# *National SOLAS networks 2017 annual reports and future activities*

**Version of 12 May 2018 by IPO**

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surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *Australia*

## *compiled by: Andrew Bowie and Sarah Lawson*

*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.

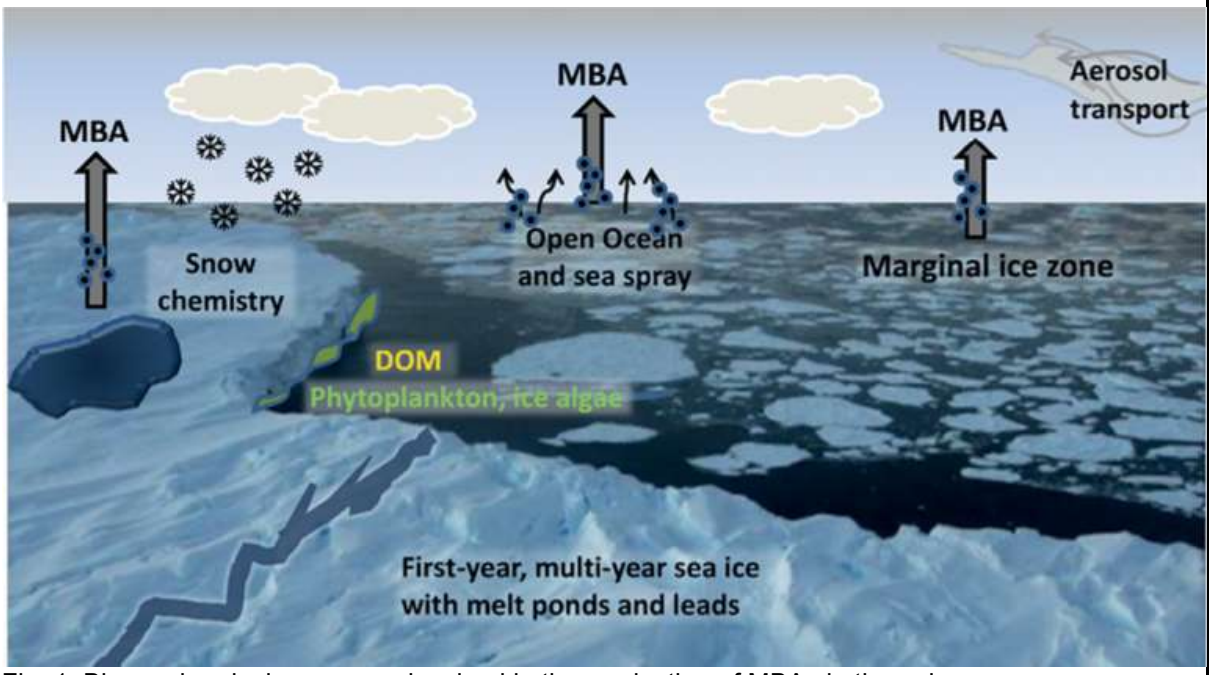


Fig. 1. Biogeochemical processes involved in the production of MBAs in the polar oceans.

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**

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# Report for the year 2017 and future activities

## SOLAS *'Belgium'*
## *compiled by: 'Nathalie Gypens'*

*This report has two parts:*

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Integrated studies;
Environmental impacts of geoengineering;
Science and society**.**

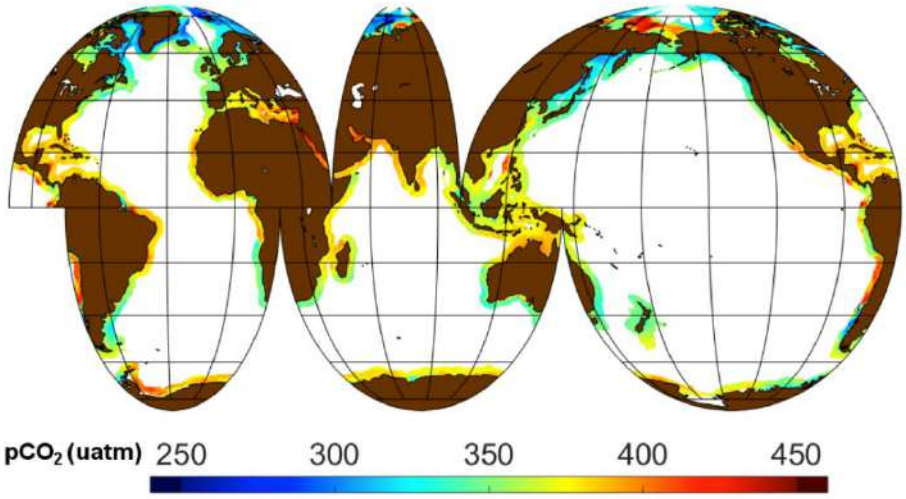
***IMPORTANT**: This report should reflect the efforts of the SOLAS community in the **entire country** you are representing (all universities, institutes, lab, units, groups, cities).*

## PART 1 - Activities from January 2017 to Jan/Feb 2018

### 1. Scientific highlight

**Highlight 1 (theme 1 and 2) : Global high-resolution monthly $pCO_2$ climatology for the coastal ocean derived from neural network interpolation**

In spite of the recent strong increase in the number of measurements of the partial pressure of $CO_2$ in the surface ocean ($pCO_2$), the air–sea $CO_2$ balance of the continental shelf seas remains poorly quantified. This is a consequence of these regions remaining strongly under-sampled in both time and space and of surface $pCO_2$ exhibiting much higher temporal and spatial variability in these regions compared to the open ocean. Here, we use a modified version of a two-step artificial neural network method (to interpolate the $pCO_2$ data along the continental margins with a spatial resolution of 0.25° and with monthly resolution from 1998 to 2015. The most important modifications compared to the original SOM-FFN method are (i) the much higher spatial resolution and (ii) the inclusion of sea ice and wind speed as predictors of $pCO_2$. The SOM-FFN is first trained with $pCO_2$ measurements extracted from the SOCATv4 database. Then, the validity of our interpolation, in both space and time, is assessed by comparing the generated $pCO_2$ field with independent data extracted from the LDVEO2015 database. The new coastal $pCO_2$ product confirms a previously suggested general meridional trend of the annual mean $pCO_2$ in all the continental shelves with high values in the tropics and dropping to values beneath those of the atmosphere at higher latitudes. The monthly resolution of our data product permits us to reveal significant differences in the seasonality of $pCO_2$ across the ocean basins. The shelves of the western and northern Pacific, as well as the shelves in the temperate northern Atlantic, display particularly pronounced seasonal variations in $pCO_2$, while the shelves in the southeastern Atlantic and in the southern Pacific reveal a much smaller seasonality. The calculation of temperature normalized $pCO_2$ for several latitudes in different oceanic basins confirms that the seasonality in shelf $pCO_2$ cannot solely be explained by temperature-induced changes in solubility but are also the result of seasonal changes in circulation, mixing and biological productivity. Our results also reveal that the amplitudes of both thermal and nonthermal seasonal variations in $pCO_2$ are significantly larger at high latitudes. Finally, because this product's spatial extent includes parts of the open ocean as well, it can be readily merged with existing global open-ocean products to produce a true global perspective of the spatial and temporal variability of surface ocean $pCO_2$.



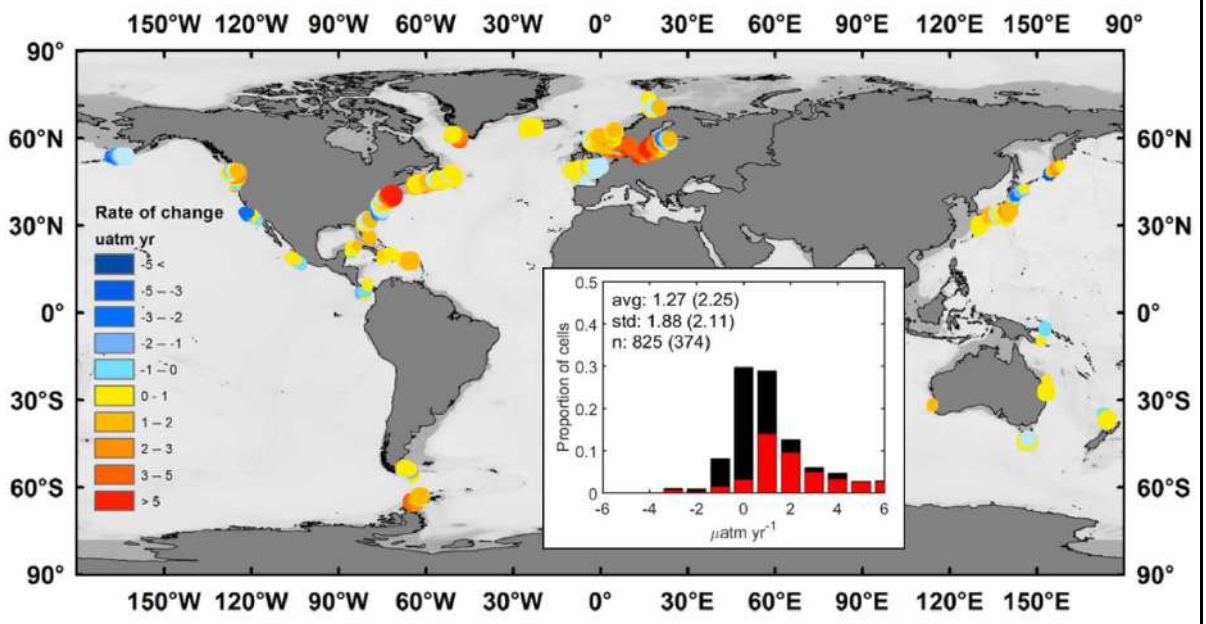

Annually averaged coastal pCO2 climatology at 0.25° resolution. The general meridional trend of the annual mean $pCO_2$ is ian important feature in all the continental shelves.

Citation : G. Laruelle, P. Landschützer, N. Gruber, JL. Tison, B. Delille, and P. Regnier (2017). Global high-resolution monthly pCO2 climatology for the coastal ocean derived from neural network interpolation. Biogeosciences, 14, 4545–4561, doi: 10.5194/bg-14-4545-2017.

**Highlight 2 (theme 1 and 2): Continental shelves as a variable but increasing global sink for atmospheric carbon dioxide**

It has been speculated that the partial pressure of carbon dioxide (pCO2) in shelf waters may lag the rise in atmospheric CO2. Here, we show that this is the case across many shelf regions, implying a

tendency for enhanced shelf uptake of atmospheric CO2. This result is based on analysis of long-term trends in the air-sea pCO2 gradient (ΔpCO2) using a global surface ocean pCO2 database spanning a period of up to 35 years. Using wintertime data only, we find that ΔpCO2 increased in 653 of the 825 0.5° cells for which a trend could be calculated, with 325 of these cells showing a significant increase in excess of +0.5 µatm yr-1 ($p<0.05$). Although noisier, the deseasonalized annual data suggest similar results. If this were a global trend, it would support the idea that shelves might have switched from a source to a sink of CO2 during the last century.




Location of 0.5° cells for which the decadal trend in winter ΔpCO2 is calculated. Large dots correspond to cells shallower than 200 m and small dots correspond to cells located within 100 km from the coast or depth less than 500 m. The distribution of d(ΔpCO2)/dt for our narrow definition of the continental shelf is displayed as histogram. The black bars report the distribution of all cells while the red bars report the distribution of cells for which the trend was deemed statistically significant using an F-test with $p < 0.05$. Here, ΔpCO2 = pCO2,air—pCO2. Thus, positive values in d(ΔpCO2)/dt indicate slower increase in water pCO2 than pCO2,air

Citation : Laruelle, G. G., Cai, W.-J., Hu, X., Gruber, N., MacKenzie F.T. and Regnier P. Continental shelves as a variable but increasing global sink for atmospheric carbon dioxide. Nature Communications 9, 454 DOI: 10.1038/s41467-017-02738-z, 2018.

**Highlight 3 : Biogeochemical impact of snow cover and cyclonic intrusions on the winter Weddell Sea ice pack**

Weddell sea in winter experience warm sea ice cover due to the combined effect of larger snow thickness and the frequent occurrence of warm cyclonic events penetrating far south in the Weddell sea towards the Antarctic coast. These conditions favors high ice permeability and cyclic events of brine movements within the ice cover. These physical settings lead to the formation of "brine tubes" and favor relatively high chl-*a* concentrations mainly related to internal communities. Algal activity continues all through the winter. Overall, permeability of Weddell Sea pack ice appears to be high enough to allow biogeochemical processes to develop during winter, contrasting with Arctic sea ice that is colder and less permeable (Tison et al., 2017).

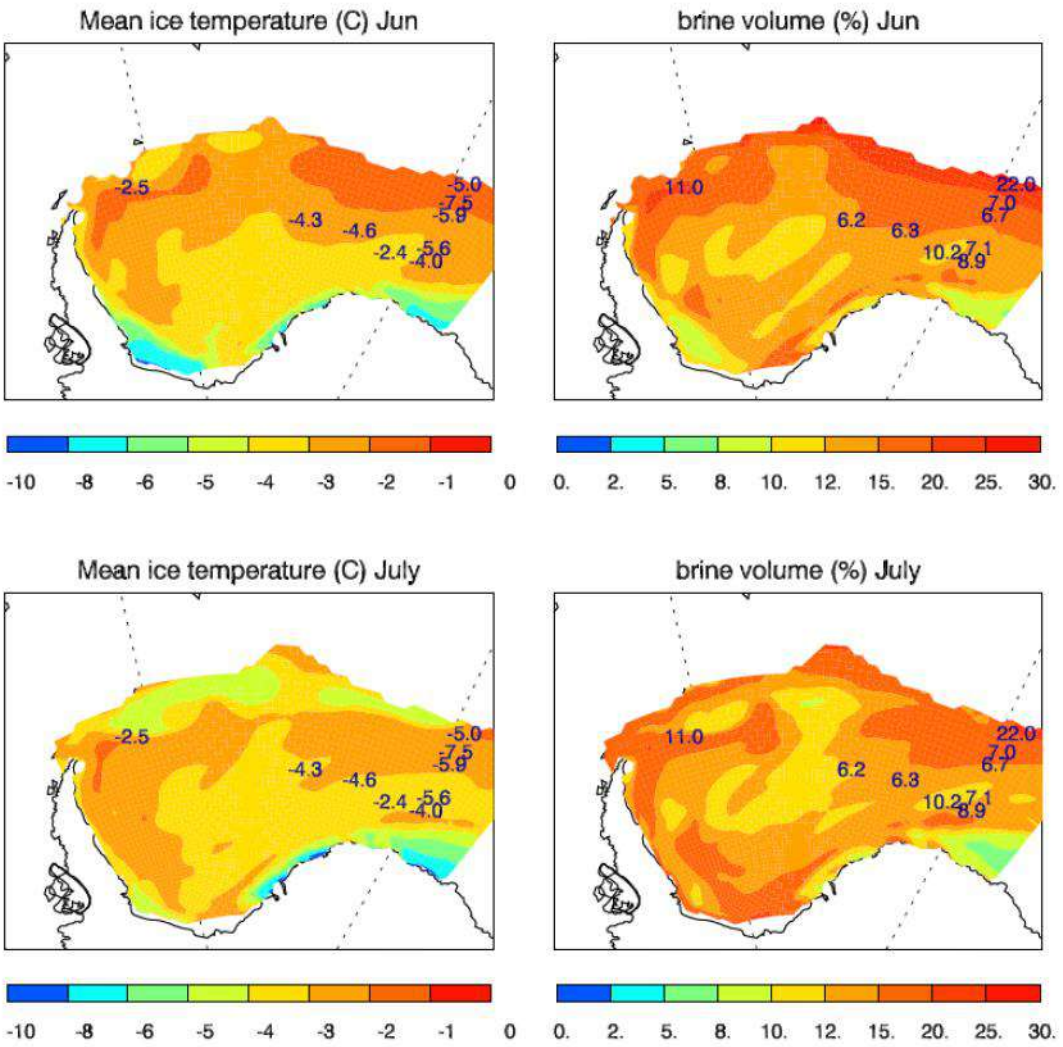
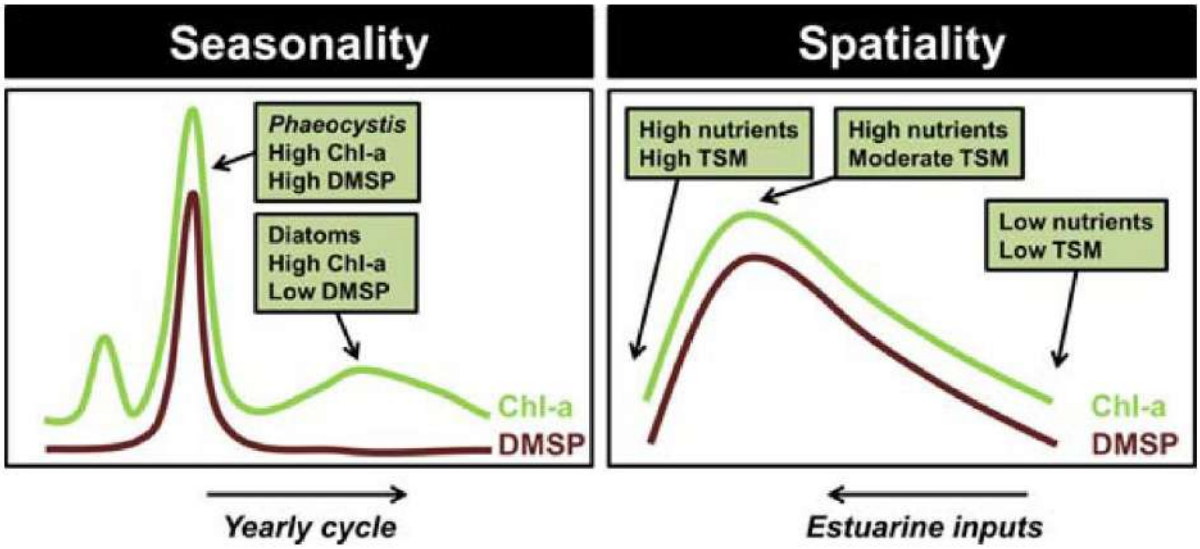



*Figure 1 NEMO LIM3simulations of mean ice temperature,and mean brine volume in the Weddell Sea for July 2013 with observations from the AWECS cruise*

Citation: Tison, J.-L., Schwegmann, S., Dieckmann, G.S., Rintala, J.-M., Meyer, H., Moreau, S., Vancoppenolle, M., Nomura, D., Engberg, S., Bloomster, L.J., Heindricks, S., Uhlig, C., Luhtanen, A.-M., de Jong, J., Janssens, J., Carnat, G., Zhou, J., Delille, B., 2017. Biogeochemical impact of snow cover and cyclonic intrusions on the winter Weddell Sea ice pack, Journal of Geophysical Research Ocean, 119, 8109–8121. doi:10.1002/2017JC013288

**Highlight 4 (theme 1 and 2, 3): Annual cycle of dimethylsulfoniopropionate (DMSP) and dimethylsulfoxide (DMSO) related to phytoplankton succession in the Southern North Sea**

The influence of abiotic and biotic variables on the concentration of dimethyl sulfide (DMS), dimethylsulfoniopropionate (DMSP), and dimethylsulfoxide (DMSO), were investigated during an annual cycle in 2016 in the Belgian Coastal Zone (BCZ, North Sea). We reported strong seasonal variations in the concentration of these compounds linked to the phytoplankton succession with high DMS(P,O) producers (mainly Phaeocystis globosa) occurring in spring and low DMS(P,O) producers (various diatoms species) occurring in early spring and autumn. Spatial gradients of DMS and DMSP were related to those of phytoplankton biomass itself related to the inputs of nutrients from the Scheldt estuary. However, the use of a relationship with Chlorophyll-a (Chl-a) concentration is not sufficient to predict DMSP. Accounting for the phytoplankton composition, two different DMSP versus Chl-a correlations could be established, one for diatoms and another one for Phaeocystis colonies. We also reported high nearshore DMSO concentrations uncoupled to Chl-a and DMSP concentrations but linked to high suspended particulate matter (SPM) presumably coming from the Scheldt estuary as indicated by the positive relationship between annual average SPM and salinity.




Citation: Speeckaert G., A. V. Borges, W. Champenois, C. Royer, N. Gypens, 2018. Annual cycle of dimethylsulfoniopropionate (DMSP) and dimethylsulfoxide (DMSO) related to phytoplankton succession in the Southern North Sea, Science of The Total Environment 622-623:362–372

**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).**

- PIPERS (Ice Production and its Seasonal Evolution in the Ross Sea) cruise in the Ross Sea on the NB PALMER funded by the NSF and led by S. Ackley and S Stammerjohn (Apr-June 2017). The PIPERS cruise was a rare opportunity to investigate sea ice biogeochemistry in the Southern Ocean in winter. We were able to sample first stages of sea ice formation (i.e. frazil ice, unconsolidated ice), Terra Nova Bay polynya for sea ice biogeochemistry, including biogases and micronutrients. Belgian Partner Bruno Delille (Université de Liège) and Jean-Louis Tison, Gauthier Carnat, Célia Sapart (Université Libre de Bruxelles).
- Optimist 2017 sea ice survey in Storefjord in April 2017. This survey was carried out in in the frame of the project OPTIMIST-bio (Observing Processes impacting The sea Ice Mass balance from In Situ Measurements: from physics to its impacts on biology) funded by the CNRS (France) and led by F. Viviers. We measured greenhouse gases (CO2, CH4, N2O) concentration and air-ice fluxes. We also collect sea ice for measurement of related physical and biogeochemical parameters. Belgian Partner Bruno Delille (Université de Liège)
- We have been involved in a RSV Aurora Australis V2 cruise that covered Dalton, Mertz and Ninnis Polynyas (Jan 2017) led by Will Hobbs and Delphine Lannuzel and supported by Will Hobbs and Dr Delphine Lannuzel University of Tasmania, the ARC-funded Antarctic Gateway Partnership, the Antarctic Climate and Ecosystems CRC, the Australian Antarctic Division, CSIRO. We get CH4 and N2O samples in sea ice and the water column. Belgian Partner Bruno Delille (Université de Liège) and Jean-Louis Tison (Université Libre de Bruxelles)
- We have been involved in a RV Xuelong cruise in Pridz Bay and Ross sea (Nov 2017- Feb 2018) Polynyas (Dec 2017) supported by the State Oceanic Administration in collaboration with Liyang Zhan. We will focus on Nitrogen cycle (including N2O) in sea ice and the water column. Belgian Partner Bruno Delille (Université de Liège), Frank Dehairs (Vrije Universiteit Brussel) and Jean-Louis Tison (Université Libre de Bruxelles).

Networking

Bruno Delille (Université de Liège), François Fripiat (Vrije Universiteit Brussel) and Jean-Louis Tison (Université Libre de Bruxelles) are strongly involved in:

- BEPSII (Biogeochemical Exchange processes at the Sea ice Interfaces) joint SOLAS-CLIC-IASC working group
- the new ECVice (Essential Climate Variable for sea ice) SCOR working group

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

- Borges AV, G Speeckaert, W Champenois, M.I. Scranton & N Gypens (2017) Productivity and temperature as drivers of seasonal and spatial variations of dissolved methane in the Southern Bight of the North Sea, Ecosystems, DOI: 10.1007/s10021-017-0171-7

- Fripiat F, Meiners KM, Vancoppenolle M, Papadimitriou S, Thomas DN, Ackley SF, Arrigo KR, Carnat G, Cozzi S, Delille B, et al. (2017). Macro-nutrient concentrations in Antarctic pack ice: Overall patterns and overlooked processes. Elementa Science of the Anthropocene, 5, 10.1525/elementa.217

- Gypens N, A.V. Borges & C. Ghyoot (2017) How phosphorus limitation can control climate-active gas sources and sinks, Journal of Marine systems, doi: 10.1016/j.jmarsys.2017.02.002

- Laruelle G. G., Goossens N., Arndt S., Cai W.-J. and Regnier P. (2017). Air-water $CO_2$ evasion from U.S. East Coast estuaries, Biogeosciences, 14, 2441 doi:10.5194/bg-14-2441-2017

- Lecomte O., H. Goosse, T. Fichefet, C. de Lavergne, A. Barthélemy, V. Zunz (2017). Vertical ocean heat redistribution sustaining sea-ice concentration trends in the Ross Sea. Nature Communications 8, 258, doi: 10.1038/s41467-017-00347-4 (http://rdcu.be/u0r2).

**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?**

## 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.).**

- ECVice experiment in Saroma Lagoon (Japan) – Intercomparison of measurement of primary production in sea ice. Belgian Partner Bruno Delille (Université de Liège), Frank Dehairs (Vrije Universiteit Brussel and Jean-Louis Tison (Université Libre de Bruxelles).
- Optimist 2018 sea ice survey in Storefjord in April 2018. This survey was carried out in in the frame of the project OPTIMIST-bio (Observing Processes impacting The sea Ice Mass balance from In Situ Measurements: from physics to its impacts on biology) funded by the CNRS (France) and led by F. Viviers. We will measured greenhouse gases (CO2, CH4, N2O) concentration and air-ice fluxes. We will also collect sea ice for measurement of related physical and biogeochemical parameters. Belgian Partner Bruno Delille (Université de Liège)

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

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

Ongoing Projects:

- ISOtopic Investigation of Greenhouse GAses in Polar regions: An Ocean Ice-Atmosphere Continuum (ISOGGAP) funded by the FRS-FNRS (2016-2019, 432 kEur). This project covers the theme 8 "High Sensitivity Systems- HS2" but will focus on arctic systems. ISOGGAP will address: 1) Gas exchange monitoring and process studies; 2) Regional dynamics of stressors and their effect in sea ice systems; 3) Improvement of the representation of biogeochemistry in regional models of sea ice 4) Identification of the elements of HS² that are key parameters to global change and incorporate them into Earth System Models. Partners: Jean-Louis Tison (Univesité Libre de Bruxelles) Bruno Delille (Université de Liège)
- OCeANIC (nitrous Oxide and nitrogen Cycling in ANtarctic sea Ice Covered zone, BL/12/C63, 2016-2019, 250 kEur) funded by the Belgian Science Policy. Partners: Bruno Delille (Université de Liège), Frank Dehairs (Vrije Universiteit Brussel), Jean-Louis Tison (Université Libre de Bruxelles)
- Iodide and halocarbons Dynamics in sea IcE (IODInE, CDR J.0262.17, 2017-2018, 41 kEur) Research Project funded by the F.R.S.-FNRS, partners: Bruno Delille (Université de Liège)

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

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

- BEPSII (Biogeochemical Exchange processes at the Sea ice Interfaces) joint SOLAS-CLIC-IASC working group
- ECVice (Essential Climate Variable for sea ice) SCOR working group
- SOOS Air-Sea Fluxes

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *Brazil*

***compiled by: L. Cotrim da Cunha (Brazil SOLAS representative, UERJ/BrOA), L. C. Cotovicz Jr. (UFF), H. C. Soares (INPE)***

*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

A) **Air-sea CO2 fluxes for the Brazilian north-east continental shelf in a climatic transition region**
In this study, fCO2 underway measurements were made in the Brazilian Equatorial Northeastern coastal zone from about 5°S to 0°S, as an effort to contribute to better understand the fCO2 variability in this region. Leading institution: UFC, in cooperation with IRD (France).

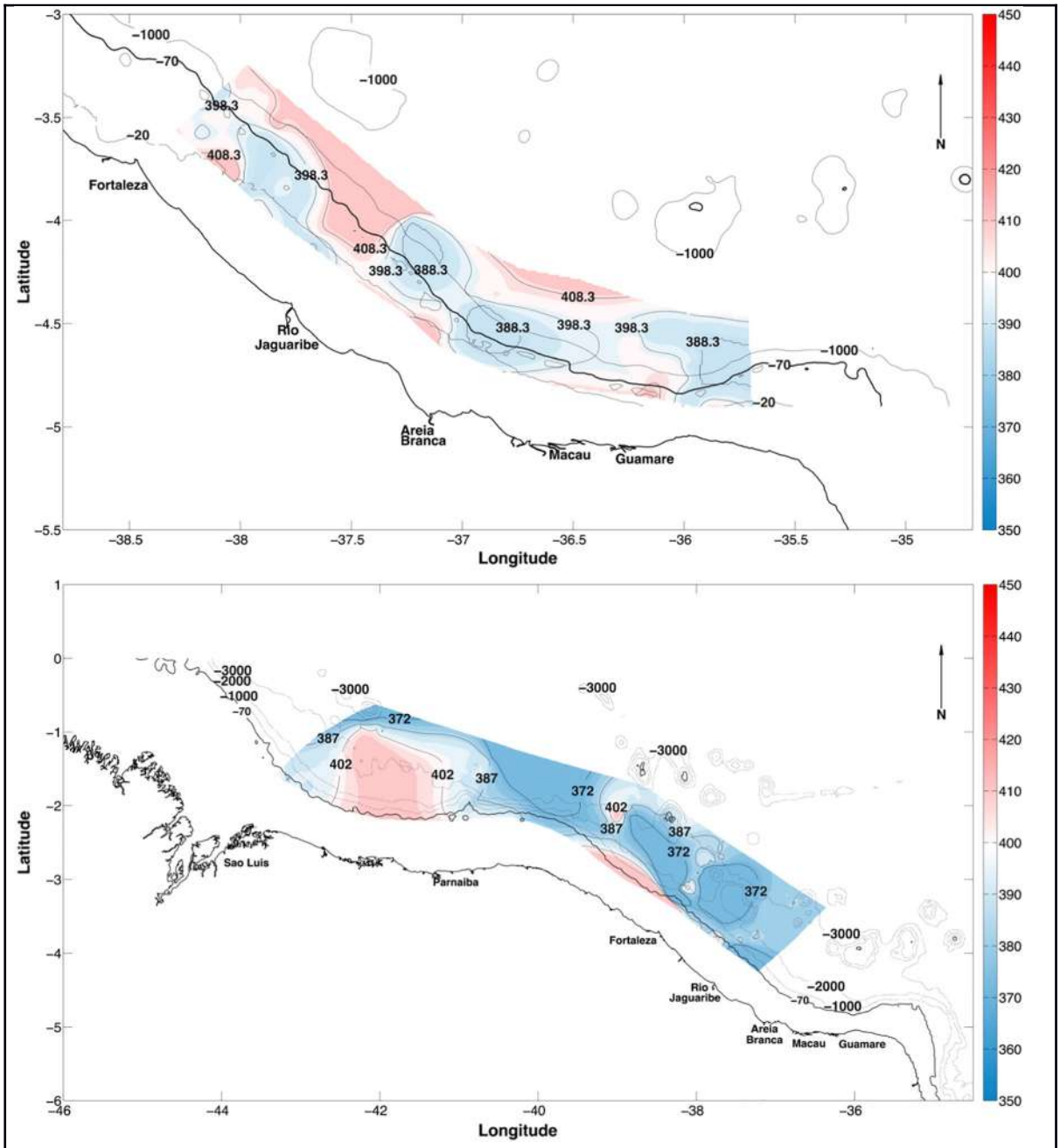



Figure 1 - a) fCO2sw spatial distribution during the first campaign, October 2012. b) fCO2sw distribution during the September 2014 campaign.

FULL REFERENCE: Carvalho, A. C. O., Marins, R. V, Dias, F. J. S., Rezende, C. E., Lefèvre, N., Cavalcante, M. S. and Eschrique, S. A.: Air-sea CO2 fluxes for the Brazilian northeast continental shelf in a climatic transition region, J. Mar. Syst., 173, 70–80, doi:https://doi.org/10.1016/j.jmarsys.2017.04.009, 2017.

**B) Variability of CO2 fugacity at the western edge of the tropical Atlantic Ocean from the 8°N to 38°W PIRATA buoy**

The objective of this study was to quantify the fCO2 variability in the northwestern tropical Atlantic region using data recorded at 8°N–38°W from 2008 to 2011. The high-frequency fCO2 variability was associated to diurnal cycle of solar radiation and heavy rainfall. This study was lead by UFPE, in cooperation with IRD (France) and the PIRATA project team (Brazil, France, USA).

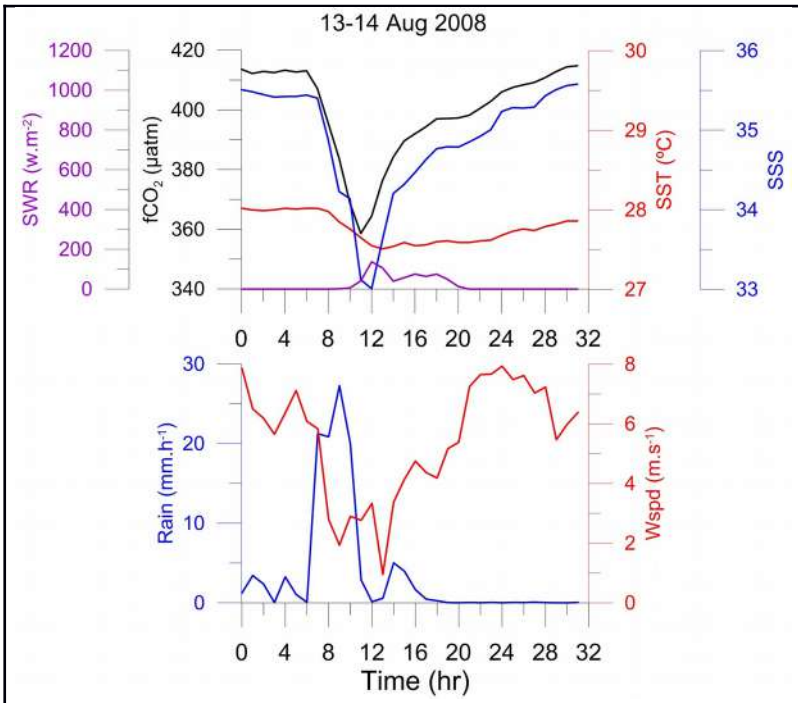


Figure 2 - High-frequency variation of precipitation (heavy rain event) and its influence on SSS and $fCO_2$ on August 13–14, 2008, at the 8°N–38°W PIRATA buoy.

FULL REFERENCE: Bruto, L., Araujo, M., Noriega, C., Veleda, D. and Lefèvre, N.: Variability of CO 2 fugacity at the western edge of the tropical Atlantic Ocean from the 8°N to 38°W PIRATA buoy, Dyn. Atmos. Ocean., 78, 1–13, doi:10.1016/j.dynatmoce.2017.01.003, 2017.

C) **A Synoptic Assessment of the Amazon River-Ocean Continuum during Boreal Autumn: From Physics to Plankton Communities and Carbon Flux**
The main objective of this work is to improve our understanding of the processes and organisms responsible for carbon and nutrient cycling along a large-scale tropical river-ocean continuum (Amazon River to offshore). The CO2 fugacity (fCO2sw) confirms that the Amazon River plume is a sink of atmospheric CO2 in areas with salinities <35 psu, whereas, in regions with salinities >35 and higher-intensity winds, the CO2 flux is reversed. This study was lead by UFPE in cooperation with IRD (France) and University of Abomey-Calavi, Benin.

FULL REFERENCE: Araujo, M., Noriega, C., Hounsou-gbo, G. A., Veleda, D., Araujo, J., Bruto, L., Feitosa, F., Flores-Montes, M., Lefèvre, N., Melo, P., Otsuka, A., Travassos, K., Schwamborn, R. and Neumann-Leitão, S.: A Synoptic Assessment of the Amazon River-Ocean Continuum during Boreal Autumn: From Physics to Plankton Communities and Carbon Flux, Front. Microbiol., 8, 1358, doi:10.3389/fmicb.2017.01358, 2017.

D) **Phytoplankton x carbon biogeochemistry, including sea-air CO2 fluxes in an eutrophic tropical bay**
Temporal and spatial survey of organic carbon and CO2 within Guanabara Bay (SE Brazil). The authors found that POC and DOC concentrations varied positively with total pigments, and negatively with DIC. Strong linear correlations between these parameters indicate that the production of organic carbon translates to an equivalent uptake in DIC, with 85% of the POC and about 50% of the DOC being of phytoplanktonic origin.

FULL REFERENCE: Cotovicz Jr. LC, Knoppers BA, Brandini N, Poirier D, Costa Santos S, Abril G (2018). Predominance of phytoplankton-derived dissolved and particulate organic carbon in a tropical highly eutrophic coastal embayment (Guanabara Bay, Rio de Janeiro, Brazil). Biogeochemistry. v. 137, p. 1-14. doi: 10.1007/s10533-017-0405-y

**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).**

Field Campaigns:

A) **NAUTILUS** – In Feb. 2017 and Feb. 2018 took place the two final cruises of the project "New autonomous technologies investigation and monitoring of AABW transformations in the Weddell Sea and Antarctic Peninsula: a contribution to the study of those implications in ocean circulation and climate" (Portuguese acronym NAUTILUS). In this context, samples for carbonate system and surface underway measurements pCO2 were performed in 2017 and 2018 in the North Antarctic Peninsula. (FURG)

B) The ongoing project **"Long term ecological research" Estuário da Lagoa dos Patos** aims to understand natural phenomena influence and human impacts on biota and ecological processes in the Patos Lagoon Estuary, south Brazil. This project is being developed since 1998, and in 2015 monthly samples for the carbonate system are being taken in this ecosystem. (FURG)

C) The ongoing project **"Long term ecological research" Baía de Guanabara** has a detached group to study the metabolism of the inner portion of Guanabara Bay, SE Brazil. Sampling campaigns (25 hours, monthly basis) have started in November 2017, and are foreseen to last for a whole year at least. Parameters: Greenhouse gases (CO2 and CH4, in continuous (former) and discrete (latter) samplings), physical-chemical parameters, carbonate system parameters, nutrients, organic carbon, organic contaminants in suspended matter, phytoplankton. (UFRJ, UFF and UERJ)

D) PIRATA-BR XVII / GEOTRACES cruise (Nov/17 to Jan/18)

During the servicing of the PIRATA buoys, 65 oceanographic stations were occupied along 22S to 15N in the tropical western Atlantic Ocean. In addition to the essential ocean variables, trace elements and C and O stable isotopes samples in the framework of GEOTRACES were collected for analysis. Additional measurements included underway surface ocean pCO2, eddy-covariance measurements of fluxes of heat, momentum, and CO2, as well as aerosol sampling (Figure 3).

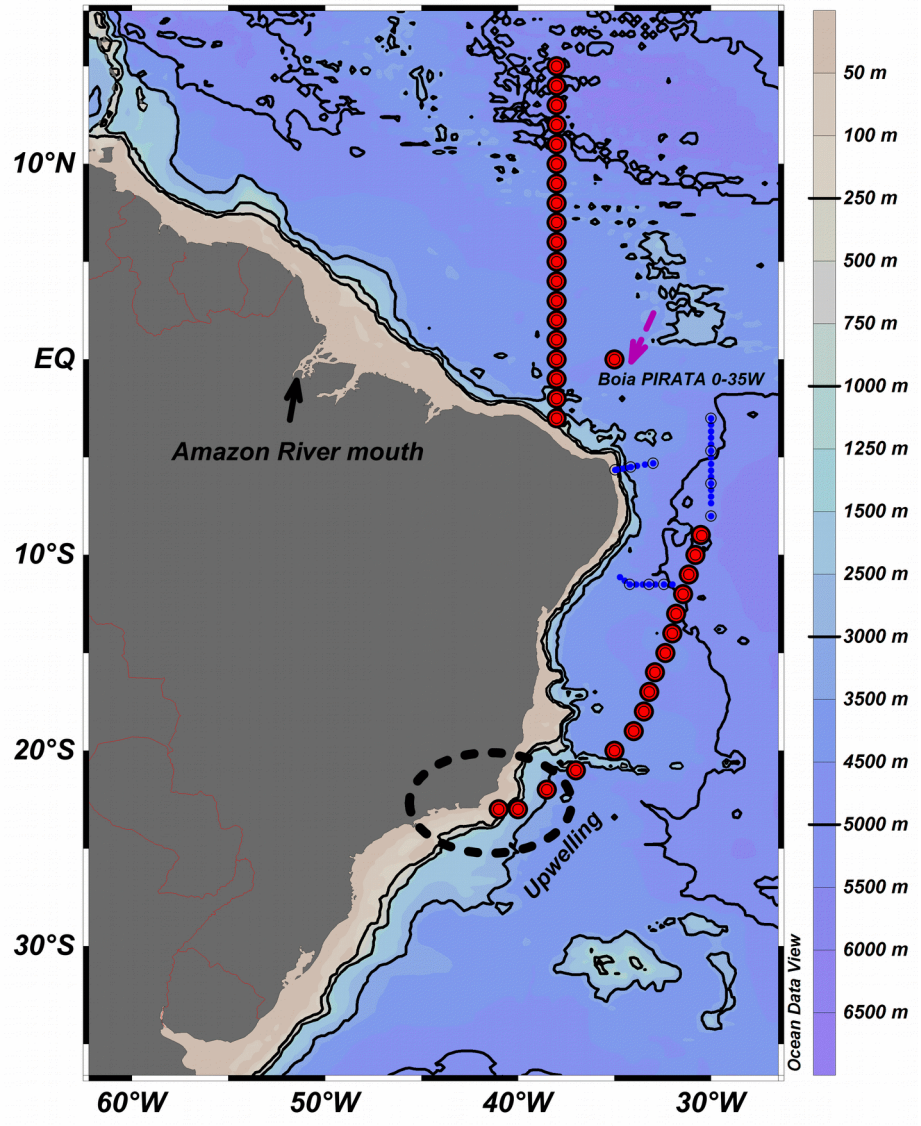



Figure 3 – Sampling stations of the PIRATA/GEOTRACES 2017/18 cruise, on board RV Vital de Oliveira (Brazilian Navy).

E) Paraiba do Sul River Estuary (tropical, mesotrophic, SE Brazil): surveys in February/2017 and October/2017. Sampling in estuarine and shelf waters. Continuous underway pCO2 measurements, TA, DIC, δ13C-DIC, nutrients, pigments, DOC, and POC. Investigation of spatial and temporal variability.

F) Araruama Lagoon (tropical, hypersaline, SE Brazil): surveys in June/2017 and Jan/2018. Sampling in lagoon and shelf waters. Continuous underway pCO2 measurements, TA, DIC, δ13C-DIC, nutrients, pigments, DOC, POC, δ13C-POC, CDOM. Investigation of spatial and temporal variations (including diel scale).

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

*1* - Orselli, I. B. M., Kerr, R., Ito, R. G., Tavano, V. M., Mendes, C. R. B. and Garcia, C. A. E.: How fast is the Patagonian shelf-break acidifying?, J. Mar. Syst., 178, 1–14, doi:10.1016/j.jmarsys.2017.10.007, 2018.

2 - Ibánhez, J. S. P., Flores, M. and Lefèvre, N.: Collapse of the tropical and subtropical North Atlantic CO2 sink in boreal spring of 2010, Sci. Rep., 7, 41694, doi:10.1038/srep41694, 2017.

3 - Guenther, M., Araújo, M., Noriega, C., Flores-Montes, M., Gonzalez-Rodriguez, E. and Neumann-Leitão, S.: Plankton carbon metabolism and air-water CO 2 fluxes at a hypereutrophic tropical estuary, Mar. Ecol., 38(2), e12423, doi:10.1111/maec.12423, 2017.

4 - Cotovicz Jr. LC, Knoppers BA, Brandini N, Poirier D, Costa Santos S, Abril G (2017). Aragonite saturation state in a tropical coastal embayment dominated by phytoplankton blooms. Marine Pollution Bulletin. doi: 10.1016/j.marpolbul.2017.10.064

5 - Araujo, M., Noriega, C., Hounsou-gbo, G. A., Veleda, D., Araujo, J., Bruto, L., Feitosa, F., Flores-Montes, M., Lefèvre, N., Melo, P., Otsuka, A., Travassos, K., Schwamborn, R. and Neumann-Leitão, S.: A Synoptic Assessment of the Amazon River-Ocean Continuum during Boreal Autumn: From Physics to Plankton Communities and Carbon Flux, Front. Microbiol., 8, 1358, doi:10.3389/fmicb.2017.01358, 2017.

**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?**

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## 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.).**

Modelling studies:

Please refer to itens I, II, and II in section 3 (funded projects) regarding the use and development of the Brazilian Earth System Model (BESM). These 3 projects are multi-institutional within Brazil and include cooperation with foreign partners.

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

*Participation in short courses, and Summer Schools:*

The marine biogeochemical component in the Brazilian Earth System Model (BESM). In: PICES/ICES 3rd Early Career Scientist Conference (ECS3): Climate Ocean and Society-Challenges and Opportunities. Busan, Korea, May 30 to June 02, 2017. Helena Cachanhuk SOARES; Paulo NOBRE (INPE).

Evaluation of the ocean pCO2 representation in the Brazilian Earth System Model. In: PIRATA 22 - PIRATA Research Project 20 years Conference. Fortaleza, Ceará, Brazil, Nov 05 to 10, 2017. Helena Cachanhuk SOARES; Paulo NOBRE (INPE).

*Foreseen participation in:*

1) Polar 2018 (https://www.polar2018.org/) - FURG group

2) OceanObs' 19 (http://www.oceanobs19.net/) - Abstracts submitted by PIRATA-Brazil group, and LAOCA (Ocean Acidification) group, including Brazilian authors.

3) PIRATA 23rd Meeting (Marseille, France, October 2018) – Brazilain PIRATA members and other participants (INPE, USP, FURG, UFPE, UERJ etc)

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

**Since 2016 – PELD Baía de Guanabara (Long-Term Ecological Research Baía de Guanabara)**
CNPq funding
SOLAS-related activities:
a) Ocean biogeochemical control on atmospheric chemistry (Coastal zone – Measurements of Volatile Organic Carbon – VOC – Researchers from UERJ, UFF and UFRJ)
b) Atmospheric deposition and ocean biogeochemistry (Coastal zone – Measurements of nutrients and carbonate-systems parameters – Researchers from UERJ, UFF and UFRJ)

**since 2015 – PELD Lagoa dos Patos (Long-Term Ecological Research)**
CNPq funding
SOLAS-related activities:
a) Atmospheric deposition and ocean biogeochemistry (Coastal zone – Measurements of carbonate-systems parameters – Researchers from FURG)

**Since 2016: Greenhouse Gas Emissions in Brazilian Coastal Waters**
FAPERJ Funding, researchers from UFF and IRD (France)
SOLAS-related activities
a) Air-sea greenhouse gases (CO2, CH4 and N2O) fluxes in estuarine and shelf waters of South-eastern Brazilian Coast;
b) Assessment of carbon and carbonate cycling (TA, DIC, underway pCO2, POC, DOC, $\delta^{13}$C-DIC)
c) Coupling of field campaigns with remote sensing techniques.

**2014 – 2018 NAUTILUS**
CNPq funding
SOLAS-related activities:
a) Ocean biogeochemical control on atmospheric chemistry (Southern Ocean – underway pCO2 measurements, phytoplankton, ocean biogeochemistry – Researchers from FURG and UERJ)

**since 1998 – PIRATA**
Ministry of Science and Technology funding (Brazil), in cooperation with USA and France
Tropical Atlantic moored buoy array
SOLAS-related activities:
a) Air-sea interface and fluxes of mass and energy
**b) Ocean biogeochemistry parameters**

**2018 – 2021 – Modelling projects using the Brazilian Earth System Model (BESM)**
SOLAS-related activities:
a) Air-sea interface and fluxes of mass and energy
b) Modelling approaches
Funded BESM-PROJECTS related to SOLAS
***I) Road- Besm - Regional Oceanic and Atmospheric Downscaling***
PI: Prof. A. Klein (UFSC)

***II) Coupled Ocean-Atmosphere-Cryosphere modelling study – BESM/SOAC***
PI: Dr. R. B. de Souza (INPE)

***III) Validating aerosol chemistry within BESM, a climate approach – BESM/AERCHEM***
PI: Dr. D. Herdies (INPE)

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

–

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

Brazil-SOLAS community, especially the researchers actively working on ocean carbon biogeochemistry, is actively cooperating with:
a) Latin American Ocean Acidification Network – LAOCA (http://www.eula.cl/musels/laoca/)

b) Global Ocean Acidification Observing Network – GOA-ON (http://goa-on.org/)

c) GEOMAR (Kiel, Germany – Prof. Arne Körtzinger and Dr. Tobias Steinhoff) – Partnership with UERJ through a DFG-FAPERJ (Brazil call) and a BMBF call (Germany)

d) Centre National de la Recherche Scientifique (CNRS), (BOREA Research Unit – Paris, France – Dr. Gwenaël Abril) – Partnership with UFF through a FAPERJ Project (E-26/202.785; 2016 to 2019).

**Comments**

**Acronyms of cited institutions:**

*BrOA: Brazilian Ocean Acidification Research Network*

*INPE: Instituto Nacional de Pesquisas Espaciais*

*FURG: Universidade Federal do Rio Grande*

*UFC: Universidade Federal do Ceará*

*UERJ: Universidade do Estado do Rio de Janeiro*

*UFRJ: Universidade Federal do Rio de Janeiro*

*UFF: Universidade Federal Fluminense*

*UFSC: Universidade Federal de Santa Catarina*

*USP: Universidade de São Paulo*

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *Canada*
## *compiled by: Jon Abbatt, University of Toronto*

*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

Mungall, J.P.D. Abbatt, J.J.B. Wentzell, A.K.Y. Lee, J.L. Thomas, M. Blaise, M. Gosselin, L.A. Miller, T. Papakyriakou, M.D. Willis, and J. Liggio, 2017. *Proc. Natl. Acad. Sci. USA*. 114(24): 6203-8, doi: 10.1073/pnas.1620571114. Microlayer source of oxygenated volatile organic compounds in the summertime marine Arctic boundary layer. (Theme 5, Integrated Studies – polar oceans)

*This paper is one of the first studies to show that a large source of oxygenated volatile organic compounds (OVOCs) may arise from the microlayer on the top of the sea surface. NETCARE measurements from the CGCS Amundsen in the summer of 2014 revealed that these OVOCs were correlated with the DOC content of the water, but some of the compounds are too soluble to be liberated from the ocean water, implicating the microlayer. These compounds are sufficiently oxygenated that they, or their larger analogues, may be intimately involved in new particle formation and growth. This was a collaborative study involving ocean biogeochemists and atmospheric chemists.*

**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).**

2012-2018 NETCARE, Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environment. Relevant to SOLAS 2015-2025 Science Plan Core Themes 1 and 4. 2017 was devoted to data analysis and publications (Many researchers)

Analysed ambient measurements of ice nucleating particles (INP) that were collected on the Amundsen during summer 2014 (Bertram). This has resulted in the following manuscript, which will be submitted to ACPD*: Ice nucleating particles in the marine boundary layer in the Canadian Arctic during summer 2014*, Victoria E. Irish, Sarah J. Hanna, Jenny Thomas, Ana Cirisan, Swarup China, Alwin Bucher, Greg Wentworth, Jeremy Wentzell, W. Richard Leaitch, Jennifer Murphy, Jonathan P.D. Abbatt, Alex Laskin, Eric Girard, and Allan K. Bertram

Analysed measurements of INP in the microlayer collected on the Amundsen during the summer 2016 (Bertram). This has resulted in the following manuscript, which will be submitted to ACPD*: Properties and concentrations of ice nucleating particles in the sea surface microlayer and bulk seawater in the Canadian Arctic during summer 2016 and comparison with summer 2014*, Victoria E. Irish, Yu Xi, Allan K. Bertram, Matthew Boyer, Lisa Miller, Jonathan P.D. Abbatt, Elena Polishchuk, and Jessie Chen.

Carried out a series of laboratories studies on the freezing properties of phytoplankton exudates to explain concentrations of INPs measured in the microlayer in the Arctic (Bertram).

2015-2018. ArcticNet funded project “Marine biogeochemistry and surface exchange of climate active gases”. Relevant to SOLAS 2015-2025 Science Plan Core Themes 1 and 4. Goal: Pursue the annual monitoring of DMS concentrations and related parameters across the high Canadian Arctic (Levasseur).

2016-2018 GreenEdge (GE) - Participation to the GE expedition in Baffin Bay, Canada. Goal: Conduct high frequency measurements of DMS and related parameters across a marginal ice zone in the Arctic (Levasseur).

2017-2020 BOND (Beacons Of Northern Dynamics: developing light-based sensing

technologies to monitor climate active gases in a mutating Arctic), a Sentinel North project (Canada First Research Excellence Fund). Relevant to SOLAS 2015-2025 Science Plan Core Themes 1 and 4. Goal: Develop and deploy at sea an Automated Cryogenic Trap Membrane-Inlet Mass Spectrometer (ACT-MIMS) for continuous underway DMS measurements during the 2017 ArcticNet/~~GreenEdge~~ expedition on the icebreaker CCGS Amundsen (Lizotte).

During the 2015 ArcticNet cruise, targeted incubation experiments were undertaken in order to assess the impacts of environmental stressors on the development of planktonic communities in the Arctic Ocean and their involvement in the cycling of sulfur compounds. This lead to the following paper:
Hussherr H, Levasseur M, Lizotte M, Tremblay J-É, Mol J, Thomas H, Gosselin M, Starr M, Miller L, Jarniková T, Schuback N, Mucci A. 2017. Impact of ocean acidification on phytoplankton and dimethylsulfide dynamics during simulated ice-free and under-ice phytoplankton blooms in the Arctic. Biogeosciences 14, 2407-2427. doi:10.5194/bg-14-2407-2017

Martí Galí finalized the development of a new satellite-based model allowing the estimation of DMS at the global and regional scales. This will lead to two articles. The first article describes the algorithm, shows its application at the global scale, and how the model-results compare favorably with the current climatology:
Galí M, Levasseur M, Devred E, Simó R, Babin M. Diagnosing sea-surface dimethylsulfide (DMS) concentration from satellite data at global and regional scales. Biogeosciences Discussion.

Laval, UQAR, UBC, Dalhousie, U of T colleagues collaborated on meshing oceanic measurements of primary production and biomass, dissolved organic carbon, and marine DMS with atmospheric measurements of the distribution of aerosol number size, leading to the following paper:
Collins DB, Burkart J, Chang R Y-W, Lizotte M, Boivin-Rioux A, Blais M, Mungall EL, Boyer M, Irish VE, Massé G, Kunkel D, Tremblay J-É, Papakyriakou T, Bertram AK, Bozem H, Gosselin M, Levasseur M, Abbatt JPD. 2017. Frequent ultrafine particle formation and growth in Canadian Arctic marine and coastal environments. Atmos. Chem. Phys., 17, 13119-13138, 2017. doi.org/10.5194/acp-17-13119-2017

Melt ponds are an important but understudied component of the Arctic sea-ice system. Our team led the sampling efforts of several melt ponds in the Canadian Arctic Archipelago to identify key biogeochemical and physical properties of these transient

features and their role as potential emitters of DMS. A paper is currently under review: Gourdal, M., Lizotte, M., Massé, G., Gosselin, M., Scarratt, M., Levasseur, M. Dimethylsulfide dynamics in first-year sea ice melt ponds in the Canadian Arctic Archipelago. Biogeosciences discussions, doi.org/10.5194/bg-2017-432, 2017.

SOLAS/NETCARE workshop on the impacts of Arctic DMS emissions on future climate, Sidney, British Columbia, Canada, 17-18 January 2017. Levasseur, Steiner, von Salzen hosted this workshop in order to accelerate the transfer of knowledge between NETCARE's researchers and climate modelers from the Canadian Government. The attendees were mostly from Canada, with one from USA (Trish Quinn) and one from Japan (Sohiko Kameyama).

United Nations GESAMP – Dr Martine Lizotte is collaborating within the United Nations GESAMP (joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) WG38: Impact of ocean acidification on fluxes of atmospheric non-$CO_2$ climate-active species. Her specific contribution is geared towards assessing the impact of Ocean Acidification on DMS production in the Arctic using data collected during NETCARE campaigns. A community paper is underway: "Changing ocean acidity as a modulator of atmospheric biogeochemistry and climate" to be submitted to PNAS.

Contributions to a Special Issue on the SOLAS sponsored SOAP program (Surface Ocean Aerosol Production):
Lizotte M, Levasseur M, Law CS, Walker CF, Safi KA, Marriner A, and Kiene RP (2017) Dimethylsulfoniopropionate (DMSP) and dimethyl sulfide (DMS) cycling across contrasting biological hotspots of the New Zealand subtropical front, Ocean Sci., 13, 961-982.
Law, C.S., Smith, M.J., Harvey, M.J., Bell, T.G., Cravigan, L.T., Elliott, F.C., Lawson, S.J., Lizotte, M., Marriner, A., McGregor, J., Ristovski, Z., Safi, K.A., Saltzman, E.S., Vaattovaarra, P., Walker, C.F. Overview and preliminary results of the Surface Ocean Aerosol Production (SOAP) campaign. Atmos. Chem. Phys. 17(22): 13645-13667, 2017

Participation to the Cryosphere and ATmospheric Chemistry (CATCH): an emerging IGAC/SOLAS activity on chemistry, biology and physics in cold regions. LATMOS, Guyancourt, France, April 2017. As part of the community workshop focused on coordinating research across disciplines or borders and research initiatives on key questions (eg. polar climate change, sea ice and biogeochemical cycles), M. Lizotte, M. Willis and J. Murphy gave talks.

Dr Martine Lizotte acted as a mentor for School's on Board, an ArcticNet Outreach

Program. She gave theoretical classes and field tutorials to students from the Inuit Nunangat during a 1-week cruise on board the CCGS *Amundsen* in the Canadian Arctic Archipelago (July 2017) with a focus on SOLAS/Netcare-related issues (production and cycling of DMS in the Canadian Arctic Archipelago).

As the Vice-Chair for International Relations at APECS Canada, M Lizotte has been involved in several Polar Outreach Activities notably during the Arctic Change 2017 Conference (Student Day) held in Quebec City (December 2017).

Interaction with Provincial Government – Ministry of Sustainable Development and Fight against Climate Change with the following forum presentation given by M Lizotte.
Lizotte M, M Levasseur, M Gourdal, R Hussherr, M Galì, V Galindo, G Massé, T. Jarnikova, P. Tortell November 2017. Plancton and clouds in the Arctic: a constraint to climate warming? 61$^{e}$ Forum Science Environnement (Partnership between Amundsen Science and the Quebec Ministry of Sustainable Development and Fight against Climate Change MDDLCC), Quebec City, Canada, November 2017.

Polar Data Catalogue (PDC) submissions:
Levasseur, M., Gourdal, M., and Lizotte, M. (2017) Dimethylsulfide dynamics in first-year sea ice melt ponds in the Canadian Arctic Archipelago. Waterloo, Canada: Canadian Cryospheric Information Network (CCIN). Unpublished Data Additional information: Gourdal, M., Lizotte, M., Massé, G., Gosselin, M., Scarratt, M. and Levasseur, M. Submitted to Biogeosciences, NETCARE special issue in October 2017.
Hussherr, R., Levasseur, M. and Lizotte, M. (2017) Incidence of light and ocean acidification on microbial community, dimethyl sulfide, dimethylsulfoniopropionate and macronutrients in Baffin Bay, Nunavut, Canada. Waterloo, Canada: Canadian Cryospheric Information Network (CCIN). Unpublished Data Additional Publication- can be accessed: Hussherr R. et al., Impact of ocean acidification on Arctic phytoplankton blooms and dimethylsulfide production under simulated ice-free and under-ice conditions, Biogeosciences Discuss., doi:10.5194/bg-2016-501.

Transfer of data to the Canadian Government: DMS measurements collected during the NETCARE program have been transferred to the modeling team of the Department of Environment and Climate Change Canada (ECCC) and the Department of Fisheries and Oceans Canada (DFO) and are currently used to improve current Arctic climate models. In addition, DMS obtained from the satellite-based DMS model developed by Galí et al. are used by ECCC investigator Knut von Salzen.

Atmospheric data from the NETCARE program are being archived for public access through Environment and Climate Change

Laboratory experiments on the role of sea ice in CO2 drawdown (Miller). A Canadian-Swiss collaboration (Institute of Ocean Sciences and ETH Zurich) examined the impact of sea-ice formation rate on $CO_2$ export with rejected brines using temperature-controlled experiments, confirming greater CO2 export when ice forms more slowly at higher temperatures. Resulted in a Master's thesis: Carbon dynamics during the formation of sea ice at different growth rates, Dept. of Environmental Systems Science, ETH Zürich. (Themes 1 & 2, & Integrated studies)

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

Macdonald, K M., Sharma, S., Toom, D., Chivulescu, A., Hanna, S., Bertram, A K., Platt, A., Elsasser, M., Huang, L., Tarasick, D., Chellman, N., McConnell, J R., Bozem, H., Kunkel, D., Lei, Y D., Evans, G J., and Abbatt, J P D., 2017: Observations of atmospheric chemical deposition in the high Arctic snow, *Atmospheric Chemistry and Physics*, 17(9), p. 5775-5788, DOI: 10.5194/acp-17-5775-2017.

Vergara-Temprado, J., Murray, B J., Wilson, T W., O'Sullivan, D., Browse, J., Pringle, K J., Ardon-Dryer, K., Bertram, A K., Burrows, S M., Ceburnis, D., DeMott, P J., Mason, R H., O'Dowd, C D., Rinaldi, M., and Carslaw, K S., 2017: Contribution of feldspar and marine organic aerosols to global ice nucleating particle concentrations, *Atmospheric Chemistry and Physics*, 17(5), p. 3637-3658, DOI: 10.5194/acp-17-3637-2017.

Irish, V E., Elizondo, P., Chen, J., Chou, C., Charette, J., Lizotte, M., Ladino, L A., Wilson, T W., Gosselin, M., Murray, B J., Polishchuk, E., Abbatt, J P D., Miller, L A., and Bertram, A K., 2017: Ice-nucleating particles in Canadian Arctic sea-surface microlayer and bulk seawater, *Atmospheric Chemistry and Physics*, 17(17), p. 10583-10595, DOI: 10.5194/acp-17-10583-2017.

Collins DB, Burkart J, Chang R Y-W, Lizotte M, Boivin-Rioux A, Blais M, Mungall EL, Boyer M, Irish VE, Massé G, Kunkel D, Tremblay J-É, Papakyriakou T, Bertram AK, Bozem H, Gosselin M, Levasseur M, Abbatt JPD. 2017. Frequent ultrafine particle formation and growth in Canadian Arctic marine and coastal environments. Atmos. Chem. Phys., 17, 13119-13138, 2017. doi.org/10.5194/acp-17-13119-2017

Hussherr H, Levasseur M, Lizotte M, Tremblay J-É, Mol J, Thomas H, Gosselin M, Starr M, Miller L,

Jarniková T, Schuback N, Mucci A. 2017. Impact of ocean acidification on phytoplankton and dimethylsulfide dynamics during simulated ice-free and under-ice phytoplankton blooms in the Arctic. Biogeosciences 14, 2407-2427, doi:10.5194/bg-14-2407-2017

Irish, V.E., Elizondo, P., Chen, J., Chou, C., Charette, J., Lizotte, M., et al. (2017). Ice nucleating particles in Canadian Arctic sea–surface microlayer and bulk seawater. Atmos. Chem. Phys., 17, 10583–10595, 2017, doi.org/10.5194/acp-17-10583-2017

Hayashida H, Steiner N, Monahan A, Galindo V, Lizotte M, Levasseur M Implications of sea-ice biogeochemistry for oceanic production and emissions of dimethylsulfide in the Arctic. 2017. Biogeosciences, 14, 3129-3155, doi.org/10.5194/bg-14-3129-2017

Ghahremaninezhad R, Norman A-L, Croft B, Martin RV, Pierce JR, Burkart J, Willis MD, Bozem H, Kunkel D, Thomas JL, Aliabadi AA, Wentworth GR, Levasseur M, Staebler RM, Sharma S, Abbatt JPD, Leaitch WR. 2017. Vertical profile of atmospheric DMS in the Arctic Spring and Summer. 2017, Atmos. Chem. Phys., 17, 8757–8770, doi.org/10.5194/acp-17-8757-2017

Lizotte M, Levasseur M, Law CS, Walker CF, Safi KA, Marriner A, and Kiene RP (2017) Dimethylsulfoniopropionate (DMSP) and dimethyl sulfide (DMS) cycling across contrasting biological hotspots of the New Zealand subtropical front, Ocean Sci., 13, 961-982.

Burgers, L.A. Miller, H. Thomas, B.G.T. Else, M. Gosselin, and T. Papakyriakou, 2017. *J. Geophys. Res. Oceans* 122: 9663-78, doi: 10.1002/2017JC013250. Surface water $pCO_2$ variations and air-sea $CO_2$ fluxes during summer in the eastern Canadian Arctic. (Theme 1, Integrated studies – polar oceans)

Mungall, J.P.D. Abbatt, J.J.B. Wentzell, A.K.Y. Lee, J.L. Thomas, M. Blaise, M. Gosselin, L.A. Miller, T. Papakyriakou, M.D. Willis, and J. Liggio, 2017. *Proc. Natl. Acad. Sci. USA*. 114(24): 6203-8, doi: 10.1073/pnas.1620571114. Microlayer source of oxygenated volatile organic compounds in the summertime marine Arctic boundary layer. (Theme 5, Integrated Studies – polar oceans)

*Ghahremaninezhad, R*., Norman, A.L., Croft, B., Martin, R.V., Pierce, J.R., Rempillo, O., Willis, M., Bozem, H., Kunkel, D., Thomas, J.L., Aliabadi, A.A., Wentworth, G.R., Levasseur, M., Staebler, R.M., Sharma, S., Leaitch, W.R. (2017). Boundary layer and free tropospheric dimethyl sulfide in the Arctic spring and summer. ACP: 17(14) 8757-8770.

Christiciello, A., Marshall, S., Evans, M., Kinnard, C., Norman, A.L., Sharp, M. (2016) Marine aerosol source regions to Prince of Wales Icefield, Ellesmere Island, and influence from the tropical Pacific, 1979-2001. *Journal of Geophysical Research Atmospheres*, 121 (16), 9492-9507. August 2016. DOI: 10.1002/2015JD024457.

**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?**

Many of the publications above proceeded through collaborations between government and academic scientists.

## 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.).**

Two studies of visibility, fog and aerosols are planned for this summer, one in Halifax (May-July 2018) and one in Tuktoyaktuk (July-Sept 2018), the latter being part of the Year of Polar Prediction (Chang). In both of these studies, the effect of ocean emissions and temperature on resulting fog events are of primary interest. The investigators are also planning on participating in the MOCCHA campaign onboard the Swedish icebreaker Oden (PI Caroline Leck, Stockholm University) this summer (Aug-Sept 2018) to study marine contributions to Arctic aerosol and their ability to act as cloud condensation nuclei.

Field study (Levasseur) - Participation to the ArcticNet/Sentinel North expedition in the Canadian Arctic (Baffin Bay) on the icebreaker CCGS Amundsen: Deployment of optical sensors to monitor climate-active gases at high frequency during BOND July 2017.

SCOR working group, #152, on Measuring Essential Climate Variables in Sea Ice (ECV-Ice) is conducting intercalibration experiments on methods for determining primary production and gas fluxes in sea ice in Japan and the UK (at the Roland von Glasow Air-Sea-Ice Chamber), with strong Canadian participation. In 2019, another intercalibration experiment focussed on primary and secondary production will be conducted in Cambridge Bay, Canada, with extenstive international participation. (Miller) (Integrated Studies – polar oceans)

Collaboration with government scientists to model trends in aerosol sulfate from DMS over the period 1993-2003 in the Arctic with Canadian Center for Climate Modeling and Analysis (Knut von Salzen). Collaboration with Environment and Climate Change Canada on modelling DMS oxidation with Weimin Gong.

Laboratory collaboration between University of Toronto and Laval University on the atmospheric multiphase chemistry of materials formed from phytoplankton cultures.

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

Participation of M Lizotte as an invited Mentor during the Sentinel North International PhD School " Shedding light on marine ecosystem services", July 2017, http://sentinellenord.ulaval.ca/en/baffin2018

BEPSII is planning a 'Winter School' on sea-ice biogeochemistry in Cambridge Bay, Canada, in 2019, along side the ECV-Ice intercalibration experiment. A COST Action proposal has been submitted to support this and other BEPSII activities (Miller). (Integrated Studies – polar oceans)

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

A large part of the SOLAS-related funding, to NETCARE, will expire in 2018.

The Oceans Frontier Institute at Dalhousie University has begun funding. Chang is part of the module led by Randall Martin on Atmospheric Composition and Visibility, which focuses on aerosols and liquid droplets in the North Atlantic and Canadian Arctic Gateway. A fog study in Halifax is being funded through this project.

Levasseur is involved with: 2017-2020 BOND (Beacons Of Northern Dynamics: developing light-based sensing technologies to monitor climate active gases in a mutating Arctic), a Sentinel North project (Canada First Research Excellence Fund). Relevant to SOLAS 2015-2025 Science Plan Core Themes 1 and 4. The goal is to develop and deploy novel optical sensors for the monitoring of climate-active gases (CO2-CH4-N2O-DMS) in contrasting polar environments: from terrestrial thermokarst lakes to arctic marine waters.

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

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

See interactions with ECV-Ice and BEPSII, above (Miller)

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *China*
## *compiled by: Minhan Dai & Huiwang Gao*

*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; N2O paper?
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).*

**Title:** Aerosols as a source of dissolved black carbon to the ocean
**Text:** Dissolved black carbon (DBC) is by far the largest known refractory dissolved organic carbon (DOC) pool in the ocean. It can persist in the open ocean for tens of thousands of years, having a much slower average turnover rate than black carbon in soils. Therefore, the cycling of DBC in the ocean is a crucial component of the global carbon budget, and it is important to constrain the sources and sinks of oceanic DBC. Atmospheric deposition could significantly contribute to the oceanic DBC pool, but respective information is lacking.
To study the contribution of atmospheric deposition to the oceanic DBC pool, we carried out an aerosol sampling campaign in spring 2015 that extended from the China coastal seas (the Yellow Sea and the East China Sea) to the northwestern Pacific Ocean. We quantified water-soluble organic carbon (WSOC), and water-soluble black carbon (WSBC) in the aerosol samples. The atmospheric dry deposition of WSBC is estimated to be ~40% of the riverine input to the China coastal seas during the dust outbreak season. The molecular composition of atmospheric WSBC determined by ultrahigh-resolution Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR-MS), reveals similar soil-derived sources as for riverine discharge. WSBC is significantly

positively correlated with WSOC in marine aerosols, and WSBC contributes on average 2.8±0.65% to the total WSOC. Based on this relationship, the global atmospheric deposition of DBC to the ocean is estimated to be 1.8±0.83 Tg $yr^{-1}$. The global WSBC flux from atmospheric deposition is much smaller than the global riverine DBC flux (26 Tg $yr^{-1}$). Nonetheless, atmospheric WSBC deposition alone can support the oceanic DBC turnover at an average rate of ~ 6700 yr, demonstrating the significance of atmospheric deposition. Recent studies found that biomass burning also releases labile OC, and the entire continuum of pyrogenic organic matter and anticipated changes of atmospheric fluxes should be considered in assessments of potential impacts on ecosystems at regional and global scales. Future changes in both dust and biomass burning activities may potentially affect the deposition of WSBC in marine environments.

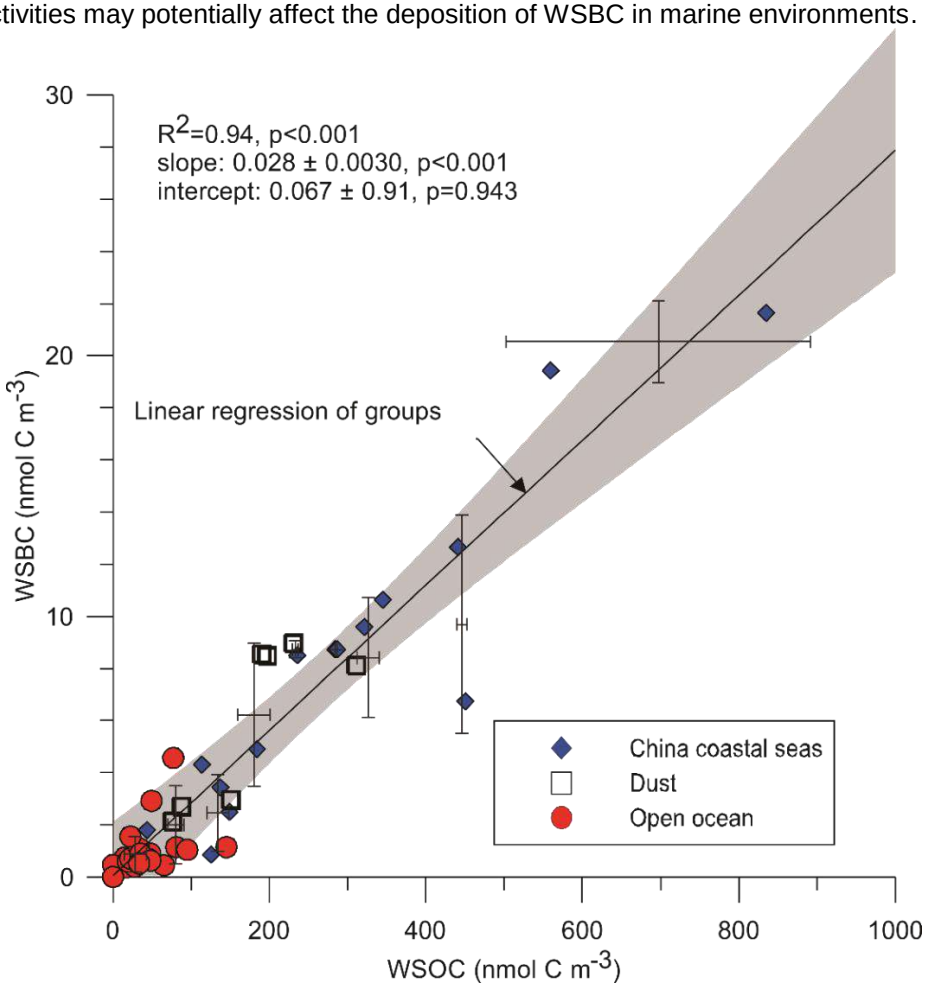



Figure: Relationship between water soluble black carbon and water soluble organic carbon. Error bars show the 1 s.d. of the average values for each concentration group. The statistics are for the regression of the average values. The grey area shows the 95% confidence interval of the linear regression

Citation: Bao, H. Y., Niggemann, J., Luo, L., Dittmar, T., Kao, S.J., 2017, Aerosols as a source of dissolved black carbon to the ocean. *Nature Communications*, 8, doi:10.1038/s41467-017-00437-3.

**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).**

- **Cruise and field experiment**

- The water and mass exchange of Luzon Strait were investigated based on large-scale observations of a cruise conducted onboard R/V *Dongfanghong II* during July 11- August 11, 2017. Parameters related to the air-sea $CO_2$ fluxes and carbonate system were collected. This cruise was supported by National Natural Science Foundation of China (NSFC) Open Research Cruise, which is funded by Shiptime Sharing Project of NSFC. (Theme 1)
- A summer cruise was conducted onboard R/V TAN KAH KEE during June 5-27, 2017 in the Southern South China Sea basin, from where there are sparse data on the carbon budget and ocean acidification. This cruise was supported by project “Carbon Cycle in South China Sea:

budget, controls & global implications (CHOICE-C II)" and "Marine Carbon sequestration: multiscale regulation and response to global changes (MACRO)" funded by the Ministry of Science and Technology (MOST) of China. (Theme 1)

- A winter cruise was conducted onboard R/V TAN KAH KEE during January 14 - February 4, 2018, which focused on the water exchange of Luzon Strait and the coupling processes between the upper ocean and the deep ocean. This cruise was supported by CHOICE-C II project and MACRO project funded by the MOST of China. (Theme 1)
- During the spring time (March-May) in 2017, we carried out dust (natural source) and haze particle (anthropogenic source) addition microcosm experiments in the South China Sea. Chl *a*, nutrients, and phytoplankton community structure (including micro, nano, and pico size cells) were determined to reflect phytoplankton growth in the surface seawater to atmospheric deposition from different sources. (Theme 3)
- Aerosol samples were collected from South China Sea during June 9 – June 26, 2017. Water soluble organic carbon and water soluble black carbon will be measured to understand the transport of biomass burning derived organic carbon to the ocean. This cruise was supported by National Natural Science Foundation of China (NSFC) No. 2015CB954000 and Ministry of Science and Technology of the People's Republic of China (No. 2016YFA0601200). (Theme 3)
- A SOLAS cruise campaign was conducted in April 2017 on the Yellow Sea and East China Sea to study the distributions, air-sea fluxes and biogeochemical cycles of trace gases (i.e. CH4, $N_2O$, DMS, $CO_2$, CO, Halogens) in the atmosphere and the seawater. (Theme 1)

- **Projects**

NSFC innovative research group: Nitrogen cycle under global change (2018-2023), Leading PI: Shuh-Ji Kao from Xiamen University, budget 10.5 million CNY. (Theme 1)

NSFC program: Utilizing ultrahigh resolution mass spectrometry and molecular markers to characterize the molecular composition and fate of atmospheric dissolved organic carbon in the South China Sea (2018-2020), Leading PI: Hongyan Bao from Xiamen University (Theme 3)

NSFC general program: Effects of multiphase reactions for atmospheric organic acid on deposition ice nucleation efficiency of particles (2018-2021), leading PI: Bingbing Wang from Xiamen University (Theme 3)

- **Infrastructure**

- A 78-m long new research vessel with the capacity of SOLAS and trace metal researches was formally delivered to Xiamen University on March 28, 2017.
- Ocean University of China's (OUC) new deep-sea research vessel (Dong Fang Hong 3) was launched on January 16, 2018. This new research vessel with the capacity of SOLAS researches will be delivered to OUC and put to use by the end of 2018.
- The first phase of the Dongshan Swire Marine Station of Xiamen University (D-SMART) was completed on May 31, 2017. Research at D-SMART will focus on monitoring the impact of human activity induced climate change on the marine ecosystem. Long-term observation platform for the environmental elements at the ocean-land-atmosphere interfaces will be established at D-SMART.

- **Workshop organized**

The Third Xiamen Symposium on Marine Environmental Sciences (3rd XMAS), Xiamen, China, January 9-11, 2017.

CHOICE-C II Annual Meeting, Dongshan, China, October 18-21, 2017.

Annual project meeting for a 973 program (Major State Basic Research Development Program of China, No. 2014CB953702, project title: Response of nitrogen cycle and primary productivity to atmospheric deposition, and climate feedback), Xiamen, China, October 28-October 30, 2017.

- **International interactions and collaborations**

Minhan Dai, SOLAS in Asia, Jan 23-25, 2017, The 5$^{th}$ workshop on Future Earth in Asia, Kyoto, Japan.

Minhan Dai co-chaired the theme “Chemistry of Ocean (past, present and future)” at the Goldschmidt 2017 conference, Aug. 13-18, 2017, Paris, France.

Prof. Huiwang Gao from Ocean University of China and Prof. Mitsuo Uematsu from Tokyo University co-chaired a session on “Atmospheric Deposition and Biogeochemical Interaction Processes” in the 10th WESTPAC/IOC international conference in Qingdao on April 17, 2017.

Prof. Huiwang Gao and Prof. Guiling Zhang attended the meeting of international SOLAS Scientific Steering Committee held in Italy on June 19-21, 2017.

- **Human dimensions (outreach, capacity building, public engagement etc.)**

The 6th Xiamen University Ocean Sciences Open House was held on November 5, 2017, Zhou-Long-Quan Building, Xiang’An Campus, Xiamen University, China.

- **Events**

Prof. Minhan Dai from Xiamen University, past SOLAS SSC member and China-SOLAS vice president, was elected as Academician of Chinese Academy of Sciences in 2017.

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


1. Du, C., Liu, Z., Kao, S.J., Dai, M.H., 2017, Diapycnal fluxes of nutrients in an oligotrophic oceanic regime: the South China Sea, *Geophysical Research Letters*, 44, doi: 10.1002/2017GL074921.
2. Bao, H. Y., Niggemann, J., Luo, L., Dittmar, T., Kao, S.J., 2017, Aerosols as a source of dissolved black carbon to the ocean. *Nature Communications*, doi:10.1038/s41467-017-00437-3.
3. Luo, L., Kao, S.J., Bao, H., Xiao, H., Xiao, H., Yao, X., Gao, H.W., Li, J.W., Lu, Y.Y., 2017, Sources of reactive nitrogen in marine aerosol over the northwest Pacific Ocean in spring, *Atmospheric Chemistry & Physics*, doi: 10.5194/acp-2017-846.
4. Li, W., Xu, L., Liu, X., Zhang, J., Lin, Y., Yao, X., Gao, H., Zhang, D., Chen, J., Wang, W., Harrison, R., Zhang, X., Shao, L., Fu, P., Nenes, A., Shi, Z., 2017, Air pollution–aerosol interactions produce more bioavailable iron for ocean ecosystems. *Science advances*, 3(3), doi: 10.1126/sciadv.1601749.
5. Wang, F. J., Chen, Y., Guo, Z. G., Gao, H. W., Mackey, K. R., Yao, X. H., Zhuang, G., Paytan, A., 2017, Combined effects of iron and copper from atmospheric dry deposition on ocean productivity. *Geophysical Research Letters*, 44(5), 2546-2555, doi: 10.1002/2016GL072349.
6. Shan J., Zhang H.-H., Zhang, J., Yang G.P., 2017. Spatiotemporal distribution characteristics and environmental control factors of biogenic dimethylated sulfur compounds in the East China Sea during spring and autumn. Limnology and Oceanography, DOI: 10.1002/lno.10737
7. Li J.-L., Zhang H.-H., Yang G.-P., 2017. Distribution and sea-to-air flux of isoprene in the East China Sea and the South Yellow Sea during summer. Chemosphere, 178, 291-300, http://dx.doi.org/10.1016/j.chemosphere.2017.03.037
8. He Z., Liu Q.-L., Zhang Y.-J., Yang G.-P., 2017. Distribution and sea-to-air fluxes of volatile halocarbons in the Bohai Sea and Northern Yellow Sea during spring. Science of the Total Environment, 584-585, 546-553, http://dx.doi.org/10.1016/j.scitotenv.2017.01.065
9. Wu M., Chen L., Zhan L., Zhang J., Li Y., Liu J, 2017. Spatial Variability and Factors Influencing the Air-Sea $N_2O$ Flux in the Bering Sea, Chukchi Sea and Chukchi Abyssal Plain. *Atmosphere*, *8*(4), https://doi.org/10.3390/atmos8040065.
10. Fu J. P., Wang B, Chen Y, Ma Q. W., 2017. The influence of continental air masses on the aerosols and nutrients deposition over the western North Pacific, Atmospheric Environment, 172, doi: 10.1016/j.atmosenv.2017.10.041.
11. Fang, Z., Yang, W., Chen, M., & Ma, H., 2017. Source and fate of dissolved black carbon in the western south china sea during the southwest monsoon prevailing season. *Journal of Geophysical Research Biogeosciences*, 122(11), 2817–2830.


*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.*

**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?**

## 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.).**

- There will be a spring cruise to the South China Sea, Luzon Strait and Northwest Pacific conducted by R/V TAN KAH KEE in 2018. This cruise will study the material exchange between South China Sea (SCS) and West Pacific. Other cruises to the Southern South China Sea basin, the Yellow Sea and Bohai Sea will be conducted by R/V TAN KAH KEE and R/V Dongfanghong 2 in 2018, which will benefit data accumulation. These cruises will be supported by NSFC Open Research Cruise, which is funded by Shiptime Sharing Project of NSFC. (Theme 1)
- It is confirmed that there will be a cruise to the Northwest Pacific conducted in April by R/V TAN KAH KEE in 2019. This cruise will study the biogeochemical responses to an eddy in the upper ocean with high resolution investigation. This cruise will be supported by NSFC. (Theme 1)
- Field sampling: Surface seawater and aerosol sampling campaign from South China Sea (January 2018, May 2018 and August 2018) (Theme 3)
- Field experiment: Bio-degradation and photo-degradation of atmospheric dissolved organic matter (precipitation and aerosol water soluble organic carbon) from South China Sea (August 2018) (Theme 3)
- Two SOLAS cruises will be conducted in summer and winter of 2018 on the Yellow Sea and East China Sea to study the distributions, air-sea fluxes and biogeochemical cycles of trace gases (i.e. $CH_4$, $N_2O$, DMS, $CO_2$, CO, Halogens) in the atmosphere and the seawater. (Theme 1)

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

A SOLAS themed session is confirmed to be held at the 4$^{th}$ Xiamen Symposium on Marine Environmental Sciences (XMAS-IV, http://mel.xmu.edu.cn/conference/4xmas), January 6-9, 2019, Xiamen, China

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

CHOICE-C (Carbon cycling in China Seas-budget, controls and ocean acidification) project was renewed by the MOST of China for another 5 years from January 2015 to December 2019. This renewed project is termed as CHOICE-C II with a budget of 25 million CNY. Through comparative study of carbon cycling in River-Dominated-Ocean-Margins (RioMars, the northern South China Sea shelf being a case) and the Ocean-Dominated-Ocean-Margin (OceMars, the South China Sea basin being a case), CHOICE-C II is focusing on the carbon cycle in South China Sea in terms of its budget, controls and global implications. (Theme 1)

National Key Research and Development Program: Biogeochemical processes and climate effect of marine biogenic trace gases in the east marginal seas of China. Leading PI: Gui-Peng Yang. Institution: Ocean University of China. Budget: 25.86 million CNY. Research Duration: 5 years

(2016.7-2021.6). (Theme 2)

Major National scientific Research Program: Atmospheric deposition and its impact on marine primary production and nitrogen cycle (2013-2018), leading PI: Huiwang Gao. (Theme 3)

NSFC innovative research group: Nitrogen cycle under global change (2018-2023), Leading PI: Shuh-Ji Kao from Xiamen University, budget 10.5 million CNY. (Theme 1)

NSFC program: Utilizing ultrahigh resolution mass spectrometry and molecular markers to characterize the molecular composition and fate of atmospheric dissolved organic carbon in the South China Sea (2018-2020), Leading PI: Hongyan Bao from Xiamen University (Theme 3)

NSFC general program: Effects of multiphase reactions for atmospheric organic acid on deposition ice nucleation efficiency of particles (2018-2021), leading PI: Bingbing Wang from Xiamen University (Theme 3)

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

- Proposal on co-limitation and utilization of major and micro/trace nutrients & export production in the West Philippine Sea will be submitted in March, 2018 to the Joint China-German Research Projects which is funded by the German Research Foundation and the National Natural Science Foundation of China.

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

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS FINLAND

***compiled by: Lauri Laakso / Finnish Meteorological Institute / Finnish National SOLAS representative***

*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** |
| **Marine shipping fuels will get a whole lot cleaner in 2020 when a regulation by the International Maritime Organization (IMO) requires fuels to contain 80-86 percent less sulphur. Study finds cleaner ship fuels will reduce childhood asthma by 3.6 percent globally but it will also accelerate climate change.** |

Photo: Hannu Manninen

The new IMO rule will decrease the allowable amount of sulphur in fuel oil from 3.5 percent to 0.5 percent, a reduction from 35,000 parts per million (ppm) to 5,000 ppm. This is the most significant improvement in global fuel standards for the shipping industry in 100 years, intended to achieve significant health benefits on a global scale. Now, a new study in *Nature Communications* quantifies these health benefits and finds cleaner shipping fuels will result in a 3.6 percent reduction of childhood asthma globally.

The team studied the impacts of sulphur emitted by ships using current marine fuels, which produce air pollution particles that are small enough to be breathed deeply into the lungs and are considered harmful to human health. Ship air pollution effects are greatest in areas where heavily travelled ship routes exist in, and next to, densely populated communities. Some key regions include China, Singapore, Panama, Brazil and coastlines of Asia, Africa and South America.

Refining industries will invest in the necessary technology to produce, and shipping will invest to adapt engine systems to use, these cleaner fuels. "Essentially, we document how much health benefit to expect from the 2020 adoption of cleaner ship fuels," said James Corbett, professor of marine science and policy in UD's College of Earth, Ocean, and Environment, and the paper's corresponding author.

Roughly 14 million annual cases of childhood asthma are estimated to be related to global ship pollution using current fuels. The change to cleaner ship fuels will reduce the ship-related childhood asthma cases by half. Additionally, shipping pollution is estimated to contribute to 400,000 premature deaths from lung cancer and cardiovascular disease annually. Using health risk estimates for ships comparable with the World Health Organization totals, ships account for about 3-4 percent of global lung cancer and cardiovascular deaths caused by air pollution. About one-third of these ship-related cardiovascular disease and lung cancer deaths will be reduced with cleaner fuels.

## Public health benefits bring climate tradeoffs

"Researchers used a state-of-the-art model of ship traffic based on satellite records to determine where ship activity was producing emissions", explains FMI researcher Jukka-Pekka Jalkanen.

While the health benefits are clear, the research also quantifies tradeoffs in terms of climate. "Sulphur dioxide emissions from ships create small particles. These sulphur containing particles reflect sunlight and help form brighter clouds, creating a global effect that temporarily diminishes the warming effects of carbon dioxide. The use of cleaner ship fuels will increase the rate of global warming by about 3 percent," said FMI senior researcher Mikhail Sofiev, who led the climate related research. "This means more attention may be needed to reduce greenhouse gases across all sectors of the global economy."

Think of this warming effect like a pot of water boiling on the stove. Adding ice cubes to the boiling water can slow how quickly the water heats up, but it does not stop the heating itself. It's the same with sulphur in the atmosphere.

At the same time, shipping activity is expected to increase with global trade and continue to produce harmful air emissions and greenhouse gases. Despite the upcoming reductions, low-sulphur marine fuels will still account for approximately 250,000 deaths and 6.4 million childhood asthma cases annually, so more stringent standards beyond 2020 may be needed to provide additional health benefits.

The study was led by University of Delaware's and included an international team of researchers from the Finnish Meteorological Institute (FMI), Rochester Institute of Technology (RIT) in New York and Energy and Environmental Research Associates. Study was funded in part by ClimateWorks Foundation, the Academy of Finland, with in-kind support from the Finnish Meteorological Institute and Energy and Environmental Research Associates, LLC.

Reference:

Sofiev, M., Winebrake, J.J., Johansson, L., Carr, E.W., Prank, M., Soares, J., Vira, J., Kouznetsov, R., Jalkanen, J.-P., Corbett, J.J., " Cleaner fuels for ships provide public health benefits with climate tradeoffs", Nature Communications Vol. 9, Article number: 406 (2018) doi:10.1038/s41467-017-02774-9, https://www.nature.com/articles/s41467-017-02774-9

**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).**

Most of marine research in Finland is coordinated by Finnish Marine Research infrastructure FINMARI. FINMARI partners are Arctia Shipping Ltd, Finnish Environment Institute (SYKE), Finnish Meteorological Institute (FMI), Geological Survey of Finland (GTK), University of Helsinki (UHEL), University of Turku (UTU), Åbo Akademi University (ÅAU) and Natural Resources Institute Finland (LUKE).

FINMARI combines all major components of the Finnish marine research community. It is an infrastructure network of field stations, research vessels and multi-purpose icebreakers, laboratory facilities, ferry boxes, fixed measurement platforms and buoys. In addition to experimental research, FINMARI facilitates modelling research through observations and communication.

FINMARI www-pages: https://www.finmari-infrastructure.fi/

As the Baltic Sea is shallow, on Finnish coast typically less than 100 m deep, we list here different actions and projects which may influence sea-atmosphere interphase in quite general sense.

**Core Theme 1: Greenhouse gases and the oceans**

- At Utö Atmospheric and Marine Research Station (operated by the Finnish Meteorological Institute and Finnish Environment institute) sea-atmosphere $CO_2$-flux measurement tests continued and observations now considered reliable (http://en.ilmatieteenlaitos.fi/uto).
- Jerico-next (Joint European Research Infrastructure Network for Coastal Observatory – Novel European expertise for coastal observatories: development of coastal observing systems) General Assembly was held in Helsinki 13-16 March 2017 as a joint effort of FMI and SYKE. In total, more than 60 people from around 15 countries participated the meeting.

- Pojo Bay is a fjord-like embayment in Tammisaari, southern Finland. It receives freshwater from river Mustionjoki and low-salinity water from the brackish Baltic Sea. In the middle of the bay a shallow sill separates the inner bay from the outer, creating salinity-stratified conditions in the inner bay which are prone to late summer hypoxia. The previous sampling campaigns by UHEL have shown that the deep waters of the inner bay accumulate methane and nitrous oxide during the period of low-oxygen conditions. However, the annual cycle of accumulation of these greenhouse gases, their potential release to the atmosphere, and the biogeochemical mechanisms controlling their distribution, are poorly constrained.

  In 2017 UHEL studied the sources and sinks of methane and nitrous oxide along a transect from river mouth towards the open sea and related these to physical and biogeochemical variables. We hypothesized that the quantity but especially the quality of organic matter limits nitrogen processes in early summer, whereas in late summer the rates are controlled by oxygen availability. As $N_2O$ production is highest in systems suffering from external stress and shifts in environmental conditions, we expect higher $N_2O$ to $N_2$ ratios in stations prone to hypoxia than at normoxic stations. We used $^{15}N$ stable isotope methods to measure nitrous oxide production rates in denitrification, ammonia oxidation and nitrifier denitrification. As the last step of denitrification is the only known sink for nitrous oxide, the sink function is defined as the efficiency of nitrate reduction to $N_2$ gas instead of $N_2O$. Methane oxidation rates in sediments were measured using $^{14}C$ radiotracer methods. In total, three field campaigns were carried out in contrasting seasons: March (concentrations below ice, nutrients, no processes); June (nitrogen process rates, concentrations in water column, carbon quantity and quality) and August (nitrogen process rates, methane oxidation rates, concentrations in water column,

carbon quantity and quality).

All process rate measurements were complemented with mapping and vertical profiling of organic carbon quality and quantity in the sediments, which is expected to regulate both the heterotrophic denitrification via energy and carbon source and autotrophic ammonia oxidation, and nitrifier denitrification via availability of ammonia released from organic matter. Bulk pore water chemical profiles of the sediments were also generated to investigate the likely zones of methane-related processes. The physicochemical characteristics of the water column were described by CTD measurements (including oxygen), and methane, nitrous oxide and nutrient concentration profiling.

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

- In June, Karasalo et al published a modeling and measurement study on underwater noise from Baltic Sea shipping: "Estimates of Source Spectra of Ships from Long Term Recordings in the Baltic Sea"

**Core Theme 3: Atmospheric deposition and ocean biogeochemistry**

- At UHEL, Tvärminne Field station, Two YSI Exo 2 loggers (T, S, $O_2$, pH, Turb) were installed and a public online portal called MONICOAST opened: https://www.helsinki.fi/en/research-stations/tvarminne-zoological-station/research/monicoast

- Shipping & Environment SHEBA-SOLAS conference was held in Gothenburg, Sweden in Oct 2017, Special issue on shipping and its environmental impacts, Atmos. Chem. Phys. & Ocean Science, opens 1.2.2018. The Finns have made/are still working with the following studies:
    - Manuscript on modelling contaminant/nutrients from ships to sea in preparation Bilge, ballast, waste, scrubber wash water, stern tube oil, antifouling paints; how these were implemented in STEAM
    - Manuscript on small boat contribution to atmospheric emissions & antifouling paints, in preparation
    - Manuscript on environmental impacts of ship emissions to air/water, in preparation
    - Magnusson et al., Marine Pollution Bulletin, "Risk assessment of bilge water discharges in two Baltic shipping lanes", in press
    - Wilewska-Bien et al., Journal of Engineering for the Maritime Environment, "Phosphorus flows on ships –case study from the Baltic Sea", accepted
- A manuscript by the FMI shipping traffic researchers on climate impacts was accepted in Nature Communications. Under embargo at the moment, will be out in Feb 2018.

- ÅAU: A vertical profiling buoy was deployed in the NW Åland measuring basic oceanographic parameters such as temperature, salinity and oxygen content from 4 to 40 metres depth. The profiling is to be continued early spring 2018.

**Core Theme 4: Interconnections between aerosols, clouds, and marine ecosystems**

- Publishing of a new aerosol-cloud-precipitation interaction model UCLALES-SALSA suited to study the evolution of cloud topped marine boundary layer with different forcing components. Model is distributed as open source code, and already employed in several project in Finland and internationally. At Finnish Meteorological Institute the model has been used to study Arctic clouds, especially how aerosol is affecting the properties and precipitation formation.
- Please see also the "Scientific highlight" above.

**Core Theme 5: Ocean biogeochemical control on atmospheric chemistry.**

- Together with SYKE, GTK published a paper about rapid fluctuations in $H_2S$, temperature, pH and dissolved oxygen in near-bottom water in the northern Baltic Sea. The $H_2S$ fluctuations are linked to free gas (methane) content in the underlying sediments, and variability in the rate of anaerobic methane oxidation in the surface sediments.

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

Five selected publications:


1) * Sofiev, M., Winebrake, J.J., Johansson, L., Carr, E.W., Prank, M., Soares, J., Vira, J., Kouznetsov, R., Jalkanen, J.-P., Corbett, J.J., " Cleaner fuels for ships provide public health benefits with climate tradeoffs", Nature Communications Vol. 9, Article number: 406 (2018) doi:10.1038/s41467-017-02774-9, https://www.nature.com/articles/s41467-017-02774-9
2) * Tonttila, J., Maalick, Z., Raatikainen, T., Kokkola, H., Kühn, T., and Romakkaniemi, S.: UCLALES–SALSA v1.0: a large-eddy model with interactive sectional microphysics for aerosol, clouds and precipitation, Geosci. Model Dev., 10, 169-188, doi:10.5194/gmd-10-169-2017, 2017.
3) * Almén A-K, Glippa O, Petterson H, Alenius P, Engström-Öst J (2017) Changes in wintertime pH and hydrography of the Gulf of Finland (Baltic Sea) with focus on depth layers. Environmental Monitoring and Assessment (2017) 189: 147.
4) * Glippa O, Brutemark A, Johnson J, Spilling K, Candolin U, Engström-Öst J (2017) Early development of the threespine stickleback in relation to water pH. Frontiers in Marine Science, 4:427.Hornick T, Bach LT, Crawfurd KJ, Spilling K, Achterberg EP, Woodhouse JN, Schulz KG, Brussaard CPD, Riebesell U, Grossart H-P (2017) Ocean acidification impacts bacteria-phytoplankton coupling at low-nutrient conditions. Biogeosciences, 14: 1-15.
5) * Myllykangas JP, Jilbert T, Jakobs G, Rehder G, Werner J, Hietanen S (2017) Effects of the 2014 major Baltic inflow on methane and nitrous oxide dynamics in the water column of the central Baltic Sea. Earth System Dynamics 8:817-826; doi: 10.5194/esd-8-817-2017


**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?**

- Finnish meteorological Institute has a seat at the European Sustainable Shipping Forum, to provide scientific support for European Commission in issues of environmental impact of ships. FMI is leading WPs concerning ship emission modeling, emission factors for ships, efficiency of emission abatement techniques and primary/secondary particle matter.

## 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.).**

- In 2018 Finnish Meteorological Institute plans to use UCLALES-SALSA to study how marine stratocumulus clouds response to changes in aerosol properties, especially the presence of giant sea salt particles which are hypothesized to initiate precipitation formation followed by cloud breakup. The simulations will be compared against literature data. Similar study will be done to study how entrainment of aerosol of anthropogenic origin above the boundary layer is delaying the precipitation formation and thus prolonging the cloud lifetime. As the third topic the model will be employed to study the phase of Arctic clouds, and how aerosol and cloud dynamics are affecting it.
- Many ongoing projects continue, there are too many individual projects to be listed. In general, work is coordinated through FINMARI research infrastructure.

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

- FINMARI science days at Tvärminne Zoological Station 26-28 February 2018.
- Construction of Finnish marine observing network continues as part of FINMARI

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

All individual FINMARI partners have received significant amount of national and international funding together with a large number of national and international partners.

In addition, FINMARI obtained 2 M€ national infrastructure funding for the years 2017-18 from Finnish Academy.

At Finnish Meteorological Institute, e.g. following projects will be active in 2018

**Finnish Academy:**

1) “Supercooled Water in Mid-level Mixed-Phase Clouds: Microphysics, Dynamics and Global Radiation Balance.”
2) “Ice Clouds and Ice Nucleation in the Arctic”
3) “Aerosol Cloud –Interactions: From Measurements to Modelling”

4) GLORIA, Global health risks related to atmospheric composition and weather, ship emission and chemical transport modeling, health effect evaluation
5) KAMON (Kara-Arctic Monitoring and Operation Planning Platform), winter navigation and inclusion of sea ice in ship emission modeling.

**European Regional Development Fund**

- Environmental Impact of Low Emission Shipping: Measurements and Modelling Strategies (EnviSuM), Local and regional scale ship emission modeling work, FMI research support to European Sustainable Shipping Forum

**Bonus/EU**

- Sustainable Shipping and Environment of the Baltic Sea region (SHEBA), EU/BONUS funding, extension of FMI modeling capabilities to cover emissions from ships to ice and water + underwater noise. Air quality studies in local/regional scales
- Bonus-Integral: Integrated carbon and trace gas monitoring for the Baltic Sea: Integration of the different data streams of ICOS and related infrastructure in the pan-Baltic area
- Jerico-Next: Joint European Research Infrastructure Network for Coastal Observatory – Novel European expertise for coastal observatories: development of coastal observing systems continues

**Finnish Transport Safety Agency**

- ShipNOEm, Annual Baltic Sea ship emission reporting for the benefit of the Helcom member states, generation of ship emission inventories

**European Center for Medium Range Weather Forecasts**

- Copernicus Atmospheric Modeling Services (CAMS-81). Regular updates of the European and global ship emission inventories

**Nordic Council of Ministers**

- Emissions from shiP and the Impacts on human healTh and envirOnMEnt - now and in the future (EPITOME). Ship emissions, air quality and its impacts in Arctic areas. Ship emission scenarios.

**Finnish Prime minister's office**

- The cost of shipping environmental legislation changes to Finnish economy (MERSU) Synthesis report on the existing and upcoming costs of of legislative changes to shipping environmental regulation.

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

There are several national and international applications to EU, Nordforsk, BONUS, national funding agencies and private foundations by the individual FINMARI partners, and different combinations of the FINMARI partners, and together with international parties. There are too many to be listed and also some plans by partners may also be confidential.

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

There are too many to be listed: EMBRC, EURO-ARGO, ICOS, ACTRIS, COPERNICUS etc.

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *'country'*
## *compiled by: 'Name'*

*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

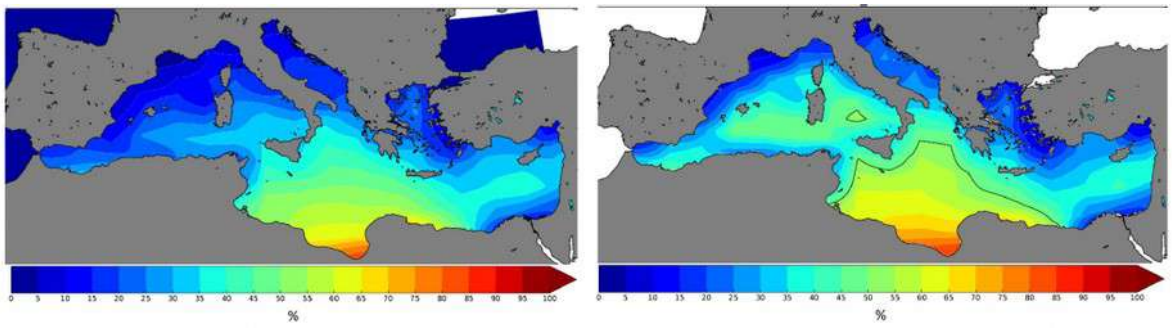
### 1. Scientific highlight

Modeling the biogeochemical impact of atmospheric phosphate deposition from desert dust and combustion sources to the Mediterranean Sea (**Topic 3**)

*Accepted to Biogeosciences*
*Camille Richon (camille.richon@lsce.ipsl.fr), Jean-Claude Dutay, François Dulac, Rong Wang, and Yves Balkanski*

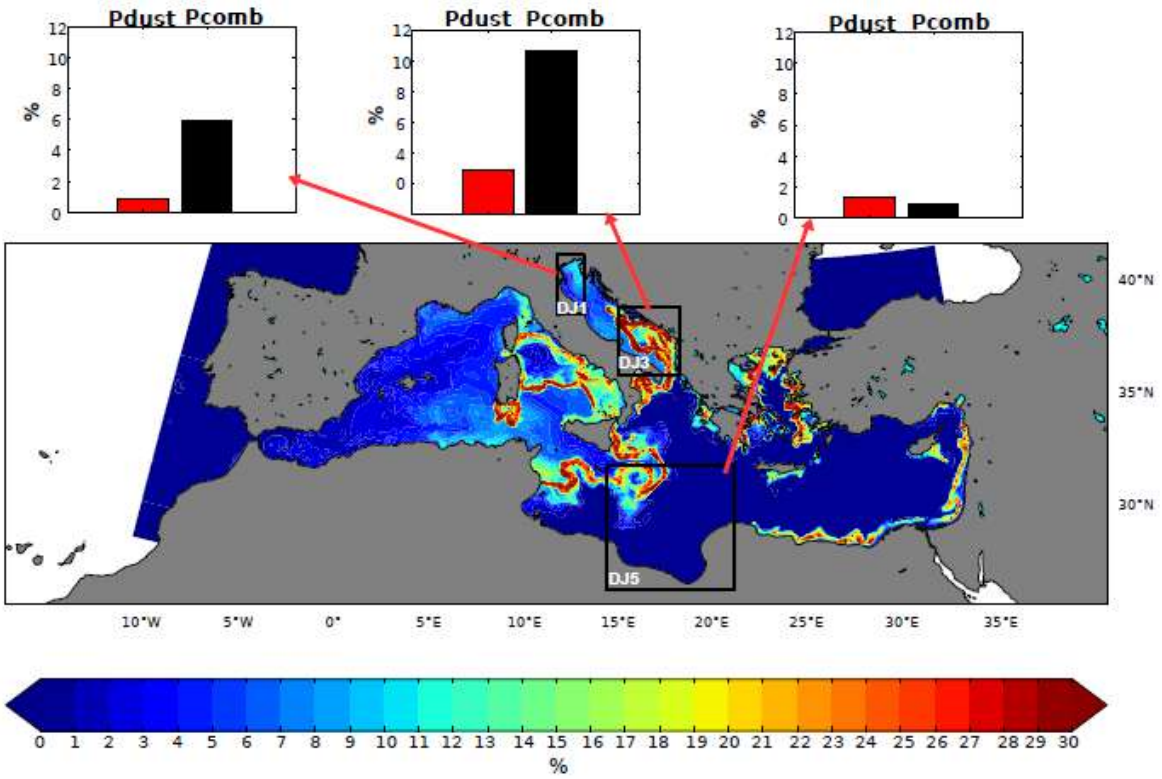
Daily modeled fields of phosphate deposition from natural dust, anthropogenic combustion and wildfires were used to assess the effect of this external nutrient on marine biogeochemistry. The ocean model used is a high resolution (1/12°) regional coupled dynamical-–biogeochemical model of the Mediterranean Sea (NEMOMED12/PISCES). The input fields of phosphorus are for 2005, which is the only available daily resolved deposition fields from the global atmospheric chemical transport model LMDz–INCA. Traditionally, dust has been suggested to be the main atmospheric source of phosphorus, but the LMDz–INCA model suggests that combustion is dominant over natural dust as an atmospheric source of phosphate (PO4, the bioavailable form of phosphorus in seawater) for the Mediterranean Sea. According to the atmospheric transport model, phosphate deposition from combustion (Pcomb) brings on average 40.5 10-6 mol PO4 m-2 year-1 over the

entire Mediterranean Sea for the year 2005 and is the primary source over the northern part (e.g., 101 10-6 mol PO4 m-2 year-1 from combustion deposited in 2005 over the North Adriatic against 12.4 10-6 from dust). Lithogenic dust brings 17.2 10-6 mol PO4 m-2 year-1 on average over the Mediterranean Sea in 2005 and is the primary source of atmospheric phosphate to the southern Mediterranean basin in our simulations (e.g., 31.8 10-6 mol PO4 m-2 year-1 from dust deposited in 2005 on average over the South Ionian basin against 12.4 10-6 from combustion). The evaluation of monthly averaged deposition fluxes variability of Pdust and Pcomb for the 1997–2012 period indicates that these conclusion may hold true for different years. We examine separately the two atmospheric phosphate sources and their respective fluxes variability and evaluate their impacts on marine surface biogeochemistry (phosphate concentration, chlorophyll a, primary production). The impacts of the different phosphate deposition sources on the biogeochemistry of the Mediterranean are found localized, seasonally varying and small, but yet statistically significant. Differences in the
geographical deposition patterns between phosphate from dust and from combustion will cause contrasted and significant changes in the biogeochemistry of the basin. We contrast the effects of combustion in the northern basin (Pcomb deposition effects are found 10 times more important in the northern Adriatic, close to the main source region) to the effects of dust in the southern basin. These different phosphorus sources should therefore be accounted for in modeling studies.




(a) 2005 average (b) 1997–2012 average

Map of average *Pdust* proportion in total P deposition for 2005 (a- left) and 1997-2012 (b- right). The black line on the right map represents 50% *Pdust* proportion limit on the average of 1997-2012.




Map of maximal relative effects of total ($P_{dust}$ + $P_{comb}$) deposition on primary production in the

surface Mediterranean (0-10m) during June 2005 (on a daily basis). The reference primary production concentration values are taken from REF simulation without atmospheric phosphate deposition. Barplots represent average relative effects of each source (in %) within the framed areas excluding land. The limits of the areas are described in Manca et al. (2004). There is no atmospheric deposition modeled in the Marmara and Black Seas.

## PEACETIME field campaign (**Topic 3**)

Cécile Guieu (guieu@obs-vlfr.fr) and Karine Desboeufs (Karine.Desboeufs@lisa.u-pec.fr)

The Mediterranean Sea, a hot spot for biodiversity but also for climate change and anthropogenic pressure, is an ideal natural laboratory to study the processes occurring at the atmosphere-ocean interface. The project PEACETIME (ProcEss studies at the Air-sEa Interface after dust deposition in the Mediterranean sea) will provide the understanding necessary to accurately represent natural and anthropogenic chemical exchanges at the air-sea interface and their impacts on marine ecosystems and services, today and in the future. PEACETIME is relevant for the questions addressed in the "SOLAS 2015-2025 Science Plan and Organisation" in particular regarding the theme "Atmospheric deposition and ocean biogeochemistry".

In the frame of PEACETIME, an oceanographic cruise onboard the R/V 'Pourquoi Pas?' took place in the Western/Central Mediterranean Sea May 10–June 11, 2017 (see: https://twitter.com/peacetimecruise and vimeo.com/channels/peacetime). The purpose of this expedition was to study critical processes induced by atmospheric deposition, in particular Saharan dust. PEACETIME yields insights into the impact of such processes on the cycle of chemical elements (nutrients, metals) and on the biogeochemical functioning of the pelagic ecosystem. The 40 scientists embarked are experts in atmosphere and ocean domains. One of the main aims of the PEACETIME expedition was the characterization of the biogeochemical processes induced by atmospheric inputs over the Mediterranean Sea, and notably the response of the system to Saharan dust inputs. To that purpose, the cruise combined in-situ observations of both the atmosphere and the ocean, as well as Climate Reactors incubation experiments. Incubation experiments were set to reproduce different water temperatures and $pCO_2$ conditions so that scientists could assess the atmospheric impacts in both present and future climate conditions.

Moreover, the PEACETIME strategy included an "in-situ, real-time" approach: catching a real event of atmospheric deposition in Mediterranean waters, and documenting the ensemble of interactions induced on the surface ocean ecosystem. A fine-tuned team of people (on and off-board) worked together to examine quasi-real time dust transport forecasts and satellite observations, adjust the cruise track, and position the ship in an area where deposition events were forecasted. This unique coordinated effort succeeded, and the scientists were able to sample and measure the "real-time" effects of a dust deposition event on the marine surface waters.

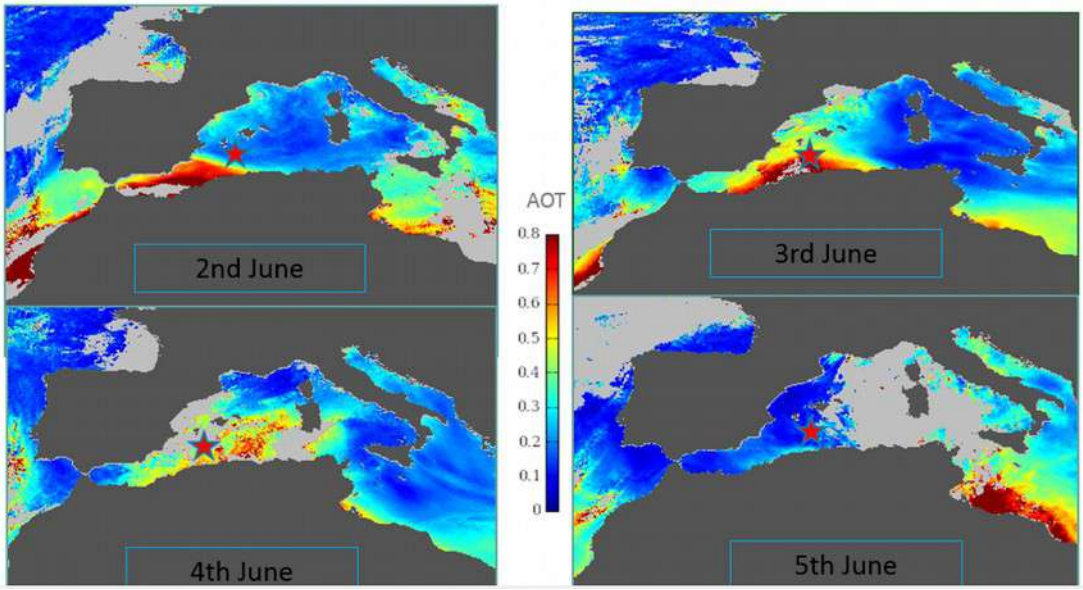



Figure 1. The Fast Action during PEACETIME allowed a direct observation of a dust deposition event to the ocean as shown on the AOT images (the boat location is the red star).

A first set of results concerning physical, chemical, and biological measurements on both the marine stations, the atmospheric and marine underway and the incubation experiments were

presented at the EGU2018 and Ocean Science Meeting in Portland.

MORE HERE: http://peacetime-project.org/index.html and https://www.researchgate.net/project/PEACETIME-ProcEss-studies-at-the-Air-sEa-Interface-after-dust-deposition-in-the-MEditerranean-sea

**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).**

## Surface changes in total carbon and ocean acidification in the NASG (G. Reverdin (LOCEAN) (**Topic 1**)

N. Metzl (LOCEAN, *Nicolas.Metzl@locean-ipsl.upmc.fr*), V. Racape (LOPS))

We have validated a surface archive of T, S, inorganic nutrients, DIC and total alkalinity, $\delta^{13}C_{DIC}$ (the isotopic ratio in DIC), as well as water isotopes that we collected between Iceland and Newfoundland in 1993-2017 (SURATLANT project) (Reverdin et al., 2018). The data illustrate the large increase in DIC, decrease in $\delta^{13}C_{DIC}$, little change in the air-sea contrast of fCO2 (as a trend), but also large interannual and decadal variability associated with the cycle of surface warming peaking in the middle of the period associated with increased surface stratification in this region.

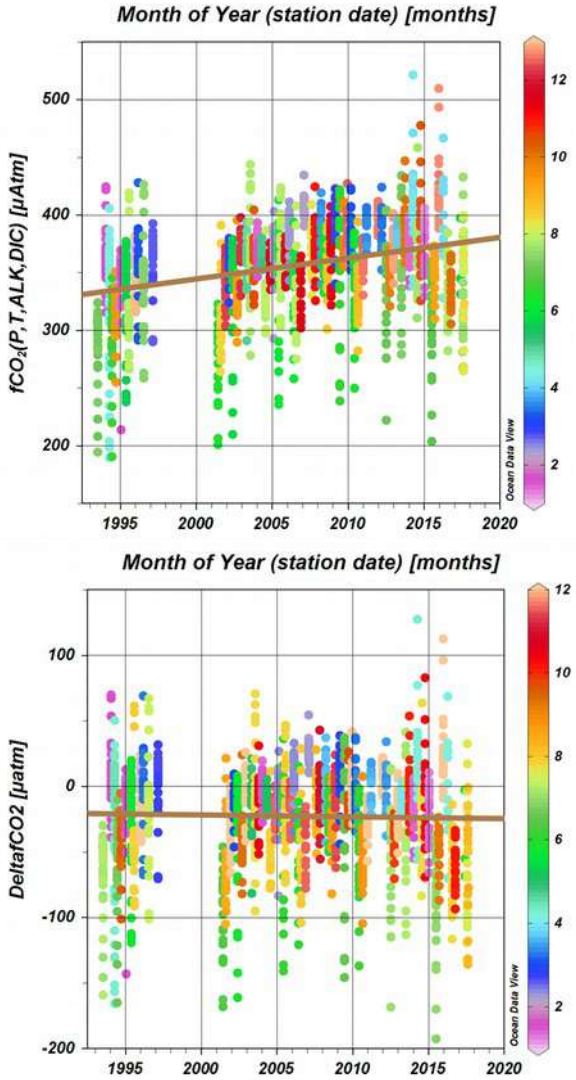



*Figure: SURATLANT. Estimated surface ocean*

*fCO2 (left panel) and sea-air difference in fCO2 (right panel) (color-coded by month of the year). Notice that the NASG has remained a sink of atmospheric CO2 (as a trend, brown curve).*

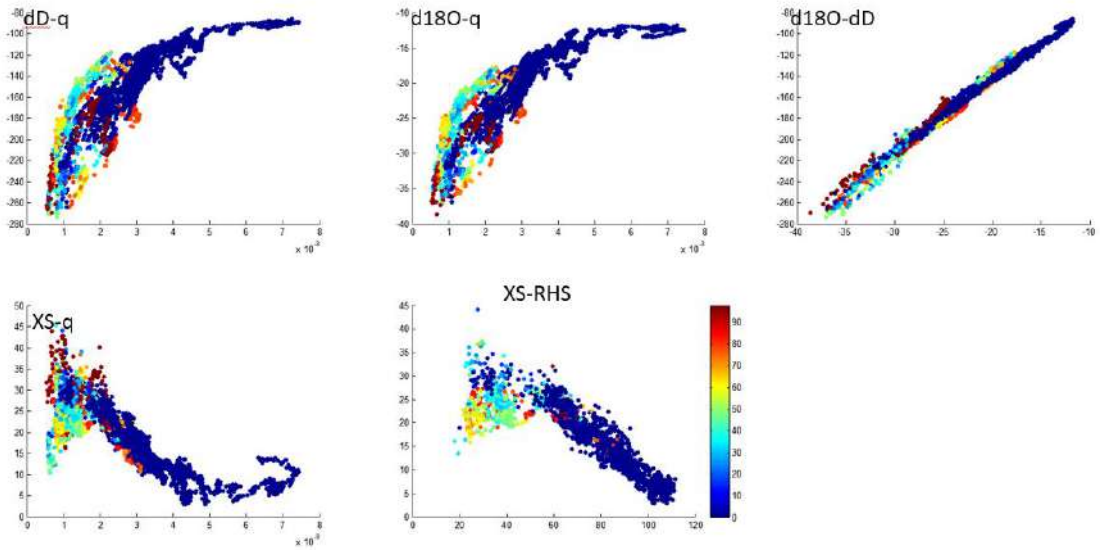
An analysis of the last 10-years of data on another transect (east-west close to 60°N) (Fröb et al., 2018), which thus corresponds to a cooling period in the central NASG, illustrated also the large influence on surface properties of a freshening that took place east of the Reykjanes Ridge in the western Icelandic Sea (thus a decrease in alkalinity).

Reverdin, G. et al.. SURATLANT: a 1993-2017 surface sampling in the central part of the North Atlantic subpolar gyre. ESSD, in review.
Fröb, K., A. Olsen, M. Becker, L. Chafik, T. Johannesen, G. Reverdin et A. Omar. Impact of recent North Atlantic freshening and cooling on the carbon cycle. Geophys. Res. Lett., in review.

## Water isotopes: a tracer of ocean-atmosphere-ice water fluxes (**Topic 2**)

*(G. Reverdin gilles.reverdin@locean-ipsl.upmc.fr (LOCEAN), J.-B. Sallée (LOCEAN), G. Aloisi (IPGP), M. Benetti (Univ. of Iceland Reykjavik), C. Akhoudas (LOCEAN))*

In the past year, we have used our collection of atmospheric boundary layer and surface data of the Atlantic Ocean (from the equator to the North Atlantic subpolar gyre) to develop a qualitative model of the atmospheric boundary layer properties (Benetti et al., 2018). The model highlights how joint data of atmospheric humidity and water isotopes can be used to diagnose relative contribution of evaporation and tropospheric water vapour to the atmospheric boundary layer In particular, this emphasizes the humidity of the air as a key factor in evaporative flux properties, and of properly estimating the properties of the evaporative fluxes including isoptopic values in surface waters in order t ointerpret the atmospheric boundary layer properties in quiescent situations.
During the WAPITI cruise (P.I. J.-B. Sallée) continuous measurements of water vapour and surface sea water isotopic properties in the Southern Ocean from the Magellan Channel to the southern Weddell Sea (January-March 2017), over a wide range of weather conditions, including some very dry air flowing from the Antarctic continents. The sea water isotopes in the southern Weddell Sea are strongly imprinted by the formation and/or melt of sea ice, evaporation in contact with the very cold continental air, as well as with exchanges of water (and melt) of the continental ice shelves (Ronne-Filchner ice shelf). The atmospheric properties are strongly influenced in this late summer period by the presence of partial sea ice cover, as illustrated below on property diagrams showing dependencies of various variables as a function of nearby sea ice cover diagnosed from satellite AMSR2 data(the data of these different plots are colour-coded as a function of sea ice cover (from 0 dark blue to 100% in dark red)): q is the water vapour ratio, RHS is the relative humidity reported at sea surface temperature, d18O, dD are the ῑ$^{18}$O and ῑ D isotopic ratios and XS the deuterium excess.




*Benetti, M., J.-L. Lacour, A.E. Sveinbjörnsdottir, G. Aloisi, G. Reverdin, C. Risi, A.J. Peters, H.-C. Steen-Larsen. A framework to study mixing processes in the marine boundary layer using water vapor isotope measurements. Geophys. Res. Lett., 10 March 2018*
*https://doi.org/10.1002/2018GL077167*

## Modeling aerosol deposition effects on the Mediterranean biogeochemical cycles (**Topic 3**)

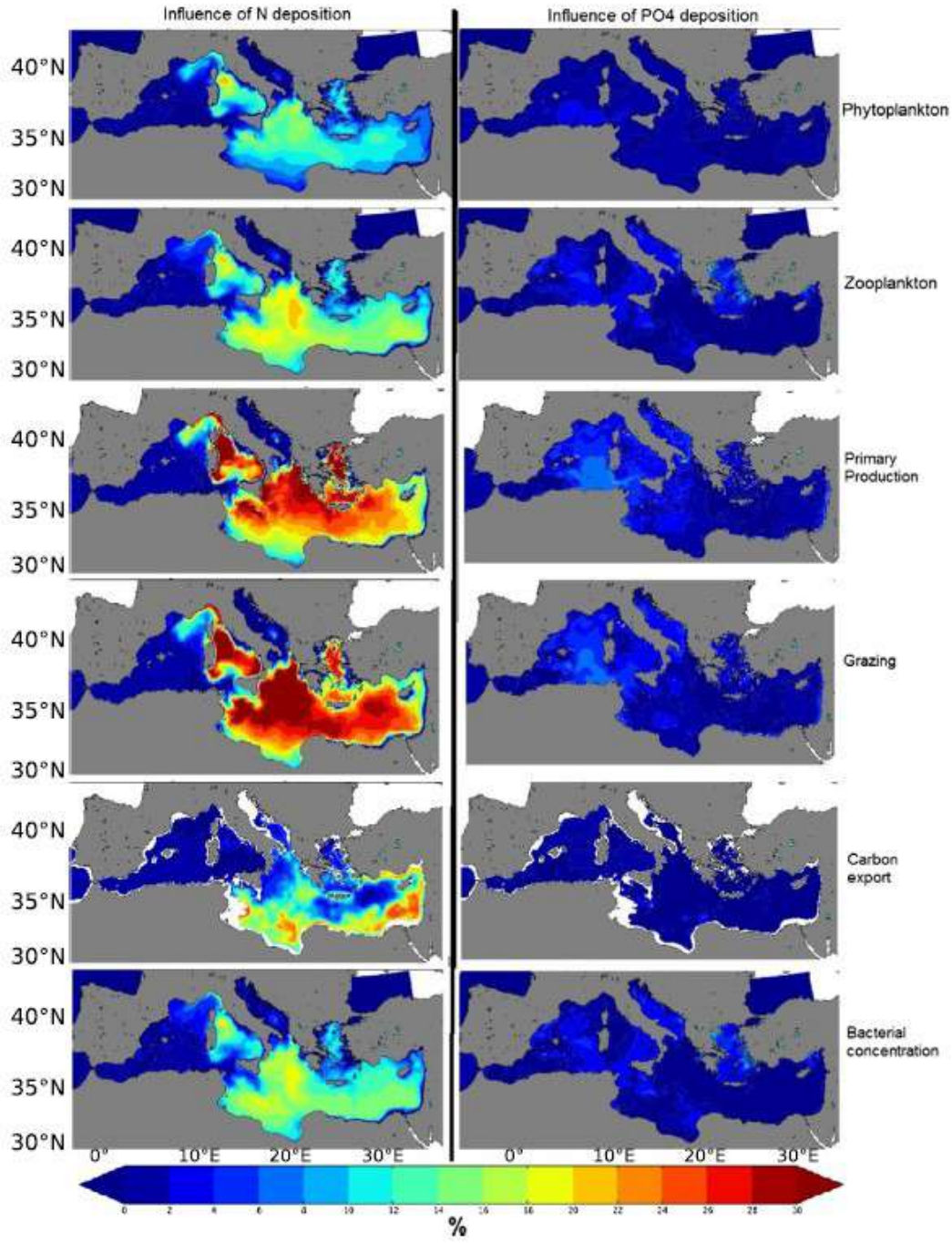
PhD Camille Richon, Paris-Saclay, december 7th, 2017 (LSCE, camille.richon@lsce.ipsl.fr)

Observations and experiments showed that aerosol deposition can increase the amount of bioavailable nutrients and favor biological production of the Mediterranean Sea. In this context, the present study yields for the first time a quantification of the effects of aerosol deposition from various sources thanks to the coupled physical-biogeochemical model NEMOMED12/PISCES.

This study consists in modeling and analyzing the effects on the Mediterranean biogeochemistry of atmospheric deposition of nitrogen and phosphate from various natural and anthropogenic sources. For this purpose, regional and global atmospheric models representing aerosol deposition were evaluated and selected. The NEMOMED12/PISCES model was modified to take into account these new nutrient sources. The analysis of the simulations showed that atmospheric deposition accounts for approximately 10 % of total external nitrate supply and 5 to 30 % of phosphate supply on average over the entire basin. Aerosol deposition can also increase biological production up to 50 % thanks to the lowering of nutrient limitations. The maximal fertilizing effects are observed during the stratied period which, in the Mediterranean region, is summer.

The effects of climate change may be particularly important in sensitive regions such as the Mediterranean. Therefore, the evolutions of basin scale biogeochemistry were evaluated under a climate change scenario. The NEMOMED8/PISCES model was used with physical and biogeochemical forcings for the IPCC A2 climate change scenario. This study shows a reduction in basin scale surface productivity by approximately 10 % triggered by warming and stratification. Nutrient limitations are modified and the Mediterranean Sea sensibility to atmospheric deposition changes.

The results of this thesis underline the importance of atmosphere as a nutrient source, in particular for nitrogen and phosphate. Deposition effects vary according to the season and the location. They are more important during the stratified period, when surface water is nutrient limited. Also, any change in biological productivity is quickly transfered along the biological chain. To refine the results, the atmospheric models could be improved and more knowledge on deposition fluxes and physical and chemical transformations of aerosols before and after deposition would be necessary. Moreover, more precise scenarios concerning climate change effects would be necessary in order to study the future evolutions of biogeochemical conditions in the Mediterranean. Finally, the recent developments on the PISCES model make new studies possible in a non redfieldian context. Preliminary results indicate that the productivity of the different phytoplanktonic groups varies with intracellular C/N/P ratios.




*Relative influence (%) of atmospheric deposition on biological tracers for the summer season (JJA). Bacterial concentration is calculated as: [Bact] = 0.7 [Microzoo] + 2 [Mesozoo]. The relation has been constructed from a version of PISCES including explicit biomass calculation (Aumont et al., 2015). Carbon export is the export of carbon particles at 100 m. White zones are shallower than 100 m.*

## First report on atmospheric fluxes of soluble organic carbon, nitrogen and phosphorus to the Mediterranean Sea (**Topic 3**)

Kahina Djaoudi (kahina.djaoudi@mio.osupytheas.fr) defended her PhD thesis on 9th March 2018. One of her main accomplishments concerns the quantification of total atmospheric deposition of soluble organic matter (C, N and P) during 1.5 years at the Frioul Island, off Marseille (France). Indeed, linking atmospheric deposition to marine carbon and nutrient cycles is currently hampered by the lack of data on atmospheric fluxes of organic matter. The organic fraction in atmospheric deposition accounted for 40% of total soluble N and 25% of total soluble P. A very variable fraction (0-97%) of soluble organic phosphorus in atmospheric deposition was found to be hydrolysable by alkaline phosphatase enzyme (i.e. potentially bioavailable for marine microorganisms). We report

annual atmospheric fluxes of soluble organic C, N and P of 59 mmol C $m^{-2}$, 16.4 mmol N $m^{-2}$ and 23.6 µmol P $m^{-2}$, respectively. Assuming these values valid for the entire western Mediterranean basin, atmospheric inputs of organic matter would be higher than inputs from the Rhone River by a factor of 6, 17, and 2 for C, N and P, respectively.

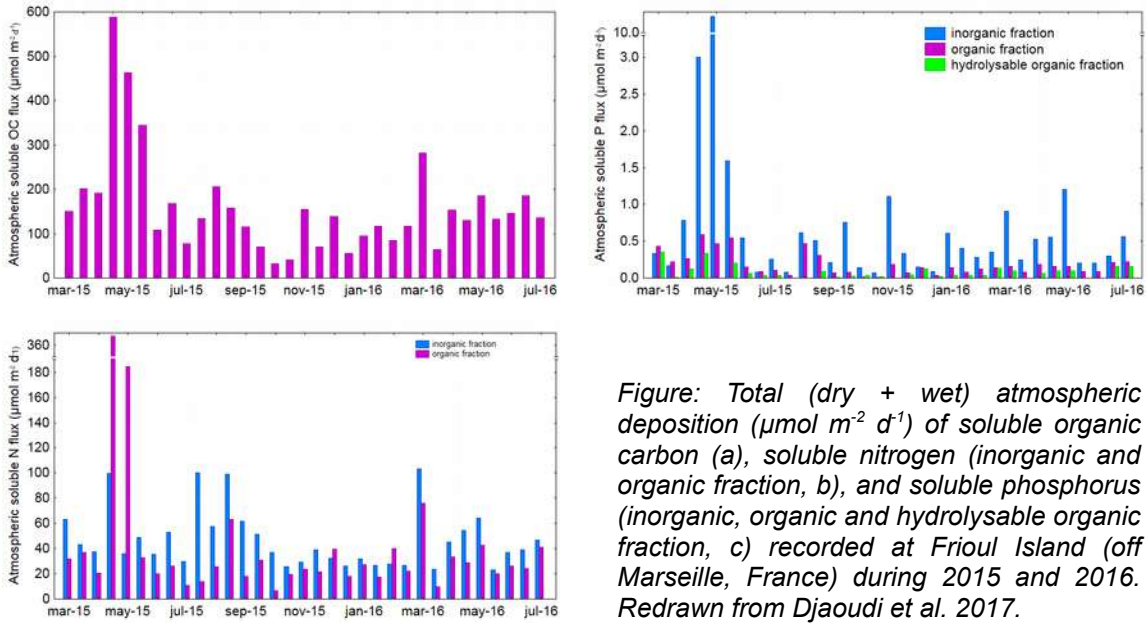



*Figure: Total (dry + wet) atmospheric deposition (µmol $m^{-2}$ $d^{-1}$) of soluble organic carbon (a), soluble nitrogen (inorganic and organic fraction, b), and soluble phosphorus (inorganic, organic and hydrolysable organic fraction, c) recorded at Frioul Island (off Marseille, France) during 2015 and 2016. Redrawn from Djaoudi et al. 2017.*

## Experimental evidence of the bioavailability to marine heterotrophic prokaryotes of aerosol-derived organic carbon, BATO (**Topic 3**)

(INSU-LEFE), Elvira Pulido (MIO, elvira.pulido@mio.osupytheas.fr). Djaoudi, K., Van Wambeke, F., Barani, A., Hélias-Nunige, S., Lefévre, D., Nouara, A., Panagiotopoulos, C., Tedetti, M., Desboeufs, K., Pulido-Villena, E.

Atmospheric deposition is the major pathway for removal of organic carbon (OC) from the atmosphere. Data on atmospheric fluxes of OC to the ocean are scarce but suggest that they might be higher than river inputs and on the same order of magnitude as main ocean carbon fluxes such as C export. However, the fate of this aerosol-derived OC source in the surface ocean upon deposition remains unexplored hampering the assessment of its role in ocean C cycle. The main goal of this project was to investigate the potential availability of aerosol-derived dissolved OC (DOC) to marine heterotrophic prokaryotes. For this purpose, experimental biodegradation assays of DOC derived from Saharan dust and anthropogenic aerosol by marine heterotrophic prokaryotes were conducted. A third treatment amended with glucose (as labile C source) and a control treatment (no added C) were run in parallel. All incubations were run in triplicate, in the dark at controlled temperature, during 16 days. An increase in both heterotrophic prokaryote production (HPP) and abundance (HPAA) was observed following dust (D) anthropogenic (A) and glucose (G) amendments. At the end of the exponential growth phase, the increase in BA was in the same order of magnitude in the G and D treatments and lower in the A treatment (Fig. 1). Growth rate (µ, d-1) and BP integrated over the exponential growth phase was highest in the G treatment, followed by D and then by A. Over the incubation period, the decrease in DOC was highest in G treatment (46 ± 7%), followed by the D-treatment (26 ± 2%) and then by the A-treatment (15 ± 5%). Bacterial growth efficiency (BGE) in the D-treatment (13 ± 4%) was similar to that of the G-treatment (9 ± 3%). In contrast, the BGE in the A-treatment was low (2 ± 1%), suggesting that most labile DOC was catabolized. These results constitute the first experimental evidence that atmospheric deposition is a source of bioavailable organic carbon to the surface ocean. Moreover, the degree of bioavailability depends on the aerosol origin: OC derived from Saharan dust shows a higher bioavailability and can potentially sustain a higher production of bacterial biomass than OC derived from anthropogenic aerosols.

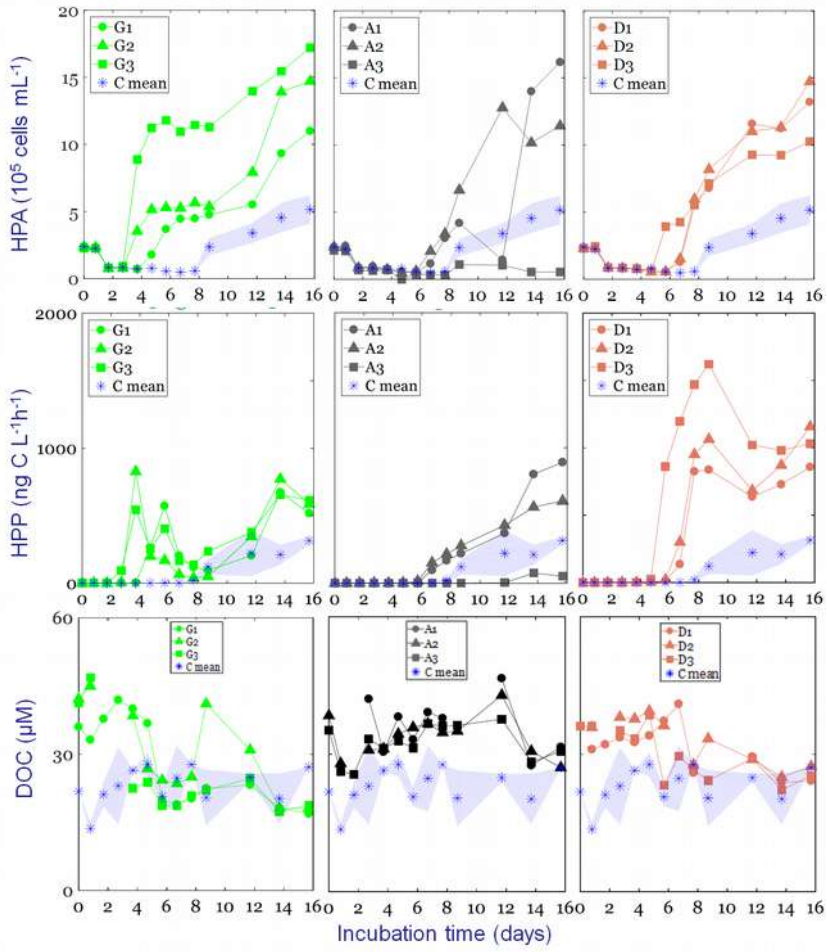



*Figure: Evolution over incubation time of heterotrophic prokaryote abundance (HPP, $10^5$ cells $mL^{-1}$), heterotrophic prokaryote production (HPP, ng C $L^{-1}$ $h^{-1}$) and concentration of dissolved organic carbon (DOC, µM) in triplicate bottles of each experimental treatment (glucose - green plots, anthropogenic aerosols – grey plots and Saharan aerosols – brown plots). The blue plot represents the control treatment (mean ±SD of three replicates).*

## Characterisation of aerosol provenance from the fractional solubility of Fe (Al, Ti, Mn, Co, Ni, Cu, Zn, Cd and Pb) in North Atlantic aerosols (**Topic 3**)

Shelley Rachel, William Landing, Simon Ussher, Helene Planquette, and Geraldine Sarthou (LEMAR)

The fractional solubility of aerosol-derived trace elements deposited to the ocean surface is a key parameter of many marine biogeochemical models. Yet, it is currently poorly constrained, in part due to the complex interplay between the various processes that govern the solubilisation of aerosol trace elements. In this study, we used a sequential two-stage leach to investigate the fractional solubility of a suite of aerosol trace elements (Al, Ti, Fe, Mn, Co, Ni, Cu, Zn, Cd and Pb) from samples collected during three GEOTRACES cruises to the North Atlantic Ocean. Regardless of the leaching protocol used (mild versus strong leach), the same trends were observed. These were that trace elements from aerosols from 1) North Africa were always the least soluble, and the most homogeneous (e.g. Fe was 0.36 ± 0.12 % and 6.0 ± 1.0 % soluble in North African and 6.5 ± 5.5 % and 17 ± 11 % soluble in non-African aerosols following leaches with ultra-high purity water, and 25 % acetic acid, respectively), 2) aerosols from the most remote locations were generally the most soluble, but had the most spread in the values of fractional solubility and 3) primarily pollution-derived TEs (Ni, Cu, Zn, Cd and Pb) were significantly enriched above crustal values in aerosols, even in samples of North African origin. We present aerosol trace element solubility data from two sequential leaches that provides a "solubility window", covering a conservative, lower limit to an upper limit, the maximum potentially soluble fraction, and demonstrate why this lower limit of solubility may underestimate aerosol TE solubility in some regions. The leaching technique that yields the upper limit can also be used to estimate trace element solubility from suspended

particulate matter (SPM). Therefore, facilitating direct comparison with SPM leached using the same technique, thereby introducing some degree of standardisation between aerosol and SPM trace element solubility studies which may help inform of in-water processes that modify the solubility, and thus bioavailability, of atmospheric particles following deposition to the surface ocean.
See:
Shelley Rachel, William Landing, Simon Ussher, Helene Planquette, and Geraldine Sarthou, Characterisation of aerosol provenance from the fractional solubility of Fe (Al, Ti, Mn, Co, Ni, Cu, Zn, Cd and Pb) in North Atlantic aerosols (GEOTRACES cruises GA01 and GA03) using a two stage leach. This article is accepted for publication in Biogeosciences, https://doi.org/10.5194/bg-2017-415

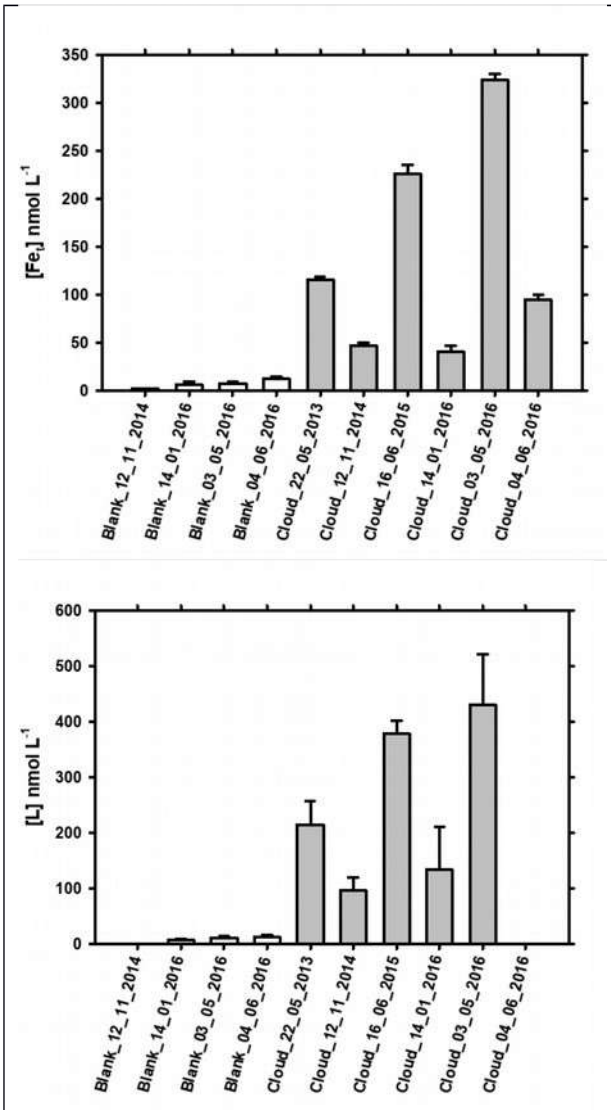
## International Conference on Atmospheric Chemical and Biological Processes: Interactions and Impacts (ATMOCHEMBIO), 19-21 June 2017, in Clermont-Ferrand (https://atmochembio.sciencesconf.org/)

Scientific committee: Dr. Pierre AMATO, ICCF, France, Dr. Marcello BRIGANTE, ICCF, France, Dr Laurent DEGUILLAUME, LaMP, France, Dr. Anne-Marie DELORT, ICCF, France, Dr. Janine FROHLICH, Max Planck Institute for Chemistry, Germany, Dr. Christian GEORGE, IRCELYON, France, Pr. Frank KEPPLER, Germany, Dr. Gilles MAILHOT, ICCF, France, Dr. Cindy E. MORRIS, Plant Pathology Research Unit, France, Dr. Géraldine SARTHOU, LEMAR, France, Dr. Virginie VINATIER, ICCF, France, Pr. Davide VIONE, Turin, Italy

## Iron Organic Complexation In Cloud Water Samples From The Puy De Dôme Station (France) (**Topic 3**)

J. Boutorh, G. Sarthou, A.G. Gonzalez, M. Cheize, H. Planquette, E. Bucciarelli, Mickaël Vaïtilingom, Laurent Deguillaume, Virginie Vinatier, Anne-Marie Delort, G. Mailhot.

Iron (Fe) is a key nutrient for all microorganisms, being involved in many metabolic processes [1]. Recent studies evidenced the impact of organic ligands on Fe speciation and solubility in aerosol rainwater, and cloudwater samples (e.g. [2-5]). It was also demonstrated that Fe complexation with organic ligands increases the photochemical efficiency (OH radical formation) and the Fe stabilization ([6,7]). However, so far, the exact nature, role and sources of Fe binding ligands in the atmosphere are still largely unknown. One hypothesis is that the production of Fe-specific organic ligands by atmospheric bacteria could play a key role on the Fe organic speciation. To test this hypothesis, we first adapted to cloudwater samples a competitive ligand exchange-adsorptive cathodic stripping voltammetry method (CLE-ACSV) recently developed for rainwater samples ([3]). The method was validated with artificial matrices containing model Fe ligands (pyoverdin, oxalate, and ethylenediamine-N,N'-disuccinic acid - EDDS), at three different pH (6.00, 5.65, and 5.37). Although the sensitivity was sufficiently high for the three pH values, the detection limits were much higher for the two lowest pH values (~ 0.3 nM) compared to the one at pH 6 (0.05 nM). We then analysed six natural cloudwater samples collected at the Puy de Dôme station (France) at pH 6. Total Fe concentrations measured by SF-ICP-MS varied between 40 and 226 nM (Figure a).




(a) (b)

*Figure: Total Fe (a) and Fe-binding ligand (b) concentrations in blanks and in cloud water samples collected at the Puy de Dôme station.*

Results clearly evidenced the presence of Fe-binding ligands in excess to the total Fe concentration in five of the cloudwater samples (Figure b). The excess Fe-binding ligand concentrations ranged from 80 to more than 400 nM.
Our results showed, for the first time, that Fe present in cloudwater could be bound to organic ligands, with conditional stability constants close to the pyoverdin, a siderophore excreted by bacteria. These results are consistent with the potential production of siderophores by cloud microorganisms ([5]). Iron complexation by siderophores could have a significant impact on the cloud chemistry and its oxidant capacity ([8]), as well as on the global Fe biogeochemical cycle.

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See:
J. Boutorh, G. Sarthou, A.G. Gonzalez, M. Cheize, H. Planquette, E. Bucciarelli, Mickaël

Vaïtilingom, Laurent Deguillaume, Virginie Vinatier, Anne-Marie Delort, G. Mailhot, Iron Organic Complexation In Cloud Water Samples From The Puy De Dôme Station (France). This study was presented at the ATMOCHEMBIO meeting (19-June 2017, Clermont-Ferrand)

## A potential source of Fe binding organic ligands to the surface ocean from wet deposition. (**Topic 3**)

M. Cheize, A.C. Baudoux, E. Bucciarelli, A. Tagliabue, K. Desboeufs, A.R. Baker, G. Sarthou ( This study was presented at the ATMOCHEMBIO meeting (19-June 2017, Clermont-Ferrand)

Iron (Fe) is an essential micronutrient for all marine organisms. More than 99% of Fe (III) is bound to natural organic ligands in seawater. One of the main inputs of iron to the surface open ocean is dry and wet aerosol deposition. We measured for the first time Fe organic speciation by voltammetry (CLE-ACSV) in seven rainwater samples collected over the Eastern Tropical North Atlantic Ocean during the AMT 19 Cruise (2009) (Figure). The potential involvement of bioaerosols on Fe organic speciation in wet deposition was also investigated.

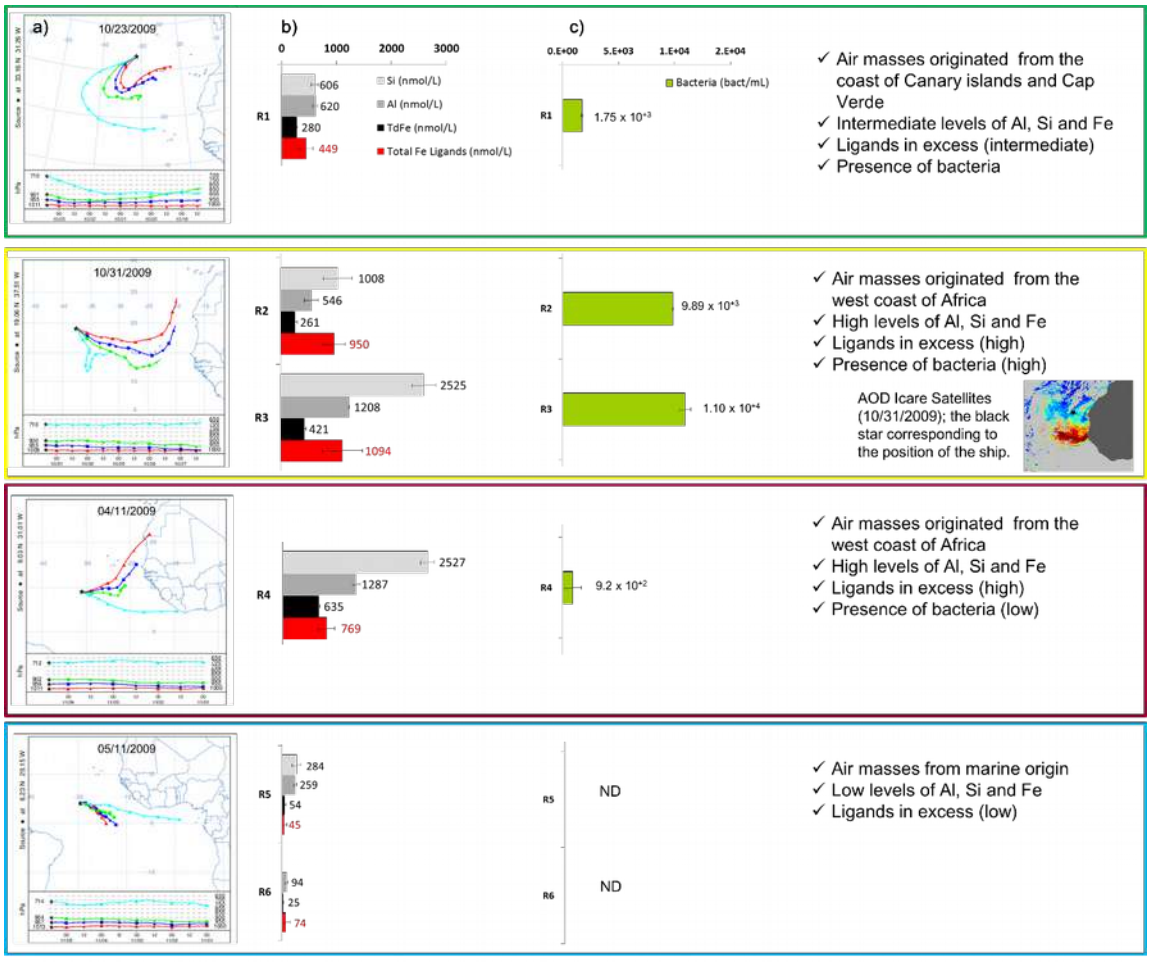


*Figure: Main biogeochemical features of rainwater samples collected during the AMT cruise*.

In these rainwaters, concentrations of total dissolvable Fe (unfiltered) ranged from 25 nM to 635 nM, while concentrations of Fe organic ligands varied between 40 and 1100 nM. Conditional stability constants were characteristic of strong Fe-binding ligands (~$10^{22}$ $M^{-1}$). The highest Fe and organic ligand concentrations were associated with the highest aluminium and silicon concentrations from a Saharan dust wet deposition event. Genomic approach revealed the presence of bacteria and yeast in the rainwater events. Their capacity to produce siderophores was tested, highlighting their ability to produce strong Fe specific organic ligands in different environmental conditions including in salty, nutrient rich and depleted media. This suggests that bioaerosols may be a source of Fe organic ligands to the open ocean that has not been considered yet. Preliminary global modeling experiments will also be discussed in terms of

potential atmospheric input of Fe organic ligands to the surface of the ocean.
Presentations in international conferences

See:

Boutorh J., G. Sarthou, A.G. Gonzalez, M. Cheize, H. Planquette, E. Bucciarelli, Mickaël Vaïtilingom, Laurent Deguillaume, Virginie Vinatier, Anne-Marie Delort, G. Mailhot, Iron Organic Complexation In Cloud Water Samples From The Puy De Dôme Station (France). ATMOCHEMBIO meeting (19-June 2017, Clermont-Ferrand)

Cheize M., A.C. Baudoux, E. Bucciarelli, A. Tagliabue, K. Desboeufs, A.R. Baker, G. Sarthou, A potential source of Fe binding organic ligands to the surface ocean from wet deposition. ATMOCHEMBIO meeting (19-June 2017, Clermont-Ferrand)

## Time series: Seasonality of Saharan Dust deposition over the Caribbeans (**Topic 3**)

Yangjunjie Xu (yxu@ipgp.fr), R. Losno (losno@ipgp.fr), C. Dessert (dessert@ipgp.fr), IPGP, OVSG

North Africa is the largest dust source area in the world, accounting for 55% of global continental dust emission (Ginoux et al., 2012, doi.org/10.1029/2012RG000388). These dusts can impact the Atlantic and Caribbean regions (Prospero et al., 1970, 10.1016/0012-821X(70)90039-7) and is important nutrition source for local ecosystem (Muhs et al., 1990, USGS 33, 157-177). La Guadeloupe island is subjected to frequent North African dust inputs. Fore coming climate change will certainly disturb the intensity and transportation patterns of North African dust revealing a strong necessity of a better knowledge of the dynamic of dust deposition in tropical regions. A continuous atmospheric deposition sampling is already operated from two years at La Guadeloupe (15°58'50" N, 61°42'13" W) and the temporal variation of the dust deposition flux over this period is calculated. The purpose of this study is to understand and quantify the atmospheric deposition of nutriments in North Tropical West Atlantic.

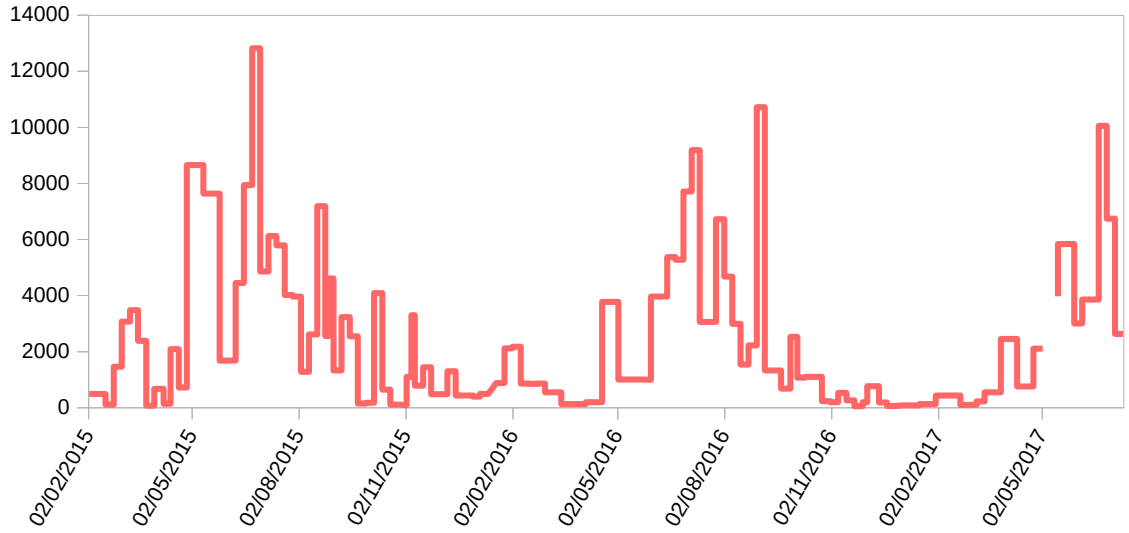


*Figure: Aluminium deposition flux in µg/m²/day on La Guadeloupe Island.*

## Marine Aerosol impact on Clouds in the Arctic (MACA): Mesocosm experiments in Ny-Aesund, Svalbard (**Topic 4**)

Karine Sellegri (LaMP, K.Sellegri@opgc.univ-bpclermont.fr)

The objective of the MACA project, funded by IPEV and the Pollution in the Arctic System project (PARCS), is to identify marine sources of ice nuclei and cloud condensation nuclei in the Arctic atmosphere (Svalbard), their relationship to marine biogeochemical properties of the seawater, and the influence of atmospheric polutant inputs to the seawater. It is an interdisciplinary project bringing together physicists, chemists and biologists from the atmosphere, as well as chemists and marine biologists. From 27 February to 27 March 2017, 3 mesocosms were deployed in the Ny-Alesund waters, to study sea-to-air exchanges. One mesocosm remained unchanged while the other two were modified with the introduction of air pollutants (sulphate, ammonia, nitrate) at representative concentrations of the maximum atmospheric concentrations measured in the Svalbard fresh snow. The atmospheric composition of the mesocosms headspace was

continuously monitored by instrumentation to characterize the physical (size distribution and concentration) and chemical properties of the particles formed from the gases emitted from the surface of the seawater. In parallel, the water of mesocosms was sampled daily in order to analyze the chemical and biological composition (Nutrients, Pigments, Chla, DOC, identification of phytoplankton species, bacteria and viruses ..) on the seawater, and the physical and chemical properties of seaspray generated via a bubble bursting system. Sea spray properties were characterized for its physical properties (size distribution and concentration), chemical composition (online concentrations by mass spectrometry, collection of aerosols on impaction supports), and hygroscopic (CCN and IN) properties.

*MACA participants from left to right : Karine Sellegri (LaMP), David Picard (LaMP), Alessia Nicosia (LaMP), Sebastien Mas (U. Montpellier), Barbara D'Anna (IrceLyon now at LCE-AMU), Remy Vades (U. Montpellier), Paolo Villani (LaMP) and Clémence Rose (U. Hesinki). Marc Mallet (IrceLyon now at LISA) taking the picture.*

**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.*


Djaoudi, K., Van Wambeke, F., Barani, A., Hélias-Nunige, S., Sempéré, R., Pulido-Villena, E. (2017). Atmospheric fluxes of soluble organic C, N, and P to the Mediterranean Sea: potential biogeochemical implications in the surface layer. Progress in Oceanography, doi:10.1016/j.pocean.2017.07.008.

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Gazeau, F., Sallon, A., Maugendre, L., Louis, J., Dellisanti, W., Gaubert, M., Lejeune, P., Gobert, S., A.V. Borges, J. Harlay, W. Champenois, Alliouane, S., Taillandier, V., Louis, F., Obolensky, G., Grisoni, J.-M., and Guieu, C., First mesocosm experiments to study the impacts of ocean acidification on plankton communities in the NW Mediterranean Sea (MedSeA project), Estuarine, Coastal and Shelf Science 186, 11-29, 2017.

Louis J, F Gazeau, C Guieu, Atmospheric nutrients in seawater under current and high pCO2 conditions after Saharan dust deposition: Results from three minicosm experiments, Progress in Oceanography, 2017 (in press)

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Shelley Rachel, William Landing, Simon Ussher, Helene Planquette, and Geraldine Sarthou, Characterisation of aerosol provenance from the fractional solubility of Fe (Al, Ti, Mn, Co, Ni, Cu, Zn, Cd and Pb) in North Atlantic aerosols (GEOTRACES cruises GA01 and GA03) using a two stage leach, Accepted for publication in Biogeosciences, https://doi.org/10.5194/bg-2017-415

**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?**

## 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.).**

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

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

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

Gilles Reverdin
2018: projects
We will work on one hand to provide a synthesis of surface isotopic data in the southern ocean in

early 2017, and use it (collaboration with Haumann) to better constrain E-P fluxes in the southern ocean. Plans for a future expedition in the Weddell Sea (WAPITI2) are ongoing, but it not yet clear whether the expedition will take place in early 2019 or early 2020.

We will also work with the SURATLANT and OISO data together with recent updates of the SOCAT and GLODAP data bases, and recent pH biogeochemical floats, in particular in the southern ocean in order to reconstruct recent (last 10-20 years) variability in the Indian Ocean sector of the southern ocean and in the central sub-polar North Atlantic (nutrients, DIC, AT, $\delta^{13}C_{DIC}$), and to relate it to major climate variability modes and to anthropogenic changes.

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

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *'Germany'*
## *compiled by: 'Christa Marandino and Hartmut Herrmann'*

*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

**Biogenic contribution to submicron marine aerosol particles**

*SOLAS 2015-2025 Science Plan Theme 4*: Interconnections between aerosols, clouds, and marine ecosystsems

The export of organic matter from ocean to atmosphere represents a substantial carbon flux in the Earth system, yet the impact of environmental drivers on this transfer is not fully understood. Here we show that organic carbon concentration and enrichment in seawater (bulk water and the sea surface microlayer; SML) tended to be relatively uniform across the North and Central Atlantic Ocean. However, the organic carbon levels observed in submicron aerosol particles were significantly affected by varying levels of chlorophyll-a (chl-a). On the basis of the present ambient concerted measurements, enrichment factors for organic carbon in ambient marine aerosol particles, hitherto not reported in the literature, were obtained. The results obtained in the present study support the thesis that elevated local biological activity (as indicated by chl-a concentrations) enhances (primary) organic carbon concentration on aerosol particles. However, a prediction of the organic carbon measurement results (transferred to $OMss_A$) by source functions based on wind

speed and chl-a levels showed a strong underestimation of $OMss_A$ in oligotrophic regions, especially at high wind speeds. For the North and Central Atlantic Ocean there may be additional parameters – either connected to biological factors not served by chl-a level as an indicator or to factors of a different nature – that must be taken into consideration in order to accurately predict the organic fractions on aerosol particles.

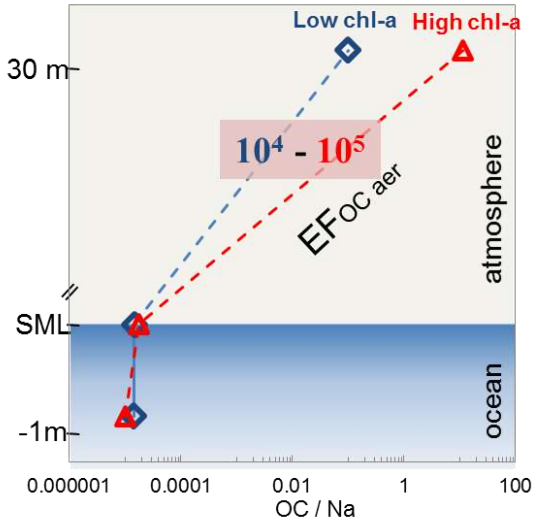



Fig 1: The enrichment of organic carbon in the SML and in aerosol particles: Comparison of the seawater and aerosol ratios of OC to sodium (Na+) to illustrate their enrichments in SML and aerosol particles at different chl-a conditions.

Citation: *van Pinxteren, M., Barthel, S., Fomba, K., Müller, K., von Tümpling, W., and Herrmann, H.: The influence of environmental drivers on the enrichment of organic carbon in the sea surface microlayer and in submicron aerosol particles – measurements from the Atlantic Ocean, Elem Sci Anth, 5, https://doi.org/10.1525/elementa.225, (2017)*

**Oceanic nitrogen cycling and $N_2O$ flux perturbations in the Anthropocene**

*SOLAS 2015-2025 Science Plan Theme* 3: Atmospheric deposition and ocean biogeochemistry

Anthropogenic changes in ocean warming, deoxygenation, and atmospheric N deposition can all individually affect the marine N cycle and the oceanic production of the greenhouse gas nitrous oxide ($N_2O$). However, the combined effect of these perturbations on marine N cycling, ocean productivity, and marine $N_2O$ production is poorly understood. We used an Earth system model of intermediate complexity to investigate the combined effects of estimated 21st century $CO_2$ atmospheric forcing and atmospheric N deposition. Our simulations suggest that anthropogenic perturbations cause only a small imbalance to the N cycle relative to preindustrial conditions (~+5 $TgNy^{-1}$ in 2100). More N loss from water column denitrification in expanded oxygen minimum zones (OMZs) is counteracted by less benthic denitrification, due to the stratification-induced reduction in organic matter export. The larger atmospheric N load is offset by reduced N inputs by marine $N_2$ fixation. Our model predicts a decline in oceanic $N_2O$ emissions by 2100. This is induced by the decrease in organic matter export and associated $N_2O$ production and by the anthropogenically driven changes in ocean circulation and atmospheric $N_2O$ concentrations.

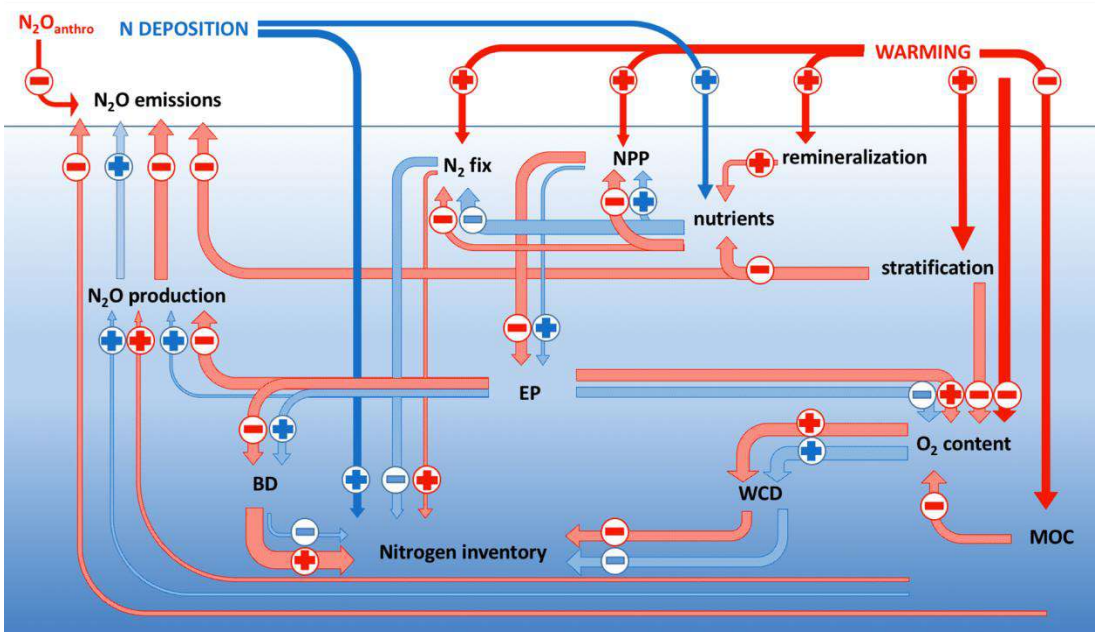



Fig. 2 Schematic of the biogeochemical feedbacks and their sign of change associated with warming and increased N deposition. Solid lines represent direct effects, light-colored lines represent indirect effects. Thickness of the lines represent, in a semiquantitative way, the intensity of the perturbation.

Landolfi, A., et al., (2017), Oceanic nitrogen cycling and $N_2O$ flux perturbations in the Anthropocene, Global Biogeochem. Cycles, 31, 1236–1255, doi:10.1002/2017GB005633.

**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).**

**MarParCloud / MARSU campaign at the CVAO**; Investigation of organic matter in the marine environment, characterization of the processes of organic matter from the (biological) formation in seawater, enrichment in the sea surface microlayer, transfer to aerosol particles and function as INP, turbulence measurements in the marine boundary layer, Activities: sampling of bulk water, sea surface microlayer (glass plate, catamaran), aerosol particles (bulk and size resolved), ice nucleating particles, cloud water on the Mt. Verde, helikite studies, Tank studies for investigation of organic matter transfer under controlled bubble bursting conditions, Dates: 18.09.2017-13.10.2018 at the CVAO and OSCM in Mindelo, Team: TROPOS, ICMB Wilhelmshaven, IOW, ZMT, CNRS-IRCELYON, CNRS-ICARE, Univ. Fudan. Theme 4

**Time series of aerosol chemical composition at the CVAO:** Continuous characterisation of the chemical and physical properties of mineral dust and marine aerosol particles at the CVAO was performed. This ongoing task helps provide a consistent time series of the chemical components of the aerosol particles in this region of the Atlantic. Investigations of dust chemical composition and provenance, dust deposition, sea salt content as well as aerosol source apportionment were carried out using data collected from continuous and short-term field measurements. TROPOS, Theme 4

**Air quality Arabian peninsula cruise in summer 2017 (Max Planck Institute for Chemistry, Mainz):** The cruise AQABA went from France to Kuwait and back, measuring concentrations of trace gases and particles both in extremely polluted marine regions (Arabian Gulf and Red Sea) and in the clean, upwelling impacted air of the northern Indian Ocean (south of Yemen and Oman). Data work-up is on-going. Themes 3 and 5

**MILAN:** The international and multidisciplinary project MILAN (sea-surface MIcroLAyer at Night) arose from the discussion group 'Microbial life at the air-sea interface' at the SOLAS conference 2015 lead by Christian Stolle (IOW, ICBM) and Mariana Ribas-Ribas (ICBM). MILAN addressed the impact of solar radiation on the sea surface microlayer (SML) in regulating air-sea exchange processes. In March/April 2017, Christian Stolle, Mariana Ribas-Ribas, and Oliver Wurl from the working group 'sea surfaces' welcomed 23 scientists from 8 countries at the ICBM-Terramare in Wilhelmshaven, Germany to study full diel cycles in the coastal North Sea employing diverse platforms (vessels, catamaran, free-drifting buoy, aerosol sampler). These field studies were combined with ex situ experiments using a laboratory gas exchange tank, solar simulators, a sea spray simulation chamber, and microsensor technology. MILAN collected unprecedented observation of the SML during day and night and will help to understand how diel solar radiation influences the physical and biogeochemical properties of the uppermost water column and the air-sea exchange of gases and aerosols. Themes 2 and 4

**Contribution to the upcoming WMO, Ozone Assessment 2018:** Birgit Quack contribution on marine halocarbons and stratospheric ozone. Theme 5

**Using aerial drones for air-sea sampling:** For the first time a team of scientists from GEOMAR Helmholtz Center for Ocean Research Kiel (Quack, Marandino, Fuhlbrügge, Paulsen) has successfully used a drone to collect marine air and water samples. The objective of the study was to better understand the role of coastal waters as a source of reactive trace gases. In April 2017, a DJI Matrice 600 drone was used to take water and air samples on the west coast of the island of Sylt during variable weather conditions with wind speeds of more than 10 m/s, where the drone proved to be very good. Both horizontal (500m) and vertical profiles (100m) were flown from the shore line to take the samples. The gas exchange between ocean and atmosphere is enhanced by wave breaking, which was detectable via whitecap coverage. The air samples were analyzed for more than 50 trace gases including halocarbons (e.g. bromoform, dimethylbromide, methyl iodide), non-methane hydrocarbons (e.g. isoprene), and sulfur containing compounds (e.g. dimethyl sulfide by Elliot Atlas at RSMAS, University of Miami). First results show, that natural halocarbon concentrations ( methyl iodide, bromoform and dibromomethane) decreased in water across the surf zone towards the coast and also with height in the atmosphere. Horizontal gradients in the atmosphere were dominated by the origin of air masses and showed relative concentration variations over time, influenced by rain events, while a horizontal gradient across the surfzone was absent, but concentrations varied between the different sampling days. Theme 5

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


Engel, A, Bange, H W Cunliffe, M, Burrows, S M, Friedrichs, G, Galgani, L, Herrmann, H, Hertkorn, N, Johnson, M, Liss, P, Quinn, P, Schartau, M, Soloviev, A, Stolle, C, Upstill-Goddard, R, van Pinxteren, M, and Zaencker, B, 2017, The ocean's vital skin: Towards an integrated understanding of the sea surface microlayer, *Frontiers in Marine Science,* DOI: 10.3389/fmars.2017.00165.

Rahlff, J, Stolle, C, Giebel H-A, Brinkhoff, T, Ribas Ribas, M, Hodapp, D, and Wurl, O, 2017, High wind speeds prevent formation of a distinct bacterioneuston community in the sea-surface microlayer, *FEMS Microbiology Ecology,* DOI: https://doi.org/10.1093/femsec/fix041.

Ribas Ribas, M, Mustaffa, N I H, Rahlff, J, Stolle, C, an d Wurl, O, 2017, Sea Surface Scanner (S3): A catamaran for high-resolution measurements of biogeochemical properties of the sea surface microlayer, *Journal of atmospheric and oceanic technology*, DOI: 10.1175/JTECH-D-17-0017.1.

Schlundt, C., Tegtmeier, S., Lennartz, S. T., Bracher, A., Cheah, W., Krüger, K., Quack, B., and Marandino, C. A., 2017, Oxygenated volatile organic carbon in the western Pacific convective center: ocean cycling, air–sea gas exchange and atmospheric transport, *Atmospheric Chemistry and Physics*, 17, pp. 10837-10854, https://doi.org/10.5194/acp-17-10837-2017.

Ziska, F., Quack, B., Tegtmeier, S. Stemmler, I., and Krüger K., 2017, Future emissions of marine halogenated very-short lived substances under climate change, Journal of Atmospheric Chemistry, 74, p. 245, https://doi.org/10.1007/s10874-016-9355-3.

**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?**

The full SOLAS Science and Society group (interdisciplinary group, including lawyers and economists, which met in Brussels in 2016 and is lead by Christa Marandino and Erik van Doorn, both from Kiel) submitted a manuscript to Ambio that is now being revised. The subgroup on shipping had their paper accepted to a Frontiers journal. The subgroups on carbon and on air-sea policy met in Monaco and Rome, respectively, to work on their papers. These papers are still in preparation.

## 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.).**

1) PHOSDMAP campaigns: 01.06 – 22.06.2018: Cape Verde (CVAO) and 29.04 -15.05.18, Namibia (Gobabeb).Investigation of phosphorus, iron and carbon content in size-resolved marine aerosol particles. Team: TROPOS, INMG, Gobabeb, MPI jena. Activities: Sampling of bulk and size-resolved aerosol particles.
2) Cruise Baltic Sea May/June 2018 (lead: Christian Stolle – IOW/ICBM) in frame of SAW-project MarParCloud and ERC-starting grant PASSME to explore the relation between SML variability, $CO_2$ gas-exchange and organic composition of aerosols in the Baltic Sea. Participating institutes: IOW, ICBM, TROPOS, ZMT, Uni Stockholm
3) Birgit Quack (GEOMAR) - Investigation of halocarbon as tracer substances for natural and anthropogenic island effects, how far does the anthropogenic imprint reaches into the open ocean in water and atmosphere
4) As the Northern Indian Ocean was identified as a region where future $N_2O$ emissions might be highly impacted by changing nutrients, A. Landolfi (GEOMAR) is contributing towards an on-going analysis to better assess the $N_2O$ regional susceptibility (Suntharalingam et al., in prep.).
5) A. Landolfi (GEOMAR) is contributing with model output towards an international effort to develop a Global Nitrous Oxide ($N_2O$) Budget to provide best estimates of the current global $N_2O$ budget, with the option to update it at regular intervals (2 – 5 years).
6) BalticGasEx cruise organized by GEOMAR, Kiel University, and US partners (David Ho – University of Hawaii, Peter Schlosser – Columbia University) in June and September, 2018 will investigate the role of natural surfactants on air-sea gas exchange. We will employ the dual tracer technique together with eddy covariance measurements of $CO_2$ and DMS, while sampling the SML.

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

Anja Engel (co-lead together with Brian Ward, NUI Galway) and Christa Marandino (helped with organisation and leading a discussion group) from GEOMAR were involved with the SOLAS Theme 2 workshop held in Cargese, Corsica in May.

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

| | | | |
|---|---|---|---|
| Marine biological production, organic aerosol particles and marine clouds: a process chain (MarParCloud) | Leibniz Association SAW funding | 05/2016 - 10/2019 | Coordinator: TROPOS, partners: ICBM Wilhelmshaven, IOW, ZMT |
| Phosphorus speciation in mineral dust and marine aerosol particles (PHOSDMAP) | German research foundation (DFG) | 01.01.2018-31.12.2020 | Coordinator: TROPOS, partners: INMG, Gobabeb, MPI Jena |
| Southern ocean trace gas air-sea exchange (SO-TRASE) | Germany Ministry for Education and Research (BMBF) | 1.8.2017 – 31.7.2020 | GEOMAR with Chinese partners in Xiamen |

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

Birgit Quack (GEOMAR) - Natural and anthropogenic biogeochemical imprints of islands in different environments on ocean and atmosphere, air- sea fluxes (Poseidon cruise proposal)

Birgit Quack (GEOMAR) - Beneficial and deleterious effects of macro algal farming around islands and polluted environments in different latitudes, biodiversity, mitigation of pollution, climate change, erosion, etc., air- sea fluxes (potential EU proposal)

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

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *'country'*
## *compiled by: 'Name'*

*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** |
| **Airborne microbes contribute to N2 fixation in surface water of the Northern Red Sea**<br>Desert dust storms are frequent in the Northern Red Sea (NRS) region, providing nutrients and trace-metals that may stimulate dinitrogen (N2) fixation. Dust also carries a high diversity of airborne microbes (bacteria, archaea), including diazotrophs, that may remain viable during transport. Here we evaluate the impact of atmospheric deposition and its associated airborne diazotrophs on N2 fixation in the surface water of the low-nutrients NRS, using mesocosm bioassay experiments. We compared the chemical (nutritional) and sole airborne microbial impact of aerosol additions on N2 fixation using 'live-dust' (release nutrients/trace-metals and viable airborne microorganisms) and 'UV-killed dust' (release only chemicals). Airborne diazotrophy accounted for about one-third of the measured N2 fixation (0.35±0.06 nmol N L-1 d-1 and 0.29±0.06 nmol N L-1 d-1, for 'February 2017' and 'May 2017', 'live-dust' additions, respectively, Figure 1). Two nifH sequences related to cluster III diazotrophs were amplified from the dust samples, consistent with the N2 fixation measurement results. We postulate that the deposition of viable airborne diazotrophs may enhance N2 fixation, especially in marine provinces subjected to high aerosol loads, and that the relative contribution of airborne N2 fixation may increase in the future with the predicted increase in dust deposition. |

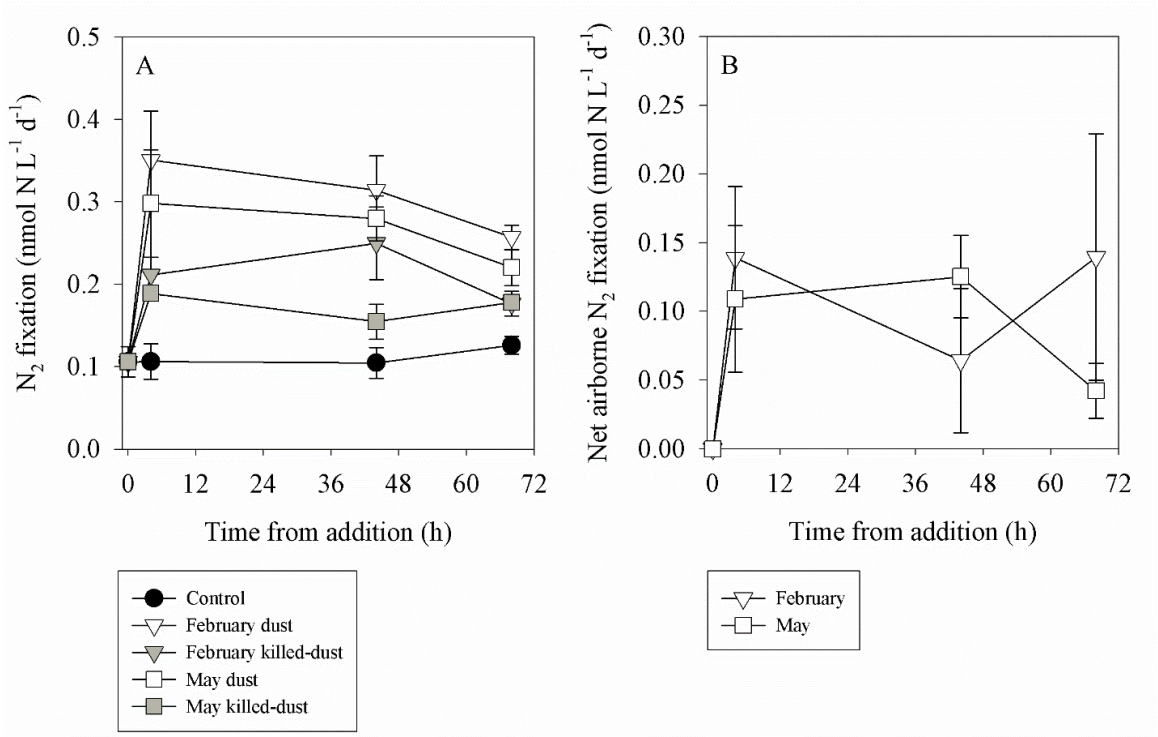



**Figure**: Temporal changes in volumetric N2 fixation rates (A) and the net airborne diazotrophic activity (B) following dust additions (~0.8 mg L-1) to surface seawater of the Northern Red Sea during July 2017. The following treatments were performed: dust collected in February 2017 (white triangle), UV-killed February 2017 dust (gray triangle), dust collected in May 2017 (white square), UV-killed May 2017 dust (gray square) and unamended controls (black circle). Data shown is the averages of 3 replicate mesocosms per treatment and their corresponding standard deviation. Note the different Y-axis. The net airborne diazotrophic contribution was calculated by subtracting the 'killed-dust' rates from the rates measured in the 'dust' treatments.

**Citation**: Rahav E., Paytan A., Mescioglu E., Galletti Y., Rosenfeld S., Raveh O., Santinelli C., Ho T.-Y. and Herut B., *Geophysical Reserach Letters*, under revision.

**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).**

Israeli scientists are involved in SOLAS-related activities in the adjacent Mediterranean and Red sea, and in World Ocean.

A major contribution to SOLAS research in the easternmost part of Mediterranean comes from a net of marine stations located off the Israeli coast. The net consists of DEEPLEV that was launched by Bar-Ilan University and the Israel Oceanographic and Limnological Research (IOLR), and THEMO that was launched by Texas A&M and the University of Haifa. DEEPLAV is a permanent marine research station ('mooring'), the first of its kind in this region, placed off the coast of Israel, 50 kilometers west of Haifa. Anchored to the seabed at a water depth of 1500 m, the station contains a large number of state-of-the-art measuring instruments, spread over a cable running from the seabed almost to the sea surface, enabling continuous study of the physical and ecological system in the eastern Mediterranean Sea. THEMO is an observatory comprising of two sensor arrays attached to 2.25m diameter surface buoys. THEMO includes an operational shallow mooring (125 m) in the coastal zone of the Levant Basin of the Mediterranean Sea, and a deep mooring (1500 m) located 50 km from the northern shores of Haifa after the continental shelf, which is planned to be launched in a few months periods. The two moorings have mealtime RF

communication capabilities, and the data is received at a shore station and is displayed at near-real time at the University of Haifa. The data from the marine stations is complemented by monthly interdisciplinary oceanographic cruises, which are carried out by researchers from different research institutes in Israel.

In the Gulf of of Aqaba, at the northern tip of the Red Sea, several SOLAS-related activities are performed by Inter-University Institute (IUI) researchers : (1) ongoing dust sampling time series, the first is a weekly resolved trap that has been deployed since 2006 and is operated by the National Monitoring Program, and the second is deployed for short time periods (~1-2 days) only during time of interest (e.g., dust storms) in order to obtain a more clear compositional fingerprint of the dust during different atmospheric settings; (2) Ongoing sediment trap mooring deployed at the north Gulf of Aqaba, a deep oligotrophic sea. This mooring has been deployed continuously since early 2014 and collects a coupled monthly and daily resolved samples. The samples are used, amongst other objectives, to identify the source to sink signal transfer of terrigenous particles (primarily atmospheric dust), and evaluate the connection between dust input, export production rates, and water column biogeochemical cycles; (3) Trace metal cycles and anthropogenic impacts in the Gulf of Aqaba. Trace metal concentrations and the Pb isotopic composition are measured monthly and sub-monthly in the dissolved phase of seawater profiles in the Gulf of Aqaba. The results are evaluated in the context of dust inputs and water column productivity and physical configuration.

Researchers from the Weizmann Institute of Science (WIZ) are currently running the 'atmosphere component' of the Tara PACIFIC expedition, which is a 2.5-year scientific expedition with continuous open-ocean sampling of the superficial layer's biodiversity and surface ocean properties in the Atlantic and Pacific Oceans. The WIZ research team is continuously measuring aerosol size distribution and total concentration (for size ranges from 20 nm to 32 µm). The team also uses a filter system to measure the biological, chemical and morphological properties of marine aerosols at 27m ASL. The main goal of this research projectis to understand the spatial and temporal variability of the bio-physico-chemical properties of marine aerosols across the TARA route, examine the main variations between the aerosols in the Atlantic and Pacific Ocean, and explore the differences between the marine aerosols emitted in the oligotrophic parts of the ocean, with highly productive areas.

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

*T*orfstein A., Teutsch N., Tirosh O., Shaked Y., Rivlin T., Zipori A., Stein M., Lazar B. and Erel Y. (2017), Chemical characterization of atmospheric dust from a weekly time series in the north Red Sea between 2006-2010. *Geochimica et Cosmochimica Acta 211,* 373-393.

Amitai Y., Gildor H. (2017), Can precipitation over Israel be predicted from Eastern Mediterranean heat content?, *International Journal of Climatology* 37 (5), 2492-2501

Zarubin M, Lindemann Y, Genin A. (2017), The dispersion-confinement mechanism: phytoplankton dynamics and the spring bloom in a deeply-mixing subtropical sea. *Progress in Oceanography* 155:13–27.

Lehahn Y., I. Koren, S. Sharoni, F. d'Ovidio, A. Vardi and E. Boss (2017), Dispersion/dilution enhances phytoplankton blooms in nutrient-limited waters, *Nature Communication* 8, 14868, doi: 10.1038/ncomms14868.

Tsagaraki T.M., Herut B., Rahav E., Berman Frank I., Tsiola A. , Tsapakis M., Giannakourou A., Gogou A., Panagiotopoulos C., Violaki K., Psarra S., Lagaria A., Christou E.D , Papageorgiou N., Zervoudaki S., Puelles M.L, Nikolioudakis N., Meador T.B , T. Tanaka T.B , Pedrotti M.L, Krom M.D, Pitta P. (2017), Atmospheric Deposition Effects on Plankton Communities in the Eastern Mediterranean: A Mesocosm Experimental Approach, *Frontiers in Marine Science*.

**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?**

## 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.).**

Most of the SOLAS-related activities described above are part of on going projects that are planned to be continued in the coming years. In 2018 several interdisciplinary air-sea mesocosm experiments are planned. This includes participation in a mesocosm experiment in the fjords of Bergen, Norway, that will allow high-resolution sampling for host-virus dynamics of an induced algal bloom. The bloom will be closely monitored at all scales, from single cell genomics to metabolic imprint and its impact on air-sea dynamics.

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

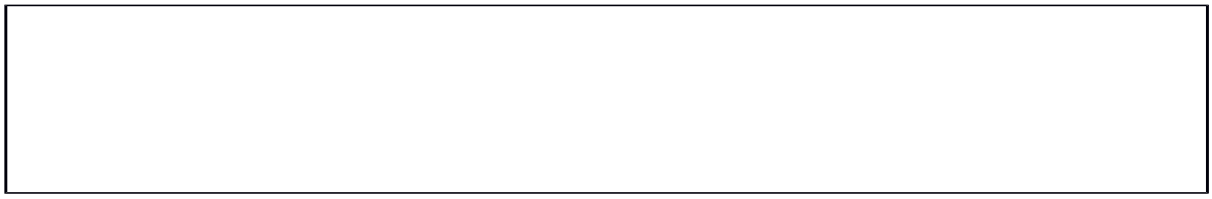
Part of the annual meeting of the Israeli Association for Aquatic Sciences (IAAS) will be dedicated to discussion on on-going and planned SOLAS activities. In addition, a course on “advanced topics in surface-ocean lower-atmosphere science”, which will be open to students from all academic institutes in Israel, is planned to be given at the University of Haifa.

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

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

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

**Comments**



# Report for the year 2017 and future activities

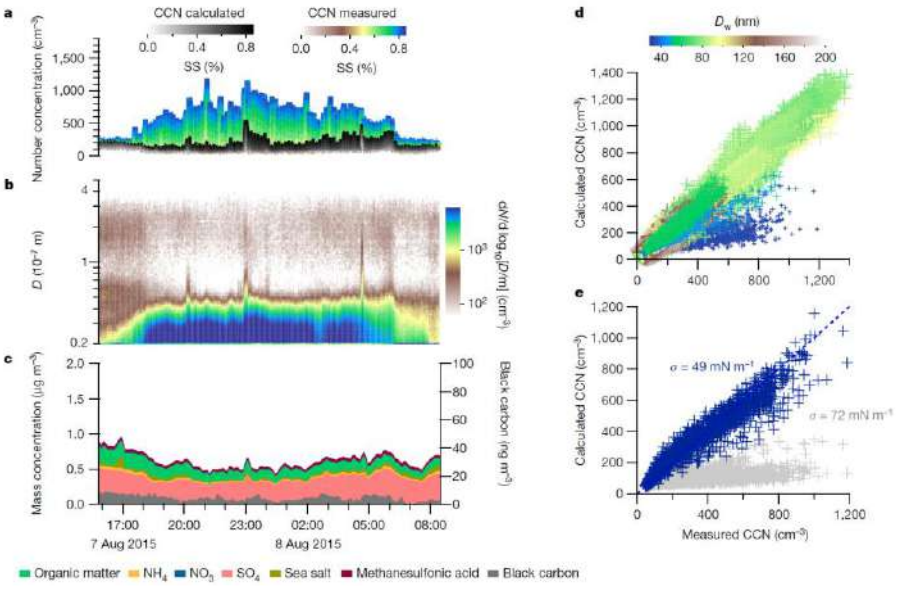
## SOLAS *'Italy'*
## *compiled by: 'Chiara Santinelli'*

## PART 1 - Activities from January 2017 to Jan/Feb 2018

### 1. Scientific highlight

**Surface tension prevails over solute effect in organic-influenced cloud droplet activation**

The spontaneous activation of cloud condensation nuclei (CCN) depends on the interplay between the Raoult effect, whereby activation potential increases with decreasing water activity or increasing solute concentration, and the Kelvin effect, whereby activation potential decreases with decreasing droplet size or increases with decreasing surface tension. Surface tension lowering caused by organic surfactants, which diminishes the Kelvin effect, is expected to be negated by a concomitant reduction in the Raoult effect, driven by the displacement of surfactant molecules from the droplet bulk to the droplet–vapour interface. Here we present observational and theoretical evidence illustrating that, in ambient air, surface tension lowering can prevail over the reduction in the Raoult effect, leading to substantial increases in cloud droplet concentrations. We suggest that consideration of liquid–liquid phase separation, leading to complete or partial engulfing of a hygroscopic particle core by a hydrophobic organic-rich phase, can explain the observations. An adequate representation of the CCN activation process is essential to the prediction of clouds in climate models, and given the effect of clouds on the Earth's energy balance, improved prediction of aerosol–cloud–climate interactions is likely to result in improved assessments of future climate change.




*CCN, chemical composition and size distribution time series for the nascent ultrafine mode event and the CCN closure.* ***a****, Measured (colour traces) and calculated (grey traces) activated CCN number concentrations, assuming a surface tension of* $\sigma$ *= 72 mN m*$^{-1}$*. Both measured and calculated CCN span the whole supersaturation range of SS = 0.2–0.82%; that is, the*

*CCN was calculated for exactly the same supersaturation as what was measured. The activated CCN concentration is calculated for the measured supersaturation by using κ–Köhler theory with an effective κ corresponding to the total AMS composition.* ***b****, Time series of aerosol number size distribution during the particle production event.* ***c****, Time series of specific aerosol chemical species mass concentrations—organics, ammonium, nitrate, sulphate, sea salt, methanesulfonic acid and black carbon.* ***d****, Scatter plot of calculated versus measured CCN using the same κ–Köhler settings as in a, but including the whole month of August 2015. The colour scale indicates a weighted SMPS size diameter ($D_w$) for every point: the smallest diameters (in dark blue) correspond to the particle production event and deviate from the 1:1 line.* ***e****, Scatter plot (subset of d) including only the particle production events. The grey points in e correspond to the dark blue points in d but using the nascent ultrafine mode chemical composition instead of bulk AMS composition; blue points correspond to the particle production event after the assumed surface tension for the CCN calculation with κ–Köhler theory was reduced to 49 mN $m^{-1}$.*

*Ovadnevaite J, Zuend A, Laaksonen A, Sanchez K J, Roberts G, Ceburnis D, Decesari S, Rinaldi M, Hodas N, Facchini M C, Seinfeld J H & O' Dowd C, 2017, Surface tension prevails over solute effect in organic-influenced cloud droplet activation, NATURE, 546, 637-641, doi:10.1038/nature22806.*

**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).**

**ACTIVITIES and EXPERIMENTS:**

1. **Study of total atmospheric deposition of dissolved organic matter (DOM) at the Lampedusa Island (Central Mediterranean Sea).** *[Galletti Y., Pulido Villena E., Becagli S., Disarra A., Gonnelli M., Sferlazzo D.,Vestri S., Santinelli C.]* Atmospheric depositions were collected between March 19th 2015 and October 6th 2017 at the Station for Climate Observations "Roberto Sarao" ENEA (Lampedusa Island, Italy). DOC, DON and DOP fluxes were in the range 0.06-1.78 mmol C $m^{-2}$ $day^{-1}$, 0.015-0.25 mmol $m^{-2}$ $day^{-1}$, and 0-0.027 mmol $m^{-2}$ $day^{-1}$, respectively. The highest atmospheric DOC fluxes were found in correspondence with high values of both soluble metals and nutrients. C:N:P molar ratios in atmospheric DOM showed a marked variability, with average values of C:N:P of 1909:292:1. The Parallel Factorial Analysis (PARAFAC) applied to 91 excitation emission matrixes, validated a seven-component model. The excitation and emission spectra of these components were similar to those observed in the open waters of the Mediterranean Sea and in the oceans, in dust samples collected in alpine lakes as well as in aerosol particles collected in the polar region.
2. **Estimating chlorophyll from continuous fluorescence measurements in North Adriatic (Emilia-Romagna coast) to validate satellite remotely-sensed observations.** *[Ravaioli M., Riminucci F., Bohm E., Santoleri R.].* Continuous fluorescence-derived total chlorophyll measurements are being collected offshore Rimini at the E1 Buoy and south of Po river Delta at the S1-GB site in the framework of cooperative research that see a collaboration between ISAC and ISMAR CNR institutes. This activity aims at constructing a chlorophyll database useful to improve the remote sensing observations. Sensor fluorescence measurements are first validated with in situ sea water sampling as close as possible to the Fluorescence optical sensor followed by lab analysis carried out by ISMAR. This incremental database is aimed at getting reliable fluorescence-derived chlorophyll based on validation points corresponding to each of in situ measurement campaign (i.e. INTERNOS)
3. **Sea-spray measurements** from the CNR-ISMAR Acqua Alta platform in the Northern Adriatic Sea in collaboration with University of Toulon (France). Supported by **JERICO NEXT TNA project.** During the experimental campaign, aerosol data were acquired in the 0.1-45 μm size range using two, co-located classical scattering spectrometer probes (Particle Measuring Systems, Boulder, CO, USA), the CSASP-200 and the CSASP-100HV. For chemical characterization, aerosols were periodically sampled with a low pressure cascade impactor (Dekati). The main objectives of the experiment were: i) to characterize the complex mixing between sea spray aerosols locally generated at the sea surface by the wind-waves interaction processes and a continental component resulting from natural and/or anthropogenic sources; ii) to provide a data set useful to validate atmospheric

chemical transport models dealing with sea spray. The campaign will continue in 2018.

4. **The PAMELA Experiment** (Photosynthetic Actinic radiation Modulation Experiment at Lampedusa) was carried out in Lampedusa, at the Station for Climate Observations (http://www.lampedusa.enea.it), from May 15th to June 10th, 2017. *Participants: ENEA, CNR-IBF, CNR-ISAC, Universities of Florence (Chemistry and Biology Departments), Rome (Physics Dep.) and Valencia (Dep.of Earth Physics and Thermodynamics,Spain), and PMOD (Switzerland), MIO (Marseille, France), in collaboration with Area Marina Protetta delle Isole Pelagie (http://www.ampisolepelagie.it).*
   The main goals of the experiment were:
   - investigate the role and effect of different factors, such as atmospheric and oceanic composition and optical properties, in modulating photosynthetically active radiation (PAR) actinic flux and irradiance, at the surface and underwater;
   - relate actinic flux and irradiance in the PAR spectral range;
   - study the behavior of the PAR actinic flux at the air-sea interface, from the atmosphere to underwater;
   - investigate the role of land and sea albedo on PAR;
   - investigate the role of PAR actinic flux in determining terrestrial and marine productivity;
   - investigate the photosynthetic performance of phytoplankton surface assemblages, through PAM fluorometry, and assess the light and/or nutrient limitation to their productivity.
   - Investigate the impact of atmospheric deposition on DOM dynamics in the surface layer of the Med Sea
   - Investigate the biological lability of atmospheric DOM

5. **Atmospheric deposition of airborne microbes into the Northern Red Sea and its effects on ambient microbial communities – a mesocosm approach.** *Participants: CNR-IBF, Italy, Israel Oceanographic and Limnological Research (IOLR), Institute of Marine Science, University of California, Santa Cruz, USA.* The experiment was carried out in Eilat (29°28'N, 34°55'E), located on the Gulf of Aqaba at the edge of a long narrow estuary separating the Arabian Peninsula and the Sinai desert. Aerosol samples were collected from the Northern Red Sea during dust storms in two different periods (February 28th and May 18th 2017), using pre-cleaned glass plates at the Interuniversity Institute (IUI) of Eilat.
   The main goals of the experiment were:
   - Study the biochemical and biological impacts of aerosols (2 types) on the autotrophic and heterotrophic surface microbial populations during summertime in the NRS.
   - Estimate the ecological significance of airborne microbes in such deposition events to the NRS.
   - Investigate the direct and indirect effects of dust deposition on DOM (DOC and CDOM) dynamics in the surface layer of the Med Sea

**CRUISES**

6. **CELEBeR Project Cruise** (In the framework of XXXII PNRA Expedition) PNRA16_00207 - A3 -P.I. Paola Francesca Rivaro. (SOLAS Core Theme 5: Ocean biogeochemical control on atmospheric chemistry).R/V Italica, Ross Sea (Antarctica), 30th December 2016 - 20th February 2017.

7. **INTERNOS CRUISE**, R/V Minerva I (CNR), March 6th to 21st 2017, (*Chief scientist: M. Bastianini-CNR-ISMAR*). Main goals of the cruise: (1) determination of spatial variability of carbonate system properties, other chemical parameters (DO, DIN, DIP,SiO2), and phytoplankton in a shelf region, highly sensitive to ocean acidification (2) maintenance of instruments and sensors on buoys

8. **MARINE STRATEGY**, monitoring cruises, performed in July-August 2017 in the Tyrrhenian and Ionian Seas, onboard the R/V Minerva I (CNR). The WP1 activities (Phyto-zooplankton, chemical-physical characteristics of the water column and beached wastes,

with the Sub-program 1.3: Monitoring of the chemical-physical variables and nutrients in the offshore area and Sub-program 1.7: Qualitative and quantitative monitoring of plankton in offshore environments) involved several Institutes from CNR (CNR-ISAC, CNR-IAMC, CNR-ISMAR) and CONISMA. The aim of this research project is to assess environmental health status of the Mediterranean Sea, through the study of the processes that regulate marine environmental functioning. In fulfillment of the commitments assumed by Italy at the European level in the Marine Strategy Framework Directive (MSFD), the agreement signed between the Ministry for the Environment and the Protection of the Territory and the Sea (MATTM) and CNR, attributed to CNR the definition of the good environmental status (GES) of pelagic marine waters; such an assessment is further submitted to the MATTM and then to the European Commission. For this purpose, the study of microbial communities and of their role in biogeochemical processes allow us to get a complete picture of the health conditions of the Mediterranean basins in order to reach the final objective of the Marine Strategy project, i.e. to achieve Good Environmental Status (GES) by 2020.

9. **SENTINEL3 CRUISE.** R/V Minerva I (CNR), May 24th to June 12th. (*P.I.: R. Santoleri- CNR-ISAC, Rome*). Area: Ionian Sea, Sicily Channel. Ship borne measurements were carried out in the same period as PAMELA experiment from the Italian CNR Minerva R/V, with the aim of characterizing ocean color and providing additional measurement for ground truth validation of satellite observations. Main goals of the cruise: (1) Characterization of bio-optical properties of Central Med Sea waters; (2) Extension of the Mediterranean Sea in situ bio-optical dataset for the support of marine biological parameter estimates using satellite data; (3) Validation of regional algorithms for the estimates of marine chlorophyll and primary production from satellite data; (4) Development of new regional algorithms for the estimates of chlorophyll, primary production, chromophoric dissolved organic matter (CDOM) and phytoplankton species from satellite data.

10. **UVASS** (Unmanned Vehicles for Autonomous Sensing and Sampling) CRUISE (Svalbard, June 2017). *Participants: Azzaro M., Zappalà G., La Ferla R., Miserocchi S., Tesi T., Maimone G., Caruso G., Ferretti R., Odetti A., Azzaro F., Madonia A., Bonamano S., Piermattei V., Marcelli M., Piazzolla D., Cosenza A., Rappazzo A.C., Furnari M., Bruzzone G. [CNR-IAMC; CNR-ISSIA; CNR-ISMAR; University of Tuscia, DEB]*. To understand how the climate change affects the microbial community in the Arctic Sea and the ongoing heating results in cascading effects on the globally delicate climatic equilibrium is an important challenge of recent research performed in vulnerable ecosystems such as the Svalbard Islands. Within the UVASS (Unmanned Vehicles for Autonomous Sensing and Sampling) project, an unmanned marine vehicle (PROTEUS, Portable RObotic TEchnology for Unmanned Surveys), equipped with an automatic water multisampler, designed and built by CNR-ISSIA and CNR-IAMC respectively, were applied to study the response of planktonic communities, particularly prokaryotes, in the extreme environment of Kongsfjorden. During June 2017, seawater samples collected by those automatic systems along three transects located from glaciers to the open sea were analyzed for nutrients, organic matter and its utilization by microbial activity, using Biolog-Ecoplates and extracellular enzymatic activity rates (leucine aminopeptidase, beta-glucosidase and phosphatase activities). Variations in organic matter distribution and in the functional diversity of microbial assemblages were observed.

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


1. Braga F, Zaggia L, Bellafiore D, Bresciani M, Giardino C, Lorenzetti G, Maicu F, Manzo C, Riminucci F, Ravaioli M, Brando V E, 2017, Mapping turbidity patterns in the Po river prodelta using multi-temporal Landsat 8 imagery, *Estuarine, Coastal and Shelf Science*, 198, 555-567, DOI: 10.1016/j.ecss.2016.11.003
2. Canepa E, Builtjes P J H, 2017, Thoughts on Earth System Modelling: from global to regional scale, *Earth-Science Reviews*, 171, 456–462, http://dx.doi.org/10.1016/j.earscirev.2017.06.017
3. Celussi M, Malfatti F, Franzo A, Gazeau F, Giannakourou A, Pitta P, Tsiola A, Del Negro P, 2017, Ocean acidification effect on prokaryotic metabolism tested in two diverse trophic regimes in the Mediterranean Sea, *Estuarine, Coastal and Shelf Science*, 186, 125-138.
4. Gazeau F, Sallon A, Pitta P, Tsiola A, Maugendre L, Giani M, Celussi M, Pedrotti M L, Marro S,

Guieu C, 2017, Limited impact of ocean acidification on phytoplankton community structure and carbon export in an oligotrophic environment: results from two short-term mesocosm studies in the Mediterranean Sea, *Estuarine Coastal and Shelf Science*, 186, 72-88, DOI: dx.doi.org/10.1016/j.ecss.2016.11.016

5. Ingrosso G, Bensi M, Cardin V, Giani M, 2017, Anthropogenic $CO_2$ in the middle and southern Adriatic Sea, *Deep-Sea Research Part I*, 123, 118-128, DOI: 10.1016/j.dsr.2017.04.004
6. McCluskey C S, Hill T C J, Malfatti F, Sultana C M, Lee C, Santander M V, Beall C M, Moore K A, Cornwell G C, Collins D B, Prather K A, Jayarathne T, Stone E A, Azam F, Kreidenweiss S M, DeMott P J, 2017, A dynamic link between ice nucleating particles released in nascent sea spray aerosol and oceanic biological activity during two mesocosm experiments, *Journal of* American Meteorological Society, https://doi.org/10.1175/JAS-D-16-0087.1.
7. Ovadnevaite J, Zuend A, Laaksonen A, Sanchez K J, Roberts G, Ceburnis D, Decesari S, Rinaldi M, Hodas N, Facchini M C, Seinfeld J H & O' Dowd C, 2017, Surface tension prevails over solute effect in organic-influenced cloud droplet activation, *Nature*, 546, 637-641, doi:10.1038/nature22806.
8. Weinbauer M G, Guinot B, Migon C, Malfatti F, Mari X, 2017, Skyfall - Neglected roles of volcano ash and black carbon rich aerosols for microbial plankton in the ocean, *Journal of Plankton Research*, 39 (2), 187-198.

**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?**

## 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.).**

1. Sea-spray measurements from the CNR-ISMAR Acqua Alta platform in the Northern Adriatic Sea in collaboration with University of Toulon (France). Supported by JERICO NEXT TNA project.
2. Cooperation among CNR-ISMAR, CNR-ISAC, UNIVPM and University of Toulon (France) for: a) to develop the sea spray local scale model MACMod; b) to study the influence of wave state and sea spray on roughness length using the WRF-Chem model.
3. The continuous collection of total depositions at the Lampedusa Island will continue in 2018. Chemical analysis (DOC, CDOM, Metals, nutrients) will be carried in collaboration among CNR-IBF, ENEA, University of Florence and MIO (Marseille, France).
4. Samples for CDOM optical properties and DOC, collected by CNR-IBF during the PAMELA experiment (May 15$^{th}$ to June 10$^{th}$, 2017), will be analyzed and the dynamics of DOM studied in collaboration with ENEA, University of Florence and MIO (Marseille, France) and Israel Oceanographic and Limnological Research (IOLR)
5. Data on CDOM optical properties and DOC, collected by CNR-IBF during the mesocosm experiments carried out in July 2017 in Eilat (Gulf of Aqaba), will be analyzed in collaboration with Israel Oceanographic and Limnological Research (IOLR) and *Institute of Marine Science, University of California, Santa Cruz, USA.*
6. Samples analysis and data processing are currently underway in order to study carbonate system chemistry and $CO_2$ air–sea fluxes in the Ross Sea (Antarctica) shelf area during austral summer 2016-17.

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

1. Integrated Carbon Observing System Ocean Thematic Center, Annual meeting, Trieste. Local organizers : OGS & ISMAR CNR. 14-15 May 2018.
2. XVII Convegno Nazionale della Divisione di Chimica dell'ambiente e dei Beni Culturali dal titolo "La tutela dell'Ambiente e dei Beni Culturali in un Mondo che cambia" Genova, 24-27 Giugno 2018.

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

- **ABBACO -** Restauro Ambientale e Balneabilità del SIN Bagnoli-Coroglio – Italian National Project
- **EMODnet European Marine Observation and Data network (2017-2020).** EMODNET aims to assemble fragmented and inaccessible marine data into interoperable, continuous and publicly available data streams for complete maritime basins. EMODNET is a long term marine data initiative from the European Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE) underpinning its Marine Knowledge 2020 strategy. **EMODnet Chemistry.** Coordinator OGS-NODC. www.emodnet-chemistry.eu.
- **JERICO NEXT (2015-2019).** Joint European Research Infrastructure network for Coastal Observatory – Novel European eXpertise for coastal observaTories. CNR-ISMAR is leading the the WP7. http://www.jerico-ri.eu/
- **Marine Strategy (MSFD) (2015-2018)**
- Progetto INFOR-MARE (2017-2019): Sistema INFORMAtivo integrato per il litoRale Emiliano-romagnolo (PG/2015/731524)
- Readiness of ICOS for Necessities of integrated Global Observations (RINGO), Coordination and support action, supported in the framework of INFRADEV-03-2016-2017. Participants OGS, ISMAR-CNR, ENEA, Università della Tuscia.
- SeadataCLOUD (2016-2020): Pan-European infrastructure for ocean & marine data management

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

***Greenhouse gases and the oceans***

**Goals:**

- To investigate organic carbon fluxes, mediated by microbes (the biological carbon pump and the microbial carbon pump), and their role in regulating ocean-atmospheric $CO_2$ exchanges, with particular regards to (i) the atmospheric $CO_2$ uptake by marine phototrophs, (ii) the heterotrophic transformation and mineralization of organic matter along the water column (iii) the role of POC and DOC in C sequestration in the ocean.
- To investigate the sea-surface microlayer and its microbial community.
- To quantify the relative contribution of physical and biological processes driving the summertime $CO_2$ air–sea fluxes in surface waters of the Ross Sea, Antarctica, in order to predict future changes in the carbonate system associated with climate change in this key area.
- To study photo-degradation processes and their role in $CO_2$ fluxes to the atmosphere.

**Future Activities:**

- An integrated air-sea observatory has been developed in the central Med Sea at Lampedusa (35.5°N, 12.6°E). Existing observations, mostly dedicated to atmospheric parameters (see http://www.lampedusa.enea.it), will be complemented with air-sea exchange measurements on a buoy close to the atmospheric measurement site on the island. Measurements will include radiation budget, p($CO_2$), oceanic optical properties, etc.
- Dissolved and particulate Lipopolysaccharides in surface layer and marine aerosol will be investigated as a biomarker of bacterial biomass. Experiments will be developed in order to

analyze bacterial metabolism and to assess the carbon budget (heterotrophic hydrolysis and respiration).

- The LTER time series of physical, chemical and biological parameters in the Gulf of Trieste will continue in order to quantify the carbon cycle
- The LTER time series of physical, chemical and biological parameters in Po river and Romagna coast will continue in order to validate satellite remotely-sensed observations and meteo-oceanographic forecast models (E1 and S1 systems). LTER sites are key nodes of the E-infrastructure for Biodiversity and Ecosystem Research ERIC - LifeWatch. The S1 system, now configured as an elastic beacon, will be implemented during 2018 with a 'yo-yo' device.
- An integrated air-sea observatory is already working in the North Adriatic Sea (PALOMA station: 35.5°N, 13.6°E) since 7 years. Existing observations (atm $pCO_2$, dissolved $pCO_2$ and oxygen) are dedicated to air-sea gas exchanges ($CO_2$ and $O_2$), with particular focus on ocean acidification. The observatory is part of GOA-ON and ICOS networks and contributes to ongoing and future projects (JERICO NEXT).
- Data collected in the Kongsfjorden, Svalbard Islands (Norway), in the framework of the project ARCA**,** will allow to explore the microbial assemblages and metabolism in an ocean-glacier melting site.
- $pCO_2$ and carbonate system measurements will continue at the Miramare observatory (Mambo buoy and C1 LTER) in the northern Adriatic Sea and at E2M3A site in the southern Adriatic Sea in the framework of ICOS JRU Italy and ICOS ERIC activities. The observatories are also part of Global Ocean Acidification-Observing Network.

***Atmospheric deposition and ocean biogeochemistry***

**Goals**

- To estimate atmospheric input of DOM, macro and micro nutrient (P, N, Fe, Si, Ca, Al, K, etc) to the Med Sea
- To study biological lability of atmospheric organic matter
- To gain qualitative information on atmospheric organic matter
- To assess the role of Saharan dust on nutrients availability and biogenic marine activity
- To study atmospheric markers of the biogenic activity
- To assess the transport and diffusion processes in the ocean

**Activities**

- To continue collection of atmospheric deposition at Lampedusa in order to acquire information with a high temporal resolution.
- Mineralization experiments to investigate the impact of atmospheric deposition on surface DOM cycle
- To use lagrangian oceanography and applications of lagrangian techniques to biological oceanography and marine ecology

***Marine ecosystems, aerosol and clouds: interactions and feedbacks***

**Goals:**

- Investigate sources and formation processes of marine organic aerosols
- Investigate the relation between marine microbiology and the formation of primary and secondary organic aerosols over the oceans
- Characterize the main climate relevant properties of marine aerosols
- Investigate sea spray aerosols and marine coastal aerosols with anthropogenic influence

**Activities**

- Investigation on the role of sea spray as ice nuclei (IN) through both atmospheric measurements and laboratory experiments held at Mace Head (Ireland) in cooperation with National University of Ireland
- Sea-spray measurements from the CNR-ISMAR Acqua Alta platform in the Northern Adriatic Sea in collaboration with University of Toulon (France)

***Remote sensing of biogeochemical processes***

**Goals:**

- Validation and development of new regional algorithms for the estimates of chlorophyll, primary production, chromophoric dissolved organic matter (CDOM) and phytoplankton species from satellite data.
- Advances in satellite retrieval of physical and biogeochemical processes and variables.
- Characterization of the marine Planetary Boundary Layer by continuous measurements of aerosol cross section from lidar/ceilometer. These measurements could be carried out either onshore or aboard cruise ships or R/V.
- Use of satellite data of Chlorophyll and in situ phytoplankton activity in the application of bio-optical models for the estimate of primary production.
- To understand how important is the impact of the diurnal variability of the Sea Surface temperature (SST), solar irradiance and PBL height on air-sea interaction processes.
- To evaluate, over one annual cycle, the impact of the diurnal SST cycle on the air-sea heat fluxes and to investigate if a relation exists between extreme diurnal warming events and intense meteorological phenomenon in coastal areas

**Activities**

- Acquisition of a time series of optical data in continuum by oceanographic platforms already installed in the Adriatic Sea (Buoy E1 and S1) and deployment with new optical instrumentation
- To combine different remote sensing techniques (satellite, radiometric and lidar measurements) and modelling
- Cruises with the use of ship radiometer, that also provides an accurate air temperature measurement.

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

**Comments**

Next year the activities carried out from the Italian community will be strongly reduced due to the unavailability of the Italian ship from the CNR and the continuous reduction of funds for research.

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS JAPAN
## *compiled by: Jun Nishioka*

*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.*

***IMPORTANT**: May we remind you that 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

### Rapid increases of VOIs in the surface and bottom waters of Funka Bay

Volatile organic iodine compounds (VOIs) emitted from the ocean surface to the air play an important role in atmospheric chemistry. Shipboard observations were conducted in Funka Bay, Hokkaido, Japan, bimonthly or monthly from 2012 to 2014. The VOI concentrations began to increase after early April at the end of the diatom spring bloom, and represented substantial peaks in June or July. The temporal variation of the $C_2H_5I$ profile, which showed a distinct peak in the bottom layer from April to July, was similar to the $PO_4^{3-}$ variation profile. It was suggested that $C_2H_5I$ production was associated with degradation of organic matter deposited on the bottom after the spring bloom. $CH_2I_2$ and $CH_2ClI$ concentrations increased substantially in the surface and subsurface layers (0–60 m) in June or July resulted in a clear seasonal variation of the sea-to-air iodine flux of the VOIs (high in summer or autumn and low in spring).

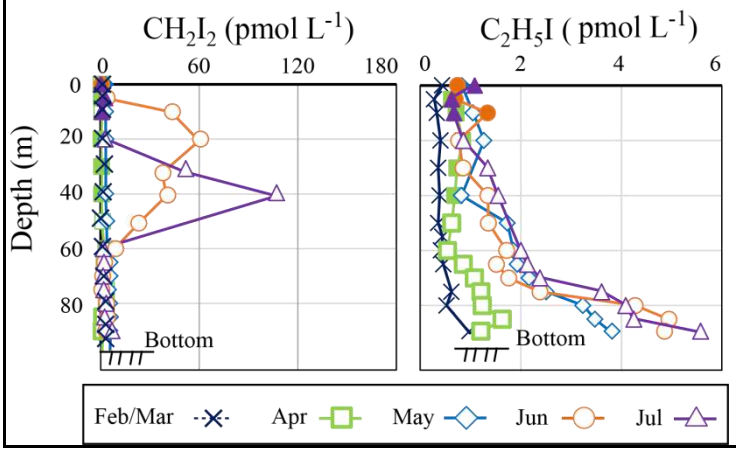



**Figure** Temporal variations of $CH_2I_2$ and $C_2H_5I$ concentration profiles in the water column in Funka Bay in 2014. Surface mixed layer is shown by solid symbols, and subsurface (below the mixed layer) is shown by open symbols. Sub-arctic open ocean water (Oyashio water) flows in the bay in March, and stays until August every year. Diatom spring bloom was found in March, 2014. [Modified figures from Shimizu et al., 2017]

Shimizu, Y., A. Ooki, H. Onishi, T. Takatsu, S. Tanaka, Y. Inagaki, K.Suzuki, N. Kobayashi, Y. Kamei, K. Kuma, 2017. Seasonal variation of volatile organic iodine compounds in the water column of Funka Bay, Hokkaido, Japan. J. Atmos. Chem. 74, 205-225.

**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). Please fill in the specific SOLAS 2015-2025 Science Plan and Organisation Core Theme or Cross-Cutting Theme.**

Theme 1: Greenhouse gases and the oceans

Cruise/observation

- Jan-Feb 2017: R/V Mirai (Japanese research vessel) cruise MR16-09, Off Chile and Southern Ocean, Trans South Pacific Project: Ocean acidification, Marine Biodiversity, Pacific Meridional Overturning Circulation, Crustal Evolution (On board: Naomi Harada (PI) and other 10 Japanese), Leonardo Román Castro Cifuentes and other 6 Chilean), Frank Lamy and other 2 German)
- May 2017: R/V Wakataka Maru (Japanese research vessel) cruise, Oyasho area, Ocean acidification and its impact on marine ecosystem on A-line, western North Pacific (On board: Katsunori Kimoto)
- Jul-Aug 2017: R/V Mirai cruise MR17-04, western North Pacific, Biogeochemistry-marine ecosystem observation in the North Pacific and Bering Sea (On board: Tetsuichi Fujiki (PI) and other 10 Japanese).
- Dec 2017: R/V Hakuho maru (Japanese research vessel) cruise KH-17-5, subtropical North Pacific, Physical, chemical and biological observation on the Kuroshio stream (Ichiro Yasuda (PI) and other Japanese)
- Underway measurement of sea surface CO2 and CH4 in the western Arctic Ocean (2017/08-09; R/V Mirai; ArCS project; by A Murata)
- Seisui-maru SE17-14 cruise in Ise Bay and coastal area of western North Pacific (chief scientist: Urumu Tsunogai) (from Sep 4 to 7, 2017).

Meetings/collaboration/ workshop

- May 2017: JpGU-AGU Joint Meeting 2017, Chiba, Japan. Responses of marine ecosystems to global warming and ocean acidification in coastal and offshore regions (Convenors: Tsuneo Ono, Masahiko Fujii, Takeshi Yoshimura)
- October 2017: The Oceanographic Society of Japan Fall meeting in 2017, Sendai, Japan. Responses of marine ecosystems to global warming and ocean acidification in coastal and offshore regions (Convenors: Takeshi Yoshimura, Masahiko Fujii, Tsuneo Ono)
- JAMSTEC and Univ. of Concepcion, Chile: Basic research on paleoceanography, biogeochemistry, biology, physical oceanography and geophysics in the coastal area off Chile.

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

Cruise/observation

- Jun-Aug 2017: Oshoro-maru cruise (C-040) in the northern Bering Sea and southern Chukchi Sea. Observations of physical, chemical, and biological oceanographic parameters. (PI: Atsushi Ooki, Hokkaido University)

- Feb, Mar, Apr, May, Jun, Aug, Oct, and Dec 2017: Ushio-maru cruises in the Funka-Bay, Hokkaido, Japan. Observations of physical, chemical, and biological parameters of oceanography. (Contributor: Atsushi Ooki, Hokkaido University)
-

Meetings/collaboration/ workshop

- NIES VOS Program (Atmosphere/Ocean Greenhouse Gas Observation: Japan-North America, Japan-Oceania; Atmosphere Greenhouse Gas Observation: Japan-Southeast Asia)
-

Theme 3: Atmospheric deposition and ocean biogeochemistry

Meetings/collaboration/workshop

- August 2017: Goldschmidt 2017, Paris, France, 16d: Atmosphere-Land-Ocean-(Sea)Ice Interaction: LINKS WITH BIOLOGY, CLOUDS, AND CLIMATE (conveners: Markus Frey, Martin King, Nicholas Meskhidze, Akinori Ito, Yves Balkanski, Paul Ginoux, Adi Torfstein, Sophie Bonnet, Eyal Rahav, William Landing)
- January 2018: PAGES-DICE workshop, Las Cruces, Chile (invited speaker: Akinori Ito)
- February 2017: GESAMP WG38 Workshop, Norwich, UK (invited speaker: Akinori Ito)

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

Cruise/observation

- 3-7 July 2017: Sampling of reactive oxygen spices in atmosphere and seawater during R/V Toyoshio Maru cruise in Seto Inland Sea, Japan, (PI: Y. Iwamoto)
- 9 August - 6 September 2017: Aerosol and microlayer observation during R/V Hakuho Maru cruise (KH-17-4 led by K. Furuya) which sailed eastern North Pacific (from Vancouver to Honolulu) as part of SSMAP project (PI: K Hamasaki)

Meetings/collaboration/workshop

- May 2015: JpGU-AGU Joint Meeting 2017, Makuhari Messe, Chiba, Japan. A-TT42 Applying flying boat for promoting Clinical Geosciences (Convenors: Urumu Tsunogai, Mitsuo Uematsu, Hiroshi Tanimoto, and Hiroshi Shinohara) (Presentation: e.g., Urumu Tsunogai, Joji Ishizaka, and Hiroshi Tanimoto).

Theme 5: Ocean biogeochemical control on atmospheric chemistry

Cruise/observation

- A study on efficient heterogeneous activation of sea-salt bromide to the gas-phase by the integrated analysis of TORERO halogen radical and aerosol bromide observations (by R. Volkamer, Y. Miyazaki, et al.).
- 9 August - 6 September 2017: Aerosol and microlayer observation during R/V Hakuho Maru cruise (KH-17-4 led by K. Furuya) which sailed eastern North Pacific (from Vancouver to Honolulu) as part of SSMAP project (PI: K Hamasaki)

Meetings/collaboration/workshop

- June 2017, Workshop La Reunion, Brussels, Belgium (Convenor: Rainer Vokamer) (Presentation: Y. Miyazaki).
- Ocean and Atmosphere session at Japan Geoscience Union-AGU joint meeting, May

2017, Biogeochemical linkages between the ocean and the atmosphere during phytoplankton bloom (conveners: H. Tanimoto, Y. Miyazaki, K. Suzuki, J. Nishioka).

Cross-Cutting Theme: Upwelling systems, polar oceans, coastal waters

Cruise/observation

- Aug-Oct 2017: R/V Mirai cruise MR17-05c, Chukchi and Beaufort Seas, Ocean warming and acidification: their impact on marine plankton (On board: Shigeto Nishino (PI) and other 15 Japanese).
- February 2017: Southern Sea of Okhotsk, ice breaker SOYA, Ice covered ocean CO2, CH4, VOC and Fe dynamics and flux (On board: Jun Nishioka, Daiki Nomura) (Team: Jun Nishioka, Atsushi Ooki, Daiki Nomura, Osamu Yoshida, Yohei Yamashita).
- July 2017: Bowdoin Fjord in northwest Greenland. Effect of glacier melt water input on biogeochemical components in surface water and iar-sea flux (On site: Kanna Naoya, Daiki Nomura) (Team: Kanna Naoya, Daiki Nomura, Jun Nishioka).
- August - October 2017: Aerosol and gas observation over the Arctic Ocean, Bering sea and North Western Pacific Ocean
  cruise by R/V Mirai (MR17-05C) as part of the ArCS project
- October – December 2017: Aerosol and gas observation over the North Western Pacific Ocean cruise by R/V Hakuhomaru(KH-17-5)
- November2017 - January 2018: Aerosol and gas observation over the Indian Ocean cruise by R/V Mirai (MR17-08)
-

Meetings/collaboration/workshop

- ECV-Ice (Measuring Essential Climate Variables in Sea Ice, SCOR working group 152 (Co-chair: Daiki Nomura, François Fripiat, and Brent Else).
- CATCH (The Cryosphere and ATmospheric CHemistry), IGAC (lead: Jennie Thomas, Thorsten Bartels-Rausch, Markus Frey) (SSC member: Daiki Nomura).
- BEPSII (Biogeochemical Processes at Sea Ice Interfaces), SCOR working group 140, and now co-sponsored by CliC (Climate and Cryosphere) and SOLAS (Surface Ocean Lower Atmosphere Study). (Co-chair: Jacqueline Stefels and Nadja Steiner) (Associate Member: Jun Nishioka, Daiki Nomura).
- September 2017, Atmosphere-ice interaction workshop, Tachikawa, Japan (Convenors: SKeiichiro Hara) (Presentation: e.g., Daiki Nomura, Sumito Matoba).
- 15 September 2017: SOLAS related special session in Annual meeting of Geochemical Society of Japan (convener: S, Kameyama, Y, Omori, A. Ooki) (Presentation: e.g., Koji Hamasaki and Hiroshi Tanimoto)
- JAMSTEC and Institute of Marine Research, Norway: Basic Research for Evaluation on the Impacts of Polar Environmental Change on Marine Ecosystem and Climate Change
- JAMSTEC and CSIRO, Australia: Basic Research for Evaluation on the Impacts of Southern Ocean Change on Marine Ecosystem
- January2018, Workshop for Role of Atmospheric Species at Atmosphere-Ocean Boundary from the View Point of Numerical-Model Study (50 participants(3 oral, 31poster presentation)) Organizer: Y. Iwamoto, F. Taketani

Cross-Cutting Theme: Science and society

Meetings/collaboration/workshop

- Workshop with stakeholder (Government, Companies, Environmental NGOs) Resilience and Adaptive Capacity of Arctic marine systems under a changing climate (RACArctic) Stakeholder workshop “Responses of Arctic marine ecosystems to climate change: fish and fisheries in the Pacific Arctic, Juneau, Alaska, Mar 21, 2017 (This is international collaboration work between Japan, Norway and USA sponsored by Belmont Forum)

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

- Hu, W., Murata, K., Fukuyama, S., Kawai, Y., Oka, E., Uematsu, M., & Zhang, D. 2017. Concentration and viability of airborne bacteria over the Kuroshio Extension region in the northwestern Pacific Ocean: Data from three cruises. Journal of Geophysical Research, 122, https://doi.org/10.1002/2017JD027287.
- Tsunogai, U., T. Miyauchi, T. Ohyama, D.D. Komatsu, M. Ito, and F. Nakagawa,2018. Quantifying nitrate dynamics in a mesotrophic lake using triple oxygen isotopes as tracers. Limnology and Oceanography, doi:10.1002/lno.10775.
- Ito, A., and J. F. Kok, 2017. Do dust emissions from sparsely vegetated regions dominate atmospheric iron supply to the Southern Ocean?, J. Geophys. Res., 122, 3987？4002, doi:10.1002/2016JD025939.
- Nagashima, K., Nishido, H., Kayama, M., Kurosaki, Y., Ohgo, S. and Hasegawa, H. 2017. Composition of Asian dust from cathodoluminescence spectral analysis of single quartz grains, Geology, 45(10), 879-882.
- Nara H., Tanimoto H., Tohjima Y., Mukai H., Nojiri Y., Machida T. 2017. Emission factors of CO2, CO and CH4 from Sumatran peatland fires in 2013 based on shipboard measurements. Tellus B: Chemical and Physical Meteorology, 69:1, 1399047, DOI: 10.1080/16000889.2017.1399047
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**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?**

## 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.). Please indicate to which of the SOLAS 2015-2025 Science Plan and Organisation Core Themes or Cross-Cutting Themes your information belongs to or specify an overlap between Themes.**

General SOLAS

- Seisui-maru (Mie University) cruise in Ise Bay, Mikawa Bay, and coastal area of western North Pacific (chief scientist: Urumu Tsunogai) (from Sep 3 to 6, 2018).
- 18 Jul- 10 Aug, 2018 R/V Mirai cruise, Biogeochemical study by Recover and redeploy of hybrid mooring system at St. K2 (western North Pacific) (Onboard: Tetsuichi Fujiki (PI), Minoru Kitamura, Katsunori Kimoto)
- 17 Jul- 21 Sep, 2018 Prof. Multanofsky (Russian research vessel) cruise, Kuril islands and Bering Sea (Onboard: Jun Nishioka (PI), Maki Noguchi)

Theme 1: Greenhouse gases and the oceans

- 14-26 Jun, 2018 T/V Oshoro maru cruise, Bering Sea, Multi stressors in the Ocean and its impact on marine ecosystem (zooplankton sampling) (On board: Koji Sugie)
- 29 Jun- 15 Jul, 2018 T/V Oshoro maru cruise, Bering and Chukchi Seas Multi stressors in the Ocean and its impact on marine ecosystem (On board: Koji Sugie)

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

- Mar, Apr, May, Jun, Aug, Oct, and Dec 2018: Ushio-maru cruises in theFunka-Bay, Hokkaido, Japan. Observations of physical, chemical, and biological parameters of oceanography. (Contributor: Atsushi Ooki, Hokkaido University)
- 9-13 July 2018: Sampling of reactive oxygen spices in atmosphere and seawater during R/V Toyoshio Maru cruise in Seto Inland Sea, Japan (Y. Iwamoto)

Theme 3: Atmospheric deposition and ocean biogeochemistry

- October - December 2018: Aerosol and gas observation over the Arctic Ocean, Bering sea and North Western Pacific Ocean cruise by R/V Mirai as part of the ArCS project
- October - December 2018: Aerosol and gas observation over Bay of Bengal cruise by R/V Hakuhomaru (M. Honda)

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

- August 2018: NIES-Hokkaido Univ-KOPRI joint field work on Arctic observation (H. Tanimoto, S. Kameyama, joint with Jinyoung Jung at KOPRI).

Theme 5: Ocean biogeochemical control on atmospheric chemistry

- Mar-June 2018: BIO-MAIDO, Oxygenated Compounds in the Tropical Atmosphere–Variability and Exchanges (OCTAVE) project: Investigating the impact of tropical marine/biogenic sources to OVOCs, halogens, and aerosols in the atmosphere at the Maïdo high-altitude observatory, Reunion Island (PI: Y. Miyazaki)
- Observation by R/V Mirai in Spring 2020, Title: Impact assessment of Asian atmospheric trace species on the marine biogeochemistry in the western North Pacific (Grant-in-Aid for Scientific Research) Microbiology of the sea surface microlayer and atmospheric aerosols: The frontier of linking biological activities and the climate" (PI: K. Hamasakai, FY2016-2019)

Cross-Cutting Theme: Upwelling systems, polar oceans, coastal waters

- February 2018: Southern Sea of Okhotsk, ice breaker SOYA, Surface Ocean CO2, CH4, VOC and Fe dynamics and flux (On board: Daiki Nomura) (Team: Daiki Nomura, Jun Nishioka, Atsushi Ooki, Osamu Yoshida, Yohei Yamashita).
- March 2018: Saroma-ko Lagoon, Hokkaido, Japan. Intercalibration experiment for sea ice biogeochemistry (primary production and gas flux) for SCOR Working Group 152 (ECV-Ice) (On ice: Daiki Nomura, Koji Suzuki, Toru Hirawake) (Team: Daiki Nomura, Fripiat Fripiat, Brent Else, Koji Suzuki, Toru Hirawake, ECV-Ice and BEPSII members)
- June 2018: The Roland von Glasow Air-Sea-Ice Chamber, UEA, UK. Intercalibration experiment for sea ice biogeochemistry (gas measurement in sea ice) for SCOR Working Group 152 (ECV-Ice) (On site: Daiki Nomura) (Team: Daiki Nomura, Atsushi

Ooki, ECV-Ice and CATCH members)
- March 2019: Cambridge Bay, Canada. Intercalibration experiment for sea ice biogeochemistry (primary production and gas flux) for SCOR Working Group 152 (ECV-Ice) (On ice: Daiki Nomura) (Team: Daiki Nomura, Fripiat Fripiat, Brent Else, ECV-Ice and BEPSII members)
- Fall 2019- Fall 2020: MOSAiC (Multidisciplinary drifting Observatory for the Study of Arctic Climate) A year Cruise. Arctic Ocean, ice breaker Polarstern. Surface Ocean and sea ice CO2, CH4, VOC and flux (On board (one of leg): Daiki Nomura) (Team: Daiki Nomura, Atsushi Ooki, Ellen Damm, Brice Loose, Jun Inoue).
- Aug, 2018 I/B Araon (Korean ice breaker) cruise, Chukchi and Beaufort Seas, Ocean warming and acidification: their impact on marine plankton (On board: Jonaotaro Onodera and other 3 Japanese and 10-20 Korean)
- 27 Nov, 2018- 23 Mar, 2019 I/B Shirase (Japanese ice breaker), Southern Ocean, Nitrogen cycle in the Southern Ocean, the 60th Japanese Antarctic Research Expedition (On board: Naomi Harada (PI of summer party) and others)
- Underway measurement of sea surface CO2 and CH4 in the Arctic Ocean, the Bering Sea, and the subarctic North Pacific (2018/08-09; R/V Mirai; ArCS project; by A Murata)
- June 2018: T/V Oshoro-maru Arctic expedition (T. Hirawake, A. Ooki, K. Sugie, S. Kameyama etc.)

**2. Events like conferences, workshops, meetings, schools, capacity building etc. (incl. all information possible). Please indicate to which of the SOLAS Core Themes or Cross-Cutting Themes your information belongs to or specify an overlap between Themes.**

Theme 1: Greenhouse gases and the oceans

- Workshop for air-sea interaction study (F. Taketani and Y. Iwamoto)
- May 2018: JpGU Meeting 2018, Chiba, Japan. Oceanic responses to global warming and ocean acidification in coastal regions (Convenors: Tsuneo Ono, Masahiko Fujii, Takeshi Yoshimura)

Theme 5: Ocean biogeochemical control on atmospheric chemistry

- Ocean and Atmosphere session at Japan Geoscience Union meeting, May 2018, Biogeochemical linkages between the ocean and the atmosphere during phytoplankton bloom (conveners: Y. Miyazaki, Y. Iwamoto, J. Nishioka, K. Suzuki).
-

Cross-Cutting Theme: Upwelling systems, polar oceans, coastal waters

- Workshop with stakeholder (Government, Companies, Environmental NGOs) Resilience and Adaptive Capacity of Arctic marine systems under a changing climate (RACArctic) Stakeholder workshop “Responses of Arctic marine ecosystems to climate change: fish and fisheries in the Pacific Arctic, Tromso, Norway, Mar 6, 2018 (This is international collaboration work between Japan, Norway and USA sponsored by Belmont Forum)

**3. Funded national and international projects / activities underway. Please indicate to which of the SOLAS Core Themes or Cross-Cutting Themes your information belongs to or specify an overlap between Themes.**

Theme 1: Greenhouse gases and the oceans

- Deployment of drifting buoys with pCO2 sensor in the Pacific Ocean founded by the Ministry of Environment of Japan (PI: A Murata; 2016-2021)
- Researches of greenhouse gases and their relevant pollutants in the atmosphere and in the ocean by NIES, supported by the fund of Global Environmental Research Coordination System from the Ministry of the Environment, Japan (H. Tanimoto, S. Nakaoka).
- NIES VOS Program planned until 2020 (Atmospheric/Oceanic Greenhouse Gas Observation: Japan-North America, Japan-Oceania; Atmospheric Greenhouse Gas Observation: Japan-Southeast Asia) (H. Tanimoto, S. Nakaoka).

Theme 3: Atmospheric deposition and ocean biogeochemistry

- Quantifying nitrate dynamics in hydrosphere using triple oxygen isotopes as tracers, MEXT/JSPS Grant-in-Aid for Scientific Research (A) (PI: U. Tsunogai, FY2017-2020).
- Long-term observations of the impacts of climate change on air quality and oceanic deposition in the Asia-Pacific regions, Ministry of Environment, (PI: H. Tanimoto, 2018-2022)

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

- Aalysis of global budget and atmospheric impacts of oceanic volatile organic compounds with integrated observations and chemistry-transport modeling (KAKENHI, PI: H. Tanimoto, 2018-2020)

Cross-Cutting Theme: Upwelling systems, polar oceans, coastal waters

- Resilience and Adaptive Capacity of Arctic marine systems under a changing climate (RACArctic) project. This is international collaboration project between Japan, Norway and USA sponsored by Belmont Forum from Jul 2015 to Jun 2018.
- Biogeochemical linkage between Polar and subarctic ocean, MEXT/JSPS Grant-in-Aid for Scientific Research (A) (PI: J. Nishioka, FY2017-2020).
- Arctic Challenge for Sustainability: Arctic region research project covering natural and social sciences. This is a national flagship project funded by the Ministry of Education, Culture, Sports, Science and Technology, Japan. The National Institute of Polar Research (NIPR), Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and Hokkaido University are playing the key roles in this project, and will continue to carry it out from Sep 2015 to Mar 2020.
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**4. Plans / ideas for future projects, programmes, proposals national or international etc. (please indicate the funding agencies and potential submission dates). Please indicate to which of the SOLAS Core Themes or Cross-Cutting Themes your information belongs to or specify an overlap between Themes.**

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

- NIES supports international pCO2 database of Surface Ocean CO2 Atlas (SOCAT) by providing NIES VOS pCO2 data as well as by executing quality control to the submitted data measured by other institutes mainly in the North Pacific as a responsible institute of the SOCAT.

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *'Korea'*

*compiled by: 'Kitack Lee (Pohang University of Science and Technology and Eunil Lee (Korea Hydrographic and Oceanographic Agency)'*

## PART 1 - Activities from January 2017 to Jan/Feb 2018

### 1. Scientific highlight

Ieodo Ocean Research Station in the East China Sea:

Ieodo Ocean Research Station is an ocean platform constructed by the Republic of Korea and placed on the submerged Ieodo Rock (known as Socotra Rock) in the East China Sea (32°N and 125°E). The Ieodo platform has foundations fixed 40 m below the sea surface on the northeastern part of Socotra Rock and rises approximately 36 m above the sea surface (see photo). In June 2003, the Ieodo platform officially opened as a research station. It has a helipad and two lower decks for equipment and workspaces. The platform also includes short-term residential facilities that accommodate a maximum of 8 people for 15 days; it is intermittently occupied between April and November and operated remotely over the winter period.

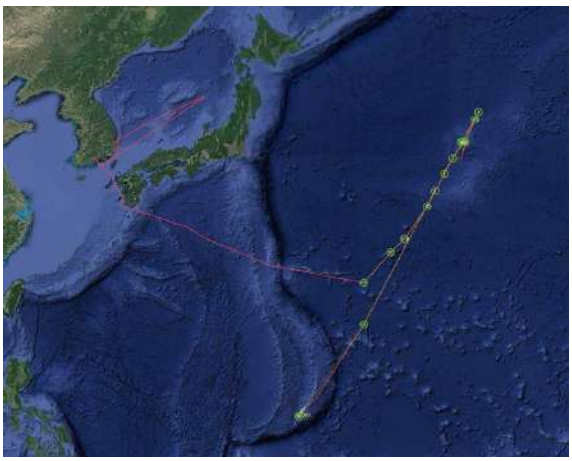

Initially, this platform in the remote ocean was used for limited activities, including meteorological data collection, maritime safety, and fisheries. However, the activities conducted at the Ieodo platform have been rapidly expanding, largely because of its geographic location. In particular, the Ieodo platform and East China Sea are located downwind of the area downstream from the populated and industrialized Asian continent, and hence have received increasing loads of anthropogenic nitrogen. Enhanced nitrogen input has potential ramifications in marine nitrogen and carbon cycles. Most notably, the ocean region surrounding the Ieodo Ocean Research Station has been recognized as a strong sink of atmospheric $CO_2$. This ocean C sink will further strengthen as long as anthropogenic nitrogen input increases.

As a consequence of the growing influence of human activities on the East China Sea, the Ieodo Station is an excellent site for investigating how human-induced changes influence ocean biogeochemistry of key elements such as C and N.

In response to growing awareness of the importance of this platform as a key ocean and atmospheric observatory, in 2015 the Korea Hydrographic and Oceanographic Agency (KHOA) initiated multidisciplinary research projects on a range of topics, including the ocean carbon cycle, remote sensing, pollutant transport, and ocean currents and climate. The KHOA encourages international collaborations.

**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).**

1. Study on the interaction between carbon and nitrogen in the western North Pacific Ocean:



Between the 17th of October and 13th of November 2017, a cruise was conducted on the R/V Isabu in the western North Pacific Ocean with the aim of investigating how atmospheric inpus of N, P and Fe influence ocean nitrogen and carbon dynamics. Surface and subsurface seawaters were sampled at three hydrographic stations. We deliberately added nutrients and atmospheric dust samples to these seawater samples. The samples were then incubated under conditions mimicking the surface ocean layer, and the response of the seawater C and N to such added dusts was measured.

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

*Park, KT; Jang, S; Lee, K; Yoon, YJ; Kim, MS; Park, K; Cho, HJ; Kang, JH; Udisti, R; Lee, BY, 2017, Observational evidence for the formation of DMS-derived aerosols during Arctic phytoplankton blooms, Atmospheric Chemistry And Physics, 17(15), 9665-9675, DOI: 10.5194/acp-17-9665-2017*

*Kim, D; Jeong, JH; Kim, TW; Noh, JH; Kim, HJ; Choi, DH; Kim, E; Jeon, D, 2017, The reduction in the biomass of cyanobacterial $N_2$ fixer and the biological pump in the Northwestern Pacific Ocean, Scientific Reports, 7, 41810, DOI: 10.1038/srep41810*

*T. H. Kim; G. Kim; Y. Shen; R. Benner, 2017, Strong linkages between surface and deep-water dissolved organic matter in the East/Japan Sea, Biogeosciences, 14, 2561-2570 , DOI: 10.5194/bg-14-2561-2017*

**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?**

## 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.).**

Study on atmospheric DMS dynamics in Iceland:

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

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| **3. Funded national and international projects / activities underway.** |
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| **4. Plans / ideas for future projects, programmes, proposals national or international etc. (please indicate the funding agencies and potential submission dates).** |
| |
| **5. Engagements with other international projects, organisations, programmes etc.** |
| |

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| **Comments** |
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surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *'Mexico'*
## *compiled by: 'José Martín Hernández-Ayón'*

*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 magnitude and temporal variability of mineral dust deposition and its associated Fe and Mn inputs to coastal waters of the California Current System (Fig.1) has been scarcely investigated. In this work a summer school SOLAS PHD student reported a 5 year time series (April 2010 to December 2014) of mineral dust ($F_{dust}$), Fe ($F_{Fe}$), and Mn ($F_{Mn}$) fluxes to the coastal zone of the southern CCS. Atmospheric deposition displayed a strong seasonal trend, with lowest $F_{dust}$, $F_{Fe}$, and $F_{Mn}$ during the warm season (May–October), a period dominated by strong moisture-laden winds of oceanic origin. In contrast, the highest $F_{dust}$, $F_{Fe}$, and $F_{Mn}$ were recorded during the cool season (November–April), a period characterized by strong winds devoid of moisture coming from the mainland (Fig.2). Our analysis suggests that Santa Ana Wind events could contribute with ~15%, 20%, and 24%, respectively, to the total annual input of dust, Fe and Mn to the region.

Besides, atmospheric soluble Fe inputs are equivalent to between 11% (warm season) and 35% (cool season) of the dissolved Fe supplied by upwelling. Our calculations indicate that atmospheric Fe deposition could explain between ~5% (warm season) and 15% (cool season) of primary production reported for the southern CCS, suggesting that this route could also be an important input of Fe for primary producers in this region. Finally, the average $F_{dust}$, $F_{Fe}$, and $F_{Mn}$ for the cool seasons showed a positive interannual trend that was significantly correlated with an intensification of drought conditions over the period 2010–2014 in northwest of Mexico and southwest of the United States.

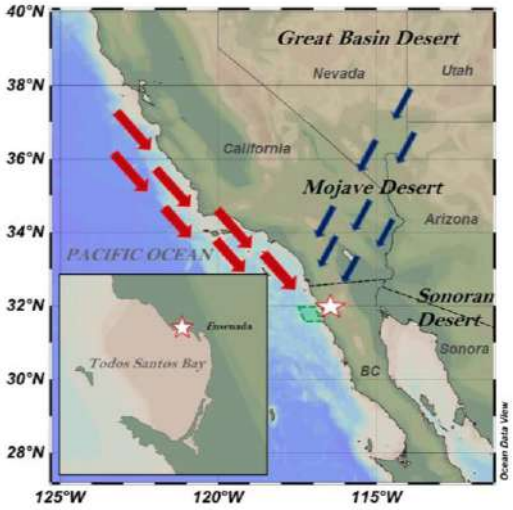


Figure 1: Study area and position of the sampling station in Todos Santos Bay. Arrows indicate the dominant wind directions observed during the warm (May–October; red) and cool (November–April; blue) seasons in our study over the period 2010–2014. The green polygon represents the area for calculation of the relative contributions of dissolved Fe and Mn fluxes associated with upwelling and atmospheric dust deposition.

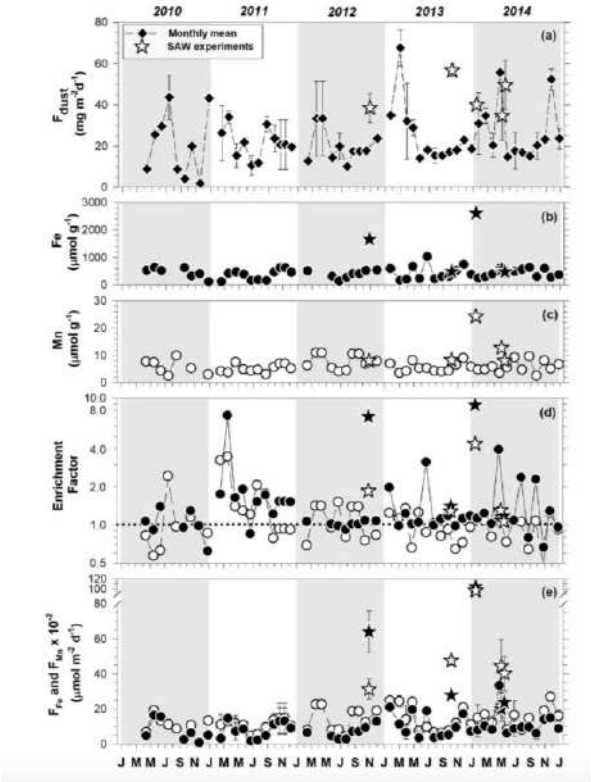


Figure 2: Time series of (a) monthly atmospheric dust deposition ($F_{dust}$), (b) Fe and (c) Mn dust concentration, (d) Fe (●) and Mn (O) enrichment factor (EF) values, and (e) atmospheric Fe (●_) and Mn (O ) fluxes over the period of 2010–2014. In all plots, the stars are the results of experiments carried out during the Santa Ana Wind conditions. Error bars represent standard deviations of the monthly means. The horizontal dotted line in Figure 2d represents the value of EF=1; values higher and lower than 1 represent enrichment and impoverishment, respectively, with respect to the average background values reported for the Earth's crust (Li & Schoonmaker, 2003).

Citation: A Félix-Bermúdez et al., (2017). Atmospheric Inputs of Iron and Manganese to Coastal Waters of the Southern California Current System: Seasonality, Santa Ana Winds, and Biogeochemical Implications. JGR. doi.org/10.1002/2017JC013224

**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).**

1) A FRENCH-MEXICAN OCEAN WORKSHOP was hosted by the Universidad Nacional Autónoma de Mexico (UNAM), on its Mexico City's campus, on September 19-20 2017. This event, organized by UNAM's Institute of Marine and Limnology Sciences (ICMyL), the Scientific section of the French Embassy in Mexico, in partnership with IRD, CNRS and the French Ocean-Climate Platform, brought together about 40 participants, including 14 French researchers, representing among others the joint research units (UMR) CRIOBE [1], LEMAR [2], BOREA [3], LOCEAN [4], LEGOS [5] and MARBEC [6]. CNRS was also represented by Bruno Blanke - Deputy Scientific Director at INSU [7] -, Thierry Bouvier - Deputy Scientific Director at INEE [8], and Xavier Morise, Director of the North-America Office, located in Washington DC.

The main objectives were to :

- Share scientific knowledge and expertise – Assess gaps, needs and complementarities
- Define collaborative efforts on issues of common interests, such as Ocean-climate, Ecology and Marine Biology, Observatories and Natural Protected Areas
- Identify specific initiatives and projects, including academic and training actions, that could be undertaken on a bilateral basis

Despite the earthquake that struck Mexico on September 19 and had an impact on the course of the workshop (relocation, program and format changes…), the dynamics of exchanges between participants were not affected. Thus, after the two days of lively and fruitful discussions, participants agreed that French and Mexican Ocean research communities should join forces to develop collaborative endeavours in both the Pacific Ocean, the Caribbean Sea and the Atlantic Ocean, on the following main thematic :

- Climate variability, ocean circulation and biogeochemical cycles, in particular on oxygen related issues (hypoxia/anoxia, oxygen minimum zones, deoxygenation of the ocean), ocean dynamics, the carbon cycle (blue carbon, acidification), climate regionalization, and extreme events (hurricanes, floods, droughts…)
- Ecosystem degradation and anthropization, including pollution, eutrophication, habitat loss (coral reefs, mangroves), coastal issues (erosion, sea level rise]
- Ecology and Biodiversity, notably on domains such as fisheries, conservation and remediation (marine protected areas), connectivity, taxonomic and functional diversity, and human health

  Participants also concurred that modelling (climate, regional oceans), technological developments (sensors, probes, platforms…) and time-series observations are instrumental for the scientific partnerships that they intent to establish. They also emphasized that these partnerships must include cross-cutting topics, such as education

and training or societal impacts, notably towards decision-making.

[1] Centre de recherches insulaires et observatoire de l'environnement (CNRS, EPHE, UPVD)
[2] Laboratoire des sciences de l'environnement marin (CNRS, IRD, Ifremer, UBO)
[3] Biologie des organismes et écosystèmes aquatiques (CNRS, MNHN, IRD, UPMC, UCN, UAG)
[4] Laboratoire d'océanographie et du climat : expérimentations et approches numériques (CNRS, UPMC, MNHN, IRD)
[5] Laboratoire d'études en géophysique et océanographie spatiales (CNRS, UPST, IRD, CNES)
[6] Centre pour la diversité marine, l'exploitation et la conservation (CNRS, UM, IRD, Ifremer)
[7] INSU = National Institute for Earth Sciences and Astronomy
[8] INEE = Institute of Ecology and Environment

2) The first Latin-American Symposium held by the LAOCA Network on ocean acidification took place in Buenos Aires, Argentina, from October 24- 26, 2017. Students and researchers had discussions about ocean observing systems, modeling and regional projections, physiological and ecological effects of ocean acidification (taking into consideration organisms and ecosystems) as well as the human dimensions of this phenomenon. This was the first version, and our aim is that the entire community working on these topics should get to know each other and strengthen future collaborative projects", explained the scientist. The LAOCA Network is very important at a Latin-American level, because it brings together scientists with common interests and objectives regarding ocean acidification; this makes it possible to create a collaborative network and also allows each group to present what they are doing in their countries, showing the results of their research on ocean acidification in Latin America. For further about the program covered visit http://laoca.cl/congreso2017.

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


Cristian Carvajal, Charles K. Paull, David W. Caress, Andrea Fildani, Eve Lundsten, Krystle Anderson, Katherine L. Maier, Mary McGann, Roberto Gwiazda, Juan Carlos Herguera; Unraveling the Channel–Lobe Transition Zone With High-Resolution AUV Bathymetry: Navy Fan, Offshore Baja California, Mexico. *Journal of Sedimentary Research* ; 87 (10): 1049–1059. doi: https://doi.org/10.2110/jsr.2017.58.

Pasqueron de Fommervault, O., P. Pérez-Brunius, P. Damien, and J. Sheinbaum, 2017: Temporal variability of chlorophyll distribution in the Gulf of Mexico: Bio-optical data from profiling floats. *Biogeosciences*, **14**, 5647–5662, https://doi.org/10.5194/bg-14-5647-2017.

Norzagaray-López, C. O., Hernández-Ayón, J. M., Calderon Aguilera, L. E., Reyes-Bonilla, H., Chapa-Balcorta, C. and Ayala-Bocos, A. (2017). Aragonite saturation and pH variation in a fringing reef are strongly influenced by oceanic conditions. Limnol. Oceanography. doi:10.1002/lno.10571

Maske, H., Cajal-Medrano, R., & Villegas-Mendoza, J. (2017). Substrate-Limited and -Unlimited Coastal Microbial Communities Show Different Metabolic Responses with Regard to Temperature. *Frontiers in Microbiology*, *8*, 2270. http://doi.org/10.3389/fmicb.2017.02270

Ávila-López, M.C., Hernández-Ayón, J.M., Camacho-Ibar, V.F., Armando Félix Bermúdez, Adan Mejía-Trejo, Isaí Pacheco-Ruiz, Jose M. Sandoval-Gil (2017). **A**ir–Water $CO_2$ Fluxes and Net Ecosystem Production Changes in a Baja California Coastal Lagoon During the Anomalous North Pacific Warm Condition. Estuaries and Coasts. 40: 792. https://doi.org/10.1007/s12237-016-

0178x.

*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.*

**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?**

1) With Oyster Producers. We are working in pH and temperature monitoring.

## 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.).**

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

A half-day PICES-Mexico Special Session will be held a day prior to the symposium (from 14:00-18:00 on April 23, 2018) to introduce PICES to Mexican scientific community and Mexican activities and achievements in marine science to PICES.

***Topic Sessions***

***Concurrent Topic Sessions every day, following a morning plenary session***

- Session 1: Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas
- Session 2: Challenges in managing highly migratory and transboundary resources in Pacific transitional areas
- Session 3: Challenges in observing and modeling Pacific transitional areas
- Session 4: Advances in understanding Pacific shelf-offshore transitional areas
- Session 5: Biodiversity changes in Pacific transitional areas
- Session 6: Transition zones in coastal habitats

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

A Mexican oceanographic observation network of physical, geochemical and ecological processes in the Gulf of Mexico started in March of 2015 and will finish in 2020. The project was approved by the CONACYT (Consejo nacional de Ciencia y Tecnología)-SENER (Secretaria de Energía)-Hidrocarbons Fund to a consortium led by CICESE (Centro de Investigación Científica y De Educación Superior de Ensenada and participating institutions CINVESTAV -IPN (Centro de Investigación y de estudios Avanzados del Instituto Politécnico nacional) Mérida, CIDESI (centro de ingeniería y Desarrollo Industrial), UABC (Universidad Autónoma de Baja California), several research Institutes from UNAM (Universidad Nacional Autónoma de México, ICMyL (Instituto de Ciencias del Mar y Limnologia), CCA (Coordinación de Cooperación Académica) , IBT (Instituto de Biotecnologia), INECC (Instituto nacional de Ecología y Cambio Climático)-SEMARNAT (Secretaria del Medio Ambiente y Recursos naturales) and Baja Innova, SAPI de CV (Sociedades Anónimas Promotoras de Inversión). In addition international institution we also involved as, Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, UC Santa Barbara, RSMUS-

UoF (Rosentiel School of Marine and Atmospheric Science), Texas A&M (USA), LOCEAN (Laboratoire d'Etudes en Géophysique et Océanographie Spatiale), UPMC (University Pierre and Marie Curie)-Paris and LEGOS (Laboratoire d'Etudes en Géophysique et Océanographie Spatiale), from France and GEOMAR from Germany. This interdisciplinary project proposes for five years the creation of a comprehensive system of oceanographic observations and numerical models to generate scenarios of potential impacts of large oil spills. The project objectives are to strengthen the scientific, technological infrastructure and human capacity of the Mexican oceanographic community to address the challenges associated with the exploitation of hydrocarbons in the Gulf of Mexico, using an interdisciplinary approach and implementing cutting edge technologies.

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

The GOOS Steering Committee will meet during the week of the 12th to the 15th of June at the INVEMAR facilities in Santa Marta, Colombia. During the first day, we are organizing a regional workshop inviting representatives of observing programs in the region from across the disciplines of biology, biogeochemistry and physics along with representatives of the GOOS Regional Alliances.

The goals of the workshop are to:

(1) strengthen and build links between Latin American communities (scientific community, observing networks, industry, navies, GRAs),

(2) showcase the work done at INVEMAR

(3) promote development of GOOS projects

Given your role as co-chair of LA-OCA, we would like to invite you to attend this workshop, and if interested and available, to stay for the rest of the week to attend the GOOS SC meeting.

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

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## **SOLAS** *New Zealand*

***compiled by:*** *Cliff Law, Kim Currie & Mike Harvey*

*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

**Overview of the SOAP (Surface Ocean Aerosol Processes) Campaign**

Establishing the relationship between marine boundary layer (MBL) aerosols and surface water biogeochemistry is required to understand aerosol and cloud production processes over the remote ocean, and represent them more accurately in Earth System Models and global climate projections. This was addressed by the SOAP (Surface Ocean Aerosol Production) campaign, which examined air-sea interaction over biologically-productive frontal waters east of New Zealand. The Voyage overview published in 2017 details the objectives, regional context, sampling strategy, and provisional findings of a pilot study, PreSOAP, in austral summer 2011, and the following SOAP voyage in late austral summer 2012. Both voyages characterised surface water and MBL composition in three phytoplankton blooms of differing species composition and biogeochemistry, with significant regional correlation observed between chlorophyll-*a* and DMSsw. Surface seawater dimethylsulfide (DMSsw) and associated air-sea DMS flux showed spatial variation during the SOAP voyage, with maxima of 25 nmol $L^{-1}$ and 100 µmol $m^{-2}$ $d^{-1}$, respectively, recorded in a dinoflagellate bloom. Inclusion of SOAP data in a regional DMSsw compilation indicates that the current climatological mean is an underestimate for this region of the South-west Pacific. Estimation of the

DMS gas transfer velocity ($k_{DMS}$) by independent techniques of eddy covariance and gradient flux showed good agreement, although both exhibited periodic deviations from model estimates. Flux anomalies were related to surface warming and sea surface microlayer enrichment, and also reflected the heterogeneous distribution of DMSsw and the associated flux footprint. Other aerosol precursors measured included the halides and various volatile organic carbon compounds, with first measurements of the short-lived gases glyoxal and methylglyoxal in pristine Southern Ocean marine air indicating an unidentified local source. The application of a real-time clean-sector, contaminant markers, and a common aerosol inlet facilitated multi-sensor measurement of uncontaminated air. Aerosol characterisation identified variable Aitken mode, and consistent sub-micron sized accumulation and coarse modes. Sub-micron aerosol mass was dominated by secondary particles containing ammonium sulfate/bisulfate under light winds, with an increase in sea-salt under higher wind-speeds. MBL measurements and chamber experiments identified a significant organic component in primary and secondary aerosols. Comparison of SOAP aerosol number and size distributions reveals an underprediction in GLOMAP-mode aerosol number in clean marine air masses, suggesting a missing marine aerosol source in the model. The SOAP data will be further examined for evidence of nucleation events, and also to identify relationships between MBL composition and surface ocean biogeochemistry that may provide potential proxies for aerosol precursors and production. The SOAP Campaign contributed to SOLAS Theme 4. (Interconnections between aerosols, clouds, and marine ecosystems) and was also a SOLAS Endorsed project.

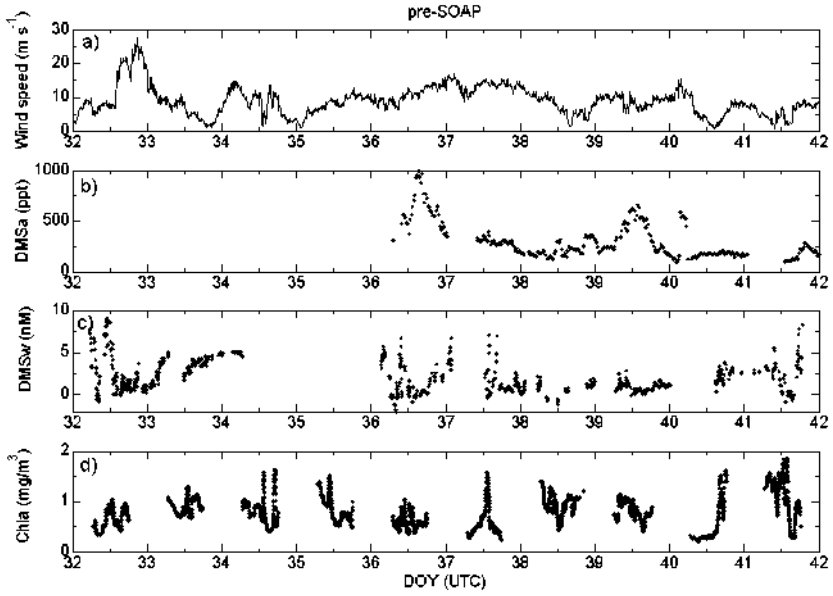


*Figure 3. Continuous measurement during PreSOAP of a) windspeed (m $s^{-1}$), b) atmospheric DMS (ppt), c) surface water DMS (nmol $l^{-1}$), and d) surface chlorophyll-a (mg $m^{-3}$; quenched data removed).*

*Citation: Law CS, Smith MJ, Harvey MJ, Bell TG, Cravigan LT, Elliott FC, Lawson SJ, Lizotte M, Marriner A, McGregor J, Ristovski Z, Safi KA, Saltzman ES, Vaattovaarra P, Walker CF. An Overview of the Surface Ocean Aerosol Production (SOAP) campaign. Atmospheric Chemistry Physics Discussions,* https://doi.org/10.5194/acp-2017-535

**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).**

*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 CO2 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 CO2 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 ROME model further developed for Firth of Thames
RA3 – 22-day mesocosm experiment 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

*SOLAS Theme 4:* Interconnections between aerosols, clouds, and marine ecosystems;

**4. 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

**5. Deep South National Science Challenge**

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

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

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. There is a focus on latitudes poleward of 60°S in this work where the models underestimate the radiative impact of clouds. Novel measurements include RPAS/drone deployment of light-weight 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, DeepSouth Symposium, NZ Met Society. Methods have been developed for regional regime based evaluation of GCM cloud simulations using self-organizing maps (PI McDonald, U Canterbury, NZ)

**6. Ship based observation of aerosols, shipping Emissions and In situ aerosol profiles**

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 CO2 and particulates

7. **Sources of sulfate aerosol at Baring Head, New Zealand**

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

*Cross-Cutting Theme: Science & Society*

8. **Climate Change Impacts on the NZ EEZ**
   Results synthesized and published with recommendations

9. **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 2017 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.**

Burrell TJ, Maas EW, Hulston DA, Law CS, 2017. Variable response to warming and ocean acidification by bacterial processes in different plankton communities. *Aquatic Microbial Ecology* 79:49-62. https://doi.org/10.3354/ame01819

Law CS, Smith MJ, Harvey MJ, Bell TG, Cravigan LT, Elliott FC, Lawson SJ, Lizotte M, Marriner A, McGregor J, Ristovski Z, Safi KA, Saltzman ES, Vaattovaarra P, Walker CF. 2017. Overview and preliminary results of the Surface Ocean Aerosol Production (SOAP) campaign. *Atmospheric Chemistry Physics*, 17(22): 13645--13667, doi: 10.5194/acp-17-13645-2017

Law CS, Bell JJ, Bostock HC, Cornwall CE, Cummings V, Currie K, Davy SK, Gammon M, Hepburn CD, Hurd CL, Lamare M, Mikaloff-Fletcher SE, Nelson WA, Parsons DM, Ragg NLC, Sewell MA, Smith AM, Tracey DM, 2017. Ocean Acidification in New Zealand waters. *New Zealand Journal of Marine & Freshwater Research* http://dx.doi.org/10.1080/00288330.2017.1374983

Law CS, Rickard GJ, Mikaloff-Fletcher SE, Pinkerton MH, Behrens E, Chiswell SM, Currie K, 2017. Climate Change projections for the surface ocean around New Zealand. *New Zealand Journal Marine Freshwater Research*, doi: 10.1080/00288330.2017.1390772

Lizotte M, Levasseur M, Law CS, Walker CF, Safi KA, Marriner A, Kiene RP 2017. Dimethylsulfoniopropionate (DMSP) and dimethyl sulfide (DMS) cycling across contrasting biological hotspots of the New Zealand subtropical front, *Ocean Science*, 13, 961-982, https://doi.org/10.5194/os-13-961-2017, 2017.

O'Brien, T. D., Lorenzoni, L., Isensee, K., Valdes, L., and Currie, K. C.: What are Marine Ecological Time Series telling us about the ocean? A status report.IOC-UNESCO, IOC Technical Series, No 129, 296, 2016.

**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?**

*SOLAS Theme 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. CARIM scientists presented and discussed the issue of coastal acidification with iwi (Maori tribes) at hui (meeting) in both the North and South Island. 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.

***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, Paua Industry Council, University of Otago, Fishing Industry, Department of Conservation, Ngai Tahu).

***The 10th New Zealand National Ocean Acidification Workshop***
*http://nzoac.nz/workshops/*
A two-day meeting at the University of Otago, included a session on Maori environmental values and concerns.

***Educational resource Unit for Secondary Schools on Ocean Acidification***

http://www.otago.ac.nz/marine-studies/resources/download/otago636544.pdf

New Zealand scientists have been training secondary school teachers following the release of the Educational resource *"The Ocean of Tomorrow: Ocean acidification and the marine world"*

**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.

## 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.).**

*SOLAS Theme 1:*

**CARIM**

**RA1 –** Continued monitoring at sentinel sites plus a spatial survey of the Firth of Thames

**RA3** – A 4th mesocosm experiment examining the effect of OA and warming on larval survival in coastal plankton communities

**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

**Munida Transect –** continuing into its 21st year

*SOLAS Theme 4:*

**Deep South Aerosol-Cloud interaction observations – Ross Sea –**

A voyage to the Ross Sea will investigate oceanographic and ecosystem function 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/

A work – package of the voyage is the multi-facetted assessment of aerosol and precursor emissions and aerosol-cloud interaction in the region in support of Earth System modelling refinement. The study involves 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.

*Cross-Cutting Theme: Science & Society*
**Mitigation of Coastal Acidification around Mussel Farms**
A measurement campaign examining carbonate variability and processes around a mussel farm is planned for March 2018

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

*SOLAS Theme 1:*

**The CARIM Workshop** will take place at the University of Waikato in February 2018

**The 11th NZ National Ocean Acidification Workshop** will take place at the University of Waikato in February 2018

*SOLAS Theme 4*

**The 14th annual Australia / New Zealand Aerosol assembly** will be held in New Zealand, date TBA in second half of 2018.

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

*SOLAS Theme 1:*
**HYDEE -** Determination of the impacts of seafloor methane seeps on water column biogeochemistry

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

**Munida Transect**

**Mitigation of Coastal Acidification around Mussel Farms**

*SOLAS Theme 4:*
**Deep South Aerosol-Cloud interaction observations – Ross Sea**

**New projects:**

Improving the representation of sulfate aerosols over the Southern Ocean in the NZESM PI: Laura Revell, Bodeker Scientific: new Deep-South project:

Versatile 4D Drones for observations of deep-south key earth system variables: PI Wolfgang Rack, U Canterbury, NZ: new Deep-South project.

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

International collaborative project:

Sea2Cloud: - Are marine living microorganisms influencing clouds?

PI: Karine Sellegri – LAMP CNRS / NIWA – EU Horizons 2020

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

*SOLAS Theme 1:*
**SCOR Working Groups:**

WG 143 Dissolved $N_2O$ and $CH_4$ measurements: Working towards a global network of ocean time series measurements of $N_2O$ and $CH_4$ : intercalibration of standards and samples

WG149: Changing Ocean Biological Systems (COBS): How will biota respond to a changing ocean?

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

*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

The Deep South National Science Challenge: http://www.deepsouthchallenge.co.nz/

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

**SOLAS *Norway***
***compiled by: Siv K. Lauvset***

## 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).*

Lauvset et al. (2017) used an Earth System Model with interactive biogeochemistry to project future ocean biogeochemistry impacts from large-scale deployment of three different radiation management geoengineering methods: stratospheric aerosol injection (SAI), marine sky brightening (MSB), and cirrus cloud thinning (CCT). We applied the geoengineering such that the change in radiative forcing in the RCP8.5 emission scenario wass reduced to the change in radiative forcing in the RCP4.5 scenario. The resulting global mean sea surface temperatures in the RM experiments were comparable to those in RCP4.5, but with regional variations. The forcing from MSB, for example, is applied over the oceans, so the cooling of the ocean is in some regions stronger for this method. The main goal of Lauvset et al. (2017) was to assess the effects of geoengineering on ocean biogeochemistry. It was found that changes in ocean net primary production (NPP, Figure 1) are much more variable than changes in temperature and oxygen. Depending on the method, the spatially inhomogeneous changes in ocean NPP are mostly dominated by the circulation changes. In general, the SAI and MSB - induced changes are largest in the low latitudes, while the CCT - induced changes tend to be the weakest of the three. The results of this Lauvset et al. (2017) underscores the complexity of climate impacts on NPP, and highlights that changes are driven by an integrated effect of multiple environmental drivers, which all change in different ways. These results stress the uncertain changes to ocean productivity in the future and advocates caution at any deliberate attempt for large-scale perturbation of the Earth system.

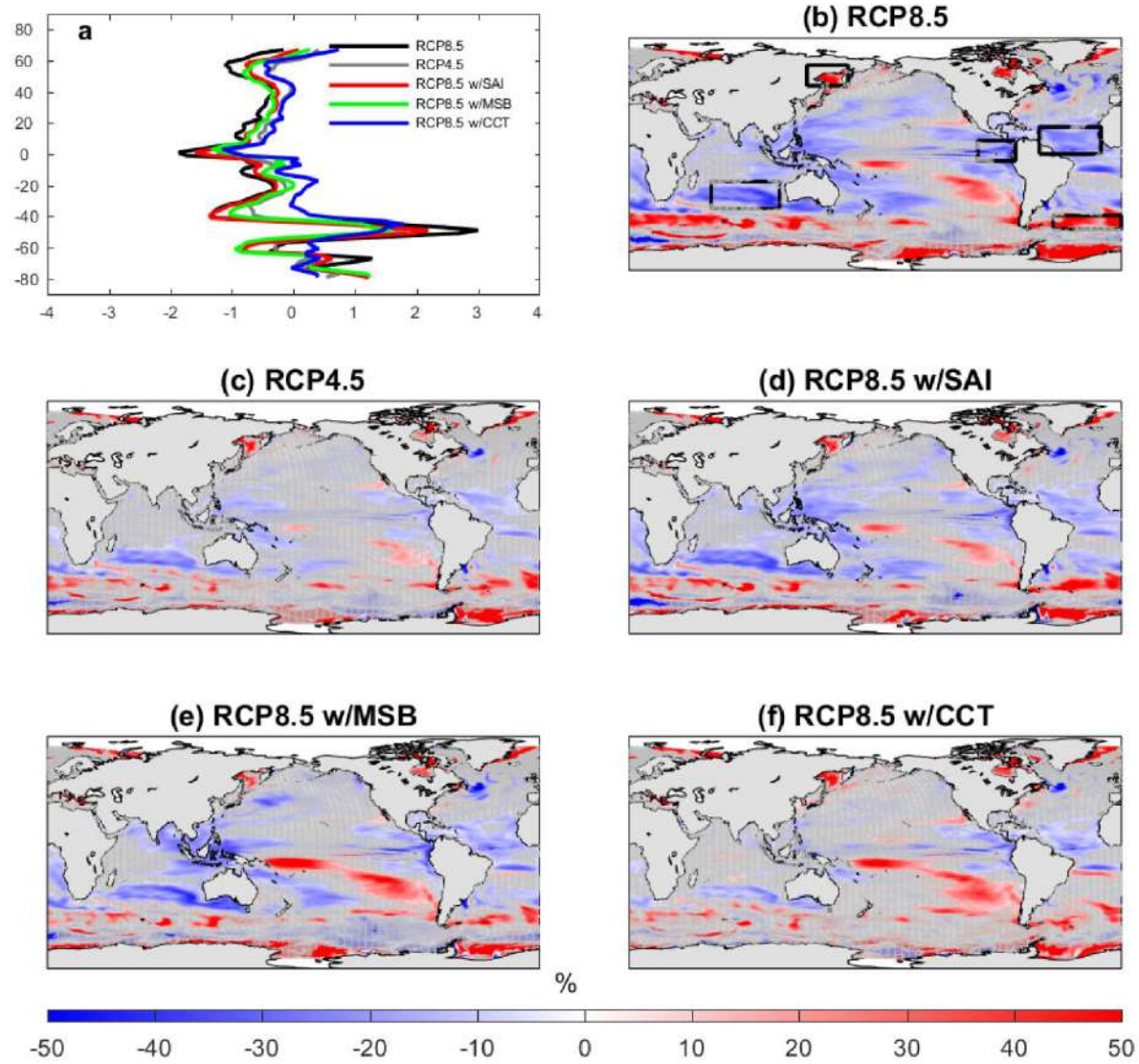


Figure 1. The percent change in the offline calculated NPP in 2071-2100 relative to the 1971-2000 average in the historical run. (a) Zonally averaged (in 2 °latitude bands) change for all simulations. (b) RCP8.5, (c) RCP4.5, (d) RCP8.5 with SAI, (e) RCP8.5 with MSB, (f) RCP8.5 with CCT. Gray shading in b)-f) indicates areas where the change is not significantly different from the 1971-2000 average (*i.e.* within one standard deviation of the 1971-2000 mean).

Lauvset, S. K., J. Tjiputra, and H. Muri (2017), Climate engineering and the ocean: effects on biogeochemistry and primary production, *Biogeosciences*, *14*(24), 5675-5691, doi:10.5194/bg-14-5675-2017.

**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).**

Outreach: ICOS facebook page and contribution to the Pepperkakebyen in Bergen.

Annual Meeting of the marine Component in ICOS Norway in Bergen. Nov 9th 2017

2017 ICOS Spring Seminar, 09-10 May 2017, Kjeller, Norway.

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

Fransson, A, M Chierici, I Skjelvan, A Olsen, P Assmy, A K Peterson, G Spreen, B Ward, 2017, Effects of sea-ice and biogeochemical processes and storms on under ice water $fCO_2$ during the winter-spring transition in the high Arctic Ocean: Implications for sea-air $CO_2$ fluxes, *J. Geophys. Res. Oceans*, doi: 10.1002/2016JC012478.

Schwinger, J., J. Tjiputra, N, Goris, K. D. Six, A. Kirkevåg, Ø. Seland, C. Heinze, C., and T. Ilyina, 2017, Amplification of global warming through pH dependence of DMS production simulated with a fully coupled Earth system model, *Biogeosciences*, 14, 3633-3648, doi:10.5194/bg-14-3633-2017.

F.Fröb, A Olsen, F F Pérez, M I García-Ibáñez, E Jeansson, A Omar, and S K Lauvset, Inorganic carbon and water masses in the Irminger Sea since 1991, *Biogeosciences*, 15, 51-72, 2018

Meike Becker, Benjamin Pfeil, Jörg Schwinger and Ingunn Skjelvan all contributed to the Global Carbon Project (2017) Carbon budget and trends 2017. Le Quéré et al. (2017), https://doi.org/10.5194/essd-2017-123, [www.globalcarbonproject.org/carbonbudget] published on 13 November 2017

**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?**

Siv K. Lauvset and Benjamin Pfeil has contributed towards the GEO Carbon Flagship

In an effort to improve communication between instrument vendors and PIs, a workshop has been planned for March 2018 by the ICOS ocean thematic center (OTC). Organisation, communications between interested parties, and set up for this workshop has primarily occurred during the second half of 2017.

Nadine Goris participated in a GESAMP-workshop (The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). GESAMP advises the United Nations on the scientific aspects of marine eenvironmental protection: * N. Goris: "Amplification of global warming through pH-dependence of DMS-production", GESAMP WG 38 workshop on 'Impact of Ocean Acidification on Fluxes of non-CO2 Climate-Active Species', February 2017, Norwich, UK.

Meike Becker held a presentation to the Norwegian Minister for Climate titled "Karbonsyklus og havforsurning" (in Swedish) on May 29th 2017.

## 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.).**

ICOS lines G.O.Sars, Nuka Arctica and Trans Carrier will be continued measuring pCO2 in surface water in the Nordic Seas and north Atlantic.

Biogeochemistry measurements in surface and deep water four times a year south of Bergen at the west coast of Norway.

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

ICOS OTC workshop March 2018

Ocean acidification monitoring of the Norwegian coast (continued)

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

ICOS Norway and ICOS OTC

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

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

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *Peru*

## *compiled by: Michelle Graco*

*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

***OMZ and upwelling system variability***

A new study of the OMZ of the Humboldt system, particularly off Peru reveal a rich spectrum of variability in the OMZ that includes frequencies ranging from seasonal to interannual scales not observed before. A monthly time series (1996–2011) recorded off the coast of Callao (12 020 S, 77 290 W) by the Instituto del Mar de Peru (IMARPE) confirm the efficient oceanic teleconnection off Peru and the equatorial Kelvin wave activity. Two OMZ regimes were observed: a “strong” regime associated with the strong 1997–1998 equatorial Pacific El Niño and biogeochemical properties largely constrained by the wave-induced downwelling conditions reflected in extreme oxygenation, reduced nutrient availability and decreased nitrogen loss processes.; and a “weak” regime corresponds to the post-2000 period associated with the occurrence of moderate central Pacific El Niño events and less intense downwelling conditions that determine a less intense OMZ (oxygen concentration increases weakly) and a higher nitrate concentration, and nitrogen loss processes appear not to be significant.

The data also reveal a long-term trend from 1999 corresponding to a deepening of the oxygen deficient waters and warming. This is in contrast to the long-term deoxygenation trend over the last decades in the eastern tropical Pacific observed by Stramma et al. (2008, 2010). This results suggests that either the low-frequency oxygen variability in the coastal area could be not representative of the low frequency changes in the offshore OMZ.

*The OMZ and nutrient features as a signature of interannual and low-frequency variability in the Peruvian upwelling system Biogeosciences, 14, 1–17, 2017. https://doi.org/10.5194/bg-14-1-2017 2017 M. Graco, S. Purca, B. Dewitte, C. Castro, O. Morón, J. Ledesma, G. Flores, and D. Gutiérrez.*

**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).**

### 2.1 KOSMOS PERU 2017
### A MESOCOSM EXPERIMENT IN OXYGEN-MINIMUM ZONE OFF PERU

The aim of this project is to study the impacts of increasing deoxygenation/acidification on the ecology and biogeochemistry of the Peru upwelling system. It is expected that this will have major implications for the functionality and productivity of the upwelling system, with potential cascading effects on the food web and fishery harvest. This complex system has been captured by scientists in "giant test tubes" off the coast of Peru: In an experiment with the KOSMOS mesocosms (KOSMOS: Kiel Off-Shore Mesocosms for Ocean Simulations), they monitor how the declining oxygen influences the productivity of plankton and material cycling in the upwelling region off Peru.

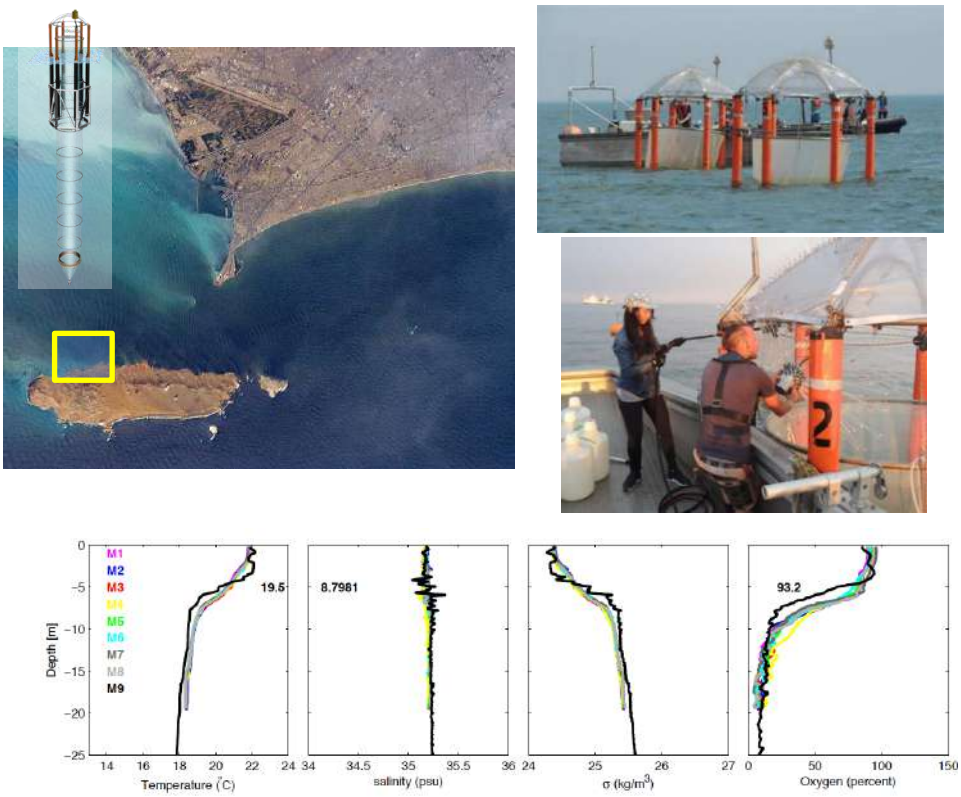


Figure: Mesocosm location (8 platforms), sampling activities and CTD preliminary data. Photos courtesy of Ulf Riebesell (GEOMAR).

A team of 23 Peruvian and 49 Chilean, Ecuadorian, Brazilian, US American, Australian, Spanish, Finnish, Austrian and German researchers has set up their base near the city of Callao. The marine research institute IMARPE (Instituto del Mar del Perú), Callao University, San Marcos University and Cayetano Heredia University togheter with local authorities and the Peruvian navy as well as the research vessel HUMBOLDT and the navy tug MORALES support the study, which takes place in

the context of the Kiel Collaborative Research Center (SFB) 754 “Climate – Biogeochemical Interactions in the Tropical Ocean”.

The deployment of the experiment occurs at the end of February, and water masses containing a plankton community typical for the region and time of the year was enclosed in the mesocosms. Two different types of deep water: one from a slightly oxygen-deficient area and one from a very low oxygen area, which also contains extremely little nitrogen, but larger amounts of phosphorus and iron were injected in the experiments. Daily sampling and measurements were obtained in order to observe how the productivity in the mesocosms temporarily increases before the system returns to nitrogen limitation. Based on their investigations, the researchers will be better able to predict how this highly productive marine ecosystem will develop in response to climate change.

Citation: GEOMAR Press Release 18/2017 Declining oxygen – is Humboldt’s nutrient boost at risk? Experiment with the KOSMOS mesocosms in Peru (https://www.geomar.de/uploads/media/pm_2017_18_KOSMOS2017_en.pdf)


2.2 1st Latino-American Symposium of Ocean Acidification- LAOCA Network. October 24-26 2017. Buenos Aires-Argentine.

By the first time the Latin-American community of ocean acidification participate in a symposium in order to share the advances in research and exchange discussion about action lines of cooperation. More than 70 people from different countries including, Chile, Brazil, Argentina, Perú, Costa Rica, Colombia, México, Cuba, EEUU, UK, France. The presentations and posters including Environmental and biological monitoring studies, models, experiments and some approaches from the economic-social sciences.

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

*The OMZ and nutrient features as a signature of interannual and low-frequency variability in the Peruvian upwelling system Biogeosciences, 14, 1–17, 2017. https://doi.org/10.5194/bg-14-1-2017 2017 M. Graco, S. Purca, B. Dewitte, C. Castro, O. Morón, J. Ledesma, G. Flores, and D. Gutiérrez.*

*Strong and Dynamic Benthic-Pelagic Coupling and Feedbacks in a Coastal Upwelling System (Peruvian Shelf).Front. Mar. Sci. 4:29. doi:10.3389/fmars.2017.00029. 2017. Dale AW, Graco M and Wallmann K.*

*Impacts of El Niño events on the Peruvian upwelling system productivity. J. Geophys. Res. Oceans, 122, doi:10.1002/ 2016JC012439.D. Espinoza-Morriberón, V. Echevin, F. Colas , J. Tam, J. Ledesma, L. Vásquez, and M. Graco. 2017.*

*Breitburg D., Levin LA., Oschlies A., Grégoire M., Chavez FP., Conley DJ., Garçon V., Gilbert D., Gutiérrez D., Isensee K., Jacinto GS., Limburg KE., Montes I., Naqvi S. W. A., Pitcher GC., Rabalais NN., Roman MR., Rose KA., Seibel BA., Telszewski M., Yasuhara M.y Zhang J., 2018: Declining oxygen in the global ocean and coastal waters. Science: Vol. 359, DOI: 10.1126/science.aam7240.*

**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?**

## 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.).**

CUSCO project 2019-2020. Mesocosm and cruises in the Peruvian Upwelling System.

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

-Participation at the Ocean Deoxygenation Conference | Kiel 2018 (SFB 754). September 3-7, 2018.

-2nd Latin-American Symposiun of Ocean Acidification- Lima. 2020.

- Ocean observation System, September 16-20, 2019. Hawaii Convention Center, Participation in the programme Committee (M. Graco, IMARPE).

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

National projects associated with the Coastal Peruvian upwelling system (IMARPE).

Participation in the SCOR Eastern boundary upwelling systems (EBUS): diversity, coupled dynamics and sensitivity to climate change Ruben Escribano (Chile), Ivonne Montes (IGP, Peru). Reporter David Halpern.

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

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

LAOCA- regional Acidification network Chairs: M. Graco (PERU, IMARPE) and M. Ayón-Hernández (México), related with GOA-ON and the UICCN.

Global Ocean Oxygen Network (GO2N). participation PERU (IGP, IMARPE)

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

**SOLAS** ***Poland***
***compiled by:*** ***Tymon Zielinski***

*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

As part of IOCCP with headquarters at IOPAN in Sopot, Maciej Telszewski (Director) and Artur Palacz (Project Officer) have continued to fulfil IOCCP's mission to promote the development of a global network of ocean carbon and biogeochemistry observations, through a number of successfully completed coordination and communication activities reported on regularly via website (www.ioccp.org) and the IOCCP quarterly newsletter, the Conveyor.
By taking part in the SOLAS-IMBER-IOCCP-GCP-CLIVAR-WCRP meeting on future ocean carbon cycle research, IOCCP has engaged with scientific partners to develop and implement a science-based strategy related to marine carbon cycle.
As coordinators of the Biogeochemistry Expert Panel of the Global Ocean Observing System (GOOS), we have published the revised version of Biogeochemistry Essential Ocean Variable Specification Sheets and coordinated their implementation on a global and regional scale, with specific focus on the Atlantic Ocean through the EU Horizon 2020 AtlantOS (https://www.atlantos-h2020.eu/) project.
Tasked with furthering the implementation of a multidisciplinary GOOS, we co-organized the workshop on Implementation of Multi-disciplinary Sustained Ocean Observations (IMSOO), and

together with members of SOLAS SSC, coordinated the follow-on conceptualization and gradual realization of the Variability in the Oxycline and Its Impacts on the Ecosystem (VOICE) project. By ensuring a tight collaboration between VOICE and the Global Ocean Oxygen Network (GO2NE), IOCCP has laid grounds for an effective coordination of oxygen-related ocean observation, research and dissemination efforts. The latter have recently been demonstrated through a publication in Science on “Declining oxygen in the global ocean and coastal waters” by Breitburg et al. (2018).

**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).**

1. Membership in the Board of Directors of the Centre for Polar Studies.
2. Organization of an international symposium called the Sopot Forum for Young Scientists.
3. Leaders in the POLAND-AOD network.
4. Polish coordination in the NASA Maritime Aerosol Network.
5. Membership in the Scientific Council of the Climate Forum – Science on Climate.
6. Coordination of the Sopot Association for the Advanced Sciences activities.
7. Organization of a number of public events, promoting science.

8. 12th Session of the International Ocean Carbon Coordination Project Scientific Steering Group, 6-7 February 2017, Miami, FL, USA.

9. Implementation of Multi-disciplinary Sustained Ocean Observations (IMSOO) workshop, 8-10 February 2017, Miami, FL, USA.

10. 3rd Meeting of the GOOS Steering Committee Executive, 11 February 2017, Miami, FL, USA.

11. 4th Integrated Carbon Observation System (ICOS) Monitoring Stations Assembly (MSA) and Ocean Thematic Centre (OTC) meeting, 1-3 March 2017, Bergen, Norway.

12. 9th Session of the Ship Observations Team (JCOMM SOT-9), 27-31 March 2017, London, UK.

13. Global Ocean Acidification Observing Network (GOA-ON) Executive Meeting, 25-27 April 2017, Paris, France.

14. 8th Session of the WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM)’s Observation Coordination Group (OCG)

15. Global Ocean Oxygen NEtwork (GO2NE) annual workshop, 11-13 September 2017, Monterey, CA, USA

16. Variability in the Oxycline and Its Impacts on the Ecosystem (VOICE) Science Plan Workshop, 13-15 September 2017, Monterey, CA, USA

17. 10th International Carbon Dioxide Conference (ICDC10), 22-25 August 2017, Interlaken, Switzerland

18. EU Horizon2020 AtlantOS 3rd General Assembly, 20-24 November 2017, Las Palmas, Spain.

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


1. *Breitburg, D., Levin, L. A., Oschlies, A., Grégoire, M., Chavez, F. P., Conley, D. J., ..., Telszewski, M, …, & Jacinto, G. S. (2018). Declining oxygen in the global ocean and coastal waters. Science, 359(6371), eaam7240.*
2. *Nielsen JR, Thunberg E, Holland DS, ..., Palacz AP, et al. Integrated ecological–economic fisheries models—Evaluation, review and challenges for implementation. Fish & Fisheries. 2017;00:1–29. https://doi.org/10.1111/faf.12232.*
3. *Ruwa R., A. Simcock, M. J. Bebianno, H. P. Calumpong, S. Chiba, K. Evans, O. K.*

*Kamara, E. Marschoff, M. McClure, E. Y. Mohammed, Ch. Park, L. Y. Randrianarisoa, M. E. Sanchez, A. Strati, J. Tuhumwire, T. Ca Vu, J. Wang, T. Zielinski; The Impacts of Climate Change and Related Changes in the Atmosphere on the Oceans; A Technical Abstract of the First Global Integrated Marine Assessment, United Nations; eISBN 978-92-1-361372-6; 28 pp.; 2017.*

4. *Drozdowska V., Wrobel I., Markuszewski P., Makuch P., Raczkowska A., Kowalczuk P.; Study on organic matter fractions in the surface microlayer in the Baltic Sea by spectrophotometric and spectrofluorometric methods; Ocean Sci., 13, 633-647, 2017.*
5. *Kulinski K., Schneider B., Szymczycha B., Stokowski M.; Structure and functioning of the acid–base system in the Baltic Sea; Earth Syst. Dynam., 8, 1107–1120, 2017.*

**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?**

We run workshops and science fairs, open lectures and projects with kids related to marine environment.

## 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.).**

1. Ny-Alesund Flagship programs, ongoing activities.
2. Summer Arctic campaign using the r/v Oceania and in cooperation with an international team of researchers.
3. NASA AERONET, ongoing activities.
4. POLAND-AOD, ongoing activities.

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

Activities and meetings to be organized in 2018:

1. Global Observing Network for Reference Surface Water pCO2 Observations - Kick-off Meeting, 11 February 2018, Portland, OR, USA.
2. Global Ocean Observing System (GOOS) Cross-Panel Meeting, 28 February – 1 March 2018, Hobart, Australia.
3. Global Ocean Acidification Observing Network (GOA-ON) Executive Council Meeting – 26-27 May 2018, Sopot, Poland.
4. 2nd Science Plan Workshop of the Variability in the Oxycline and Its Impacts on the Ecosystem (VOICE) project, 7-8 September 2018, Kiel, Germany.
5. Organization of an international conference for young scientists entitled: Where the World is Heading (25 May 2018).
6. Continuation of work within the POLAND-AOD network.

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

A number of projects to be submitted during 2018/19.

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

A number of projects to be submitted during 2018. We will seek funding on national and international levels.

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

1. IOCCP.

2. NASA AERONET (agreement until 2019).

2. Ny-Alesund Flagship programs.

3. Bilateral agreement with the Alfred Wegener Institute.

4. Global Observing Network for Reference Surface Water $pCO_2$ Observations.

5. Global Ocean Observing System (GOOS).

6. Global Ocean Acidification Observing Network (GOA-ON).

**Comments**

surface ocean solas lower atmosphere study

**Report for the year 2017 and future activities**

**SOLAS *South Africa***
***compiled by: Sarah Fawcett, University of Cape Town***

## PART 1 - Activities from January 2017 to Jan/Feb 2018

### 1. Scientific highlight

**Re-evaluating the magnitude and impacts of anthropogenic atmospheric nitrogen deposition to the global ocean**

Across much of the global ocean, primary production in surface waters is limited by the availability of bioavailable nitrogen (N). Nitrogen is supplied to sunlit surface waters mainly as nitrate upwelled from depth, which exists mainly as nitrate in the deep ocean, support most of this primary production. External inputs of N to the ocean from rivers, groundwater, oceanic $N_2$ fixation, and atmospheric deposition may further augment ocean productivity. Prior to human intervention, we assume that the ocean's N budget was in steady state, with the external inputs balancing the losses. However, the global N cycle is now being massively perturbed by human activity, such that the estimated anthropogenic release of N into the global environment (160 Tg N/yr) is now of similar magnitude to all natural $N_2$ fixation (250 Tg N/yr) and is likely to increase in future with a growing global population. The increasing inputs of N from human activity have the potential to modify oceanic, and even global, biogeochemical systems. However, our understanding of the scale and impact of such perturbations on the oceans is limited.

Premised on the idea that atmospheric deposition is the dominant mechanism by which anthropogenic perturbations of the N cycle affect the open ocean, Duce et al. (2008) provided the first comprehensive estimates of atmospheric N inputs to the global ocean and attempted to quantify the impact of this deposition on ocean biogeochemistry. Since then, new (data and modeling) studies of atmospheric N emissions and their deposition to the oceans have motivated an effort to reevaluate the conclusions of Duce et al. (2008). The present study (Jickells et al. 2017), which involves authors from all over the world, many of whom contributed to the original Duce et al. (2008) paper, reports improved estimates of preindustrial and modern atmospheric N inputs to the ocean, details improved models to describe the distribution and impact of these inputs on the oceans and their effects on the exchange of some important greenhouse gases, and considers possible future changes in atmospheric N fluxes to the ocean.

In brief, Jickells et al. (2017) find that anthropogenic N inputs are currently increasing oceanic carbon sequestration at a rate of 0.4% per year (equivalent to 0.15 Pg C/yr, which is less than the Duce et al. (2008) estimate). The resulting reduction in climate forcing driven by this additional oceanic $CO_2$ uptake is partially offset by an increase in marine $N_2O$ emissions. The authors identify four important feedbacks in the ocean-atmosphere N system that need to be better quantified if we are to improve our understanding of the perturbation of ocean biogeochemistry by atmospheric N inputs. These include recycling of (1) ammonia and (2) organic N from the surface ocean to the lower atmosphere and back again, (3) the suppression of $N_2$ fixation by increased N concentrations in surface waters from atmospheric N deposition, and (4) increased loss of N from the ocean by denitrification due to increased productivity stimulated by atmospheric N inputs.

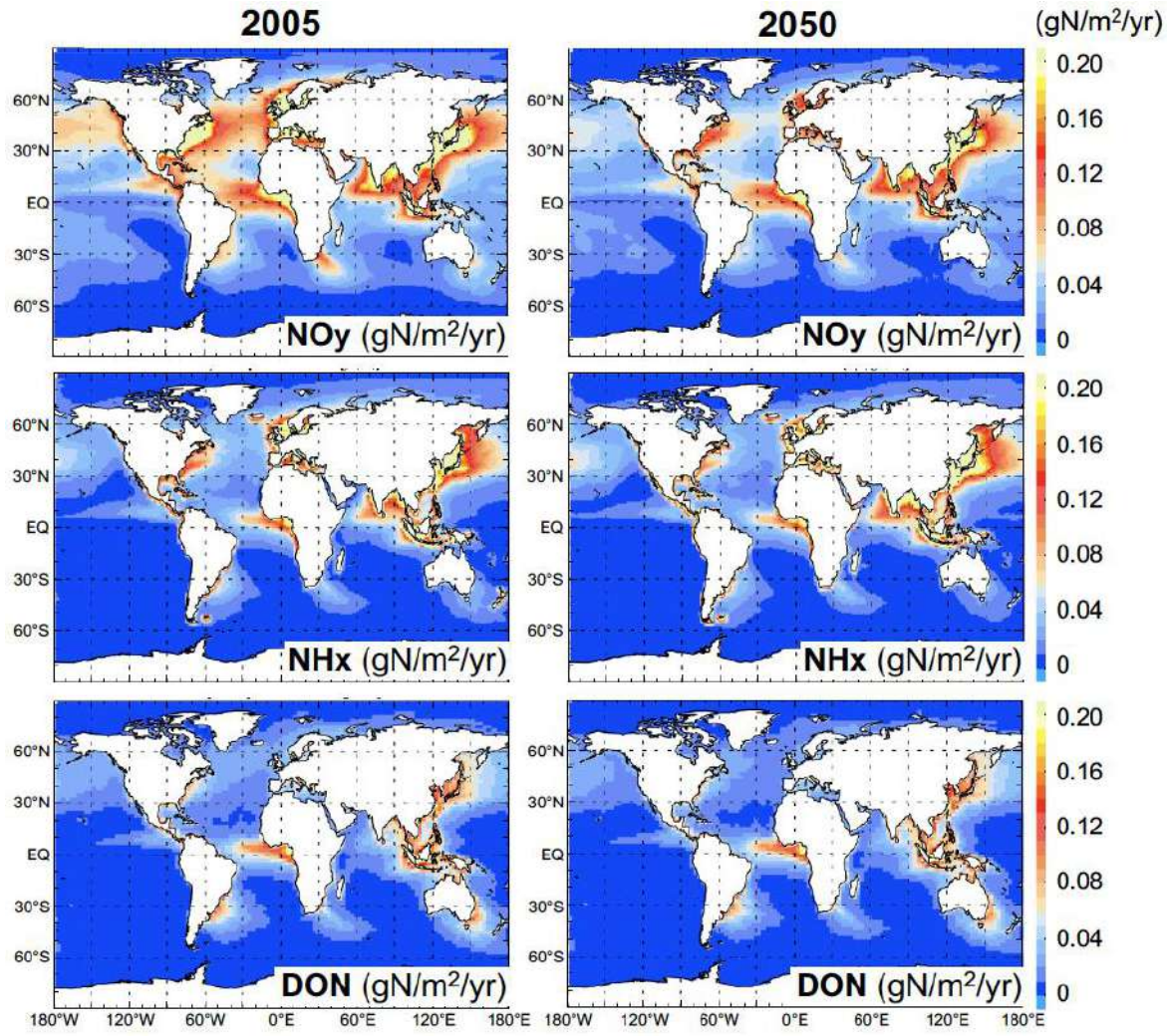


Figure: Atmospheric deposition (in g N/m$^2$/yr) to the ocean for 2005 (left) and 2050 (right) for oxidized N (NOy; top row), reduced N (NHx; middle row), and organic N (bottom row). Estimates are based on the TM4-ECPL model (Daskalakis et al. 2015; Tsigaridis et al. 2014) and agree well with other model outputs and with data (Kanakidou et al. 2016).

Citation: Jickells TD, et al. (2017). A re-evaluation of the magnitude and impacts of anthropogenic atmospheric nitrogen inputs on the ocean, *Global Biogeochemical Cycles*, 31, 289-305, doi:10. 1002/2016GB005586.

**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).**

Research cruises aboard the R/V *SA Agulhas II*: SANAE (South African National Antarctic Expedition) November 2016-February 2017 and November 2017- February 2018 (Cape Town to Antarctica along the GoodHope Line), Prince Edward Islands (April/May 2017), Marginal Ice Zone and WOCE IO-6 line (June/July 2017), SEAmester cruise along the SAMBA line (Southeast Atlantic, Cape Town to meridian along 34.5°S); IIOE-2 (2$^{nd}$ International Indian Ocean Expedition) Durban to Dar-e-Salaam (October 2017); Tristan de Cunha and Gough Island (September 2017) (SOLAS themes 1, 2, 3, 4 and 5, as well as *Science and Society*).

Integrated Ecosystem Programme (IEP) research cruises (February, May, August, November 2017) aboard the R/V Algoa to the southern Benguela upwelling system to monitoring the physics, chemistry and biology of the region (SOLAS themes 1 and 2).

Wave Glider wind stress and $pCO_2$ flux deployments (CSIR SOCCO for more details); Each R/V *SA Agulhas II* cruise was continuously collecting air-sea heat flux data to derive bulk net heat flux estimates. Also, dissolved inorganic carbon, alkalinity, $pCO_2$ (SOLAS themes 1 and 2).

Phytoplankton sampling of SAMBA line in Southeast Atlantic Ocean. Phytoplankton sampling of winter sea-ice in South Indian ocean at 55 degrees South, and meridional line into South Indian Ocean. In both cases coupled with primary production and nutrient uptake, nitrification experiments.

Monitoring and collection of size-segregated aerosols on the R/V *SA Agulhas II*, as well as at the Cape Point Global Atmospheric Watch Tower (SOLAS themes 1, 2, 3, 4 and 5).

Southern Ocean ecosystem response to dust input (SOLAS themes 3 and 4).

Aerosol monitoring in Stellenbosch town (January to October 2017)

Microbial Community dynamics in the Benguela upwelling region and around a Seamount south of Madagascar (MADRIDGE cruise project).

Continued field campaign at Cape Point to measure and monitor atmospheric halocarbons. This campaign was in partnership with the Atmospheric Chemistry Research Group at the University of Bristol and the South African Weather Service GAW Department (SOLAS themes 3 and 4).

Focus on surface wind speed and the turbulent latent heat flux across area of high SST gradient (eddies and Agulhas Current). Data intercomparison and data analysis (reanalysis and satellite remote sensing), model, international collaborations (SOLAS theme 2).

Southern Ocean biogeochemical monitoring: net carbon drawdown by the upper ocean ecosystem; rates of net primary production, nitrogen uptake, nitrification on varying timescales and using various methods; microbial community composition and function; role of sea ice in setting uppwer ocean chemistry, air-sea-ice fluxes of heat; trace metal concentrations and cycling (SOLAS themes 1, 2 and 3, as well as *Science and Society*).

Antarctic Circumnavigation Expedition (ACE) (2016-2018): funded by the Swiss Polar Institute and involving 22 projects from all over the world focused on the coupled ocean-atmosphere-ice-climate system (http://spi-ace-expedition.ch/). December 2016-March 2017: research cruise aboard the *Akademik Treshnikov* circumnavigating Antarctica. Two South African-led projects, with South African scientists involved in six other projects (SOLAS themes 1, 2, 3, 4 and 5, as well as *Science and Society*).

SEAmester: South Africa's first class afloat (annually from 2016) (http://www.seamester.co.za/): funded by the National Research Foundation, the goal of SEAmester is to encourage interaction between young South African scientists, lecturers and field specialists in a hands-on, practical environment on board the R/V *SA Agulhas II*. 40 students and 20 lecturers and numerous technicians at sea for 11 days, engaging in classroom learning, hands-on oceanography and atmospheric sampling, and "real" science. 2017 cruise was along the SAMBA line (Southeast Atlantic, Cape Town to meridian along 34.5°S) (SOLAS theme *Science and Society*).

The Preface program allowed the deployment and annual maintenance of an Atlas mooring at 6°S, 8°E during preface cruises. A first mooring was bought by South Africa in 2006 and was deployed successfully for a year during a pilot project. Preface then funded a second mooring in order to establish a permanent monitoring location. This is an extension of the PIRATA array of moorings in the tropical South-East Atlantic (Prediction and Research Moored Array in the Atlantic; designed to study ocean-atmosphere interactions in the tropical Atlantic that affect regional weather and climate variability on seasonal, interannual and longer time scales) and an African contribution to the global observing system. The "Kizomba" mooring is equipped with an extra current meter at 10 m and an extra shortwave radiation sensor that allows for the calculation of the radiative flux and the net heat budget at a 10 minute temporal resolution. Turbulent, sensible and latent heat fluxes can also be calculated at a 10 minute resolution. Sensible and daily averages are available in real time. A $CO_2$ sensor is also deployed on the mooring. The strategic location of the mooring in the stratocumulus deck, which is a problem for coupled models, offshore of the Congo River panache and upstream of the Angola Current make this mooring a unique measuring platform which has continuously worked in real time since May 2013 (SOLAS themes 1 and 2) (SOLAS themes 1 and 2).

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

Botha, R., Labuschagne, C., Williams, A.G., Bosman, G., Brunke, E.-G., Rossouw, A., Lindsay, R. (2018) Characterising fifteen years of continuous atmospheric radon activity observations at Cape Point (South Africa). *Atmospheric Environment* 176, 30-39, doi:10/1016/j.atmosenv.2017.12.010.

Du Plessis M, Swart S, Ansorge I J, Mahadevan A (2017) Submesoscale processes promote seasonal restratification in the Subantarctic Ocean. *Journal of Geophysical Research Oceans* 122, 2960-2975, doi:10.1002/2016JC012494.

Gregor L, Kok S, Monteiro P M S (2017) Empirical methods for the estimation of Southern Ocean $CO_2$: support vector and random forest regression. *Biogeosciences* 14, 5551-5569, doi:10.5194/bg-14-5551-2017.

Mawren D, Reason C J C (2017) Variability of upper ocean characteristics and tropical cyclones in the South West Indian Ocean. *Journal of Geophysical Research Oceans* 122, 2012-2028, doi: 10.1002/2016JC012028

Schmidt K, Swart S, Reason C J C, Nicholson S (2017) Evaluation of satellite and reanalysis wind products with *in situ* Wave Glider wind observations in the Southern Ocean. *Journal of Atmospheric and Oceanic Technology*, doi.org/10.1175/JTECH-D-17-0079.1

**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?**

International: Collaborative research and shared student supervision with MIT, CalTech, Princeton University, University of Connecticut, Florida State University, University of Bristol, Hong Kong University of Science, Swiss Polar Institute, ICEMASA, Max Planck Institute for Chemistry.

National (non university): Collaborative research and shared student supervision with the Council for Scientific and Industrial Research, Department of Environmental Affairs, South African Weather Service, Department of Science and Technology, South African Environmental Observation Network. Department of Agriculture, Forestry and Fisheries.

Collaborations included shared field work (specifically, research cruises, field campaigns, research at the Cape Point Global Atmospheric Watch Tower), student exchanges, modelling efforts, secondment of faculty from foreign institutions to teach and co-supervise students.

**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.).**

NO-PANTS – New Observations of Processes within Antarctic Sea-ice (August 2018): multiple glider, ship, wave glider and perhaps other buoy deployments in the marginal ice zone, East Weddell to measure surface fluxes and impact on upper ocean stratification processes (SOLAS themes 1 and 2).

SANAP – South African National Antarctic Programme (2018-2020) Winter and summer cruises to the Southern Ocean on the R/V *SA Agulhas II* (ice-breaker), including sampling of the marginal ice zone. Annual cruises to the Prince Edward Islands (Subantarctic) and Gough Island (SOLAS themes 1, 2, 3, 4 and 5).

Southern Benguela Integrated Ecosystem Programme (IEP; Department of Environmental Affairs) – four cruises annually to the SBUS to monitor the region's physics, chemistry and biology (SOLAS themes 1 and 2).

PLATO – The role of PLankton in a coupled Atmosphere-Ocean System: Biannual cruises to the Benguela upwelling system, modelling efforts, atmospheric sampling to investigate the role of phytoplankton in albedo and global climate: The coupled ocean-atmosphere Benguela System

(SOLAS themes 1, 2, 3, 4 and 5).

Continued aerosol collection, trace gas monitoring (including $CO_2$, $CH_4$, NOx, $N_2O$, bromoform, etc), mercury deposition at the Cape Point GAW tower (SOLAS themes 1, 4 and 5).

SOLSTICE-WIO – Sustainable Oceans, Livelihoods and food Security Through Increased Capacity in Ecosystem research in the Western Indian Ocean (http://solstice-wio.org/) (2017-2020): Focus on the Agulhas bank (SOLAS themes 1 and 2).

Antarctic Circumnavigation Expedition (ACE) (2016-2018): 22 international projects focused on understanding the Subantarctic Ocean-Atmosphere system (SOLAS themes 1, 2, 3, 4 and 5).

False Bay (Western Cape) monitoring project (2018-2019): Water quality, biogeochemistry, rocky shore ecology, pollution (run-off, atmospheric deposition), aerosols (SOLAS themes 3, 4, 5, as well as *Science and Society*).

IIOE-2 ($2^{nd}$ International Indian Ocean Expedition) (2017 onwards): Investigation of western Indian Ocean physics, chemistry, biology (with Mozambique, Tanzania, Mauritius) (SOLAS themes 1, 2, 5, as well as *Science and Society*).

Preface: Continued deployment and maintenance of the "Kizomba" mooring (South Africa's contribution to the PIRATA array of moorings in the tropical South-East Atlantic) – measurements of currents, radiative flux and the net heat budget, $CO_2$ fluxes (SOLAS themes 1 and 2).

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

SOFLUX meeting at Polar2018 (Davos) - SOOS Southern Ocean Flux Working Group: June 2018. OSM 2018 (Portland) side meeting between SOFLUX and SOLAS for future collaboration and engagement on common issues (SOLAS themes 1 and 2).

Polar2018 (Davos): June 2018. South African researchers and students engaged in Antarctic research will present their findings at the SCAR Open Science Conference. South Africa also participates in the SCAR business meetings held alongside the conference (SOLAS themes 1, 2, 3, 4 and 5, as well as *Science and Society*).

ACE (Antarctic Circumnavigation Expedition) meetings: January 2018 (Lusanne, Switzerland) and June 2018 (Davos, Switzerland). Two South African-led projects are part of the 22 international projects funded through the Swiss Polar Institute (South African contribution to SOLAS themes 1 and 3, as well as *Science and Society*).

PHYCOLOG workshops – PHYtoplankton COmmunities along the Land-Ocean Gradient in a warmer climate (South Africa and Denmark): 2018-2019. Four workshops over the course of two years (the first held in March 2018) involving researchers and students from the University of Cape Town, Cape Peninsula University of Technology, and Aarhus University (SOLAS themes 1 and 3, as well as *Science and Society*).

SANAP (South African National Antarctic Programme) symposium (Hermanus): August 2018. Four-day meeting of all South African scientists engaged in Antarctic research (addresses SOLAS themes 1, 2, 3, 4 and 5, as well as *Science and Society*).

SCOR Working Group 155: "Eastern boundary upwelling systems (EBUS): diversity, coupled dynamics and sensitivity to climate change". One South African full member and one associate member. First meeting June 2018 (Washington, DC). Terms of reference include: 1) synthesizing existing knowledge of EBUS forcing and feedbacks, 2) development of an assessment tool for EBUS, 3) review paper, 4) recommendations of regional observation systems, 5) socio-economic evaluation that provides guidance for all stakeholders. Also, planned contribution to Ocean Obs'19 and IPCC WGII, possible collaboration with CLIVAR RF EBUS, and organization of summer school (likely in Senegal or Peru) focused on EBUS (SOLAS themes 1, 2 and 4, as well as *Science and Society*).

NOSASSO (N-OSmolytes Across the Surface Southern Ocean: Environmental Drivers and Bioinformatics) workshop (September 2018): post-cruise activity to exploit data and knowledge generated during ACE (see above) to address cross-disciplinary issues and increase international breadth. This project will address four major themes: 1) Microbes, genes, trace gases and their precursors; 2) Nutrient influences on osmolytes, trace gases and productivity; 3) Ocean-atmosphere exchange: ocean emissions and the chemistry of aerosols; 4) Data extrapolation via remote sensing and modelling (SOLAS themes 1, 3, 4 and 5).

SASAS (South African Society for Atmospheric Sciences) Conferences planned for 2018 and 2020 (SOLAS themes 1, 2, 3, 4 and 5).

SAMSS (South African Marine Sciences Symposium) Meeting planned for 2020 (SOLAS themes 1 and 3, as well as *Science and Society*).

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

Sweden Wallenberg NO-PANTS project (see above) together with Southern Ocean Carbon and Climate Observatory (SOCCO), CSIR (SOLAS themes 1 and 2).

SANAP (2018-2020): Role of Southern Ocean on Western Cape drought and flood events; Biogeochemical controls on the sources and chemical composition of Southern Ocean marine aerosols; A nitrogen cycle view of atmospheric $CO_2$ sequestration in the Antarctic Ocean; South Ocean ecosystems response to dust input; Shifts in phytoplankton and microbial community composition and functional diversity; trace metal cycling and availability in the Southern Ocean; Southern Ocean $CO_2$ and heat fluxes; submesoscale physical processes in the Southern Ocean; phytoplankton community composition (remote sensing/optical measures) (SOLAS themes 1, 2, 3, 4 and 5, as well as *Science and Society*).

SEAmester – South Africa's first class afloat (annually): teaching university aboard the R/V SA Agulhas II (SOLAS theme *Science and Society*).

SA-SAMOC (South Atlantic Meridional Overturning Circulation) (2018-2020): continued monitoring of volume transport across the South Atlantic (with the University of Cape Town, France, Brazil, USA and UK) (SOLAS theme 2).

ASCA (Agulhas System Climate Array): continued monitoring (with the University of Cape Town, South African Environmental Observation Network, Netherlands and USA) (SOLAS theme 1 and 2).

ACCESS (Alliance for Collaboration on Climate and Earth Systems Science) (2018-2020): Annual cycle of ocean-atmosphere interaction over ocean hotspots near southern Africa and influence on regional climate variability; The role of phytoplankton in albedo and global climate: The coupled ocean–atmosphere Benguela System (with Namibia, USA, UK); Predictability of seasonal anomalies for societal benefit (SOLAS themes 1, 2, 3, 4 and 5, as well as *Science and Society*).

South African National Research Foundation Competitive Support Programme: Investigation of the sources and interactions of reduced nitrogen species in the remote marine atmosphere (with USA); Late Quaternary ocean-climate interactions: palaeo-science training through palaeo-climate research (with USA, Germany) (SOLAS themes 1, 3, 4 and 5, as well as *Science and Society*).

SOLSTICE project (2017-2020). Focusing on the Agulhas bank, the microbial dynamics of the nephloid layer and its effect on squid recruitment.

Activities underway: Airborne particle monitoring in Western Cape (year round); **see also major field studies above for activities underway**.

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

H2020 proposal being submitted: University of Gothenburg and CSIR collaborating on $pCO_2$ and heat flux Work Package (SOLAS themes 1 and 2); University of Cape Town, CSIR and UK partners collaborating on Phytoplankton Work Package (SOLAS themes 1 and 4).

South African Water Research Commission (submission date May-July 2018): Drivers and indicators of water quality in South Africa's largest natural bay: weather patterns, nitrogen biogeochemistry, and fishers' knowledge (SOLAS themes 3, 4 and 5, as well as *Science and Society*).

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

ORCHESTRA, UK; GEOTRACES; COMICS; GO-SHIP; ROSES; BIO-ARGO; SOCCOM; ACE; SOOS; SCAR; SCOR; CLIVAR

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *'Spain'*
## *compiled by: 'Alfonso Saiz-Lopez'*

*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 atmosphere plays a fundamental role in the transport of microbes across the planet but it is often neglected as a microbial habitat. Although the ocean represents two thirds of the Earth's surface, there is little information on the atmospheric microbial load over the open ocean. This study provides a global estimate of microbial loads and air-sea exchanges over the tropical and subtropical oceans based on the data collected along the Malaspina 2010 Circumnavigation Expedition. Total loads of airborne prokaryotes and eukaryotes were estimated at $2.2 \times 10^{21}$ and $2.1 \times 10^{21}$ cells, respectively. Overall 33–68% of these microorganisms could be traced to a marine origin, being transported thousands of kilometres before re-entering the ocean. Moreover, these results show a substantial load of terrestrial microbes transported over the oceans, with abundances declining exponentially with distance from land and indicate that islands may act as stepping stones facilitating the transoceanic transport of terrestrial microbes.

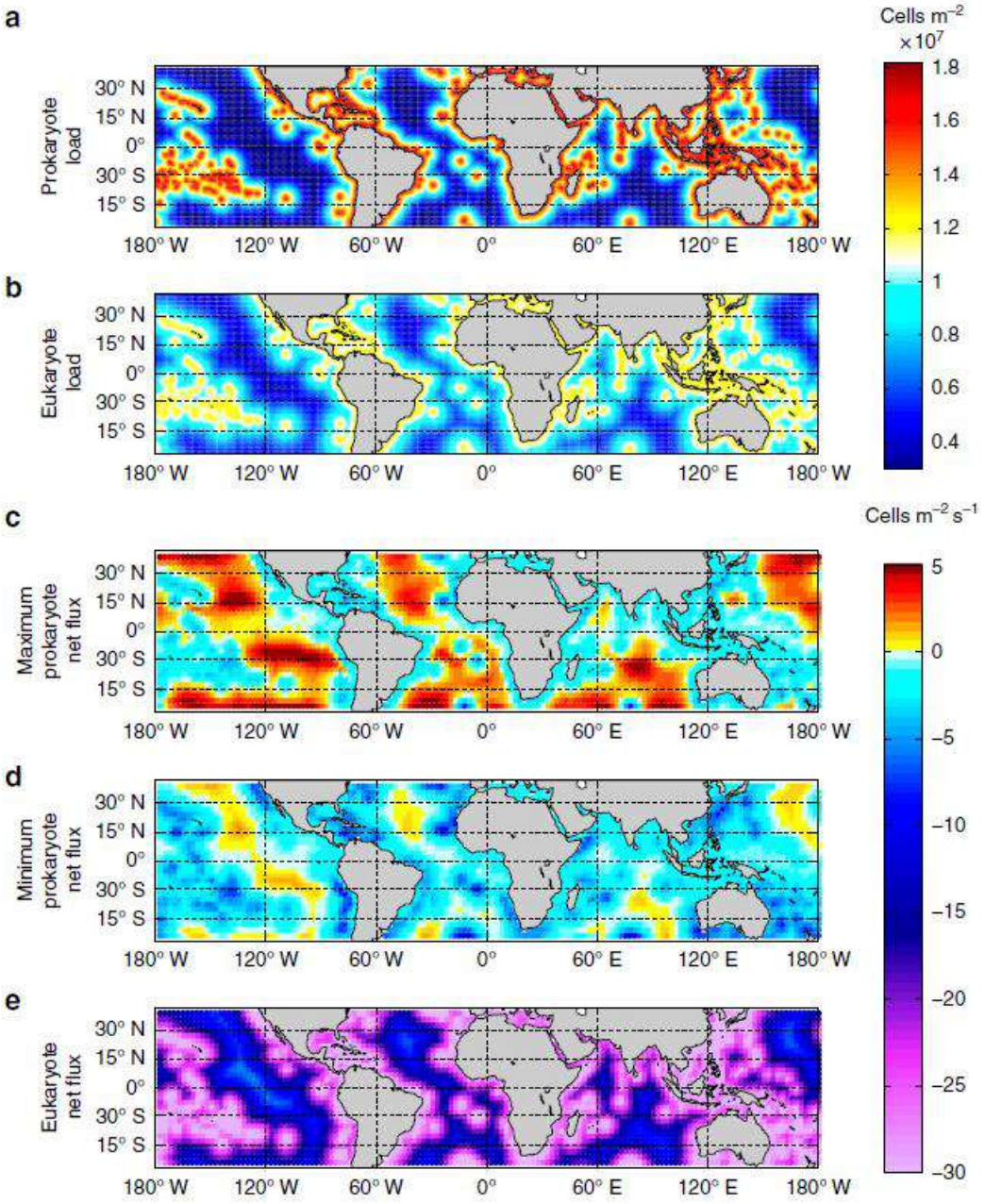


Figure: Microbial loads and air-sea exchange fluxes over the global tropical and subtropical ocean. Prokaryotic load a and eukaryotic load b over the ocean extension compressed between 40° S and 40° N with resolution of 1° × 1°; maximum net fluxes of prokaryotes considering high spray fluxes c and low spray fluxes d; and net fluxes of eukaryotes e considering high spray fluxes (the differences between net fluxes of eukaryotes using high or low spray fluxes were negligible) with resolution of 2.5° × 2.5°. Negative values indicate net deposition fluxes.

Citation: Mayol et al., Long-range transport of airborne microbes over the global tropical and subtropical ocean. *Nature Communications*, 8 (1), 2017.

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**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).**

The **Antarctic Circumnavigation Expedition** (ACE) was a project funded by the Swiss Polar Institute with sponsorhip by Ferring Pharmaceuticals. It consisted of a 3 months cruise across the Southern Ocean around Antarctica, visiting the Subantarctic islands and touching twice the Antarctic coasts. Scientists from 30 countries are involved through 22 projects covering island ecology, glaciology, plankton and benthic biodiversity, plankton productivity, whale distribution, air-sea interactions, the water cycle, winds and waves. The ICM-CSIC team (R. Simó) led the subproject **SORPASSO** (ACE#8), aimed at measuring the distribution and drivers of trace gases and organic particles in the surface Southern Ocean.

During the period 2015-2017 (extended to 2018), INTA conducted routine tropospheric measurements of BrO, IO and aerosol extinction from the sites of Belgrano and Marambio within the HELADO project (Halogens in the Antarctic atmosphere and its role in the Ozone distribution, CTM2013-41311-P, Spanish Ministry of Economy and Competitiveness).

SENTINEL project sampling campaigns: February 2017-Deception Island (South Shetland islands). December 2017-March 2018- Livingston Island (South Shetland islands). Objective: Atmospheric deposition and cycling of organic pollutants in the coastal Antarctica.

An oceanographic cruise was conducted on board Victor Angelescu (Argentina) from Vigo (Spain) to Buenos Aires (Argentina) in November 2017 providing underway $CO_2$ measurements apart from advising about its installation and supervising its working during the cruise.

Project ANIMA (ongoing). ANIMA is a research project funded by the Spanish Ministry of Economy and Competitiveness (CTM2015-65720-R), running from 2016 to 2018. http://anima.icm.csic.es

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

Mayol E, Arrieta JM, Jiménez MA, Martínez-Asensio A, Garcias-Bonet N, Dachs J, González-Gaya B, Royer S-J, Benítez-Barrios VM, Fraile-Nuez E, Duarte CM, 2017 Long-range transport of airborne microbes over the global tropical and subtropical ocean. *Nature Communications*, 8 (1), art. no. 201, DOI: 10.1038/s41467-017-00110-9.

Dall'Osto M., J. Ovadnevaite, M. Paglione, D.C.S. Beddows, D. Ceburnis, C. Cree, P. Cortés, M. Zamanillo, S.O. Nunes, G.L. Pérez, E. Ortega-Retuerta, M. Emelianov, D. Vaqué, C. Marrasé, M. Estrada, M.M. Sala, M. Vidal, M.F. Fitzsimons, R. Beale, R. Airs, M. Rinaldi, S. Decesari, M.C. Facchini, R.M. Harrison, C.D. O'Dowd, R. Simó (2017). Antarctic sea ice region as a source of biogenic organic nitrogen in aerosols. *Scientific Reports* 7: 6047, doi:10.1038/s41598-017-06188-x.

Burgos, M., Ortega, T., Forja, J.M. 2017. Temporal and spatial variation of N2O production from estuarine and marine shallow systems of Cadiz Bay (SW, Spain). The Science of the Total Environment, 607-608: 141-151. doi: 10.1016/j.scitotenv.2017.07.021.

González-Dávila, M., Casiano, J.M.S., Machín, F. (2017) Changes in the partial pressure of carbon dioxide in the Mauritanian-Cap Vert upwelling region between 2005 and 2012. Biogeosciences. 14, 389-3871. DOI: 10.1016/j.dsr2.2016.10.004.

Navarro G, Almaraz P, Caballero I, Vázquez A, Huertas IE (2017) Reproduction of Spatio Temporal Patterns of Major Mediterranean Phytoplankton Groups from Remote Sensing OC-CCI Data. *Frontiers in Marine Science* 4, 246,doi:10.3389/fmars.2017.00246

**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?**

The Antarctic Circumnavigation Expedition has been a major endeavour of a number of research institutions with a private foundation (Editions Paulsen and the ACE Foundation).

## 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.).**

OVIDE line cruise Jun-Jul 2018. $pCO_2$ underway measurements.

FICARAM-18 from Ushuaia-Cartagena: $pCO_2$ underway measurements.

The BIOGAPS Expedition to Moorea. An island-based intensive sampling study in the open ocean and coral reef waters of the tropical South Pacific. Accommodation, labs and sampling facilities are provided by the Richard B. Gump Station (UC Berkeley . April 4 to 27, 2018).

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

F. Peters (ICM-CSIC) convened a Session at the Ocean Sciences Meeting on Air-sea exchanges and Ocean Biogeochemistry. Portland OR, 16 February 2018.

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

**2016-2018 SENTINEL-The Antarctic as sentinel of global pollution. Funded by Spanish Government (PN).**

SORPASSO (Surveying organic reactive gases and particles in the surface Southern Ocean). A subproject of the Antractic Circumnavigation Expedition. EPFL – Polar Swiss Institute. PI: R. Simó. 120.000 €. 2016-2019.

BIOGAPS (Biogenic trace gases and their cycling processes in the surface sea). CTM2016-81008-R (Spanish MINECO). PI: R. Simó. 258.940 €. Dec 2016- Dec 2019.

VIMS-Ehux (Viral Infection and Microbiome Succession during an *E. huxleyi* bloom and its implications for the biogeochemical S and C cycles), an AQUACOSM Transnational Access project funded by the EC through H2020-INFRAIA. PI: Assaf Vardi (Wassmann Inst, Israel); co-PI: R. Simó. 2018.

Response of Mediterranean jellyfish to the interacting effect of climate-related drivers of impacts: survival in a warmer and more acidic Mediterranean (CTM2016-75487-R). Funding agency: Spanish Ministry of Economy, Industry and Competitiveness. (2017-2019)

Effect of permeabilization of Doñana marshland on the biogeochemical status of its aquatic ecosystems (1539/2015). Funding agency: Spanish Ministry of Agriculture, Food and Environment. (2016-2018).

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

Proposal to the H2020 Programme: ACCENTO (Aerosol-Clouds interactions and their Climate Effects in Antarctica and the Southern Ocean). Partners: BAS (UK), TROPOS (G), ICM-CSIC (E), Univ. Aveiro (Por), Uni. Leeds (UK), AWI (G), CNRS (F), KU Leuven (B), UCO (G), TU Delft (NL), GAIA (I). To be submitted February 2018.

MOSAiC (Multidisciplinary drifting Observatory for the Study of Arctic Climate). An international project led by AWI, with participation of a number of international institutions. Subproject to be submitted to a special call of the Spanish MINECO on a hitherto unknown date. PI. R. Simó.

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

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *'Turkey'*
## *compiled by: 'Nazli Olgun'*

*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.*

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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 international collaboration. (If you wish to put more than one, feel free to do so).*

**Scientific Highlight 1: To which extent organic matter at the ocean surface affect properties of marine boundary layer aerosols? (Related SOLAS Theme-2, Air-sea interface and fluxes of mass and energy)**

**N. Olgun** attended the SOLAS/ESA meeting '*HARNESSING REMOTE SENSING TO ADDRESS CRITICAL SCIENCE QUESTIONS IN THE OCEAN-ATMOSPHERE INTERFACE*' on 12-15 June 2016 in Frascati, Italy. The scientific highlight indicated below is the outcome of 'Organic Matter' working group leaded by Dr. Yoav LeHahn and the manuscript is still in preparation.

Sea spray aerosols (SSA), which are emitted from the ocean to the atmosphere through wind-driven processes, originate in an aquatic environment that contains varying amounts of organic matter (OM). The presence of OM may have a strong impact on SSA population, both through enrichment of the emitted particles and through altering the efficiency of the aerosol production process. Observed properties of organic marine aerosols is the contribution of marine hydrogels which are emitted during the sea spray production process. Orellana et al. (2011), have shown that marine gels may have an important effect on the chemical and physical properties of the atmosphere, by providing an important source of cloud condensation nuclei during the pristine arctic summer. Although it is well acknowledged that OM has an important effect of the properties of sea spray aerosols, fundamental questions on the nature of this effect are still open. Importantly, there is an ongoing debate on the dependency of sea spray aerosols on localized (in space and in time) events of enhanced biological activity, and on the efficiency of using chlorophyll-a (Chl, a measure to phytoplankton biomass) data as a proxy for OM enrichment. The manuscript will focus on the use of remote sensing tools to understand the impact of organic matter in the physico-chemical properties of marine boundary layer.

Citation: Manuscript in preparation (author list is not available yet).

**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).**

Selected Projects:

1. Impact assessment of Hydroelectric Power Plants (HEPP) to marine ecosystems, Coordinator: Prof. Dr. Zahit Uysal, Institute of Marine Sciences, Middle East Technical University, Turkey, 2017/2019 (active).
2. Development of Integrated Modelling System for the Marmara Sea, National Project, Coordinator: Dr. Barış Salihoğlu, Institute of Marine Sciences, Middle East Technical University, 2017/2017 (active).
3. New approaches for investigating the marine microbial reactions: genetic, biogeochemistry and modelling, National Project, Coordinator: Dr. Barış Salihoğlu, Institute of Marine Sciences, Middle East Technical University, Turkey, 2016/2017 (active).
4. Impact of microplastic particles and 'Bisphenol A' compound on marine zooplankton communities in the Gulf of Mersin. Coordinator: Prof. Dr. Ahmet E. Kıdeys, Institute of Marine Sciences, Middle East Technical University, Turkey, 2016/2018 (active).
5. In situ observations of hydrogen sulphur in anoxic marine environments: Development of voltammetric micro sensor methods for detecting low concentrations, Dr. Mustafa Yücel, Institute of Marine Sciences, Middle East Technical University, Turkey, 2016/2018 (active).
6. Phosphorous compounds and their redox related processes: Atmosphere, river water column and sediment phosphorous speciation, Coordinator: Dr. Mustafa Yücel, Institute of Marine Sciences, Middle East Technical University, Turkey, 2016/2018 (active).
7. Determination and quantification of microplastic compounds and possible impacts of accumulation of microplastic on marine products. Coordinator: Prof. Dr. Ahmet E. Kıdeys, Institute of Marine Sciences, Middle East Technical University, Turkey, 2016/2018 (active).
8. Investigation of the impacts of primary productivity on methane emissions in lakes in Cape Horn (55° S) ve King George (62° S) Islands in Antarctica' **Olgun N.,** Istanbul Technical University (ITU) Project 42605 ' ended 29.03.2017, related to SOLAS Theme 1 Greenhouse gases and the oceans.

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

1. Spatio-temporal variability of the size-fractionated primary production and chlorophyll in the Levantine Basin (northeastern Mediterranean), Yücel N., 2017, Oceanologia 155, doi.org/10.1016/j.oceano.2017.12.0033
2. Microplastic litter composition of the Turkish territorial waters of the Mediterranean Sea, and its occurrence in the gastrointestinal tract of fish, Güven O., Gökdağ K., Jovanovic B., Kıdeys A. E., 2017, Environmental Pollution, http://dx.doi.org/10.1016/j.envpol.2017.01.025.
3. Seasonal and spatial variation of bacterial production and abundance in the northern Levantine Sea, Yücel N., Mediterranean Marine Science, 18/1, 97-106, http://dx.doi.org/10.12681/mms.1627
4. Eutrophication assessment, classification and management in the Northeastern Mediterranean Sea S. Tugrul*, K. Ozhan and I. Akcay, 2017, Sixth International Conference On Environmental Management, Engineering, Planning And Economics (CEMEPE) And SECOTOX Conference
5. A high-resolution modelling study of the Turkish Straits System, Sannino G., Sözer A., Özsoy A., 2017, Ocean Dynamics, 67, 397-432, DOI 10.1007/s10236-017-1039-2

*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.*

**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?**

Two pretentions were given to introduce SOLAS in different departments at İstanbul Technical University in Turkey:

- Surface Ocean Lower Atmosphere - SOLAS Research Initiative, Dr. N.Olgun, İstanbul Technical University Meteorological Engineering Seminars, 11.10.2017
- Surface Ocean Lower Atmosphere - SOLAS Research Initiative, Dr. N.Olgun, İstanbul Technical University Eurasia Institute of Earth Sciences Seminers, 22.11.2017

## 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.).**

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

- A SOLAS workshop organization in Turkey is intended for 2018-2019, to be organized in ITU or METU.

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

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

Planned Project Proposal: N. Olgun 'Evaluating the carbonate chemistry dynamics and the climate change response of The Sea of Marmara, Turkey', to be submitted on **September 2018** to The Scientific and Technological Research Council of Turkey (TUBITAK). The project is related to SOLAS Theme-1, Greenhouse gases and the oceans.

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

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS *'country'*
## *compiled by: 'Name'*

*This report has two parts:*

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2 Air-sea interfaces and fluxes of mass and energy;
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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).*<br><br>Sabbaghzadeh et al. present the first measurement of surfactant activity in the surface microlayer (SML) and sub-surface water at an Ocean Basin scale. Measurements from two Atlantic Meridional Transect cruises (50°N to 50°S) show that the SML is ubiquitously enriched in surfactants relative to underlying water (i.e. Enrichment Factor > 1). Interestingly SML enrichments appear to persist at intermediate-high wind speeds (>7 m/s). These results have important implications for air/sea gas transfer and for the production and composition of primary marine aerosol. |

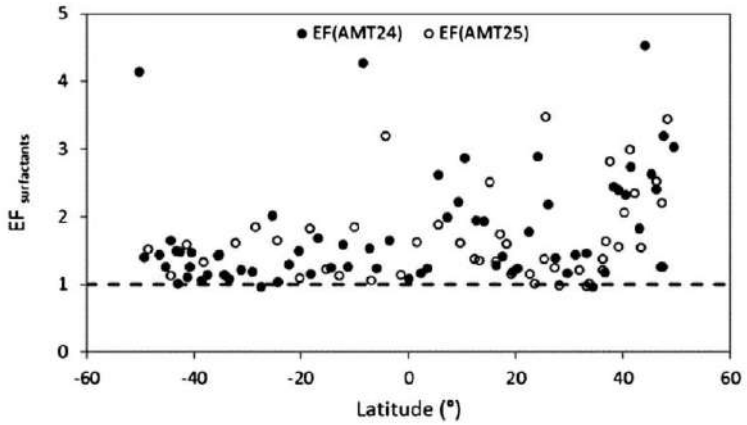


**Figure 3.** Latitudinal distribution of SA enrichment factors (EFs) in the SML.

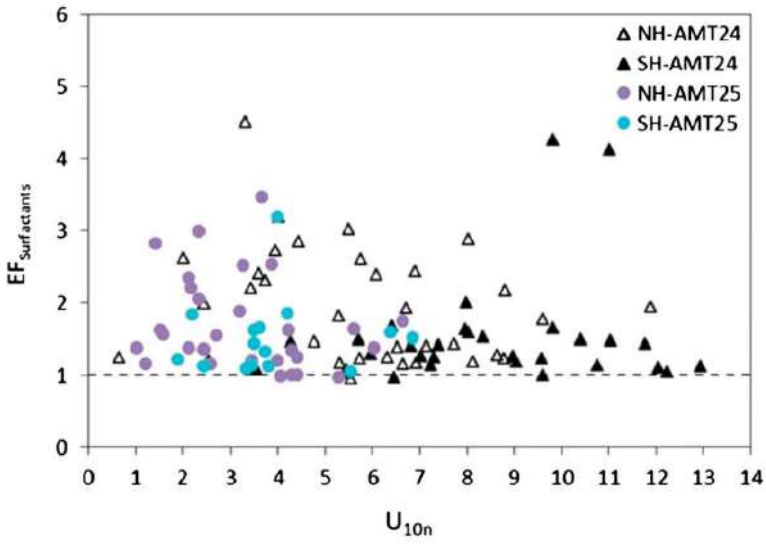


**Figure 4.** EF versus $U_{10n}$ in the Northern Hemisphere (NH) and the Southern Hemisphere (SH). The dashed line represents EF = 1.

**Reference:**

Sabbaghzadeh, B., R. C. Upstill-Goddard, R. Beale, R. Pereira and P. D. Nightingale (2017). The Atlantic Ocean surface microlayer from 50°N to 50°S is ubiquitously enriched in surfactants at wind speeds up to 13 m/s. *Geophysical Research Letters* 44(6): 2852-2858.

I know I'm not supposed to put more than one highlight, but I didn't feel comfortable selecting myself. With the obvious bias, I think Bell et al. (2017) is important. The paper presents the first field-based estimates of bubble-mediated gas exchange. The air/sea gas transfer velocities of gases with different solubility (DMS and $CO_2$) were measured concurrently. The difference between the gas transfer velocities is very likely to be due to enhanced bubble-mediated exchange of the less soluble gas ($CO_2$). The difference between the transfer velocities ($\Delta k$) shows strong relationships with wind speed and whitecap fraction. $\Delta k$ was also used to estimate the bubble component of $CO_2$ transfer at high wind speeds and compare with existing models of bubble mediated exchange. The data suggest that the models overpredict the bubble component of gas exchange at intermediate wind speeds.

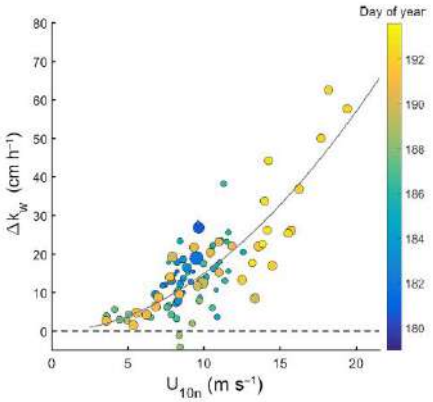


**Figure 6.** Difference ($\Delta k_w$) between 2 h average $k_{CO_2}$ and $k_{DMS,Sc}$ plotted against $U_{10}$. Data are coloured by the date of measurement (Day of Year). Sea surface temperature (SST) is indicated by symbol size (range is 7.1 to 12.5 °C). The solid grey line describes the power law fit to the data (see Eq. 7).

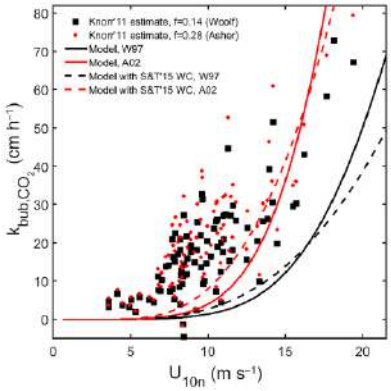


**Figure 8.** Bubble-mediated transfer velocity of $CO_2$ ($k_{bub,CO_2}$) as a function of wind speed. Individual points are Knorr_11 observations using solubility and diffusivity scaling from Woolf (1997) (black squares) and Asher et al. (2002) (red circles). Continuous lines are model calculations of $k_{bub,CO_2}$ using the Knorr_11 wind speed versus whitecap areal fraction relationship (see Fig. 2) and mean SST (Woolf, 1997: black; Asher et al., 2002: red). Model calculations were also performed using the Schwendeman and Thomson (2015) wind speed versus whitecap areal fraction relationship (dashed lines).

**Reference:**

Bell, T. G., Landwehr, S., Miller, S. D., de Bruyn, W. J., Callaghan, A. H., Scanlon, B., Ward, B., Yang, M., and Saltzman, E. S.: Estimation of bubble-mediated air–sea gas exchange from concurrent DMS and CO2 transfer velocities at intermediate–high wind speeds, Atmos. Chem. Phys., 17, 9019-9033, https://doi.org/10.5194/acp-17-9019-2017, 2017.

**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).**

### *Meetings*

- *GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) WG 38* held two workshops (hosted at the University of East Anglia):
  1. Changing Atmospheric Acidity and the Oceanic Solubility of Nutrients
     25 people came to the meeting from around the world. It was co-sponsored by SOLAS, SCOR, GESAMP, NSF and UEA.
  2. Impact of Ocean Acidification on Fluxes of non-$CO_2$ Climate-Active Species

Participants left Norwich full of enthusiasm for the new scientific insights the groups had developed. The aim now is to write a series of papers synthesising these conclusions. At least one review paper is in preparation:

FE Hopkins, P Suntaralingham, M Gehlen, et al. Changing ocean acidity as a modulator of atmospheric biogeochemistry and climate.

Bob Duce & Tim Jickells (co-chairs of GESAMP WG38)

Alex Baker, Cécile Guieu and M.M. Sarin (Co-chairs of Workshop 1)

Parv Suntharalingam, Marion Gehlen and Frankie Hopkins (Co-chairs for Workshop 2)

- UK Greenhouse Gas Strategy meeting, University of Leeds, Leeds, 08-09/1/2017.
- SOOS (Southern Ocean Observing System) West Antarctic Peninsula meeting, British Antarctic Survey, Cambridge, 15-16 May 2017.
- West Antarctic Peninsula Royal Society meeting on biogeochemical cycling. Kavli International Centre, Chicheley Hall, 17-18/05/2017.

- ICDC10, the 10th International Carbon Dioxide Conference, Interlaken, Switzerland, 20-27/08/2017.
- SOCAT (2017) SOCAT (Surface Ocean CO2 Atlas) update and road ahead. IOCCP side event at the 10th International Carbon Dioxide Conference (ICDC10) Interlaken, Switzerland, 23 August 2017. https://www.socat.info/wp-content/uploads/2017/06/2017_SOCAT_Road_Ahead_at_ICDC10_Report.pdf
- Rob Upstill-Goddard participated in "The Ocean Surface Microlayer and Biogeochemical Feedbacks in the Earth System," international workshop held from 1–3 July 2015 at the Wissenschaftszentrum, Kiel. Resulted in Engel et al. (2017) – see below.

### *Projects*

Rob Upstill-Goddard's (Newcastle University) and Lucy Carpenter's (University of York) research groups participated in the MILAN project (Sea-surface MIcroLAyer functioning during the Night) during March/April 2017 in the Southern N. Sea: http://www.ncl.ac.uk/nes/research/marine/projects/completemilan.html. This was an international collaboration hosted by ICBM (Institute for Chemistry and Biology of the Marine Environment, University of Oldenburg). The Newcastle contribution was funded by the School of Marine Science and Technology, Newcastle University.

*Surface Ocean $CO_2$ Atlas (SOCAT) news:*

• The Surface Ocean $CO_2$ Atlas (SOCAT) released version 5 on 19 June 2017.

• SOCAT updated its website on the occasion of its 10th anniversary (www.socat.info).

• The Surface Ocean $CO_2$ Atlas (SOCAT) celebrated its 10th anniversary at ICDC10, the Tenth International Carbon Dioxide Conference, with a festive dinner on 24/08/2017 in Interlaken, Switzerland.

• The SOCAT Scientific Community, 09/06/2017. Voluntary Commitment to the 2017 UN Conference for 'Annual, public SOCAT releases' #OceanAction20464 for the UN Ocean Conference. https://oceanconference.un.org/commitments/?id=20464

**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.*

The following alphabetical list of SOLAS-relevant, peer-reviewed 2017 publications (n = 46) with UK authors/co-authors is based on researchers' input and Web of Knowledge searches. There has been no attempt to formally rank the "top 5" in terms of scientific quality or importance.

1. Bachman S. D., J. R. Taylor, K. Adams K and P. J. Hosegood, 2017. Mesoscale and Submesoscale Effects on Mixed Layer Depth in the Southern Ocean, Journal of Physical Oceanography, doi: 10.1175/JPO-D-17-0034.1, https://doi.org/10.1175/JPO-D-17-0034.1
2. Baker, A.R., M. Kanakidou, K.E. Altieri, N. Daskalakis, G.S. Okin, S. Myriokefalitakis, F. Dentener, M. Uematsu, M.M. Sarin, R.A. Duce, J.N. Galloway, W.C. Keene, A. Singh, L. Zamora, J.F. Lamarque, S.C. Hsu, S.S. Rohekar, J.M. Prospero. (2017). Observation- and model-based estimates of particulate dry nitrogen deposition to the oceans, Atmospheric Chemistry and Physics, 17, 8189-8210.
3. Baker, A.R. and T.D. Jickells. (2017). Atmospheric deposition of soluble trace elements along the Atlantic Meridional Transect (AMT), Progress in Oceanography, 158, 41-51.

4. Bell, T. G., S. Landwehr, S. D. Miller, W. J. de Bruyn, A. H. Callaghan, B. Scanlon, B. Ward, M. Yang and E. S. Saltzman (2017). "Estimation of bubble-mediated air-sea gas exchange from concurrent DMS and CO2 transfer velocities at intermediate–high wind speeds." Atmos. Chem. Phys. 17(14): 9019-9033.
5. Blomquist, B. W., S. Brumer, C. W. Fairall, B. Huebert, C. J. Zappa, I. M. Brooks, M. Yang, L. Bariteau, J. Prytherch, J. E. Hare, H. Czerski, A. Matei, R. W. Pascal, 2017: Wind speed and sea state dependencies of air-sea gas transfer: results from the High Wind speed Gas exchange Study (HiWinGS), J. Geophys. Res. 122, doi: 10.1002/2017JC013181
6. Bridgestock, L., M. Rehkämper, T. Flierdt, K. Murphy, R. Khondoker, A. R. Baker, R. Chance, S. Strekopytov, E. Humphreys-Williams and E. P. Achterberg (2017). "The Cd isotope composition of atmospheric aerosols from the Tropical Atlantic Ocean." Geophysical Research Letters 44(6): 2932-2940.
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8. Brumer, S. E., C. J. Zappa, I. M. Brooks, H. Tamura, S. M. Brown, B. Blomquist, C. W. Fairall, A. Cifuentes-Lorenzen, 2017: Whitecap coverage dependence on wind and wave statistics as observed during SO GasEx and HiWinGS, J. Phys. Oceanogr. 47, 2211-2235, doi:10.1175/JPO-D-17-0005.1
9. Callaghan, A. H., G. B. Deane and M. D. Stokes (2017). "On the imprint of surfactant-driven stabilization of laboratory breaking wave foam with comparison to oceanic whitecaps." Journal of Geophysical Research: Oceans 122(8): 6110-6128
10. Carpenter, L.J., Yokouchi, Y. and Atlas, E.L. (2017) Introduction to special issue on natural halocarbons in the atmosphere. J. of Atm Chem., 74(2) 141-143.
11. Carpenter, L.J., Andrews, S.J., Lidster, R.T. et al. J Atmos Chem (2017) 74: 145. https://doi.org/10.1007/s10874-015-9320-6
12. Chance, R. J., J. F. Hamilton, L. J. Carpenter, S. C. Hackenberg, S. J. Andrews and T. W. Wilson (2018). "Water-soluble organic composition of the Arctic sea surface microlayer and association with ice nucleation ability." Environmental Science & Technology 52(4): 1817-1826.
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20. Gonzales J, Tymon T, Küpper FC, Edwards MS, Carrano CJ, 2017: Iodine speciation in coastal seawater: A role for marine macroalgae.- PLoS ONE 12 (8): e0180755. doi: 10.1371/journal.pone.0180755

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**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?**

Bakker, D. C. E. and K. Currie, 15/11/2017. The Surface Ocean $CO_2$ Atlas. GOOS (Global Ocean Observing System) Webinar. http://goosocean.org/index.php?option=com_content&view=article&id=60&Itemid=169, 38 participants.

## 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.).**

Multi-million £ NERC-funded field programs will be taking place in the Southern Ocean during the S. Hemisphere summer season in the next 4 years.

For more details see:

Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports (ORCHESTRA) https://www.bas.ac.uk/project/orchestra/

Role of the Southern Ocean in the Earth System (RoSES) http://www.nerc.ac.uk/research/funded/programmes/roses/

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

Helen Czerski and Ian Brooks have fieldwork planned next summer (August/September 2018) as part of the Microbiology-Ocean-Cloud Coupling in the High Arctic (MOCCHA) study, which is funded by the Swedish Polar Research Secretariat and the NSF. It is an international study led by Caroline Leck at Stockholm University, with participants from the UK, USA, and Germany.

MOCCHA will study the links between marine microbiology, biochemistry, and aerosols produced at the water surface in open leads, and their interaction with ubiquitous Arctic stratiform clouds within the boundary layer: http://www.aces.su.se/research/projects/microbiology-ocean-cloud-coupling-in-the-high-arctic-moccha/ A 2 month cruise on icebreaker Oden will more to a stable ice floe close to the pole and drift for 5 weeks. An extensive set of instrumentation will be deployed on the sea ice. The Leeds group will measure surface fluxes, atmospheric boundary layer structure, cloud properties via a suite of remote sensing instruments, and ice nucleating particles. Some sampling will be conducted from a tethered balloon.

Helen is waiting to hear whether an additional component to the work on that ship will be funded by NERC.

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

***2017 projects***

**Ongoing (no specific order)**

- Radiatively Active Gases from the North Atlantic Region and Climate Change (RAGNARoCC) – Lead PI: A. Watson (www.greenhouse-gases.org.uk/ragnarocc)
- NERC/Defra Shelf Sea Biogeochemistry programme – Science Coordinator: P. Williamson (http://www.uk-ssb.org/)
- Atlantic BiogeoChemical fluxes (ABC) – PI: E. McDonagh (http://www.rapid.ac.uk/abc/)
- Coordinated Research in Earth Systems and Climate: Experiments, kNowledge, Dissemination and Outreach (CRESCENDO) H2020 project – PI: C. Jones.

*Aims to improve the representation of key biogeochemical, biogeophysical and aerosol processes and feedbacks in seven European Earth System Models.*

- Surface Mixed Layer Evolution at Submesoscales (SMILES) – Lead PI: P. Hosegood (http://www.smiles-project.org/)

*Aims to identify the influence of submesoscales upon the structure and properties of the upper ocean, and thereby the transformation of surface water masses, within the Southern Ocean.*

- A novel pathway for the production of the climate cooling gas dimethyl sulfide - how important is the mddA gene to global DMS emissions? (NERC) – Lead PI: Jonathan Todd
- Importance of marine gases and particles for tropospheric chemistry (NERC). PI: Claire Reeves
- Determining the Impact of Seawater Chemistry on the Solubility of Atmospheric Trace metals: DISCOSAT (Marie Curie) – Lead PI: Simon Ussher
- Oceanic Reactive Carbon: Chemistry-Climate impacts: ORC3 (NERC) – Lead PI: Steve Arnold

- Biogeochemical cycling of N-osmolytes in the surface ocean (NERC) – Lead PI: Y. Chen.
- Microbial degradation of dimethylsulfoxide in the marine environment (NERC) – Lead PI: H. Schaefer.
- Trace gases at the Rothera Time-series Site (BAS Collaborative Gearing Scheme, CGS) – Lead PI: C. Hughes
- Marine particles as sources of ice nucleating particles (MarineIce, ERC consolidator grant) –Lead PI: Ben Murray
- The Global Methane Budget (NERC Highlight Topic) – Lead PI: Euan Nisbet
- Eco-interactomics: From microbial interactions to the fate of dissolved organic matter in the oceans (NERC Fellowship for J. Christie-Oleza).
- North Atlantic Climate System: Integrated Study (ACSIS) – Lead PI: Rowan Sutton (https://www.ncas.ac.uk/index.php/en/acsis-home)
- Ocean Regulation of Climate through Heat and Carbon Sequestration and Transports (ORCHESTRA) – Lead PI: Mike Meredith (https://www.bas.ac.uk/project/orchestra/)
- Bacteria make DMSP - how significant is this process? (NERC) – Lead PI: Jonathan Todd
- Iodide in the ocean: Distribution and impact on iodine flux and ozone loss (NERC) – Lead PI: L. J. Carpenter.
- How do eukaryotic $CO_2$ fixers co-exist with faster growing prokaryotic $CO_2$ fixers in the oligotrophic ocean covering 40% of Earth? (NERC) – Lead PI: Mike Zubkov
- A multidisciplinary study of DMSP production and lysis – from enzymes to organisms to process modelling (NERC) – Lead PI: Jonathan Todd
- Does Ozonolysis Chemistry affect Atmospheric Marine Boundary Layer Sulphur Cycling? (NERC) – Lead PI: William Bloss
- Climate and Air Quality Impact of Airborne Halogens (NERC Fellowship for Ryan Hossaini).
- Zinc, iron and phosphorus co-limitation in the Ocean (ZIPLOc). (NERC) – Lead PI: Claire Mahaffey

**Newly-funded (no specific order)**

- Functional biology and ecology of planktonic marine fungi – Revealing the mechanistic basis of the roles of mycoplankton in the marine carbon cycle (MYCO-CARB) (European Research Council, Consolidator Grant) – Lead PI: Michael Cunliffe
- EU RINGO https://www.icos-ri.eu/ringo – Lead UK PI: Richard Sanders
- EU BONUS Integral, led by Gregor Rehder https://www.io-warnemuende.de/integral-home.html – UK PI: Jamie Shutler
- International Space Science Institute (ISSI) Working Group on air-sea gas fluxes – Lead PI: Jamie Shutler
- Is bacterial DMS consumption dependent on methylamines in marine waters? (NERC) Lead PI: Jo Dixon
- MOCCHA Analysis of Dynamic, Cloud, and Aerosol Processes – Lead PI: Ian Brooks
- Seasonal inorganic carbon dynamics at the land-ocean interface – Lead PI: Dorothee Bakker
- The sources, processing and activity of dust as ice nucleating particles in the high latitudes – Lead PI: Ben Murray
- The Impact of Short-Lived Halocarbons on Ozone and Climate (ISHOC): An International Multi-Model Intercomparison – Lead PI: Ryan Hossaini

- CAMPUS (Combining Autonomous observations and Models for Predicting and Understanding Shelf seas) – Lead PI: Icarus Allen
- A War of Tiny Giants - Do viruses impact Pelagibacterales genotype dynamics in the Western English Channel – Lead PI: Ben Temperton
- An ocean habitat trap? Impacts of global oxygen-minimum zone expansions on threatened apex predator ecology – Lead PI: David Sims
- How do eukaryotic $CO_2$ fixers co-exist with faster growing prokaryotic $CO_2$ fixers in the oligotrophic ocean covering 40% of Earth? – Lead PI: Mike Zubkov
- NSFGEO-NERC: A Thermodynamic Chemical Speciation Model for the Oceans, Seas, and Estuaries – Lead PI: Simon Clegg
- Marine bacterioplankton respiration: a critical unknown in global carbon budgets (The Leverhulme Trust) - Lead PI: Carol Robinson
- REMineralisation of organic carbon by marine bActerIoplanktoN (REMAIN) (NERC) – Lead PI: Carol Robinson
- NERC Fellowship: Beyond Iron in the Ocean: Trace metal micronutrients and the carbon cycle (BIO-Trace) – PI: Susan Little

PhD Studentships:

- CASE award: OMG The Southern Ocean Bias: Observing and Modelling trace Gases to explore the Southern Ocean temperature Bias – Lead PI: Paul Halloran
- CASE award: The impact of atmosphere-wave-ocean coupling on extreme surface wind forecasts – Lead PI: Suzanne Gray
- CASE award: Quantification and characterisation of dissolved organic matter in the North Sea – Lead PI: Martin Johnson
- CASE award: Understanding controls on oxygen deficits in UK waters using a community ecosystem model and isotopic tools – Lead PI: James Clark

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

Links between UK S. Ocean projects and US SOCCOM program (see 1. Above)

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

**Comments**

surface ocean solas lower atmosphere study

# Report for the year 2017 and future activities

## SOLAS: *USA*
## *compiled by: Rachel Stanley*

*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).*

Title: A global intercomparison of oceanic methane and nitrous oxide measurements

Intercomparison exercises are invaluable for scientists as they allow the variability that exists between independent laboratories conducting the same analyses to be determined. During 2013-2017, the Scientific Commission on Oceanic Research Working Group #143 exchanged multiple batches of seawater samples between twenty laboratories to determine the inter-laboratory variability that exists for measurements of dissolved methane and nitrous oxide. Simultaneously, compressed gas standards were distributed between Working Group members. Several prominent trends were observed for both methane and nitrous oxide (Figure 1) and the intercomparison exercise also facilitated comparisons of sampling techniques, sample storage, gas extraction, gas calculations, and other procedures relevant to the quantification of dissolved methane and

nitrous oxide. The study is currently being prepared for publication and although the SCOR Working Group will formally end in 2018, the momentum will continue with an OCB workshop in October 2018 on Oceanic Methane and Nitrous Oxide: The Present Situation and Future Scenarios'. An objective of the workshop is to build on the intercomparison exercises and ask the question 'Where in the oceans should spatial-temporal surveys be conducted to discern climatologically-relevant changes in water-column inventories of methane and nitrous oxide?'

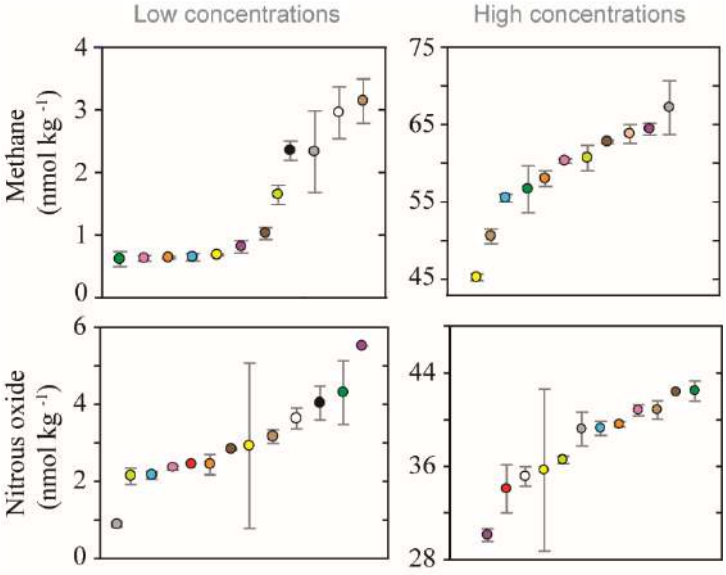


Figure: The intercomparison revealed several prominent trends for both methane and nitrous oxide including a skewed distribution of data values at low concentrations and a large range in data values at the highest concentrations. Each color represents a different laboratory with consistency for the separate figures. The data values are represented by the mean and standard deviation.

Citation: Wilson et al., in preparation.

**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).**

**Enzymes in Coastal Air:** Lihini Aluwihare and Matthew Pendergraft (UCSD) surveyed coastal air for enzymes, investigated the photodixdative effects on enzymes in aerosols and tested the ice nucleating ability of specific enzymes as part of CAICE, the Center for AerosolImpacts on the Chemistry of the Environment.

**Hydrocarbon emissions from marine plastics:** Sarah-Jeanne Royer, Dave Karl, and colleagues have measured emission of hydrocarbon gases from polypropylene debris collected in the North Pacific Subtropical Gyre over a time-series from September, 2016 to April, 2017. They found that due to the longevity of the plastics and the large amount of plastics in the environment, gas production from plastics may represent a source of climate-relevant trace gases for an extended period of time.

**Gas Exchange**: Brian Haus, Rachel Stanley, and colleagues are investigating gas exchange at high wind speeds and wave conditions in the SUSTAIN wind-wave tank by simultaneously collecting high-temporal resolution records of noble gases, oxygen, and carbon dioxide, imaging

bubbles, and measuring wave properties. The first “field” campaign took place in July, 2017. An additional series of experiments will take place in July, 2018.

**NAAMES:** The NASA funded North Atlantic Aerosol and Marine Ecosystem Study (NAAMES) is currently conducting its last field campaign – a combination aircraft and ship campaign designed to understand how environmental changes are altering plankton production, species composition, and aerosol emissions. For more information on NAAMES and access to data from the cruise, visit https://naames.larc.nasa.gov/

**Workshop:** A workshop on “Ocean Carbon Hotspots”, co-sponsored by Ocean Carbon Biogeochemistry Office and US-CLIVAR was held in Moss Landing, CA from Sept 25-26, 2017, brought together much of the current research community studying carbon uptake and storage in Western Boundary Current regions, regions which display the largest magnitude air-to-sea carbon dioxide fluxes.

**Workshop:** A workshop on 'Remote Sensing for Studying the Ocean-Atmosphere Interface', co-sponsored by the European Space Agency (ESA), the National Aeronautics and Space Administration (NASA), and the Surface Ocean - Lower Atmosphere Study (SOLAS) was held 13 - 15 March 2018, in Potomac, Maryland. The international workshop highlighted current research in remote sensing.

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


Brumer, S E., C J Zappa, B W Blomquist, C W Fairall, A Cifuentes-Lorenzen, J B Edson, I M Brooks, and B J Huebert (2017), Wave-related Reynolds number parameterizations of CO2 and DMS transfer velocities, *Geophysical Research Letters*, 44(19), 9865-9875, doi:10.1002/2017GL074979.

Cassar, N, W Tang, H Gabthuler, and K Huang. (2018) Method for High Frequency Underway N2 Fixation Measurements: Flow-Through Incubation Acetylene Reduction Assays by Cavity Ring Down Laser Absorption Spectroscopy (FARACAS). *Analytical Chemistry*. doi: 10.1021/acs.analchem.7b04977

Sanchez, K J, C-L Chen, et al. (2018) Substantial Seasonal Contribution of Observed Biogenic Sulfate Particles to Cloud Condensation Nuclei. *Nature Scientific Reports*. 8: 3235. doi:10.1038/s41598-018-21590-9 1

Sedwick P N, P W Bernhardt, M R Mulholland, R G Najjar, L M Blumen, B M Sohst, C Sookhdeo, B Widner. (2018) Assessing phytoplankton nutritional status and potential impact of wet deposition in seasonally oligotrophic waters of the Mid-Atlantic Bight. *Geophysical Research Letters*. doi: 10.1002/2017GL075361.

Stanley, R H R., D J McGillicuddy Jr., Z O Sandwith, and H M Pleskow,(2017) Submesoscale hotspots of productivity and respiration: Insights from high-resolution oxygen and fluorescence sections. *Deep Sea Research I* 130: 1-11. doi: 10.1016/j.dsr.2017.10.005

Stephans, B, M C Long, et. al (2018) The O2/N2 Ratio and CO2 Airborne Southern Ocean Study. *Bulletin of the American Meteorology Society*. doi: 0.1175/BAMS-D-16-0206.1


*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.*

**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?**

## 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.).**

**EXPORTS:** The NASA EXPORTS program will commence its first fieldwork activities with a cruise in the North Pacific in August, 2018. The cruise will use 2 ships and a fleet of autonomous platforms (gliders, floats, etc) to collect data in support of EXPORT's goal of understanding and predicting the fate of marine net primary production.
https://cce.nasa.gov/ocean_biology_biogeochemistry/exports/index.html

**CLIVAR GO-SHIP Cruises**: US CLIVAR will be conducting GO-SHIP (formerly known as Repeat Hydrography) Cruises that aim to quantify changes and storage of $CO_2$, heat and freshwater in the ocean. The cruises reoccupy WOCE lines and scientists onboard measure many variables from the atmosphere, the surface ocean and the deep ocean. Upcoming planned cruises consist of cruises in the Indian Ocean (I05, I06S, IO7N) in 2018 and 2019, and in the Atlantic Ocean (A13.5) in 2020.

**GEOTRACES**: A 60 day cruise along a transect from Alaska to Tahiti at 152 W will be taking place in Fall, 2018 as part of the US GEOTRACES project. The cruise focuses on the study of trace elements and their isotopes. The cruise will include sampling in the high nutrient low chlorophyll equatorial upwelling regions in the equatorial Pacific and subarctic as well as the oligotrophic subtropical gyres.

**Ongoing US Time-series**: Regular cruises (typically monthly but each time-series differs) will occur in 2018 and 2019 in the Pacific Ocean near Hawaii as part of the Hawaii Ocean Time-series (HOT), in the Sargasso Sea as part of the Bermuda Atlantic Time-series Study (BATS), in the Cariaco Basin as part of the CARIACO Ocean Time-series, and in coastal California waters as part of of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) time series.

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

**Cornell Satellite Remote Sensing Training Program.** June 4-15, 2018. Ithaca, New York. A short course to teach graduate students and other researchers the basic skills to acquire and use data sets derived from a variety of satellite sensors. Course is intended for scientists with essentially no experience in remote sensing.

**Gordon Research Conference: Mesophotic Coral Reef Ecoystems.** June 17-22. Lewiston, Maine. The Functional Roles of Mesophotic Coral Reefs in the Anthropocene

**Ocean Carbon Biogeochemistry Workshop**: June 25-28, 2018, Woods Hole, Massachusetts. Annual workshop that highlights research and includes substantial time for community discussion of new directions.

**OCB Biogeochemical Profiling Float Workshop**, July 9-13 2018. Seattle, Washington. This workshop will bring together potential users to discuss biogeochemical profiling float technology, sensors, and data management, in order to begin the process of the intelligent design of future scientific experiments.

**Gordon Research Conference Ocean Global Change Biology**: July 15-20. Waterville Valley, New Hampshire Theme: Integrative Research Addressing Responses, Refuges and Rescue in Marine Ecosystems

**Gordon Research Conference Atmospheric Chemistry.** July 28-Aug 2. Newry, Maine.

**Goldschmidt 2018**. August 12-17. Boston, MA. International conference on geochemistry. Abstracts due March 30.

**10th International Aerosol Conference.** Sept. 2-7, 2018. St. Louis, Missouri.

**Fall American Geophysical Union (AGU) Meeting**: Dec. 10-14, 2018. Washington D.C.,

**American Meteorological Society Annual Meeting**. Jan 6-10, 2019. Pheonix, Arizona.

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

Too many to report though some major ones are listed in the upcoming studies section of this report (section 2).

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

Too many to report.

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

Too many to report.

**Comments**