Multiphase sulfur chemistry facilitates particle growth in a cold and dark urban environment

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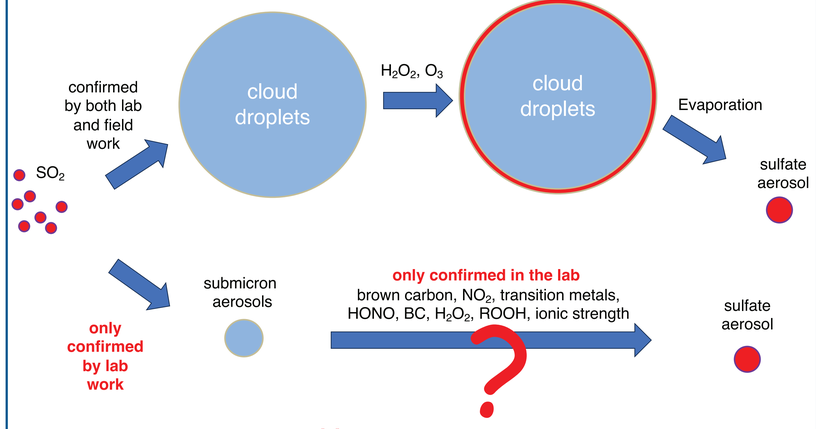
MOTIVATION

Is there any secondary sulfate formation in a cold and dark urban environment?



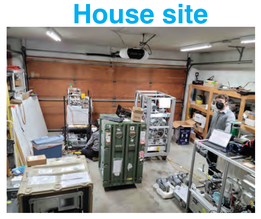
Yes

ALPACA field experiment in Fairbnks, Alaska (Jan-Feb 2022)

Map of the three sampling sites within the larger Fairbanks area.

CTC site

House site



NCore site

Fairbanks, Alaska (latitude 64.84°N) is a subarctic city with cold winter (sometimes <-30C) and high PM2.5 pollution due to strong surface inversion layer and emissions.

- CTC site: HR-ToF-AMS, SMPS, PILS-IC, MC-IC, PTR-MS, HCHO by LIF, NO_x, SO_2, CO, O_3, aerosol optical properties.
- House site: HR-ToF-AMS (pToF mode), SMPS, PTR-MS, NO_x, CO, O_3, HCHO by Picarro CRDS.
- NCore site: ACSM, photolysis rate, NO_x, SO_2, CO, O_3, BAM.

Acknowledgement

This work is supported by the the NSF grants AGS-2029747 and NNA-1927750.

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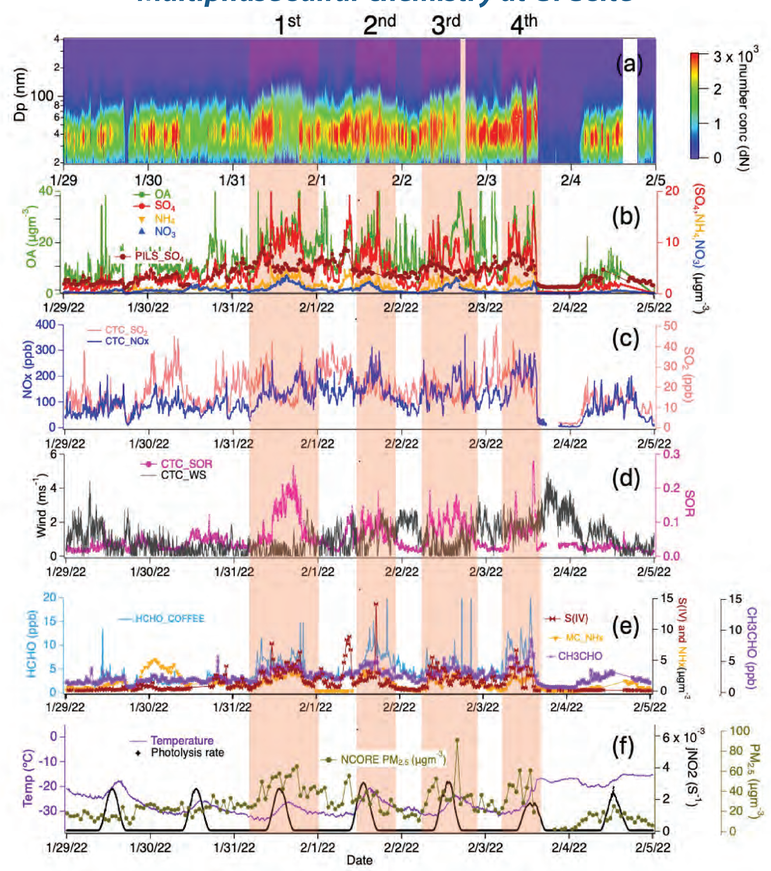
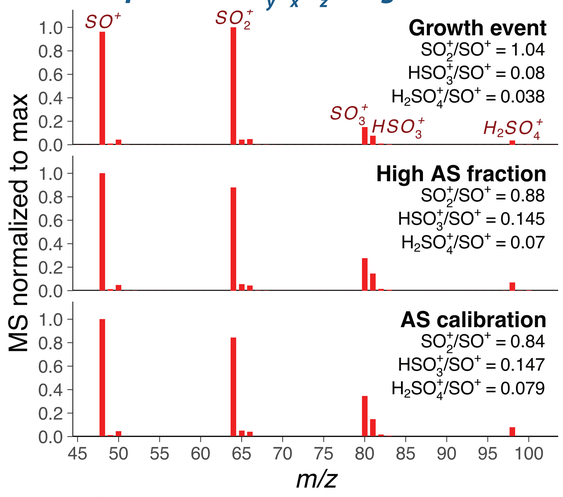
Multiphase sulfur chemistry at CTC site



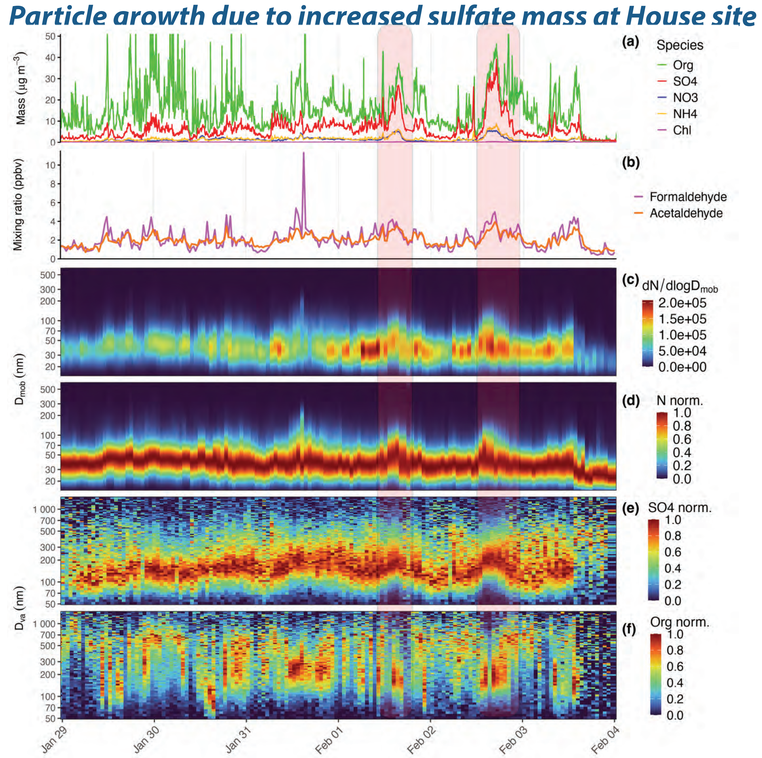
- *AMS-sulfate spikes did not appear until the third day of this cold event, despite high levels of SO_2 and NO_2 for the first two days (Jan 29th and 30th).*
- *AMS-sulfate spikes are strongly related to the increases of HCHO, CH_3CHO and S(IV).*
- *80% of AMS-sulfate spikes are due to S(IV) enhancement.*

HR-ToF-AMS spectra of $H_yS_xO_z^+$ fragments at the House site



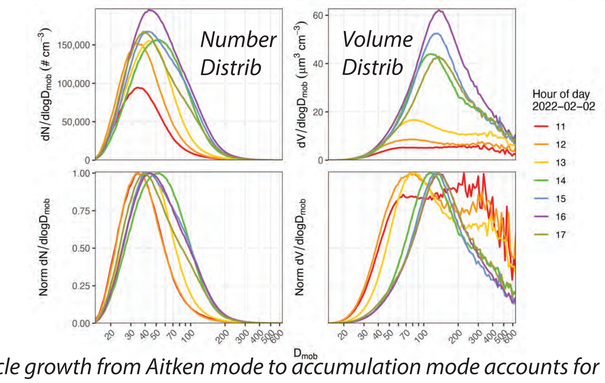
- *It appears that AMS-sulfate spikes are mainly due to organosulfur compounds.*

Particle arowth due to increased sulfate mass at House site



- *AMS-sulfate spikes account for up to 50% of particle growth from Aitken mode to accumulation mode, resulting from multiphase sulfur chemistry.*

Time evolution of aerosol number and volume distribution



- *Particle growth from Aitken mode to accumulation mode accounts for the majority of increase in aerosol mass.*

ACSM measurements in three winters at NCore site

- *Sulfate spiking events occurred during periods of high NO_y, SO_2, CO, and low ambient temp.*
- *Sulfate spiking events are present in most high $PM_{2.5}$ events.*
- *Sulfate spiking events do not take place when ambient temp is higher than -15C.*