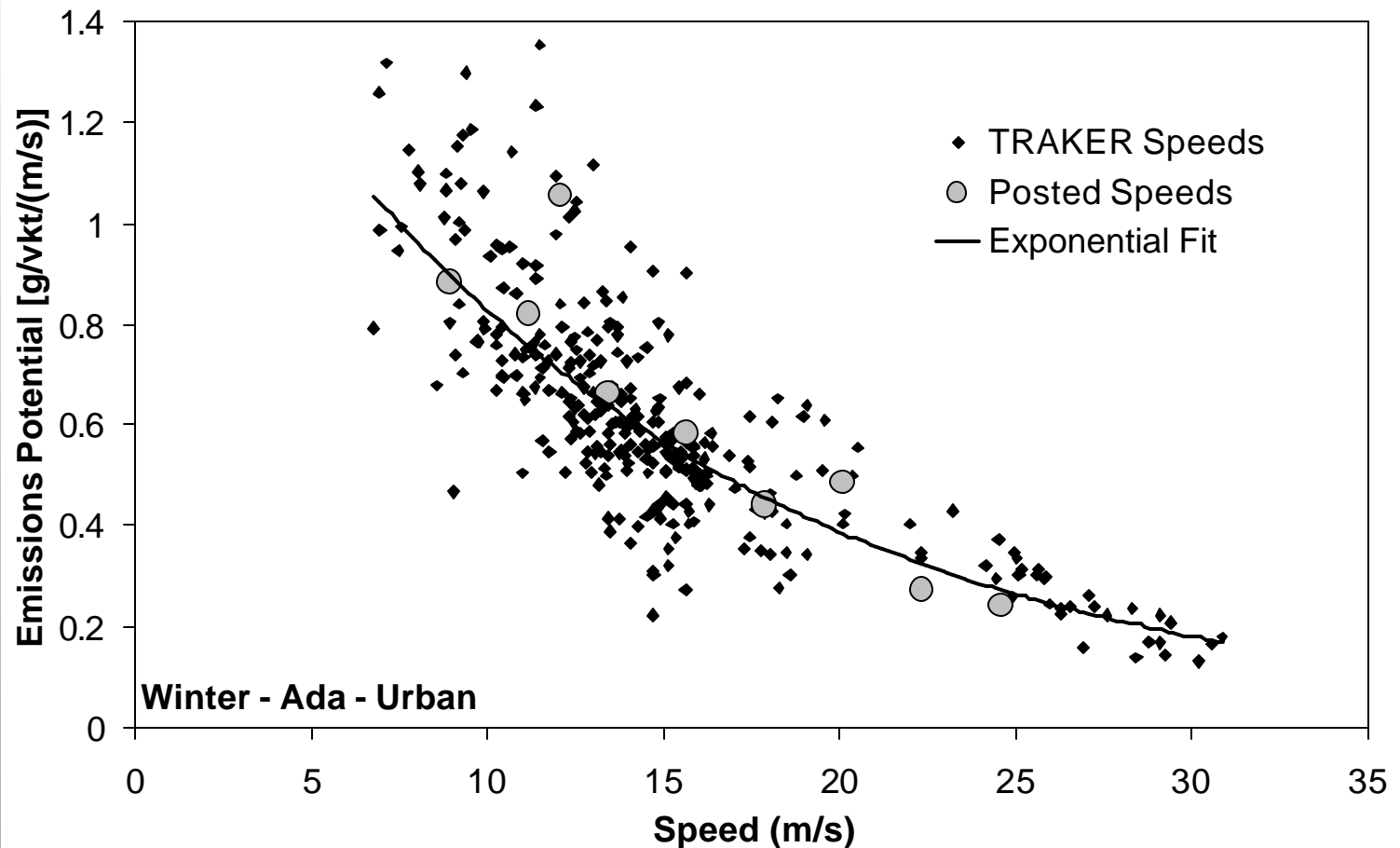
TRAKER Results: Seasonal Changes of Emission Potential



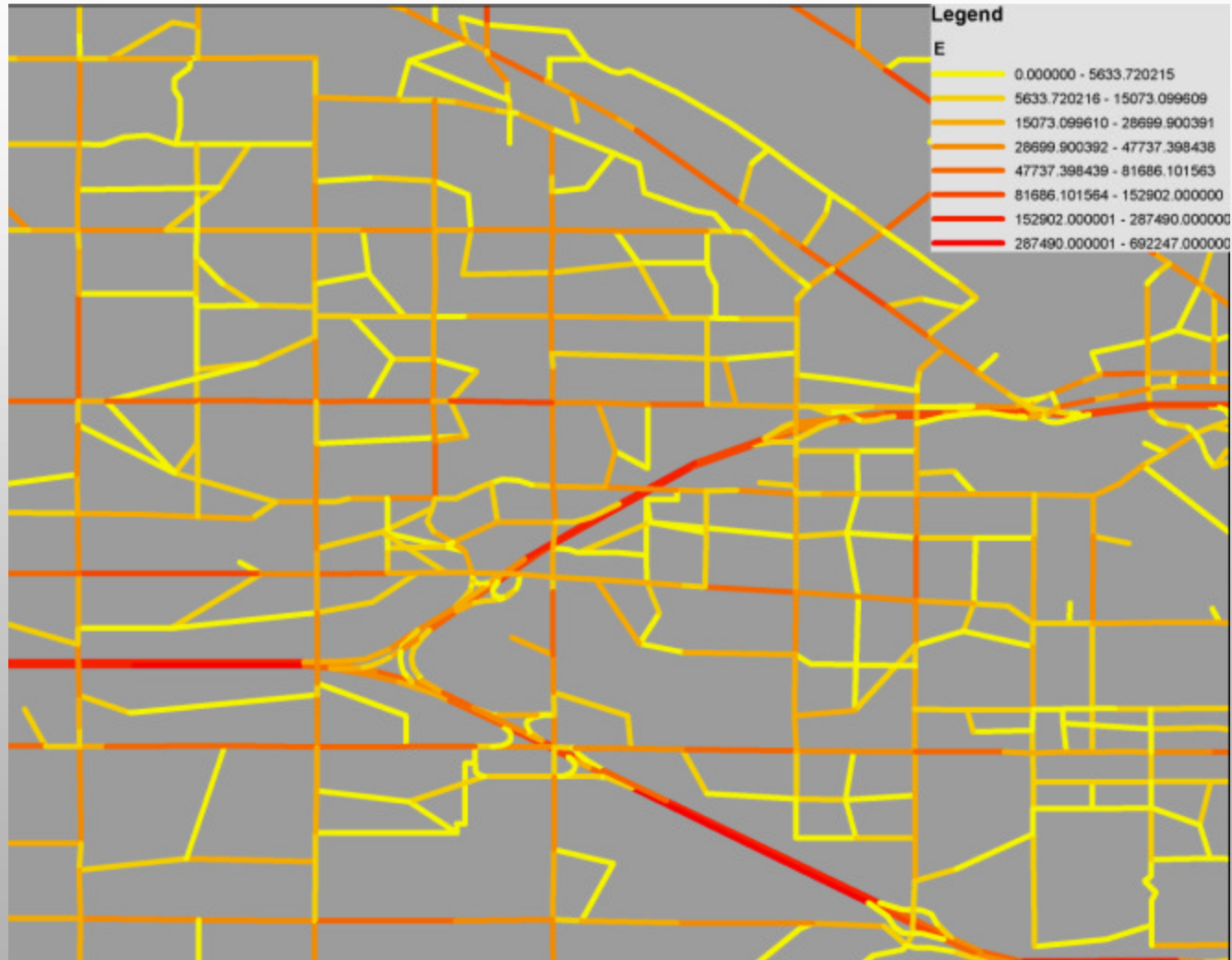
Road Dust EI Development with TRAKER

1. Measure TRAKER signal over 500+ km of roads.
2. Calculate emissions factor for each measurement based on TRAKER signal and TRAKER speed
3. Characterize emissions factors by season, road type, speed, and location (i.e. county, urban/rural).
4. Extrapolate emissions factors to all roads in domain based on season, road type, modeled speed, location, and VKT.
5. Apply Average Daily Traffic (ADT) estimates from Traffic Demand and Forecasting Models to create EI.

Emission Potential vs. Typical Road Speed



Map of Boise Road Dust Emissions



Summary and Conclusions

TRAKER Road Dust Measurement System

- obtains local road dust emission potential
- has been calibrated using a tower flux measurements
- provides high spatial and temporal resolution of road dust emissions
- can be used to
 - create road dust emission inventories
 - evaluate effectiveness of control strategies