surface ocean solas lower atmosphere study

Report for the year 2020 and future activities

SOLAS Sweden

compiled by: Paul Zieger, Stockholm University

This report has two parts:

***- Part 1:** reporting of activities in the period of January 2020 - Jan/Feb 2021*
***- Part 2:** reporting on planned activities for 2021 and 2022.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies of high sensitivity systems;
Environmental impacts of geoengineering;
Science and society**.**

***IMPORTANT**: This report should reflect the efforts of the SOLAS community in the **entire country** you are representing (all universities, institutes, lab, units, groups, cities).*

First things first…Please tell us what the IPO may do to help you in your current and future SOLAS activities. ?
Since I have recently taken over the job of being the representative for Sweden, I would like to get a better overview on SOLAS-related activities in Sweden and in the Nordic countries in general.

PART 1 - Activities from January 2020 to Jan/Feb 2021
1. Scientific highlight
*Describe one scientific highlight with a title, text (**max. 300 words**), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in results of international collaborations. (If you wish to include more than one highlight, feel free to do so).*

Highlight I: New particle formation in the high Arctic driven by enhanced iodine emissions

As part of the *Arctic Ocean 2018* expedition on board the Swedish icebreaker *Oden*, the MOCCHA campaign (Microbiology–Ocean–Cloud-Coupling in the High Arctic) was dedicated to study the role of microbiological life in the ocean and ice and how it is connected to the formation of clouds.

One first major finding by Baccarini at al. (2020) has now shown that new particle formation, a process that where particles are formed from gaseous precursors, is driven by iodic acid with little contribution from sulfuric acid. The figure below shows the iodic acid (HIO_3) concentration and the concentration of ultrafine particles (UFP, particles between 2.5-15 nm) for the entire expedition color-coded by ambient temperature. The HIO_3 concentrations increased significantly with the start of the freeze-up towards the beginning of autumn, which lead to a strong increase in the concentration of newly formed particles. The authors hypothesized that newly formed sea ice could be a potential source of iodine (e.g. produced by microalgae below the sea ice which is later transported via brine channels or cracks in the sea ice to the atmosphere). In addition, a higher ozone concentration in the atmosphere has been observed, which has been found to facilitate the emission of iodine from seawater and frozen saline surfaces. Additional measurements also showed that particles smaller than 30 nm were involved in cloud formation, suggesting the that new particle formation via iodine has the potential to influence cloud formation in the high Arctic.

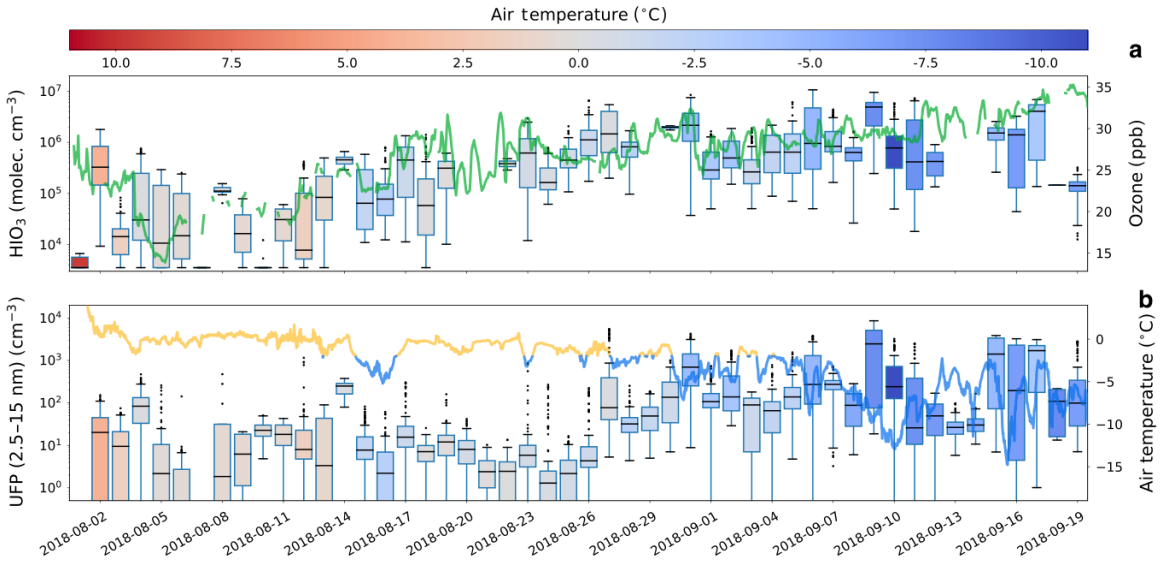

Figure: Daily box and whiskers plot of iodic acid concentration (upper panel) and the ultrafine particle concentration (lower panel) color-coded by the ambient temperature for entire campaign. The ambient ozone concentration is shown in the upper panel (green curve). With the start of the ice freeze-up (around the end of August), the increase of iodic acid was concurrent with a one order of magnitude higher concentration of newly formed particles. Figure taken from Baccarini et al. (2020).

Citation: Baccarini, A., Karlsson, L., Dommen, J. et al. Frequent new particle formation over the high Arctic pack ice by enhanced iodine emissions. Nat Commun 11, 4924 (2020). https://doi.org/10.1038/s41467-020-18551-0

Highlight II: Studying the CO_2 gas exchange rate in the high Arctic

Another highlight from the Arctic Ocean 2018 expeditions was recently published by Prytherch and Yelland (2021). Here, the authors determined the gas exchange rate of CO_2 at an Arctic sea-ice lead by means of eddy covariance flux measurements. In contrast to previous studies, it was found that the CO_2 gas exchange rate was lower compared to typical ocean rates in previous work, suggesting that the CO_2 uptake by polar oceans has previously been overestimated.

Citation: Prytherch and Yelland: Wind, convection and fetch dependence of gas transfer velocity in an Arctic sea-ice lead determined from eddy covariance CO_2 flux measurements. Global Biogeochemical Cycles (2021). https://doi.org/10.1029/2020GB006633

2. Activities/main accomplishments in 2020 (e.g., projects; field campaigns; workshops and conferences; model and data intercomparisons; capacity building; international collaborations; contributions to int. assessments such as IPCC; collaborations with social sciences, humanities, medicine, economics and/or arts; interactions with policy makers, companies, and/or journalists and media).

- Participation at the MOSAiC drift expedition until June 2020 (Katarina Abrahamsson, Universty of Gothenburg)
- Field campaign at Tjärnö (Sweden) to study the microbial dispersal from sea-surface microlayer to air and snow/rain (Janina Rahlff, Linnaeus University)
- Setup of coastal air-sea interaction study site at Askö, Sweden (John Prytherch, Stockholm University)
- Organization of Arctic Ocean 2018 / MOCCHA online workshop series (Matthew Salter and Paul Zieger, Stockholm University)
- Evaluation of models (Michael Tjernström, Stockholm University)
- Determination of the importance of sea spray aerosol to PFAAs concentrations in ambient marine aerosol; Role of sea spray in transporting mercury to the atmosphere using laboratory sea spray simulation chambers (Matthew Salter, Stockholm University)
- AREX Cruise on board rv Oceania: June-August, Gdańsk-Tromso-Longyearbyen-Horsund-Kongsfjorden-Longyearbyen-Gdańsk; November: cruise on board rv Oceania: Gdańsk-Östergarnsholm-Bothnian Bay-Östergarnsholm-Gdańsk (Piotr,Markuszweski, Stockholm University)
- Engagement in CATCH SSC (the Cryosphere and Atmospheric CHemistry) (Paul Zieger, Stockholm University)
- Continuation of the NASCENT campaign (The Ny-Ålesund Aerosol Cloud Experiment 2019-2020) https://www.aces.su.se/research/projects/the-ny-alesund-aerosol-cloud-experiment-nascent-2019-2020/ (Paul Zieger, Stockholm University)
- Extended funding for ICOS (Integrated Carbon Observation Systems) with two Swedish marine stations (Östergarnsholm, UU; and Tavastland SMHI)
- Field activities were generally limited in 2020 due to the Corona pandemic

3. Top 5 publications in 2020 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Ickes et al. (2020), The ice-nucleating activity of Arctic sea surface microlayer samples and marine algal cultures, Atmos. Chem. Phys., 20, 11089–11117, https://doi.org/10.5194/acp-20-11089-2020;

Sha et al. (2020), Influence of Water Concentrations of Perfluoroalkyl Acids (PFAAs) on Their Size-Resolved Enrichment in Nascent Sea Spray Aerosols, Environ. Sci. Technol., https://doi.org/10.1021/acs.est.0c03804

Thornton et al. (2020), Shipborne eddy covariance observations of methane fluxes constrain Arctic sea emissions. Science Advances, 6(5), eaay7934. https://doi.org/10.1126/sciadv.aay7934

Heslin-Rees et al. (2020), From a polar to a marine environment: has the changing Arctic led to a shift in aerosol optical properties?, Atmos. Chem. Phys., 20, 13671–13686, https://acp.copernicus.org/articles/20/13671/2020/

Rutgersson et al. (2020) Using land-based stations for air–sea interaction studies, Tellus A: Dynamic Meteorology and Oceanography, 72:1, 1-2, https://doi.org/10.1080/16000870.2019.1697601

Plus the two references mentioned in the scientific highlight section.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2020? If yes, who? How did you engage?

n/a

PART 2 - Planned activities for 2021 and 2022

1. Planned major national and international field studies and collaborative laboratory and modelling studies (incl. all information possible, dates, locations, teams, work, etc.).

- Oden expeditions in 2021 and 2022: Synoptic Arctic Survey (International project with many icebreakers. Swedish component on Oden https://polar.se/om-polarforskning/expeditioner/synoptic-arctic-survey-2020-2022/) and piggyback on drilling expedition (John Prytherch and Michael Tjernström, Stockholm University)
- Measurements of PFAAs at Cape Point, South Africa and Alert, Canada to determine the importance of sea spray aerosols in transporting PFAAs to the atmosphere. Laboratory studies on the transport of mercury to the atmosphere via sea spray aerosols using a sea spray simulation chamber. Investigation of the sea spray aerosol processes in the NorESM model (Matthew Salter, Stockholm University)
- A field campaign in the Azores to investigate aging of nascent of sea spray aerosols and its impact on marine boundary layer composition in collaboration with DOE/ARM as part of a new Swedish Research Council project (Claudia Mohr, Matthew Salter and Paul Zieger, Stockholm University)
- Two research cruises in the Baltic sea to investigate the role of sea spray in transporting bacteria to the atmosphere as part of the CROISSANT project (https://www.aces.su.se/research/projects/characterising-properties-of-climate-relevant-organic-and-inorganic-sea-spray-aerosols-sources-and-air-seaexchange-causing-their-net-emission-croissant/) (Douglas Nilsson, Matthew Salter, Piotr Markuszewski and others, Stockholm University)
- SAS21 expedition/ Arctic cruise (Janina Rahlff, Linnaeus University)
- AREX Cruise on board rv Oceania: June-August, Gdańsk-Tromso-Longyearbyen-Horsund-Kongsfjorden-Longyearbyen-Gdańsk, Baltic Cruises (May, September) (Piotr Markuszewski, Stockholm University)
- Contribution to U.K. M-PHASE campaign (Resolving climate sensitivity associated with shallow mixed phase cloud in the oceanic mid- to high-latitudes, PI Ben Murray, University of Leeds, U.K.) to Baffin Bay and the Labrador Sea in summer 2022 (Paul Zieger, Matthew Salter and Claudia Mohr, Stockholm University)
- ShipTRASE, Belmont forum project (Anna Rutgersson, Uppsala University)

2. Events like conferences, workshops, meetings, summer schools, capacity building etc. (incl. all information possible).

- Arctic Ocean 2018/MOCCHA workshop in 2021 (Caroline Leck, Stockholm University)
- European Geoscience Union General Assembly 2021 (Katarina Abrahamsson, Universty of Gothenburg)
- Aquatic Science Meeting (ASLO), SOLAS summer school (Janina Rahlff, Linnaeus University)
- Course for PhD students and advanced master students: eScience Tools in Climate Science: Linking Observations with Modelling in November 2021 (Paul Zieger, Stockholm University) https://www.aces.su.se/research/projects/escience-tools-in-climate-science-linking-observations-with-modelling/

3. Funded national and international projects/activities underway.

Upcoming

- H2020 project CRiceS (Climate Relevant interactions and feedbacks: the key role of Sea ice and Snow in the polar and global climate system), start fall 2021
- VR (Swedish Research council) project "Closing the gap between properties of fresh sea spray aerosol and aerosol observed in the marine boundary layer", start 2021

Ongoing

- H2020 project FORCeS (Constrained aerosol forcing for improved climate projections), https://forces-project.eu/
- VR (Swedish Research council) project "Characterizing properties of Climate Relevant Organic and Inorganic Sea-Spray-aerosols, Sources and Air-sea-exchange causing their Net-emission (CROISSANT)"
- Viral-bacterial interactions between ocean and atmosphere (VIBOCAT) funded by the German Research Foundation (DFG)
- VR (Swedish Research council) project "Biogenic particles and their role in the formation of Arctic clouds"

4. Plans / ideas for future national or international projects, programmes, proposals, etc. (please indicate the funding agencies and potential submission dates).

- Michael Tjernström et al. (Stockholm University): Early summer Oden expedition in 2023, focusing on melt onset (ARTofMELT, see https://polar.se/en/expeditions/upcoming-call-artofmelt-expedition-to-the-arctic-ocean-in-2023/)
- John Prytherch (Stockholm University): Observing Arctic Surface Interactions, Formas annual call, April 2021
- Piotr Markuszewski (Stockholm University): National Science Center (Poland) - grant application (Quantification of marine aerosol production in relation to bursting bubbles generated by breaking wind waves.) proposal submited 2020-12-15, results in June 2021. Project intend to be inter alia supportive to CROISSANT project.
- Development of a Swedish ACTRIS (European Aerosol, Clouds and Trace Gases Research Infrastructure) with 5 Swedish universities involved

5. Engagements with other international projects, organisations, programmes, etc.

- Planning of SCOR working group and joint expedition in ~2025 in the Southern Ocean together with BEPSII (Biogeochemical Exchange Processes at Sea Ice Interfaces, https://sites.google.com/site/bepsiiwg140/home) and CATCH (the Cryosphere and Atmospheric CHemistry, https://www.catchscience.org/) (Paul Zieger, Stockholm University)
- ASSEMBLE Plus funded research stay in Tjärnö 2020 (Janina Rahlff, Linnaeus University)

Comments