Summary of Published Results from CARES 2010 Campaign

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CARES Breakout Session

March 20, 2013

ASR Science Team Meeting

Bolger Center, Potomac, MD

ARM CLIMATE RESEARCH FACILITY

ASR Atmospheric System Research

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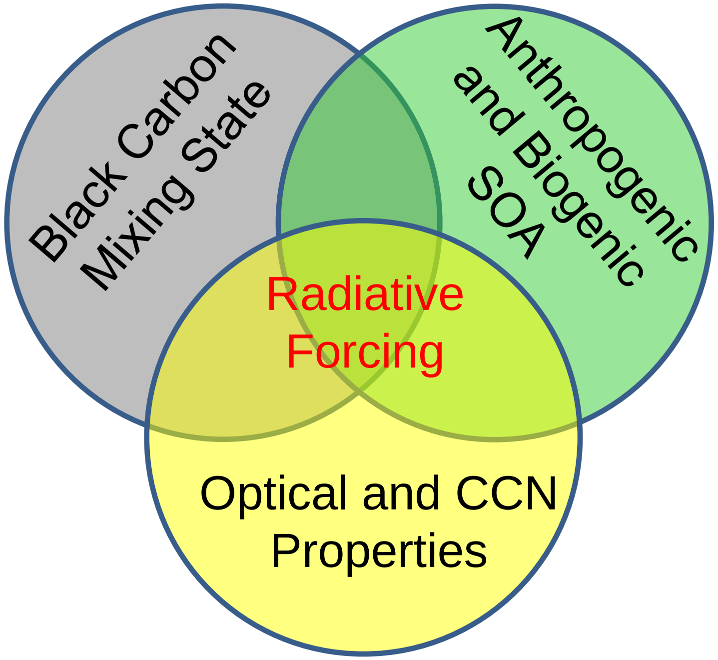
CARES Science Objectives

- Investigate **Anthropogenic-Biogenic Interactions** in SOA formation.
- Investigate **black carbon (BC) mixing state evolution**.
- Quantify the effects of aerosol ageing on **aerosol optical and CCN activation properties**.
- Develop and evaluate **improved models** of these processes for use in **regional and global climate models**.



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Overview of 2010 CARES Campaign

ARM
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Sacramento, June 2 – 28, 2010

Rationale

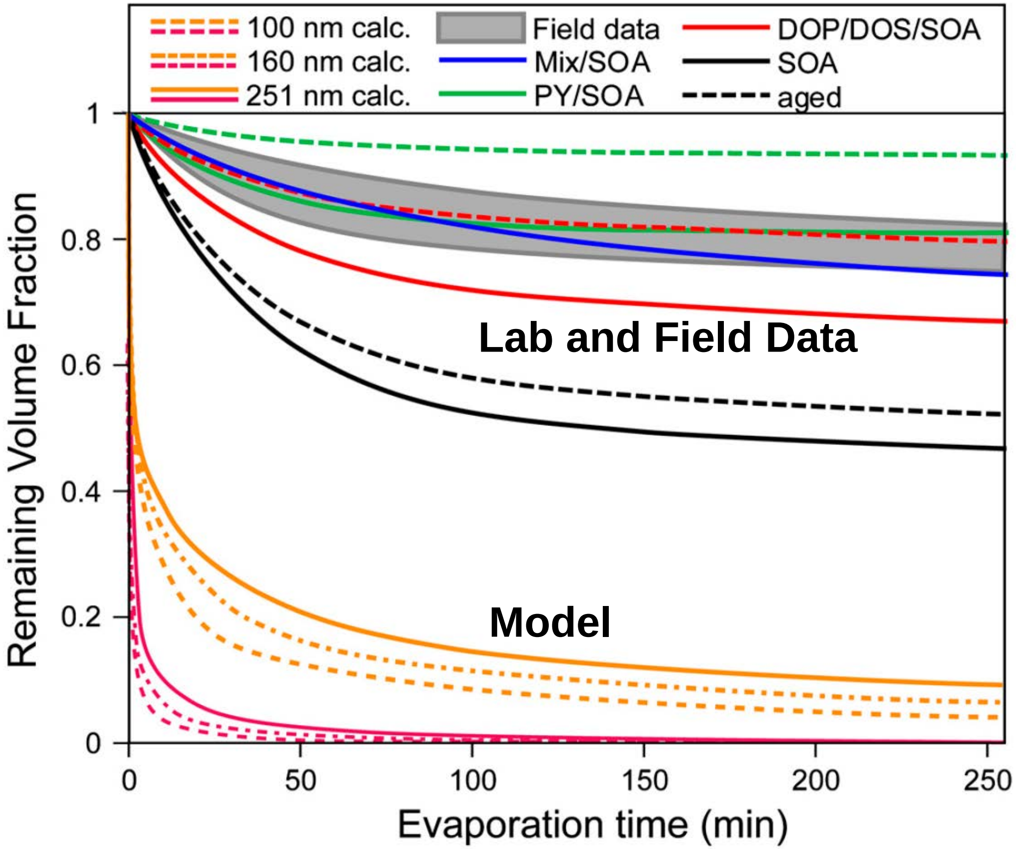
- Mid-size metropolitan area (pop. ~500,000)
- Low anthropogenic emissions to the north
- High biogenic emissions to the east.
- Regular wind pattern during summer.

Sacramento plume serves as a meso-scale flow reactor

Zaveri, R. A. et al., Overview of the 2010 Carbonaceous Aerosols and Radiative Effects Study (CARES), *Atmos. Chem. Phys.*, 2012.

Fast, J. D. et al., Transport and mixing patterns over Central California during the carbonaceous aerosol and radiative effects study (CARES), *Atmos. Chem. Phys.*, 12, 1759-1783, 2012.

Evaporation of SOA Much Slower Than Expected

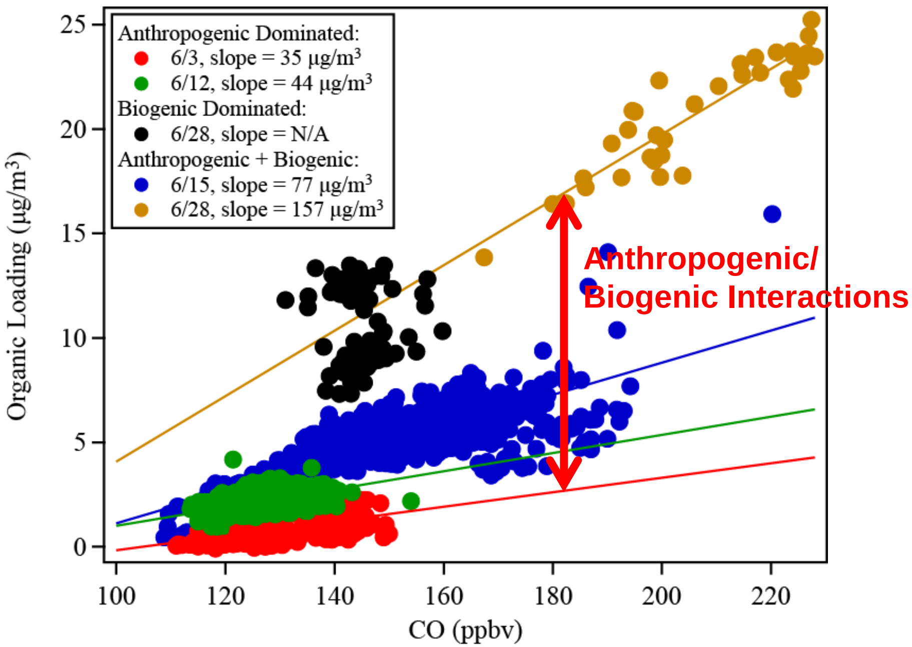


Laboratory SOA and ambient SOA during CARES were found to evaporate much slower compared to the ~10 min time scale predicted by kinetic mass transfer model assuming liquid SOA particles.

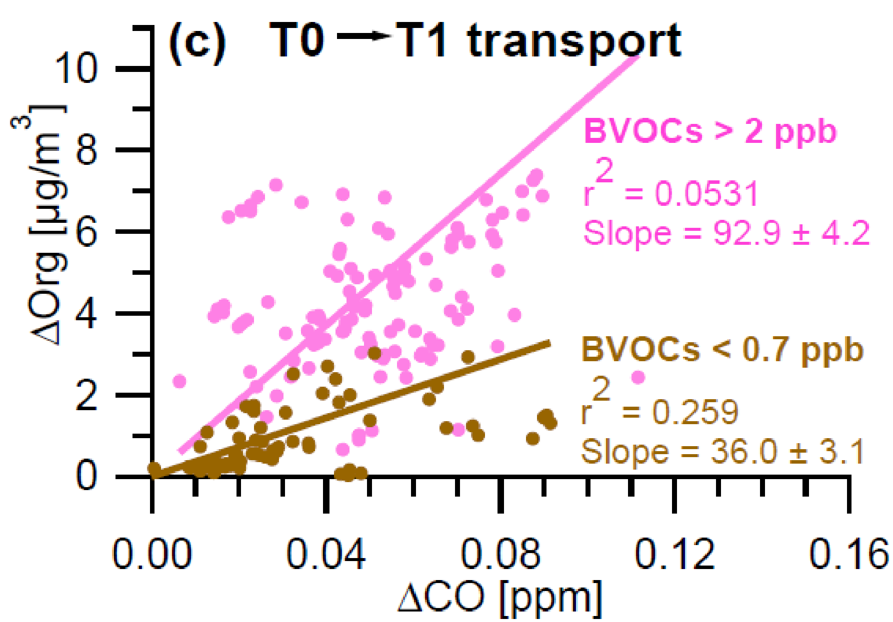
Vaden, T. D. et al., Evaporation kinetics and phase of laboratory and ambient secondary organic aerosol, *Proc. Natl. Acad. Sci. U.S.A.*, 108, 2190-2195, 2011.

Enhanced SOA Formation from Anthropogenic-Biogenic Interactions

Shilling, J. E. et al., Enhanced SOA formation from mixed anthropogenic and biogenic emissions during the CARES campaign, *Atmos. Chem. Phys.*, 2013

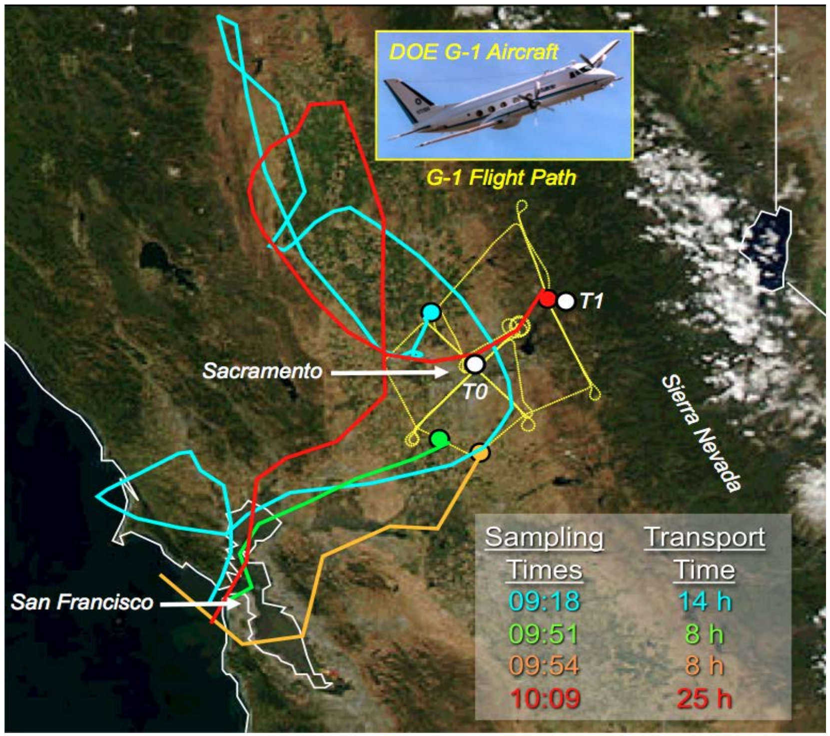


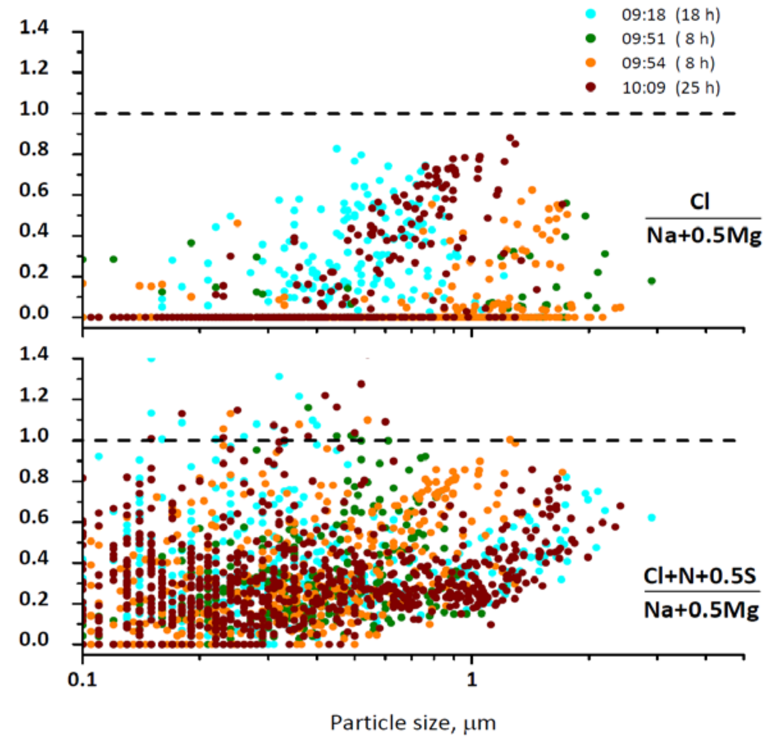
Setyan, A. et al., Characterization of submicron particles influenced by mixed biogenic and anthropogenic emissions using high-resolution aerosol mass spectrometry: results from CARES, *Atmos. Chem. Phys.*, 2012



Enhanced SOA formation found when both anthropogenic and biogenic emissions mixed together compared to scenarios where these emissions did not mix.

SOA Found to React with Sea-Salt Aerosol and Displace Chloride

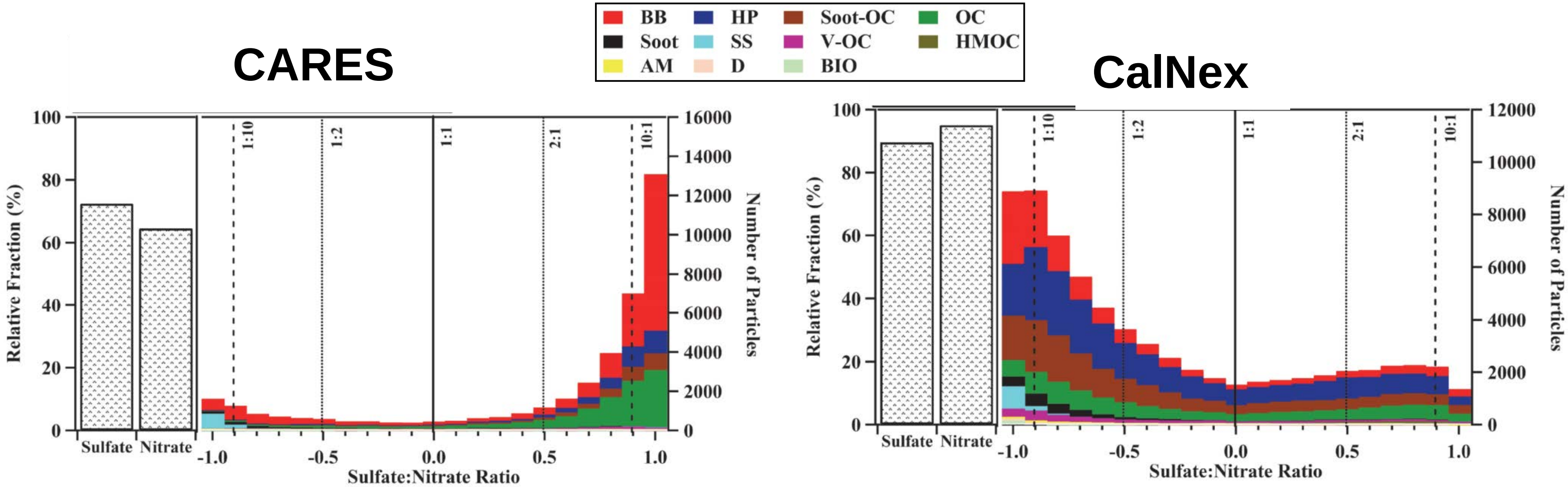




SOA consisting of weak organic acids found to react with sea salt particles and displace HCl gas, leaving behind particles depleted in chloride and enriched in the corresponding organic salts.

Laskin, A. et al., Tropospheric chemistry of internally mixed sea salt and organic particles: Surprising reactivity of NaCl with weak organic acids, *J. Geophys. Res.*, 117:D15302, 2012.

Very Different Carbonaceous Aerosol Mixing States in Northern and Southern California

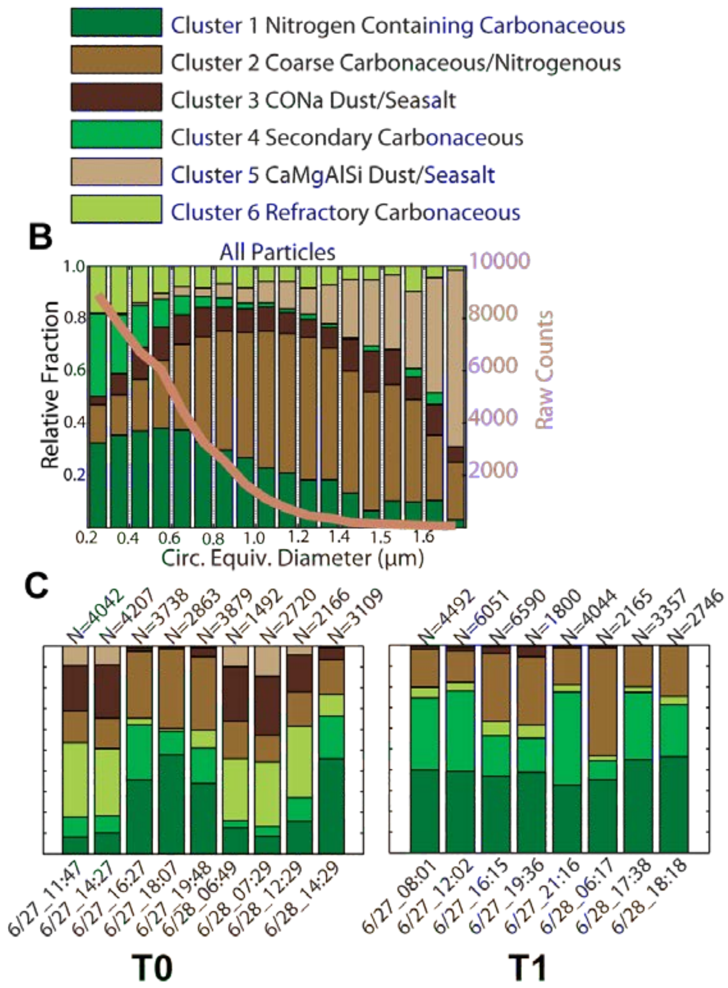


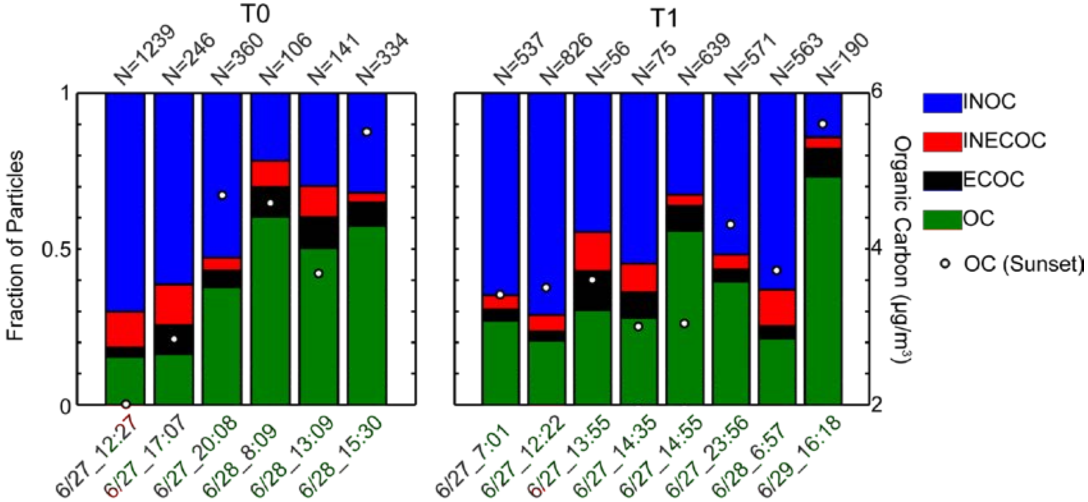
Most carbonaceous aerosols in N. California were mixed with sulfate.

Most carbonaceous aerosols in S. California were mixed with nitrate.

Cahill, J. et al., The mixing state of carbonaceous aerosol particles in Northern and Southern California measured during CARES and CalNex 2010, *Atmos. Chem. Phys.*, 2013.

Spectro-microscopic analyses of aerosol ageing





Moffet, R.C. et al., Spectro-microscopic measurements of carbonaceous aerosol aging in California, ACPD, 2013.

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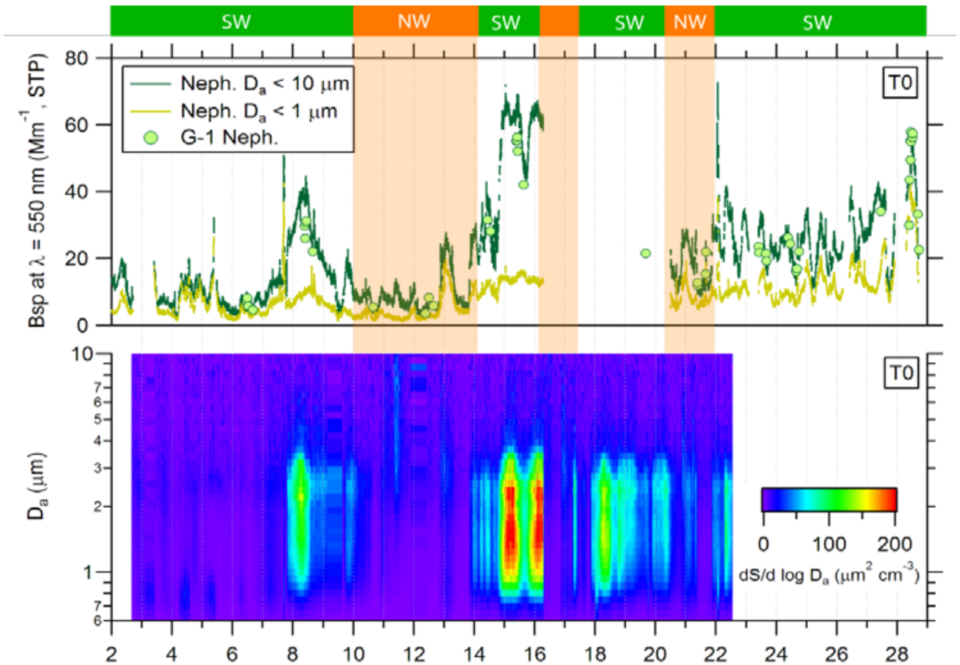
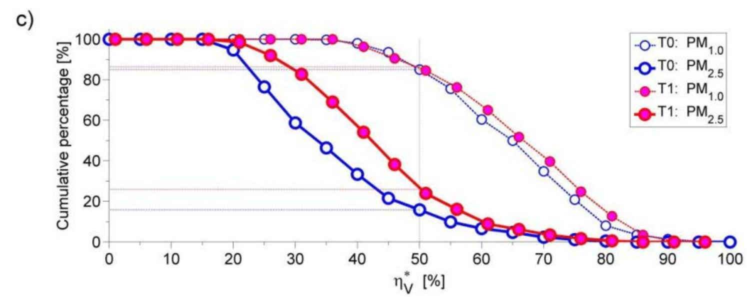
Large Contribution of Coarse-Mode Aerosols to Light Scattering



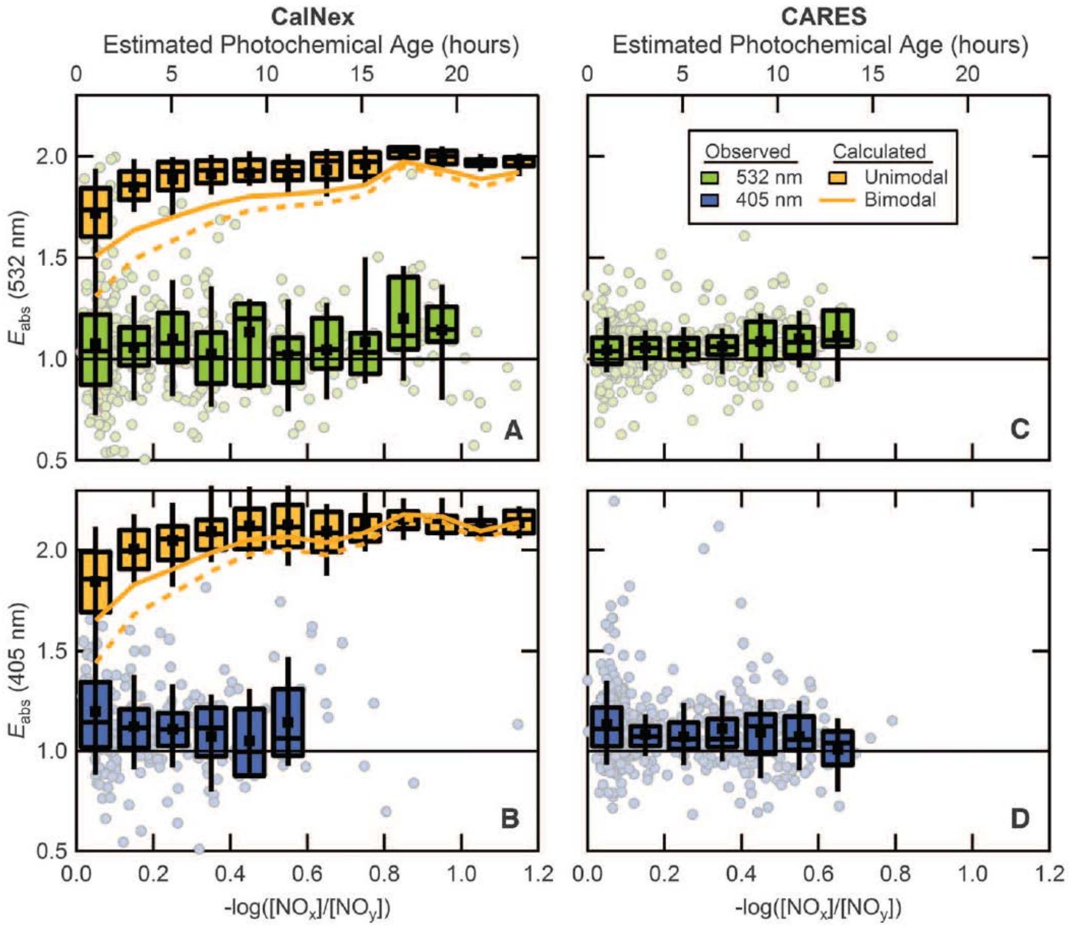


Coarse sea-salt frequently observed over Sacramento during SW flow.

Supermicron aerosols contributed significantly to the total light scattering, especially at longer wavelengths.

Kassianov, E. et al., Aerosols in Central California: Unexpectedly large contribution of coarse mode, *Geophys. Res. Lett.*, 2013.

Lack of Absorption Enhancement in Aged BC



Cappa, C. D. et al., Radiation absorption enhancements due to the mixing state of atmospheric black carbon, *Science*, 2012.

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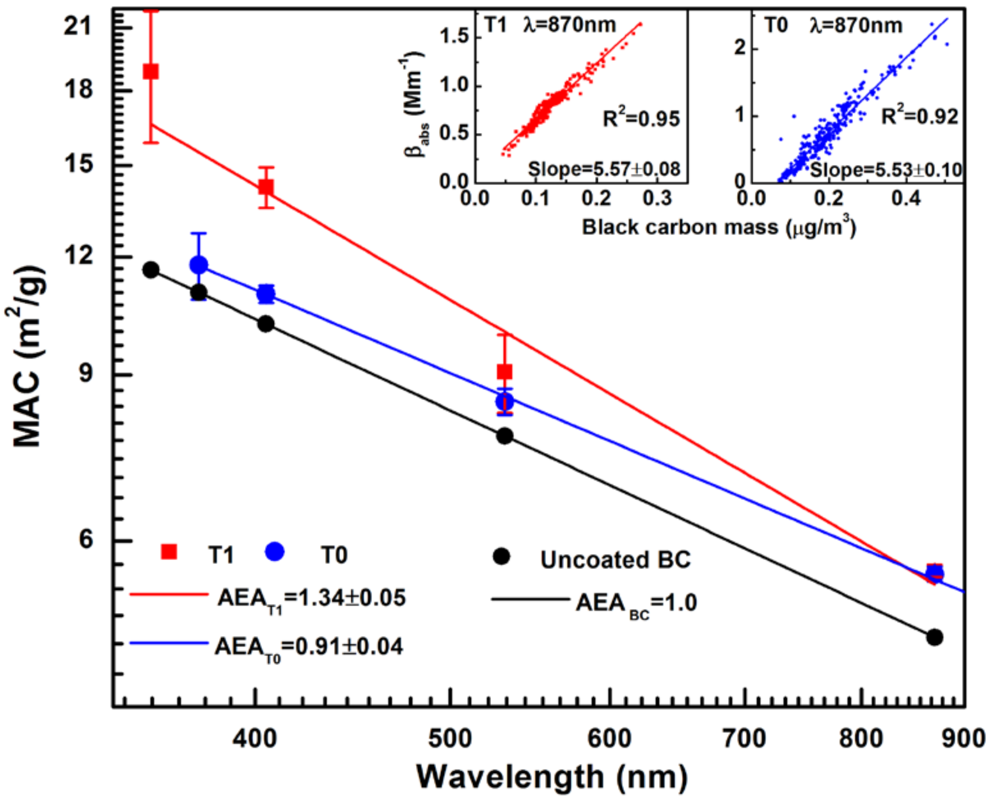
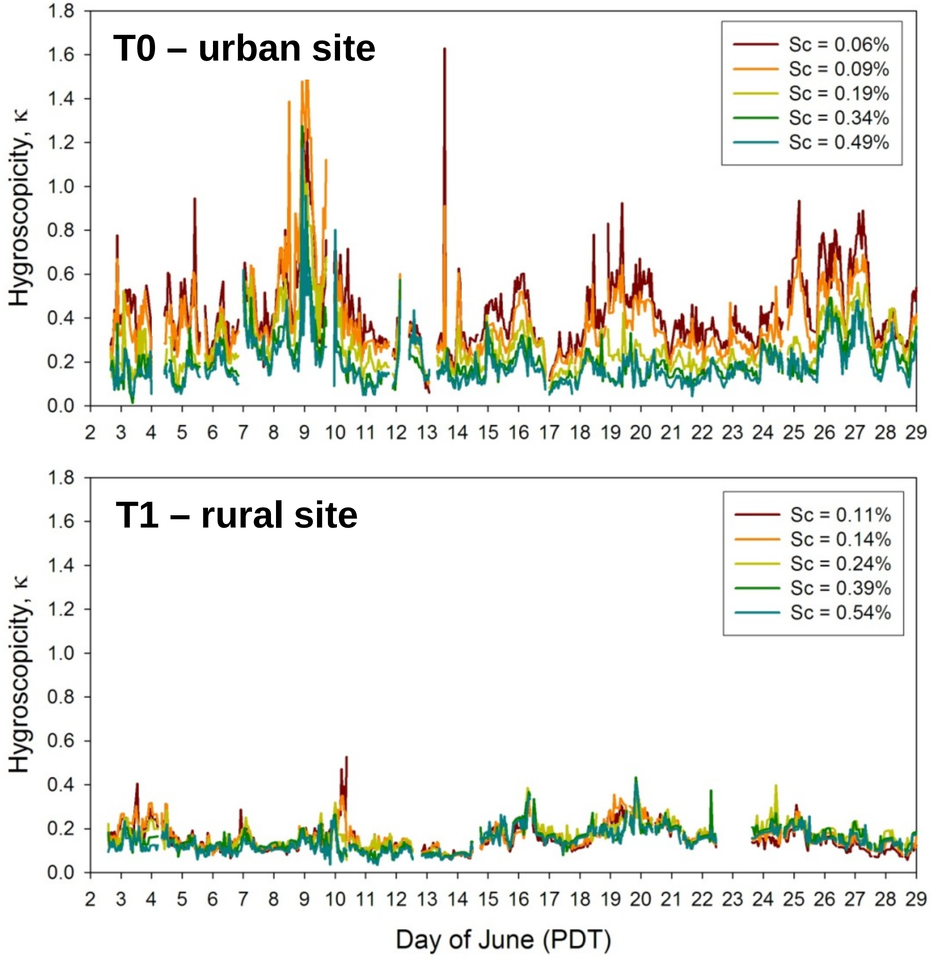
Evidence of Brown Carbon in Aged Airmass



Lack of absorption enhancement due to lensing effect, but some browning occurs from T0 to T1

Gyawali, M. et al., Evolution of multispectral aerosol optical properties in a biogenically-influenced urban environment during the CARES campaign, *ACPD*, 2013.

Large Impact of SOA Formation and Aerosol Ageing on CCN Activation



Aerosols at the T0 urban site showed appreciable day-to-day variability in hygroscopicity (κ), with large differences in values at different supersaturations.

The aged aerosols at T1 rural site, dominated by SOA, displayed much lower and similar κ values at different supersaturations, with much less day-to-day variability.

Hiranuma, N. et al., CCN activity of anthropogenically and biogenically influenced aerosol particles during the 2010 CARES campaign, *ACPD*, 2013, to be submitted.