Microscopic Measurements of Aerosols Collected During CARES

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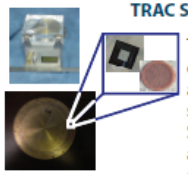
Abstract

During the carbonaceous aerosols and radaitive effects study (CARES), chemical composition and mixing state was determined with spectro-microscopic techniques. Using scanning electron microscopy, a variety of particles were observed including fresh/aged sea salt and primary biological particles (brochosomes). X-ray spectromicroscopy measured an increase in carboxylic acids and a decrease in carbon-carbon double bonds due to oxidative aging. Moreover, the number of homogenous organic particles increased over a period of two days at the end of the study. Lastly, a statistical analysis of particles indicates that soot inclusions had much larger coating in Sacramento compared to Los Angeles.

Experimental



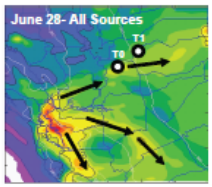
TRAC Sampler

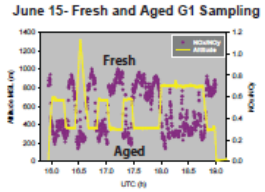
The time resolved aerosol collector (TRAC) impacted aerosols onto microscopy substrates during CARES. Sampling was carried out at T0, T1 and the G1 Aircraft.

Microscopy samples were analyzed by scanning electron microscopy and scanning transmission X-ray microscopy coupled with near edge X-ray absorption fine structure spectroscopy (STXM/NEXAFS).

June 28th Ground Sampling of T0 to T1 Transport & June 15th G1 Sampling of Fresh/Aged Plumes

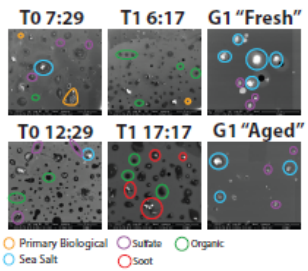
On June 28th, airflow was from T0 to T1. In addition, fresh and aged plumes were sampled with the G1 on June 15.





Results

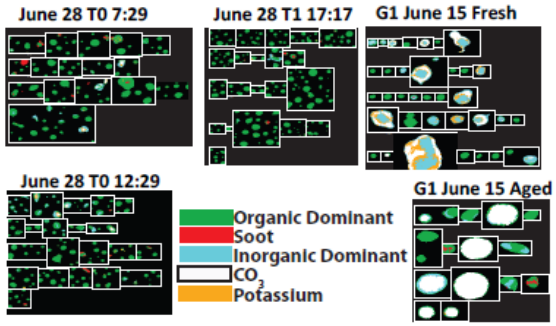
Scanning Electron Microscopy



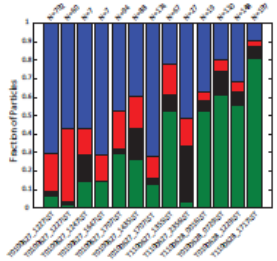
As evidenced by SEM (left) and STXM/NEXAFS (top of next panel), particles sampled on June 28 were observed to be a complex mixture of sea salt, organics, sulfates and biogenic particles. G1 aircraft samples indicated the aging of sea salt particles in "fresh" and "aged" plumes.

Results

STXM/NEXAFS Spectromicroscopy

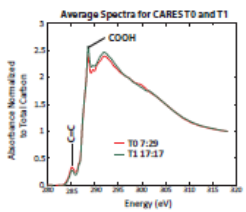


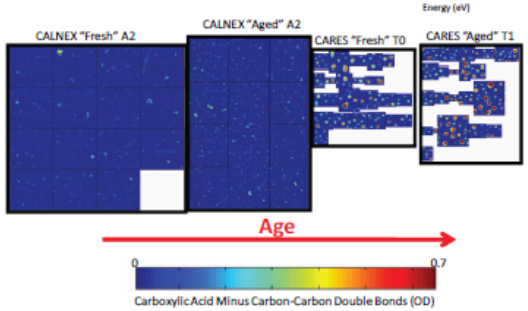
Aerosol component maps (above) for June 28. Processing of seasalt measured on the G1 shows a disappearance of distinct NaCl crystals.



The mixing state (left) of the particles changed slowly from June 27 to June 28, becoming more organic dominant with time.

The amount of carboxylic acids increases and carbon-carbon double bonds decreases with age (right and below).





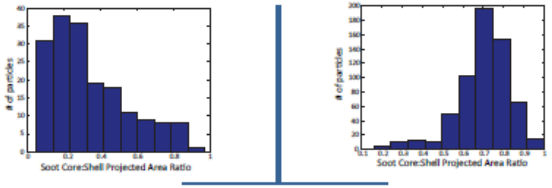
Results

STXM/NEXAFS Inclusion Analysis

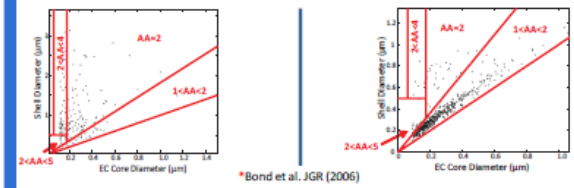
CARES Sacramento

CALNEX Los Angeles

Soot Core : Shell Distributions

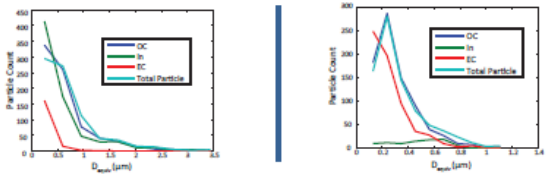


Absorption Amplification (AA*)



*Bond et al. JGR (2006)

Inclusion Size Distributions



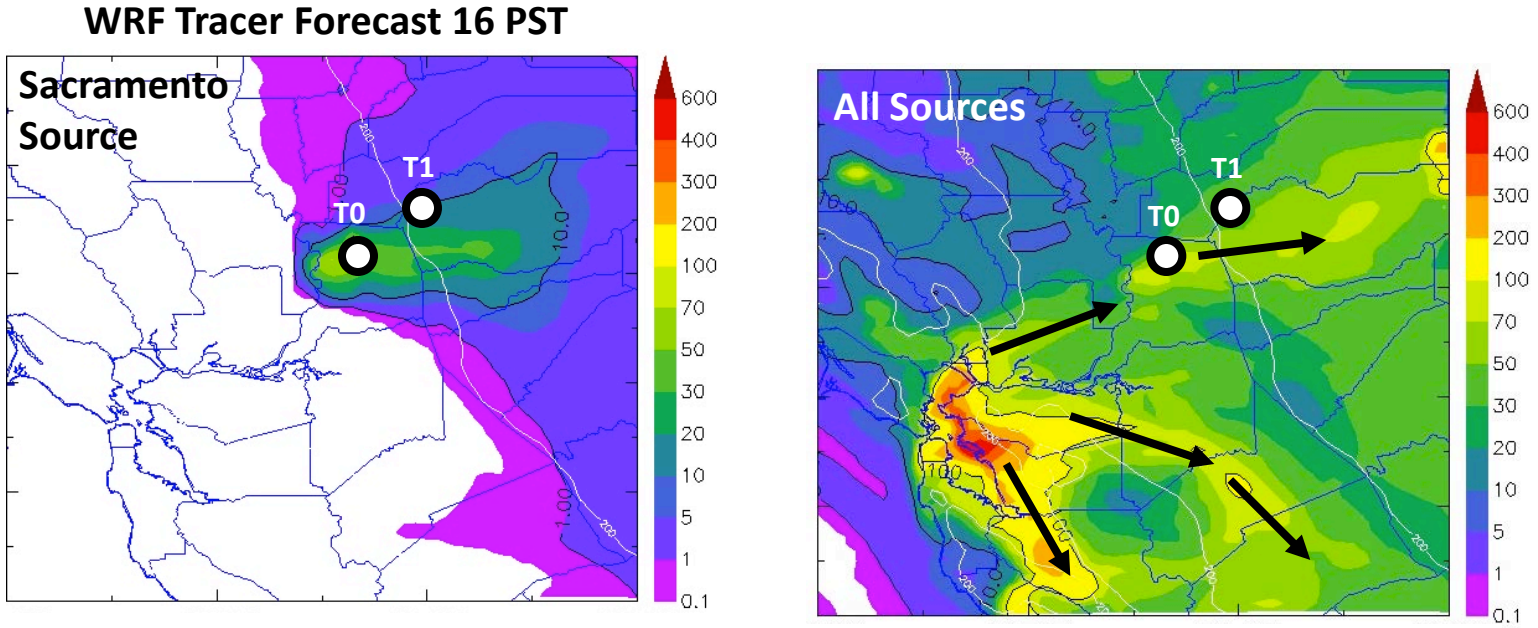
Conclusions

Aerosol particles sampled in Sacramento during CARES had an abundance of organic species, sea salt and sulfates. From June 27 to 28, an increase in homogenous organic particles was observed - likely due to secondary organic aerosol formation. As particles aged, a decrease in carbon-carbon double bonds and and increase in carboxylic acids was measured. The majority of soot particles observed in Sacramento were aged, with coatings that were much larger than the soot inclusions.

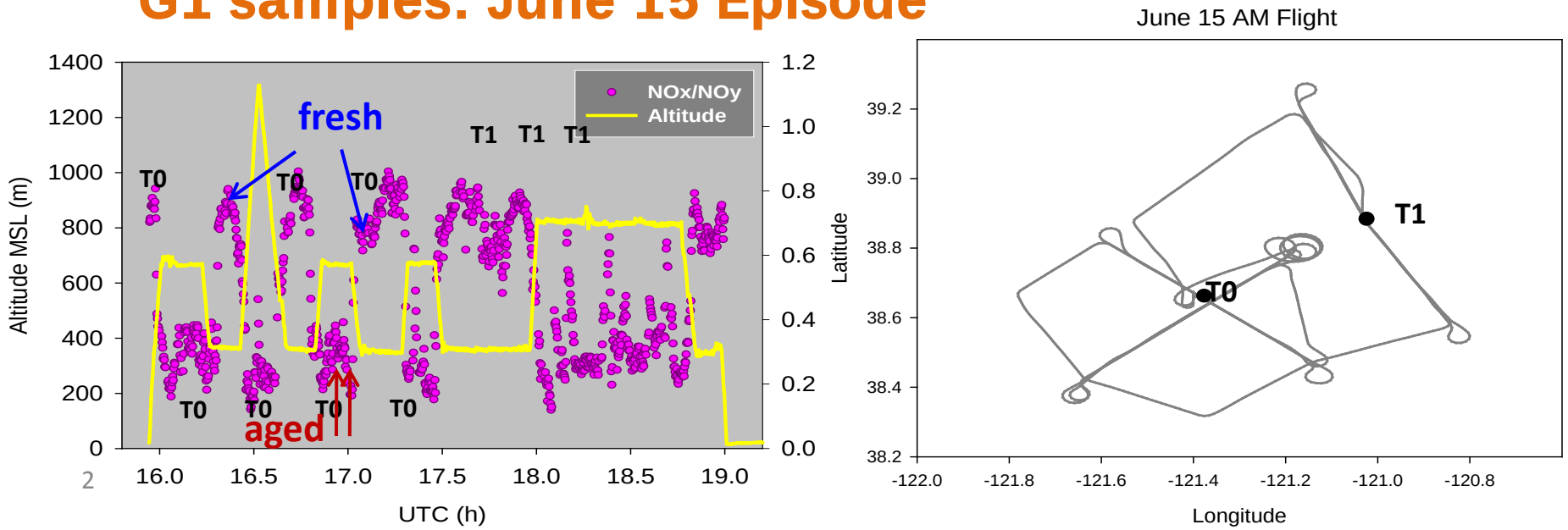
Acknowledgements

We would like to acknowledge generous support from the Department of Energy's Atmospheric Systems Research program. Also, A. Bateman, T. Nguyen, D. Bones, and N. Levac kindly collected samples at Caltech during CALNEX.

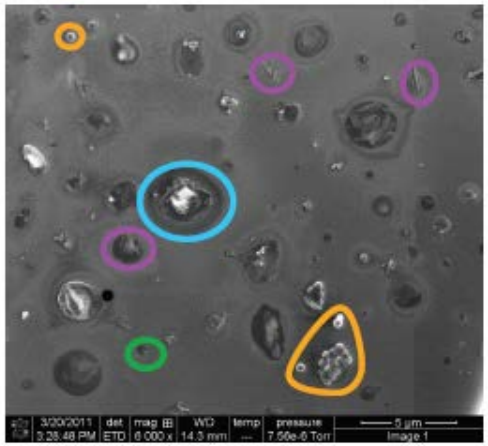
T0, T1 samples: June 28 Episode



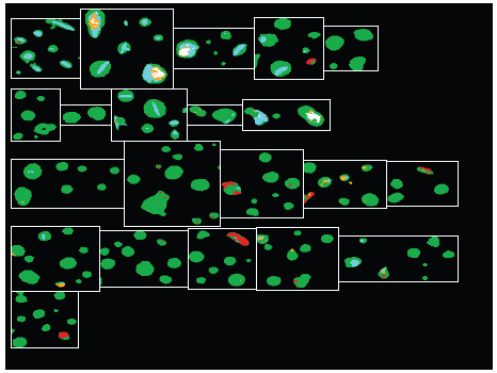
G1 samples: June 15 Episode

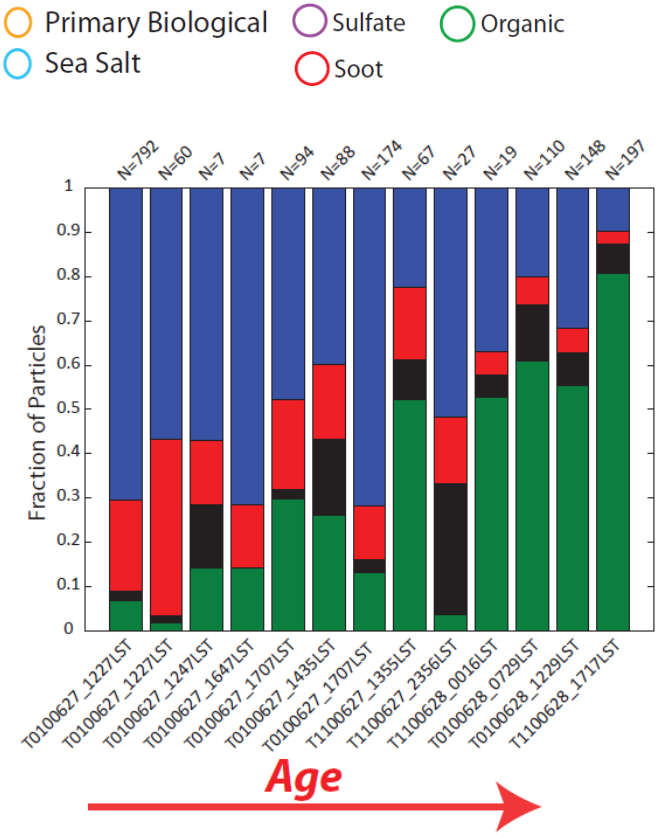


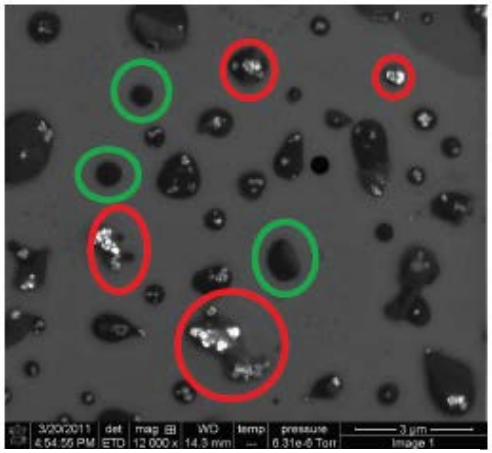
T0, T1 samples: June 28 Episode



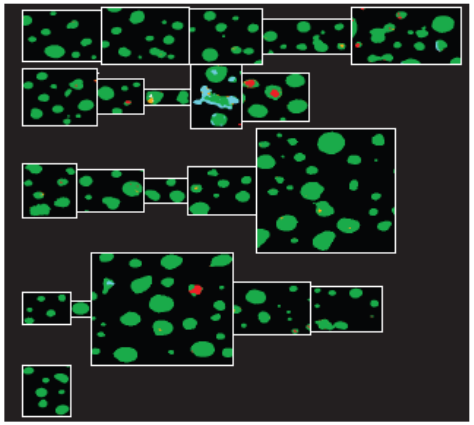
June 28 T0 12:29







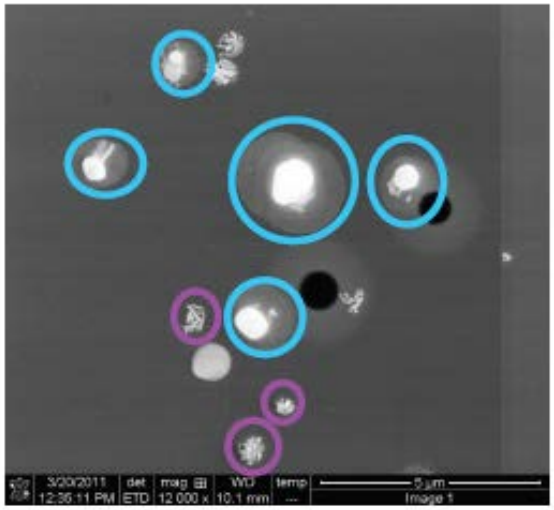
June 28 T1 17:17



G1 samples: June 15 Episode

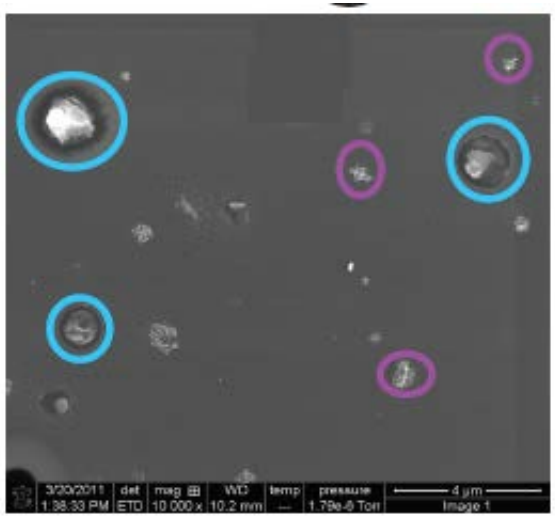
Samples are dominated by sea salt and amm. sulfate, low organics

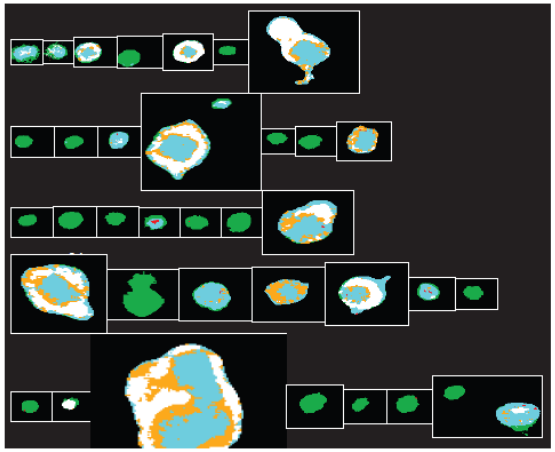
fresh



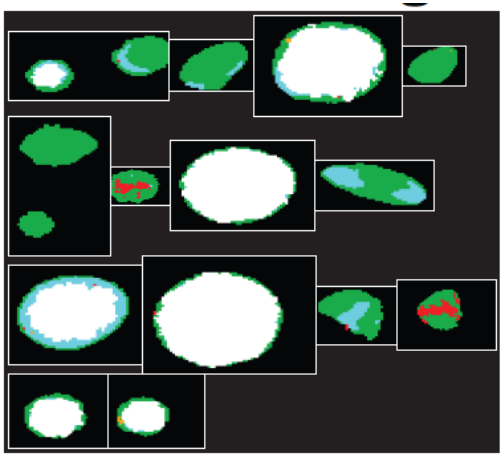
Processed sea salt, higher organics

aged





Organic Dominant
Soot
Inorganic Dominant
CO_3^- Organic
Potassium



High resolution MS molecular characterization of CARES samples

A. Laskin, J. Laskin, P. Roach, B. Heath