

## Report for the year 2018 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 2018 – Jan-Feb 2019
- **Part 2:** reporting on planned activities for 2019/2020 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;
- 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).*

#### PART 1 - Activities from January 2018 to Jan/Feb 2019

##### 1. Scientific highlight

###### Sources of sulfate at a coastal station (Baring Head, N.Z.) determined from isotopic analysis

A detailed study was completed analysing the sulfur isotopic component of sulfate aerosols over a year at Baring Head, with results also presented to the 4th Australasian Environmental Isotope Conference held in Wellington in Mar 2018. This work was a collaboration between Purdue University (P.I. Greg Michalski), working with GNS and NIWA in NZ supported through East Asia and Pacific Summer Institutes for U.S. Graduate Students (EAPSI) programme.

Samples in the project were segregated in size by cascade impaction between “coarse” > 1µm and “fine” <1µm modes, by air sector as solely marine compared with all wind sectors (which include, marine, terrestrial and urban influences) and by ion chemistry into sea-salt and non-sea salt components. The results provide independent support for marine biogenic sulfur being the dominant precursor to climatically important secondary sulfate aerosols that have a regionally important role as Cloud Condensation Nuclei. Marine biogenic sources dominate and are strongly seasonal with a peak in spring/summer. The isotopic ratio  $\delta^{34}\text{S}$  is well established at +21‰ and biogenic DMS derived sulfate lies in the range +15‰ to +19‰. At Baring Head, fine aerosol sulfate was found to be in the range +10‰ to +15‰ over autumn/winter due to a isotopically “lighter” fossil

fuel influence accounting for about half of the all-sector sub-micron sulfate in winter with shipping emissions thought to contribute significantly here.

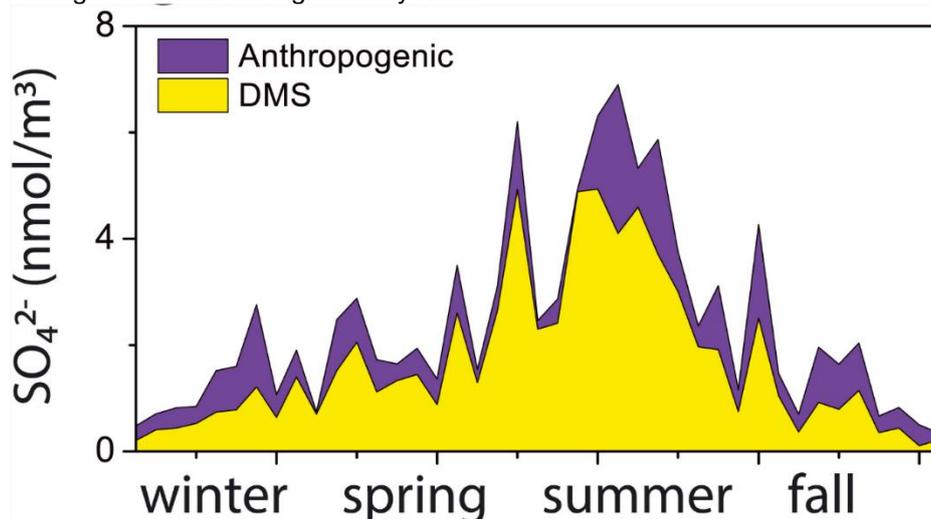


Figure: estimated anthropogenic and DMS contribution to NSS-sulfate in ambient fine aerosol from Li et al., GRL 2018; <https://doi.org/10.1002/2018GL077353>

**2. Activities/main accomplishments in 2018 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, social sciences, and media).**

#### **SOLAS Theme 1**

##### **1. The New Zealand Ocean Acidification Observing Network (NZOA-ON)**

A coastal observing network comprising 14 sites throughout New Zealand was sampled fortnightly in collaboration with partners from local councils, research institutes, Māori iwi, aquaculture and fishing industries. The resulting ocean acidification data is publicly available, via a website and data portal (<https://marinedata.niwa.co.nz/>).

##### **2. Munida Transect**

Time series CO<sub>2</sub> data has been collected from the surface Munida transect for 19 years, with 6 voyages per year conducted along the 65 km long transect. The data has contributed to the IGMETS Status report (O'Brian et al, 2016), and several journal papers (Baltar et al, 2016, Baltar et al, 2016b, Law et al 2017, Law et al, 2017b, Morales et al 2018)  
Surface SOOP CO<sub>2</sub> data was collected from 11 voyages of the RV Tangaroa in the South West Pacific Ocean, and submitted to SOCAT. These data then contributed to the Global Carbon Budget (Le Quere et al, 2018).

##### **3. Coastal Acidification: Rates, Impact & Management (CARIM) <http://www.carim.nz/>**

RA1 - Continuous monitoring and bottle samples at 3 sentinel sites (Firth of Thames, Nelson Bays, Karitane); data quality controlled and publicly available on NZOA-ON website

RA2 – Biogeochemical budgets produced and ROMS model further developed for Firth of Thames

RA3 – 4 mesocosm experiments completed examining responses of coastal plankton to ocean acidification and warming

RA4 – Experiments completed examining impact of low pH on mussel and paua adults, larvae and fertilisation, including adult pre-exposure assessments

RA5 – determination of adaptation potential to low pH in different families of Greenshell Mussel & Paua

There has been significant engagement with NZ stakeholders on ocean acidification and warming, including a presentation to Members of Parliament in the Beehive (NZ Parliament). NZ Ocean Acidification. Invited presentations on national OA research coordinated were also given at three side events during COP24 (Katowice, Poland, December 2018).

#### **SOLAS Theme 4**

1. Surface Ocean Aerosol Production (SOAP)

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

10 papers published to date, with 8 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)  
Invited presentation, SOLAS Marine aerosols workshop, Rome, November 2018

2. Development of the Sea2Cloud voyage (see below)

3. Deep South National Science Challenge

The Deep-South National Science challenge is building capacity at the interface between Atmospheric Processes and Observations and Earth System Modelling and Prediction to refine the Earth System Modelling representation of clouds and aerosols. The initial observational focus has been at latitudes poleward of 60°S in this work where the models underestimate the radiative impact of clouds. Novel measurements have included ship-based micro-pulse lidar profiles of aerosol and cloud, alongside radiosonde and ceilometer observations and first trials of RPAS/drone deployment of light-weight in situ aerosol sensors. Results were discussed this year at a number of international meetings including EGU, International Conference on Nucleation and Atmospheric Aerosols, Finland, NZ Antarctic conference, Deep South Symposium, NZ Meteorological Society. Methods have been developed for regional regime based evaluation of GCM cloud simulations using self-organizing maps (PI McDonald, U Canterbury, NZ). Model development has been focussing on the improvement of the representation of clouds south of 60°S through improvements in ice/liquid phase partitioning with consideration of ice nucleating particles.

<http://www.deepsouthchallenge.co.nz/programmes/processes-and-observations>

<http://www.deepsouthchallenge.co.nz/programmes/earth-system-modelling-and-prediction>

4. Clean-air sampling from vessels, avoidance and quantification of ship emissions.

Multi-tracer/meteorological variables have been found to be necessary for identifying pollution contamination of background aerosol sampled from ships. Parallel analyses have been done in connection with NZ and Australian SOLAS programmes with RV Tangaroa and RV Investigator (PI's Harvey, NIWA, Humphries, CSIRO). Results were discussed at the 2017 Annual Atmospheric Composition & Chemistry Observations & Modelling Conference, NSW, Australia.

In collaboration with the Australian SOLAS activity PI: Ristovski, QUT, a new method was developed to investigate particulate emissions from ships using airborne in-situ profiling sensors deployed from tethered balloons and RPAS through measurement of ship exhaust plume CO<sub>2</sub> and particulates

5. Sources of sulfate aerosol at Baring Head, New Zealand

(See scientific highlight) New analyses have shown a mix of biogenic and anthropogenic sources of background sulfate through stable isotopic analyses of sulfate aerosol from size-resolved selective sampling at Baring Head. PI: Michalski, Perdue University, USA, GNS NZ, NIWA NZ.

6. Southern Ocean/Ross Sea Voyage

Antarctic marine aerosol and sulfur studies were undertaken on R/V Tangaroa Ross Sea Ecosystems and Environment Voyage in Feb - Mar 2018. The voyage spent 30 days south of 60°S making a range of aerosol and cloud observations to aid Earth System model development. Measurements were made in conjunction with an oceanographic and ecosystem function study of the northern Ross Sea region in conjunction with the establishment of the Ross Sea marine protected area:

<https://www.niwa.co.nz/our-science/voyages/antarctica-2018>

<https://www.mfat.govt.nz/en/environment/antarctica/ross-sea-region-marine-protected-area/>

The ocean-atmosphere aerosol-cloud studies involve NZ/European/US collaborators from: NZ: NIWA, U Canterbury, Auckland University of Technology, Bodeker Scientific, France: LAMP CNRS, Germany: Forschungszentrum Jülich, Helmholtz Centre for Ocean Research Kiel, USA: Sigma Space Corp, NASA, Colorado State University.

7. Low background aerosol in the tropical western Pacific

Eight transect voyages of opportunity between New Zealand and Japan (2006 and 2013) show consistently low aerosol in air masses originating in the North Pacific sub-Tropical high.

Bromley, A.M., Harvey, M.J., Gray, S., A., McGregor, J.A. (2018) Condensation Nuclei and Aerosol Optical Depth measurements through the western Pacific Ocean. Weather and Climate, 38(1): 38-57.

**Cross-Cutting Theme: Science & Society**

1. Mitigation of Coastal Acidification around Mussel Farms

Field measurements and experiments completed to examine the potential of using waste shell and aeration to ameliorate impacts of low pH at mussel farm scales.

**3. Top 5 publications in 2018 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.**

1. Smith M.J., Walker C.F., Bell T.G., Harvey M.J., Law C.S., Saltzman E.S. Gradient flux measurements of sea-air DMS transfer during the Surface Ocean Aerosol Production (SOAP) experiment. *Atmos. Chem. Phys. Discuss.*, 18, 5861-5877, <https://doi.org/10.5194/acp-18-5861-2018>

2. Wannicke N, Frey C, Law CS, Voss M. 2018. The response of the marine nitrogen cycle to ocean acidification. *Global Change Biology* 24(11): 5031-5043 doi: 10.1111/gcb.14424

3. Li, J., Michalski, G., Davy, P., Harvey, M., Katzman, T., & Wilkins, B. (2018). Investigating Source Contributions of Size-Aggregated Aerosols Collected in Southern Ocean and Baring Head, New Zealand Using Sulfur Isotopes. *Geophysical Research Letters*, 45(8), 3717-3727.

4. Schuddeboom, A., McDonald, A. J., Morgenstern, O., Harvey, M., & Parsons, S. (2018). Regional Regime-Based Evaluation of Present-Day General Circulation Model Cloud Simulations Using Self-Organizing Maps. *Journal of Geophysical Research: Atmospheres*, 123(8), 4259-4272.

5. Le Quéré, C., Andrew, R.M., Friedlingstein, P., Sitch, S., Pongratz, J., Manning, A.C., Korsbakken, J.I., Peters, G.P., Canadell, J.G., Jackson, R.B. and Boden, T.A., 2017. Global carbon budget 2017. *Earth System Science Data Discussions*, pp.1-79.

**4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2018? If yes, who? How did you engage?**

**SOLAS Theme 1:**

1. CARIM <http://www.carim.nz/>

The CARIM project has major interaction with Maori and other national stakeholders, including the shellfish fishery sector, MPI, regional councils, DOC and the Hauraki Gulf Forum, as well as international scientists in the US and Australia. In addition, discussions with regional councils and the mussel industry has led to spin off projects and co-funding. The CARIM project also has a major Outreach component that includes an "Oceans Guardians" programme for schools and local communities around the sentinel sites.

2. The New Zealand Ocean Acidification Observing Network (NZOA-ON)

<https://marinedata.niwa.co.nz/nzoa-on/>

NZOA-ON – Collaborators collect fortnightly water samples and are the backbone of the NZOA-ON. Engagement is via email and website; and sampling Partners include Auckland Council, Auckland University, NIWA, Bay of Plenty Regional Council, Cawthron Institute, Aquaculture New Zealand, Puaa Industry Council, University of Otago, Fishing Industry, Department of Conservation, Ngai Tahu).

3. 12<sup>th</sup> New Zealand National Ocean Acidification Workshop

<http://nzoac.nz/workshops/>

A two-day meeting at the University of Waikato in February, included representatives from a number of national stakeholders and a major session on science-policy connections with VC presentations from the International Action on OA Alliance

4. International Ocean Acidification Alliance <https://www.oaalliance.org/>

The Ocean Foundation, SPREP and the University of the South Pacific in Fiji recently hosted a series of courses on ocean acidification monitoring and research. Kim Currie from the NIWA / University of Otago Research Centre for Oceanography in Dunedin joined scientists from NOAA to train participants from Pacific Island nations in the analytical and field skills necessary to initiate and implement an ocean acidification monitoring and research programme. An Introductory Course involved lectures, lab and field work; this was followed by an applied course providing hands-on training. A parallel course focused on policy development. This suite of skills will enable the participating nations to work towards enhancing resilience of local marine environments to changing ocean chemistry resulting from uptake of anthropogenic carbon and other stressors. These include coral reefs, mangroves and sea grass beds which are of social and economic importance to our South Pacific neighbours. NZ has developed an OA Action Plan, and NZ activities were presented in the International Ocean Acidification Alliance side event at COP24 (Katowice, Poland) in November 2019.

NZ Scientists attended the “Reinvigorating Ocean Acidification research in Australia” meeting, and the “Negative Emissions” meeting, in Canberra in October 2018

#### **SOLAS Theme 4**

##### 5. Black Carbon Workshop (3 October 2018)

CASANZ and Benchmark Monitoring convened a workshop at NIWA in Wellington to review aethalometry instrumentation and technology developments. The meeting had strong local government participation. “Background” oceanic black-carbon levels were discussed in addition to the main focus on polluted urban environments.

##### 6. The 14<sup>th</sup> Annual Australia-New Zealand Aerosol Assembly (18 – 19 Oct 2018)

was convened in Alexandra 18-19<sup>th</sup> October and included sessions on marine aerosols and climate modelling <https://www.aerosolanz.com/programschedule/>. The Australia/New Zealand aerosol assembly (ANZAA), a special interest group of CASANZ with membership including researchers, local government and instrument developers and suppliers <https://www.casanz.org.au/casanz-sigs/australia-and-new-zealand-aerosol-assembly/> and interests that range from air pollution to background aerosol processes.

A NZ Scientist attended the SOLAS Aerosol workshop in Rome (27/11/18)

### **PART 2 - Planned activities for 2019/2020 and 2021**

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

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

##### 1. CARIM

Continued monitoring at sentinel sites plus a spatial survey of the Nelson Bays

##### 2. The New Zealand Ocean Acidification Observing Network (NZOA-ON)

Additional sites will be added in collaboration with regional councils. Data will be available via the GOA-ON web portal

##### 3. Munida Transect – continuing into its 22<sup>nd</sup> year

##### **SOLAS Theme 4**

##### 4. Sea2Cloud

An international voyage will take place in October/November 2019 to examine how marine microorganisms influencing clouds. This is a continuation of the collaboration between Karine Sellegri (LAMP CNRS) and NIWA, with the research being funded by EU Horizons 2020. The voyage will examine air-sea interactions on a transect from sub-tropical waters across the subtropical front into sub-Antarctic waters.

##### **SOLAS Cross-Cutting Theme: Science & Society**

Mitigation of Coastal Acidification around Mussel Farms

A 2<sup>nd</sup> measurement campaign examining carbonate variability and processes around a mussel farm is planned for February 2019

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

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

New Zealand is leading the Commonwealth Blue Charter Action on Ocean Acidification and is holding a workshop for Commonwealth State representatives in Dunedin in February 2019. The aim of this workshop is to inform state representatives on the current state of the science, impacts, adaptation and governance, and to facilitate action via linkage to international networks. To date over 20 Commonwealth countries have signed up to attend.

The CARIM Workshop will take place at the University of Otago in February 2018, and the CARIM Stakeholder workshop will take place towards the end of 2019

The 12<sup>th</sup> NZ National Ocean Acidification Workshop will take place at the University of Otago in February 2018

**SOLAS Cross-Cutting Theme: Science & Society**

There will be a session on the Ocean at the "Climate Matters" workshop in Wellington in June 2019. This is a one-day meeting for a broad range of NZ stakeholders at which the primary issues relating to climate change will be discussed

**SOLAS Cross-Cutting Theme: Environmental impacts of geoengineering**

NZ scientists are coordinating a Special Session on Marine Geoengineering at the SOLAS Open Science Conference in Sapporo, Japan in April 2019

**3. Funded national and international projects / activities underway.****SOLAS Theme 1**

1. HYDEE (Economic opportunities & environmental implications of energy extraction from gas hydrates) - A voyage will take place on the south-east shelf of the NZ North Island in June to look at the biogeochemical and biological impacts of seabed methane seeps
2. The New Zealand Ocean Acidification Observing Network (NZOA-ON)
3. Munida Transect
4. Mitigation of Coastal Acidification around Mussel Farms

**SOLAS Theme 4**

5. Sea2Cloud (see above)

A Research Strategy and Planning is underway for the second phase of Deep-South National Science Challenge research <https://www.deepsouthchallenge.co.nz/our-research-strategy-2019-2024>

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

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**5. Engagements with other international projects, organisations, programmes etc.****SOLAS Theme 1**

SCOR Working Groups:

WG 143 Dissolved N<sub>2</sub>O and CH<sub>4</sub> measurements: Working towards a global network of ocean time series measurements of N<sub>2</sub>O and CH<sub>4</sub>

IOCCP Scientific Steering Group

SOCAT Global QC Group

OA-ICC Advisory Board and member of SOLAS-IMBER Working Group on Ocean

Trainer at two ocean acidification capacity building workshops for Pacific Island States and Nations

Planning & coordination of a workshop for the Commonwealth Blue Charter Action on Ocean Acidification

**SOLAS Theme 4**

CSIRO Access ESM and Southern Ocean Aerosol-Cloud Research

Australia/New Zealand aerosol assembly (ANZAA), a special interest group of CASANZ <https://www.casanz.org.au/casanz-sigs/australia-and-new-zealand-aerosol-assembly/> includes background aerosol processes

New Zealand Earth System Model development is collaborating with CSIRO and the Australian Community Climate and Earth System Simulator (Access) with GLOMAP aerosol model (PI: Dr. Matthew Woodhouse) for Surface Ocean aerosol production and the Southern Ocean Aerosol-Cloud Research.

The Deep South National Science Challenge: <http://www.deepsouthchallenge.co.nz/> polar aerosol processes.

Process and observation studies of Aerosol-Cloud: "Sea2Cloud Are marine living microorganisms influencing clouds?" (PI Karine Sellegri, Laboratoire de Météorologie Physique – CNRS, France

Ice nucleation measurement programme PI: Paul J. DeMott, Colorado State University

**Comments**