Relationships between sulfur aerosol concentrations for a Summit, Greenland ice-core and sea ice area over the last 40 years

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Abstract

Sulfate concentrations have been changing over the years in due to anthropogenic emissions in the Arctic region. As the sea ice cover changes the biogenic productivity also changes which may impact sulfate and MSA concentrations in the atmosphere. Records of sulfur and MSA were gathered from the Summit, Greenland ice-core records over a time frame of around 40 years and were then compared to two regions of sea ice coverage. These regions were determined by a NOAA HYSPLIT model in which it projects the path of where the aerosols are coming from when we set site location as Summit. Baffin Bay and East Greenland Sea were found to be reliable areas to look at for the changing sea ice coverage over the summer and winter months. Previous work had suggested that there is a relationship between MSA and Sea Ice Extent.

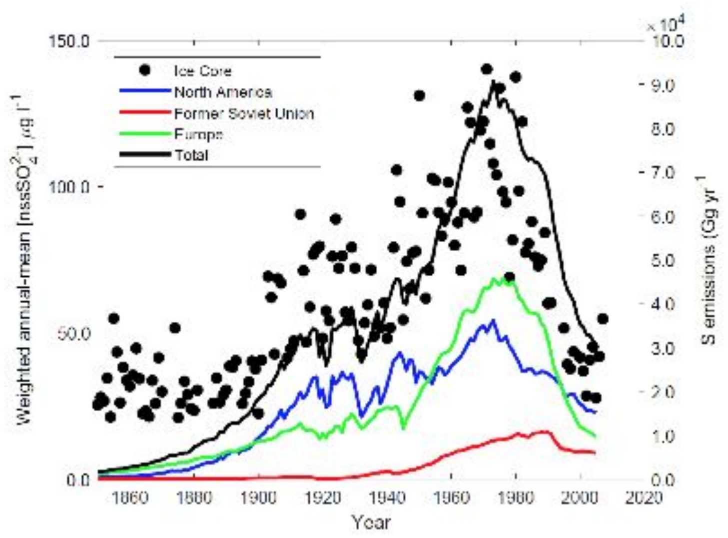
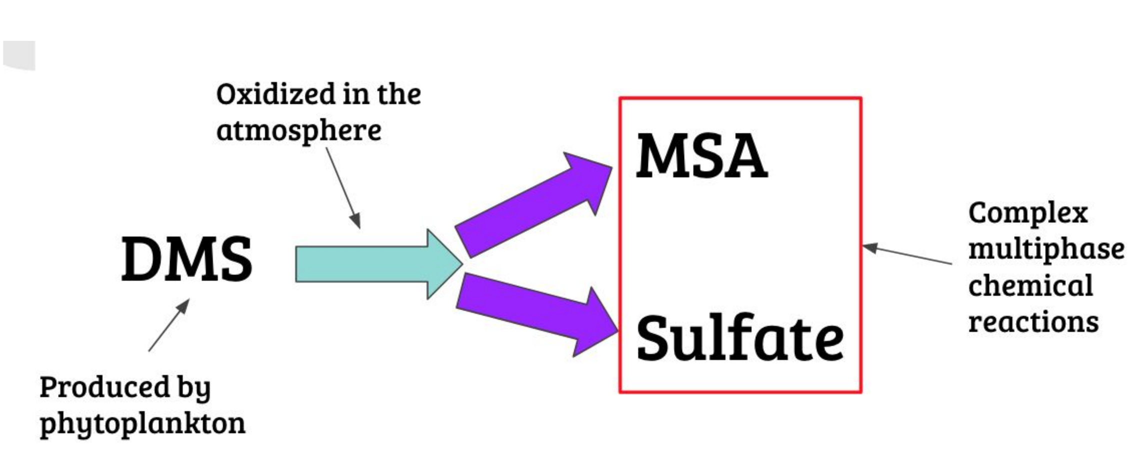


Fig.1 Sulfate concentrations of (Summit) Greenland ice-core (black dots). Sum of the emissions is shown by the black line. Smith et al. [2011] Sulfate emissions in North America, Europe, and the FSU.

Background

Large changes in sea ice area in the Arctic region could possibly affect the oceanic emissions of Dimethyl Sulfide (DMS), a trace gas that is created by means of biogenic productivity like ice algae and phytoplankton. The oxidation of DMS in the atmosphere leads to the formation of the Methane Sulfonic Acid (MSA) and sulfate (H2SO4). As the SIA decreases in the Arctic there is an expected increase in biogenic productivity leading to more emission of DMS and thus more MSA and sulfate in the atmosphere as the DMS is oxidized.



MSA and Sulfur concentration over time

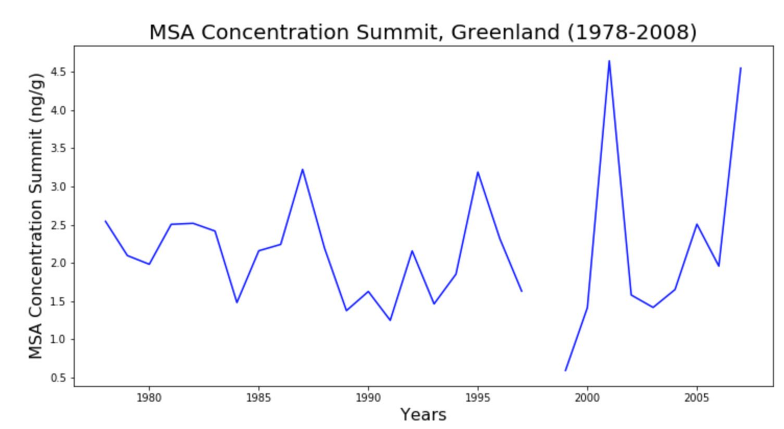


Fig. 2 Annual MSA concentration from Summit (ng/g) plotted vs time 1979-2008.

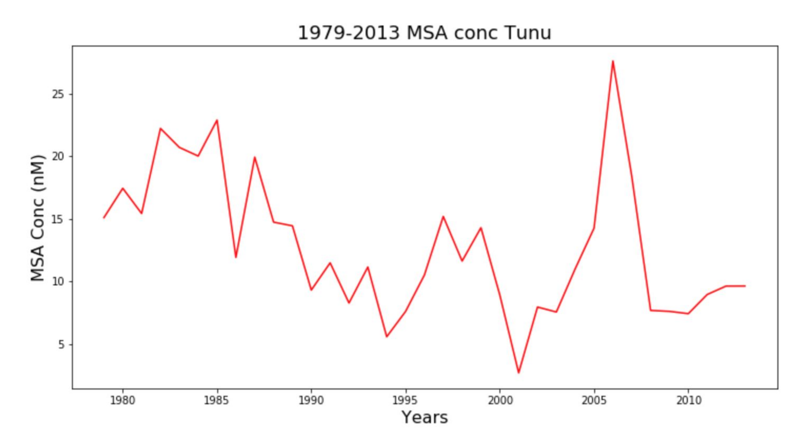
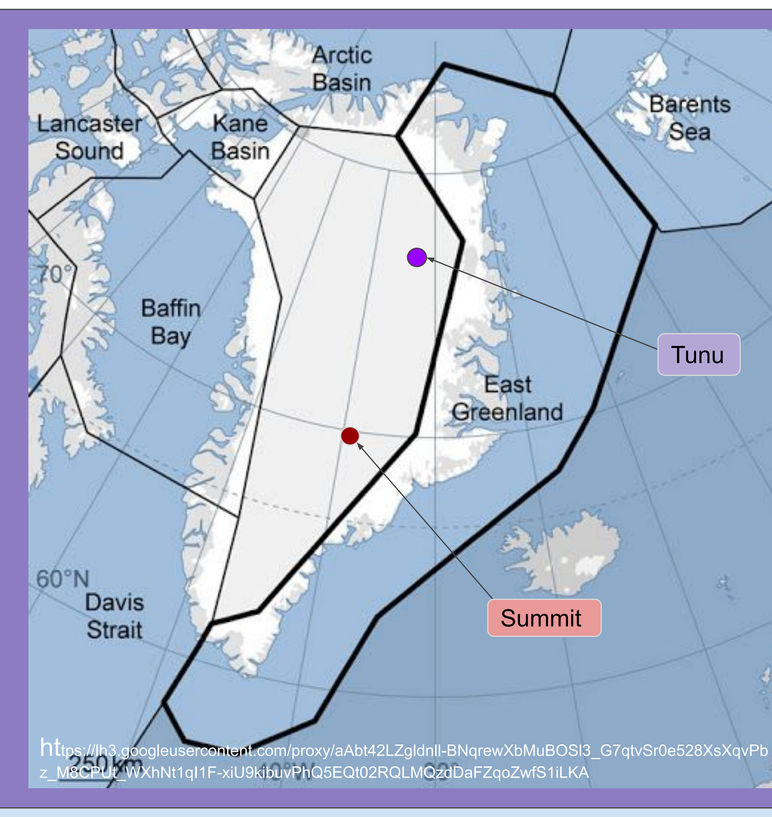


Fig. 3 Annual MSA concentration from Tunu (nM) plotted vs time 1979-2008. Data from Maselli paper.



SIA Baffin Bay and East Greenland Sea

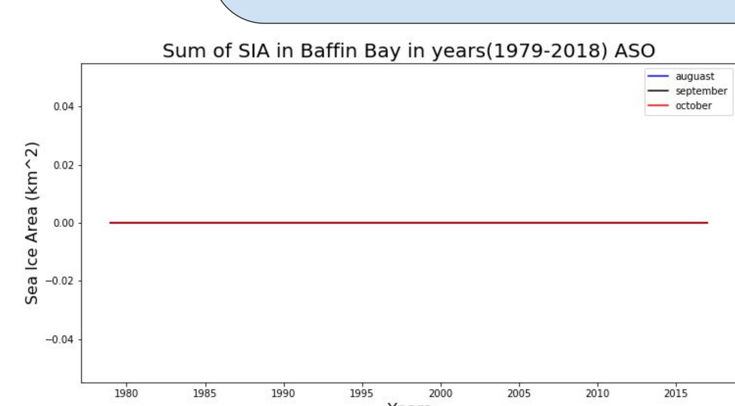


Fig. 4 Sea ice area (SIA) of Baffin Bay vs time in years (1979-2018) for months of August (blue), September (black), and October (red) (ASO). No SIA for BB during the Arctic summer.

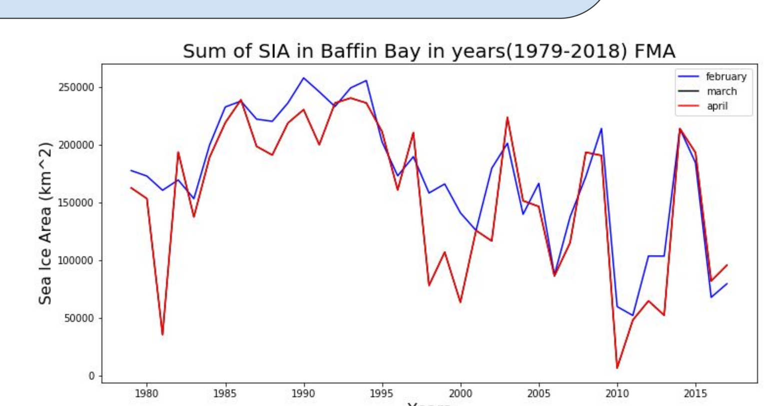


Fig. 5 SIA of Baffin Bay vs years (1979-2018) for months of February (blue), March (black), and April (red) (FMA). March and April are equal.

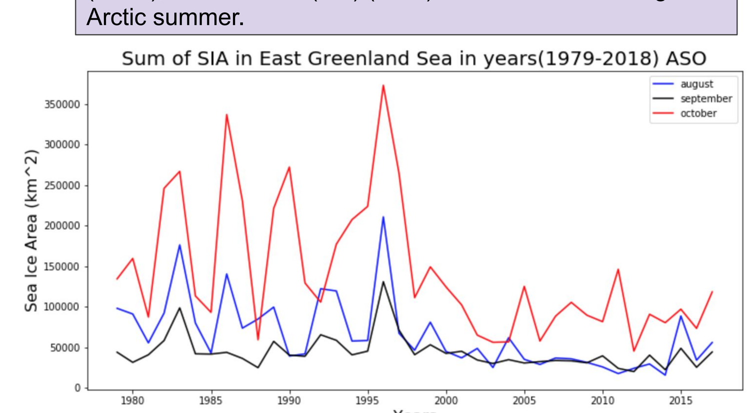


Fig. 6 SIA of East Greenland Sea vs years (1979-2018) for months of (ASO).

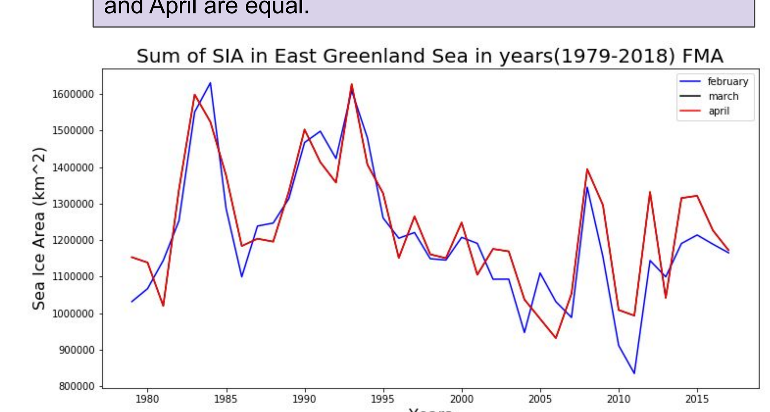


Fig. 7 SIA of East Greenland Sea vs years (1979-2018) for months of (FMA). March and April are equal.

Acknowledge:

Olivia J. Maselli for her paper on "Sea ice and pollution-modulated changes in Greenland ice core methanesulfonate and bromine"

MSA vs SIA Tunu and Summit (FMA)

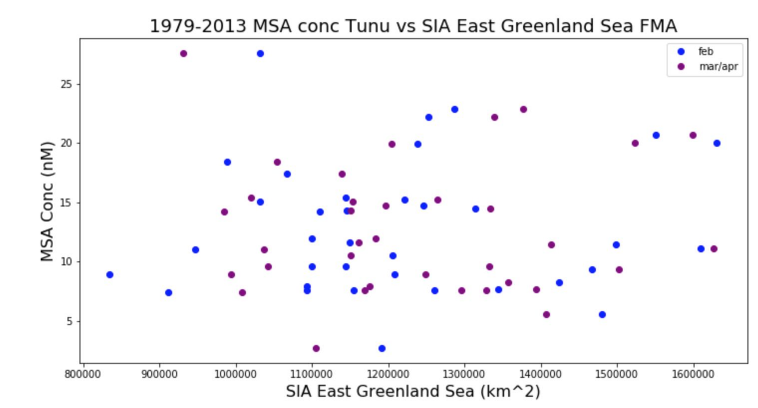


Fig. 8 MSA concentration from Tunu (nM) vs the SIA of Baffin Bay during FMA. February (blue) and March/April (purple).

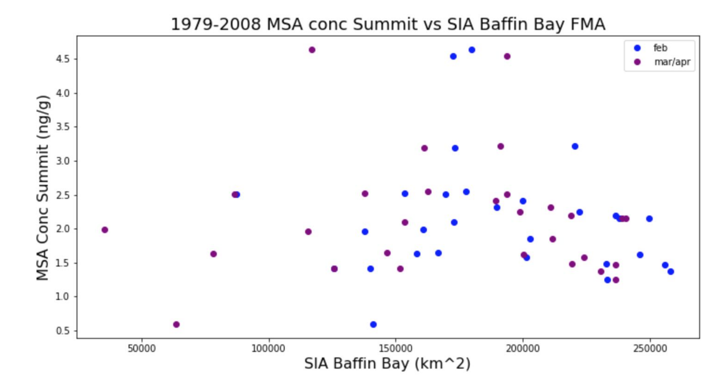


Fig. 9 MSA concentration from Summit (ng/g) vs the SIA of Baffin Bay during FMA.

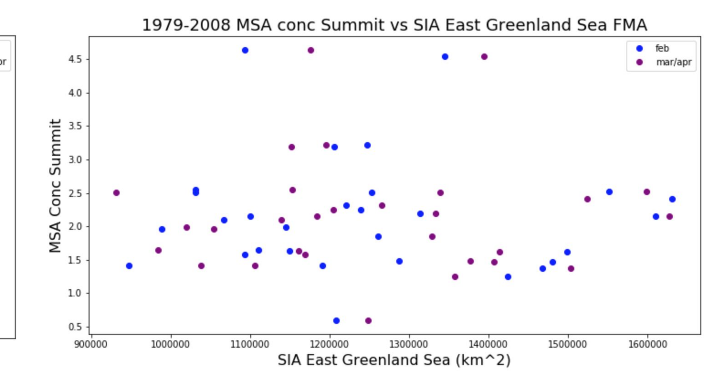


Fig. 10 MSA concentration from Summit (ng/g) vs the SIA of East Greenland during FMA.

Preliminary Conclusions

- There is no apparent relationship between MSA and Sea Ice Extent.
- MSA concentration in Summit, Greenland has stayed relatively unstable over the recent years (increasing) whereas sulfur concentrations have been decreasing.
- Tunu MSA concentration has been gradually decreasing.

Future Directions

- This summer I will be collecting and measuring the biogenic source of sulfate from the Summit ice-cores.
- Ratio of the heavy to light isotopes of sulfate over time.
- Identify how oxidant has changed over time in the atmosphere (MSA compared to sulfate).