

Report for the year 2022 and future activities

SOLAS Aotearoa New Zealand **compiled by: Holly Winton**

This report has two parts:

- **Part 1:** reporting of activities in the period of January 2022 - Jan/Feb 2023
- **Part 2:** reporting on planned activities for 2023 and 2024.

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. ?

The SOLAS Seminars and Newsletters provide highly useful and accessible updates on the latest science and activities.

PART 1 - Activities from January 2022 to Jan/Feb 2023

1. Scientific highlight

Clouds over the Southern Ocean are a large source of error in the current generation of climate models. To help address this the goSouth project characterised climate relevant aerosol processes in the turbulent boundary layer over the Southern Ocean as part of an international collaboration between the Leibniz Institute for Tropospheric Research (TROPOS), the Institute for Meteorology and Climatology (IMUK) at the Leibniz University of Hannover, the University of Auckland, the University of Canterbury and NIWA. A measurement campaign was carried out in November 2022 at a site overlooking Te Waewae Bay near Pahia (46.31°S, 167.71°W, 10 m a.s.l.), about 50 km west of Invercargill (Figure 1). Five researchers from TROPOS and one researcher from IMUK joined the NZ contingent for three weeks of aerosol and turbulence

measurements from ground level to 1 km. Measurements were made of aerosol physicochemical properties and concentrations in conjunction with a LOSTECCA remote-sensing campaign (Hofer et al., 2022) at the same site.

Despite severe logistical difficulties, due mainly to international shipping and local power problems, a potentially interesting ground-based and vertically resolved in-situ aerosol, meteorological and turbulence dataset, was acquired. First indications are that particle formation events were observed but due to the circulation patterns in the bay, it is possible that formation came from gaseous precursors emitted from New Zealand terrestrial sources. The project successfully demonstrated the feasibility of joint field campaigns in NZ and that due to the complex terrain and flow conditions, Te Waewae Bay is not the best place for investigating undisturbed Southern Ocean air-masses. First results were presented at a special session of the NZ Metsoc conference in Dunedin on December 6th 2022. Plans are now being made to seek funding for a larger campaign in 2025 to align with potential air and ship born campaigns planned for then.



Figure 1: The sampling site at Te Waewae Bay.

Acknowledgement: Go South is funded by BMBF (German Federal Ministry for Education and Research, project 01LK2003A), TROPOS, the Deep South Challenge and NIWA through SSIF.

Hofer et al., 2022. Lidar observations of spatiotemporal contrasts in clouds and aerosols (LOSTECCA) in New Zealand. *Proceedings of the Hydrometsoc22 meeting (Our water: a taonga in an ever-changing world)*.

2. Activities/main accomplishments in 2022 (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).

Guest Editor for the forthcoming SOLAS Special Issue in Elementa – Cliff Law.

Theme 1: Greenhouse gases and the Oceans

Southern Ocean CO₂ fluxes

- Lower atmosphere and surface ocean radiocarbon observations are used to investigate the drivers of varying Southern Ocean CO₂ fluxes. This work includes ongoing atmospheric radiocarbon

measurements from Ships of Opportunity crossing the Southern Ocean between New Zealand and Antarctica, and historic atmospheric radiocarbon measurements reconstructed from tree rings collected in New Zealand and its subantarctic islands and Chile. This research is led by GNS and NIWA.

The Munida Time Series

- Now in its 24 year, the Munida Time Series continuing to collect carbon chemistry data, in subantarctic and frontal waters of the SW Pacific. An empirical multivariate linear regression (MLR) model was developed to estimate the concentration of dissolved inorganic carbon (DIC) in the surface ocean, capable of utilizing remotely sensed and modelled data to fill data gaps. This MLR was evaluated with seven other imputation models using data from seven long-term monitoring sites, including the Munida Time Series in a comparative assessment of gap-filling performance and the impacts on variability in the reconstructed time series.

RV Tangaroa (TAN2302) voyage, New Zealand to Ross Sea, 10 January-23

- Methane sources in coastal waters (NZ Antarctic Science Platform), PIs Sarah Seabrook, Cliff Law.

UNESCO

- Introduction to Ocean Acidification module of UNESCO's Global Teacher Ocean Academy Ocean Acidification course (launched February 2022). Developed by Christina McGraw.

RV Ikatere (IKA2205) voyage, Bay of Plenty, 6 Oct 2022

- Sampling to track the fate of gases in the Bay of Plenty from the Calypso vent field.

UN Decade of Ocean Science endorsement of project focused on quantifying gases in the ocean using shipboard acoustic technology. <https://oceandecade.org/actions/quantifying-gases-in-the-ocean-using-acoustics/> Sally Watson, Yoann Lacroix, Sarah Seabrook, and Cliff Law.

Pacific Island Ocean Acidification Centre (PIOAC), a Fiji-based partnership between Otago, SPC, University of the Pacific, and NIWA. Founding members Kim Currie and Christina McGraw.

Pacific Island Ocean Acidification

- 'Train the trainers' workshop (July 2022). Lead by Christina McGraw and Kim Currie.
- Pacific Island Ocean Acidification Centre (PIOAC), a Fiji-based partnership between Otago, SPC, University of the Pacific, and NIWA. Founding members Kim Currie and Christina McGraw.

Waiti Waiti, The NZMSS & NZFSS Joint Conference 2022, Auckland

- Ocean Acidification in New Zealand: potential mitigation and adaptation, Law CS, Currie, K, McGraw.
- Evaluating Seasonal and Long-term Carbon Dynamics in the South Pacific, Currie K, Vance J, Law C and Suanda.

Oceans in a High CO2 World, Lima, Peru

- Evaluating Seasonal and Long-term Carbon Dynamics in the South Pacific, Currie, K, Vance J., Law CS, Suanda A.

Goldschmidt Conference, Honolulu, Hawaii

- Biogeochemical Feedbacks of Marine Methane Seeps in Aotearoa New Zealand, Seabrook S, Bowden D, Campbell K, Hillman J, Lacroix Y, Law C, Rowden A, Spain E, Torres M, Turco F, Watson S.

Media

- Ocean acidity rising in New Zealand coastal waters, Radio New Zealand News, <https://www.rnz.co.nz/news/national/473764/ocean-acidity-rising-in-new-zealand-coastal-waters> (Cliff Law)
- The secrets of Antarctic Microbes, Our Changing World, Radio New Zealand <https://www.rnz.co.nz/national/programmes/ourchangingworld/audio/2018850609/secrets-of-antarctic-microbes> (Sarah Seabrook)

Theme 2: Air-sea interface and fluxes of mass and energy

Gas Transfer at Water Surfaces (Plymouth, UK)

- Testing and application of a diffusion-based method for sampling DMS in the Sea Surface Microlayer. Alexia Saint-Macary, Theresa Barthelmess, Cliff Law.

Theme 3: Atmospheric deposition and ocean biogeochemistry

RV Tangaroa (TAN2302) voyage, New Zealand to Ross Sea, 10 January-23 February

- Influence of dust and ash deposition in NZ surface waters (PI Cliff Law)

Theme 4 Interconnections between aerosols, clouds, and marine ecosystems

Guest Editor for *Sea2Cloud* Special Issue in *Atmospheric Chemistry & Physics/Ocean Sciences*

- 6 papers published and submitted.

SOLAS OSC, Cape Town, S. Africa.

- K. Sellegri, C. Law et al. *Sea2Cloud: from biogenic emissions to cloud properties in the South-West Pacific*.

RV Tangaroa (TANG2302) voyage, New Zealand to Ross Sea, 10 January-23 February:

- Ocean derived aerosol-cloud-climate interactions in the Ross Sea region (PI Holly Winton)
Collection of aerosol samples and seawater particulates to understand air-sea transfer of biogenic and marine aerosol as fatty acids, trace elements and major ions. Real time measurement of aerosol concentration and size.
- Measuring microplastics over the Southern Ocean (PI Laura Revell)
Daily seawater and air samples were collected to analyse for the presence of microplastics on the 2023 *RV Tangaroa* voyage on the Southern Ocean. This data set is complementary to a similar data set collected in 2021.
- Monitoring Clouds and Aerosol in the Southern Ocean (PI Adrian McDonald)
Climatological measurements of near surface properties and low-level cloud and identifying Super-cooled liquid cloud.

RV Investigator (IN2022_V01) voyage Hobart to Southern Ocean, January-February 2022:

- Organic aerosol characterisation in the Southern Ocean (PI Holly Winton; piggyback project on the SOTS voyage)
Collection of aerosol samples to understand biogenic emissions such as fatty acids.

Present-day spatial distribution of lipid biomarkers of marine microbes in the Ross Sea region, Antarctica (PI Holly Winton)

- Phytoplankton biomarker (fatty acid and highly branched isoprenoids) analysis of surface snow and marine sediment to understand ocean-atmosphere transfer processes and sources.
- de Jong E., winner of Creative Poster Prize at SOLAS 2022 summer school for presentation "The Unknown Future of Ross Sea, Antarctic Phytoplankton: A multi-archive biomarker approach to the recent past".

Oceanic and atmospheric microplastics

- Kvale K, (2022) Microplastics. Invited contribution to *The Climate Book*, Thunberg, G. (ed) Penguin Press, London, UK
- Kvale ,K, Lou Del Bello, [China Dialogue](#) (19/05/2022)
- Kvale K., interviewed for [In the ocean, its snowing microplastics](#). Sabrina Imbler, New York Times, (03/04/2022)
- Winton H., Radio New Zealand Afternoon Show, interviewed By Jesse Mulligan on "First microplastics found in Antarctic snow" 8 June 2022.
- Winton H., Science Media Centre expert reaction on "[First microplastics found in Antarctic snow](#)"

Modelling marine aerosol and ice nucleating particles

- Two postdocs, Abhi Venugopal and Nick Edkins, were appointed at the University of Canterbury and NIWA to work on modelling marine aerosol and ice nucleating particles over the Southern Ocean using the New Zealand Earth System Model.

Theme 5: Ocean biogeochemical control on atmospheric chemistry

3th International Conference on Southern Hemisphere Meteorology and Oceanography

Measurements of air-sea fluxes of biogenic & oxygenated organic gases in the South-West Pacific measured via novel ship-born mesocosm studies. Manon Rocco, Erin Dunne, Maija Peltola, Neill Barr, Jonathan Williams, Aurélie Colomb, Karl Safi, Alexia Saint-Macary, Andrew Marriner, Stacy Deppeler, James Harnwell, Cliff Law, Karine Sellegri.

3. Top 5 publications in 2022 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Allen, D., S. Allen, S. Abbasi, A. Baker, M. Bergmann, J. Brahney, T. Butler, R. A. Duce, S. Eckhardt, N. Evangeliou, T. Jickells, M. Kanakidou, P. Kershaw, P. Laj, J. Levermore, D. Li, P. Liss, K. Liu, N. Mahowald, P. Masque, D. Materić, A. G. Mayes, P. McGinnity, I. Osvath, K. A. Prather, J. M. Prospero, L. E. Revell, S. G. Sander, W. J. Shim, J. Slade, A. Stein, O. Tarasova and S. Wright (2022). "Microplastics and nanoplastics in the marine-atmosphere environment." *Nature Reviews Earth & Environment* 3(6): 393-405. *This paper resulted from deliberations at the virtual workshop The Atmospheric Input of Chemicals to the Ocean, organized by the Joint Group of Experts on Scientific Aspects of Marine Environmental Protection (GESAMP; www.gesamp.org) Working Group 38 (led and supported by the World Meteorological Organization, <https://public.wmo.int/en>), and GESAMP Working Group 40 (co-led and supported by the Intergovernmental Oceanographic Commission of UNESCO, <https://ioc.unesco.org>, and the United Nations Environment Programme, <http://www.unep.org>).*

Aves, A. R., L. E. Revell, S. Gaw, H. Ruffell, A. Schuddeboom, N. E. Wotherspoon, M. LaRue and A. J. McDonald (2022). "First evidence of microplastics in Antarctic snow." *The Cryosphere* 16(6): 2127-2145.

Bhatti, Y. A., L. E. Revell and A. J. McDonald (2022). "Influences of Antarctic Ozone Depletion on Southern Ocean Aerosols." *Journal of Geophysical Research: Atmospheres* 127(18): e2022JD037199.

Hurd CL, Law CS, Bach L, Britton F, Hovenden M, Paine E, Raven JA, Tamsitt V, Boyd PW. (2022). Forensic Carbon Accounting: Assessing the role of seaweeds in carbon dioxide removal and sequestration *J. Phycol.* DOI: 10.1111/jpy.132491.

Kvale K and Oschlies A. (2022) Recovery from microplastic-induced marine deoxygenation may take centuries. *Nature Geosciences*. 10.1038/s41561-022-01096-w (1,5)

Kvale K. (2022) Implications of plastic pollution on global marine carbon cycling and climate. Invited review at *Emerging Topics in Life Sciences: Impact of Plastic Pollution on Organisms and the Environment*, Portland Press. <https://doi.org/10.1042/ETLS20220013> (1,5)

Saint-Macary AD, Marriner A, Barthelmeß T, Deppeler S, Safi K, Santana RC, Harvey M, Law CS (2022). DMSP and DMS in the Sea Surface Microlayer of the South-West Pacific: 1. Potential for enrichment determined by a novel sampler. *Ocean Sciences*, <https://doi.org/10.5194/egusphere-2022-499>

Saint-Macary, A. D., Marriner, A., Deppeler, S., Safi, K. A., and Law, C. S. (2022) Dimethyl sulfide cycling in the sea surface microlayer in the southwestern Pacific – Part 2: Processes and rates, *Ocean Sci.*, 18, 1559–1571, <https://doi.org/10.5194/os-18-1559-2022>.

Taucher J, Bach L, Prowe AEF, Boxhammer T, Kvale K, Riebesell U. (2022) Global decline of diatoms through ocean acidification. *Nature* 605, 696–700. (1,5)

Turco F, Ladroit Y, Watson SJ, Seabrook S, Law CS, Crutchley GJ, Mountjoy J, Pecher IA, Hillman JIT, Woelz S and Gorman AR (2022) Estimates of Methane Release from Gas Seeps at the Southern Hikurangi Margin, New Zealand. *Front. Earth Sci.* 10:834047. Doi: 10.3389/feart.2022.834047.

Yao W, Kvale K, Koeve W, Landolfi L, Achterberg E, Bertrand E, Oschlies A. (2022) Simulated future trends in marine nitrogen fixation are sensitive to model iron implementation. *Global Biogeochemical Cycles* 36,

e2020GB006851. <https://doi.org/10.1029/2020GB006851>. (1,5)

Vance, J.M., Currie, K., Zeldis, J., Dillingham, P., Law, C. (2022) An empirical MLR for estimating surface layer DIC and a comparative assessment to other gap-filling techniques for ocean carbon time series. *Biogeosciences*, 19(1). 10.5194/bg-19-241-2022

Winton, V.H.L., Bowie, A.R., Curran, M, Moy, A. (2022). Enhanced Deposition of Atmospheric Soluble Iron by Intrusions of Marine Air Masses to East Antarctica, *Journal of Geophysical Research: Atmospheres*. 127, e2022JD036586. <https://doi.org/10.1029/2022JD036586>.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2022? If yes, who? How did you engage?

Commonwealth Blue Charter training for policymakers and government officials, Addressing the Impacts of Ocean Acidification through Mitigation, Monitoring and Policy (23 – 27 May 2022). Led by Christina McGraw Leader. Presentations by Kim Currie and Cliff Law.

Kim Currie:

- The Ocean Foundation
- 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

New Zealand Regional and Local Councils Coastal Special Interest Group (C-SIG) Invited expert presentation on Coastal and Marine ecosystem impacts of climate change by Cliff Law.

PART 2 - Planned activities for 2023 and 2024

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

6 Bimonthly transects on the Munida Time Series (Kim Currie)

Theme 3: Atmospheric deposition and ocean biogeochemistry

Laboratory studies of iron deposition from ice core records:

- Iron leaching experiments and biomarker analysis of ice core tephra from the 25,000 ka Oruanui supereruption, New Zealand (Holl Winton)

Laboratory studies of iron deposition

- Impact of dust/ash on phytoplankton in subantarctic water (Otago)

Theme 4 Interconnections between aerosols, clouds, and marine ecosystems

Hauraki Gulf, DMS distribution and influence on grazers, October 2023 (C. Law)

BIO Hesperides voyage, South America to the Antarctic Peninsula, Feb-March 2023 (PI Dall'Osto)

- Aerosol emissions from polar changing environments - Polar Change
Collection of aerosol, seawater particulates and sea ice to understand air-sea transfer of fatty acids (Holly Winton)

Le Ponant voyage, New Zealand to Adélie Basin, Ross Sea, Amundsen and Bellingshausen Seas, the Antarctic Peninsula and Ushuaia, Feb-March 2023:

- Collection of snow and seawater for biomarker analysis.

RV Investigator (IN2023_V01) voyage Western Australia to coastal East Antarctica, January-February 2023:

- Organic aerosol characterisation in the Southern Ocean
Collection of aerosol samples to understand biogenic emissions such as fatty acids.

Antarctic fieldwork, Terra Nova Bay, Victoria Land (Nov-Feb 2023) (PI Holly Winton)

- Ocean-air-snow transfer study of biogenic emissions and ice core drilling.

Laboratory studies of phytoplankton biomarkers in aerosol, seawater and ice cores:

- Fatty acid and biofluorescent analysis of samples collected from multiple voyages to the Southern Ocean (PI Holly Winton).

Biogeochemical modelling of phytoplankton sensitivity to changing sea ice conditions in the Ross Sea (PI Holly Winton).

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

HYDEE (Economic opportunities and environmental implications of energy extraction from gas hydrates)
Final workshop – Methane seep distribution and dispersion in the water column (Cliff Law)

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

Royal Society of New Zealand Marsden Fund, Climatic and environmental impacts of the largest explosive volcanic eruptions on Earth, 2023-2026, PI Simon Barker

Royal Society of New Zealand Marsden Fund, Metal micronutrients: Major players in the Southern Ocean's carbon sink, 2023-2026, PI: Claudine Stirling

University of Otago Research Grant, Fire and iron: The response of marine phytoplankton to the Australian bushfires, 2022-2024, Co-PIs: Cliff Law, Claudine Stirling and Linn Hoffmann

Theme 4 Interconnections between aerosols, clouds, and marine ecosystems

Royal Society of New Zealand Rutherford Discovery Fellowship, Southern Ocean phytoplankton and climate: understanding the ability of phytoplankton to modulate climate in a warmer world, 2023-2028, PI Holly Winton

Royal Society of New Zealand Marsden Fund, How did changing sea ice conditions impact primary production in the Ross Sea over the past 200 years? 2023-2026, PI: Holly Winton

Deep South National Science Challenge, Marine organic aerosol as freezing and cloud-condensation nuclei: Improving the realism of cloud-aerosol coupling, 2022-2024, PI: Laura Revell and Olaf Morgenstern

Royal Society of New Zealand Catalyst Seeding fund, Development of a standardized analytical method for measuring airborne microplastics, 2022-2024, PI: Laura Revell

Royal Society of New Zealand Marsden Fund, The longevity of airborne microplastic-climate forcing from legacy plastic pollution, 2023-2026, PI: Laura Revell

Royal Society of New Zealand Rutherford Discovery Fellowships, Airborne microplastics in a changing climate, 2023-2028, PI: Laura Revell

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

Krapp M, Kvale K, et al. (submitted, pending) The long reach of slow climate feedbacks in the earth system. New Zealand Royal Society Marsden submission.

Bednarsek N, Kvale K, et al. (submitted, pending) Pel-Ocean. >1 mil. € requested as ERC Consolidator Grant.

Kvale K (submitted, pending) PlastTip: Quantifying earth system feedbacks and tipping points in marine plastic pollution. 1.3 mil. € requested as Emmy Noether Junior Professorship. DFG.

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

Scientists' Network for an Effective Plastics Treaty (SNEPT) Scientific engagement with and support for the UNEP plastics treaty negotiations (2022-present).

Funding of new SCOR working group "Reducing Uncertainty in Soluble aerosol Trace Element Deposition (RUSTED)" including associate member Holly Winton.

Ocean Acidification Research for Sustainability, an endorsed UN Decade of Ocean Science for Sustainable Development programme. Member of Working Group 7, whose aim is to "Develop strategies and solutions to enable countries and regions to include measures to reduce ocean acidification in their respective legislation" (2022 - present). Including working group member Christina McGraw.

Comments