Tower Based Real Time Monitoring System for Quantifying Fugitive Emissions

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Objectives:

- Describe the tower system.
- Present a graphical depiction of its operation.
- Present several examples of its use to characterize and quantify fugitive PM emissions.
- Future developments.

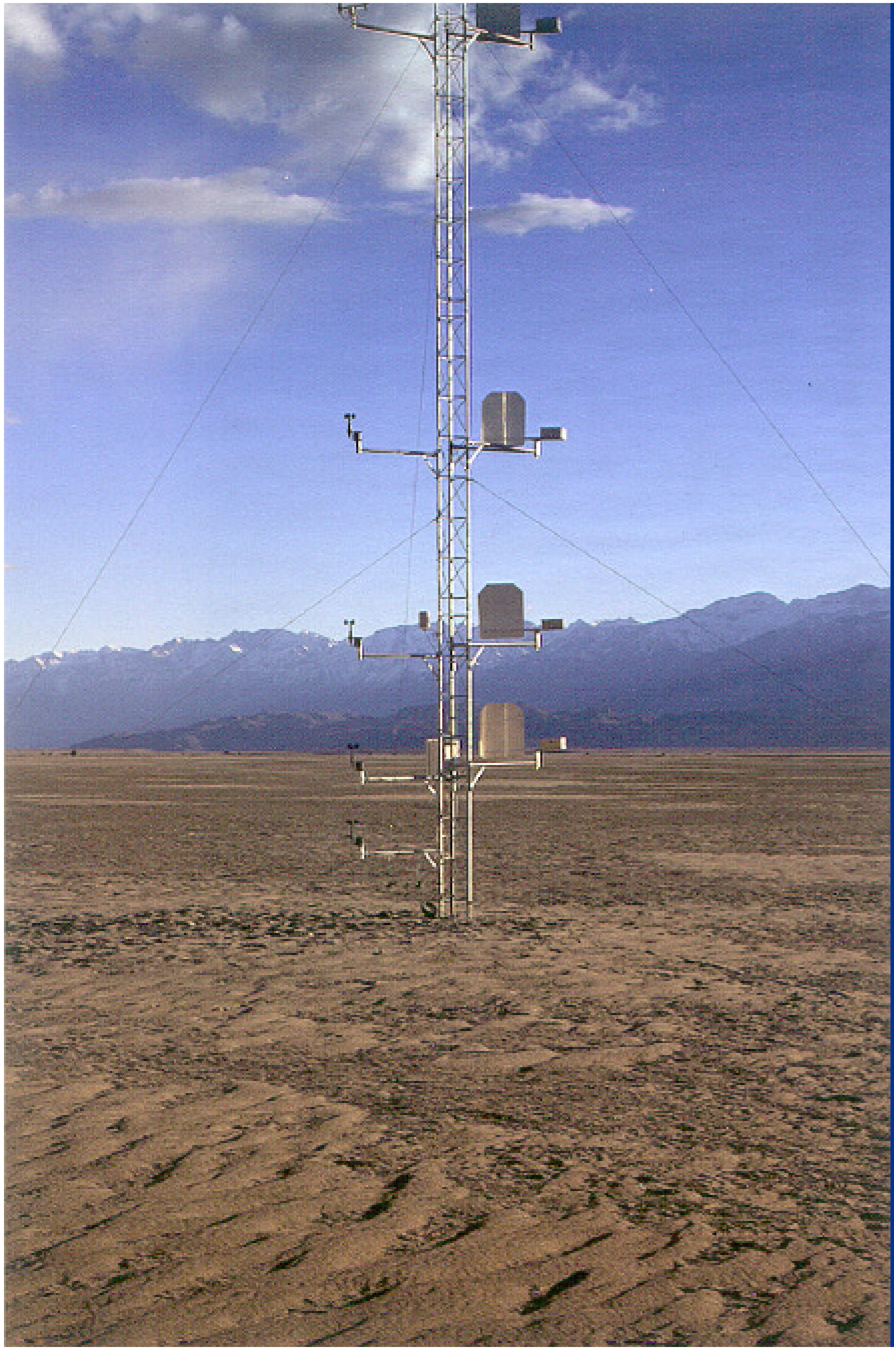
The Tower System:

- A multi-towered system has been developed and assembled at DRI to allow for measurement flexibility depending on the goals and objectives of the research.
- The system has been designed to:

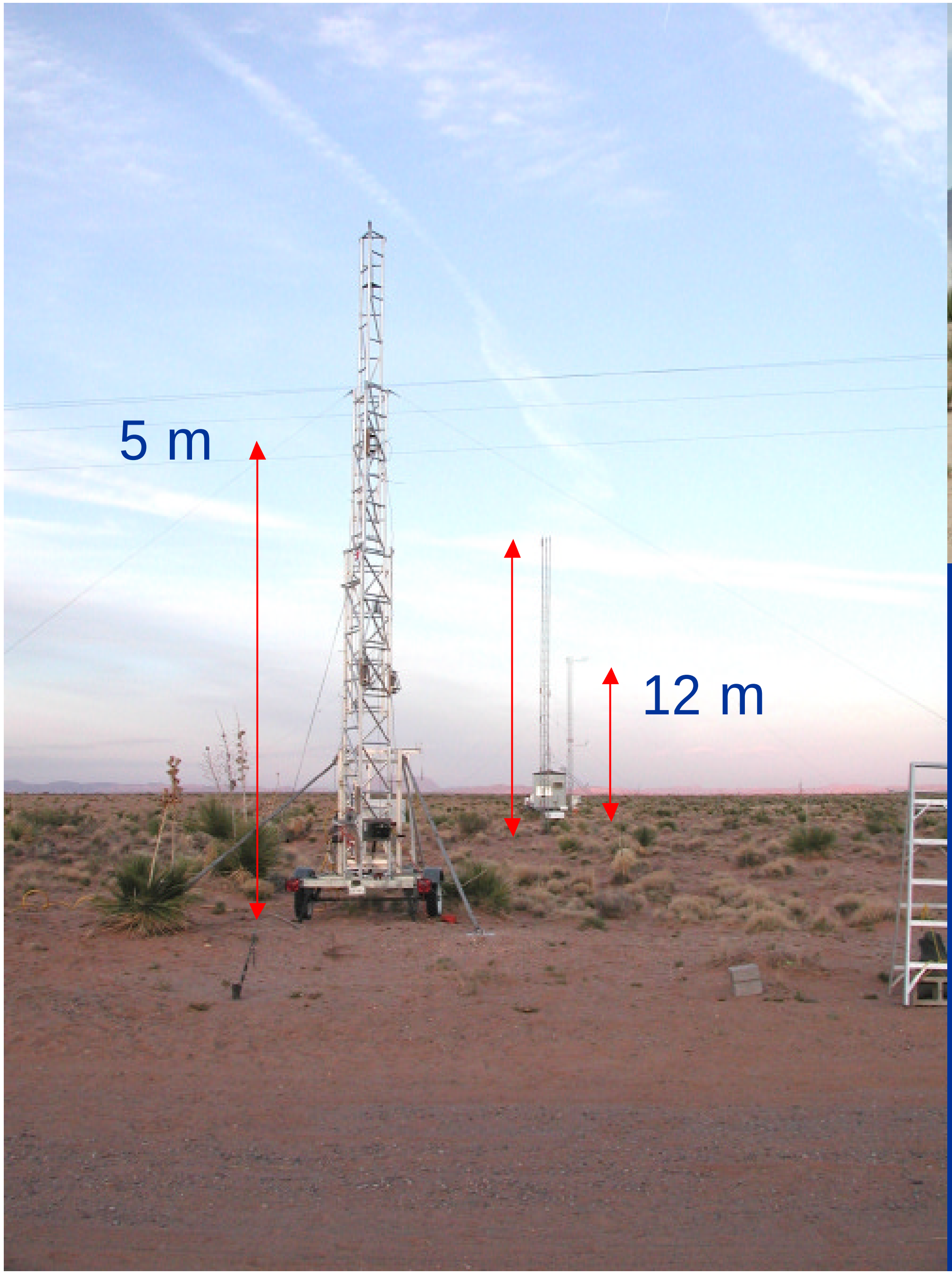
1) measure vertical flux of dust during wind erosion events.

The Tower System (cont.)

2) measure PM to derive emission factors from mobile sources (fugitive & tail-pipe) traveling on unpaved and paved roads,
3) quantify the visibility impairment potential of the emissions,
4) develop further understanding of near-field emission and deposition processes (i.e., quantify the transportable fraction of the emissions).



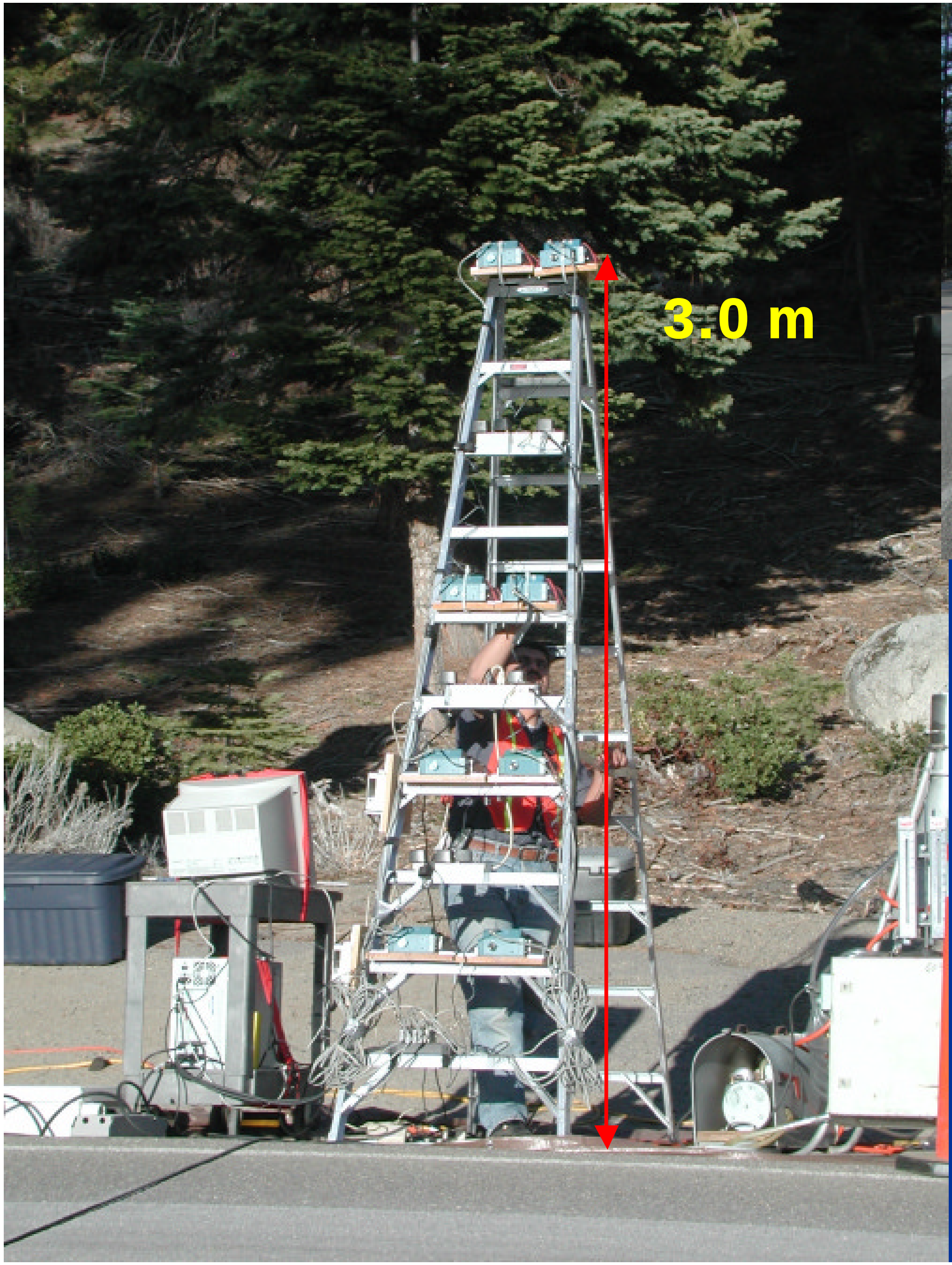
Tower system configured to measure PM_{10} dust emissions on Owens Lake, California to characterize and quantify the vertical flux of the dust during storm events.



Tower system configured to measure PM_{10} emissions produced by military vehicles on unpaved surfaces, evaluate its visibility degrading potential, and fraction available for long range transport.

PM mass concentration, particle size distribution, and meteorological instruments that provide data to estimate horizontal and vertical mass fluxes.

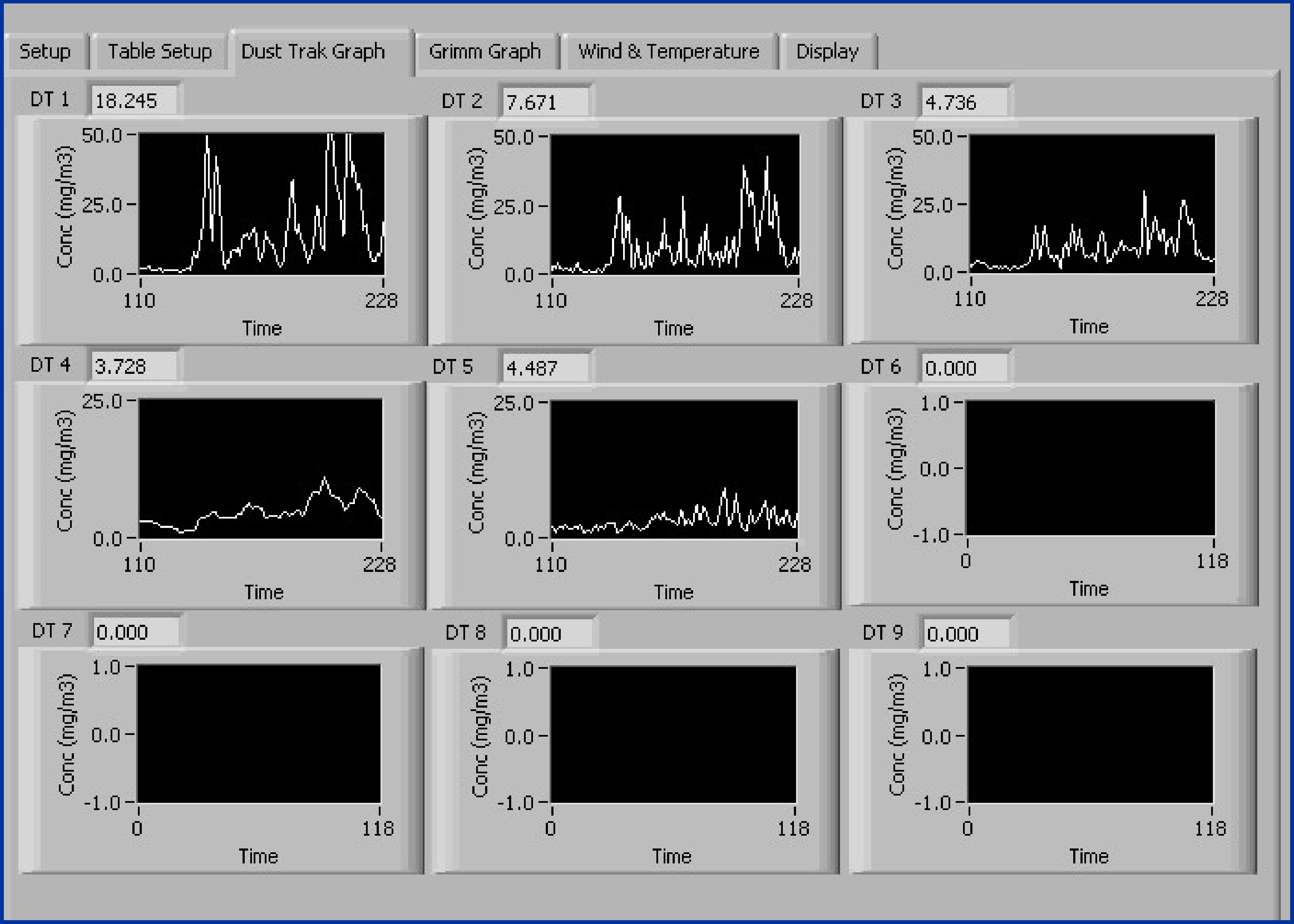
Visibility instruments for measuring: scattering, absorption, and total extinction.



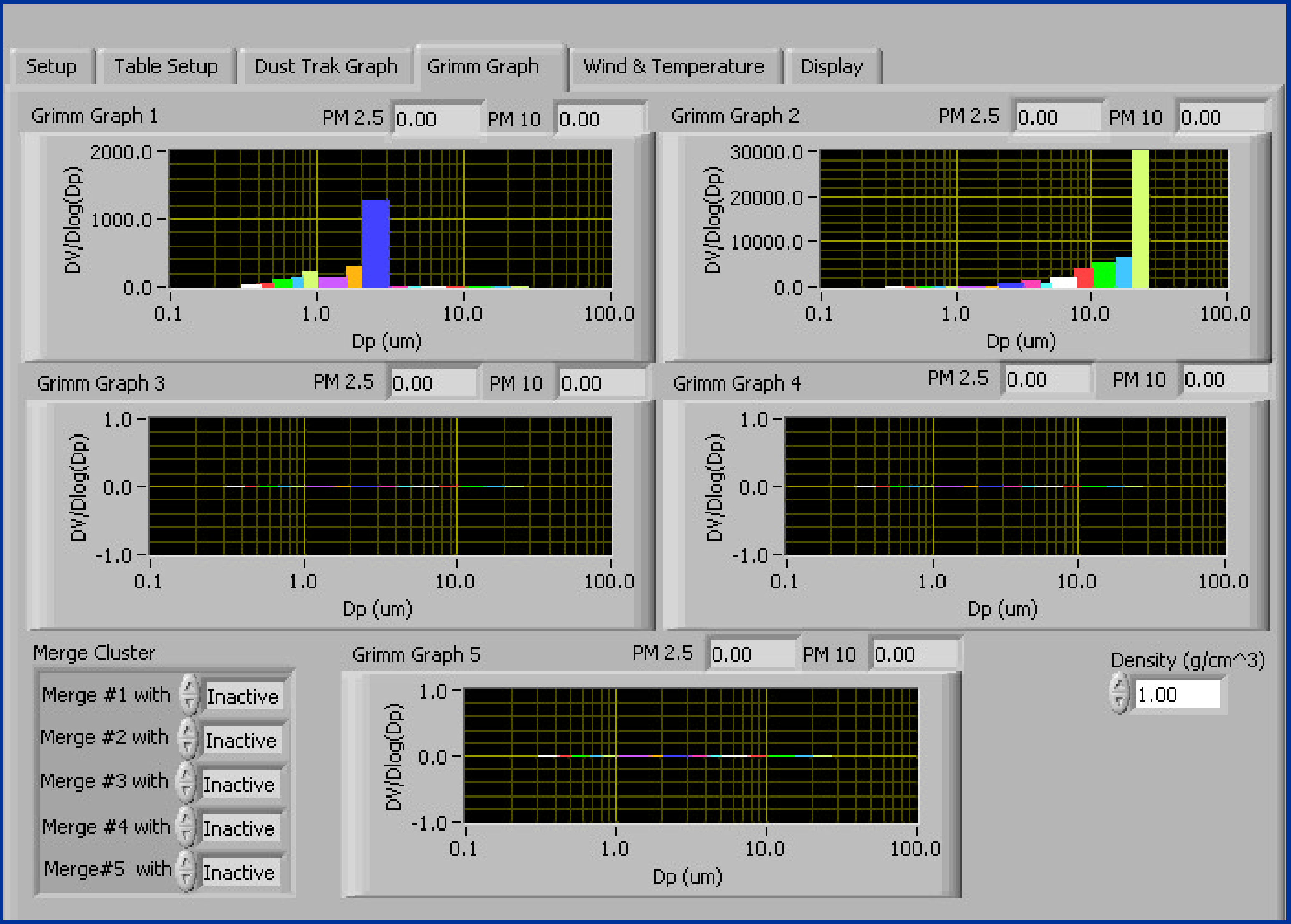
Instruments re-configured to measure PM_{10} and $PM_{2.5}$ emissions from paved roadways from on-road mobile sources. Emission factors for different vehicle classes are developed and effects from roadway treatments (e.g., road sanding) evaluated.

Data Acquisition and Visualization:

- Data are acquired using a custom-designed LabView program interfacing with multiple PCs, instruments, and peripherals (e.g., multi-port RS-232, A/D board).
- The LabView program synchronizes data collection and writes the acquired data to a Microsoft Access compatible database.
- Data are visualized in real-time, which provides an important first level of quality assurance and control.



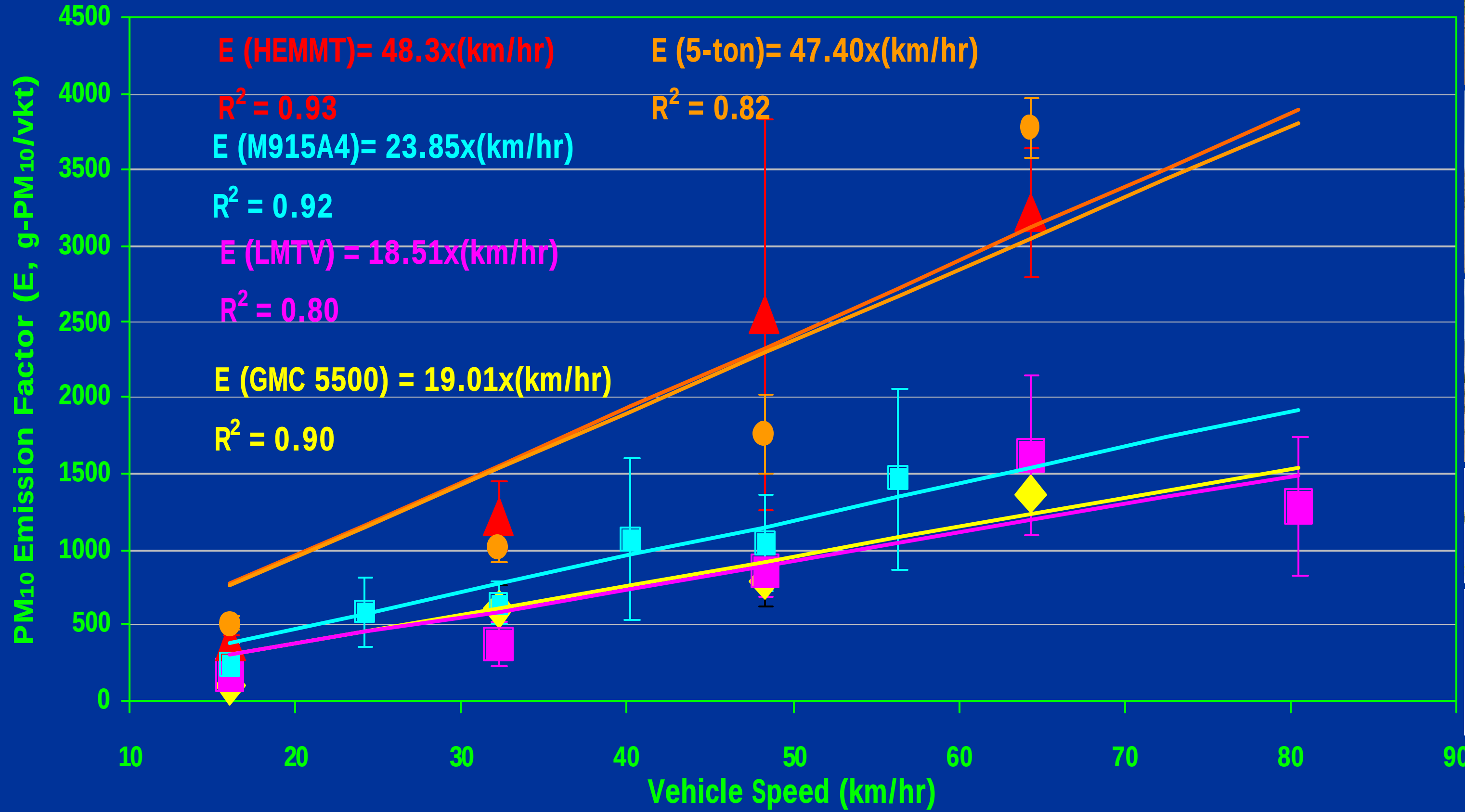
Example of dust (PM_{10}) concentration data acquired at 1 Hz for 5 sampling heights above the ground.

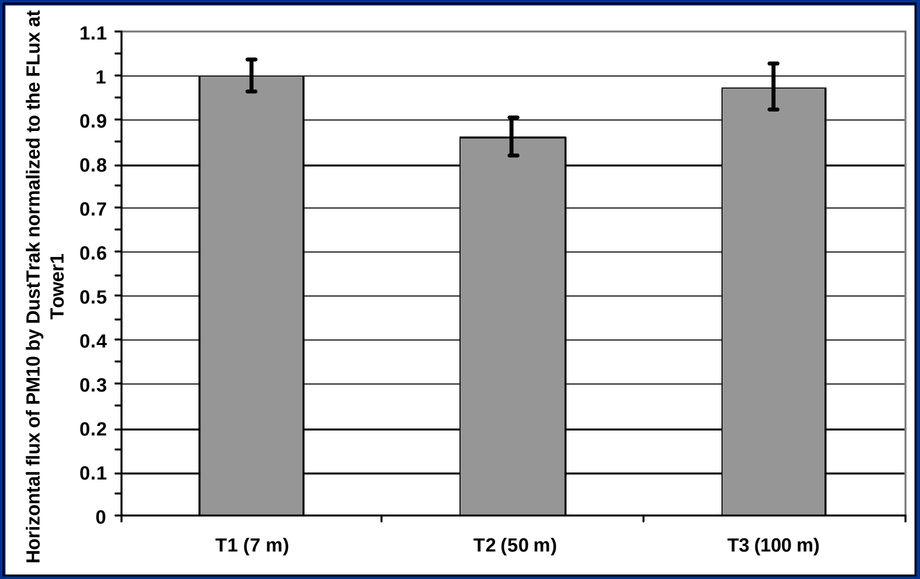


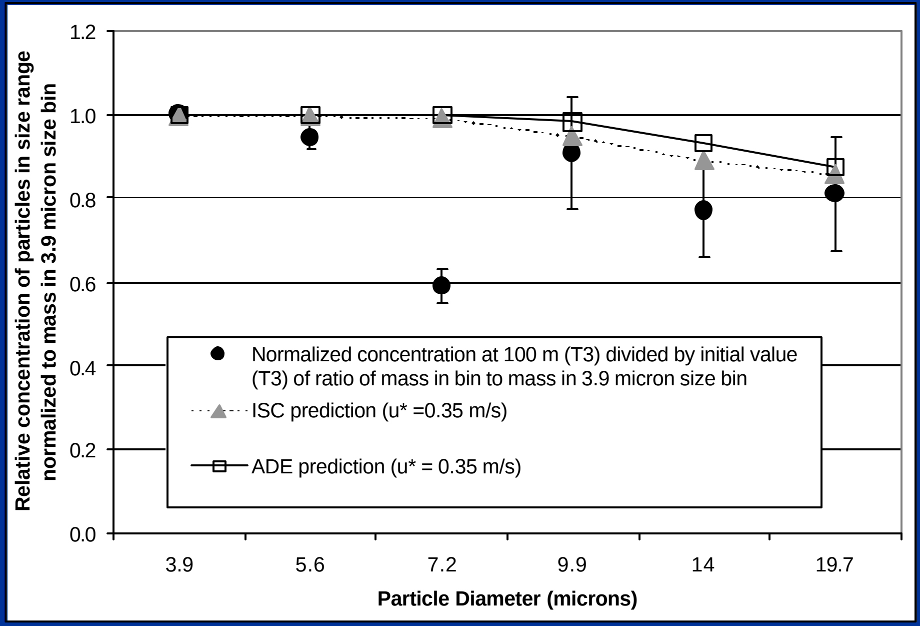
Example of particles size distribution data (0.4-20 μm) acquired at 1 Hz for 1 sampling height.

Examples of data products:

- **Heavy Military vehicle unpaved roadway emission factors: g-PM_{10} per vehicle kilometer traveled.**







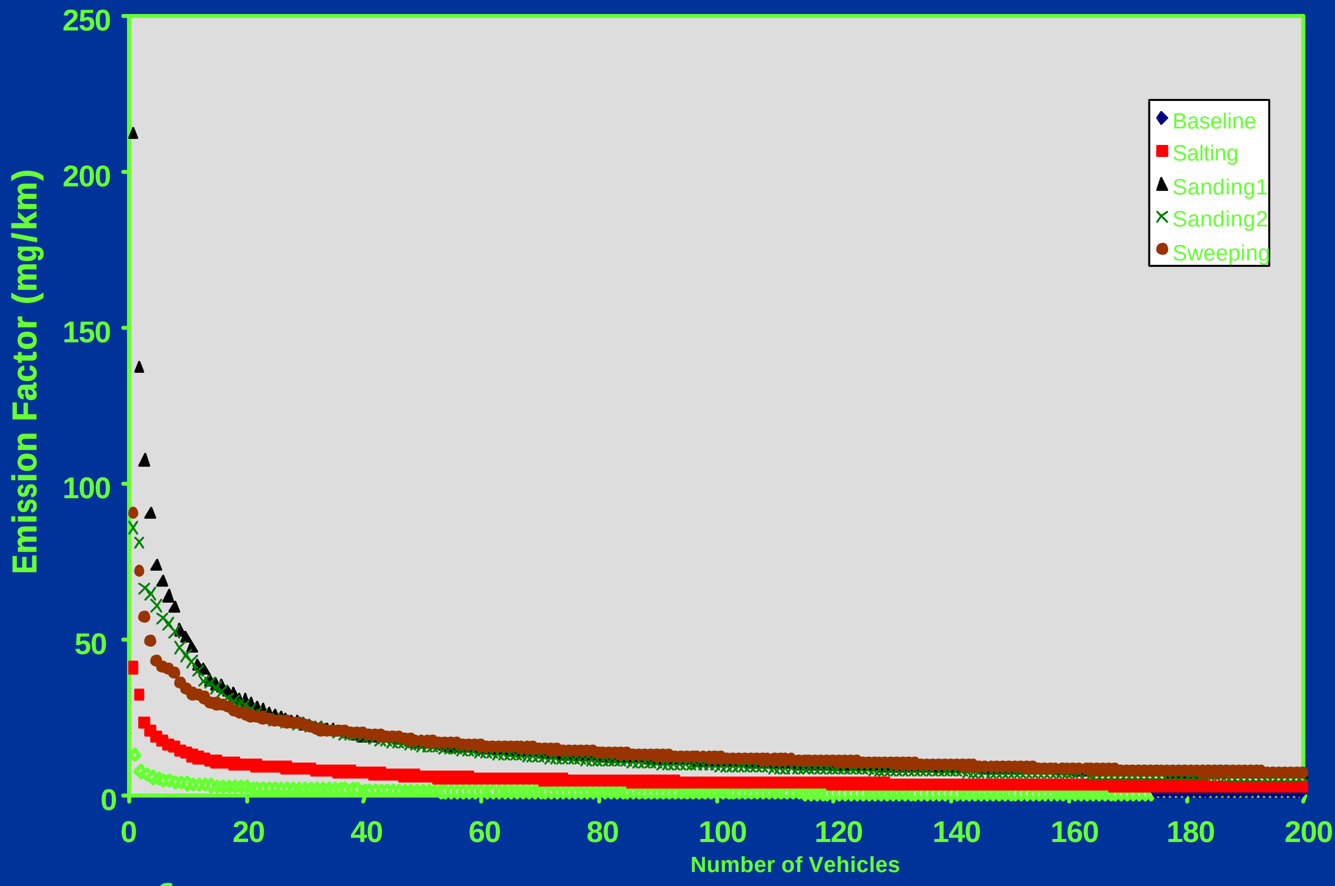
For sparsely vegetated desert surfaces at Ft. Bliss, TX:

Measured horizontal fluxes indicate little or no removal of PM_{10} between unpaved road and tower located 100 m downwind. (top)

Fraction of particles removed at 100 m downwind compared to roadside value. Comparison of model results and field data (bottom) agree that there is little removal for particles up to 10 µm in aerodynamic diameter.

Larger particles appear to be removed measurably.

Evolution of emissions through a sequence of salting, sanding, snow storm, drying, and subsequent sweeping.



Sequence of events:

1) Baseline (green), 2) add de-icer (red), 3) 1 day after sanding (black), 4) 2 days after sanding (dark green), 5) after sweeping (brown).

System Advantages:

Rapid deployment of system (dependent on scope of measurement program).

Real time visualization of data acquisition and sensor performance.

Emission measurements and emission factors are based on only the periods when plumes impact the sensing instruments and activity producing plumes is clearly delineated.

The instrumentation and software for command/control and data logging makes the system very flexible in terms of its configuration for the research being addressed.

System Developments:

Develop custom-designed circuits with military specs for data capture and logging at a tower with “palm computer” interface to view instrument measurements and download stored data.

Incorporate wireless network capabilities to telemeter data from each tower to a master computer.

Incorporate sub-routines into the LabView program to carry out computations (e.g., friction velocity, aerodynamic roughness length calculations from wind speed profile measurement or sonic anemometry), reduce data (averages, std. deviations, etc.), and calculate emission flux and factors.

Improve ease of set up for multiple-tower configurations.

Acknowledgments:

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