Dimethylsulfide (DMS) Hotspots Linked to Hydrographic Frontal Structures and Sea Ice Dynamics in the Canadian Arctic Archipelago

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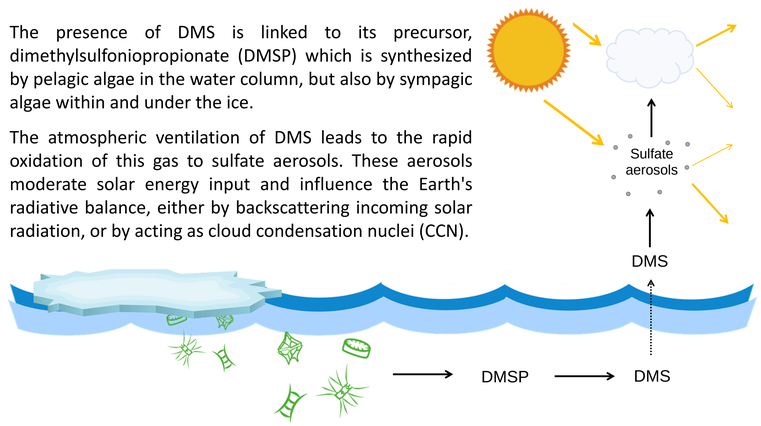
The goal of this study was to investigate the spatial distribution of dimethylsulfide (DMS) concentrations in relation to biological and physicochemical parameters as well as sea ice dynamics. More than 3500 sea surface concentrations of DMS were collected in the Canadian Arctic in 2017 (July-August) and 2018 (July). The results of this study strengthen the belief that marine DMS cycling in the Arctic is intimately linked to sea ice dynamics, the origin of water masses and hydrographic frontal structures. As such, future changes in the seasonality of the Arctic cryosphere will likely play an essential role in shaping DMS emissions.

INTRODUCTION

The presence of DMS is linked to its precursor, dimethylsulfoniopropionate (DMSP) which is synthesized by pelagic algae in the water column, but also by sympagic algae within and under the ice.

The atmospheric ventilation of DMS leads to the rapid oxidation of this gas to sulfate aerosols. These aerosols moderate solar energy input and influence the Earth's radiative balance, either by backscattering incoming solar radiation, or by acting as cloud condensation nuclei (CCN).

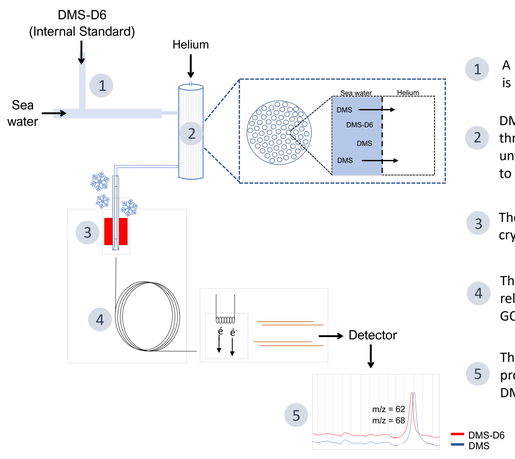


Hypothesis:

The distribution of DMS is characterized by rapid variations related to physiological responses of phytoplankton, as well as local patterns related to hydrography.

METHOD

Automated Cryogenic Trap Membrane Inlet Mass Spectrometer (ACT-MIMS) used to perform high resolution measurements

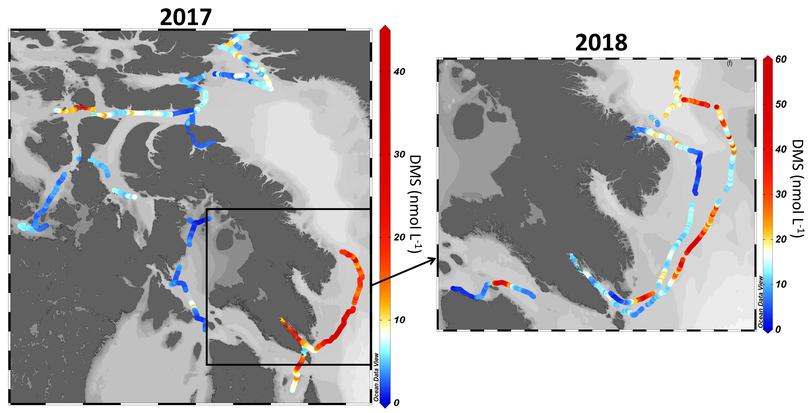


1. A deuterated solution of DMS (DMS-D6) is used as an internal isotopic standard
2. DMS present in sea water diffuses through the semi-permeable membrane until the partial pressures are equivalent to obtain a gas sample.
3. The sample is concentrated using a cryogenic trap at -90 ° C.
4. The rapid heating of the trap at 180 ° C releases the sample which is analyzed by GC-MS
5. The signal obtained is directly proportional to the concentration of DMS in the sample

Ancillary measurements:

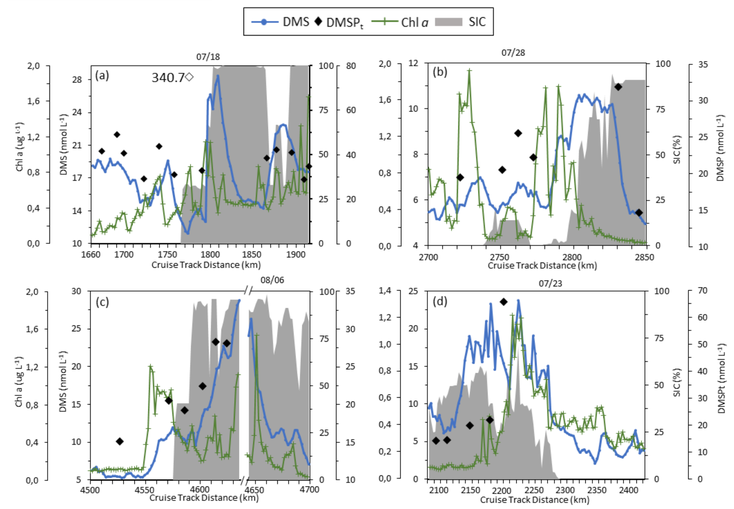
- Sea surface salinity (SSS), sea surface temperature (SST), Chl *a*, sea ice concentration (SIC), photosynthetically active radiation (PAR), $DMSP_t$.

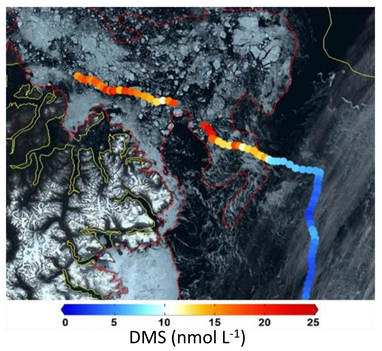
RESULTS



What influences DMS concentrations in the Arctic?

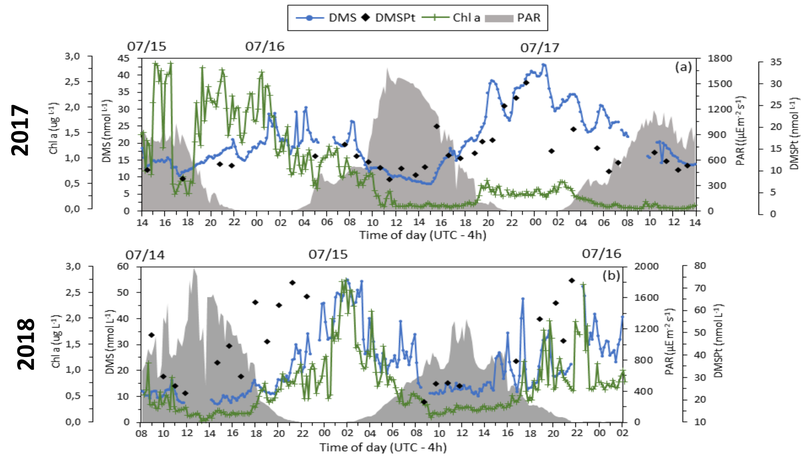
DMS AT THE ICE-EDGE





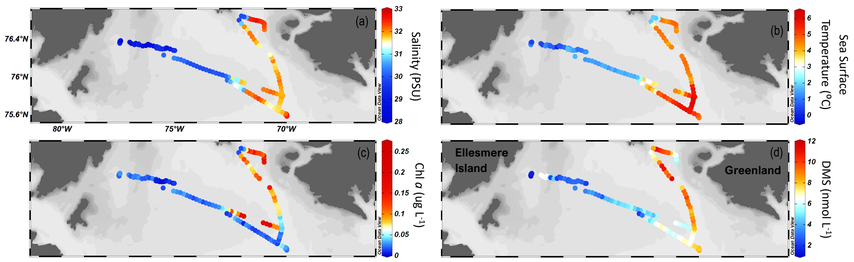
- Phytoplankton can adapt and acclimate to very low light conditions under the ice. This makes them particularly sensitive to sudden high light exposure when the ice melts and break up.
- The production of DMSP and DMS by under-ice phytoplankton could be upregulated by the drastic changes in light exposure.

DAY-NIGHT TRENDS IN THE LABRADOR SEA



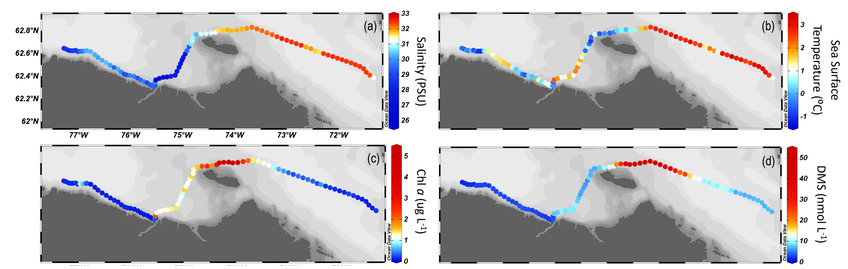
- DMS and $DMSP_t$ appeared to follow day-night trends with minimums during the day and maximums during the night.
- It is possible that a strong solar irradiation causes photoinhibition of DMSP synthesis.
- The effects of light on phytoplankton and bacteria may also have resulted in an imbalance between the production and consumption of DMS.
- Photolysis, an important elimination process for DMS, could also have contributed.

EAST-WEST GRADIENT IN BAFFIN BAY



- DMS concentrations were highest close to Greenland and decreased westward towards Ellesmere Island. This could be explained by differences between phytoplankton communities.
- This gradient was characterized by a contrast of SSS and SST typical of the circulation in Baffin Bay.

HYDROGRAPHIC FRONT IN HUDSON STRAIT



- Hudson Strait is strongly influenced by the input of low salinity waters from Hudson Bay and Foxe Basin flowing southeastward and the input of the Labrador Sea waters flowing northwestward.
- The complex circulation could influence the distribution of DMS concentrations because of enhanced vertical mixing conditions and stronger biological production.

CONCLUSION

- Overall, DMS concentrations were highest in the northern Labrador Sea and lower throughout the Archipelago.
- This study provides evidence that phytoplankton at the ice-edge can be an important source of DMS emissions in the Arctic during the melting season.
- Results revealed apparent day-night trends in DMS and DMSPt concentrations in the northern Labrador Sea with maximums at night and minimums during the day.
- In northern Baffin Bay, DMS and DMSPt concentrations followed an east to west gradient. This gradient appears to be related to the differences in water bodies.
- In Hudson Strait, high concentrations of DMS were associated with a strong hydrographic front caused by the difference in water inflow. This region is thought to be characterized by more active hydrodynamic processes and enhanced mixing conditions, which would lead to enhanced biological production.

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