

Report for the year 2021 and future activities

SOLAS Ireland

compiled by: Prof. Peter Croot and SOLAS Ireland community

This report has two parts:

- **Part 1:** reporting of activities in the period of January 2021 - Jan/Feb 2022
- **Part 2:** reporting on planned activities for 2022 and 2023.

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. ?

As there is now an IPO office at NUI Galway in Ireland, this is perhaps a mutual activity, as SOLAS Ireland look to help the IPO office settle into Ireland and look to incorporate the IPO office into national networks while also seeking to develop more international contacts for SOLAS Ireland researchers. This cooperation also extends to funding opportunities and outreach activities and we look forward to working with the IPO on this moving forward.

The new SOLAS MSc course at NUI Galway will also benefit from interactions with both IPO's to attract students to the course and for helping to advertise and develop this course over time. This is an exciting new development at NUI Galway and helps to build on the SOLAS related expertise there and throughout Ireland.

In this context we are planning to have shortly a network meeting (Q2 2022) where the SOLAS IPO in Ireland is able to meet SOLAS researchers in Ireland and build links and establish communications with the IPO

PART 1 - Activities from January 2021 to Jan/Feb 2022

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).

Sea spray as an obscured source for marine cloud nuclei

It has been suggested that the sea spray aerosol (SSA) contribute small fraction to cloud condensation nuclei (CCN) in global ocean, due to the low number concentration of SSA. However, the SSA number concentration was poorly constrained and often extrapolated from supermicron size distribution. Here we analyse long-term observations of concentrations and compositions of aerosol in Northeast Atlantic. We derive submicron SSA number size distribution from ambient by combining hygroscopicity growth measurement and aerosol number size distribution. Our results showed that the number concentration of submicron SSA has been greatly underestimated and SSA contributed significantly to the marine CCN budget, exceeding previous estimates by up to 50% to 500% at moderated marine cloud supersaturations. Given the impact of marine clouds on the Earth's radiative budget, accounting for submicron SSA is essential to better constrain the aerosol-cloud interaction and future climate.

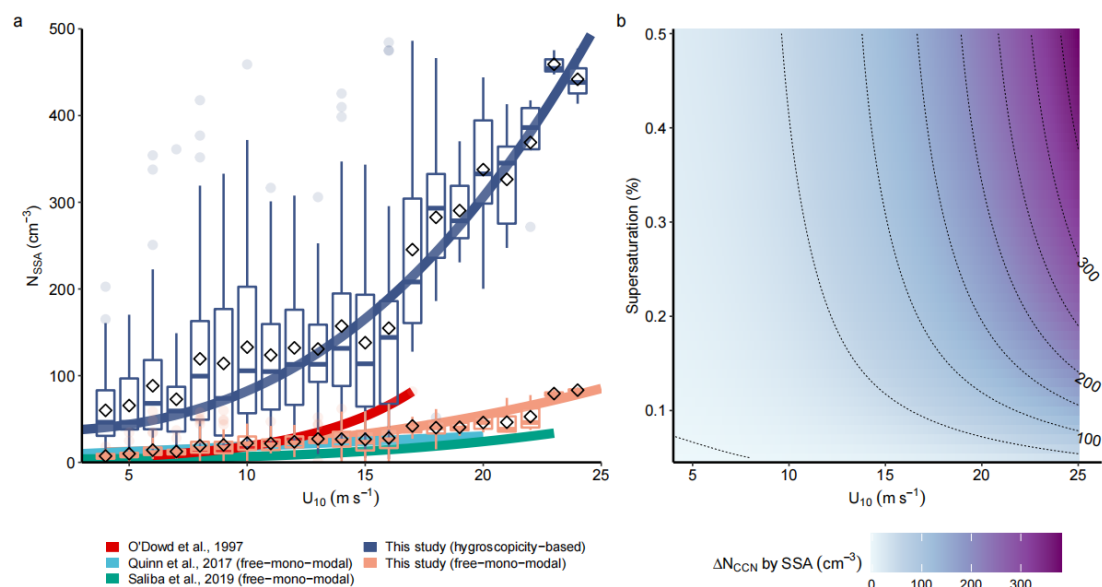


Figure | U_{10} versus N_{SSA} and ΔN_{CCN} . **a**, N_{SSA} as a function of U_{10} derived by hygroscopicity-based (dark blue curve and boxes) and free-monomodal (light orange curve and boxes) approaches. The hourly data are binned to the U_{10} intervals equal to 1 m s^{-1} , the horizontal lines represent the median value, the boxes represent 25th to 75th percentile, the whiskers represent 1.5 inter-quartile range, the points represent outliers and the diamond markers represent mean values. Also shown are previous parametrizations. **b**, The difference of N_{CCN} contributed by SSA between hygroscopicity-based and free-monomodal parametrization (denoted as ΔN_{CCN} by SSA) under varying supersaturation (0.05% to 0.5%) and U_{10} (4 to 25 m s^{-1}).

Citation: Wei Xu, Jurgita Ovadnevaite, Kirsten N. Fossom, Chunshui Lin, Ru-Jin Huang, Darius Ceburnis, Colin O'Dowd: Sea spray as an obscured source for marine cloud nuclei, Nature Geoscience: <https://doi.org/10.1038/s41561-022-00917-2>, 2022.

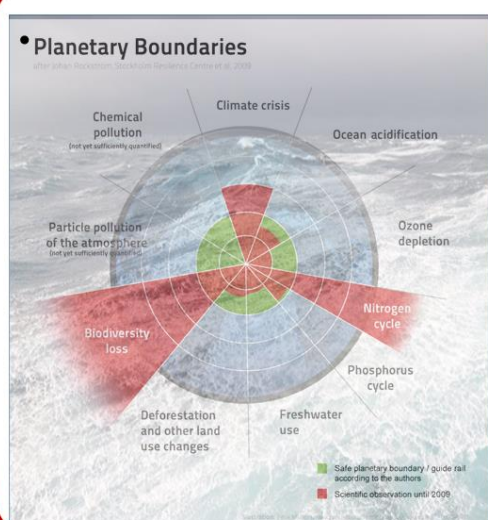
2. Activities/main accomplishments in 2021 (e.g., projects; field campaigns; workshops and conferences; model and data intercomparisons; capacity building; international

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).

Exploring the Boundaries of the Atlantic Atmosphere Science Strategy Meeting Galway

An online workshop took place, comprising some of the leading scientific experts in the field of in situ and remote observations of the North Atlantic Atmosphere, as well as representatives from the relevant communities and networks.

The workshop built on the legacy of the ACE experiments^{1, 2}, which successfully brought together previously fragmented international aerosol communities to increase quantitative understanding of the complex gas/aerosol/cloud system.



The impact of human activity since industrialisation has altered the state of the environment, pushing the boundaries of environmental stability to the point of threatening the future of life on earth. There is evidence that this threshold has already been crossed due to anthropogenic radiative forcing, biodiversity loss and disruption to the Nitrogen cycle. Breach of the boundaries of planetary stability risks abrupt and non-linear alterations to our environment, with major implications for societal and economic systems. The atmosphere and its changing composition both reflect and drive the pressures applied to the boundaries of environmental stability. Here the aim is to focus the planetary boundaries concept on the Atlantic Ocean and particularly, the atmospheric composition of the North Atlantic region.

3. List SOLAS-related publications published in 2021 (only PUBLISHED articles). If any, please also list weblinks to models, datasets, products, etc.

Baker, A.R., Kanakidou, M., Nenes, A., Myriokefalitakis, S., Croot, P.L., Duce, R.A., Gao, Y., Guieu, C., Ito, A., Jickells, T.D., Mahowald, N.M., Middag, R., Perron, M.M.G., Sarin, M.M., Shelley, R., Turner, D.R., 2021. Changing atmospheric acidity as a modulator of nutrient deposition and ocean biogeochemistry. *Science Advances* 7 (28), eabd8800.

Beca-Carretero, P., Azcárate-García, T., Julia-Miralles, M., Stanschewski, C.S., Guihéneuf, F., Stengel, D.B., 2021. Seasonal Acclimation Modulates the Impacts of Simulated Warming and Light Reduction on Temperate Seagrass Productivity and Biochemical Composition. *Frontiers in Marine Science* 8.

Coleman, L., Mc Govern, F. M., Ovadnevaite, J., Ceburnis, D., Baroni, T., Barrie, L. & O'Dowd, C. D. Envisioning an Integrated Assessment System and Observation Network for the North Atlantic Ocean. *Atmosphere* 12, 955, (2021).

Duerschlag, J., Mohr, W., Ferdelman, T.G., LaRoche, J., Desai, D., Croot, P.L., Voß, D., Zielinski, O., Lavik, G., Littmann, S., Martínez-Pérez, C., Tschitschko, B., Bartlau, N., Osterholz, H., Dittmar, T., Kuypers, M.M.M., 2021. Niche partitioning by photosynthetic plankton as a driver of CO₂-fixation across the oligotrophic South Pacific Subtropical Ocean. *The ISME Journal*.

Fossum, K. N., Ovadnevaite, J., Liu, D., Flynn, M., O'Dowd, C. & Ceburnis, D. Background levels of black carbon over remote marine locations. *Atmos Res* 271, 106119, <https://doi.org/10.1016/j.atmosres.2022.106119> (2022).

Hanna, G.S., Choo, Y.-M., Harbit, R., Paeth, H., Wilde, S., Mackle, J., Verga, J.-U., Wolf, B.J., Thomas, O.P., Croot, P., Cray, J., Thomas, C., Li, L.-Z., Hardiman, G., Hu, J.-F., Wang, X., Patel, D., Schinazi, R.F., O'Keefe, B.R., Hamann, M.T., 2021. Contemporary Approaches to the Discovery and Development of Broad-Spectrum Natural Product Prototypes for the Control of Coronaviruses. *Journal of Natural Products*.

Jordan, C., Cusack, C., Tomlinson, M.C., Meredith, A., McGeady, R., Salas, R., Gregory, C., Croot, P.L., 2021. Using the Red Band Difference Algorithm to Detect and Monitor a *Karenia* spp. Bloom Off the South Coast of Ireland, June 2019. *Frontiers in Marine Science* 8 (436).

Schmid, M., Guihéneuf, F., Nitschke, U., Stengel, D.B., 2021. Acclimation potential and biochemical response of four temperate macroalgae to light and future seasonal temperature scenarios. *Algal Research* 54, 102190.

Xu, W., Ovadnevaite, J., Fossum, K. N., Lin, C., Huang, R.-J., Ceburnis, D. & O'Dowd, C.: Sea spray as an obscured source for marine cloud nuclei, *Nature Geoscience*: <https://DOI: 10.1038/s41561-022-00917-2>, 2022.

Xu, W., Ovadnevaite, J., Fossum, K. N., Lin, C., Huang, R.-J., O'Dowd, C. & Ceburnis, D. Seasonal Trends of Aerosol Hygroscopicity and Mixing State in Clean Marine and Polluted Continental Air Masses Over the Northeast Atlantic. *Journal of Geophysical Research: Atmospheres* 126, e2020JD033851, <https://doi.org/10.1029/2020JD033851> (2021).

Xu, W., Fossum, K. N., Ovadnevaite, J., Lin, C., Huang, R.-J., O'Dowd, C., and Ceburnis, D.: The impact of aerosol size-dependent hygroscopicity and mixing state on the cloud condensation nuclei potential over the north-east Atlantic, *Atmos Chem Phys*, 21, 8655–8675, <https://doi.org/10.5194/acp-21-8655-2021>, 2021.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2021? If yes, who? How did you engage?

Walking Air Tour: <https://media.heanet.ie/page/42443cf9128c4951ad19e76ebc873617>

“Atmospheric states” is a transdisciplinary art, architecture and science research project investigating how atmospheric dynamics, pollution and their politics challenge fixed notions of the nation-state and sovereign borders on the land, and as experienced by different bodies. Atmospheric States is a collaboration between arts and architectural researchers and artists. Initial activities have taken place in Galway city, where the Atlantic Ocean meets western Ireland.

As part of Atmospheric States, an event entitled “The Air we Breathe/Aer Anála” took place as part of the Architecture at the Edge Festival, 9th October 2021 (see images in Figure 1 below). This project, co-funded by Architecture at the Edge, suggests that “the air we breathe” is a shared resource that offers an alternative way to think about the public realm. The project was led by Paula McCloskey and Sam Vardy of art and architecture practice ‘a place of their own’, in collaboration with Dr Liz Coleman NUI Galway. The event consisted of a performance walk starting at Seapoint ballroom, ending in a collective discussion at the Galway City Museum.

A new sculptural installation was installed to raise interest in the atmosphere and act as a visible and interactive symbol of the project. The sculpture takes the form of a LED neon sign that simply reads ‘Aer Anála’. With it, a small air quality sensor which monitors particulate matter was set up to live

stream, with a small plaque with information about the project, and a link/QR code that enables people to view the live data about air quality from the sensor on their phone or device.



Figure 1 Images from the Aer Anála Performance walk that took place as part of the Architecture at the Edge festival, Galway City October 9th 2021.

Video from the event [at this link](#).

Deep Blue Sea Workshops

The Deep Blue Sea pilot workshop (October 2021) was developed in collaboration with Baboró International Arts Festival for Children, STEM education and public engagement specialist Mairéad Hurley, and singer-songwriters and musical education specialists Nicola Joyce and Noelle McDonnell. The workshop was aimed at primary school students and explored the interconnections of the Earth System, carbon emissions and ocean acidification, the impact of human behaviour on the environment and designed multi-scale solutions for reduction of carbon emissions. The topics were explored through active learning, and artistic creation (visual art, movement and song). Images taken from the workshops, as well as Baboró blurb on the workshop are shown in the figure below (Photo credit Anita Murphy). Workshops took place over three consecutive weeks. The workshop will be disseminated in a science communication publication, and following positive reception of the workshop, it is planned to seek further funding opportunities to scale up the workshop programme.



Baboró International Arts
Festival for Children
4-17 October 2021



Workshops | Schools Only |
Creative Connections

In
Person

The Deep Blue Sea

Imeall and Nicola Joyce &
Noelie McDonnell



Can you hear the singing of the sea?

A series of science and music workshops invites a class to consider the balance between humans and nature, and to examine their relationship with the sea. Through observations and questioning, hands-on activities, exploration and music, you will learn about concepts relating to carbon in the atmosphere, the role of carbon in ocean acidification, and the ways that one small activity on dry land can lead to consequences for the species that live in our oceans.

You will participate in a creative, collaborative challenge to design innovative ways to protect Galway Bay from the perils of climate change, and to imagine a future in which human-nature relationships are balanced and our ocean is cared for. You and the workshop team will collectively compose and record the soundtrack to this future, drawing on the stories and feelings about the sea that emerge during the workshops.

Given the specialist nature of 'The Deep Blue Sea' workshop series, a primary school has been offered this event directly and is not available for booking.

Figure 2 Images from the Deep Blue Sea workshop that took place as part of the Baboró International Children's Theatre festival in October 2021 Photo Credit: Anita Murphy.

PART 2 - Planned activities for 2022 and 2023

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

Collaborative research with the Center for Physical Sciences and Technology in Vilnius, Lithuania focusing on carbon, nitrogen and sulphur isotopes aimed at elucidating marine biogenic sources and processes, together with a development of analytical methods of environmental isotopes.

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

Currently there are plans for a workshop in the summer of 2022, around the theme of "sustainability of Irish marine transitional zones", this would be in cooperation with a number of Irish agencies and be a contribution from Ireland's SOLAS, IMBER and Future Earth communities. This workshop is an output from the EPA (Ireland) funded project, NUTS&BOLTS, which is also endorsed by IMBER. The exact date for this workshop was not set at the time of this report due to uncertainties around post-covid meetings (in-person, hybrid or remote).

3. Funded national and international projects/activities underway.

The NUTS&BOLTS funded by the EPA/MI in Ireland is entering into its 4th year and likely will be granted a no-cost extension for a 5th year, due to the covid pandemic. This work includes a work package on the fluxes of climate relevant gases from marine transitional zones in Ireland.

New projects of relevance to SOLAS are expected to be starting in 2022 within the 2nd phase of the SFI centre iCrag (Irish Centre for Research in Applied Geoscience), however at the time of writing no formal decision had been made.

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

At the time of this report, there were no firm plans for any new national or international projects. However, several researchers are looking at upcoming EC calls for potential involvement and collaboration with other European partners.

In the context of the UN Decade for Ocean Science, a number of researchers were involved in endorsed projects but as of yet there was no joint funding applications being made.

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

Samhail Project [Samhail \(@Samhail 2022\)](#) / [Twitter](#).

Samhail is an arts-science collaborative team which comprises Liz Coleman, artistic and spatial research practice **a place of their own**, and STEM education and public engagement specialist, Mairéad Hurley ([webpage here](#)). Stemming from exploratory workshops with Atmospheric States, *Samhail* designed a project to create public-participatory transdisciplinary events in two Galway locations. The aim of the project is to examine the public relationship with the atmosphere and illustrate our capacity to collaborate for environmental solutions via the co-creation of “Stories of the Air/Spéirscéalta”- a bilingual publication which will contain the sharing, merging and creating of stories to reflectively reimagine our relationship with climate and society. Concurrently, the project aims to bring diverse actors together to grow a regional STEAM learning ecosystem to be active in the west of Ireland.

As an art-science collaboration, *Samhail* proposes to use storytelling as a mechanism to entangle scientific knowledge with local knowledge, developing new methods of storytelling that entwine atmospheric science history, data and expertise with stories of the air from different specific communities. *Samhail* proposes a series of workshops, tours and events to be held in Galway city and county, to co-create new stories of the air that draw from different histories, reflect current experiences, and imagine sustainable futures. Scientific stories from Mace Head Atmospheric Research Centre in Connemara will weave with local community stories from Connemara and from Galway City, and during the process the two communities will be linked virtually, and physically during the Mace Head tour.

Comments

The SOLAS Ireland community is looking forward to working with the SOLAS IPO in Ireland to help integrate the IPO into the local networks and helping to facilitate the development of new activities in Ireland and internationally.