Concentration, Size Distributions, and Transport of Agricultural Aerosols

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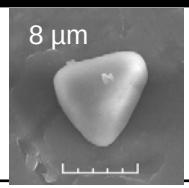
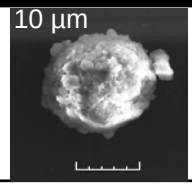
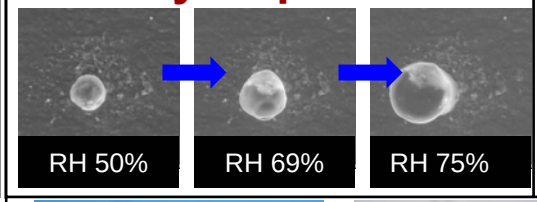
Characterization of “Agricultural Aerosol”

Aerosol Source: 45,000 head open-air CAFO in Texas

	Smooth-Rounded	Amorphous
Surface Shape (Size range 1 to 20 µm)		
Population	**8%**	**92%**
Elemental Composition	**Carbon >65%** **Potassium ~20%**	**Carbon >90%**
Hygroscopicity	**Hydrophilic** 	**Less Hygroscopic** (Growth Factor @ RH 90% ~1)
Extinction Efficiency (m^2g^{-1})	 	**0.4-0.8** Soot=10 Nitrates/Sulfates=3

Auvermann et al. (2006), Hiranuma et al. (2008) and Upadhyay et al. (2008)

Objectives & Motivations

1 To quantify atmospheric concentration of agricultural aerosols and its size distributions

Wet Condition

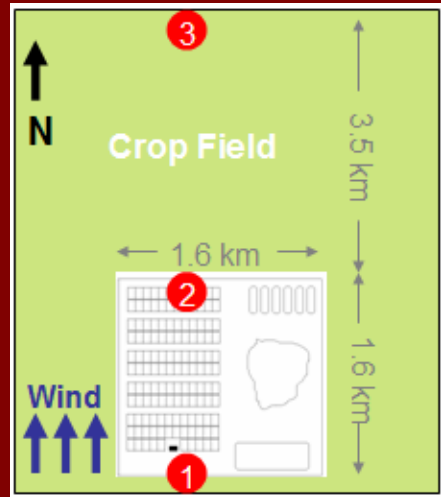
Dry-Dusty

2 To measure horizontal transport of agricultural aerosols

1. Upwind Site

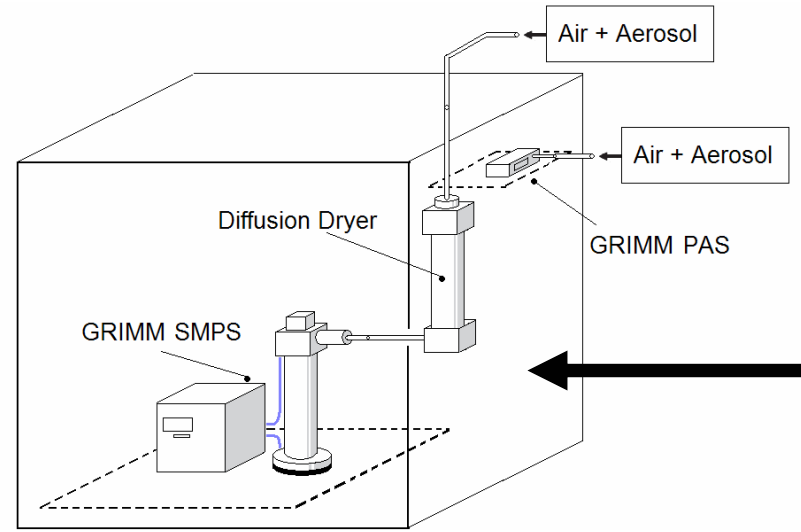
2. Downwind Site

3. Far-Field Site



Methods

Instruments



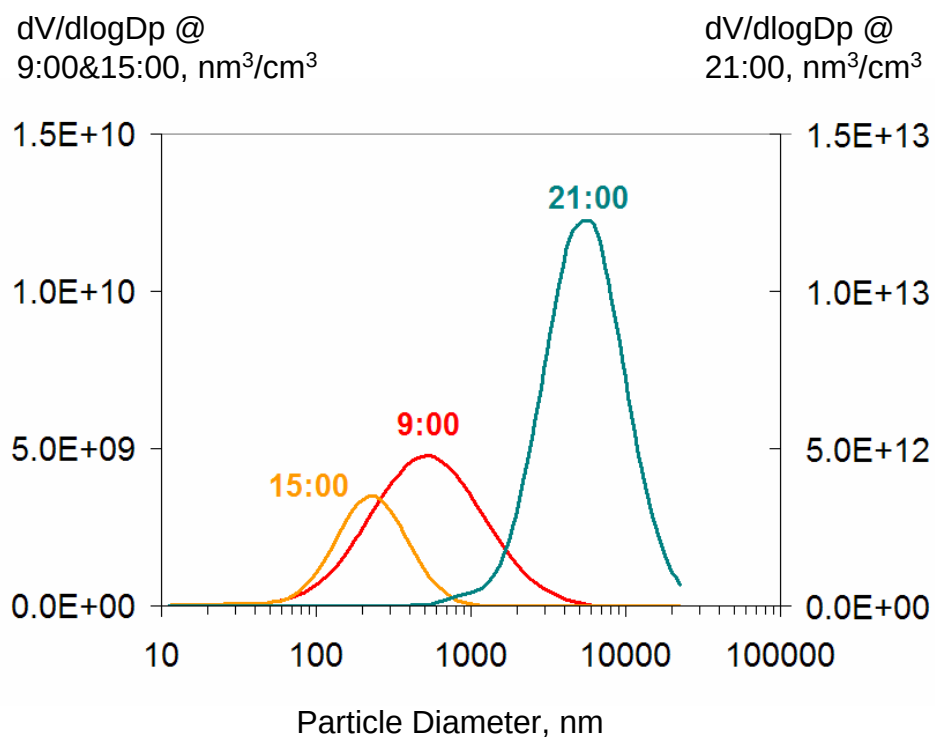
Aerosol Measurements + α

	Sequential Mobility Particle Sizer (SMPS)	Portable Aerosol Spectrometer (PAS)
Measurement Principal	Optical	Electrical Mobility
Size Range	11.1-521 nm	0.3 - 20 µm
Number of Channels	39	15

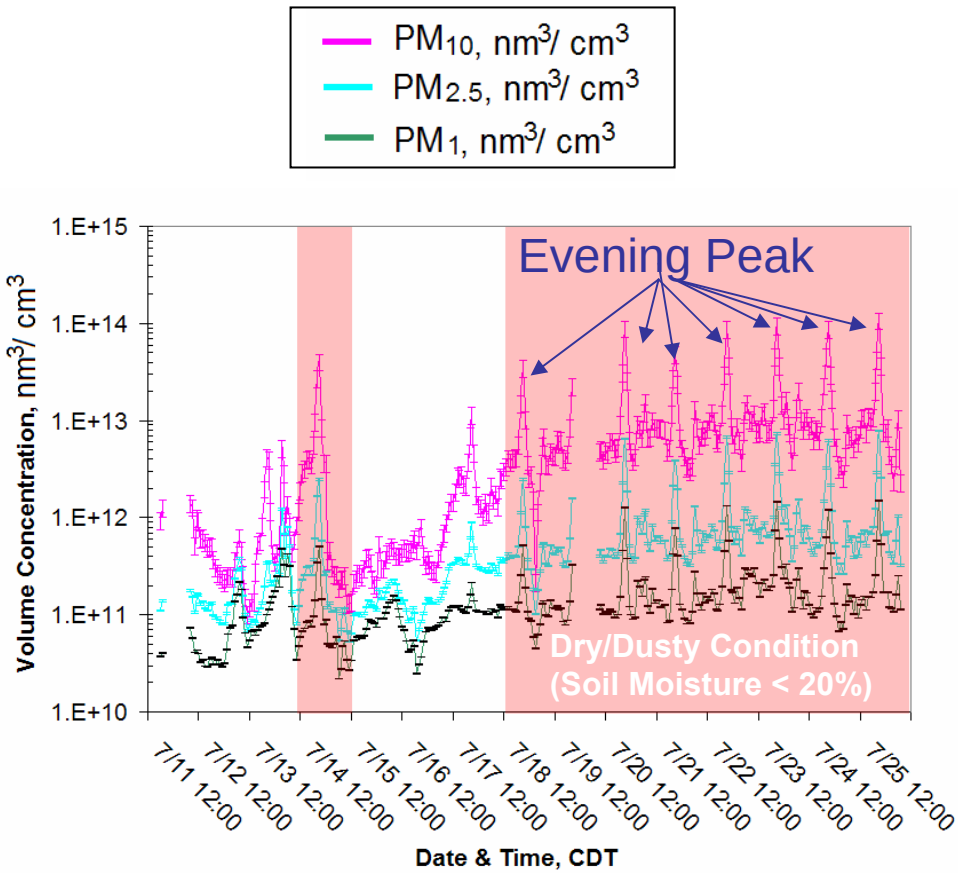
Results

Log-Normal Particle Size Distribution

Jul 25-2008

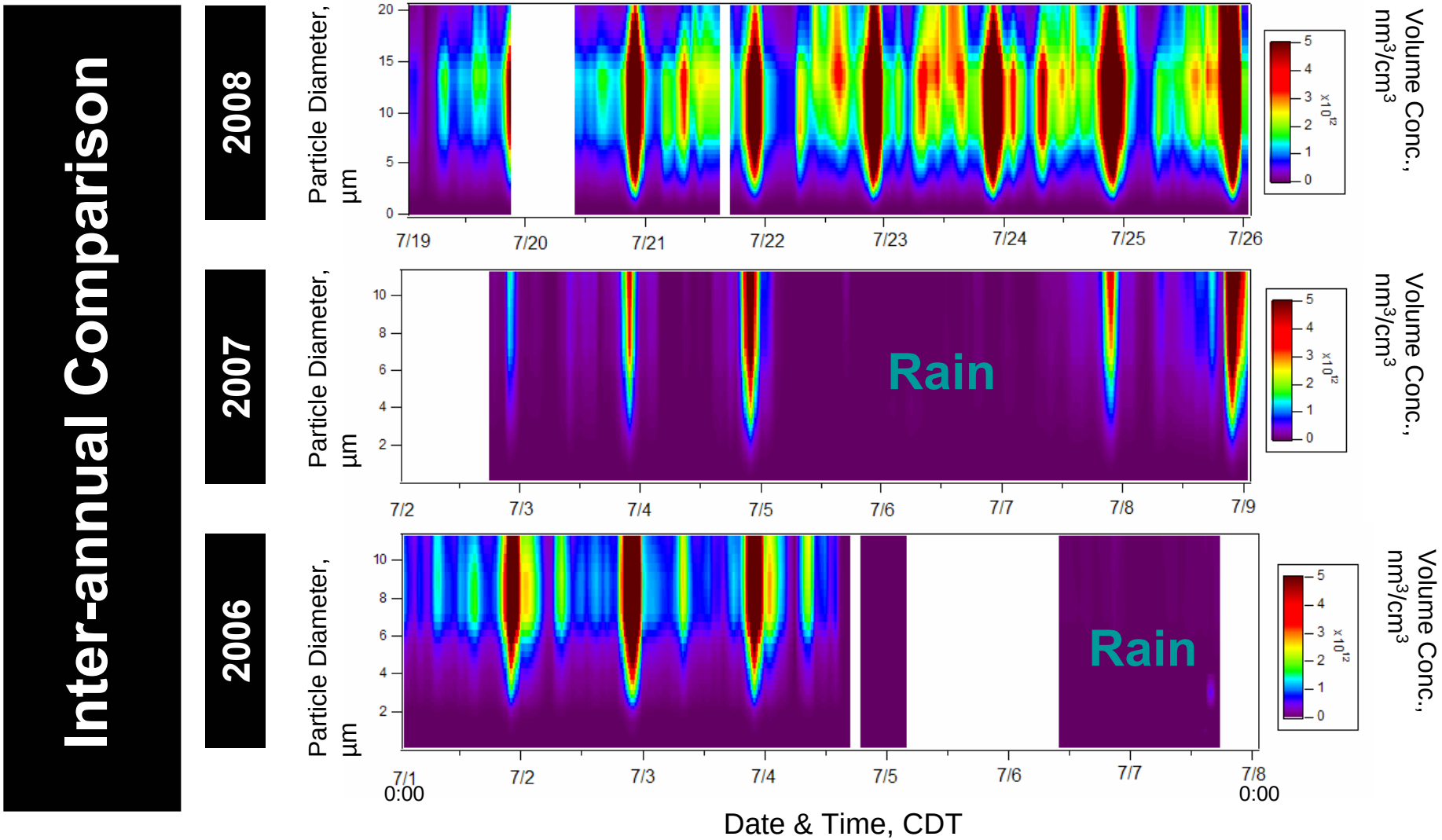


Aerosol Concentration in July 2008



PM_{10} >10^{13} nm^3/cm^3 (~21:00)
PM_{10} >2 x 10^{12} nm^3/cm^3 (~8:00)

Results

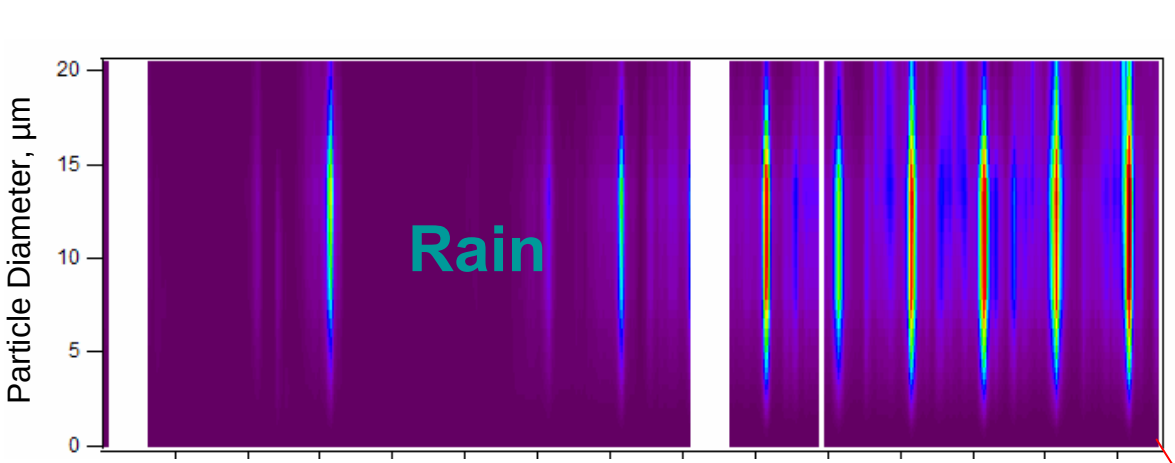

Inter-annual Comparison
2008
2007
2006
Particle Diameter, µm
Volume Conc., nm³/cm³
x10¹²
Rain
Rain
7/19
7/20
7/21
7/22
7/23
7/24
7/25
7/26
7/2
7/3
7/4
7/5
7/6
7/7
7/8
7/9
7/1 0:00
7/8 0:00
Date & Time, CDT

Results

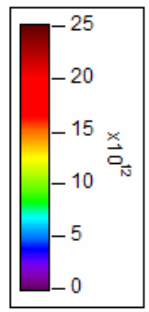
Location Comparison

2. Downwind

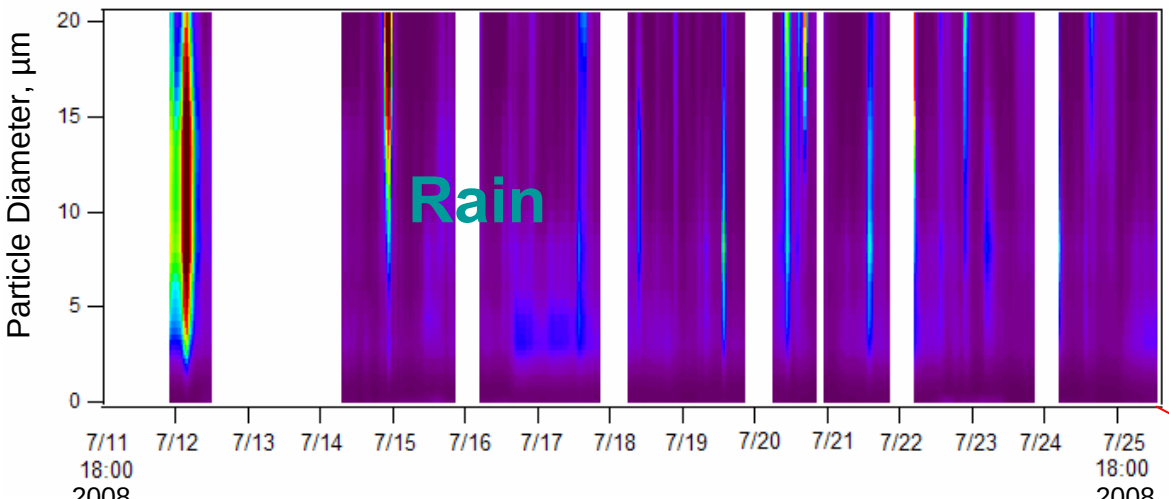
1. Upwind



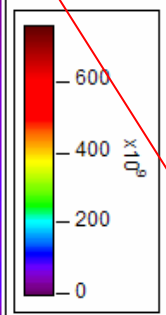
Volume Conc., nm^3/cm^3



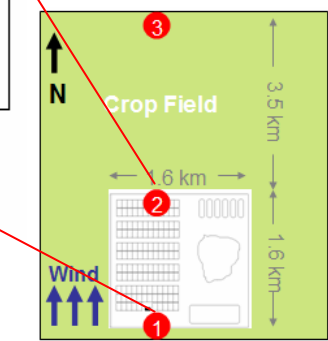
DW MAX: 2.5e+13



Volume Conc., nm^3/cm^3



UW MAX: 7.5e+11



Results

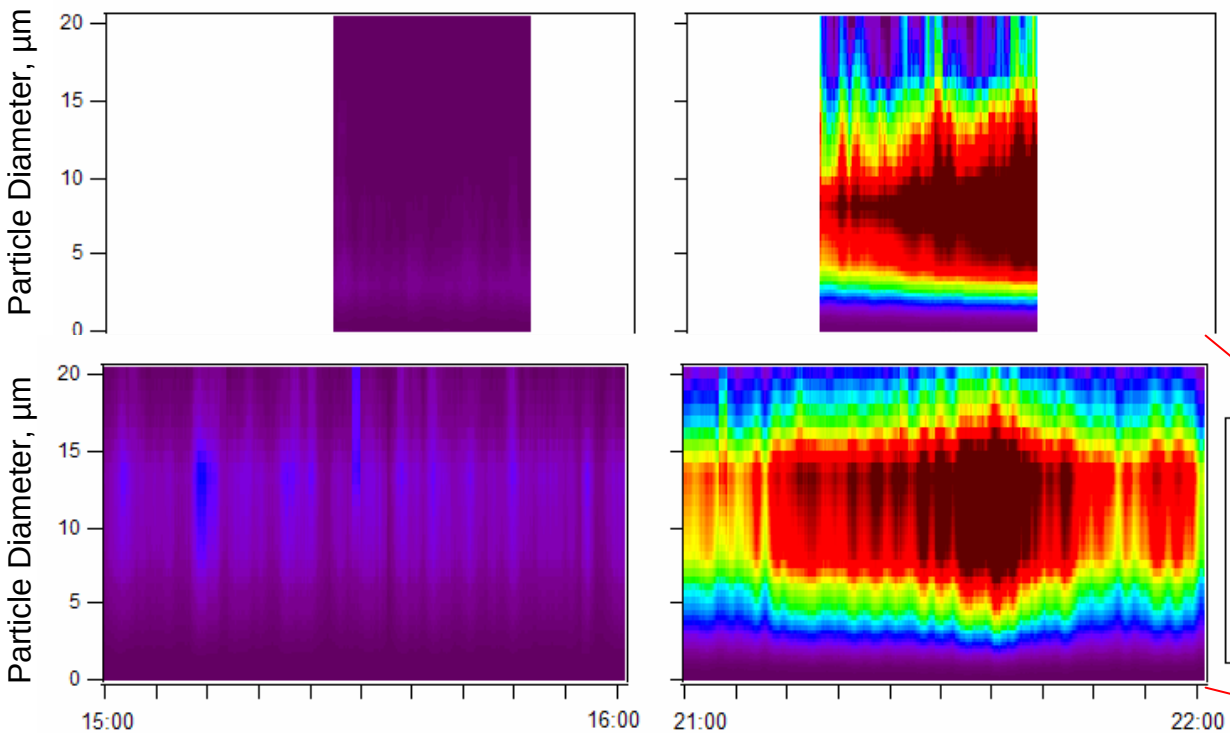
~5% of PM_{20} is transported for 3.5 km

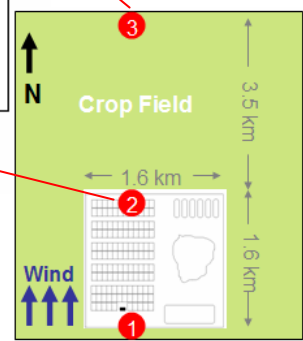
PM_1: R^2 = 0.83, $PM_{2.5}$: R^2 = 0.84, PM_{10}: R^2 = 0.9, PM_{20}: R^2 = 0.9

Location Comparison

3. Far-Field | **2. Downwind**

07-20-08 Afternoon | **07-20-08 Evening**



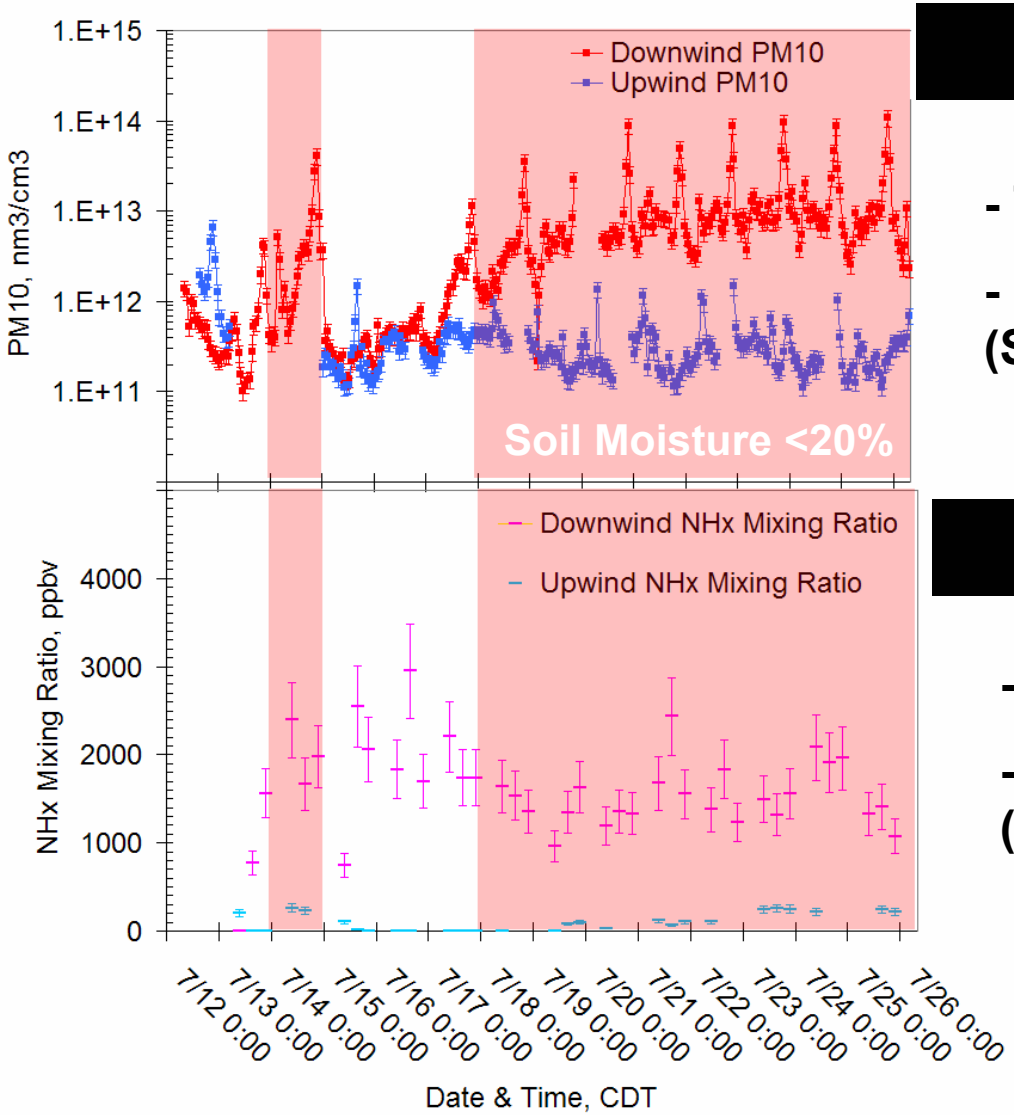


Conclusions

- **Concentration & Size Distributions**
  - Coarse particles > Fine particles (to volume concentration)
  - Daily evening peak (~21:00)
  - Variation with atmospheric conditions & locations
- **Open-Air Feedyard**
  - Time-specific source of agricultural aerosols
  - Aerosol emission max. under dry condition (soil moisture <20%)
- **Environmental/Atmospheric Implications**

  Is the water application via sprinkler system good mitigation strategy to reduce feedyard emissions?

Sprinkler System ?



Agricultural Aerosol

- **Time-specific emission**
- **Highest under dry condition (Soil Moisture <20%)**

Ammonia (>92% Gas Phase)

- **Consistent emission with variations**
- **Highest under wet condition (Soil Moisture >20%)**

Future Directions

- **Aerosol Dispersion Model**
  - Soil-ambient temperature gradient
  - Turbulence/upward shear
  - Boundary height
  - Upward diffusion/downward deposition
- **Detailed Chemical Analysis**
  - Raman Specro-Microscopy
- **Horizontal & Vertical Distribution of NH_3**
  - Details Available in Poster Session

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QUESTIONS?