The Organic Contribution to Stratospheric Aerosol Particles Collected during the SABRE 2023 Campaign

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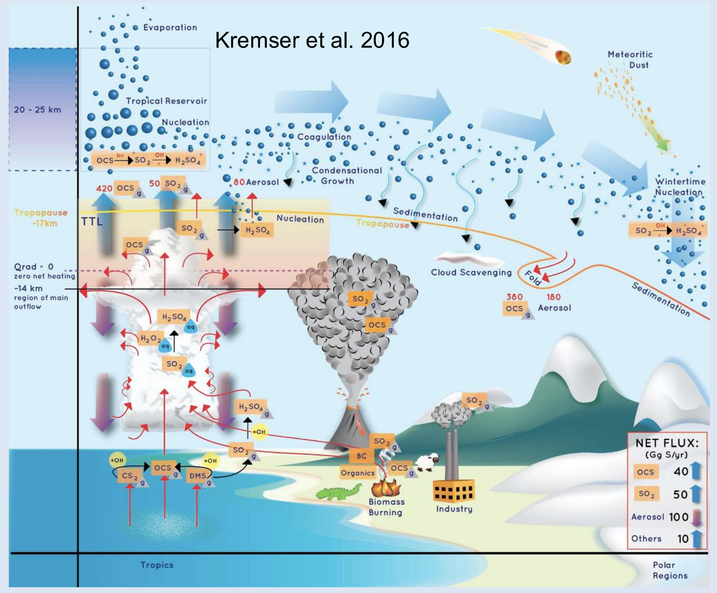
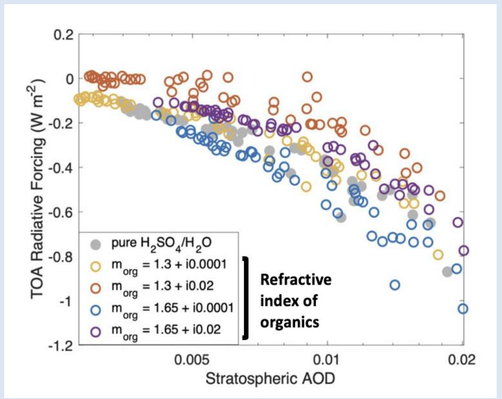
Importance of Stratospheric Aerosols

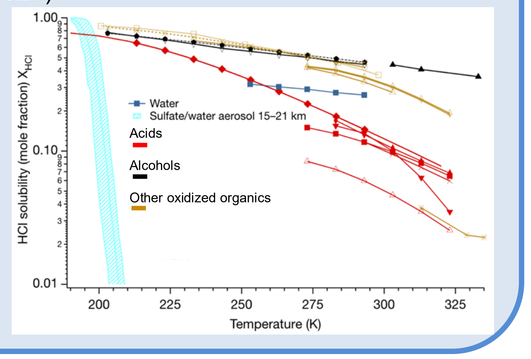


- Approximately **21% of total aerosol direct radiative forcing** since 1850 is contributed by stratospheric aerosols (Yu et al., 2016)
- Current knowledge of the physicochemical properties of stratospheric aerosols is still quite limited, especially for the particles within the polar vortex, which represent the oldest air in the stratosphere



Scatter plot of top of atmosphere (TOA) shortwave radiative forcing (RF) and total stratospheric aerosol optical depth (AOD) illustrates the dependence of radiative impacts on chemical composition

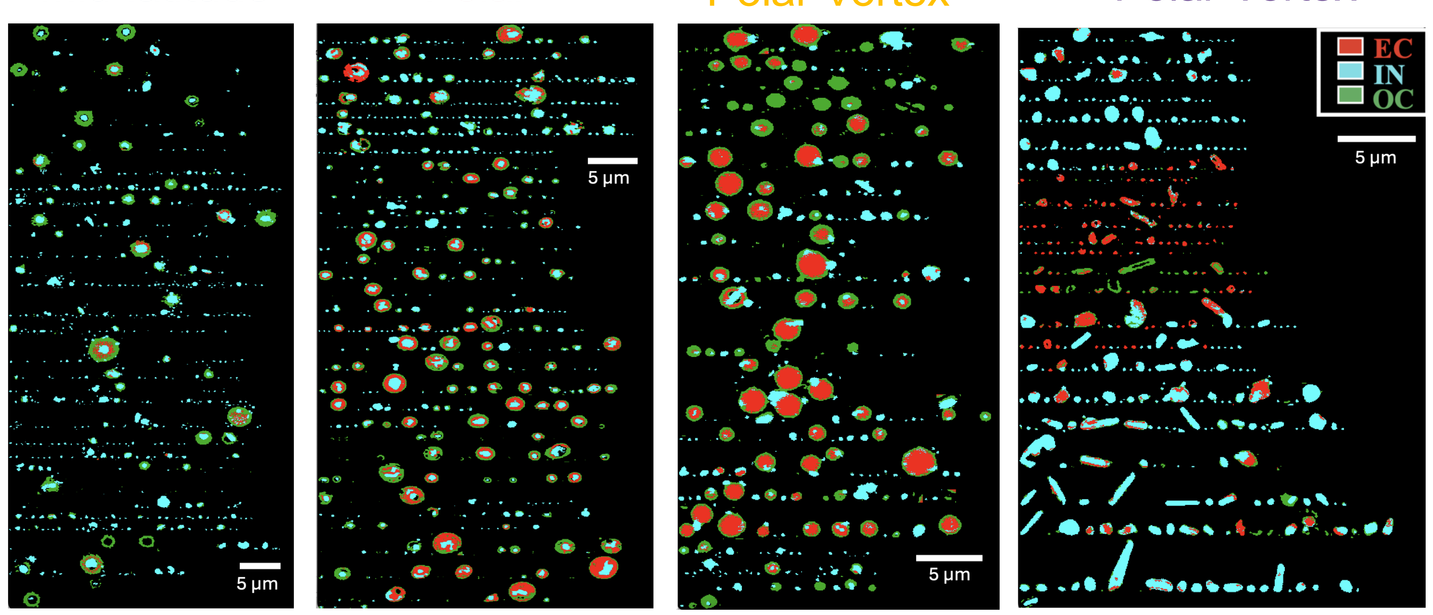
- Depending on the complex refractive index of organics and the particle mixing state, **the relative change in TOA shortwave RF could be as high as ±100%** when substituting pure sulfate with 50% organic-containing particles (Li et al., 2021)
- Organic aerosols could uptake HCl much more rapidly than sulfate aerosols (Solomon et al., 2023)
- HCl uptake could be crucial for both removing Cl from the stratosphere, and for enabling particle phase reactions that could slow ozone recovery



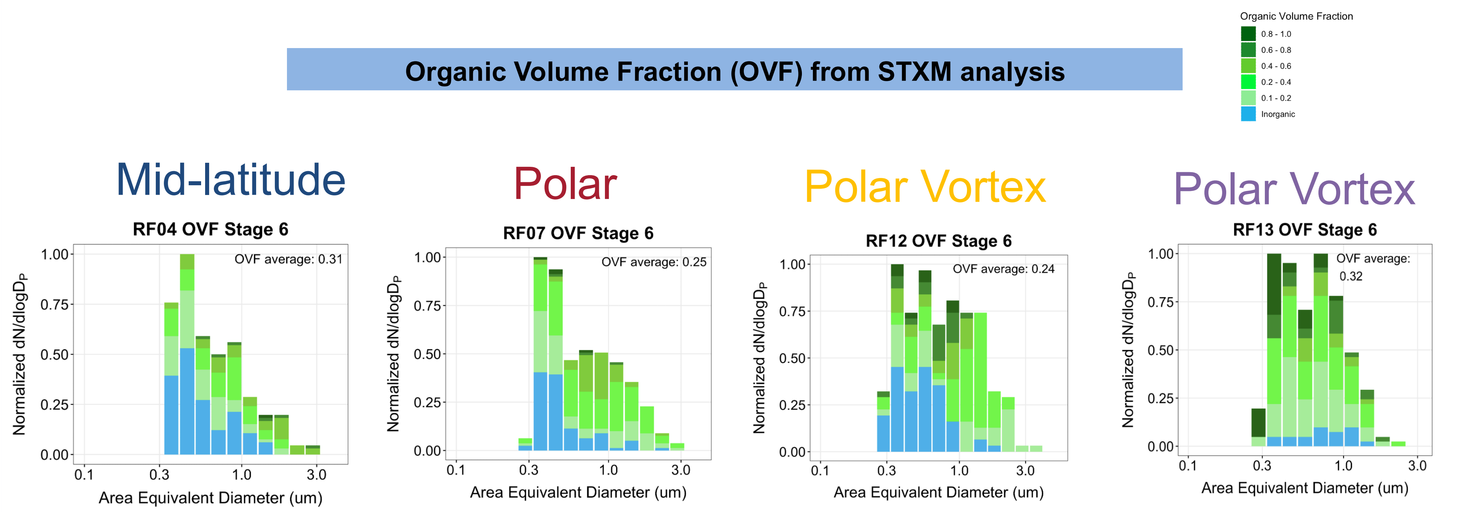
Organic Contributions via STXM-NEXAFS analysis techniques

Here we present an analysis of aerosol samples collected from mid-latitude, polar (non-vortex), and polar vortex regions, emphasizing the detection and distribution of organics across varying latitudinal flight paths.

Contributions of EC, IN, and OC from STXM analysis

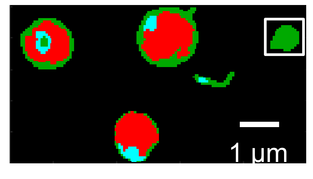


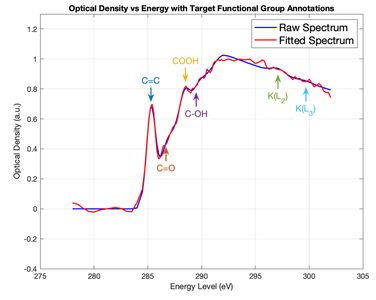
Organic Volume Fraction (OVF) from STXM analysis

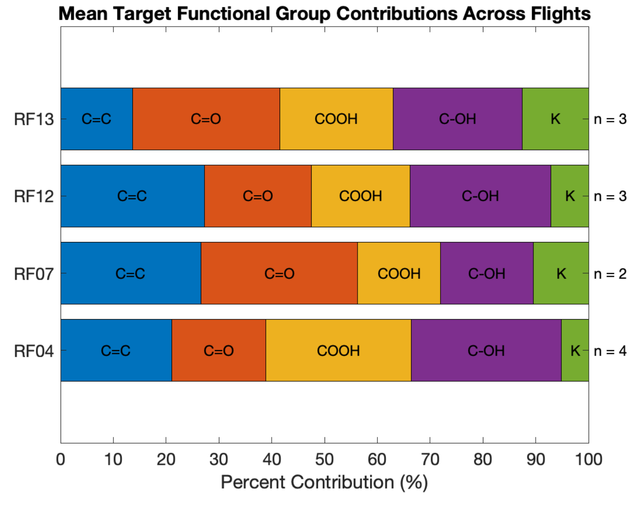


Percent contributions per flight of organic functional groups

Ex. RF12: Polar Vortex Particle

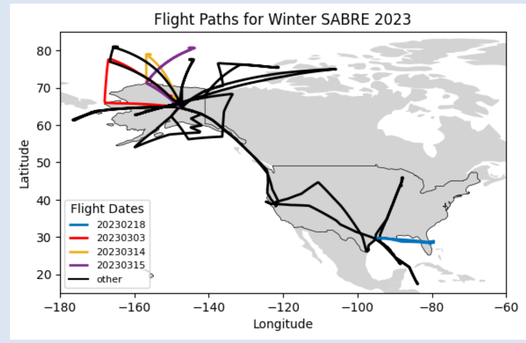






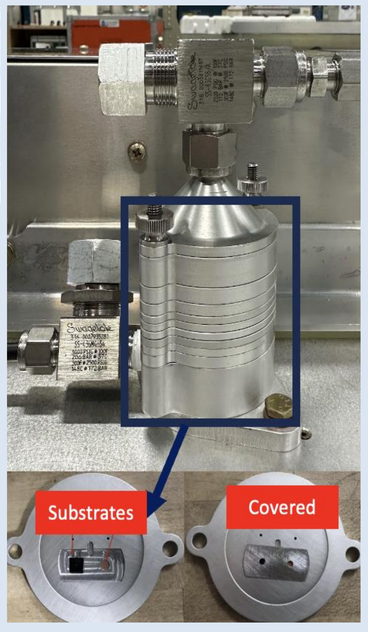
Across all research flights, we observed aerosol particles with variability in the organic composition, with different functional groups that could impact chemical reactions (Solomon et al., 2023). We also observe morphological diversity (i.e. core-shell, rods, homogenous mixing) which could have chemistry and radiative impacts (Li et al., 2021). These findings suggest that aerosols could influence climate and chemical interactions differently than the standard assumption of spherical, sulfate aerosols.

Aerosol collection during Winter SABRE 2023



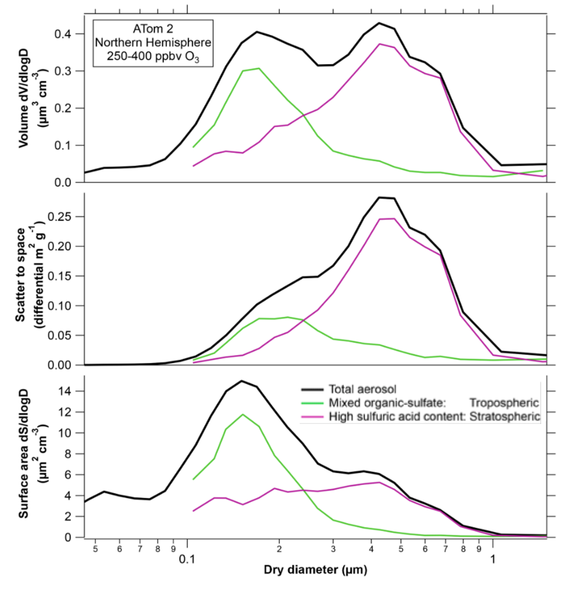
- **Stratospheric Aerosol processes, Budget, and Radiative Effects (SABRE)** is a NOAA Earth's Radiation Budget Initiative Project with the WB57 high-altitude aircraft (up to 18.5 km) flying from Houston, TX, and Fairbanks, AK in winter 2023 to advance the current knowledge of stratospheric aerosol processes

Mini-MOUDI: miniature Micro-Orifice Uniform Deposit Impactor



- Mini-MOUDI: Cascade impactor to collect size-fractionated (180-3200 nm) aerosol particles based on aerodynamics for offline chemical analyses: **chemical composition and morphology**
- Real-time controls allow for the sampling of specific targets (e.g. rocket plume) and the avoiding of specific events (e.g. cirrus clouds)

Future Directions



Murphy et al., 2021 illustrates that size distribution can impact both scattering (climate impacts) and surface area (chemistry impacts)
Mini-MOUDI collection measures most of this size range, and highlights the potential impact organics could have on climate and chemistry

Data Availability

- All SABRE data presented here are available upon request

Acknowledgements

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References

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Kremser et al., *Reviews of Geophysics,* 2016
Li et al., *Geophysical Research Letters,* 2021
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Solomon et al., *Nature,* 2023

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