Measurement of ambient aerosols in northern Mexico City by single particle mass spectrometry

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Overview

- Background on ATOFMS
  - On-line measurements of single particle size and chemistry at T0 (single particle mixing state vs. size)
    - Measured size and chemistry of 1.6 million single particles during MILAGRO
    - Soot, dust, OC, metals, sea salt
  - Optical properties as a function of size-resolved mixing state
- Results: Size-resolved number fractions of major PM sources
- Ultimate goal: Determine the impact of specific PM sources on climate forcing and cloud formation

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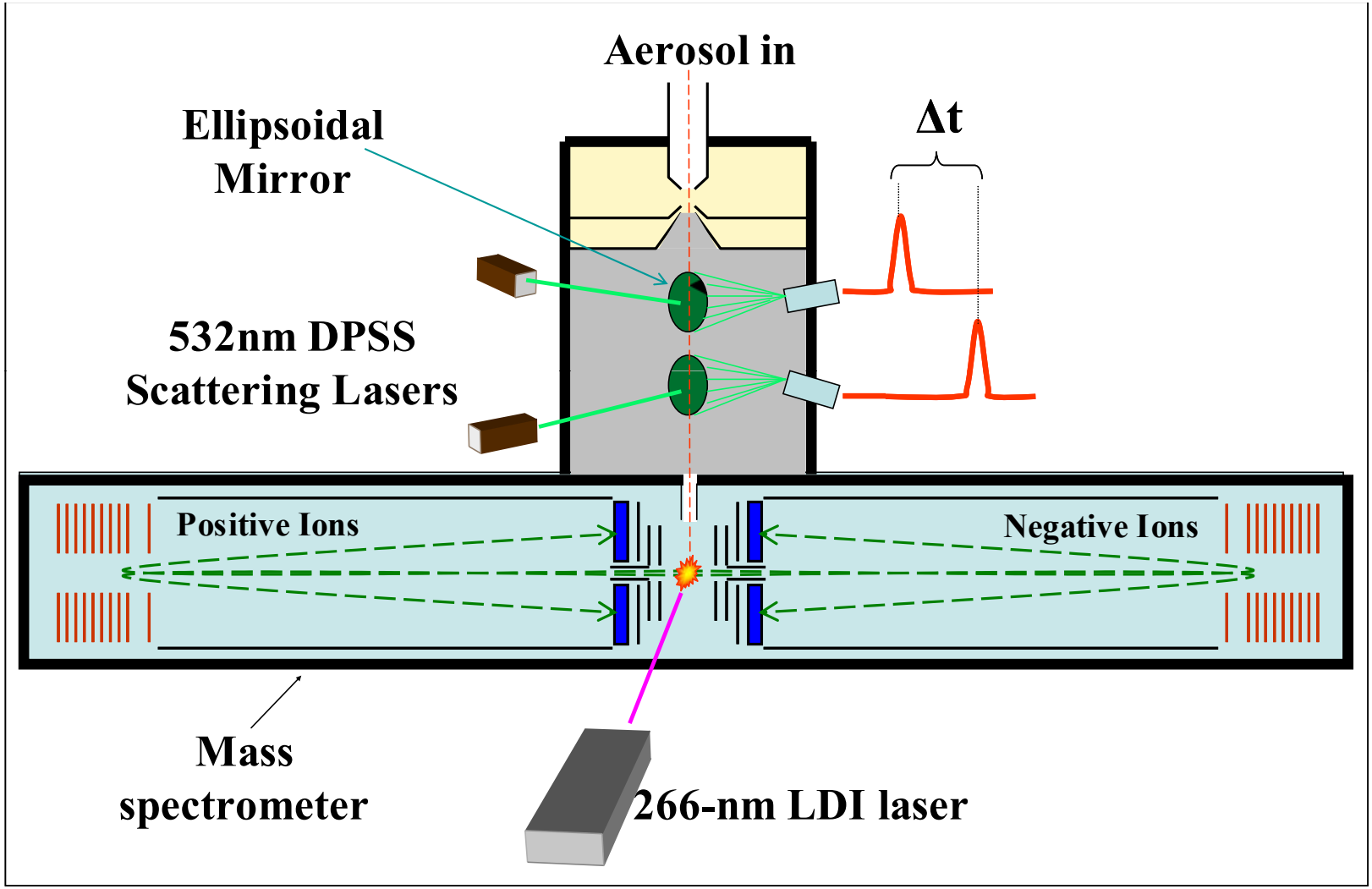
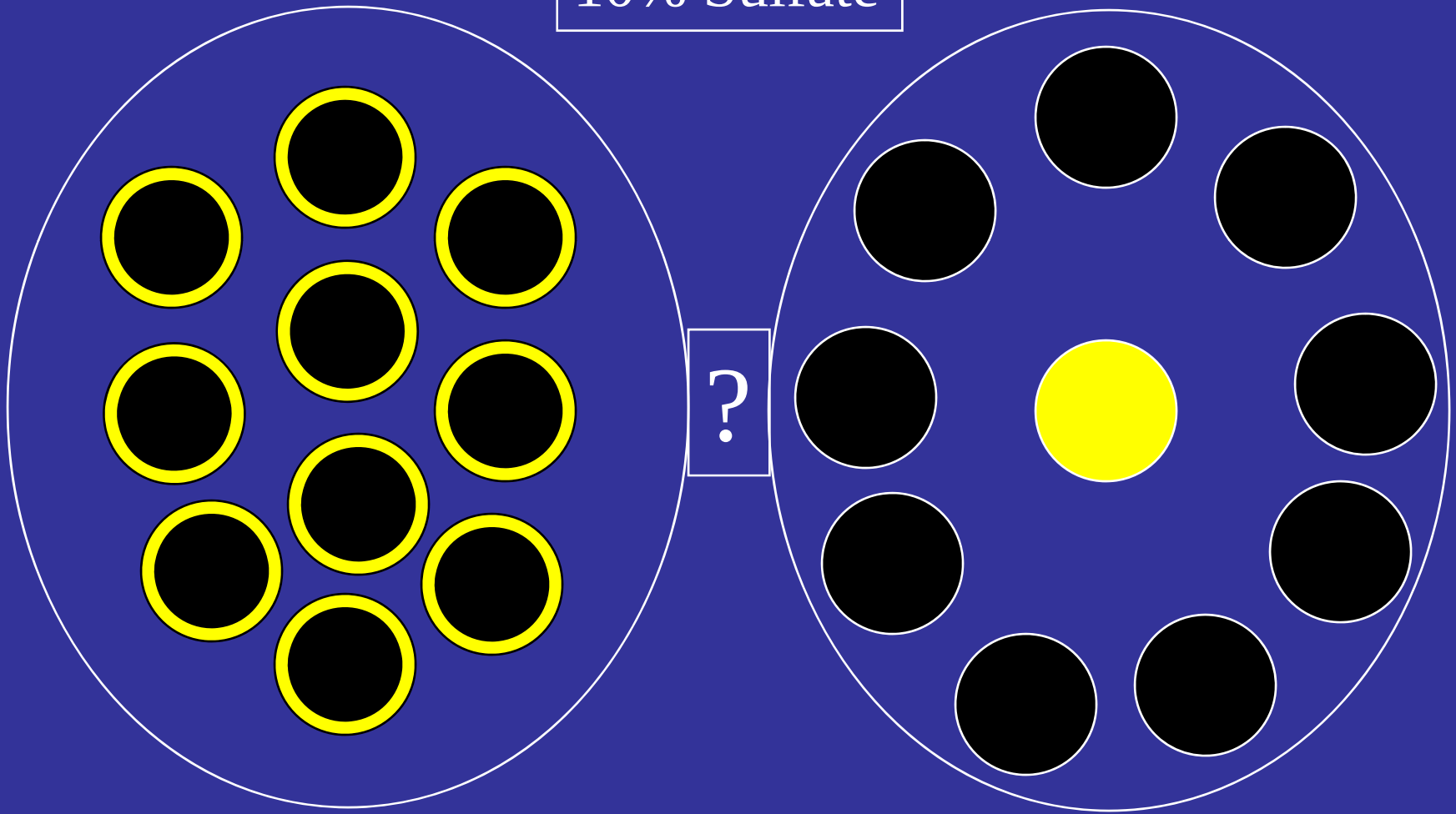
Aerosol Time-of-Flight Mass Spectrometer



Moffet, R. C. and K. A. Prather (2005). "Extending ATOFMS measurements to include refractive index and density." Analytical Chemistry **77**(20): 6535-6541.

Chemical Associations (Mixing State)

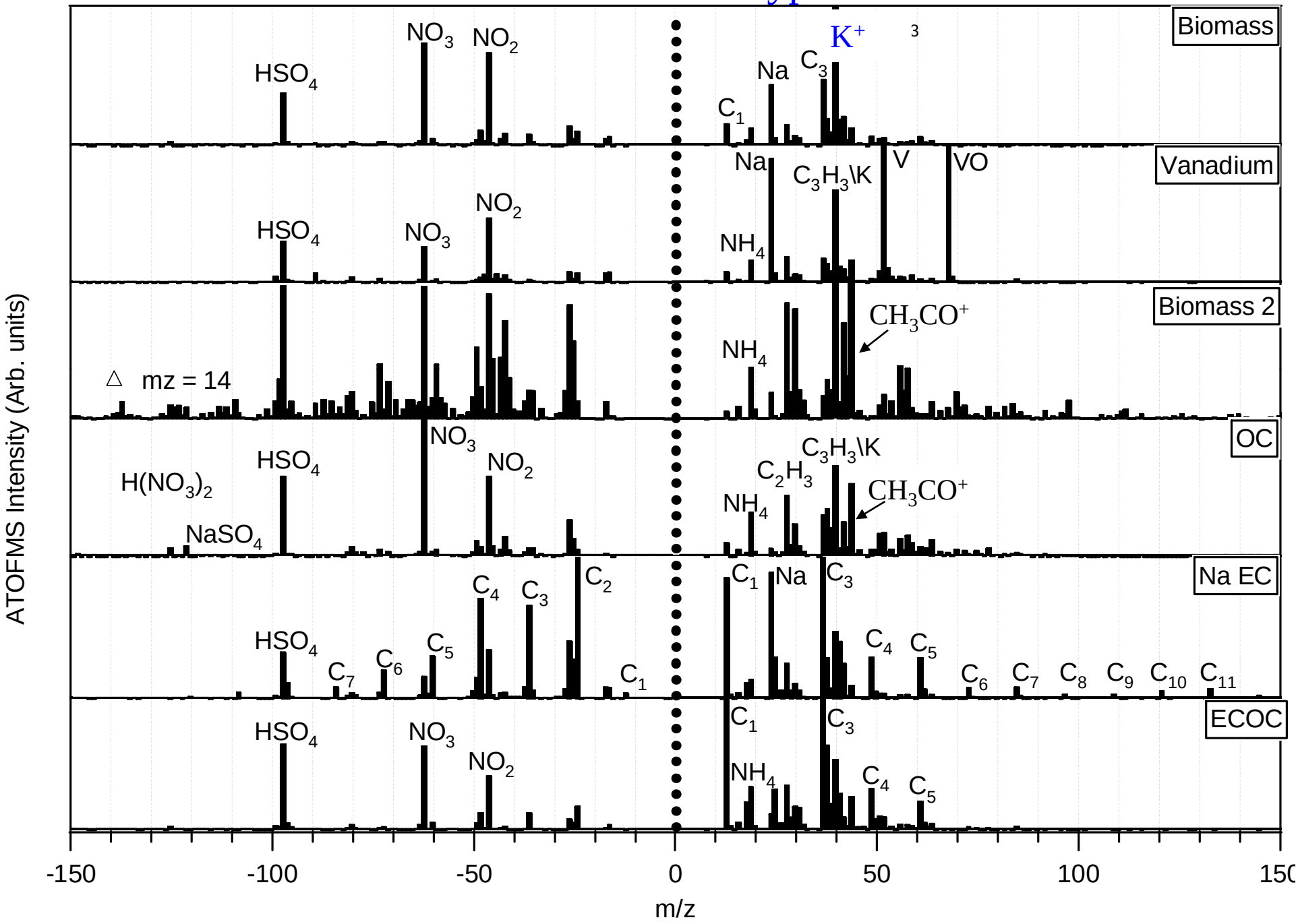
90% Soot
10% Sulfate



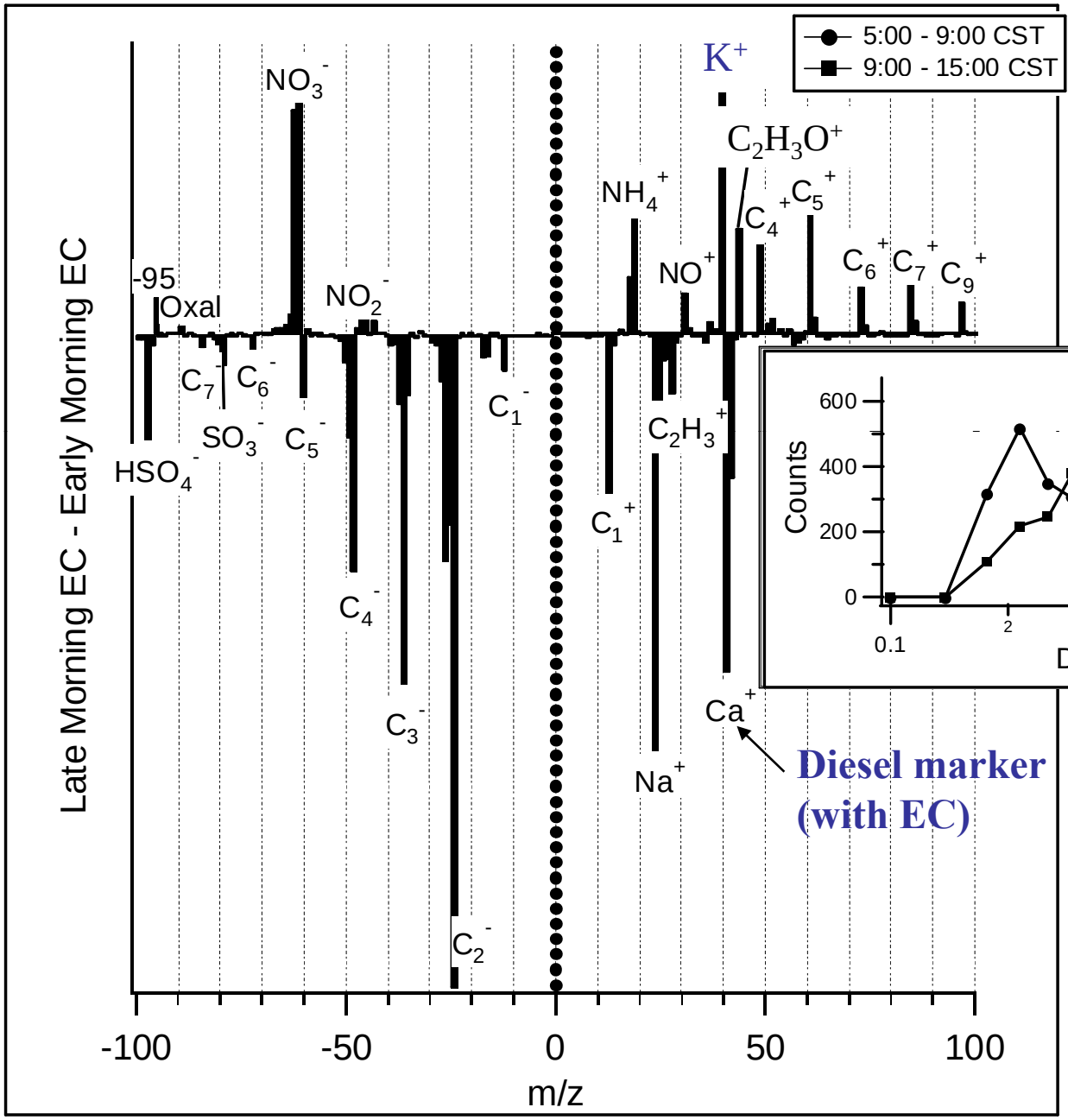
Sulfate ( )

Soot ( )

Sub-micron Particle Types



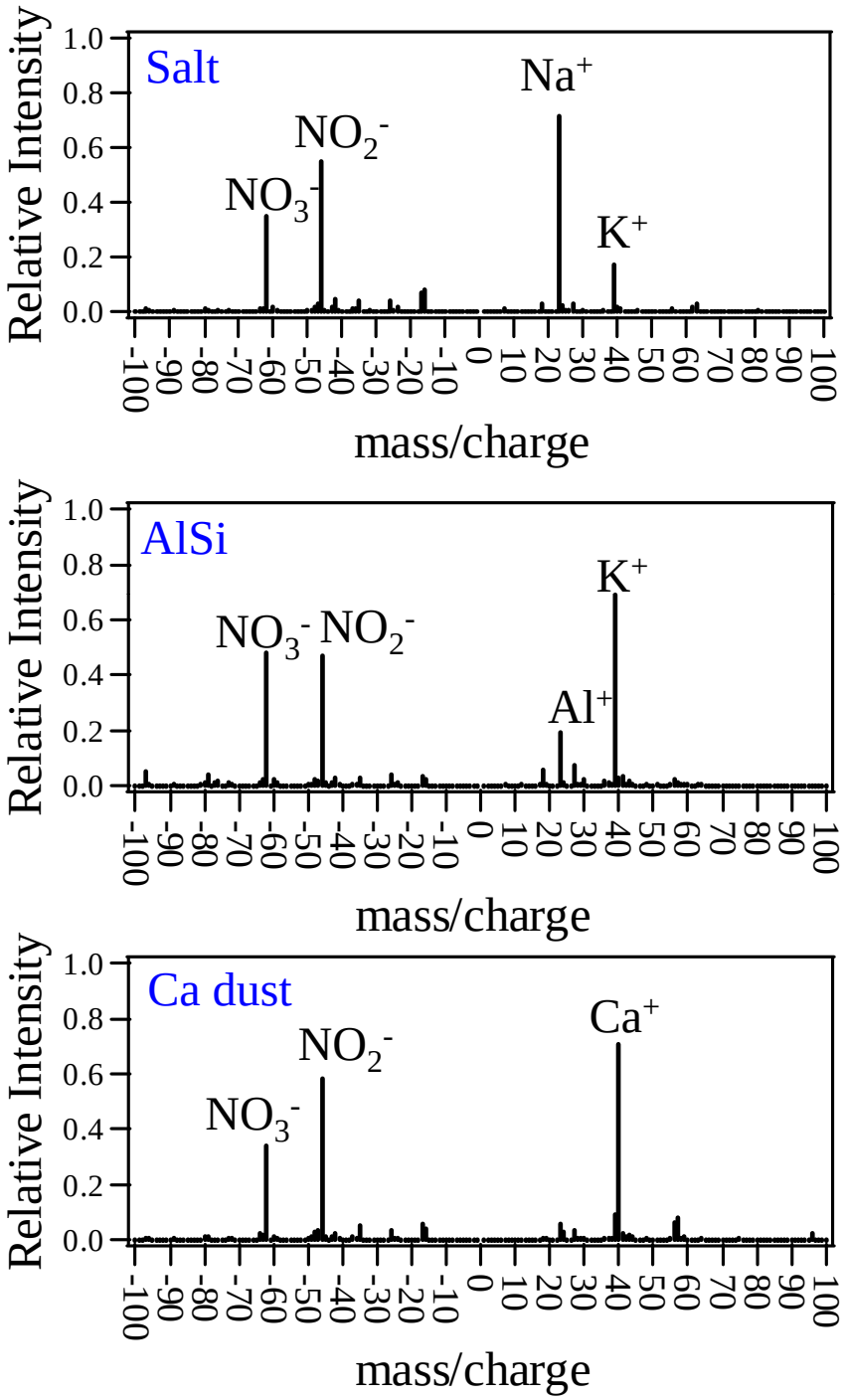
Temporal evolution of EC single particle signatures



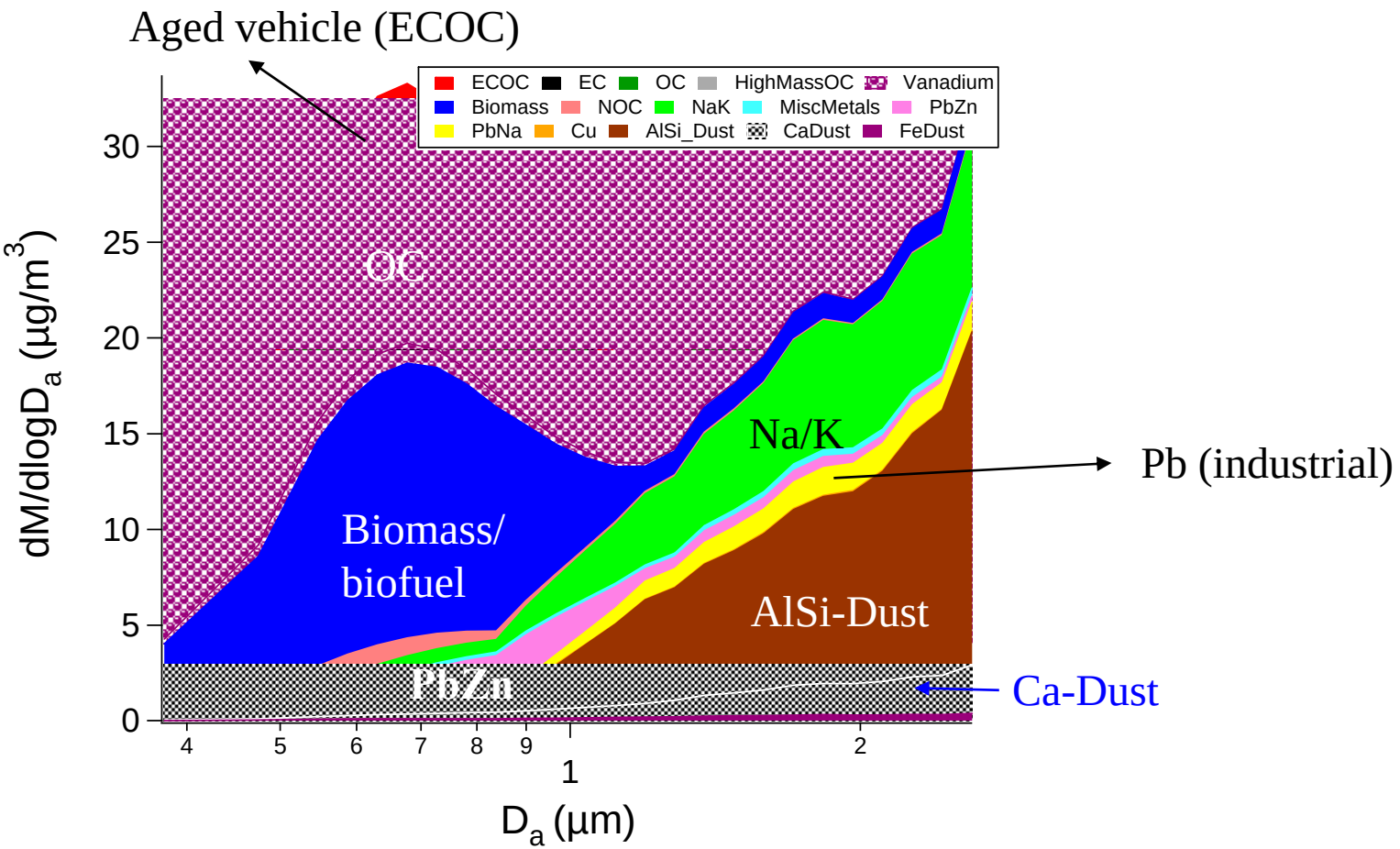
Late Morning
9:00-15:00 CST

Early Morning
5:00-9:00 CST

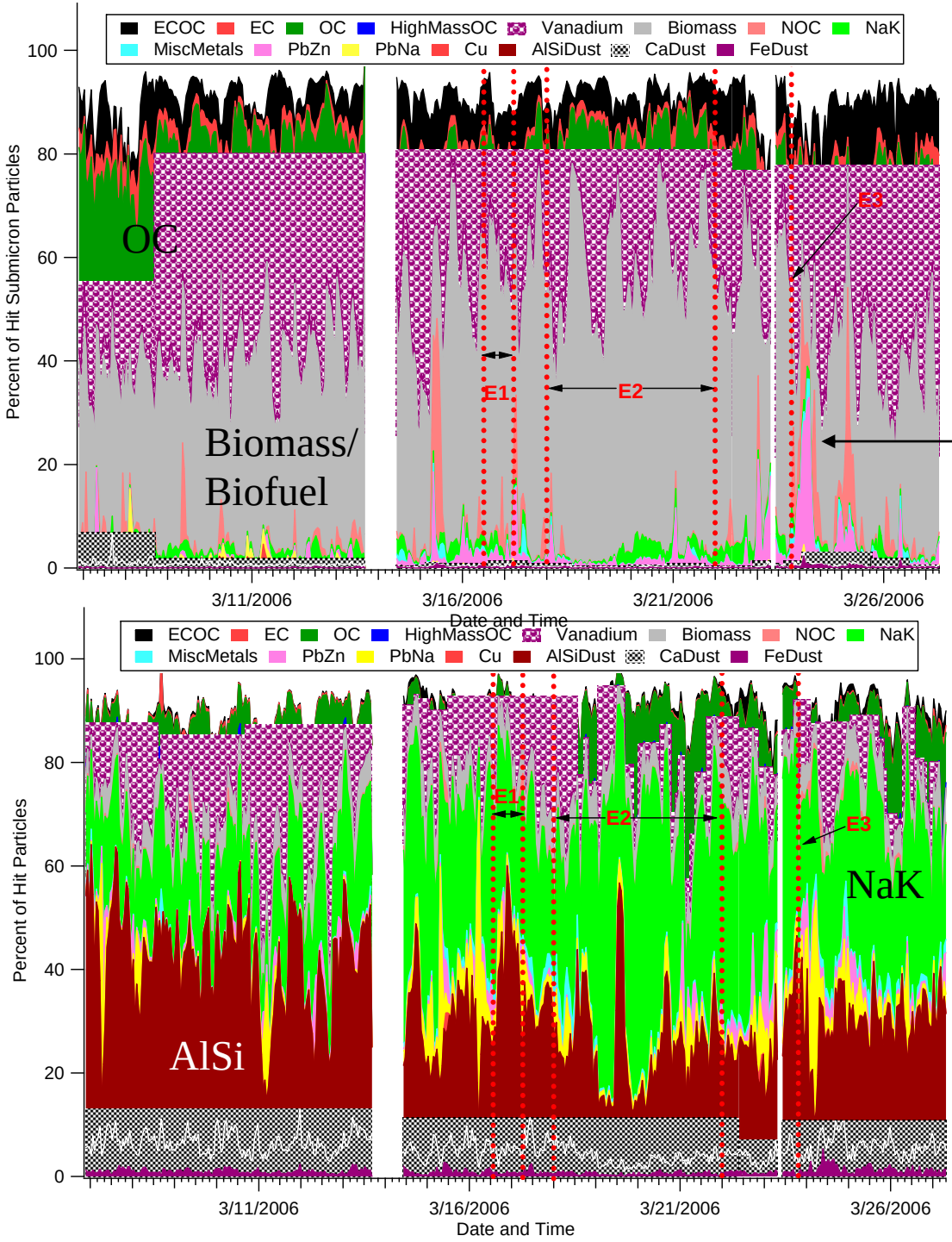
Supermicron types dominated by dust with nitrate (1-3 μm)



Mass Concentrations of General Single Particle Types



- Biomass/biofuel represented ~40% of the sub-micron mass
- Aged OC (with secondary species) the other major sub-1µm particle type
- Dust (w/ Na/K and AlSi) represented a substantial fraction of $PM_{2.5}$ mass and showed high degree of aging (with nitrates)



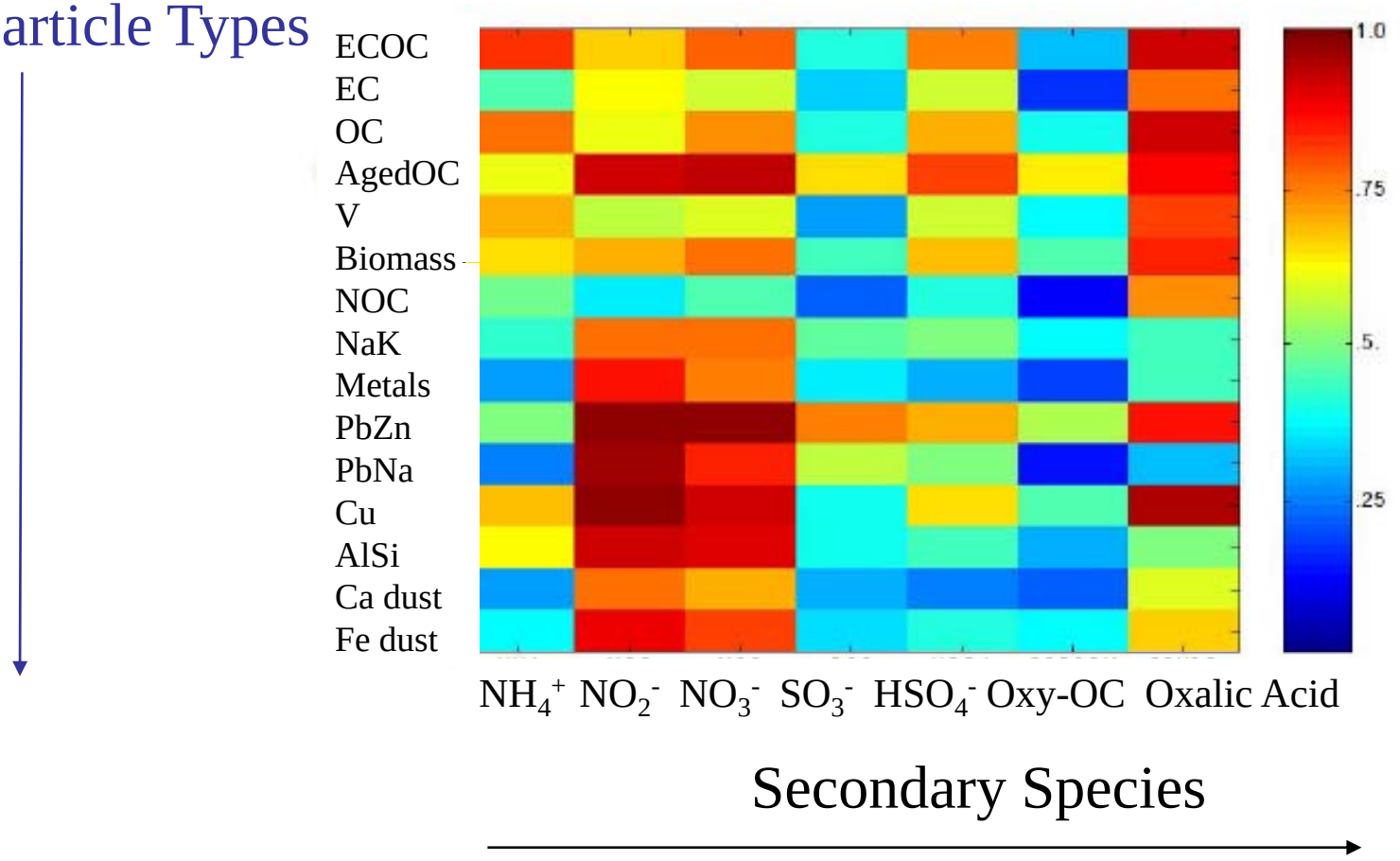
Submicron

Supermicron

Dust + Nitrate!

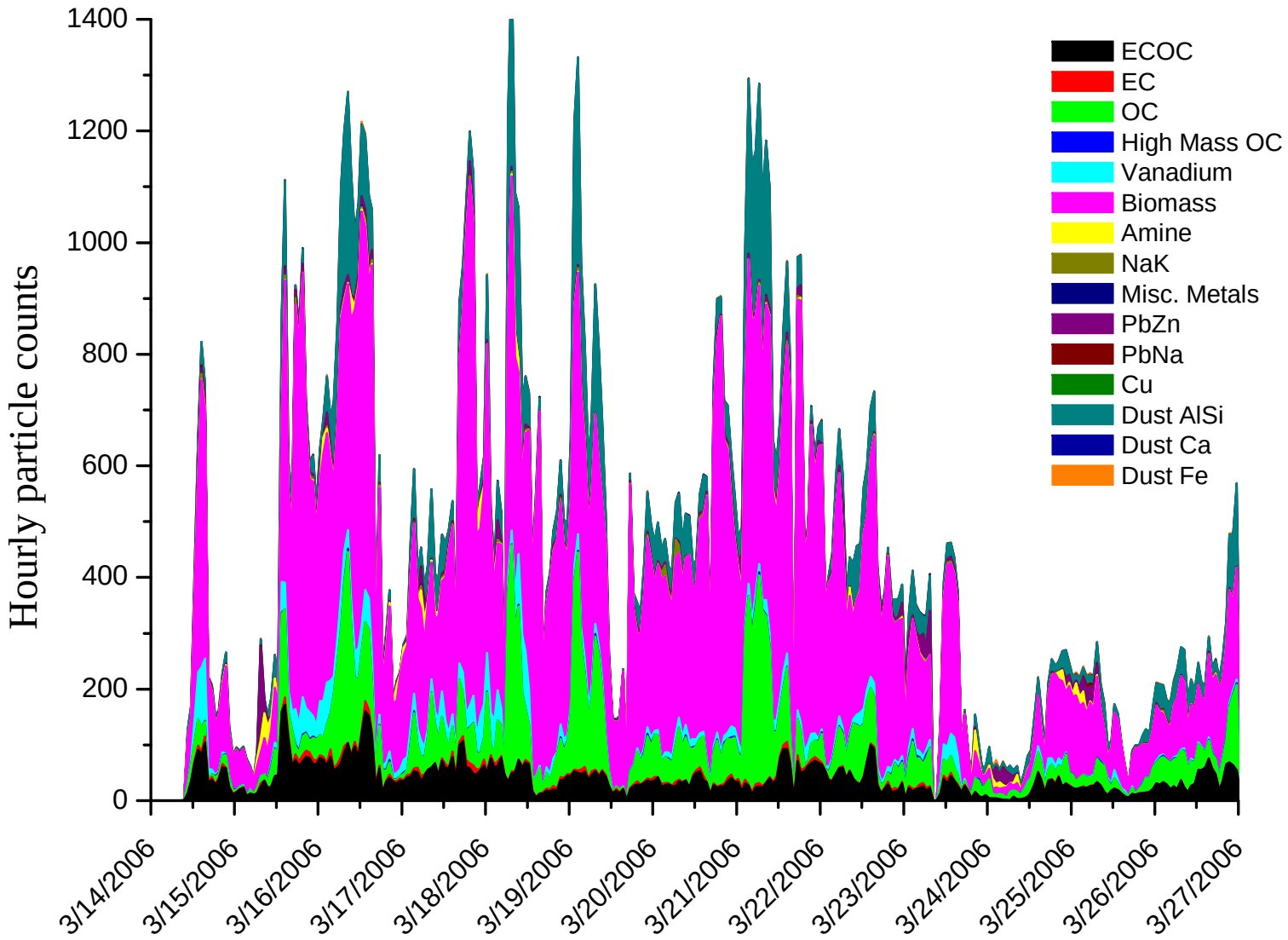
Aerosol Mixing State

Major Particle Types

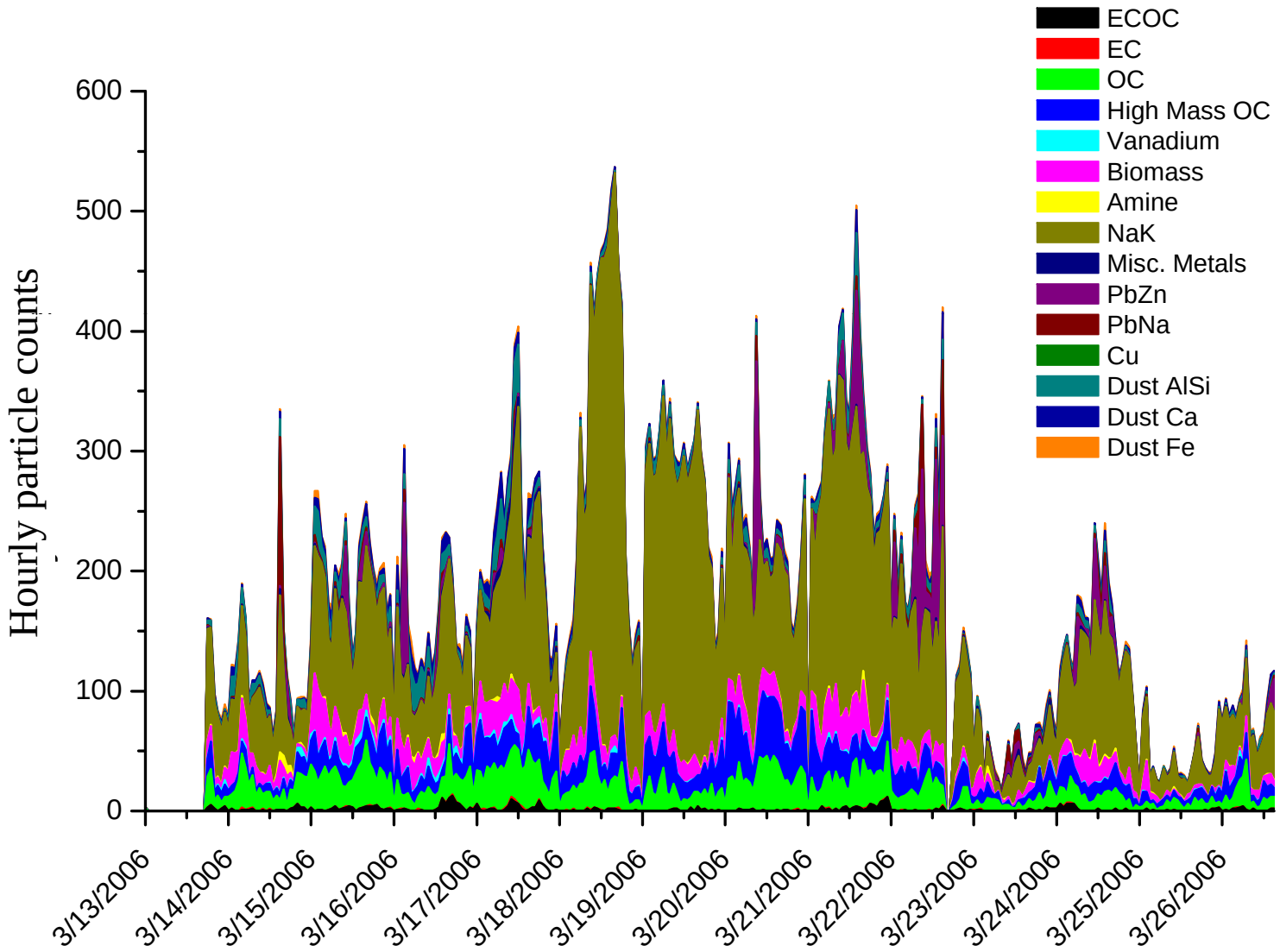


Secondary Species

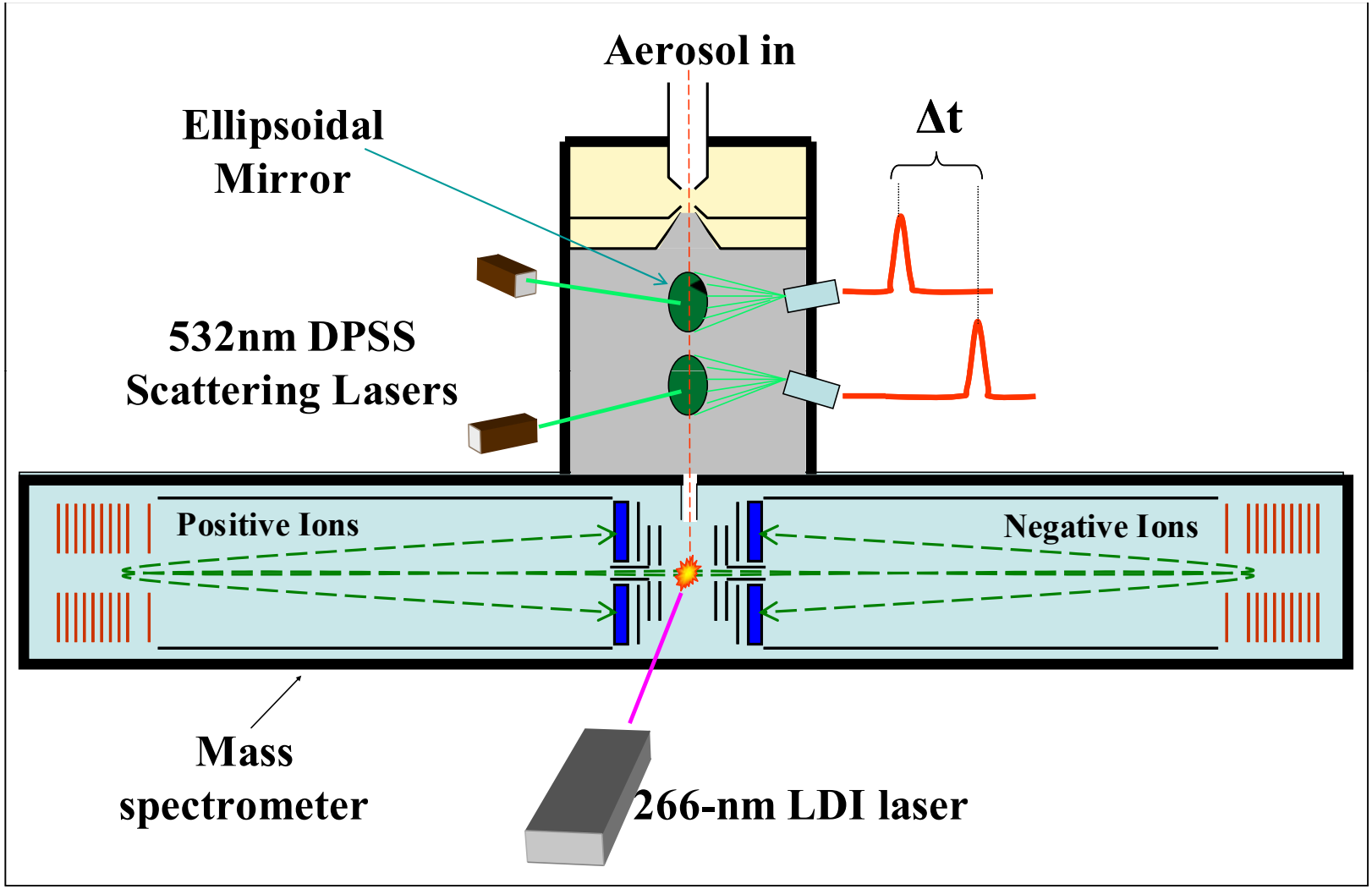
Submicron Oxalate Associations



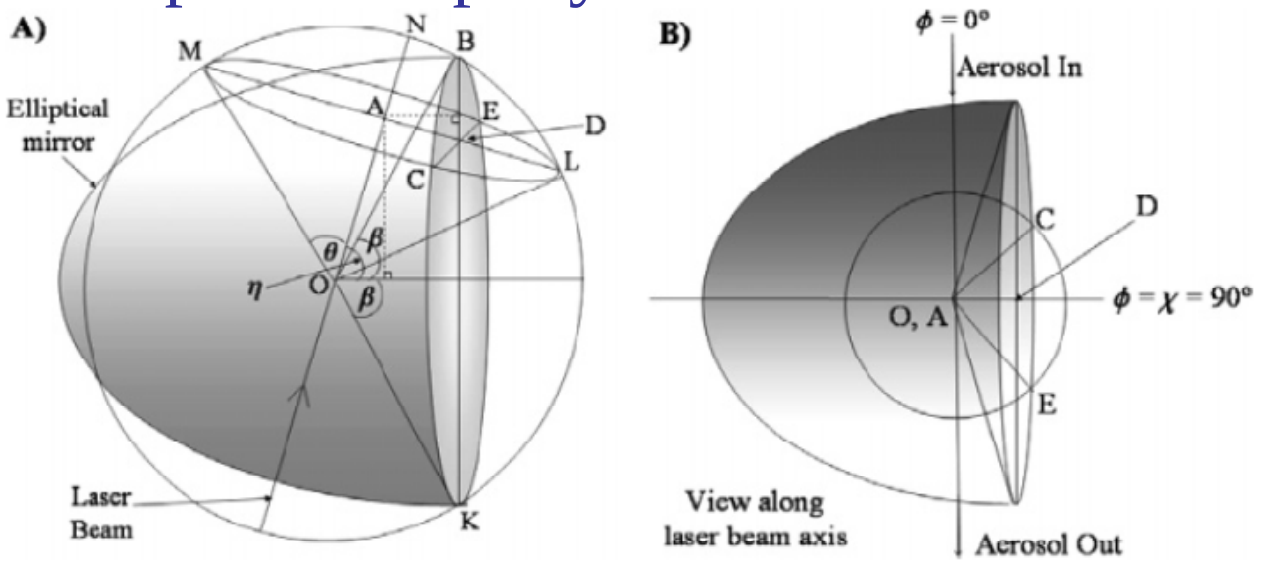
Supermicron Oxalate Associations

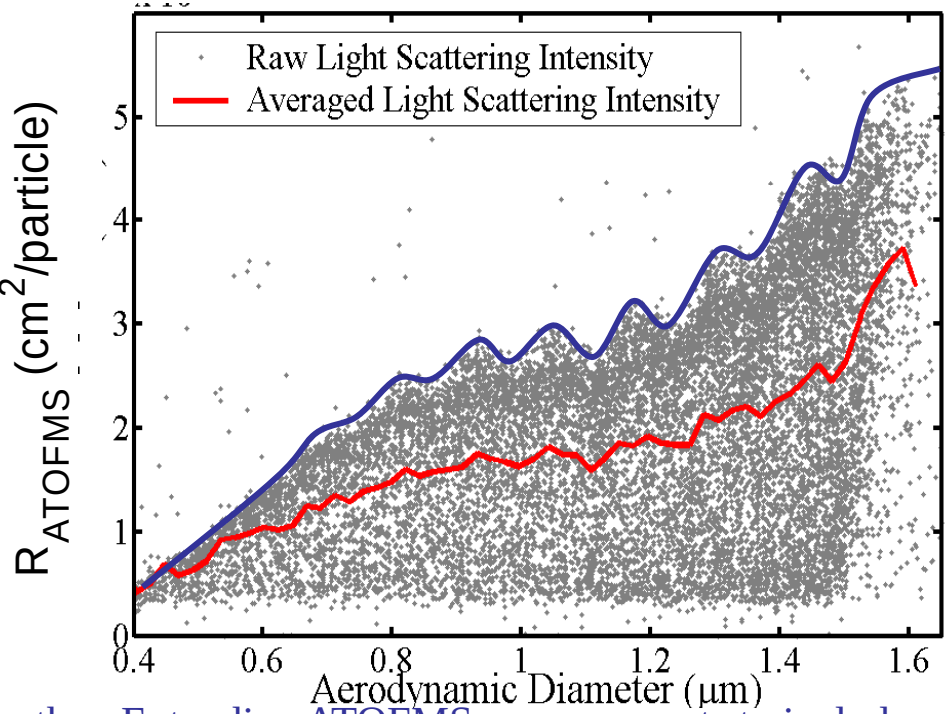


Optical Measurements w/ ATOFMS



Optical Property Measurements

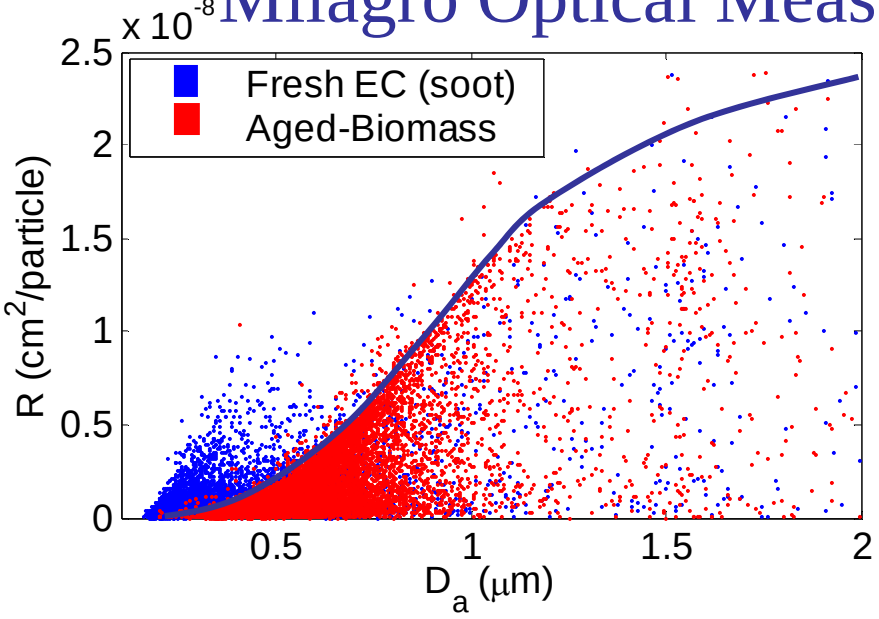


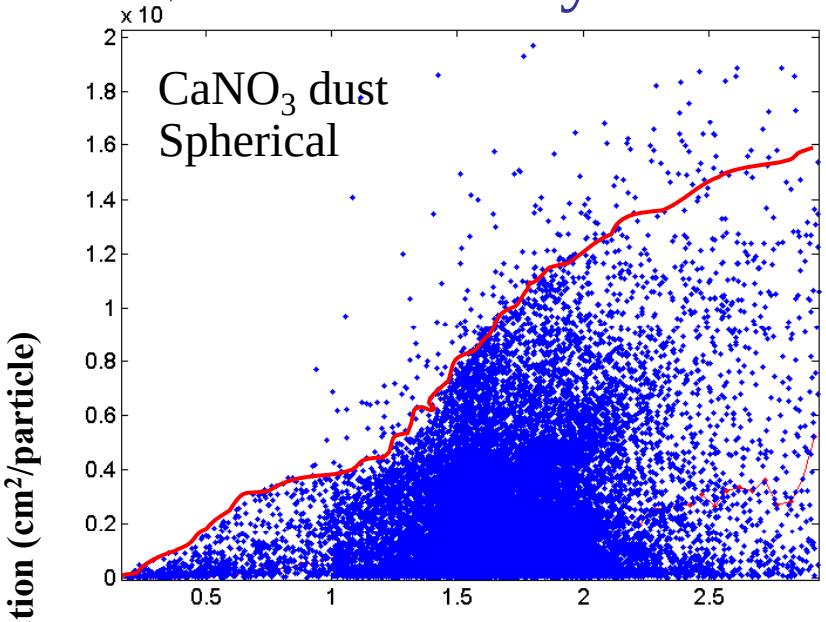


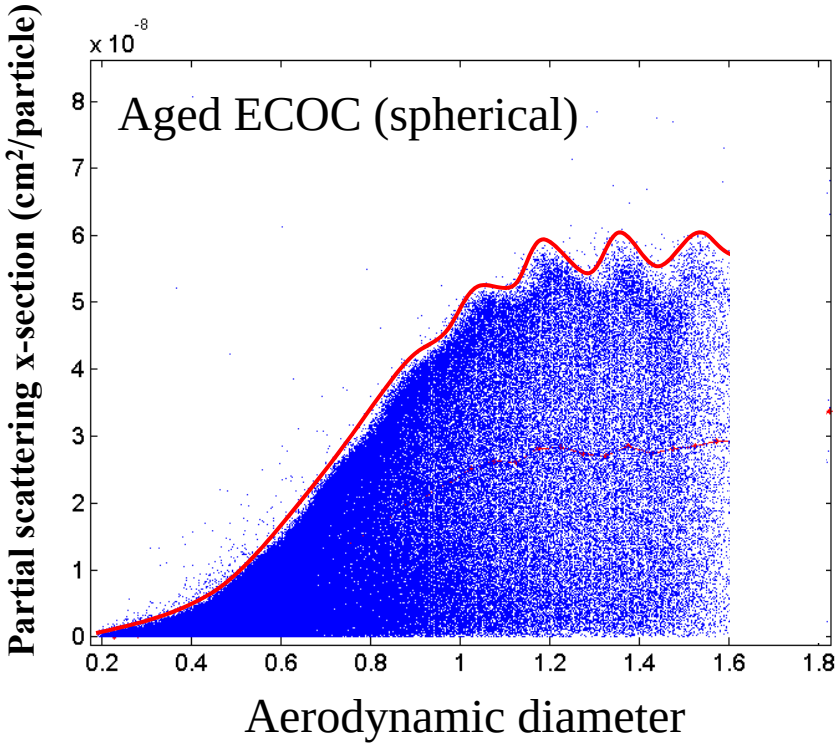
Calibration with DOS

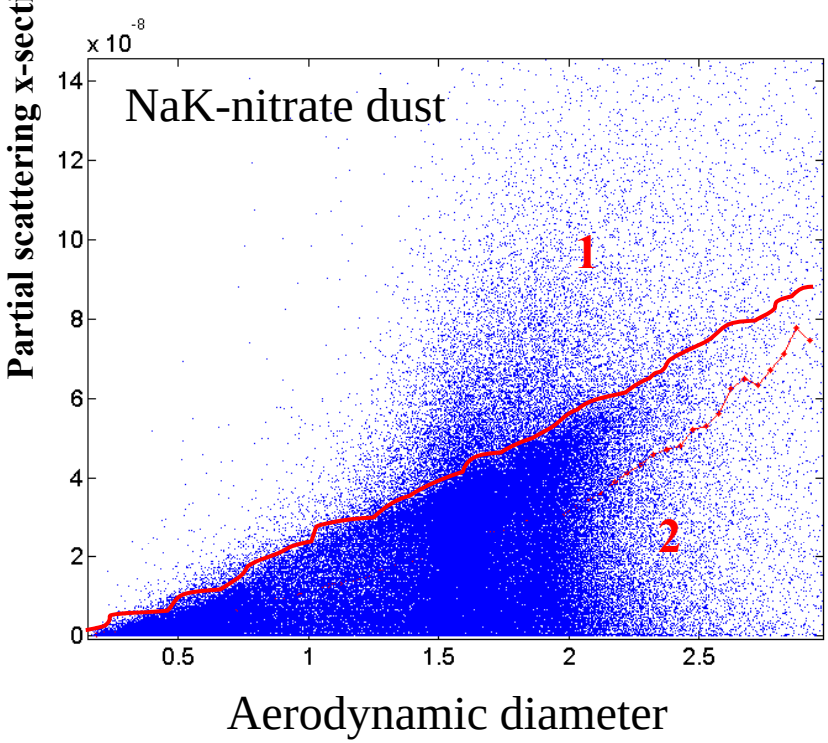
Moffet, R.C. and K.A. Prather, Extending ATOFMS measurements to include refractive index and density. *Analytical Chemistry*, 2005. **77**: 6535-6541.

Milagro Optical Measurements: R vs. aerodynamic size









Conclusions

- Mexico city sub-micron aerosol at T0 showed strong contributions from **biomass/biofuel and aged OC** mixed with sulfate, nitrate, and ammonium
- **Organic aerosols** showed strong diurnal pattern
  - OC peaked in morning, biomass in early afternoon
  - Organic-N species detected during certain episodes (amines)
  - Oxalic acid mixed with many different particle types (direct emissions, photochemistry, aqueous processing)
- 3 distinct types **dust** (reacted with nitrate) dominated supermicron particles (**Na/K** non-spherical, **$CaNO_3$** particles spherical)
- **EC/soot** heavily processed except during morning traffic periods
- Industrial emissions with **metals** (**Ag, V, Zn, Pb, Cu**) showed sharp temporal spikes
- Comparisons with other gas and particle phase measurements and models is critical to developing a complete picture of the aerosols in Mexico City
- Optical properties of size-resolved chemistry now possible
  - Provide additional information on shape, density, refractive index
  - provide information on the radiative forcing of aerosols from specific sources (SSA as a ftn. of size)

Acknowledgements

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