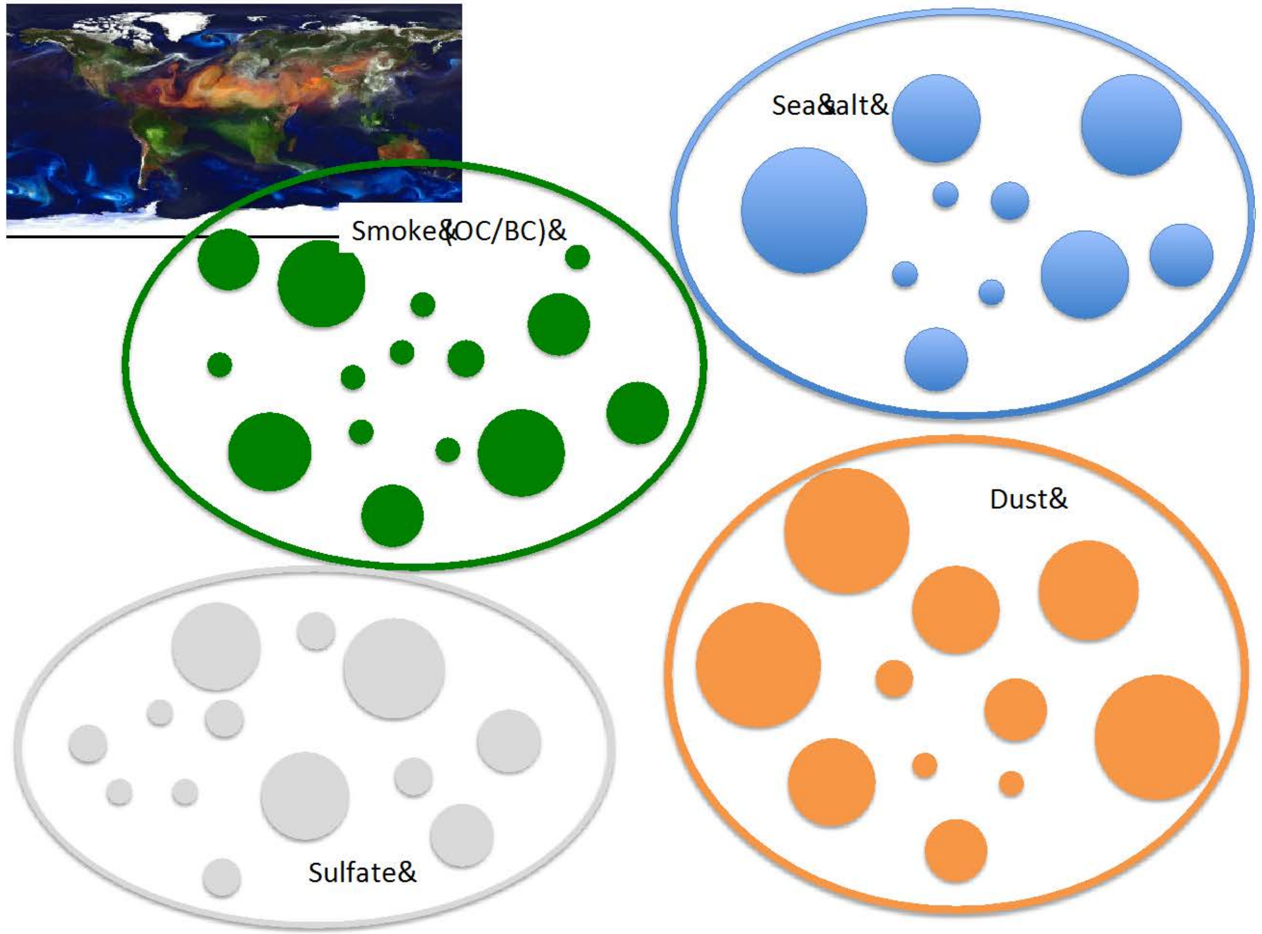
Aerosol Mixing State Focus Group

- Focus group was officially approved in August 2013
- First break-out session during the last Fall Working Group meeting

Aerosol mixing state definition:

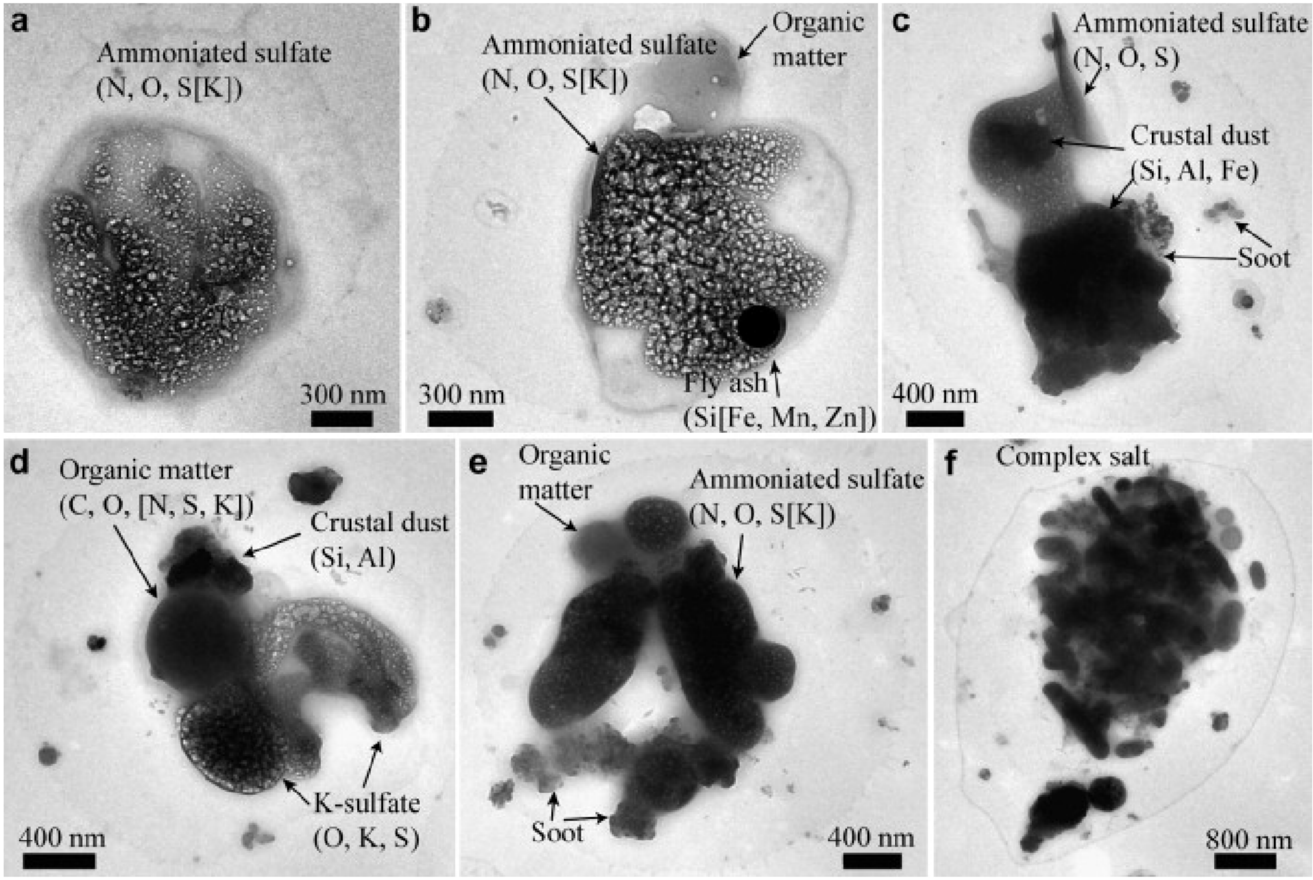
- **Population mixing state:** Distribution of chemical compounds across the particle population.
- **Morphological mixing state**: Distribution of chemical compounds within and on the surface of each particle.

Aerosol populations in Global Models



External mixture of di□erent aerosol types

Real Particles in the Atmosphere



Li et al., Atmospheric Environment, 45, 2488-2495, 2011

Scientific Questions

- Q1: What is the impact of mixing state on the climate-relevant properties of aerosol particles?
- Q2: What mixing state information should be included in models that quantify aerosol climate impacts?
- Q3: What mixing state information should be measured in the field and in the lab?
- Q4: How can we connect measurements (lab and field) to each other and to modeled mixing state information?

Working group whitepaper from August 2013, evaluating specific scientific needs and action items.

Connections between Different Tools

	Theory/ Metrics[1]	PRM[2]	GCM[3]	SP2[4]	Micros-copy[5]	SP mass spectro-metry[6]	Remote sensing[7]	Bulk measure-ments[8]
Theory/ Metrics[1]		high	low	medium	medium	low	low	low
PRM[2]	high		low	medium	low	low	low	high
GCM[3]	low	low		low	low	low	high	medium
SP2[4]	medium	medium	low		low	low	low	high
Micros-copy[5]	medium	low	low	low		low	low	medium
SP mass spetro-metry[6]	low	low	low	low	low		low	medium
Remote sensing[7]	low	low	high	low	low	low		high
Bulk measure-ments[8]	low	high	medium	high	medium	medium	high	

Table 2: Assessment of current abilities to connect data and outputs amongst different tools. The lack of comparable mixing state outputs between many tools is a key bottleneck in our ability to understand mixing state impacts.

Bottleneck:

Lack of comparable mixing state outputs between many tools

Connections between Different Tools

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SP mass	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]

Bottleneck:

Lack of comparable mixing state outputs between many tools

How can we improve the connections between poorly-connected tools?

Table 2: Assessment of current abilities to connect data and outputs amongst different tools. The lack of comparable mixing state outputs between many tools is a key bottleneck in our ability to understand mixing state impacts.

Integration of Field Campaigns and Modeling

Campaign	Measurements	Models		
		PRM	RM	GCM
MILAGRO	D1			
CARES	D1, D5, D8	D8	D4	D3
ClearfLo	D5			
TCAP	D8	D8	D4	
GVAX	D7		D7	
BBOP	D14			
Laboratory	D6, D9	D6, D9		

Table 4: Integration of deliverables with observational data from recent field campaigns and modeling work. The colors indicate coverage level (green: well-covered; yellow: some coverage; red: no coverage).

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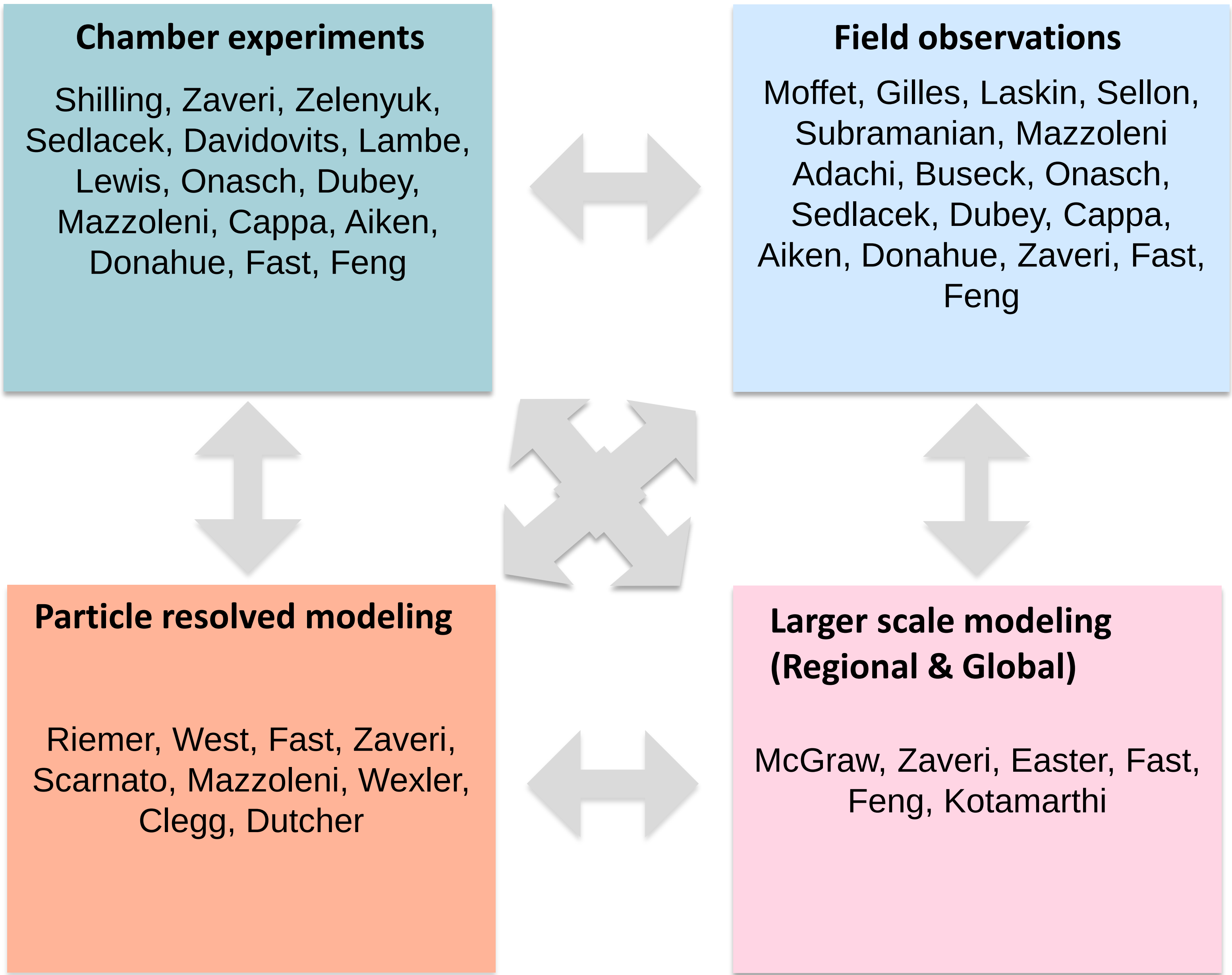
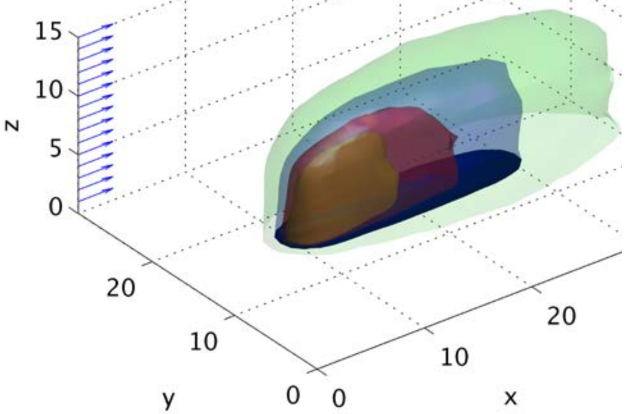
We don’t have a model hierarchy in place.
How can we improve this?

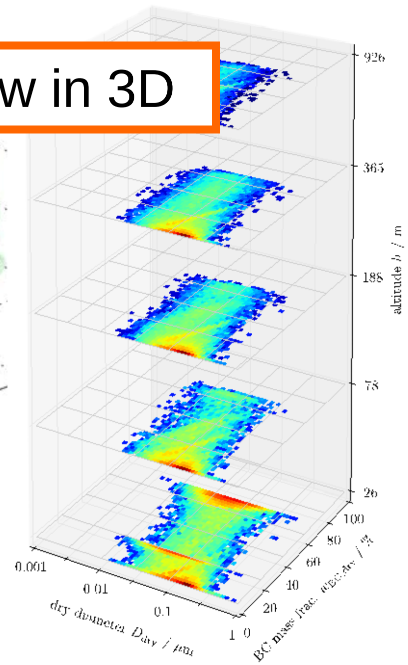

Chamber experiments
Shilling, Zaveri, Zelenyuk, Sedlacek, Davidovits, Lambe, Lewis, Onasch, Dubey, Mazzoleni, Cappa, Aiken, Donahue, Fast, Feng
Field observations
Moffet, Gilles, Laskin, Sellon, Subramanian, Mazzoleni Adachi, Buseck, Onasch, Sedlacek, Dubey, Cappa, Aiken, Donahue, Zaveri, Fast, Feng
Particle resolved modeling
Riemer, West, Fast, Zaveri, Scarnato, Mazzoleni, Wexler, Clegg, Dutcher
Larger scale modeling (Regional & Global)
McGraw, Zaveri, Easter, Fast, Feng, Kotamarthi

Highlight 1: Particle-Resolved Modeling

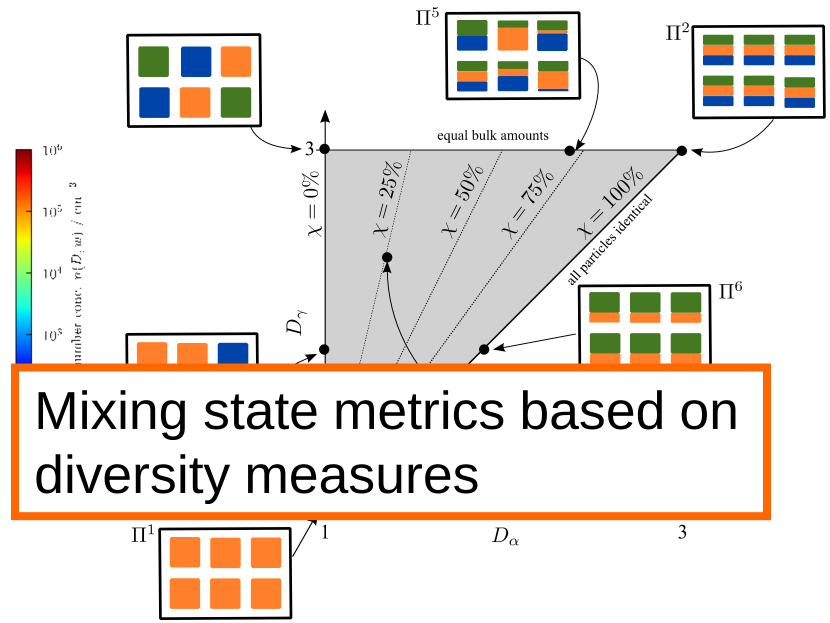
Riemer, West, Fast, Zaveri

PartMC-MOSAIC now in 3D

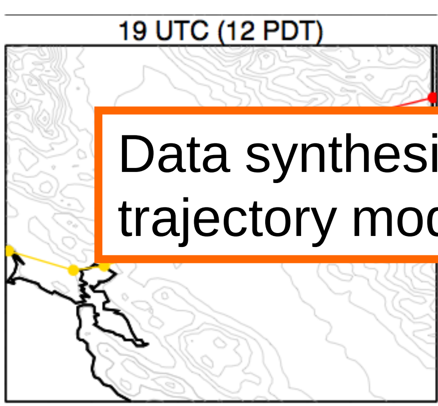


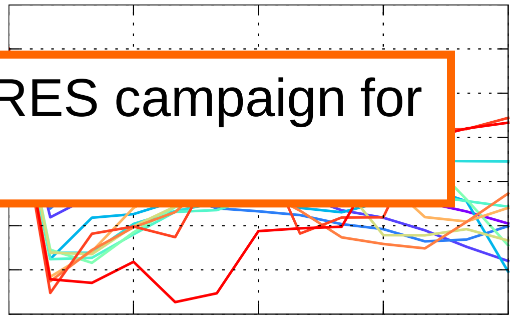


Mixing state metrics based on diversity measures



Data synthesis from CARES campaign for trajectory modeling

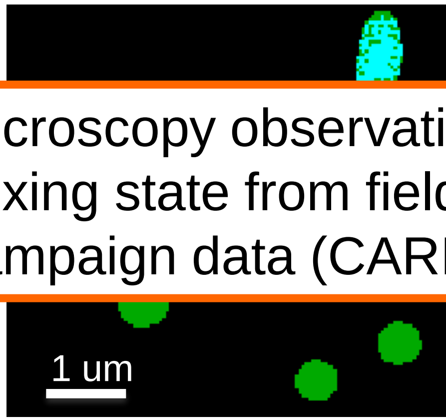




Highlight 2: Spectro-microscopy

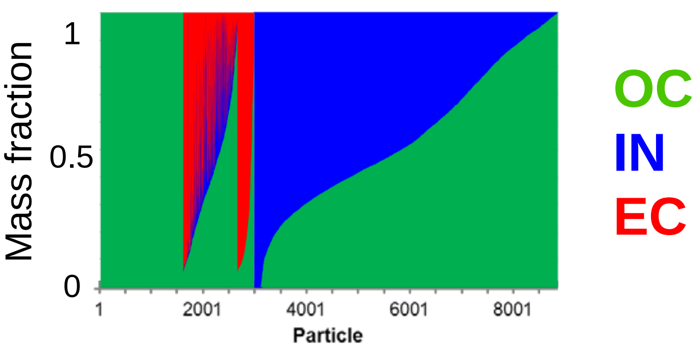
Sellon, Moffet, Gilles, Laskin

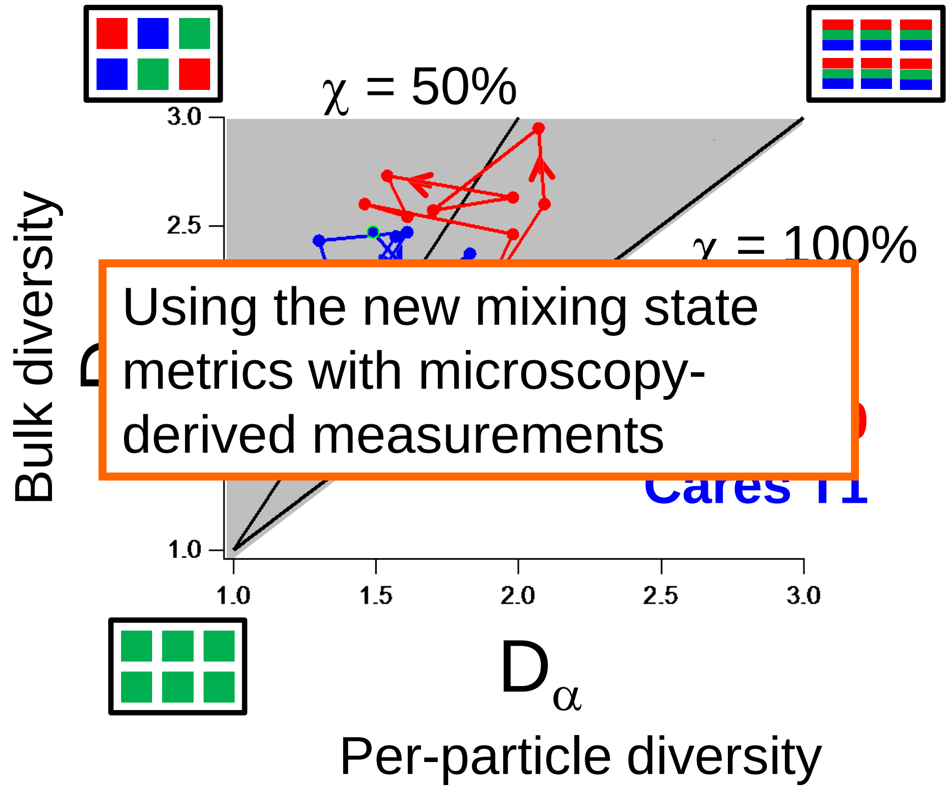
STXM-NEXAFS



Microscopy observations of mixing state from field campaign data (CARES)

Particle Diversities → Characterize mass fractions: 3 components





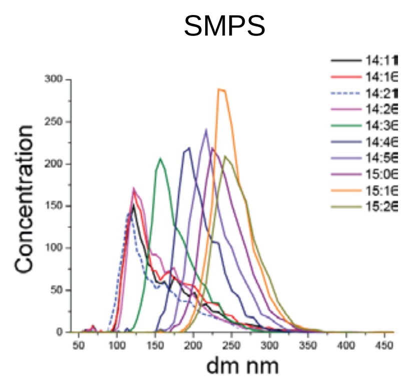
Using the new mixing state metrics with microscopy-derived measurements

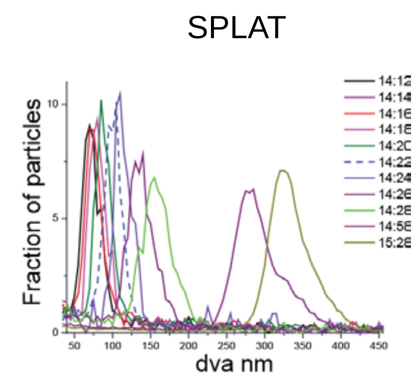
T1 lower mixing state parameters → higher organic loading at the site

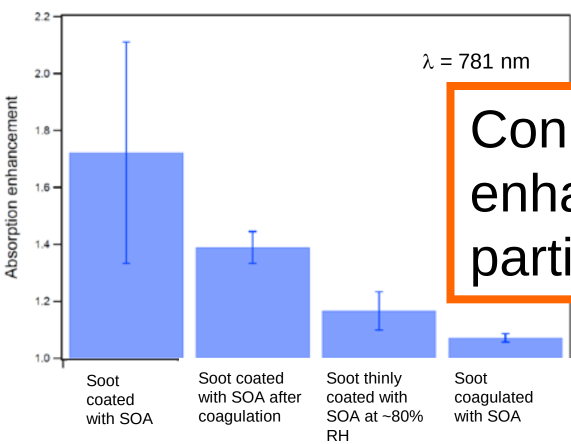
Highlight 3: Soot Aerosol Aging Study (SAAS) Laboratory Campaign

R.A. Zaveri[1], J.E. Shilling[1], M. Pekour[1], G. Kulkarni[1], D. Chand[1], J. Wilson[1], A. Zelenyuk-Imre[1], A. Laskin[1], S. Liu[2], A. Aiken[2], M. Dubey[2], R. Subramanian[3], N. Sharma[4], S. China[4], C. Mazzoleni[4], A. Sedlacek[5], T.B. Onasch[6], R. Sellon[7], M.K. Gilles[7], and R. Moffet[8]

Aerosol mixing state data in controlled laboratory conditions



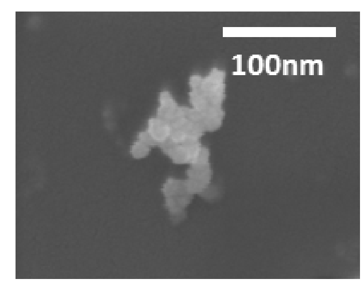




Connecting absorption enhancement with single-particle mixing state data

Soot before coating

After Coating



Aerosol Mixing State Posters

1. **Curtis, J., West, M., and Riemer, N.**
   Coupling the Stochastic Particle-resolved Aerosol Model PartMC-MOSAIC with WRF
2. **Gilles, M.**
   Spectro-microscopic Characterization of Physical Properties in Individual Atmospheric Particles
3. **Lambe, A., Ahern, A., Onasch, T., Wright, J., Croasdale, D., Worsnop, D., and Davidovits, P.**
   Laboratory simulated atmospheric aging processes of combustion-generated soot particles
4. **Liu, J. and Li, Z.**
   Estimation of cloud condensation nuclei concentration from aerosol optical quantities: influential factors and uncertainties
5. **Mazzoleni, C., Swarup, C., Marian, A., Sharma, N., Schum, S., Gebreeyesus, S., Dzepina, K., Kumar, S., Wright, K., Dziobak, M., Fialho, P., Hueber, J., Helmig, D., Kramer, L., Owen, R., Mazzoleni, L., and Zhang, B.**
   Free Tropospheric North Atlantic Aerosols Observed at the Pico Mountain Observatory
6. **O'Brien, R., Wang, B., West, M., Riemer, N., Laskin, A., Gilles, M., and Moffet, R.**
   Spectro-microscopy of Ambient Aerosol Particles: Observational Constraints on Mixing State Parameterization
7. **Sedlacek, A., Kleinman, L., Arnott, P., Adachi, K., Buseck, P., Lewis, E., Onasch, T., Pikridas, M., Shilling, J., Springston, S., Wang, J., and Yokelson, R.**
   Evolution of Biomass Burning Aerosols in the Near Field
8. **Subramanian, R.**
   BC aerosol optical properties as a function of mixing state: Results from SAAS-PNNL
9. **Zaveri, R., Shilling, J., Pekour, M., Kulkarni, G., Chand, D., Wilson, J., Zelenyuk-Imre, A., Laskin, A., Liu, S., Aiken, A., Dubey, M., Subramanian, R., Sharma, N., China, S., Mazzoleni, C., Sedlacek, A., Onasch, T., Sellon, R., Gilles, M., and Moffet, R.**
   An Early Overview of the Soot Aerosol Aging Study (SAAS) Laboratory Campaign