surface ocean solas lower atmosphere study

Report for the year 2017 and future activities

SOLAS *Australia*

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This report has two parts:

***- Part 1:** reporting of activities in the period of January 2017 – Jan-Feb 2018*
***- Part 2:** reporting on planned activities for 2018/2019 and 2020.*

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 2017 to Jan/Feb 2018

1. Scientific highlight

Describe one scientific highlight with a title, text (max. 200 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).

The Nexus between Sea Ice and Polar Emissions of Marine Biogenic Aerosols

The relationship between sea ice dynamics, phytoplankton biomass, and emissions of marine biogenic aerosols in both the Arctic and Southern Oceans was examined in a recent article published in the Bulletin of the American Meteorological Society.

Accurate estimation of the climate sensitivity requires a better understanding of the nexus between polar marine ecosystem responses to warming, changes in sea ice extent, and emissions of marine biogenic aerosol (MBA). Sea ice brine channels contain very high concentrations of MBA precursors that, once ventilated, have the potential to alter cloud microphysical properties, such as cloud droplet number, and the regional radiative energy balance. In contrast to temperate latitudes, where the pelagic phytoplankton are major sources of MBAs, the seasonal sea ice dynamic plays a key role in

determining MBA concentration in both the Arctic and Antarctic. We review the current knowledge of MBA sources and the link between ice melt and emissions of aerosol precursors in the polar oceans. We illustrate the processes by examining decadal-scale time series in various satellite-derived parameters such as aerosol optical depth (AOD), sea ice extent, and phytoplankton biomass in the sea ice zones of both hemispheres. The sharpest gradients in aerosol indicators occur during the spring period of ice melt. In sea ice–covered waters, the peak in AOD occurs well before the annual maximum in biomass in both hemispheres. The results provide strong evidence that suggests seasonal changes in sea ice and ocean biology are key drivers of the polar aerosol cycle. The positive trend in annual-mean Antarctic sea ice extent is now almost one-third of the magnitude of the annual-mean decrease in Arctic sea ice, suggesting the potential for different patterns of aerosol emissions in the future.

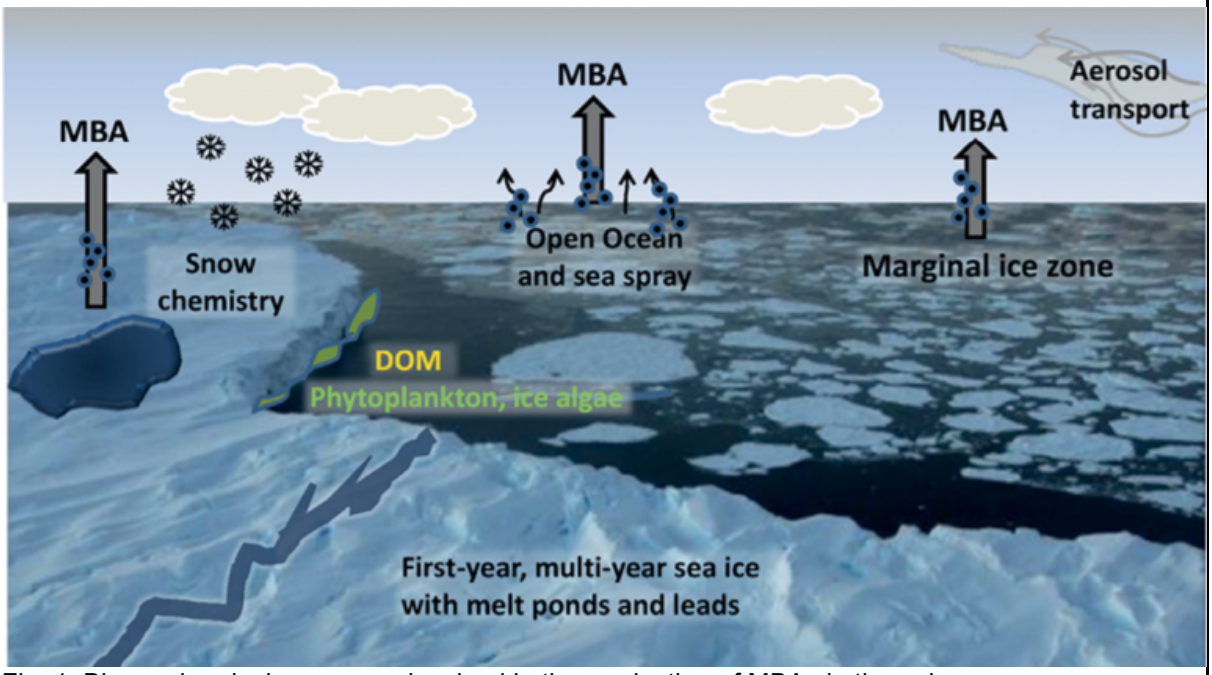

Fig. 1. Biogeochemical processes involved in the production of MBAs in the polar oceans.

Citation: Gabric et al., The Nexus between Sea Ice and Polar Emissions of Marine Biogenic Aerosols. Bulleting of the American Meteorological Society, DOI:10.1175/BAMS-D-16-0254.1.

2. Activities/main accomplishments in 2017 (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).

Two atmospheric measurement campaigns were undertaken on the RV Investigator during this period on voyages IN2017_T01 and IN2017_V05, under the project “Natural iron fertilisation of oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry” (Sydney to Broome and Broome to Fremantle)

Long term aerosol-cloud measurements are being made at Macquarie Island for two years

An on-going aerosol trace metal and major ion sampling program at land-based locations around Australia has been continued at Gingin (WA), Lord Howe Island (NSW) and Mt Wellington (TAS).

In order to support the MAXDOAS instrument and aerosol soundings a workshop was held at the University of Melbourne from 14-16th August 2017. This supported and facilitated MAXDOAS participation on resupply ship voyages of the Aurora Australis in 2017-2019 and RV Investigator 2016 and 2017 over the Southern Ocean as well as built community around the Southern Hemisphere in ground-based observation of aerosols. This Joyce Lambert funded workshop focused on aerosol observation interpretation using modeling and technical aspects of ship-based

observations (see attached program). Bringing the New Zealand and German collaborators to Melbourne for three days of workshop participants from the NIWA, NZ, Bureau of Meteorology, Australian Antarctic Division, CSIRO and the University of Wollongong registered. Dr Udo Friess from the University of Heidelberg shared his expertise and modeling tools in profile retrievals of aerosols and trace-gases with the community at the workshop and worked closely with Robert Ryan at University of Melbourne PhD student during his two-week visit. Karin Kreher from Bodeker Scientific and shared her experience from a recent European MAXDOAS intercomparison CINDI II; during her two visits she assisted in planning the August workshop, created a data handling framework and provided standard guidelines for analyses. Participating in a MAXDOAS intercomparison exercise in 2017 with the Bureau of Meteorology, NIWA and University of Wollongong enabled traceability of our MAXDOAS observations to international standards. The Joyce Lambert supported University of Melbourne workshop had both formal talks by participants and dedicated modeling demonstrations to support the capacity building aims. As a result of the workshop and Udo Friess' visit funding is being sort for Robert Ryan to spend time at the University of Heidelberg with Dr Friess through DAAD student exchange program in 2018 to advance publications of aerosol data from the Antarctic and Southern Ocean regions.

3. Top 5 publications in 2017 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

For journal articles please follow the format:
Author list (surname and initials, one space but no full stops between initials), year of publication, article title, full title of journal (italics), volume, page numbers, DOI.

Chambers S.D., Choi T., Park S.-J., Williams A.G., Hong S.-B., Tositti L., Griffiths A.D., Crawford J., Pereira E., 2017. Investigating local and remote terrestrial influence on air masses at contrasting Antarctic sites using Radon-222 and back trajectories, Journal of Geophysical Research – Atmospheres, 122(24), 13525-13544, DOI: 10.1002/2017JD026833

Ellwood M.J., Bowie A.R., Baker A., Gault-Ringold M., Hassler C., Law C.S., Maher W.A., Marriner A., Nodder S., Sander S., Stevens C., Townsend A., van Der Merwe P., Woodward E.M.S., Wuttig K., Boyd P.W., 2017. Insights into the biogeochemical cycling of iron, nitrate, and phosphate across a 5,300 km South Pacific Zonal Section (153°E-150°W)", Global Biogeochemical Cycles, 32 (2), 187-207. DOI:10.1002/2017GB005736

Gabric A., Matrai P., Jones G., Middleton J., 2017. The nexus between sea ice and polar emissions of marine biogenic aerosols. Bulletin of the American Meteorological Society, DOI:10.1175/BAMS-D-16-0254.1.

Qu B., Gabric A., Zeng M., Xi J., Jiang L., Zhao L., 2017. Dimethylsulfide model calibration and parametric sensitivity analysis for the Greenland Sea. Polar Science, 13, 13-22, DOI:10.1016/j.polar.2017.07.001

Williams A.G., Chambers S.D., Griffiths A.D., Loh Z.M., Krummel P.B., 2017. Seasonal variations in 'deep baseline' radon over the Southern Ocean. Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2017, 8-10 November 2017, Murramarang, NSW, N. Derek and P. B. Krummel (eds.), Bureau of Meteorology and CSIRO Oceans and Atmosphere, Climate Science Centre, Melbourne, Australia, page 10

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2017? If yes, who? How did you engage?

Media coverage following publication of Gabric et al. “The Nexus between Sea Ice and Polar Emissions of Marine Biogenic Aerosols”: https://www.theaustralian.com.au/news/health-science/sea-ice-a-handbrake-on-global-warming/news-story/4f35434660076cff01ba91f429e56361

Sea ice a ‘handbrake on global warming’
Melting sea ice could help cool the planet by flooding the atmosphere with particles that deflect sunlight.

Australian research suggests climate modellers have under-estimated a natural “thermostat” that helps alleviate the rise in temperatures: immense quantities of reflective compounds, emitted by marine microbes, that act like a handbrake on global warming.

The study, published by the American Meteorological Society, suggests an overlooked source of these so-called aerosols — algae living in ice — could jam the handbrake on even harder. Lead author Albert Gabric said with the Arctic expected to see ice-free summers within a decade, far more of the aerosols would be emitted.

“Whether that can slow the rate of warming of the Arctic is the trillion-dollar question,” said Dr Gabric, a marine biogeo-chemist with Griffith University in Brisbane.

Climate scientists have long known that aerosols help mitigate global warming by bouncing sunrays back into space, and by altering clouds to make them more reflective. Experts believe half of the -potential warming from greenhouse gases may be offset in this way.

Much research has focused on aerosols produced artificially, through the burning of fossil fuels and vegetation. Scientists worry that if China switched to renewable sources of energy overnight, it could trigger a massive surge in warming.

Aerosols are also produced naturally by volcanoes — such as the 1991 eruption of Mount Pinatubo in The Philippines, which is credited with cutting global temperatures by about 0.5C for two years — and by marine ecosystems.

Algae known as “phytoplankton” are a major contributor, with increasingly massive blooms of these marine creatures emerging in the warming Arctic waters.

The new study analysed terabytes of satellite data to track atmos-pheric aerosol concen-trations. For the first time, it identified sea ice as a “very strong source” of the airborne particles.

Dr Gabric said “ice algae” had evolved to tolerate the subzero temperatures of sea ice and the water that formed it. They used a compound called dimethyl sulfide as an “antifreeze” to survive the chill. “When the sea ice melts during spring, these algae don’t need that protection any more. They expel these compounds, which are degassed to the atmosphere and converted into sulfate aerosols very similar to what you get from burning sulphur-containing coal.

“This happens every year as the sea ice melts. The difference in recent decades is that the ice is melting a lot earlier. We now think that within 10 years there won’t be any ice in the Arctic during summer.”

He said the process had “absolutely not” been factored into the Intergovernmental Panel on Climate Change models of global warming. “The whole aerosol question and its relationship to warming is the biggest uncertainty to projecting what’s going to happen this century.

“This is a new area of -research, primarily because people can’t get up there and measure it very easily. You need an ice-breaker and a big gun to shoot any polar bears that might want to eat you,” he said.

PART 2 - Planned activities for 2018/2019 and 2020

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

Aurora Australis resupply voyages taking mercury and MAXDOAS measurements, while the ARM facility is onboard the Aurora Australia.

AIRBOX instrument's mini-MPL and CIMS on CAPRICORN project ("Clouds, Aerosols, Precipitation, Radiation, and atmospherIc Composition Over the southeRn ocean") as part of voyage IN2018_V01 ("Detecting Southern Ocean change from repeat hydrography, deep Argo and trace element biogeochemistry").

Full AIRBOX campaign program available at http://airbox.earthsci.unimelb.edu.au/#tab19, including DSTG campaign coming up in April – May and then AIRBOX on Aurora Australis 2018-2019 resupply season.

RV Investigator ship and land based stations for trace element aerosol monitoring under project "Natural iron fertilisation of oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry" continuing through 2018-19.

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

Participation of Australian PhD students in SOLAS Summer School

3. Funded national and international projects / activities underway.

A Bowie, Natural iron fertilisation of oceans around Australia: linking terrestrial dust, marine biogeochemistry and climate. ARC Future Fellowship 2014-18

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

Z Chase, A Bowie, P Strutton. Dust to the ocean: Does it really increase productivity? ARC Discovery 2019, submitted

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

GEOTRACES through participation in GEOTRACES Section cruises and Process Studies and contributions to the Scientific Steering and Data Management of the international program.

SCOR through submission of a proposal for a SCOR Working Group on: "Co-ordinated approach for Aerosol Trace element Solubility and Bioavailability Research in Oceanography (CoATS-BRO)"

Comments