



Effect of composition on aerosol properties

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Unlike gases, **aerosol particles** (aka aerosols) are composed of **many species**.

- Minerals (dust), metals (industrial or meteoritic), sodium chloride and other sodium salts, elemental carbon, organic material, sulfate, nitrate, and ammonium.
- At high relative humidity, **water** can be the largest component.

Identifying and quantifying these components as well as their **physical and chemical properties** are needed to understand the impact of aerosols on air quality and climate.

CSD's Current Tools for Particle Chemical Composition (plus Black Carbon)

Particle Analysis by Laser Mass Spectrometry (PALMS)

- Developed in-house and now led by Karl Froyd

Compact Time-of-Flight Aerosol Mass Spectrometer (AMS)

- CSD played a key role in the development of the AMS
- Our instrument is semi-custom



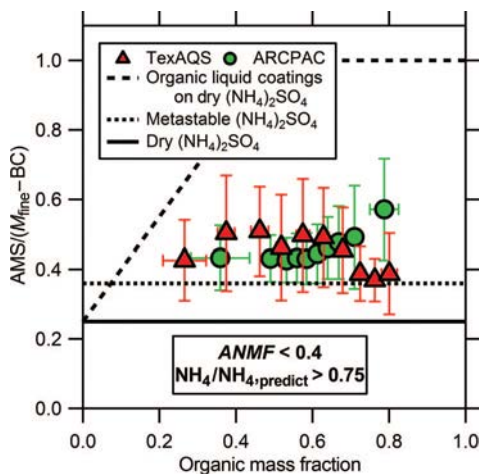
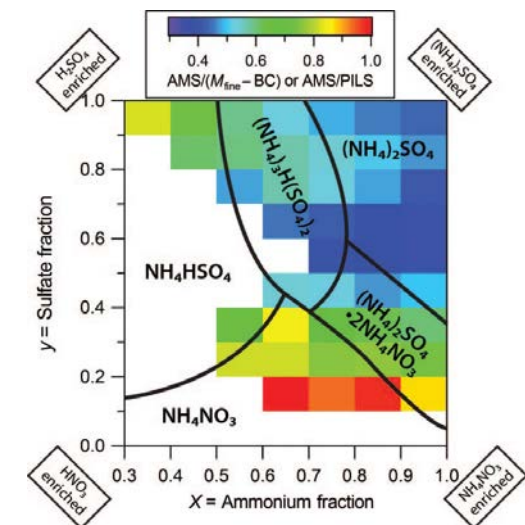
PALMS



AMS

CSD is a leader in observations of atmospheric aerosol chemical composition.

From Middlebrook et al., *AS&T*, 2012.



To better quantify aerosol composition, we performed **laboratory experiments** and analyzed our **field data** that showed **particle phase** affects measurements with the AMS.

We used CSD's data to develop an **algorithm** to account for this effect and correct for undetected mass by up to a factor of 2.

About 200 **AMS instruments** all over the world are using **our algorithm** to improve quantification of their data.

Future work: We will be refining the algorithm for biomass burning aerosols with data from the upcoming fire studies.



AQ & Climate Connection:

Obtain high-quality measurements of aerosol mass, which is important for both themes.



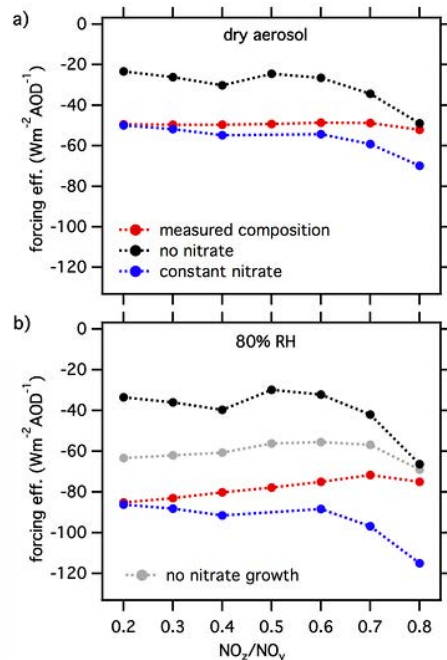


Aerosol Composition Affects Radiative Properties

CSD Contributors: Bahreini, Brock, Gordon, Hall, Lack, Langridge, Law, Liao, Mason, Middlebrook, Murphy, Neuman, Nowak, Richardson, Wagner, and the NOAA CSD P3 Team



From Langridge et al.,
J. Geophys. Res., 2012.



Over the Los Angeles Basin, much of the aerosol mass is **ammonium nitrate** which is **semi-volatile (ammonia + nitric acid)**.

Using **CSD's data** obtained from the NOAA P3, we investigated how aerosol nitrate and water affected **light extinction** and calculated the radiative impact.

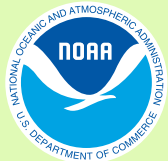
Ammonium nitrate and water affect the **forcing efficiency** by up to a factor of 4 over dry aerosols without nitrate.

As sulfur dioxide emissions are reduced, ammonium nitrate will be **more prevalent** in aerosols and needs further study.

Future work: We are examining the effect of ambient water uptake on light extinction in a nitrate-rich environment.

AQ & Climate Connection:

Anthropogenic nitrogen oxide emissions convert into nitric acid, which partitions between gas and particle phases.

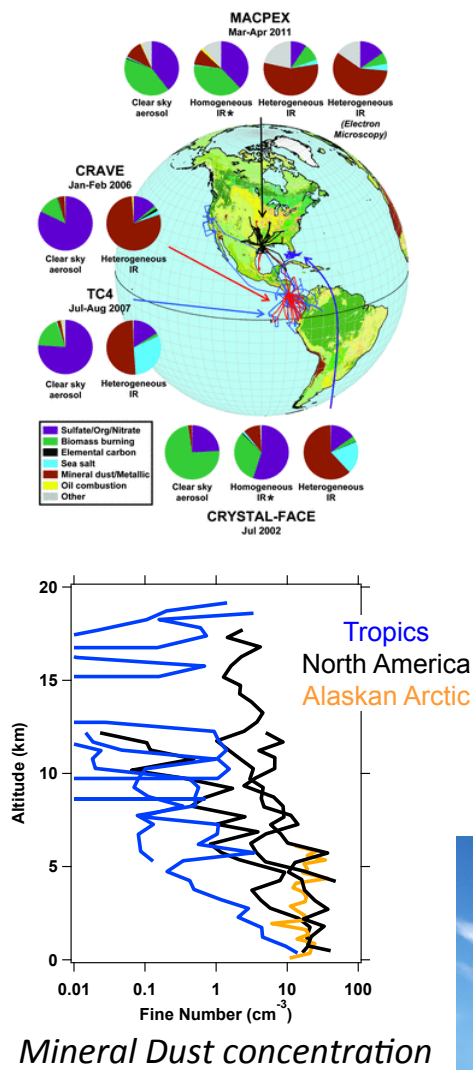


Effect of Composition on Cirrus Cloud Formation

CSD Contributors: Froyd and Murphy



From Cziczo et al., *Science*, 2013.



Cirrus (ice) clouds are prevalent and a key component of the Earth's radiation budget.

CSD developed an inlet for sampling **ice residuals**, measured them with PALMS, and compared them to ambient particles.

We found that **mineral dust and metal particles** are the most abundant ice nuclei and made the first measurements of the **number** of these particles in the upper atmosphere.

These results can be put into global models.

Future work: We will be investigating sources and mechanisms for ice nuclei in the upper atmosphere.



AQ & Climate Connection:

Some components of ice residuals are metals, including lead, which can be released into the atmosphere by anthropogenic activities.

