surface ocean solas lower atmosphere study

Report for the year 2019 and future activities

SOLAS *Ireland*
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This report has two parts:

***- Part 1:** reporting of activities in the period of January 2019 - Jan/Feb 2020*
***- Part 2:** reporting on planned activities for 2020 and 2021.*

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. ?

In 2018 Ireland set up a SCOR national committee and attended for the first time in October 2019 the SCOR international annual meeting. As part of the National SCOR activities in Ireland there is a concerted effort to get more researchers from all institutes involved in SCOR programs, including SOLAS. Previously, SOLAS related activities in Ireland have been almost exclusively concentrated at the National University of Ireland Galway (NUIG), as the bulk of oceanographic and marine atmospheric research is carried out there and/or in partnership with the nearby Marine Institute. This trend still exists today as SOLAS research in Ireland is split between atmospheric work at Mace Head (C-CAPS) and oceanographic work undertaken by researchers in the College of Science and Engineering at NUIG. One aspect then that we would like to explore with the IPO is linking making better links to Future Earth Ireland and developing links to social scientists outside of NUIG. A key potential collaborator in this context is the Socio-Economic Marine Research Unit (SEMRU) at NUIG, as they are not yet part of SOLAS Ireland. Researchers from outside NUIG may be attracted to SOLAS Ireland through links via the SFI research centres iCRAG and MAREI. ICRAG's Public Perception and Understanding platform could also help to develop tools to communicating SOLAS science to stakeholder, industry and the general public.

PART 1 - Activities from January 2019 to Jan/Feb 2020

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).*

Sulfate aerosols are typically the dominant source of cloud condensation nuclei (CCN) over remote oceans and their abundance is thought to be the dominating factor in determining oceanic cloud brightness. Their activation into cloud droplets depends on dynamics (i.e. vertical updrafts) and competition with other potential CCN sources for the condensing water. We present new experimental results from the remote Southern Ocean illustrating that, for a given updraft, the peak supersaturation reached in cloud, and consequently the number of droplets activated on sulfate nuclei, is strongly but inversely proportional to the concentration of sea-salt activated despite a 10-fold lower abundance. Greater sea-spray nuclei availability mostly suppresses sulfate aerosol activation leading to an overall decrease in cloud droplet concentrations; however, for high vertical updrafts and low sulfate aerosol availability, increased sea-spray can augment cloud droplet concentrations. This newly identified effect where sea salt nuclei indirectly controls sulfate nuclei activation into cloud droplets could potentially lead to changes in the albedo of marine boundary layer clouds by as much as 30%.

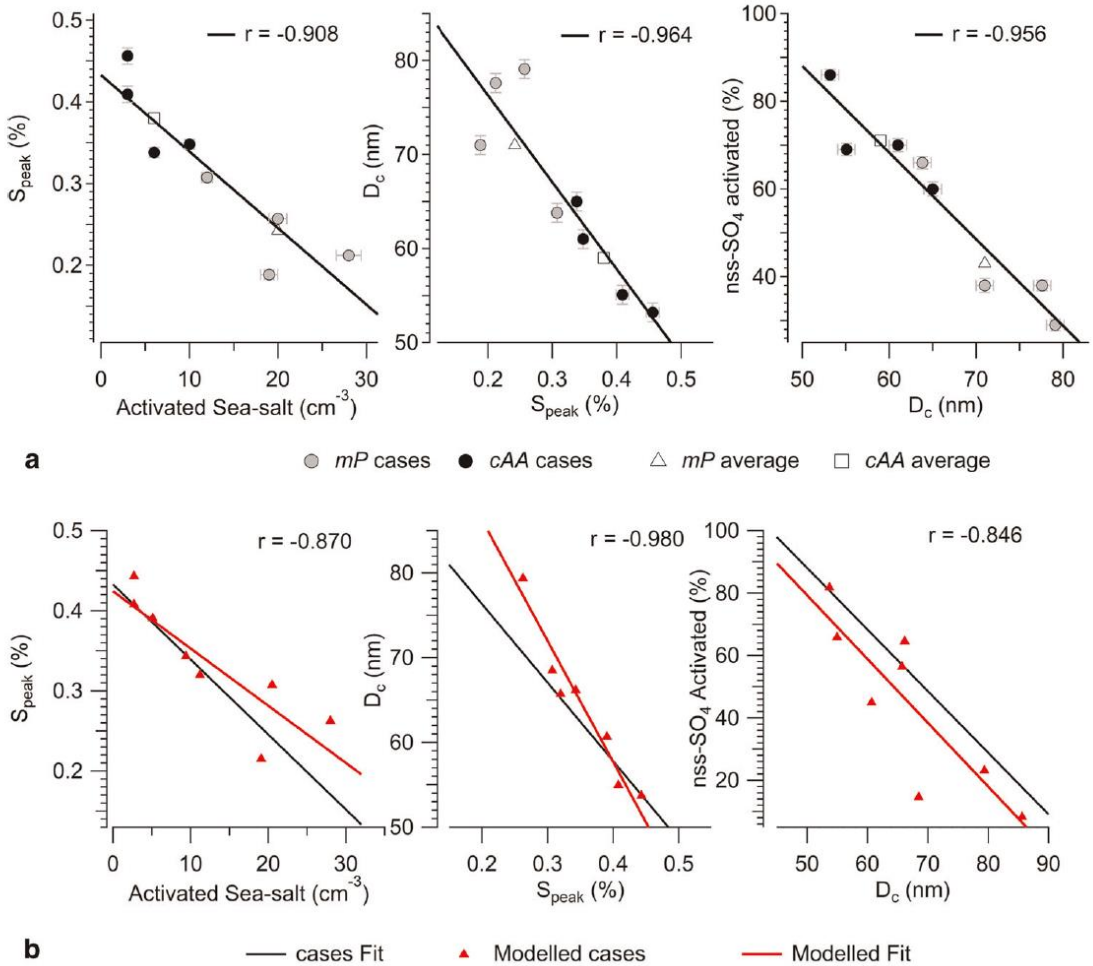


Figure: **Comparison of cloud properties showing linear relationships in both observed data and subsequent parcel modelling**. **a** Linear representation of the link between (Left) the cloud peak supersaturation (S_{peak}, %) and number concentration of sea-salt particles which activated into cloud droplets; (Middle) critical dry diameters (D_c) and S_{peak}; and (Right) the percentage of sulfate particles which activated into cloud droplets and D_c. The three linear representation give Pearson's *r*-values as indicated at the top of the graphs (all are significant for $p < 0.01$). Each panel shows individual *mP* cases as grey circles and *cAA* cases as black circles, where error bars represent the uncertainty calculated

for S_{peak}, D_c, and nss-SO4 activated (see Methods). The open triangle (*mP*) and open square (*cAA*) shows the averaged case examples. **b** Parcel model simulations of experimental cases (red markers) with best fit line from model (red line) and experimental (black line) data.

Citation: Fossum, K. N., Ovadnevaite, J., Ceburnis, D., Preißler, J., Snider, J. R., Huang, R.-J., Zuend, A., and O'Dowd, C.: Sea-spray regulates sulfate cloud droplet activation over oceans, *npj Climate and Atmospheric Science*, 3, 14, 10.1038/s41612-020-0116-2, 2020

2. Activities/main accomplishments in 2019 (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).

Jurgita Ovadnevaite has been invited to contribute to the IPCC Working Group I (The Physical Science Basis) Sixth Assessment Report by providing an update on the sea-spray chapter;

Peter Croot is the convener for Chapter 7P on the Open Ocean for the United Nations 2nd World Ocean Assessment report.

Indian Ocean GO-SHIP expedition on the RV Mirai MR19-04 (Dec 2019 – Feb 2020). Prof. Peter Croot participated in this expedition through a piggyback project hosted by JAMSTEC to look at urea and iodine cycling in this region.

POGO South North Atlantic (SoNoAT) training school onboard the RV Polarstern (PS120) from Port Stanley in the Falklands to Bremerhaven, Germany in June 2019. 23 Early career scientists from around the world took part in this training school, selected from nearly 900 applications. Prof. Croot participated as the chief lecturer during this expedition. During this shipboard training expedition, Prof Croot lead the teaching program and the shipboard physical oceanography program and introduced the students to the work of SOLAS and other SCOR activities.

International workshop entitled "Taller de observación global del océano", held at the Universidad De Magallanes, Punta Arenas, Chile (May 30-31, 2019). This was a bilingual (Spanish/English) workshop on climate change in the ocean for students going on the POGO SoNoAT expedition and for interested students from the Universidad De Magallanes. The first day was a series of lectures and the 2nd day devoted to teaching modules on a variety of topics. Funding for this workshop was provided by POGO, the Nippon Foundation, AWI, NUI Galway, iCRAG and the Universidad De Magallanes. Prof Croot organized the workshop and developed the program, he introduced the students to the role of the SCOR programs, GEOTRACES, IMBER and SOLAS in ocean climate research.

Mace Head and C-CAPS, NUIG, are partners in MaREI, the SFI Research Centre for Energy, Climate and Marine RA3 (Observations & Operations) https://www.marei.ie/;

NUIG are partners in iCRAG, the SFI research centre for research in Applied Geoscience https://icrag-centre.org

Mace Head is part of the following activities:

INP sampling in collaboration with Karlsruhe Institute of Technology, Ottmar Mohler, 2017.11-2019.06

INP sampling in collaboration with CNR-ISAC, Bologna, Matteo Rinaldi, 2018.04-ongoing

ACTRIS PESPAT (pesticide) sampling campaign, RECETOX, Czech Republic, 28.04.2020-28.05.2020.

MONET POP (persistent organic pollutants) sampling campaign, RECETOX, Czech Republic, 2009.03-ongoing.

3. Top 5 publications in 2019 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Publications:

1. ***Fossum, K. N., Ovadnevaite, J., Ceburnis, D**., **Preißler, J**., Snider, J. R., **Huang, R.-J.,** Zuend, A., and **O'Dowd, C**.: Sea-spray regulates sulfate cloud droplet activation over oceans, npj Climate and Atmospheric Science, 3, 14, 10.1038/s41612-020-0116-2, 2020.*
2. *Xu, W., **Ovadnevaite, J., Fossum, K. N**., Lin, C., **Huang, R. J**., **O'Dowd, C., and Ceburnis, D**.: Aerosol hygroscopicity and its link to chemical composition in coastal atmosphere of Mace Head: marine and continental air masses, Atmos. Chem. Phys. Discuss., 2019, 1-25, 10.5194/acp-2019-839, 2019.*
3. ***ten Doeschate, A**., G. Sutherland, H. Bellenger, S. Landwehr, L. Esters, and **B.Ward**, 2019. Upper ocean response to rain observed from a vertical profiler. J. Geophys. Res., 124. doi:10.1029/2018JC014060*
4. *Swart, S., S. T. Gille, B. Delille, S. Josey, M. Mazloff, L. Newman, A. F. Thompson, J. Thomson, **B. Ward**, M. D. D. Plessis, E. C. Kent, J. Girton, L. Gregor, P. Heil, P. Hyder, L. P. Pezzi, R. B. D. Souza, V. Tamsitt, R. A. Weller, and C. J. Zappa, 2019. Constraining southern ocean air-sea-ice fluxes through enhanced observations. Front. Mar. Sci. doi:10.3389/fmars.2019.00421*
5. *Meskhidze, N., Völker, C., Al-Abadleh, H.A., Barbeau, K., Bressac, M., Buck, C., Bundy, R.M., **Croot, P**., Feng, Y., Ito, A., Johansen, A.M., Landing, W.M., Mao, J., Myriokefalitakis, S., Ohnemus, D., Pasquier, B., Ye, Y., 2019. Perspective on identifying and characterizing the processes controlling iron speciation and residence time at the atmosphere-ocean interface. Marine Chemistry 217, 103704.*

Products:

Streamair app (a real-time data system, merging forecast and observational air pollution data into a multi-purpose data fusion, management and visualization platform for mobile devices)
http://streamair.nuigalway.ie/

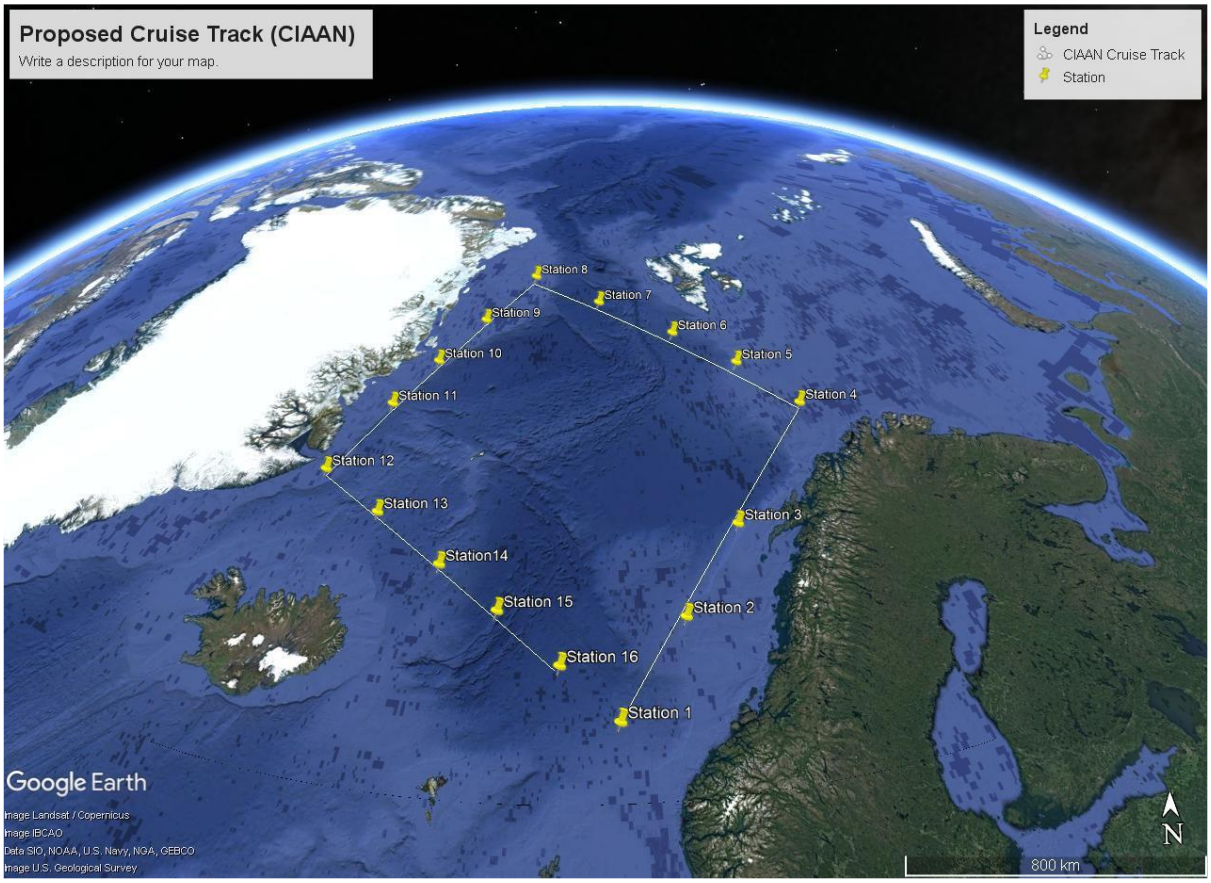
4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2019? If yes, who? How did you engage?

N.A.

PART 2 - Planned activities for 2019/2020 and 2021

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

Celtic Explorer Expedition CE20009 (24/8/20 – 15/9/20 Galway to Killybegs) Constraining the Impact of Arctic Amplification in the Nordic Sea: A biogeochemical approach (CIAAN) Chief Scientist: Audrey Morley (NUIG). Collaborators: Peter Croot (NUIG), Ulysses Ninnemann(U Bergen, Norway), Gavin Foster (U Southampton, UK), Rachel Cave (NUIG), Gerard McCarthy (Maynooth). Study Area:



Main research objectives: *(1) Monitor current hydrographic conditions in the Nordic and Greenland Seas*. *(2) Determine Biogeochemical processes in the upper ocean. (3) Determine the climate signal transfer from modern hydrography into the geologic archive. (4) Constrain the transfer of temperature into the geologic archive. (5) Constraining the transfer of salinity into the geologic archive. (6) Constrain the transfer of the carbonate system into the geologic archive. (7) Constraining natural vs. anthropogenic carbon cycling using NPS. (8) Investigate the variation in cetacean and seabird species between Irish waters and Nordic waters in the survey area.*

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

None planned for 2019-2020.

3. Funded national and international projects/activities underway.

National

Ocean Acidification and Biogeochemistry: variability, trends and vulnerability (VOCAB), Marine Institute, Jan 1st 2017 – Dec 31st 2020 (R. Cave, NUIG)

Importance of Physico-Chemical cycling of nutrients and carbon in Marine Transitional Zones (NUTS&BOLTS), EPA Ireland, Feb 1st 2019 – Jan 31st 2023 (P. Croot, NUIG)

The national project VOCAB has been endorsed by IMBER and NUTS&BOLTS has also applied for IMBER endorsement. Engagement has been through the IMBER IPO.

An ocean microlab for autonomous dissolved inorganic carbon depth profile measurement, Science Foundation Ireland, January 1st 2020–December 31st 2022 (B. Ward, NUIG)

International

Southern Ocean Carbon and Heat Impact on Climate (SOCHIC), Horizon 2020, November 1st 2019–October 30th 2023 (B. Ward, NUIG))

South and Tropical Atlantic climate-based marine ecosystem prediction for sustainable management (TRIATLAS), Horizon 2020, June 1st 2019–May 31st 2023 (P. Croot, NUIG))

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

The 2nd phase (2021-2026) of the SFI funded Irish Centre for Research in Applied Geoscience (www.icrag-centre.org) has been applied for and an official decision is due in the 3rd quarter of 2020. Within iCRAG2 there are SOLAS related projects on air/sea exchange of CO_2 and other climate relevant gases (co-PI Croot (NUIG), FI's Cave (NUIG), Ward (NUIG), McGovern (MI)).

Centre for Climate and Air Pollution Studies, Ryan Institute, National University of Ireland Galway, has submitted a proposal to the ESA-Future Earth funding for Research Demonstrators for COP-26 (https://futureearth.org/initiatives/funding-initiatives/esa-partnership/). Submission deadline: 18th May 2020. SOLAS and Future Earth Ireland provided the Support letters.

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

Cooperation with other IMBER endorsed projects likely over the next year. Also looking to develop links to other SOLAS projects in other countries where possible.

Comments

SOLAS activities in Ireland are still ongoing and looking to expand and interact with other SOLAS researchers in the next years.