

## Report for the year 2020 and future activities

### SOLAS New Zealand

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*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. ?**

### **PART 1 - Activities from January 2020 to Jan/Feb 2021**

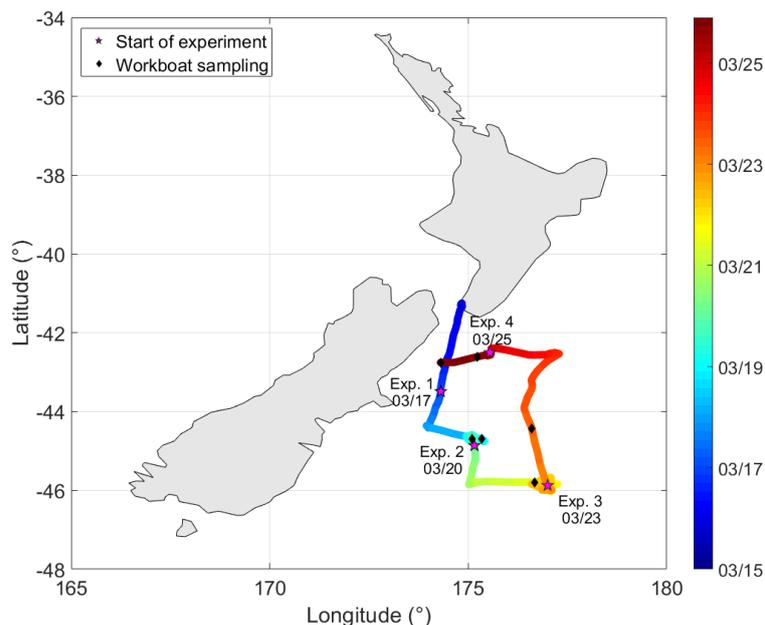
#### **1. Scientific highlight**

*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).*

Sea2Cloud Voyage:

The voyage of the Sea2Cloud project took place in March 2020 on R/V Tangaroa in the Chatham Rise frontal region to the east of New Zealand. This collaboration had developed and was

endorsed as a SOLAS Theme 4 activity led by PI's Dr. Cliff Law, NIWA with N.Z. collaborators, Dr. Karine Sellegri, Université Clermont Auvergne, CNRS, Laboratoire de Météorologie Physique with a consortium of French partners as well participation from CSIRO Australia, Geomar Germany and Colorado State University, USA.



Biological and biogeochemical influence on marine aerosol and aerosol-cloud interaction was investigated through a multifaceted measurement programme, including in situ ambient measurements, nascent aerosol measurements from sea-spray generator chamber and two on-board air-sea interaction (mesocosm) tanks used to investigate fluxes of gas-phase emissions and their potential to form new nano-particles in the headspace air. In the study region, water was sampled from a range of biological productivity across the Chatham Rise in sub-tropical, frontal and subantarctic water masses. In addition, an on-board cloud radar/lidar was run to characterize cloud properties including ice phase fraction with the goal of examining the influence of ice nuclei of marine origin on precipitation and persistence of lower level clouds.

The first results published from Sea2Cloud by Rocco et al. (2021) "Oceanic phytoplankton are a potentially important source of benzenoids to the remote marine atmosphere." <https://doi.org/10.1038/s43247-021-00253-0> present new evidence for emissions of benzenoids aromatic VOC emissions from open ocean of order one to a few  $\text{ng m}^{-2} \text{s}^{-1}$ .

Analyses are progressing towards a Sea2Cloud special issue jointly published in Atmospheric Chemistry and Physics and Ocean Science journals.

Project web pages:

<https://sea2cloud.data-terra.org/en/welcome/about/>  
<https://cordis.europa.eu/project/id/771369>

**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).**

**SOLAS Theme 1: "Greenhouse gases and the Oceans"**

1. The New Zealand Ocean Acidification Observing Network (NZOA-ON) increased the number of monitoring sites in collaboration with The Department of Conservation and Waikato Regional Council  
<https://marinedata.niwa.co.nz/nzoa-on/>
2. The Munida Time Series Transect continued in its 23<sup>rd</sup> year of measuring ocean carbon

chemistry

3. Economic opportunities and environmental implications of energy extraction from gas hydrates (HYDEE)

Analysis and interpretation of data collected during the 2019 HYDEE voyage on R/V Tangaroa

4. Southern Ocean/Ross Sea Voyage January/February 2021

SOLAS related aspects of the TAN2101 voyage on R/V Tangaroa included dissolved methane measurement and collection of water and air samples for microplastics

5. 13th & 14th New Zealand National Ocean Acidification Workshop held:

a two-day meeting at Victoria University of Wellington in February 2020

a two-day meeting at University of Otago in February 2021

<http://nzoac.nz/conferences>

#### **SOLAS Theme 4 “Interconnections between aerosols, clouds, and marine ecosystems”**

- 1 Surface Ocean Aerosol Production (SOAP)

<https://www.niwa.co.nz/atmosphere/research-projects/soap>

Twelve papers published, with 10 in a Special Issue in Ocean Science and Atmospheric Chemistry & Physics and Ocean Science at

[http://www.ocean-sci.net/special\\_issue10\\_333.html](http://www.ocean-sci.net/special_issue10_333.html)

- 2 Sea2Cloud – ~ the Sea2Cloud voyage (see above) was at sea between 16 – 26 March 2020 (11 days) shortened from 22 day plan by first NZ Covid lockdown. At the coast, just short of 1 year of Sea2Cloud aerosol measurements were completed at Baring Head station in Feb 2021

<https://niwa.co.nz/climate/research-projects/sea2cloud> (see above)

General interest media:

Colombani, H. (2020) De La Mer aux Nuages. You Tube, CNRS, NIWA and Sea2Cloud Science Team: 41 min. <https://youtu.be/6wP-Eq6Lw1k> (French), <https://youtu.be/0MOOzQLdcZ0> (English)

- 3 The CARIM Mesocosm experiments: experiments on the impact of ocean acidification and warming on the biology and biogeochemistry of New Zealand coastal waters during 2017-2019 included studies on DMS/DMS cycling, non-CO<sub>2</sub> GHG concentrations and also sea-spray aerosol. This led to two publications (in Section 3)

- 4 Reef2Rainforest voyage (RV Investigator): analyses of air mass source influence on airborne fungi and bacteria were published by Archer et al (2019) “Air mass source determines airborne microbial diversity at the ocean-atmosphere interface of the Great Barrier Reef marine ecosystem”. The ISME Journal: <http://doi.org/10.1038/s41396-019-0555-0> with commentary: Pointing (2019) <https://naturemicrobiologycommunity.nature.com/users/207254-stephen-pointing/posts/56181-microbes-connect-the-earth-sea-and-sky>

- 5 Deep South National Science Challenge: data were contributed to a new global collation of ship-borne measurements of ice nucleating particles (INP) showing a gradient of decreasing INP efficacy with latitude increase towards the poles of the Southern Hemisphere in Welti et al (2020) “Ship-based measurements of ice nuclei concentrations over the Arctic, Atlantic, Pacific and Southern Oceans: <https://doi.org/10.5194/acp-20-15191-2020>

New model / data comparisons:

- (i) a study evaluated the influence of a new sea-salt parameterisation on a HadGEM3 climate model performance – Hartery et al (2020) “Constraining the surface flux of sea spray particles from the Southern Ocean”. <https://doi.org/10.1029/2019JD032026> and

Revell et al (2019) "The sensitivity of Southern Ocean aerosols and cloud microphysics to sea spray and sulfate aerosol production in the HadGEM3-GA7.1 chemistry–climate model." <https://doi.org/10.5194/acp-19-15447-2019>.

(ii) ship-based ceilometer observations in the Southern Ocean showed an underestimation of low level cloud and fog in connection with excess short radiation at the surface in HadGEM climate model: - Kuma et al (2020) "Evaluation of Southern Ocean cloud in the HadGEM3 general circulation model and MERRA-2 reanalysis using ship-based observations." <https://doi.org/10.5194/acp-20-6607-2020>

Workshops:

Deep South work was presented at the SOAR (Southern Ocean Atmospheric Research) 2019 Workshop held from 19-21 November 2019 at the University of Tasmania's Institute for Marine and Antarctic Studies (IMAS) and:

16th Australia and New Zealand Aerosol Assembly - New Zealand adjunct meeting, University of Canterbury, Christchurch, N.Z., 24 November.

#### 6 Aerosol nitrogen chemistry

New analyses suggested the seasonal variations in the oxidation pathways of NO<sub>2</sub> δ<sup>15</sup>N values in nitrate aerosols displayed a clear seasonal variation, with lower δ<sup>15</sup>N values (-12‰ to ~-9‰) in the summer and higher δ<sup>15</sup>N values (0‰ to 3‰) in the winter.. This variation was much bigger than could be accounted for by a seasonal shift in sources; and is driven largely by seasonal differences in both nitrate yields and isotopic fractionation in the oxidation pathways from NO<sub>2</sub> to nitrate: - Li et al. (2021) "Nitrogen isotopes in nitrate aerosols collected in the remote marine boundary layer: implications for nitrogen isotopic fractionations among atmospheric reactive nitrogen species." <https://doi.org/10.1016/j.atmosenv.2020.118028>

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

1. Saint-Macary, A.D., N. Barr, E. Armstrong, K. Safi, A. Marriner, M. Gall, K. McComb, P. W. Dillingham, and C. S. Law. "The Influence of Ocean Acidification and Warming on DMSP & DMS in New Zealand Coastal Water." *Atmosphere* 12, no. 2 (2021): 181.
2. Sellegri, K., Nicosia, A., Freney, E., Uitz, J., Thyssen, M., Grégori, G., ... & Law, C. S. (2021). Surface ocean microbiota determine cloud precursors. *Scientific reports*, 11(1), 1-11.
3. Cravigan, L. T., M. D. Mallet, P. Vaattovaara, M. J. Harvey, C. S. Law, R. L. Modini, L. M. Russell et al. "Sea spray aerosol organic enrichment, water uptake and surface tension effects." *Atmospheric Chemistry and Physics* 20, no. 13 (2020): 7955-7977.
4. Hopkins, Frances E., et al. "The impacts of ocean acidification on marine trace gases and the implications for atmospheric chemistry and climate." *Proceedings of the Royal Society A* 476.2237 (2020): 20190769.
5. Lawson, S. J., Law, C. S., Harvey, M. J., Bell, T. G., Walker, C. F., Bruyn, W. J. D., & Saltzman, E. S. (2020). Methanethiol, dimethyl sulfide and acetone over biologically productive waters in the southwest Pacific Ocean. *Atmospheric Chemistry and Physics*, 20(5), 3061-3078.
6. Vance, J. M., Currie, K. I., Law, C. S., Murdoch, J., & Zeldis, J. (2020). NZOA-ON: the New Zealand Ocean Acidification Observing Network. *Marine and Freshwater Research*, 71(3), 281-299.

#### Models, datasets, products & resources

Blue Charter Action Group on Ocean Acidification's A Policymaker's Handbook for Addressing the Impacts of Ocean Acidification <https://bluecharter.thecommonwealth.org/policymakers-handbook-ocean-acidification/>

New Datasets (Ross Sea 2018 voyage aerosol-cloud interactions):

Kremser et al 2020. Southern Ocean Cloud and Aerosol data: a compilation of measurements from the 2018 Southern Ocean Ross Sea Marine Ecosystems and Environment voyage.

<https://doi.org/10.5281/zenodo.4060237> and <https://doi.org/10.5194/essd-2020-321>

Hartery et al., 2019 Number Concentrations of Sea Spray Particles in the Ross Sea (February - March, 2018), R/V Tangaroa voyage TAN1802 <https://doi.org/10.1594/PANGAEA.909249>

#### **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?**

##### **SOLAS Theme 1**

1. Coastal Acidification: Rates, Impact & Management (CARIM) <http://www.carim.nz/>: the CARIM project had major interaction with Maori and other national stakeholders, including the shellfish fishery sector, Ministry of Primary Industries, regional councils, Department of Conservation and the Hauraki Gulf Forum. The CARIM Project ended in early 2020 with the publication of a Report Card coinciding with a Stakeholders Workshop. CARIM highlights were also presented in a Keynote at the N.Z. Coastal Society,
2. The New Zealand Ocean Acidification Observing Network (NZOA-ON) continues collaboration with stakeholders and end-users to collect ocean acidification samples: <https://marinedata.niwa.co.nz/nzoa-on/>
3. Commonwealth Blue Charter on Ocean Acidification: A Handbook for Policymakers. A New Zealand scientist held two online "Virtual Coffee" events with policymakers from a variety of Commonwealth nations to discuss the development of a Handbook for Policymakers on Ocean Acidification.
4. Scientists contributed expert assessment to the Our Marine Environment Report 2019 for the New Zealand Ministry of Environment: New Zealand's Environmental Reporting Series: Our marine environment 2019. pp 70. <https://www.stats.govt.nz/information-releases/new-zealands-environmental-reporting-series-our-marine-environment-2019>
5. Mitigation of Coastal Acidification around Mussel Farms: This project was completed in mid-2020 with a report published: C.S. Law, N. Barr, M. Gall, V. Cummings, K. Currie, J. Murdoch, J. Halliday, E. Frost, C. Stevens, D. Plew, J. Vance, J. Zeldis (November 2020). Final report for Sustainable Seas National Science Challenge Innovation Fund project Ocean acidification mitigation strategies for the mussel industry (IF2.2.2.1).
6. A commissioned report on ocean acidification for Waikato Regional Council was publicly released in December 2020: Law, C.S, Zeldis J.R., Bostock H., Cummings, V., Currie K., Frontin-Rollet, G., MacDonald, H, Mikaloff-Fletcher, S., Parsons D., Ragg, N., Sewell, M. A synthesis of New Zealand ocean acidification research, with relevance to the Hauraki Gulf, Prepared for Waikato Regional Council. NIWA Client Report No: 2019165WN. May 2019. <https://waikatoregion.govt.nz/services/publications/tr202016>

#### **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.).**

1. The New Zealand Ocean Acidification Observing Network (NZOA-ON)
2. Munida Time Series Transect

1. goSouth field “campaign”(Model assisted vertical in-situ investigation of aerosols, and aerosol-cloud-turbulence interactions in the **Southern Hemisphere marine boundary layer** Campaign is planned for October 2022

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

13th International Conference on Southern Hemisphere Meteorology and Oceanography  
<https://confer.eventsair.com/icshmo-2022/> 8 – 12 February 2022

15th New Zealand National Ocean Acidification Conference (November 2022)

**3. Funded national and international projects/activities underway.**

**SOLAS Theme 1**

1. HYDEE (Economic opportunities & environmental implications of energy extraction from gas hydrates)
2. The New Zealand Ocean Acidification Observing Network (NZOA-ON)
3. Munida Time Series Transect

**SOLAS Theme 4**

4. Sea2Cloud (see above)

**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.**

Commonwealth Blue Charter Action Group on Ocean Acidification  
GOA-ON Executive Committee  
GOOS Executive Committee  
IOCCP Scientific Steering Group  
OA-ICC Advisory Board and member of SOLAS-IMBER Working Group on Ocean

**Comments**