Relationships linking satellite-retrieved ocean color data with atmospheric components in the Arctic

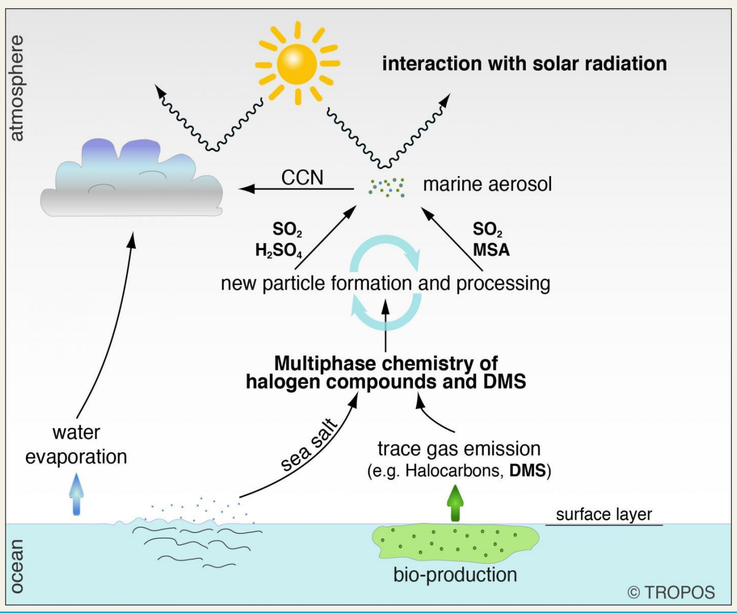
M. MARBOUTI[1], S. JANG[2], S. BECAGLI[3], T. NIEMINEN[1], G. NAVARRO[4], M. SIPILÄ[1], M. KULMALA[1]

[1]Institute for Atmospheric and Earth System Research (INAR), [2] Pohang University of Science and Technology, South Korea, [3] Department of Chemistry, University of Florence, Italy. [4] Instituto de Ciencias Marinas de Andalucía (ICMAN-CSIC), Spain.

Introduction

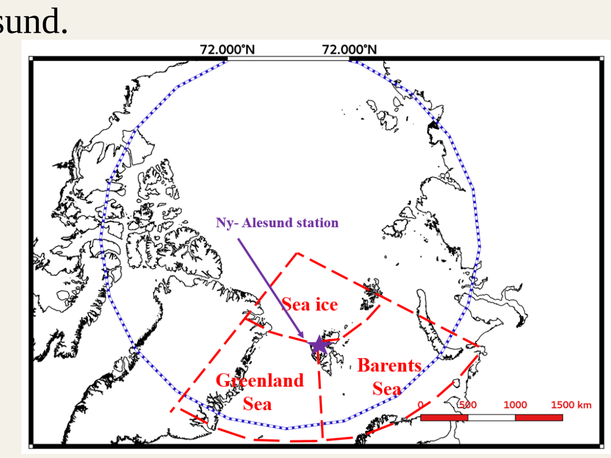
New particle formation (NPF) and the growth of particles in the atmosphere are crucial processes which have great impact on climate by contributing to the concentration of cloud condensation nuclei (CCN). Because marine aerosols and clouds can have direct and indirect impact on the Earth's radiation budget, it is known that particle formation process is important in climate regulation. There are many source compounds for new particle formation and growth in the atmosphere in remote ocean such as sulfuric acid (SA), methane sulfonic acid (MSA), highly oxidized molecules (HOMs), and HIO3.

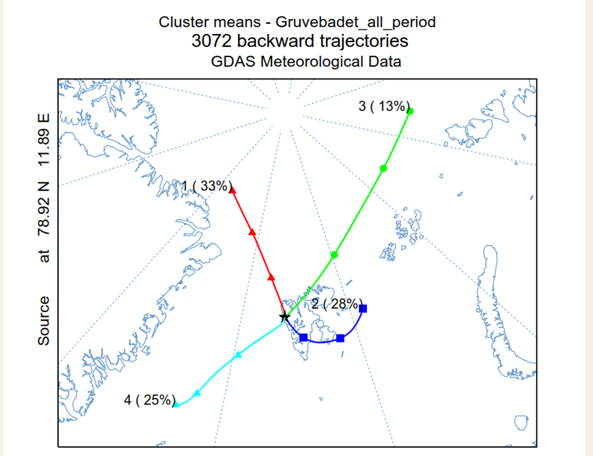
In this study, we examined the relationships linking atmospheric in-situ data of MSA, SA, HIO3, HOM and aerosol concentrations (with sizes of 10nm, 50nm and 100nm) with satellite-derived chlorophyll a (Chl-a), oceanic primary production (PP) also as a function of sea ice concentration and extent during two time spans – the phytoplankton bloom period, April-May 2017 (30th March-1st June) and post-phytoplankton bloom; June – July 2017 (2nd June- 4th August) – in two ocean domains; Greenland and Barents sea.



Sampling site and trajectory analysis

Field measurements and trajectory analysis were performed at Gruvebadet laboratory in Ny Ålesund.





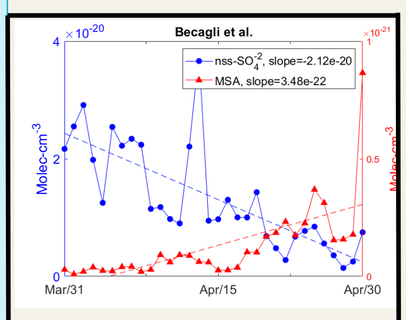
Sampling methods

The MSA, SA, HIO3 and HOMs were measured by a nitrate ion Chemical Ionization Atmospheric Pressure interface - Time-of-Flight - mass spectrometer (CI - Api - ToF) and TSI's Scanning Mobility Particle Sizer (SMPS) was used for submicrometer particle size distribution measurements.

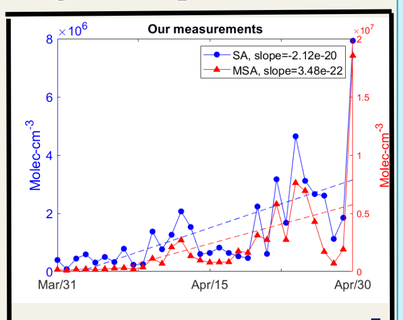
Results and discussion

MSA and SA (gaseous and particle phases)

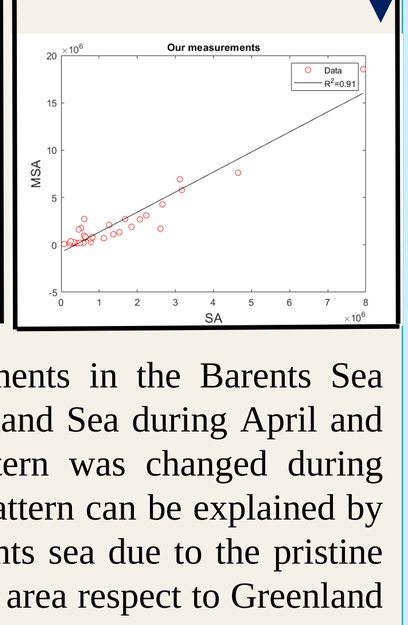
In Becagli et al., 2019 work, MSA and non-sea-ice-SO2 (nss-SO4) show different patterns to each other; this would be much stronger especially during Arctic Haze period, (Figure 4a). But in our measurements, a surprising accord is found between the two MSA and SA (H2SO4) measurements (Figure 4b). Becagli's work is in particle phase and our measurements are in gaseous phase.



Becagli et al.

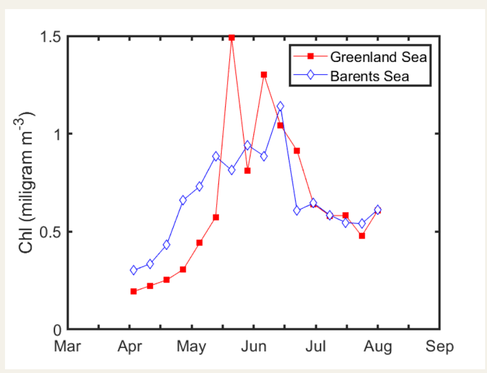


Our measurements

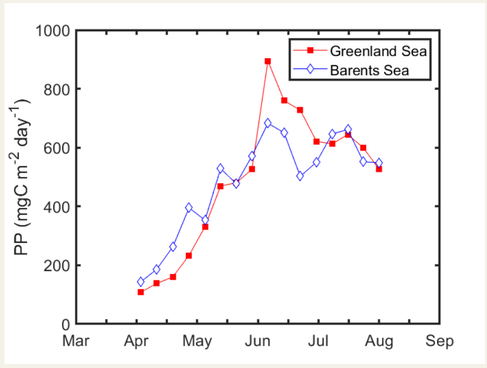


PP and Chl-a measurements in the Barents Sea were more in the Greenland Sea during April and May and then, the pattern was changed during June-July period. This pattern can be explained by the early bloom in Barents sea due to the pristine melting of sea ice in this area respect to Greenland sea that show a late melting in the sea areas near to Svalbard island.

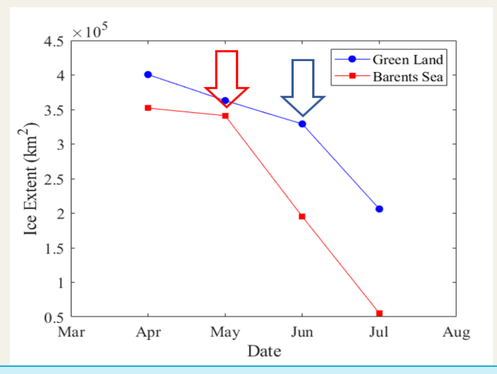
Chl-a



PP



Sea ice extent



Correlation between MSA and PP, Chl-a

Increasing and decreasing patterns emphasize in role of phytoplanktonic bloom due to sea ice melting in both seas (Table 1).

Increasing

R^2	Greenland (Spring)	Barents (Spring)	Greenland (Summer)	Barents (Summer)
Chl-a . MSA	0.40	0.56	0.83	0.49
PP . MSA	0.55	0.46	0.83	0.27

Decreasing

Table 1

Correlation between HIO3 and PP, Chl-a

HIO3 has significant correlations in Spring period with ocean color parameters (Chl-a and PP) in especially in Greenland sea. Sipilä et al. (2016) speculated that the source of HIO3 would be the sea ice.

R^2	Greenland (Spring)	Barents (Spring)	Greenland (Summer)	Barents (Summer)
Chl-a . HIO3	0.82	0.44	0.30	0.23
PP . HIO3	0.55	0.35	0.07	0

Table 2

Significant correlation

Correlation between HOM and PP, Chl-a

This indicates that HOM probably have a completely different source than MSA, SA and HIO3 (Table 3). It can be anthropogenic source.

R^2	Greenland (Spring)	Barents (Spring)	Greenland (Summer)	Barents (Summer)
Chl-a . HOM	0.08	0.24	0.01	0.01
PP . HOM	0.28	0.28	0.08	0

Weak correlation

Table 3

Correlation between 10, 50, 100 nm and PP, Chl-a

High correlation for small particles in Spring

No-correlation for small particles in summer

R^2	Greenland (Spring)	Barents (Spring)	Greenland (Summer)	Barents (Summer)
PP and 10nm	0.54(Y=1.42e+00*X+3.71e+02)	0.45(Y=1.38e+00*X+3.00e+02)	0.07 (Y=-1.21e+00*X+2.10e+03)	0.09 (Y=-2.40e+00*X+2.72e+03)
PP and 50nm	0.2 (Y=-1.66e-01*X+3.87e+02)	0.32 (Y=-2.28e-01*X+4.20e+02)	0.02 (Y=1.47e-01*X+2.68e+02)	0.08 (Y=4.90e-01*X+7.36e+01)
PP and 100nm	0.38 (Y=-2.01e-01*X+3.05e+02)	0.51 (Y=-2.52e-01*X+3.35e+02)	0.41 (Y=2.74e-01*X-9.79e+00)	0.35 (Y=4.33e-01*X-8.47e+01)

Anti - correlation for big particles

Table 4