surface ocean solas lower atmosphere study

Report for the year 2021 and future activities

SOLAS *New Zealand*
compiled by: Mike Harvey and Cliff Law

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. ?
It would be useful to be aware of regional SOLAS activities by other countries; the development of SOLAS regional networks could provide a platform for dissemination of this information and also coordination of regional activities.

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

1. Scientific highlight

Surface ocean microbiota determine cloud precursors

As part of the New Zealand-France collaboration in the *Sea2Cloud* campaign, the influence of surface ocean biology on sea spray emission was examined. Application of a consistent seaspray generation methodology in field studies and mesocosm experiments in three different regions (Arctic, Mediterranean, coastal NW Pacific), identified a significant relationship between nanophytoplankton cell abundance and sea-spray derived Cloud Condensation Nuclei (CCN) number fluxes (Figure a). The

relationship indicated that seaspray fluxes vary over an order of magnitude in response to nanophytoplankton abundance, which was attributed to nanophytoplankton influence on dissolved organics that modify bubble surface tension and so lifetime. The relationship in Figure a) was applied to examine the regional variability of CCN number fluxes at the global scale, by use of ocean colour phytoplankton group retrieval, with calculated $CCN_{0.1\%}$ number fluxes 5 times greater at high latitudes compared to the subtropical areas (Fig. b). Surface ocean biogeochemistry is currently only considered in global models via simulated marine organic matter in CCN mass; as our new relationship demonstrates greater sensitivity of seaspray flux it provides an improved parameterisation for global models.

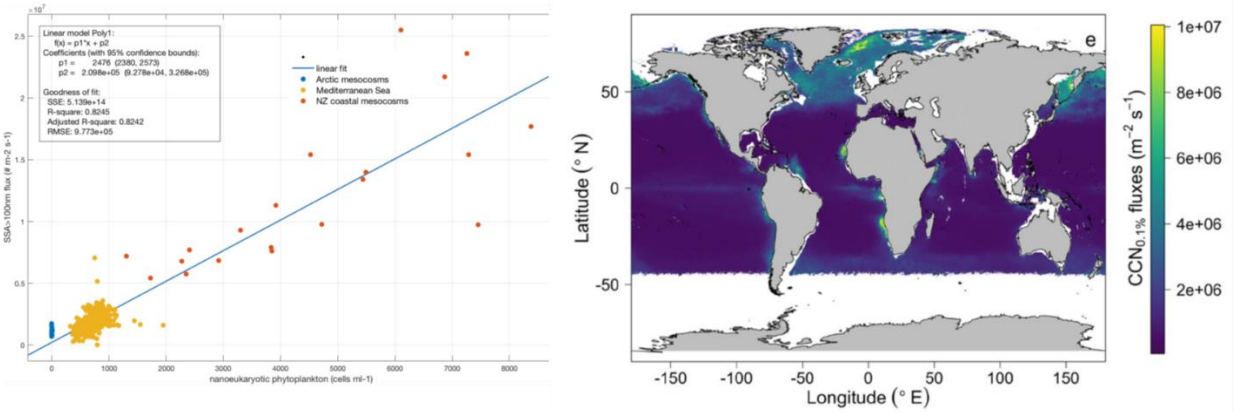

Fig a) Sea spray aerosol (>100 nm) flux number (m-2 s-1, calculated at wind speed 9 m s^{-1} and 15°C) as a function of nanophytoplankton abundance(cells ml-1). The solid line indicates the linear fit and the different colour symbols the different regions. b) Global $CCN_{0,1\%}$ emission fluxes (m^{-2} s^{-1}) computed at 15°C from satellite-based nanoplankton cell abundance in June.

Sellegri K, Nicosia A, Freney E, Uitz J, Thyssen M, Grégori G, Engel A, Zäncker B, Haëntjens N, Mas S, Picard D, Saint-Macary A, Peltola M, Rose C, Trueblood J, Lefevre D, D'Anna B, Desboeuf K, Meskhidze N, Guieu C, Law CS. 2021 Surface ocean microbiota determine cloud precursors. Scientific Reports, 11(1), 1-11.

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).

Cliff Law was International SOLAS Co-chair January-July 2021.

Cliff and Lisa Miller (SOLAS Canada) have initiated a Special Issue on SOLAS science in *Elementa*

Theme 1: Greenhouse gases and the Oceans

1. A Policymakers handbook for addressing the impacts of Ocean Acidification was produced on behalf of the Commonwealth Blue Charter Action on Ocean Acidification and launched by the New Zealand Government Minister for International Affairs. https://bluecharter.thecommonwealth.org/new-policy-handbook-to-help-governments-fight-ocean-acidification/
2. The New Zealand Ocean Acidification Observing Network (NZOA-ON) increased the number of monitoring sites in collaboration with the NZ Department of Conservation and Waikato Regional Council. https://marinedata.niwa.co.nz/nzoa-on/
3. The Munida Time Series Transect continued in its 23rd year of measuring ocean carbon chemistry
4. Methane emissions in New Zealand shelf waters were examined in a project on Economic opportunities and environmental implications of energy extraction from gas hydrates (HYDEE)

5. Southern Ocean/Ross Sea Voyage in January/February 2021included some SOLAS related aspects such as dissolved methane measurement and collection of water and air samples for microplastics
6. 14th New Zealand National Ocean Acidification Workshop; two-day meeting at University of Otago in February 2021 http://nzoac.nz/conferences
7. NIWA and Otago support for the establishment of the Pacific Islands Ocean Acidification Centre, will provide support, training, and capacity development throughout the Pacific.

Theme 3: Atmospheric deposition and ocean biogeochemistry

1. Atmospheric dust transport to high-elevation Dronning Maud Land, Antarctica, over the satellite era was examined using FLEXPART dust trajectory modelling and the implications for centennial scale ice core records of dust deposition were assessed .

Theme 4 "Interconnections between aerosols, clouds, and marine ecosystems"

1. Analysis of data from the Sea2Cloud campaign (https://niwa.co.nz/climate/research-projects/sea2cloud has resulted in insights and publications on the influence of surface ocean biology on sea spray aerosol properties and VOC production.
2. goSouth – Planning for campaign on high-resolution meteorological modelling of aerosol and cloud properties in the Southern Hemisphere marine boundary layer, in collaboration with Leibniz Institute for Tropospheric Research for measurement (TROPOS) and LOSTECCA (Lidar Observations of SpatioTEmporal Contrasts in Cloud and Aerosol).
3. Aerosol nitrogen chemistry: Analysis of aerosol samples collected at the Baring Head GAW station with colleagues from Pudue University identified that seasonal variations in the oxidation pathways of NO_2 are the main driver of the seasonal variations of nitrate $\delta^{15}N$ values
4. Potential climate impacts on marine aerosol precursors – a mesocosm study established that ocean acidification have little impact on DMSP and DMS emissions, whereas higher temperatures had more significant effect (Saint-Macary et al, 2021).Development of new ice core biomarkers of phytoplankton composition and abundance to extend satellite records of primary production.

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

Theme 1: Greenhouse gases and the Oceans

McGraw CM, Currie KC, Law CS, Vance JM. 2021. A Policymakers' Handbook for Addressing the Impacts of Ocean Acidification. https://bluecharter.thecommonwealth.org/new-policy-handbook-to-help-governments-fight-ocean-acidification/

Theme 3: Atmospheric deposition and ocean biogeochemistry

Saint-Macary AD, Barr N, Armstrong E, Safi K, Marriner A, Gall M, McComb K, Dillingham PW, Law CS. 2021. The Influence of Ocean Acidification and Warming on DMSP & DMS in New Zealand Coastal Water. *Atmosphere* 12(2):181.

Sellegri K, Nicosia A, Freney E, Uitz J, Thyssen M, Grégori G, Engel A, Zäncker B, Haëntjens N, Mas S, Picard D, Saint-Macary A, Peltola M, Rose C, Trueblood J, Lefevre D, D'Anna B, Desboeuf K, Meskhidze N, Guieu C, Law CS. 2021 Surface ocean microbiota determine cloud precursors. *Scientific Reports*, *11*(1), 1-11.

Rocco, M., Dunne, E., Peltola, M., Barr, N., Williams, J., Colomb, A., Safi, K., Saint-Macary, A., Marriner, A., Deppeler, S., Harnwell, J., Law C, Sellegri K 2021. Oceanic phytoplankton are a potentially important source of benzenoids to the remote marine atmosphere. *Communications Earth & Environment*, *2*(1), pp.1-8.

Li, J., Davy, P., Harvey, M., Katzman, T., Mitchell, T. and Michalski, G., 2021. Nitrogen isotopes in nitrate aerosols collected in the remote marine boundary layer: Implications for nitrogen isotopic fractionations among atmospheric reactive nitrogen species. *Atmospheric Environment*, *245*, p.118028.

Stephen Archer, Kevin Lee, Tancredi Caruso et al. Global biogeography of atmospheric microorganisms reflects diverse recruitment and environmental filtering, 08 February 2022, PREPRINT (Version 4) available at Research Square [https://doi.org/10.21203/rs.3.rs-244923/v4]

McFarquhar, G.M., Bretherton, C.S., Marchand, R., Protat, A., DeMott, P.J., Alexander, S.P., Roberts, G.C., Twohy, C.H., Toohey, D., Siems, S. and Huang, Y., 2021. Observations of clouds, aerosols, precipitation, and surface radiation over the Southern Ocean: An Overview of CAPRICORN, MARCUS, MICRE, and SOCRATES. *Bulletin of the American Meteorological Society*, *102*(4), pp.E894-E928.

Kremser, S., Harvey, M., Kuma, P., Hartery, S., Saint-Macary, A., McGregor, J., Schuddeboom, A., Von Hobe, M., Lennartz, S.T., Geddes, A. and Querel, R., 2021. Southern Ocean cloud and aerosol data: a compilation of measurements from the 2018 Southern Ocean Ross Sea Marine Ecosystems and Environment voyage. *Earth System Science Data*, *13*(7), pp.3115-3153.

Paton-Walsh, C., Emmerson, K.M., Garland, R.M., Keywood, M., Hoelzemann, J.J., Huneeus, N., Buchholz, R.R., Humphries, R.S., Altieri, K., Schmale, J. and Wilson, S.R., 2022. Key challenges for tropospheric chemistry in the Southern Hemisphere. *Elem Sci Anth*, *10*(1), p.00050.

Integrated studies of high sensitivity systems

Grégoire, M. et al. . (2021). "A global ocean oxygen database and atlas for assessing and predicting deoxygenation and ocean health in the open and coastal ocean." Frontiers in Marine Science, Ocean Observation 8.

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?

Theme 1: Greenhouse gases and the Oceans

Commonwealth Blue Charter Action on Ocean Acidification - coordination and delivery of Handbook for Policymakers involved engagement with a number of international partners (see Handbook)

The New Zealand Ocean Acidification Observing Network (NZOA-ON). Sampling Partners: Te Papa Atawhai Department of Conservation, Waikato Regional Council, Bay of Plenty Regional Council, Te Runanga o Nga Tahu, Paua Industry Council, Marlborough Shellfish Monitoring Programme

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.).

Theme 1: Greenhouse gases and the Oceans

Continuation of:

The New Zealand Ocean Acidification Observing Network (NZOA-ON)
https://marinedata.niwa.co.nz/nzoa-on/

The Munida Time Series Transect bimonthly sampling of ocean carbon chemistry

Theme 3: Atmospheric deposition and ocean biogeochemistry

Hunga Tonga–Hunga Ha‘apai volcano impact voyage. R/V Tangaroa April-May 2022. Impacts of volcanic ash deposition o marine biogeochemistry and primary production.

Western Ross Sea voyage and Nz-Ross Sea transect voyage. R/V Tangaroa January -February 2023. SOLAS-related topics include aolien deposition, coastal trace metal inputs and budgets

Climatic and environmental impacts of the largest explosive volcanic eruptions on Earth: SOLAS activities include the investigation of volcanic ash deposition, iron fertilisation and Southern Ocean

biogeochemical response to the Taupo and Oruanui supereruptions from Antarctic ice core records (3 year project).

Theme 4 "Interconnections between aerosols, clouds, and marine ecosystems"

goSouth – Planning for campaign on high-resolution meteorological modelling of aerosol and cloud properties in the Southern Hemisphere marine boundary layer, in collaboration with Leibniz Institute for Tropospheric Research for measurement (TROPOS) and LOSTECCA (Lidar Observations of SpatioTEmporal Contrasts in Cloud and Aerosol)

Biogenic aerosol composition in the Ross Sea and Weddell Sea: planning for RV Tangaroa voyage to Ross Sea region and BIO Hesperides voyage to the Weddell Sea in January 2023 to collect aerosol samples to characterise the physical and chemical composition of biogenic aerosol emissions.

Ocean-Atmosphere-Snow interactions of biogenic emissions in the Ross Sea: Air-snow transfer study of biogenic emissions, ice core records of biogenic emissions and biogeochemical modelling to understand relationships between sea ice and phytoplankton composition in the Ross Sea over the past 200 years (3 year project).

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

Theme 1: Greenhouse gases and the Oceans

15th NZ Ocean Acidification Conference November 2022

3. Funded national and international projects/activities underway.

Theme 1: Greenhouse gases and the Oceans

Munida Time Series (continuing)

New Zealand Ocean Acidification Observing Network (Continuing)

Theme 3: Atmospheric deposition and ocean biogeochemistry

Climatic and environmental impacts of the largest explosive volcanic eruptions on Earth (Marsden Fund; PI Barker)

Theme 4 "Interconnections between aerosols, clouds, and marine ecosystems"

goSouth – see above

How did changing sea ice conditions impact primary production in the Ross Sea over the past 200

years? (Marsden Fast-Start Fund; PI Winton)

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

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

NIWA and University of Otago partnering with SPC and University of the South Pacific to establish the Pacific Islands Ocean Acidification Centre.

Comments