Real-time Mapping and Mass Accounting of Particle Emissions from Field Crop Operations Using Portable, Elastic-Backscatter LIDAR and Cascade Impactor Technologies

Research Personnel

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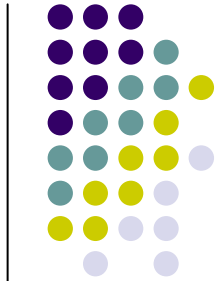
Objectives:

- Measure and account for atmospheric particulate emissions from field operations
  - Characterize chemistry and size distribution of particulate emissions
  - Quantify the particulate emissions
  - Relate the wind and turbulence flow field to the amounts, movements and dispositions of particle emissions.

General Methods



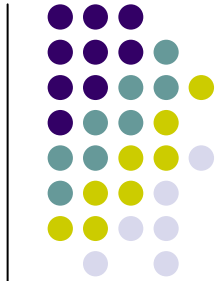
- Measure particle size distributions and chemical makeup of the emissions with low pressure cascade impactors
- Measure the amount, movement and disposition of the particles emitted with elastic-backscatter LIDAR
- Measure and characterize the wind and turbulence fields with fast response sonic anemometers and thermal sensors

Field Operations

To Date:

- Field preparation and planting of :
  - Silage Corn in Connecticut
  - Irrigated Cotton in New Mexico
- Left to do:
  - Harvest in Connecticut
  - Harvest in New Mexico

Measurements to date



- Emissions from Cotton fields in NM in the 2005 growing season
  - Plowing
  - Crushing
  - Disking
  - Leveling
  - Listing
  - Planting

Dust from Leveling Operation Lofting into Atmospheric Boundary Layer, Rio Grande Valley NM, April 2005

UCONN Elastic Backscatter Aerosol Lidar

LIDAR Trailer

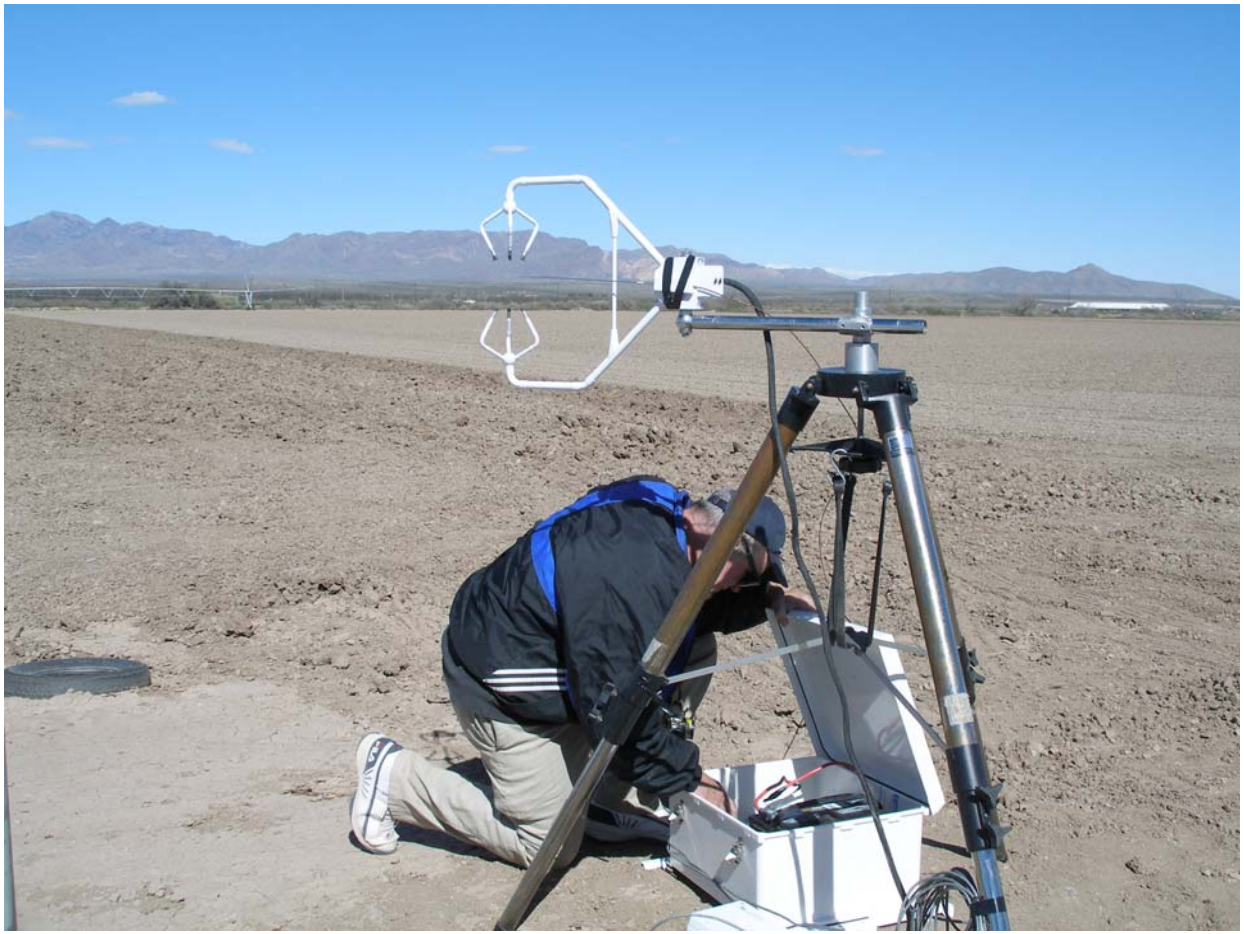
Samplers, generator and exhaust pipe on sampler tractor

PM 2.5, PM 10, TSP samplers

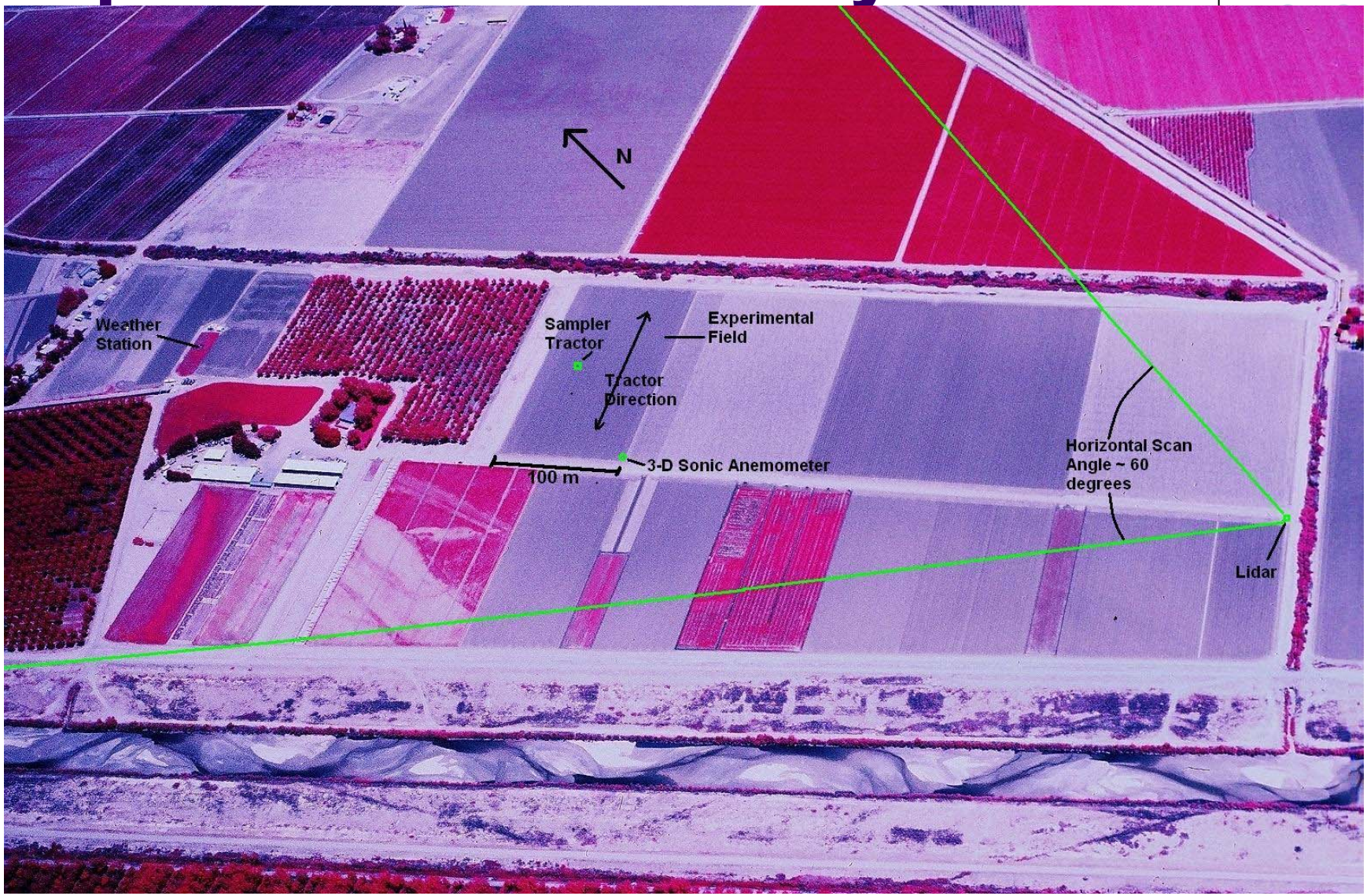
MOUDI Cascade Impactor

Disk Operation

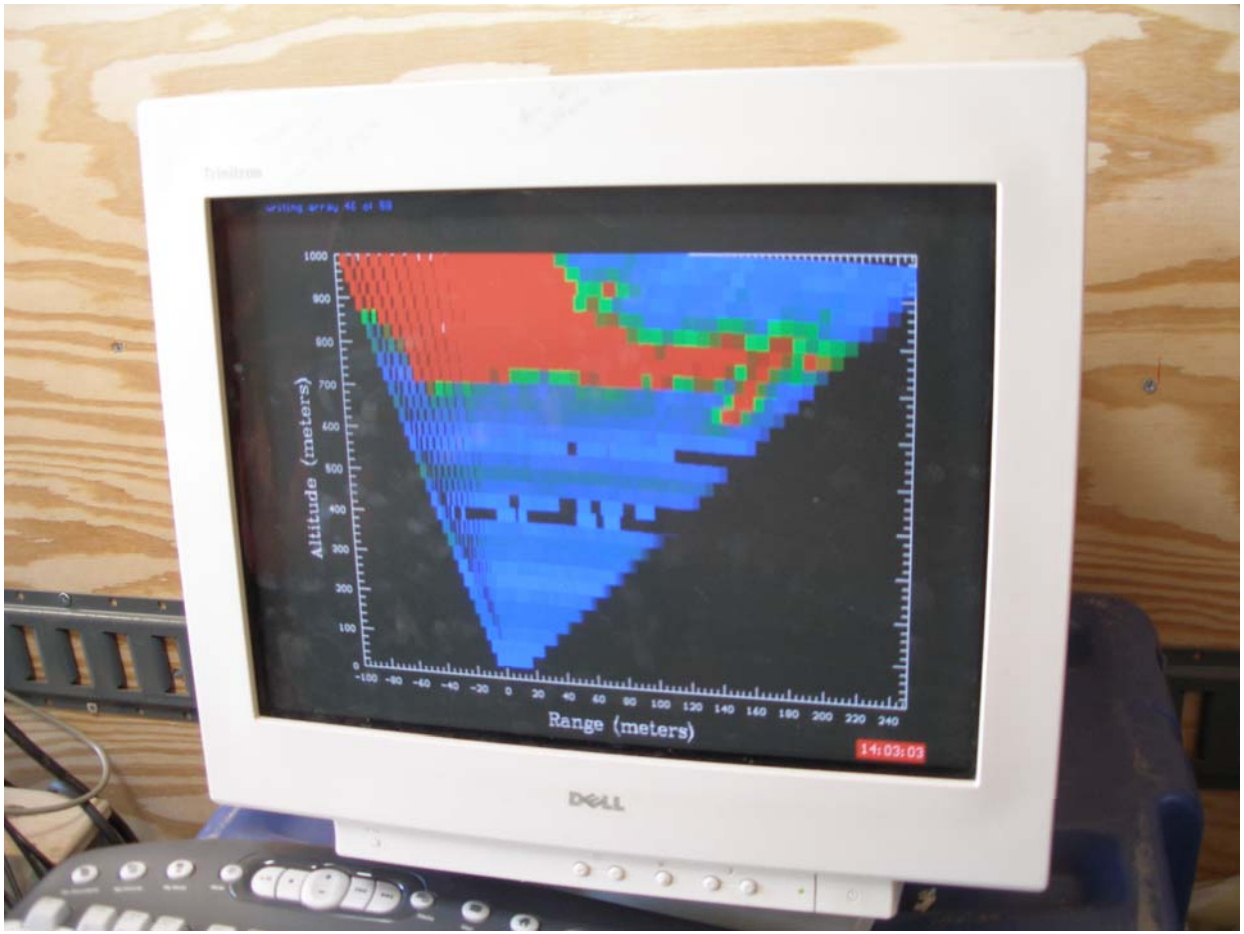
CSAT Sonic Anemometer



NMSU Leyendecker Experimental Farm Layout



Lidar Real Time Scan Display: Elevation 0.5 degrees ~ 3 m



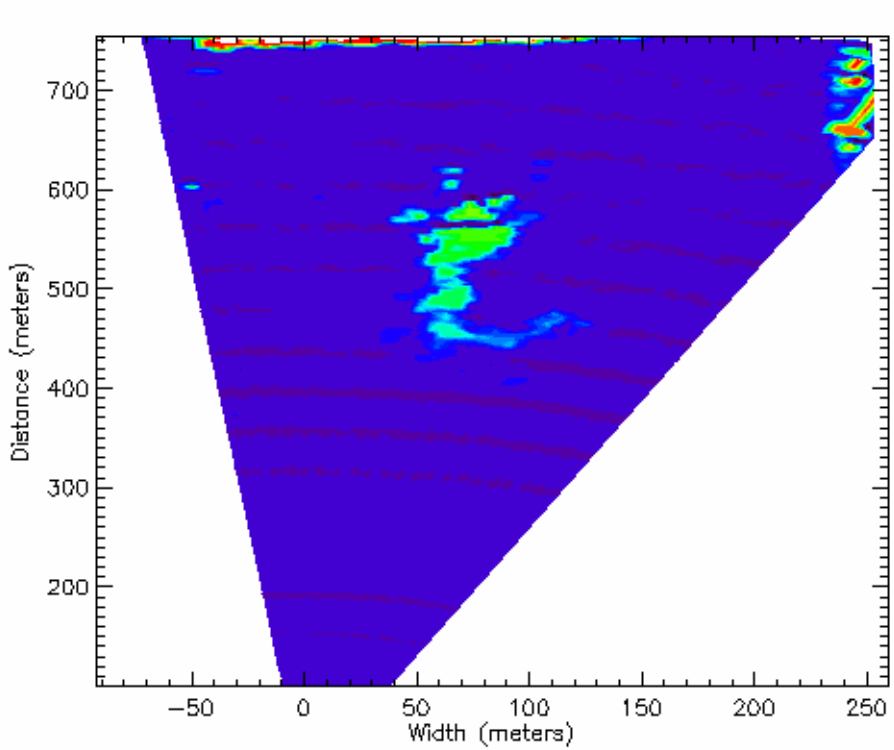
Dust Cloud on Real Time Display

Post Process Scans

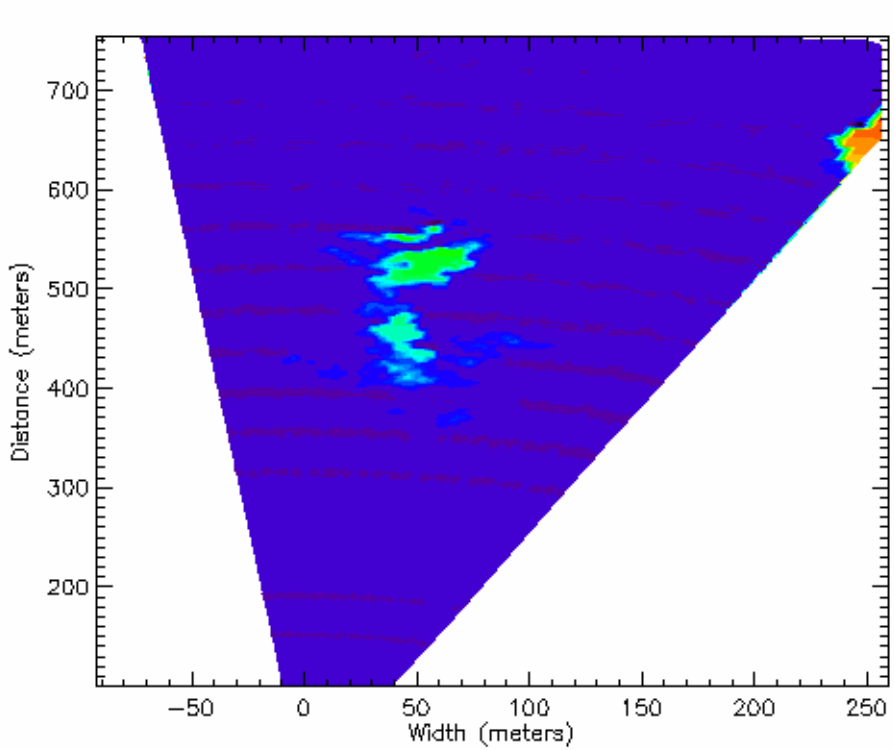
- Example series of horizontal slices through a single dust cloud from disking operation 3/31/05

First (lowest) slice is 3 m above ground (z).
Highest slice is 30 m above ground

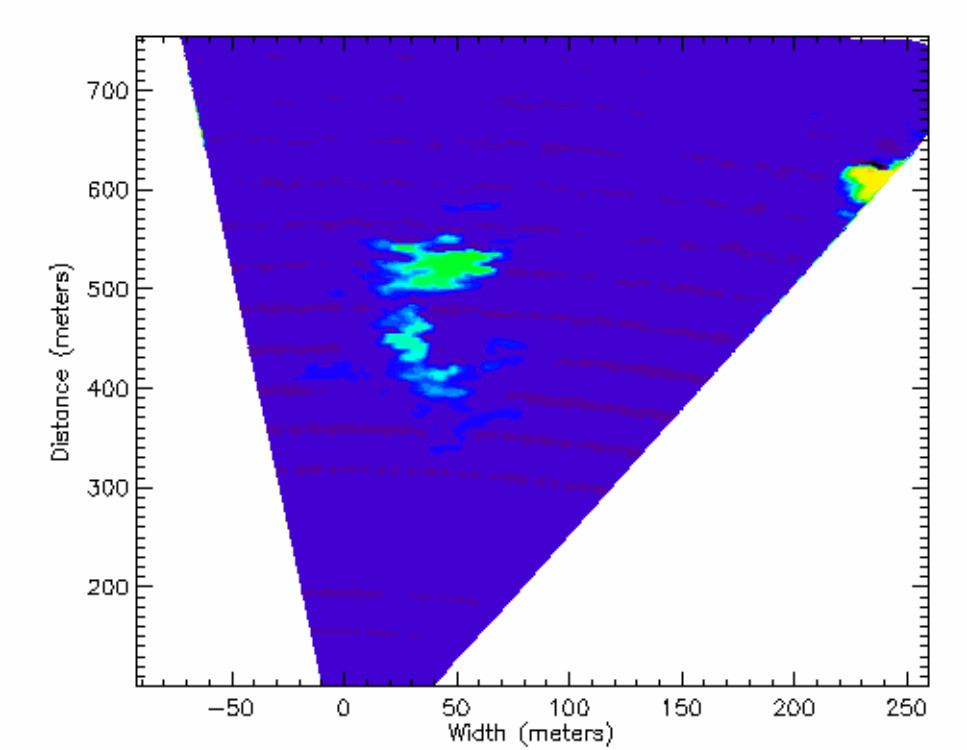
Slice through Dust Cloud at z=3m



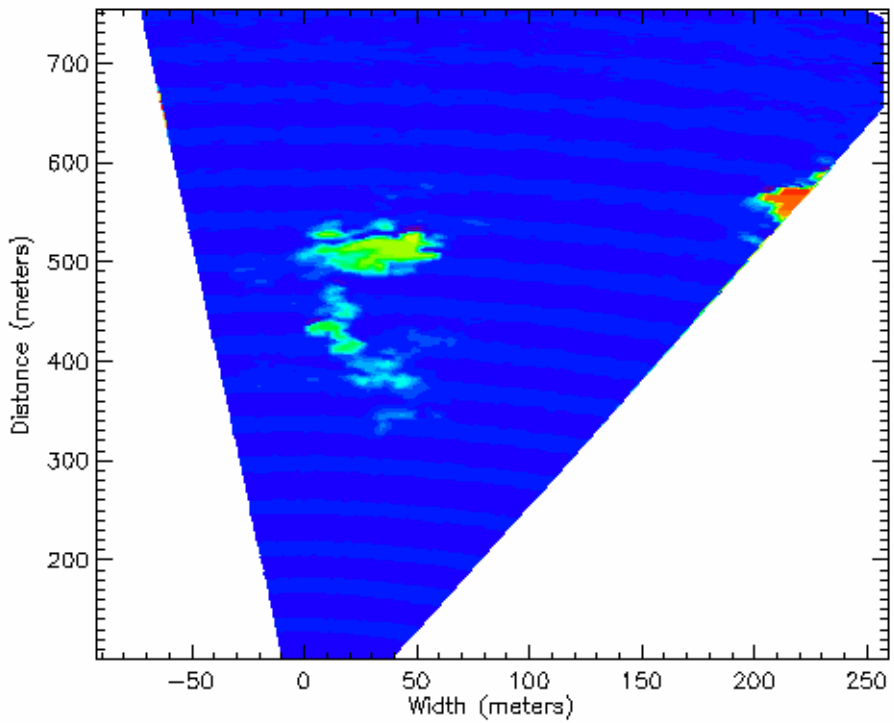
Slice through Dust Cloud at z=6 m. Note Dust Devil appearing at Upper Right Hand Edge of Scan



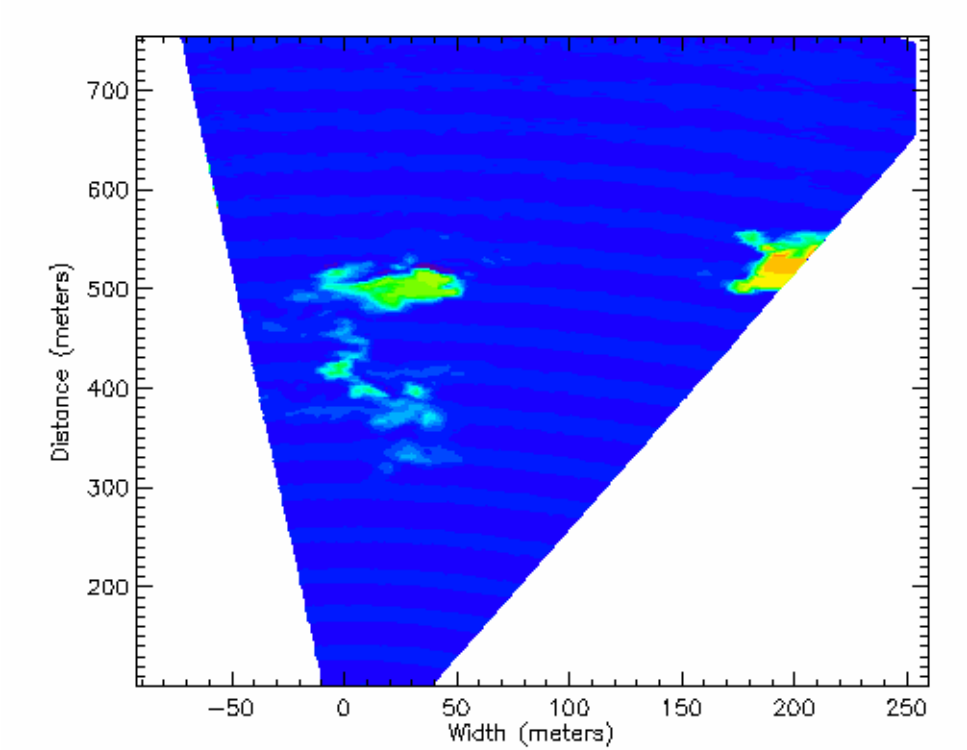
Slice at z=9m


700
600
500
400
300
200
Distance (meters)
−50
0
50
100
150
200
250
Width (meters)

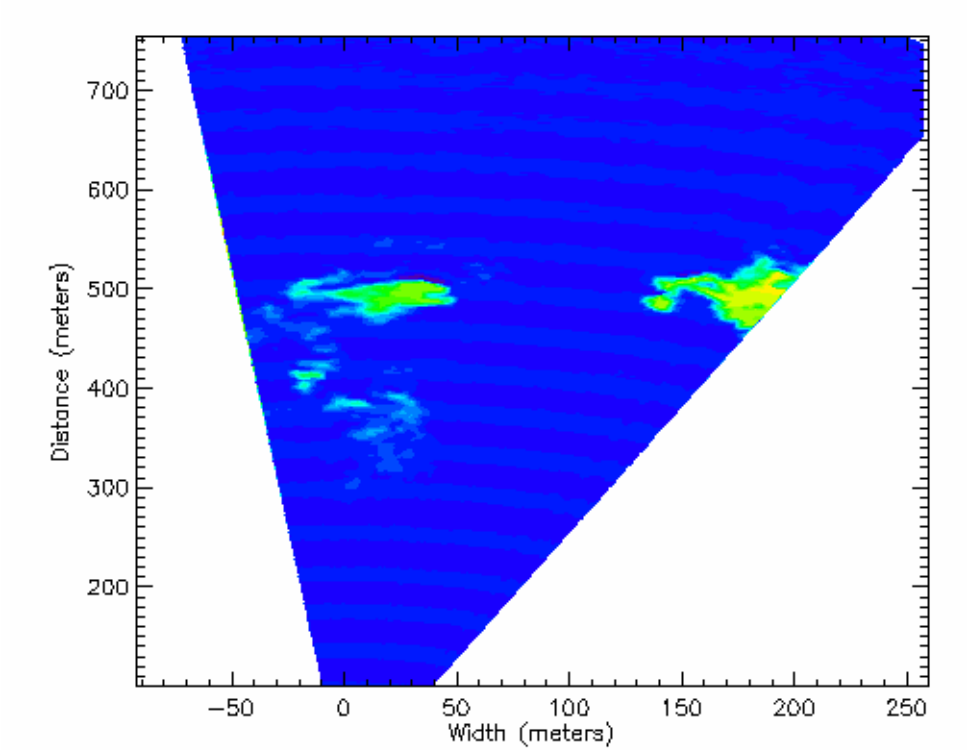
Slice at z=12 m



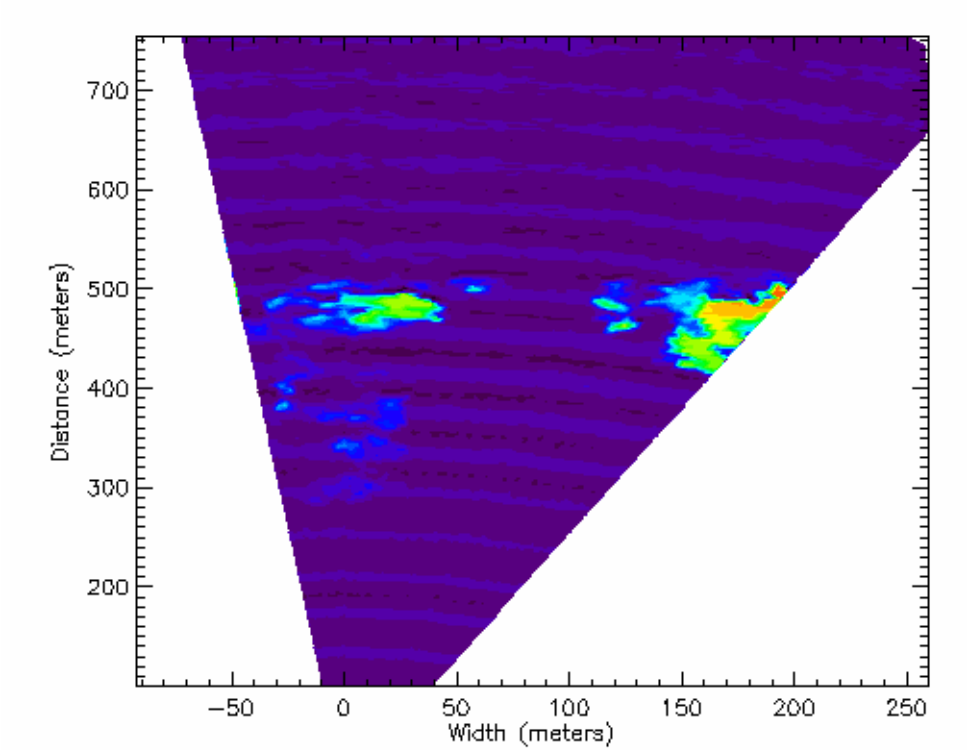
Slice at z = 14 m



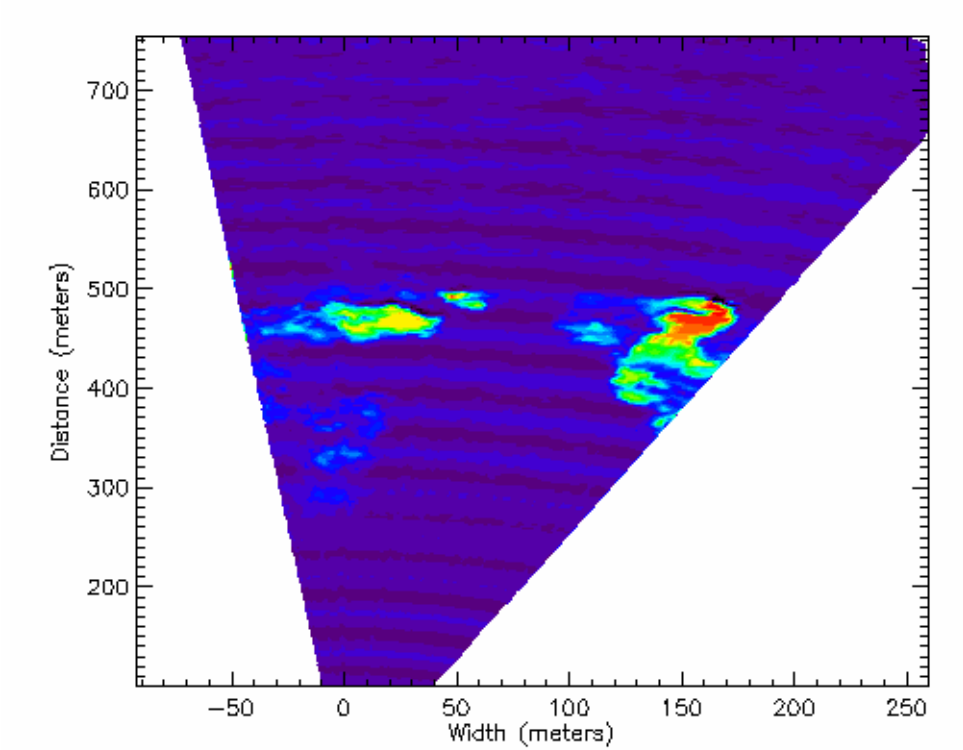
Slice at z = 18 m



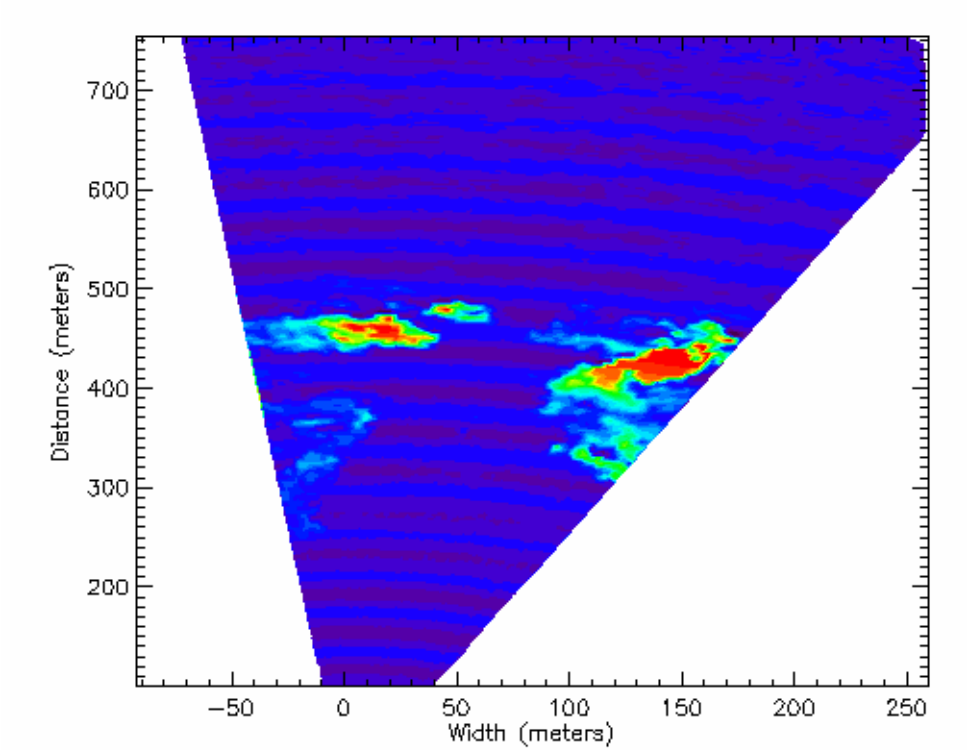
Slice at z = 24m



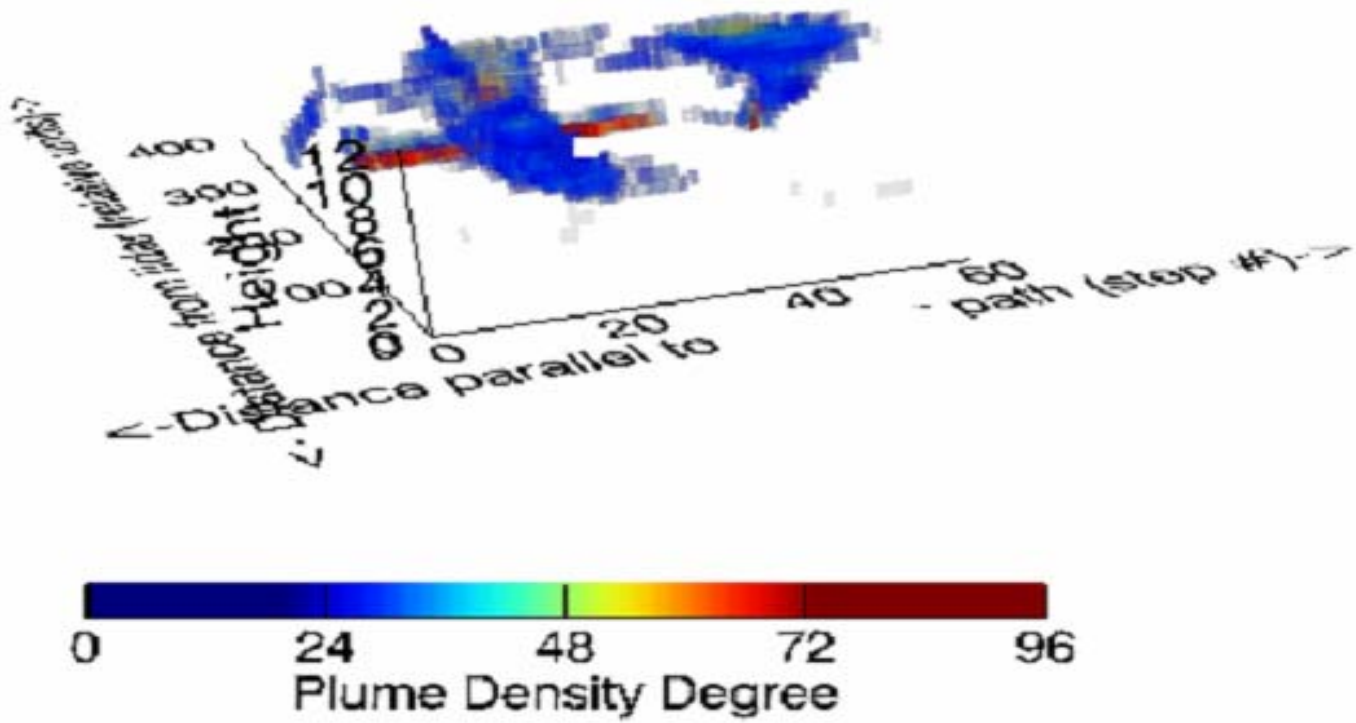
Slice at z = 27 m



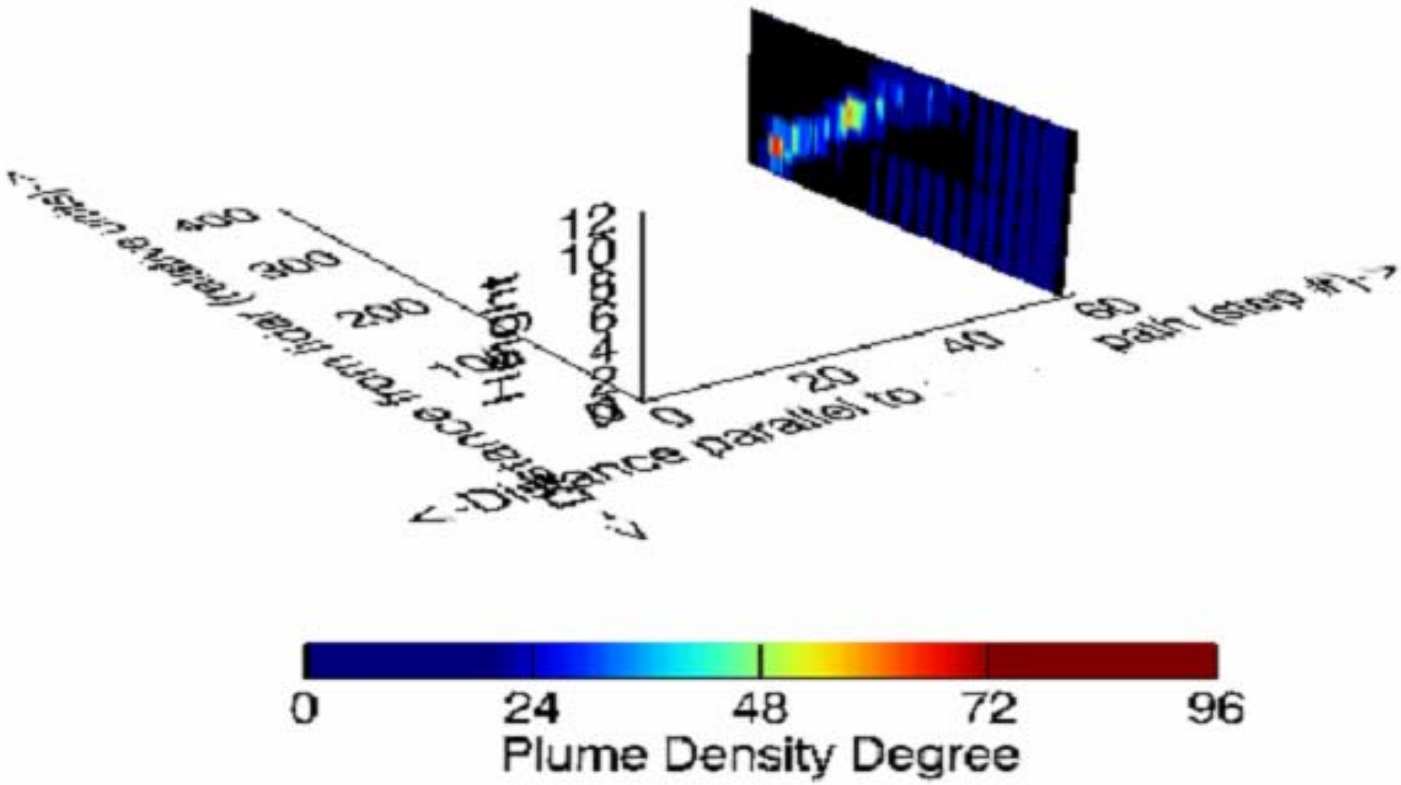
Slice at z = 30 m



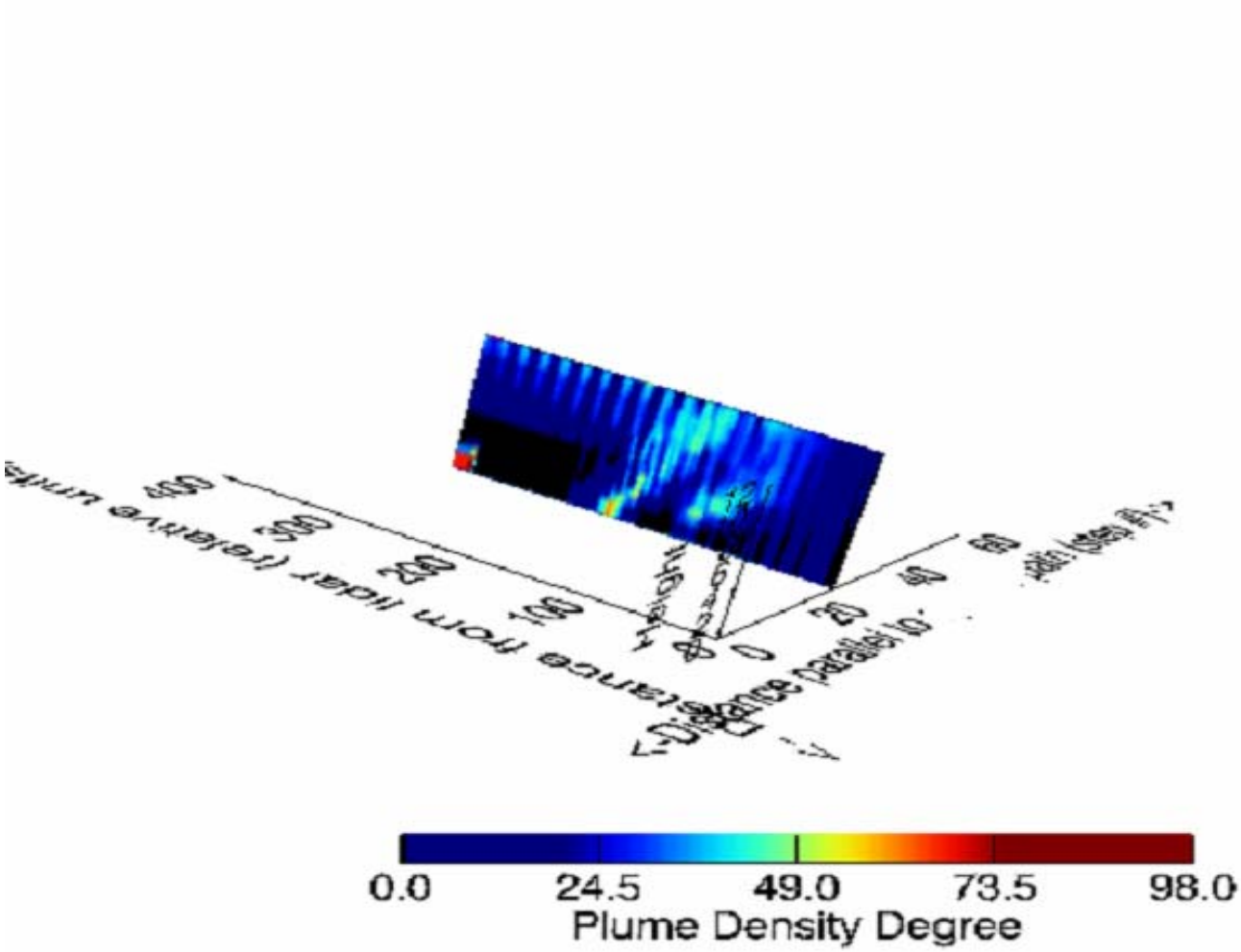
Tractor Dust (left) and Dust Devil (right)



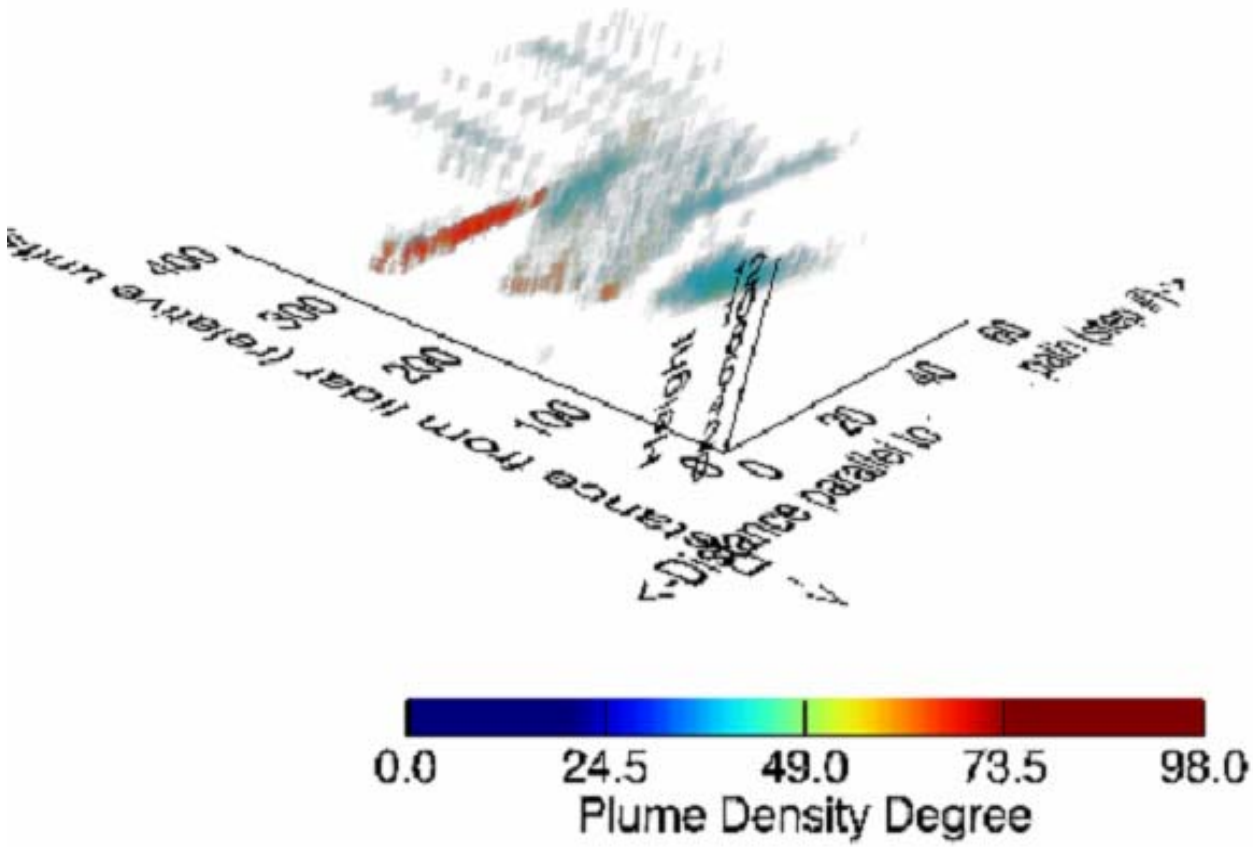
Dust Devil Slice



Pesticide spray from adjacent field – located at the lower right in slice



Dust and spray volumes



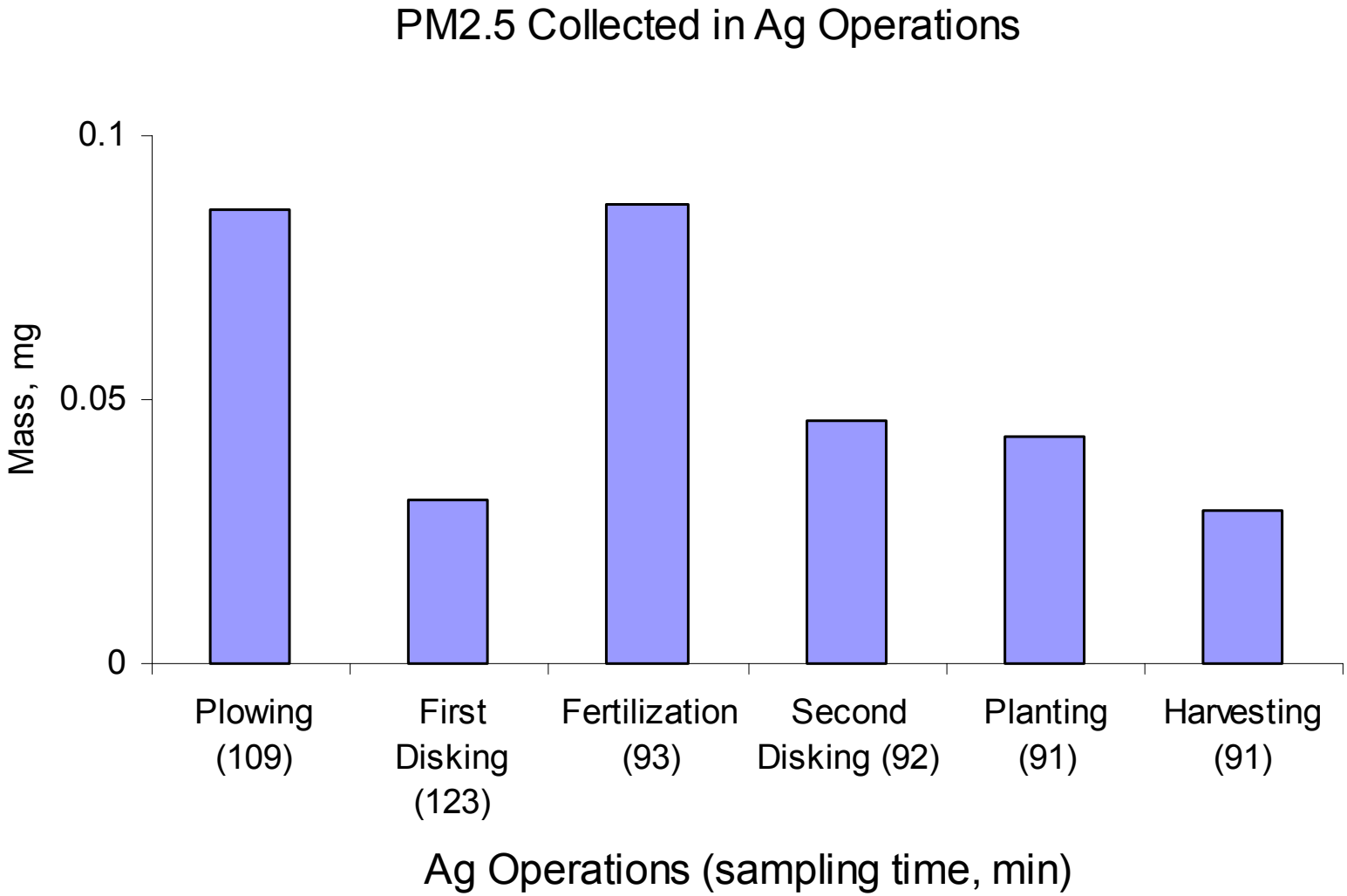
Measurements to Date

- Corn Silage operation in Connecticut
  - Plowing
  - Disking
  - Fertilizing
  - Disking
  - Planting
  - Harvesting (sampling only)

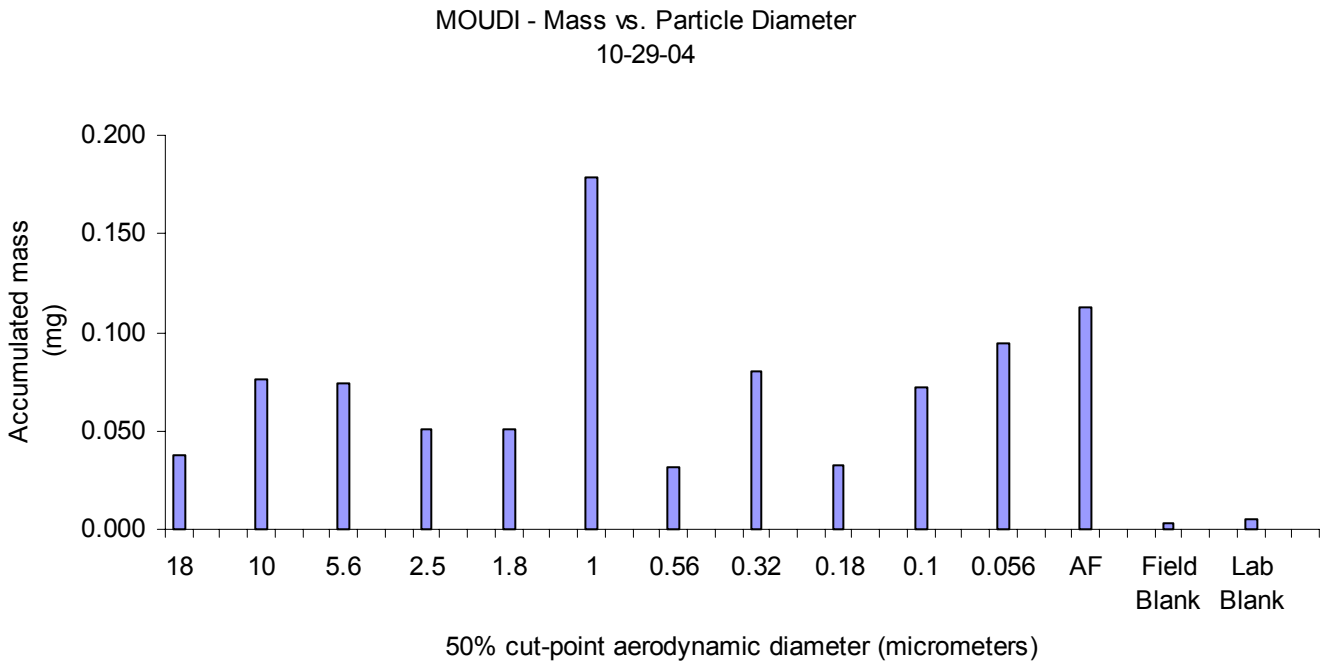
Corn field before harvest

Corn Harvest

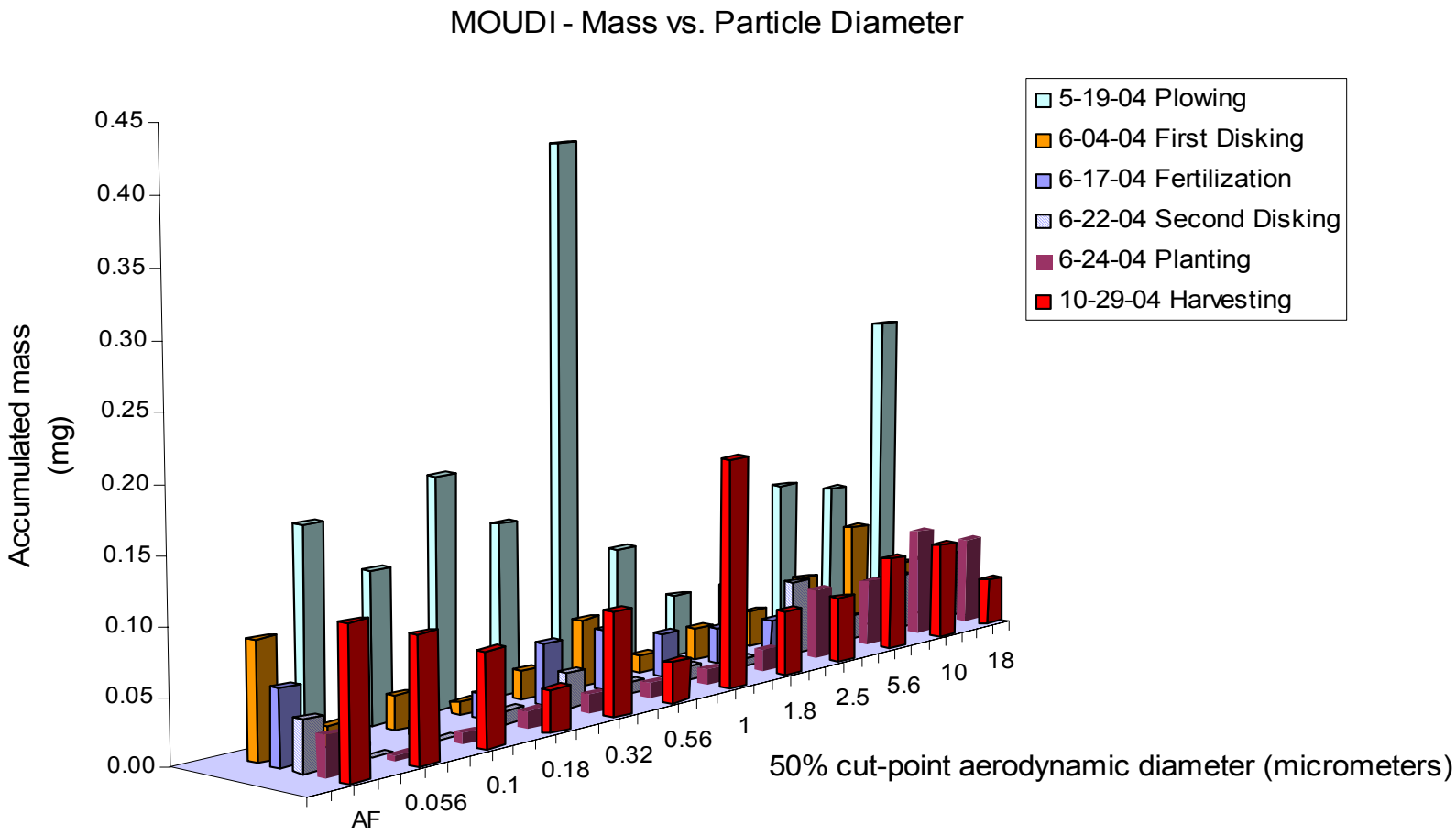
PM 2.5 Collected in Silage Operations



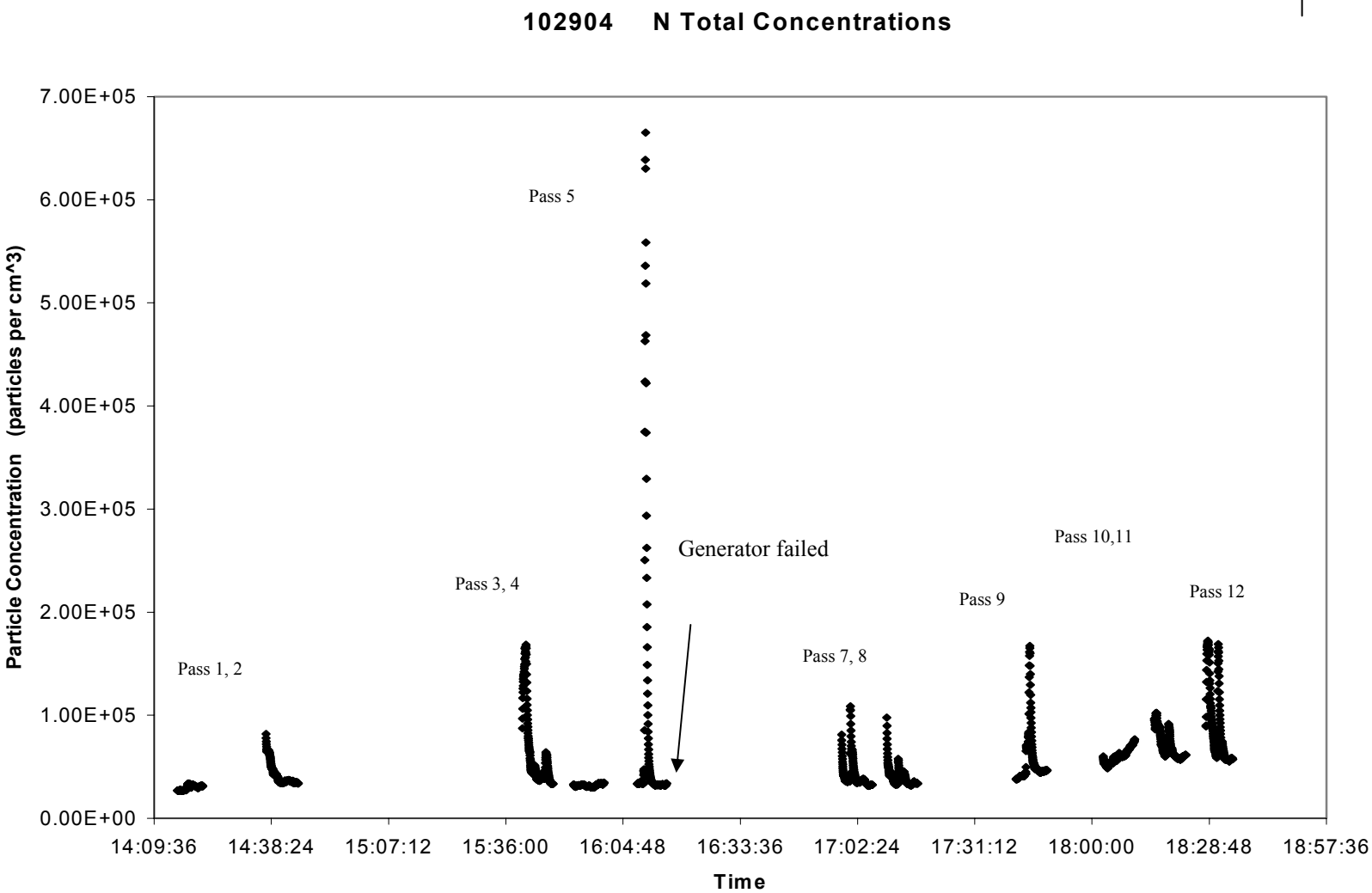
Mass-Particle Size Distribution from Harvesting



Mass Particle Size Distribution for Corn Silage Operations



ELPI Particle Concentrations Silage Corn Harvest



Particle Number Change as Tractor Passes. Corn Harvest