National SOLAS networks 2018 annual reports and future activities

Version of 13 May 2019 by IPO

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surface ocean **solas** lower atmosphere study

Report for the year 2018 and future activities

SOLAS *Australia*

compiled by: *Sarah Lawson and Andrew Bowie*

This report has two parts:

- Part 1: *reporting of activities in the period of January 2018 – Jan-Feb 2019*
- Part 2: *reporting on planned activities for 2019/2020 and 2021.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies;
Environmental impacts of geoengineering;
Science and society**.**

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

PART 1 - Activities from January 2018 to Jan/Feb 2019
1. Scientific highlight
Atmospheric research aboard the RV *Investigator*   The Australian Marine National Facility RV *Investigator* is equipped with world-class facilities for undertaking atmospheric research. Its Global Atmosphere Watch (GAW) station provides continuous, high-quality atmospheric data wherever the vessel goes. For atmospheric-focussed projects, it provides excellent infrastructure for guest instruments.   GAW is the only long-term international global programme providing a framework for observations and assessment of the state and development of environmental issues related to atmospheric chemical composition.   The RV *Investigator* hosts a comprehensive set of measurements in three of the GAW focal areas (equivalent to a GAW global station): (1) aerosols (e.g., black carbon and CCN), (2) reactive gases (e.g., ozone mixing ratio), and (3) greenhouse gases (e.g., greenhouse gas

mixing ratios). The RV *Investigator* provides infrastructure for guest scientists, enabling intensive project-based measurements. This infrastructure includes two dedicated atmospheric labs, a clean outdoor sampling space, and a range of specially designed systems for atmospheric measurements.

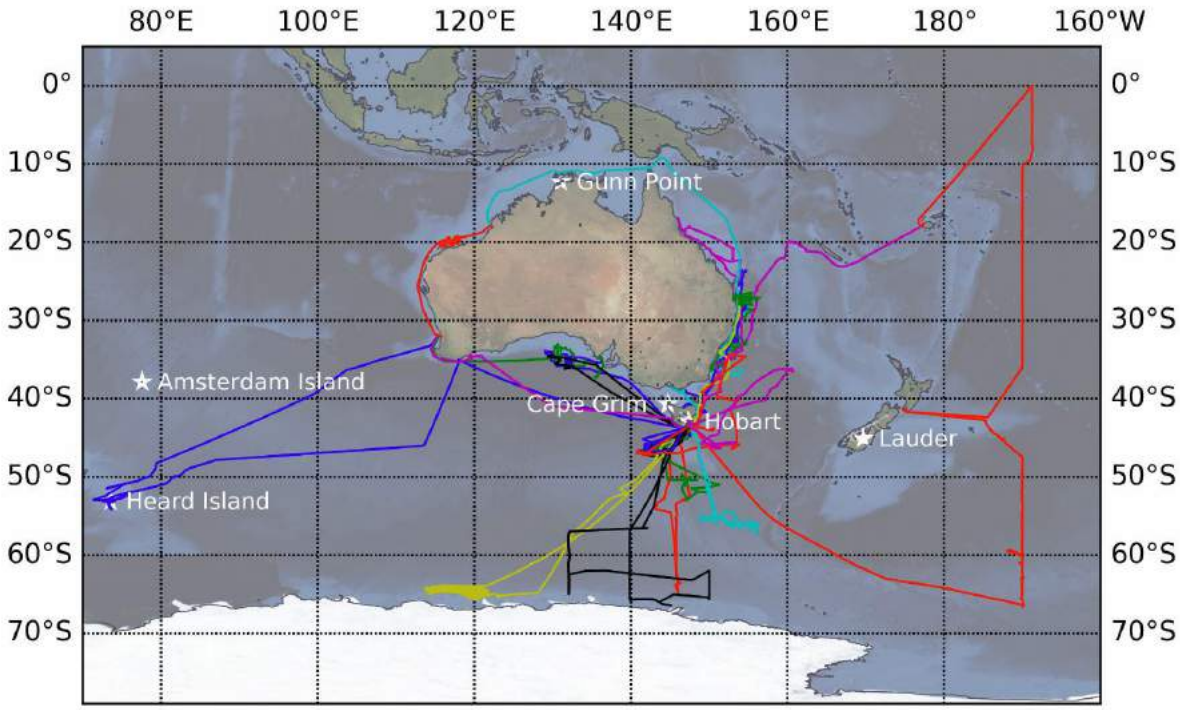

Figure 1. Voyages undertaken by the RV *Investigator* from its commissioning in 2014, until December 2018. Voyage tracks are determined by scientific objectives which are assessed in a competitive process by peer-review and independent steering committee. Capable of travelling from Antarctica's ice-edge up to the equator, the *Investigator* is at sea for up to 300 days each year, and is capable of travelling almost 11 000 nautical miles in a single voyage. Starred locations show other GAW station locations in the region (except Heard Island).

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

- Australia's RV Investigator registered as the world's first mobile GAW station, providing ongoing atmospheric measurements from the Southern Hemisphere's marine environment https://research.csiro.au/acc/rv-investigator-recognised-as-worlds-first-mobile-gaw-site/

- RV Investigator January/February 2018 voyage (IN2018_V01 – CAPRICORN2), investigated cloud and aerosol properties in the deep southern ocean, alongside the larger SOCRATES project. https://www.eol.ucar.edu/content/socrates-iss-0 http://media.bom.gov.au/social/blog/1628/studying-clouds-over-the-southern-ocean/

- Aurora Australis research voyages - MARCUS and CAMMPCAN – parallel projects, measuring aerosol and cloud properties in the Antarctic sea-ice region. MARCUS was 2017/18 summer, while CAMMPCAN's main deployment period is 2018/19 summer season. http://www.antarctica.gov.au/news/2018/seeding-southern-clouds https://www.abc.net.au/news/2018-12-16/cloud-researchers-using-new-technology-in-antarctica/10623752

- Rainforest to Reef Workshop Aspendale https://airbox.earthsci.unimelb.edu.au/reef-to-rainforest/
- Voyages highlighted on Airbox page https://airbox.earthsci.unimelb.edu.au/#tab19

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

Luhar, A.K., Woodhouse, M. T., and Galbally, I. E (2018): A revised global ozone dry deposition estimate based on a new two-layer parameterisation for air–sea exchange and the multi-year MACC composition reanalysis. Atmospheric Chemistry and Physics, 18, 4329-4348, https://doi.org/10.5194/acp-18-4329-2018.

Dominick, D., Wilson, S.R. Paton-Walsh, C. , Humphries, R., Andree Guérette E., Keywood,M.D., Kubistin, D., Marwick, B. Characteristics of airborne particle number size distributions in a coastal-urban environment, Atmospheric Environment, Volume 186, 2018, Pages 256-265, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2018.05.031

Jones, G., Curran, M., Deschaseaux, E., Omori, Y., Tanimoto, H., Swan, H., et al. (2018). The flux and emission of dimethylsulfide from the Great Barrier Reef region and potential influence on the climate of NE Australia. Journal of Geophysical Research: Atmospheres, 123, 13,835–13,856. https://doi.org/10.1029/ 2018JD029210

Cropp, R., Gabric, A., van Tran, D. et al. Coral reef aerosol emissions in response to irradiance stress in the Great Barrier Reef, Ambio (2018) 47: 671., Australia https://doi.org/10.1029/2018JD029210

Humphries, R. S., McRobert, I. M., Ponsonby, W. A., Ward, J. P., Keywood, M. D., Loh, Z., Krummel, P. B., and Harnwell, J.: Identification of platform exhaust on the RV Investigator, Atmospheric Measurement Techniques Discussussions, https://www.atmos-meas-tech-discuss.net/amt-2018-214/, in review, 2018.

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

PART 2 - Planned activities for 2019/2020 and 2021

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

Future RV Investigator voyages

-Oct-Dec 2019– IN2019_v06 to understand the Maritime Continent region, 2 x 30 day voyages Darwin to Christmas Island, and Christmas Island to Darwin.. Maritime Continent observations of atmospheric convection, biogenic emissions, ocean vertical mixing, and the Indonesian Throughflow. Atmospheric chemistry, surface meteorology, and air-sea flux components to operate for entire voyage

- Measuring the world's cleanest air – validating atmospheric measurements above the Southern Ocean (IN2020_V08) (August/September 2020) will provide a first-ever comparison of two Global Atmospheric Watch stations (Cape Grim and the RV Investigator). This will allow validation of Investigator aerosol instrumentation against a world-class benchmark which will improve confidence in both stations.

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

3. Funded national and international projects / activities underway.

ARC Discovery funding, 2019-22, "Dust to the ocean: Does it really increase productivity?" Zanna Chase, Andrew Bowie, Peter Strutton

Involvement in proposed SCOR Working Group on "Co-ordinated approach for Aerosol Trace element Solubility and Bioavailability Research in Oceanography"

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.

Engagement with Australia GEOTRACES program

Comments

Report for the year 2018 and future activities

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

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Integrated studies;
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PART 1 - Activities from January 2018 to Jan/Feb 2019

1. Scientific highlight

Highlight 1 : Continental shelves as a variable but increasing global sink for atmospheric carbon dioxide

As more carbon dioxide enters the atmosphere, the global ocean soaks up much of the excess, storing roughly 30 percent of the carbon dioxide emissions coming from human activities. In this sense, the ocean has acted as a buffer to slow down the greenhouse gas accumulation in the atmosphere and, thus, global warming. However, this process also increases the acidity of seawater and can affect the health of marine organisms and the ocean ecosystem.
It has been speculated that the partial pressure of carbon dioxide (pCO_2) in shelf waters may lag the rise in atmospheric CO_2. An international study led by researchers from the ULB and published in Nature Communication, shows that this is the case across many shelf regions, implying a tendency for enhanced shelf uptake of atmospheric CO_2. This result is based on analysis of long-term trends in the air–sea pCO_2 gradient (ΔpCO_2) using a global surface ocean pCO_2 database spanning a period of up to 35 years. Using wintertime data only, we find that ΔpCO_2 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 CO_2 during the last century.

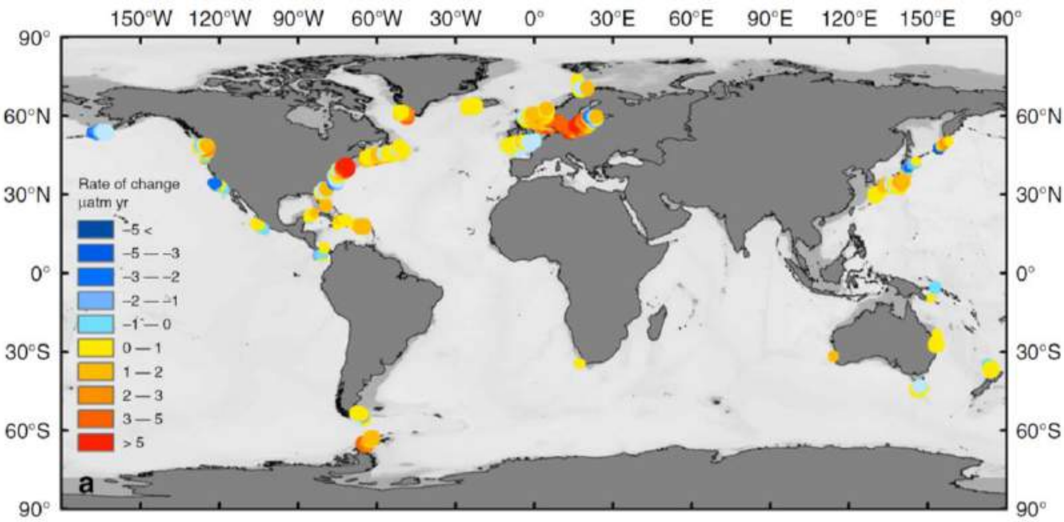

Figure 1: Location of 0.5° cells for which the decadal trend in winter ΔpCO_2 is calculated. Large dots correspond to cells shallower than 200 m and small dots correspond to cells located within 100 km from the coast or depth less than 500 m.

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 (1), 454, 2018.

Highlight 2 : Uncertainty in the global oceanic CO_2 uptake induced by wind forcing

The calculation of the air–water CO_2 exchange (FCO_2) in the ocean not only depends on the gradient in CO_2 partial pressure at the air–water interface but also on the parameterization of the gas exchange transfer velocity (k) and the choice of wind product. Here, we present regional and global-scale quantifications of the uncertainty in FCO_2 induced by several widely used k formulations and four wind speed data products (CCMP, ERA, NCEP1 and NCEP2). Our results show that the range of global FCO_2, calculated with these k relationships, diverge by 12% when using CCMP, ERA or NCEP1. Due to differences in the regional wind patterns, regional discrepancies in FCO_2 are more pronounced than global. To minimize uncertainties associated with the choice of wind product, it is possible to recalculate the coefficient c globally (hereafter called c^*) for a given wind product and its spatio-temporal resolution, in order to match the last evaluation of the global k value. We thus performed these recalculations for each wind product at the resolution and time period of our study but the resulting global FCO_2 estimates still diverge by 10%. These results also reveal that the Equatorial Pacific, the North Atlantic and the Southern Ocean are the regions in which the choice of wind product will most strongly affect the estimation of the FCO_2, even when using c^*.

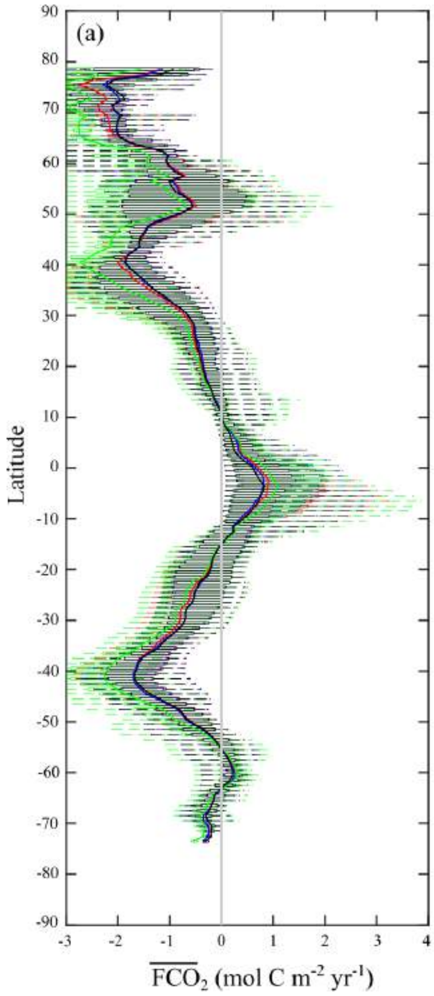

Figure 2: Latitudinal distribution of FCO_2 (mol Cm^{-2} yr^{-1}) using the CCMP, ERA, NCEP1 and NCEP2 wind products. FCO_2 is calculated using the quadratic k_{U10} relationship from Wanninkhof (2014). Results refer to the 1991–2011 period. The median value for each latitude is represented by a line, while the box plots delineate the 5th and 95th percentile of the variation within each 1° latitudinal band, respectively.

Citation: Roobaert, A., Laruelle, G. G., Landschützer, P., and Regnier, P.: Uncertainty in the global oceanic CO_2 uptake induced by wind forcing: quantification and spatial analysis, Biogeosciences, 15, 1701-1720, https://doi.org/10.5194/bg-15-1701-2018, 2018.

Highlight 3 : Dimethylsulfoniopropionate and dimethylsulfoxide in seagrass meadows (result of a collaboration between Belgian, French and Portuguese institutions)

Posidonia oceanica is the only reported seagrass to produce dimethylsulfoniopropionate (DMSP) and the biggest producer among marine and inter-tidal autotrophs. We studied the temporal and depth variability of DMSP and its derivative dimethylsulfoxide (DMSO) in *P. oceanica* leaves of a non-disturbed meadow in Corsica and the potential role of light, temperature, photosynthetic activity and leaf size on DMSP and DMSO contents. The annual average concentrations of organosulfured compounds in *P. oceanica* leaves were 129 ± 39 $\mu mol.g_{fw}^{-1}$ for DMSP and 5.0 ± 2.1 $\mu mol.g_{fw}^{-1}$ for DMSO. Concentrations of both DMSP and DMSO decreased from a maximum in the fall to a minimum in the summer and were inversely correlated to the leaf size, *i.e.*, the leaf age. Concentrations of the two molecules were weakly to modestly correlated with light and temperature along the year, but not with effective quantum yield of photosystem II. To explain this seasonal pattern we hypothesized two potential protection functions for young leaves: antioxidant against reactive oxygen species and predator-deterrent. The similar variation of the two molecule concentrations over time and with depth suggested that DMSO content in P. oceanica leaves results from oxidation of DMSP. More research is now needed to confirm the functions of DMSP and DMSO in seagrasses.

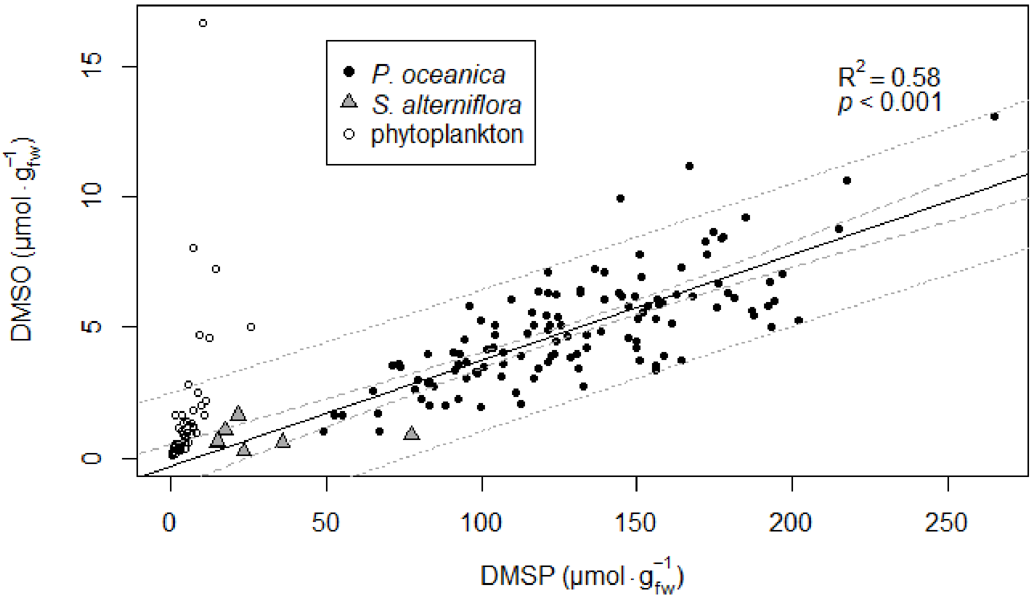

Figure 3: Scatterplot of DMSP and DMSO concentrations (µmol.g_{fw}^{-1}) in *Posidonia oceanica* leaves (black dots), *Spartina alterniflora* leaves (grey triangles) and marine phytoplankton communities (empty dots). *S. alterniflora* and phytoplankton data are from literature (Husband and Kiene (2007), Husband et al. (2012) and McFarlin and Alber (2013) Simó and Vila-Costa (2006)). The full black line is the linear regression modelling the relationship between *P. oceanica* DMSP and DMSO concentrations. Model R^2 and *p*-value are shown on the graph. 95% confidence (dashed grey lines) and prediction (dotted grey lines) intervals are plotted.

Citation: J. Richir et al. A 15-month survey of dimethylsulfoniopropionate and dimethylsulfoxide contents in *Posidonia oceanica*. Submitted in Frontiers in Ecology and Evolution.

Highlight 4 : Nutrient controls of marine nitrogen fixation

Biological nitrogen (N_2) fixation represents the major source of new nitrogen input to the ocean. Diazotrophic activity has thus great implications in the biogeochemical cycling of nitrogen and plays an important role in marine primary productivity. Iron (Fe) and phosphorus (P) are considered to be co-limiting factors in most regions and the deposition of mineral dust is believed to promote N_2 fixation through increasing availability of both Fe and P. Laboratory bioassays (+Fe, +P, +Dust) via incubation experiments performed on *Trichodesmium* IMS101, show that the addition of Fe, P or desert particles could stimulate the growth and N_2 fixation of this cyanobacteria. In addition, during a field study using natural phytoplankton assemblages from the temperate Northeast Atlantic Ocean the key role of dissolved Fe (DFe) has been furthermore highlighted by the remarkably enhanced N_2 fixation rate observed after the addition of DFe under low temperature and P-depleted conditions. Figure 4 shows as an example of the results obtained for the dust addition incubation experiments.

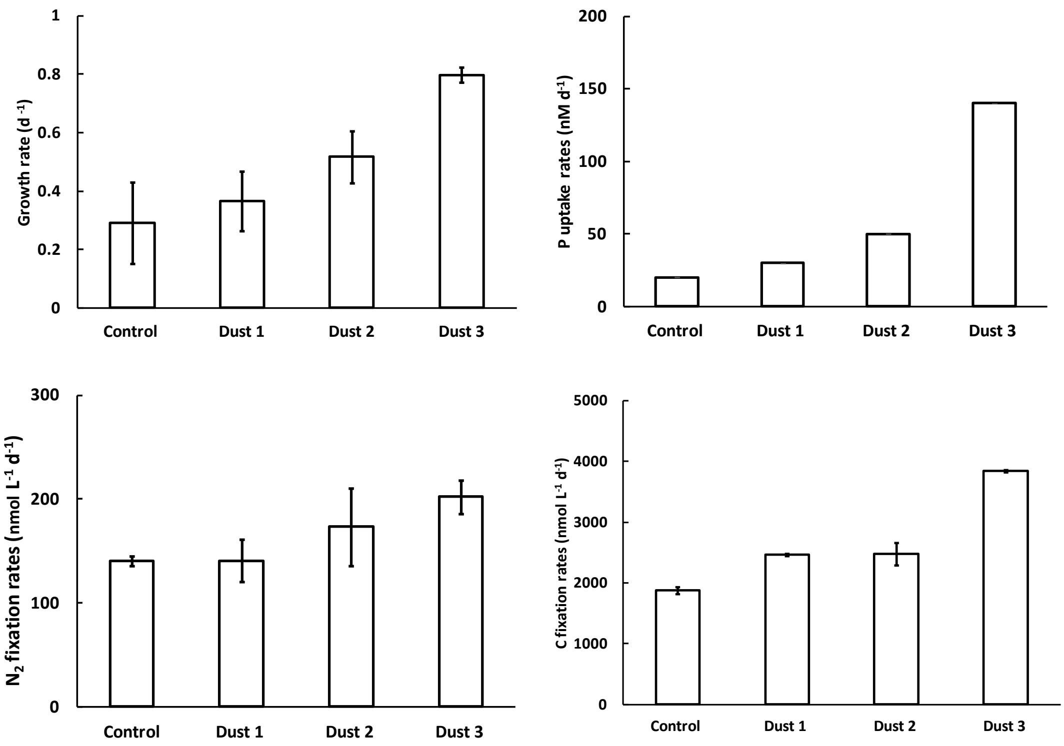

Figure 4. (a) Chl-a concentrations, (b) PO4 uptake rates, (c) N_2 fixation rates and (d) C fixation rates of *Trichodesmium* IMS-101 for Control (without dust addition), and three +Dust addition treatments (25, 50 and 100 mg L^{-1}) during 24h incubations at 24°C (incident irradiance at 150 µmol photons m^{-2} s^{-1}, 14h/10h light/dark cycle). The initial dissolved Fe and PO4 concentrations were 5 nM and 90 nM in the medium respectively. The dust particles (< 63 µm) were taken from the Kubuqi desert (Inner Mongolia, Autonomous Region, China), which contained 2.58% Fe and 0.19% P.

Citation: Li X, Fonseca-Batista D, Roevros N, Dehairs F and Chou L (2018) Environmental and nutrient controls of marine nitrogen fixation. *Progress in Oceanography*, 167, 125-137. https://doi.org/10.1016/j.pocean.2018.08.001.

<u>Highlight 5</u> : Impact of climate change on N_2 fixation

Recently, the effects of ongoing climate change (ocean warming and acidification) on N_2 fixation has been intensively studied but controversial conclusions have been reached. Semi-continuous dilution growth experiments were conducted on *Trichodesmium* IMS101 under two pCO_2 (400 µatm and 800 µatm) and temperature (24°C and 28°C) conditions. The results indicate that higher pCO_2 and therefore ocean acidification may be beneficial for *Trichodesmium* growth and N_2 fixation. However, Fe or P limitation in oligotrophic seawaters may offset the stimulation induced on *Trichodesmium* IMS101 resulting from ocean acidification. In contrast, ocean warming may not play a crucial role in *Trichodesmium* growth and N_2 fixation with a 4°C increase from 24°C to 28°C. Nevertheless, ocean warming is predicted to cause a shift in the geographical distribution of *Trichodesmium* species towards higher latitudes, extending its niche to subtropical ocean regions and potentially reducing its coverage in tropical ocean basins. Figure 5 shows the results of the influence of pCO_2 and temperature on *Trichodesmium* growth and N_2 fixation.

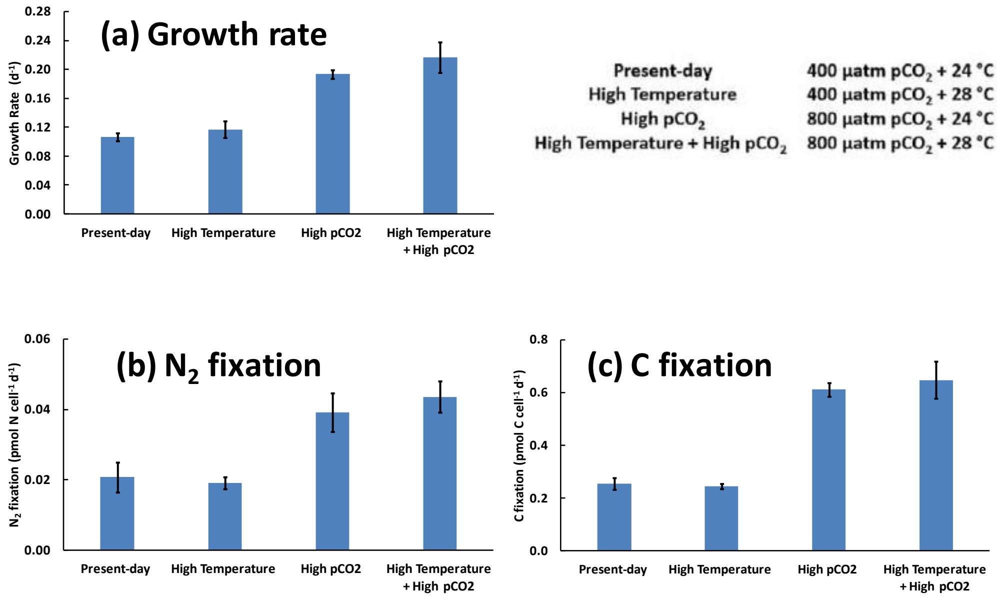

Figure 5. (a) Growth rates, and cell-number normalised (b) N_2 and (c) C fixation rates of *Trichodesmium* IMS 101 acclimated to different pCO_2 and temperature conditions during 24h incubations (incident irradiance at 150 µmol photons m^{-2} s^{-1}, 14h/10h light/dark cycle). The various treatments correspond to Present-day (400 µatm pCO_2 and 24°C), High Temperature (400 µatm pCO_2 and 28°C), High pCO_2 (800 µatm pCO_2 and 24°C), and High Temperature+High pCO_2 (800 µatm pCO_2 and 28°C) conditions.

Citation: Li X, Fonseca-Batista D, Roevros N, Dehairs F and Chou L (2018) Environmental and nutrient controls of marine nitrogen fixation. *Progress in Oceanography*, 167, 125-137. https://doi.org/10.1016/j.pocean.2018.08.001.

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

Field campaign and project

- The University of Liège (A.V. Borges) was involved in the tnternational intercomparison of CH_4 and N_2O measurement techniques under SCOR 143. The results were published in:

  Wilson ST, HW Bange, DL Arévalo-Martínez, J Barnes, AV Borges, I Brown, JL. Bullister, M Burgos, DW Capelle, M Casso, M de la Paz, L Farías, L Fenwick, S Ferrón, G Garcia, M Glockzin, DM. Karl, A Kock, S Laperriere, CS. Law, CC Manning, A Marriner, J-P Myllykangas , JW. Pohlman, A P. Rees, AE. Santoro, M Torres, PD. Tortell, RC Upstill-Goddard, DP. Wisegarver, GL Zhang, G Rehder (2018) An intercomparison of oceanic methane and nitrous oxide measurements, Biogeosciences, 15, 5891-5907.

- In order to understand the role played by environmental parameters, i.e., light availability on the production dynamics of DMSP and DMSO in P. oceanica, 9 m2 seagrass bed quadrats were shaded. Light reduction was 15, 30 and 60 %. The experience was conducted in situ from April to August 2018, and sampling and measurements were performed monthly. DMSP and DMSO analysis will be done during year 2019. Available results already showed a net effect on the plant photosynthetic activity. This research work is done in collaboration with French and German partners.

- Intercalibration experiment for sea ice primary production in Saroma-ko Lagoon, Hokkaido, Japan. Collaboration with D. Nomura in the frame of ECV-ice SCOR working group. March 2018.

- 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 (CO_2, CH_4, N_2O) 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)

- 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 N_2O) 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).

- A (bio)geochemical investigation was conducted from 20 June to 4 July 2018 on board the RV Belgica in the Gotland basin of the Baltic Sea where low dissolved oxygen concentrations had been recurrently observed in deep waters. The objectives were to understand benthic nutrient and trace metal cycling, benthic-pelagic coupling and diagenetic pathways (oxic, anoxic) and the impact of hypoxia on these processes. Microprofiling of geochemical gradients of dissolved O2, pH and H2S were taken on board the ship. Sediment cores were taken and porewaters were extracted using the Rhizon technique under nitrogen atmosphere for nutrient and trace metal determinations. The analyses of samples collected are underway. This work was conducted in the framework of the BENTHOX project funded by the Fund for Scientific Research - FNRS (Belgium).

- Also for the BENTHOX project, work is ongoing for a biogeochemical cruise conducted on board the RV Mare Nigrum during August-September 2017 in the Black Sea on the Ukrainian shelf and in the deep basin. During this cruise, bottom hypoxia on the shelf was observed. This investigation was carried out in collaboration with the EMBLAS-II project funded by UNDP and EU. The objective was to obtain a better understanding of the impact of benthic hypoxia on the diagenetic pathways. Microprofiling of geochemical gradients of dissolved O2, pH, H2S and N2O were taken on board the ship. Porewaters were extracted on board the ship using the Rhizon technique under N2 atmosphere for laboratory dissolved nutrients and major ions.

<u>Conferences</u>

- Plante A., N. Roevros, A. Capet, M. Grégoire, N. Fagel and L. Chou (2018) Black Sea north-western shelf hypoxia: a study based on diagenetic processes and sedimentary proxies. EGU General Assembly, Vienna, Austria, 8-13 April 2018. Poster presentation
- Plante A., N. Ahmed Butt, N. Roevros, A. Capet, M. Grégoire, N. Fagel and L. Chou (2018) Coastal hypoxia in the Black Sea: Effects on diagenetic pathways and benthic fluxes. Ocean Deoxygenation Conference 2018, Kiel, Germany, 02-08 September 2018. Poster presentation.
- Li X., D. Fonseca-Batista, N. Roevros, F. Dehairs and L. Chou (2019) Marine nitrogen fixation: Environmental and nutrient controls. Forth Xiamen Symposium on Marine Environmental Sciences. Xiamen, China, 6-10 January 2019. Oral presentation.

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

- Borges AV, G Abril, S Bouillon (2018) Carbon dynamics and CO_2 and CH_4 outgassing in the Mekong delta, Biogeosciences, 15, 1093-1114

- Carnat, G., W. Said-Ahmad, F. Fripiat, B. Wittek, J-L. Tison, C. Uhlig and A. Amrani (2018). Variability in sulfur isotope composition suggests unique dimethylsulfoniopropionate cycling and microalgae metabolism in Antarctic sea ice. Communication Biology. 1 (212). Doi: 10.1038/s42003-018-0228-y

- Nomura D, Granskog M A, Fransson A, Chierici M, Silyakova A, Ohshima K I, Cohen L, Delille B, Hudson S R and Dieckmann G S (2018) CO_2 flux over young and snow-covered Arctic pack ice in winter and spring, Biogeosciences 15, doi:10.5194/bg-15-3331-2018, 2018.

- Li X, Fonseca-Batista D, Roevros N, Dehairs F and Chou L (2018) Environmental and nutrient controls of marine nitrogen fixation. Progress in Oceanography, 167, 125-137.

https://doi.org/10.1016/j.pocean.2018.08.001.

- Speeckaert G, AV Borges, W Champenois, C Royer and 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

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

PART 2 - Planned activities for 2019/2020 and 2021

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

- Intercalibration experiment for measurement of carbonate system parameter in sea ice, University of East Anglia, Norwich, UK in the frame of ECV-ice SCOR working group. Spring 2019.
- MOASIC, International Arctic Drift Expedition on the RV Polarstern led by AWI.
- Two field studies are planned for 2019 by the The University of Liège (J. Richir and A.V. Borges). First, we will test the effect of heat waves on DMSP and DMSO production dynamics in P. oceanica. This will be done in collaboration with colleagues of the Stazione Zoologica Anton Dohrn (SZN), Napoli, Italy. Second, we will test the potential role as predator deterrent played by DMS(P) on seagrass grazers (urchins).
- In addition, we will finish analysing DMSP and DMSO contents in P. oceanica leaves in order to propose a mass balance analysis at the scale of a meadow (above-ground tissues). We will also perform analyses in leaves of Zostera sp. in collaboration with colleagues from the Netherlands. Indeed, Zostera is the most widely distributed seagrass genus, so its role in the coastal dynamic of DMSP(O) require to be investigated next.
- The results obtained in the framework of the BENTHOX project continues to be worked out and will be disseminated via publications.
- Within the framework of the C-Cascades project (https://c-cascades.ulb.ac.be/) funded by the EU (Horizon 2020), efforts are undertaken to make a breakthrough in the understanding of the transfer of carbon along the land and ocean continuum (via rivers, lakes and coastal waters) at the global scale. This will allow a better quantification of the fluxes of greenhouse gases (primarily CO_2 and CH_4) exchanged with the atmosphere and their impacts on the climate system.

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

Conferences

- Capet A., A. Plante, L. Chou, N. Fagel, A. Teaca and M. Grégoire (2019) Upscaling the impact of varying macro-benthic activity from local diagenesis to biogeochemical cycles in the frame of Black Sea northwestern shelf hypoxia dynamics. EGU General Assembly, Vienna, Austria, 7-12 April 2019.
- Grégoire M., A. Capet, L. Chou, N. Fagel, A. Plante and A. Teaca (2019) Upscaling the impact of coastal hypoxia from species to ecosystem function. The case of bioturbation in the Black Sea. EGU General Assembly, Vienna, Austria, 7-12 April 2019.
- The University of Liège (J. Richir and A.V. Borges) will participate at the 42nd CIESM Congress in Cascais, Portugal, in October 2019. The Mediterranean Science Commission CIESM involves researchers from all shores of the Basin in its activities. The Commission integrates a broad spectrum of marine disciplines, encompassing geo-physical, chemical and biological processes.

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3. Funded national and international projects / activities underway.

- 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)

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

The University of Liège (J. Richir and A.V. Borges) aim at describing factors that drive DMSP and DMSO production in seagrasses, at quantifying their role as provider of the dissolved DMS(P)(O) pool in the above water column and their sea-air transfer and at studying the ecological functions these molecules play in seagrass beds. This will be done in collaboration with European academic partners.

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 task group on Air-Sea Fluxes

Comments

surface ocean **solas** lower atmosphere study

Report for the year 2018 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 2018 – Jan-Feb 2019*
***- Part 2:** reporting on planned activities for 2019/2020 and 2021.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies;
Environmental impacts of geoengineering;
Science and society**.**

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

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

1. Scientific highlight

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).

Highlight 1

The Tortell group has continued to make progress towards documenting the distribution and cycling of climate active trace gases in marine surface waters. The paper by Jarnikova et al. presents a new data set of dimethylsulfide, and the related compound DMSP in the Canadian Arctic Ocean. Our new observations, conducted with much higher spatial resolution than any previous measurements, highlight the influence of hydrographic frontal zones driving DMS/P variability in this region. Our observations also help fill in critical gaps in the existing PMEL DMS data, leading to more robust estimates of the Arctic Ocean DMS emissions to the atmosphere.

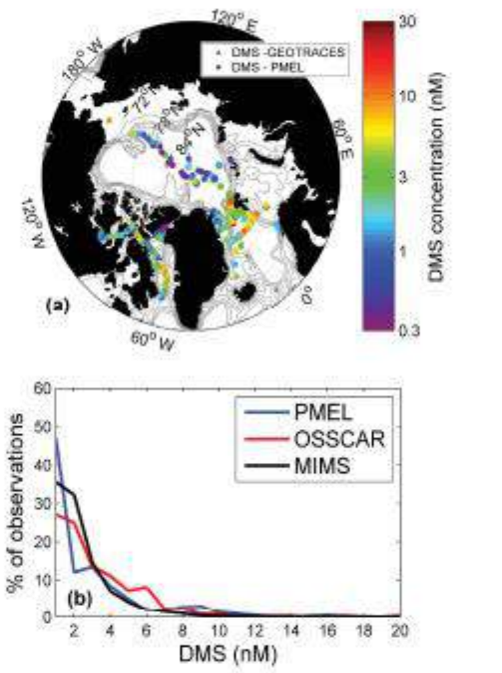


Figure 6. Comparison of OSSCAR- and MIMS-measured DMS from this study with existing summertime data in the PMEL database. Panel **(a)** shows the geographic distribution of DMS measurements in the PMEL database and those obtained by this study (using OSSCAR), while panel **(b)** shows a histogram of DMS concentrations in three datasets – the MIMS dataset (33 250 data points), the OSSCAR dataset (344 points) and the PMEL dataset (415 points).

Jarnikova T., Dacey J., Lizotte M., Levasseur, M. and P. Tortell. 2018. The distribution of methylated sulfur compounds, DMS and DMSP, in Canadian Subarctic and Arctic waters during summer, 2015. Biogeoscience. 15, 2449–2465, doi.org/10.5194

The group also published the results of a three year study of CH_4 and N_2O measurements in the Subarctic Pacific, examining spatial trends along the coastal-oceanic gradient of the Line P time-series transect, and temporal variability associated with environmental variability including the 2015 warm anomaly ('The Blob'). Our results highlighted the strong mid-water N_2O maximum associated with the large oxygen deficient zone, and the presence of CH_4 hot-spots along the continental shelf. Examination of ancillary data (nutrients etc.), provided some insight into the role of various microbial processes driving N_2O cycling.

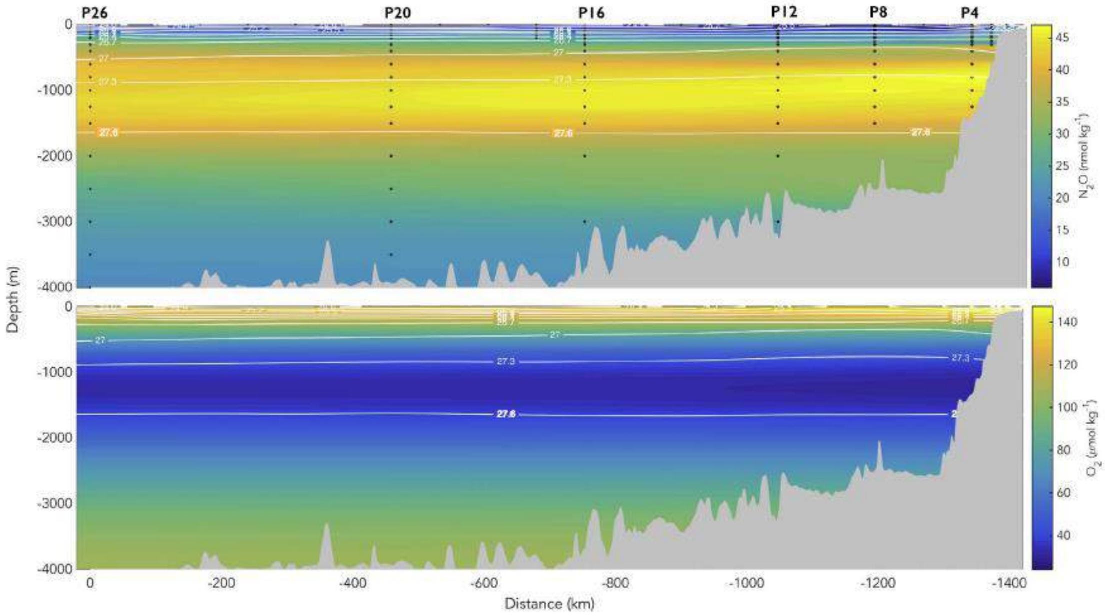


Fig. 7. Longitudinal – depth section of N_2O and O_2 distributions, averaged across all six cruises. The white lines denote density surfaces (σ_t).

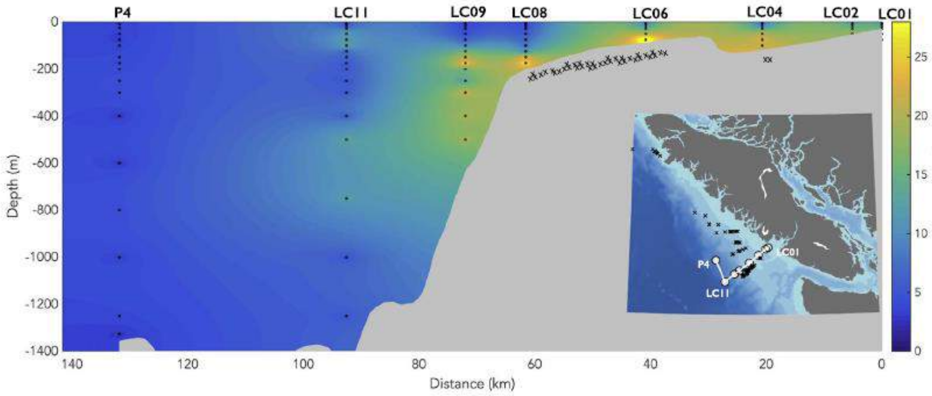


Fig. 5. Methane distribution off the coast of Vancouver Island during spring 2015. On the map inset in panel b, the white symbols denote the stations, while the black x's denote the locations of previously observed gas seeps (Vaughn J. Barrie, personal communication).

Fenwick, L. and P. Tortell. 2018. Methane and nitrous oxide distributions in coastal and open waters of the Northeast Subarctic Pacific during 2015-2016. Marine Chemistry, volume 200 (20) Pages 45-56.

Highlight 2

Ice nucleating particles in the marine boundary layer in the Canadian Arctic during summer 2014

Ice nucleating particles (INPs) in the Arctic can influence climate and precipitation in the region; yet our understanding of the concentrations and sources of INPs in this region remain uncertain. In the following we 1) measured concentrations of INPs in the immersion mode in the Canadian Arctic marine boundary layer during summer 2014 on board the CCGS *Amundsen*, 2) determined ratios of surface areas of mineral dust aerosol to sea spray aerosol, and 3) investigated the source region of the INPs using particle dispersion modelling. Average concentrations of INPs at -15, -20 and -25 °C were 0.005, 0.044, and 0.154 L^{-1}, respectively. These concentrations fall within the range of INP concentrations measured in other marine environments. For the samples investigated the ratio of mineral dust surface area to sea spray surface area ranged from 0.03 to 0.09. Based on these ratios and the ice active surface site densities of mineral dust and sea spray aerosol determined in previous laboratory studies, our results suggest that mineral dust is a more important contributor to the INP population than sea spray aerosol for the samples analysed. Based on particle dispersion modelling, the highest concentrations of INPs were often associated with lower latitude source regions such as the Hudson Bay area, eastern Greenland, or northwestern continental Canada. On the other hand, the lowest concentrations were often associated with regions further north of the sampling sites and over Baffin Bay. A weak correlation was observed between INP concentrations and the time the air mass spent over bare land, and a weak negative correlation was observed between INP concentrations and the time the air mass spent over ice and open water. These combined results suggest that mineral dust from local sources is an important contributor to the INP population in the Canadian Arctic marine boundary layer during summer 2014.

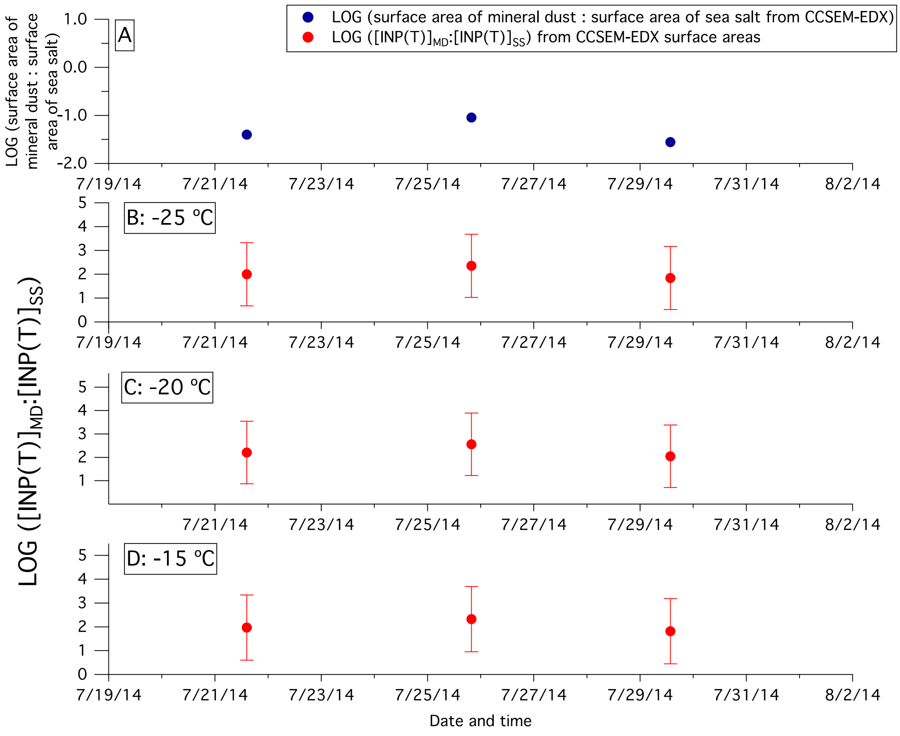


Figure: A) Ratios of the surface area of mineral dust particles to the surface area of sea salt particles measured by CCSEM-EDX (blue circles). Ratios of predicted concentrations of ice nucleating particles from mineral dust, $[INP(T)]_{MD}$, to the predicted concentrations of ice nucleating particles from sea spray aerosol, $[INP(T)]_{SS}$, calculated using CCSEM-EDX measurements (red circles) at B) -25 °C, C) -20 °C, and D) -15 °C.

Irish, V E, S J Hanna, M D Willis, S China, J L Thomas, J J B Wentzell, A Cirisan, M Si, W R Leaitch, J G Murphy, J P D Abbatt, A Laskin, E Girard, and A K Bertram, 2019, Ice nucleating particles in the marine boundary layer in the Canadian Arctic during summer 2014, *Atmospheric Chemistry and Physics*, 19, 1027-1039, DOI: 10.5194/acp-19-1027-2019.

Highlight 3

A Swiss-Canadian collaboration involving laboratory experiments on carbon export from freezing sea ice was recently published . We found that when ice forms more quickly at lower temperatures (as opposed to more slowly at higher temperatures), less CO2 is injected into the underlying water, but it is injected in more intense plumes that sink deeper into the water. This has future climate implications, wherein a thinner, warmer solid ice cover would sequester less carbon in deep waters, but a broken, mobile ice cover resulting in more open water and ice formation in winter could foster more carbon sequestration (see figure 8 in the paper). This was published in a BEPSII-related special issue in Frontiers in Earth Science.

D. Konig, L.A. Miller, K.G. Simpson, S. Vagle, Carbon Dynamics During theFormation of Sea Ice at Different Growth Rates, Frontiers in Earth Science, 6, doi: 10.3389/feart.2018.00234, 2018.

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

Coastal Fog Project (CFOG) – research cruise on the R/V Hugh R. Sharp headed by University of Notre Dame Aug 31 – Oct 9, 2018 to study marine fog including air-sea interactions in the NW Atlantic Ocean off the coast of NS and NL (Theme 2)

Fog and Visibility Experiment in Tuktoyaktuk (FAVET) – coastal fog and aerosol project in Tuktoyaktuk (NWT) that aims to link ocean and sea-ice effects on atmospheric observations, July – Sep 2018 (Theme 2)

Microbiology-Ocean-Cloud-Coupling in the High Arctic (MOCCHA) – research cruise on the I/B Oden headed by Stockholm University Jul 31 – Sep 23, 2018 in the Central Arctic Ocean to study contributions of biological ocean emissions on atmospheric particles and cloud condensation nuclei (Themes 4 & 5)

Halifax Harbour Air Quality Study – preliminary study in Halifax harbour to study emissions in the harbour from anthropogenic and biogenic sources (Aug – Oct 2018). (Themes 1 & 5)

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: Deploy an Automated Cryogenic Trap Membrane-Inlet Mass Spectrometer (ACT-MIMS) in the Canadian Arctic Archipelago for continuous underway DMS measurements during the Sentinel North expedition aboard the icebreaker CCGS Amundsen in July 2018.

Laboratory studies of the VOCs emitted from cultured phytoplankton in axenic conditions. Investigation of the potential for these emissions to form aerosol. (Theme 4)

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

Gourdal M, Lizotte M, Massé G, Gosselin M, Scarratt M, Levasseur M (2018). Dimethylsulfide dynamics in first-year sea ice melt ponds in the Canadian Arctic Archipelago. *Biogeosciences*, 15, 3169–3188. https://doi.org/10.5194/bg-15-3169-2018

Galí M, Levasseur M, Devred E, Simó R, Babin M (2018). Sea-surface dimethylsulfide (DMS) concentration from satellite data at global and regional scales. *Biogeosciences*, 15, 34973519. https://doi.org/10.5194/bg-15-3497-2018, 2018

Jarnikova T., Dacey J., Lizotte M., Levasseur, M. and P. Tortell. 2018. The distribution of methylated sulfur compounds, DMS and DMSP, in Canadian Subarctic and Arctic waters during summer, 2015. Biogeoscience. 15, 2449–2465, doi.org/10.5194

Irish, V E, S J Hanna, M D Willis, S China, J L Thomas, J J B Wentzell, A Cirisan, M Si, W R Leaitch, J G Murphy, J P D Abbatt, A Laskin, E Girard, and A K Bertram, 2019, Ice nucleating particles in the marine boundary layer in the Canadian Arctic during summer 2014, *Atmospheric Chemistry and Physics*, 19, 1027-1039, DOI: 10.5194/acp-19-1027-2019.

D. Konig, L.A. Miller, K.G. Simpson, S. Vagle, Carbon Dynamics During theFormation of Sea Ice at Different Growth Rates, Frontiers in Earth Science, doi: 10.3389/feart.2018.00234, 2018.

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

Several of the publications are co-authored with researchers at Environment and Climate Change Canada.

Tortell groups has worked with communities in the high Canadian Arctic, helping to develop a new social media platform, SIKU, which facilitates the use of remote sensing observations to support local environmental stewardship - https://arcticeider.com/en/about.

PART 2 - Planned activities for 2019/2020 and 2021

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

Tortell group has many cruises (> 6) planned this year

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

3. Funded national and international projects / activities underway.

Ocean Frontier Institute at Dalhousie University and Memorial University, module funded to study marine atmospheric composition and visibility.

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 2018 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 2018 – Jan-Feb 2019*
***- Part 2:** reporting on planned activities for 2019/2020 and 2021.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies;
Environmental impacts of geoengineering;
Science and society**.**

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

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

1. Scientific highlight

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: Ratios of greenhouse gas emissions observed over the Yellow Sea and the East China Sea
Text: Greenhouse gases are pervasively produced by human activities and the Asian continent has become the largest source of anthropogenic pollutants. In order to explore the factors that affected the distribution of the greenhouse gases over the East China Seas, we determined carbon dioxide (CO_2), methane (CH_4), carbon monoxide (CO), and nitrous oxide (N_2O) over the East China Sea (ECSs, i.e. the Yellow Sea and East China Sea) in spring of 2017 using a continuous observation system. The spatial variations of these gases were very similar. The ratios of the mole fraction enhancements between every pair of trace gases downwind of the source areas showed that the distributions of these trace gases over the ECSs in the spring were mainly caused by the emissions from Eastern China. The much higher enhancement ratio of $\Delta CO/\Delta CO_2$ and the lower ratio of $\Delta CH_4/\Delta CO$ observed in the air parcels from big cities indicated high CO emission from the cities. The ratios of the averages in the air coming from the Northern sector (Russia) were on average closer to the Marine Boundary Layer (MBL), and the air that stayed over the Yellow Sea and the

East China Sea was a mixture of emissions from wide regional areas.

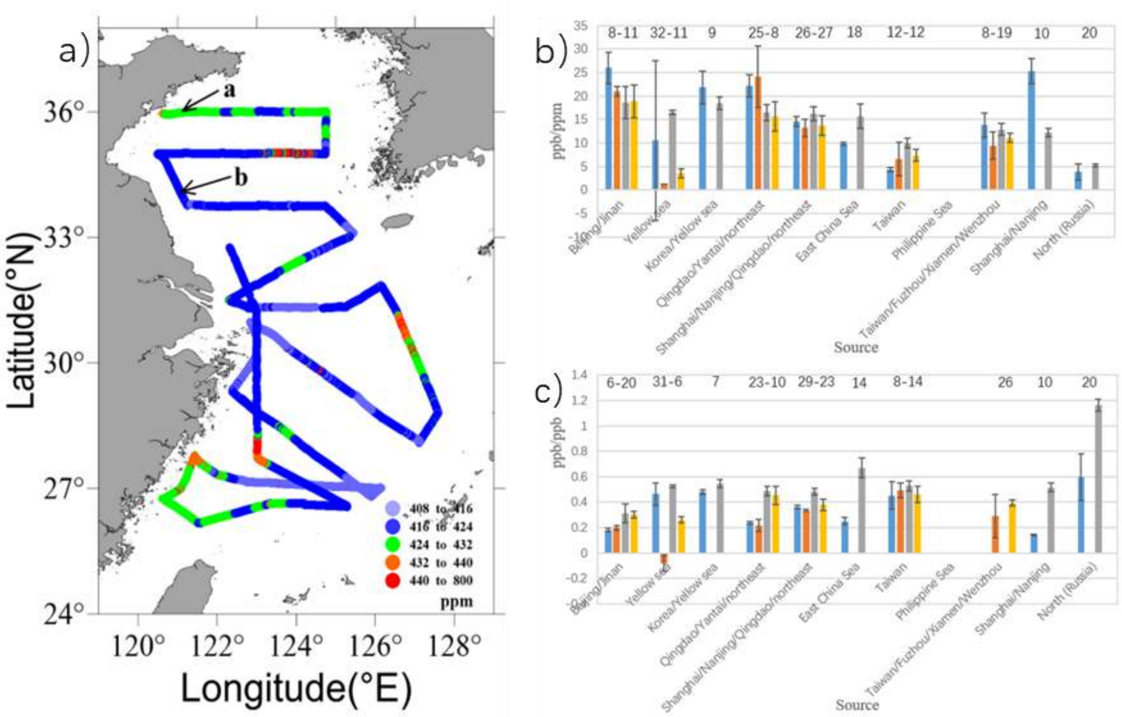


Figure: a) Spatial distribution of CO_2 mole fraction. b) The enhancement ratios of $\Delta CO/\Delta CO_2$ downwind different source areas. c) The enhancement ratios of $\Delta CH_4/\Delta CO$ downwind different source areas.

Citation: Liu, Y., Zhou, L., Tans, P. P., Zang, K., Cheng, S., 2018, Ratios of greenhouse gas emissions observed over the Yellow Sea and the East China Sea. *Science of the Total Environment*, 633, 1022-1031, doi: 10.1016/j.scitotenv.2018.03.250.

Title: Source of reactive nitrogen in marine aerosol over the Northwest Pacific Ocean in spring
Text: Atmospheric deposition of long-range transport of anthropogenic reactive nitrogen (Nr, mainly comprised of NHx, NOy and water-soluble organic nitrogen, WSON) from continents may have profound impact on marine biogeochemistry. Despite the importance of off-continent dispersion and Nr interactions at the atmosphere–ocean boundary, our knowledge of the sources of various nitrogen species in the atmosphere over the open ocean remains limited due to insufficient observations. We conducted two cruises in the spring of 2014 and 2015 from the coast of China through the East China seas (ECSs, i.e. the Yellow Sea and East China Sea) to the open ocean (i.e. the Northwest Pacific Ocean, NWPO). Aerosol NO_3^-, NH_4^+ and WSON decreased logarithmically with distance from the shore, reflecting strong anthropogenic emission sources in China. Obviously, marine DON emissions should be considered in model and field assessments of net atmospheric WSON deposition in the open ocean. This study contributes information on parallel isotopic marine DON composition and aerosol Nr datasets, but more research is required to explore complex Nr sources and deposition processes in order to advance our understanding of anthropogenic influences on the marine nitrogen cycle and nitrogen exchange at land–ocean and atmosphere–ocean interfaces.

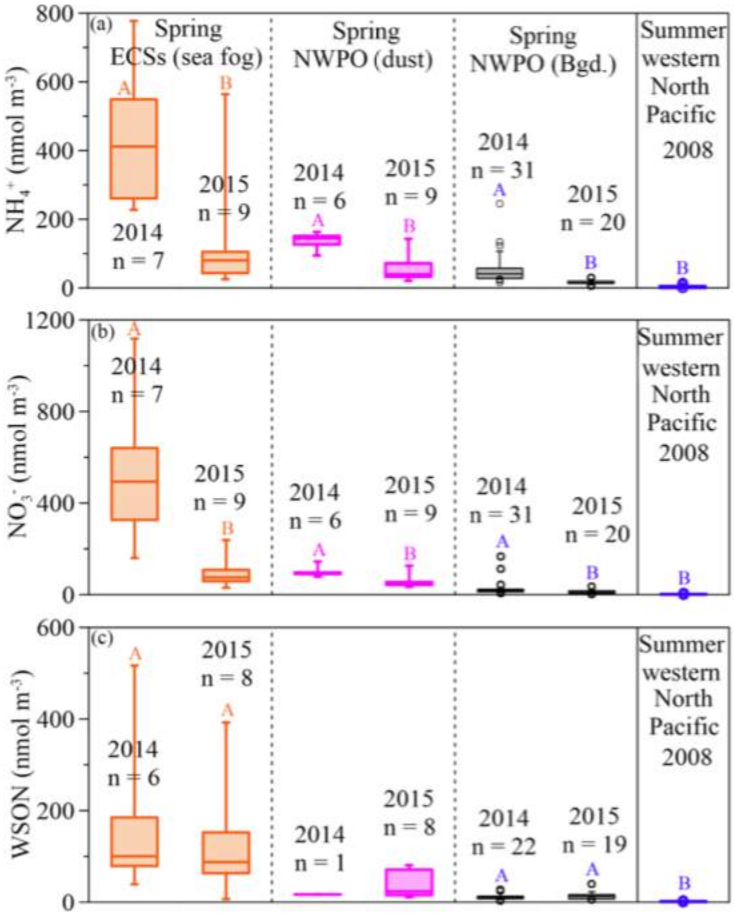


Figure: Box plots for spring concentrations of aerosol NH_4^+ (a), NO_3^- (b) and WSON (c) in the ECSs and NWPO.

Citation: Luo, L., Kao, S. J., Bao, H., Xiao, H., Yao, X., Gao, H., Li, J., Lu, Y., 2018, Source of reactive nitrogen in marine aerosol over the Northwest Pacific Ocean in spring. *Atmospheric Chemistry and Physics*, 18, 6207-6222.

Title: Variations in the phytoplankton community due to dust additions in eutrophication, LNLC and HNLC oceanic zones

Text: Dust deposition can bring nutrients and trace elements to the upper ocean and affect phytoplankton growth and community structure. We conducted a comparative study using on-board microcosm experiments amended with varying amounts of dust in the East China Sea (eutrophic zone), the subtropical gyre (Low-Nutrient and Low-Chlorophyll zone, LNLC), and the Kuroshio-Oyashio transition region (High-Nutrient and Low-Chlorophyll zone, HNLC) of the Northwest Pacific Ocean. The additions of dust supplied a considerable amount of nitrogen and negligible phosphorus relative to the seawater, contributing to the increases in chlorophyll a and the shifts towards larger cells of phytoplankton with increasing dust additions. In the experiments conducted in LNLC and HNLC zones, micro-sized phytoplankton benefited most from dust additions, while in eutrophic zone, the primary beneficiary was the nano-sized phytoplankton. The relative abundance of diatoms (RAD) increased substantially with increases in the N: P ratio until the ratio approached the Redfield ratio, and then decreased gradually as the N: P ratio increased. This was ascribed to the lower sensitivity of dinoflagellates to nutrient shortage. Overall, our results suggested that the overwhelming input of N relative to P by dust deposition might cause significant ecological impacts by altering the N: P ratio of varying trophic seawaters.

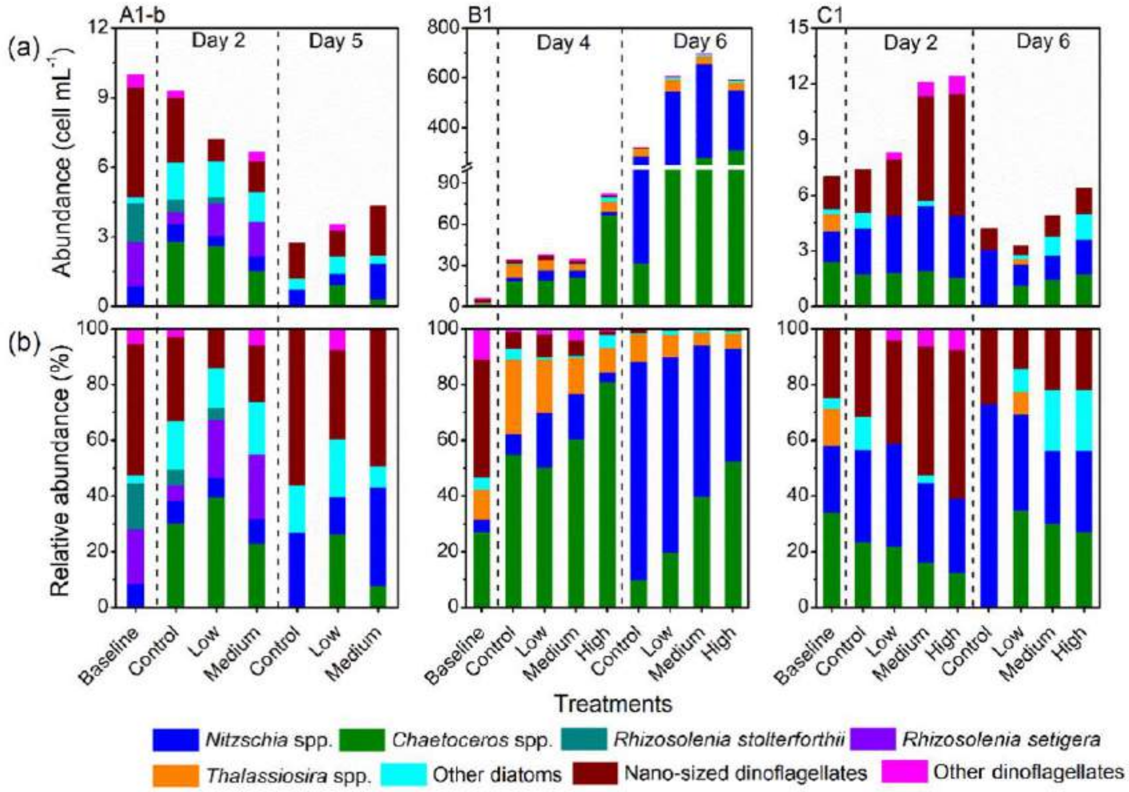


Figure: (a) Abundance of large size phytoplankton and (b) their contributions to the total abundance, with different amounts of dust added during the incubation experiments conducted in LNLC (A1-b), HNLC (B1) and eutrophic zone (C1).

Citation: Zhang, C., Yao, X., Chen, Y., Chu, Q., Yu, Y., Shi, J., Gao, H., 2019, Variations in the phytoplankton community due to dust additions in eutrophication, LNLC and HNLC oceanic zones. *Science of the Total Environment*, doi: 10.1016/j.scitotenv.2019.02.068.

Title: Analysis of the co-existence of long-range transport biomass burning and dust in the subtropical West Pacific region

Text: Biomass burning and wind-blown dust has been well investigated during the past decade regarding their impacts on environment, but their co-existence hasn't been recognized because they usually occur in different locations and episodes. However, we reveal the unique co-existence condition that dust from the Taklamakan and Gobi Desert (TGD) and biomass burning from Peninsular Southeast Asia (PSEA) can reach to the West Pacific region simultaneously in boreal spring. The upper level trough at 700 hPa along east coast of China favours the large scale subsidence of TGD dust while it travels southeastwards, and drives the PSEA biomass burning plume carried by the westerlies at 3–5 km to descend rapidly to around 1.5 km and mix with dust around southeast China Mainland and Taiwan Island. As compared to the monthly averages in March and April, surface observations suggested that concentrations of PM_{10}, $PM_{2.5}$, O_3, and CO were 69%, 37%, 20%, and 18% higher respectively during the 10 identified co-existence events. Co-existence also lowers the surface O_3, NOx, and SO_2 by 4–5% due to the heterogeneous chemistry between biomass burning and mineral dust as indicated by model simulations. These results provide new insights into the atmospheric deposition to the west Pacific.

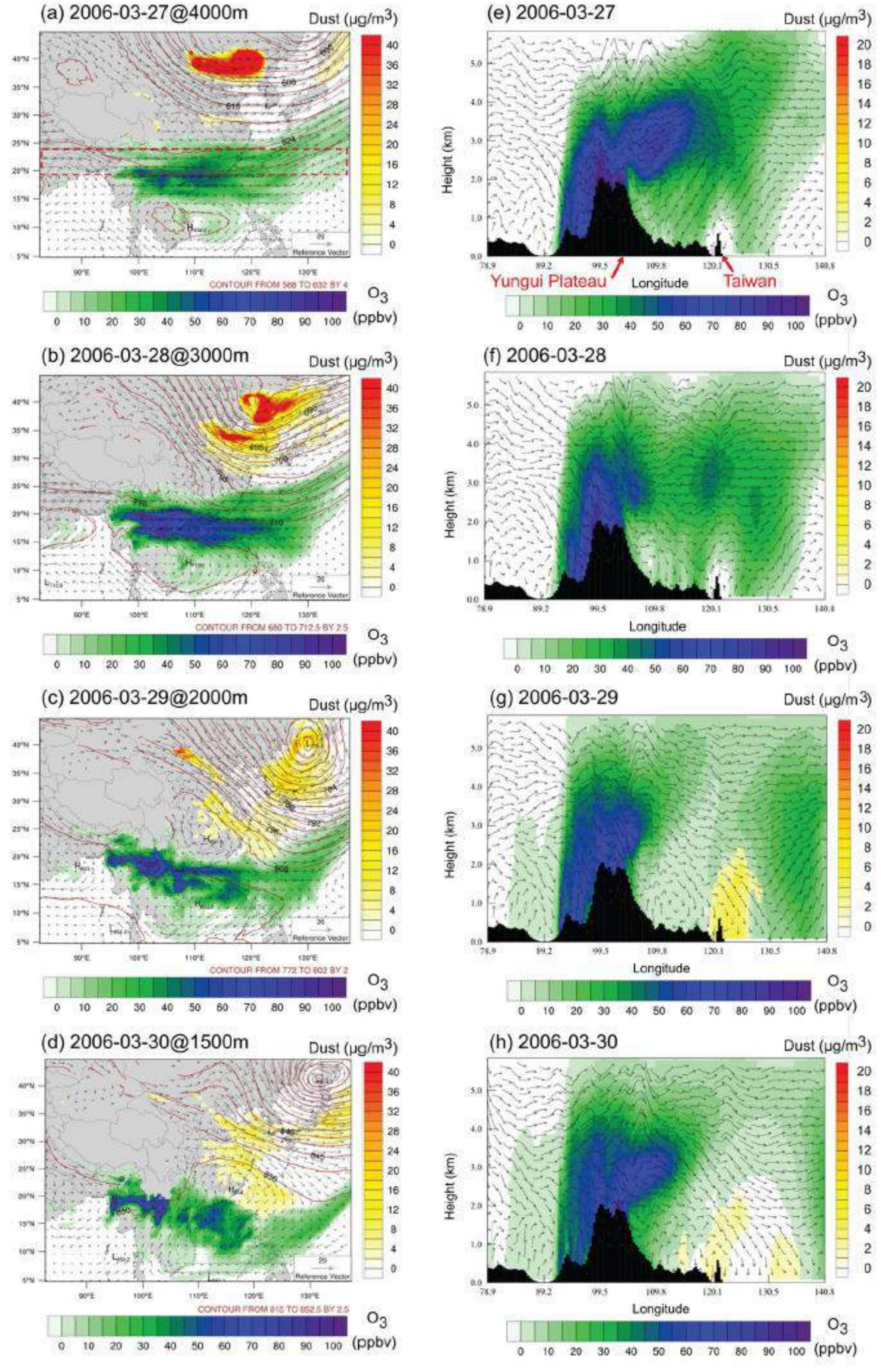


Figure: Spatial distributions of wind vector, pressure contour, dust concentration, and biomass burning O_3 concentration on (a) Mar. 27 at 4000 m; (b) Mar. 28 at 3000 m; (c) Mar. 29 at 2000 m; and (d) Mar. 30 at 1500 m above sea level; Zonal average (19°N-24°N, along the red dashed box in (a)) cross section distributions of wind vector, dust concentration, and biomass burning O_3 concentration on (e) Mar. 27; (f) Mar. 28; (g) Mar. 29; and (h) Mar. 30.

Citation: Dong, X., Fu, J. S., Huang, K., Lin, N. H., Wang, S. H., Yang, C. E., 2018, Analysis of the co-existence of long-range transport biomass burning and dust in the subtropical West Pacific region. *Scientific Reports*, 8(1), 8962, doi: 10.1038/s41598-018-27129-2.

Title: The influence of terrestrial transport on visibility and aerosol properties over the coastal East China Sea

Text: Air pollutants from East Asia continent can affect the physico-chemical and optical properties of marine aerosols under seasonal winds. We investigated the change of visibility and haze frequency from 1974 to 2017 over the coastal East China Sea (ECS), and reconstructed the light extinction coefficients according to the chemical compositions of $PM_{2.5}$ samples collected at Huaniao Island in the ECS. The annual average visibility significantly decreased from over 25 km in the early 1970s to <18 km in recent 4 years. The occurrence of daily maximum haze frequency was approximately 3-h later with respect to land sites, which could be explained by the diffusion of air pollutants from nearby cities to the coastal ECS as well as the formation of secondary aerosols enhanced by photochemical reactions around noon. Meanwhile, anthropogenic chloride transported from the land could increase the concentration of Cl^- in marine aerosol, which may weaken the Cl^- depletion phenomenon over coastal ECS and even induced considerable Cl^- enrichment during the severe haze event. The largest contributor to the light extinction was $(NH_4)_2SO_4$ followed by NH_4NO_3 and OM in almost all seasons. Especially in winter and spring, $(NH_4)_2SO_4$ accounted for 45% and 52% of total light extinction, respectively.

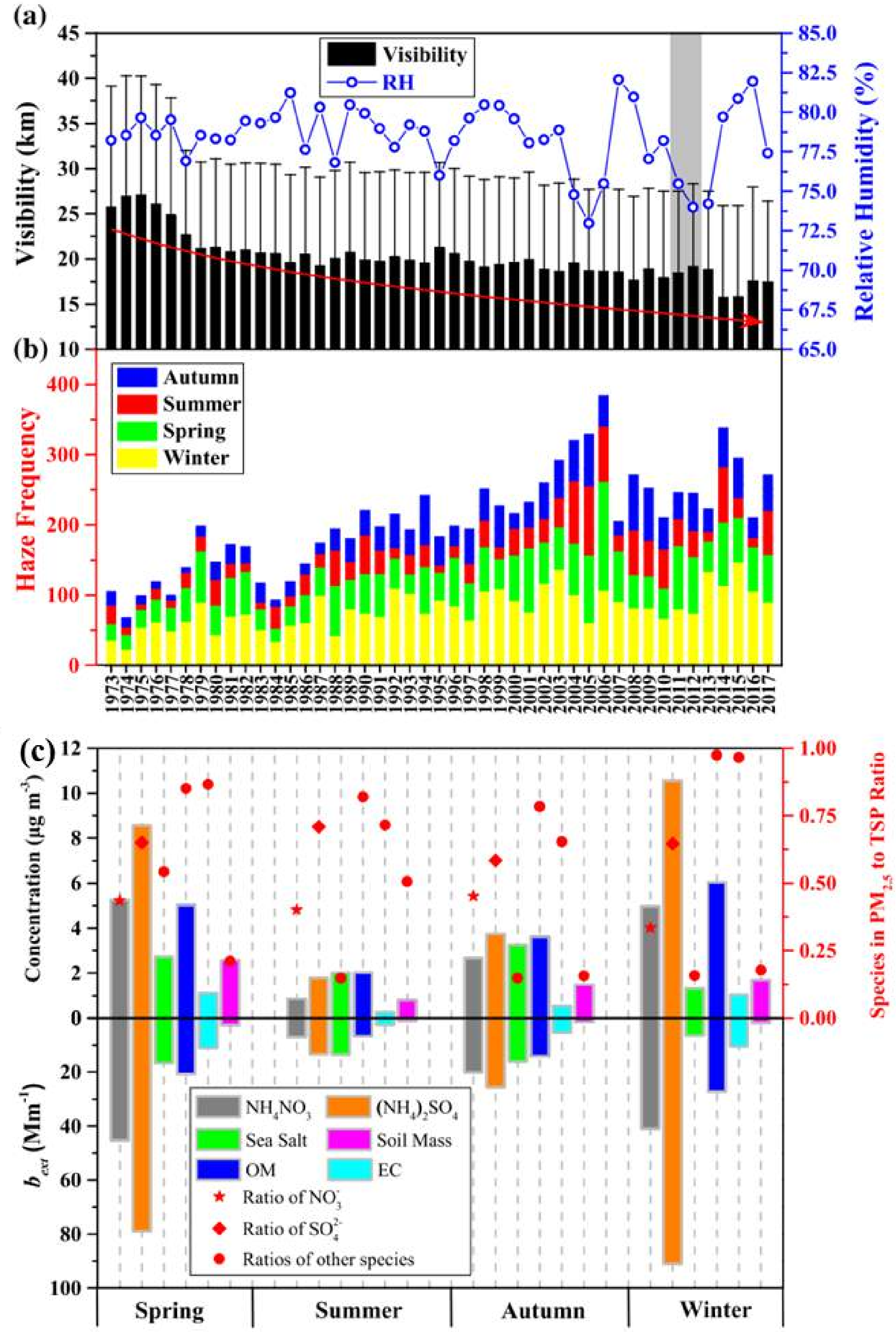


Figure: (a) Variation of annual average visibility and relative humidity over the coastal ECS from 1973 to 2017 (b) Haze frequency in different years and seasons. (c) Seasonal variation of $PM_{2.5}$ components concentration and light extinction coefficient (b_{ext}).

Citation: Wang, B., Chen, Y., Zhou, S., Li, H., Wang, F., Yang, T., 2018, The influence of terrestrial transport on visibility and aerosol properties over the coastal East China Sea. *Science of the Total Environment*, 649, 652-660, doi: 10.1016/j.scitotenv.2018.08.312.

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

- **Cruise and field experiment**

- Cruise studying on marine biogenic reactive gases in the Yellow Sea and East China Sea was conducted during the summer of 2018 (Theme 1-5).
- Atmospheric chemistry and marine ecology were investigated on Huaniao Island during March 31- May 9 and October 23-November 22, 2018 (Theme 3-5).
- A SOLAS cruise campaign was conducted from June 26 to July 17 of 2018 to 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)
- The material exchange between South China Sea (SCS) and West Pacific were investigated based on large-scale observations of a cruise conducted onboard R/V TAN KAH KEE during June 12- July 10, 2018. 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 Aug. 1-12, 2018 to the South East Asia Time-series Station (SEATS) in the SCS. This cruise aimed to understand how monsoonal forcing controls biogeochemical cycles in the SCS. This cruise was supported by the Fundamental Research Funds for the Central Universities. (Theme 1)

- **Model and data intercomparisons**

The modelling of marine biogenic DMS emissions and reactions using WRF-CMAQ (Theme 5)

- **Projects**

National Key Research and Development Program: Vertical Observation of Aerosol Particles and Their Characteristics at Single Particle Level within Marine Boundary Layer at Coastal Areas (2018-2021), leading PI: Bingbing Wang from Xiamen University (Theme 4)

NSFC Innovative Research Group: Nitrogen Cycle under Global Change (2018-2023), leading PI: Shuh-Ji Kao from Xiamen University (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)

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. 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 (2016-2021), leading PI: Gui-Peng Yang from Ocean University of China (Theme 2)

- **Infrastructure**

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 completed its first trial voyage at the end of December, 2018.

- **International interactions and collaborations**

In October 2018, Prof. Zhiyu Liu and Dr. Jinyu Yang attended a workshop in Kiel, which was related to establish an international research lab working on a time-series observation in the North Atlantic Ocean. This prospective International Lab is a significant initiative towards integrated ocean-atmosphere observations and experiments, which is a central theme of international programs such as SOLAS. This International Lab would also be an exciting platform for fruitful international collaborations that MEL/XMU is looking forward to.

- **Workshop organized**

From 6 to 9 January 2019, the 4th Xiamen Symposium on Marine Environmental Sciences (XMAS-IV) with the theme of 'The Changing Ocean Environment: From a Multidisciplinary Perspective' took place in Xiamen, China. The symposium consists of 33 sessions covering physical oceanography, marine biogeochemistry, biological oceanography, and marine ecotoxicology along with workshops for emerging topics in marine environmental sciences. A SOLAS Session C4 entitled "Surface Ocean and Lower Atmosphere Study—Air-Sea interactions and their climatic and environmental impacts" was included. In this session, the SOLAS scientific community exchanged new ideas and discussed the latest achievements in our understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and the atmosphere, and of how this coupled system affects and is affected by climate and environmental change. Studies focusing on atmosphere-ocean exchange of climate active gases, atmospheric deposition, chemical transformations of gases and particles, interactions between anthropogenic pollution with marine emissions, feedbacks from ocean ecosystems and impacts to environments and climate were presented in particular.

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

The 7th Xiamen University Ocean Sciences Open House was held on November 4, 2018, Zhou-Long-Quan Building, Xiang'An Campus, Xiamen University, China.

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

1. Liu, Q., Guo, X.H., Yin, Z.Q., Zhou, K.B., Roberts, E.G., Dai, M.H., 2018, Carbon fluxes in the China Seas: An overview and perspective. *Science China-Earth Sciences*, 61(11), 1564-1582.
2. Jiang, Y., Lin, T., Wu, Z., Li, Y., Li, Z., Guo, Z., Yao, X., 2018, Seasonal atmospheric deposition and air–sea gas exchange of polycyclic aromatic hydrocarbons over the Yangtze River Estuary, East China Sea: Implications for source–sink processes. *Atmospheric Environment*, 178, 31-40, doi:10.1016/j.atmosenv.2018.01.031.
3. Dong, X., Fu, J. S., Huang, K., Lin, N. H., Wang, S. H., Yang, C. E., 2018, Analysis of the Co-existence of Long-range Transport Biomass Burning and Dust in the Subtropical West Pacific Region. *Scientific Reports*, 8(1), 8962, doi:10.1038/s41598-018-27129-2.
4. Wang, B., Chen, Y., Zhou, S., Li, H., Wang, F., Yang, T., 2018, The influence of terrestrial transport on visibility and aerosol properties over the coastal East China Sea. *Science of the Total Environment*, 649, 652-660, doi:10.1016/j.scitotenv.2018.08.312.
5. Sun, M.-S., Zhang, G.-L., Ma, X., Cao, X. -P., Mao, X.-Y., Li, J., Ye, W.-W., Liu, S.-M., 2018, Dissolved Methane in the East China Sea: distribution, seasonal variation and emission. *Marine Chemistry,* 202, 12-26, doi: 10.1016/j.marchem.2018.03.001.

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 2018? If yes, who? How did you engage?

PART 2 - Planned activities for 2019/2020 and 2021

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

- Two SOLAS cruises will be conducted in fall and winter of 2019 to 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)

- A spring cruise to the Northwest Pacific is being conducted by R/V TAN KAH KEE in March-April, 2019. This cruise is studying the biogeochemical responses to an eddy in the upper ocean with high resolution investigation. This cruise is supported by NSFC.
- It is confirmed that there will be a cruise to the Northwest Pacific conducted in April by R/V TAN KAH KEE in 2019. It will be the 1st GEOTRACES-China Cruise.
- There will be a winter cruise to the Northwest Pacific conducted by R/V TAN KAH KEE under Carbon-FE project from the end of 2019 to January of 2020, which aims to examine carbon fixation and export, or the biological bump in general, regulated by differently sourced nutrients including macronutrients (i.e., N, P, Si) and micronutrients (e.g., Fe).

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

- The 4th Global Ocean Acidification Observing Network (GOA-ON) International Workshop will be held at Hangzhou, April 14-17, 2019.
- More than 20 scientists and students from China will attend the SOLAS Open Science Conference 2019 held in Sapporo Hokkaido, Japan, April 21-25, 2019.

3. Funded national and international projects / activities underway.

- NSFC program: CARBON Fixation and Export in the oligotrophic ocean (Carbon-FE) (2019-2023), leading PI: Minhan Dai from Xiamen University (Theme 1)

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.

Prof. Minhan Dai engage in REgional Carbon Cycle Assessment and Processes-2 (RECCAP2) which is an activity of the Global Carbon Project with a number of partners. The objectives of RECCAP2 are: 1) to quantify anthropogenic greenhouse gas emissions, 2) to develop robust observation-based estimates of changes in carbon storage and greenhouse gas emissions and sinks by the oceans and terrestrial ecosystems, distinguishing whenever possible anthropogenic vs. natural fluxes and their driving processes, 3) to gain science-based evidence of the response of marine and terrestrial regional GHG (CO_2, CH_4, N_2O) budgets to climate change and direct anthropogenic drivers. To address these objectives, RECCAP2 will design and perform a set of global syntheses and regional GHG budgets of all lands and oceans, and explore mechanisms by which to deliver regular updates of these regional assessments based on scientific evidence, considering uncertainties, understanding of drivers, and retrospective analysis of recent trends. RECCAP2 is expected to accomplish most of the work over 2019-2020 with publication of all papers by 2021.

Comments

surface ocean solas lower atmosphere study

Report for the year 2018 and future activities

SOLAS *Taiwan*
compiled by: Chon-Lin Lee and Hon-Kit Lui

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

1. Scientific highlight

(1) Massive coral mortality could be exacerbated by distant volcanic eruption under the influence of global warming

Coral reefs, the so-called rainforests of the sea, are one of the important components of the marine ecosystems. However, mainly because of seawater warming, coral bleaching even mortality has been spread widely since the early 1980s. One such episode occurred in 1991 over the tropical Pacific-Indian Ocean region. It was suggested that the main cause was due to high summer sea surface temperatures. However, sea surface temperature from the South China Sea did not support for that. Time series records of rare earth elements, trace element Al/Ca ratios, and microdomain images from corals collected in the South China Sea suggested that the coral mortality event was exacerbated by heavy ash fallout from the cataclysmic 1991 volcanic eruption of Mount Pinatubo in Philippines (ca. 1,300 km from the sampling site). It was suggested that the volcanic ash released acids and metals after falling to the ocean, causing reef degradation and coral mortality with other stressors. This study demonstrated that massive coral mortality could be exacerbated by distant volcanic eruption.

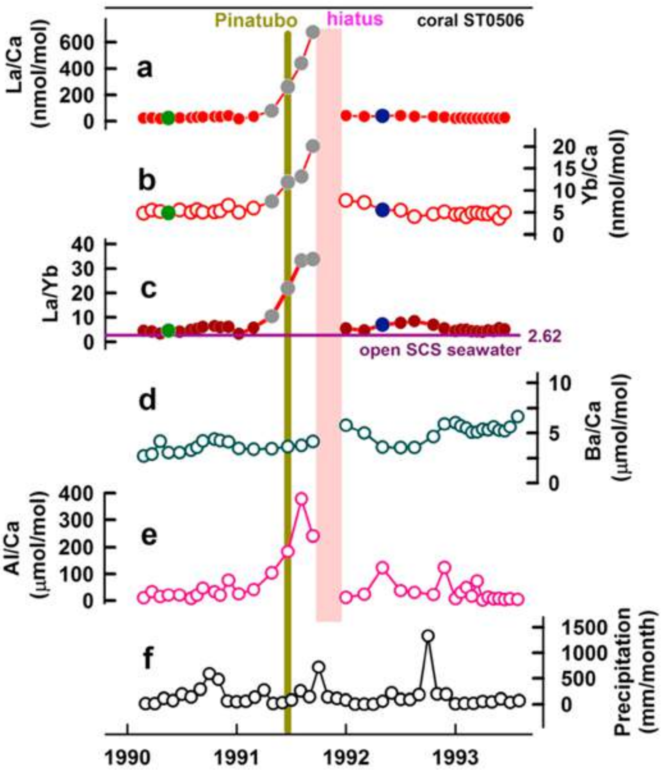


Figure: Monthly-to-bimonthly resolved coral ST0506 rare earth element records between CE 1990 and 1993. (a) La/Ca ratios, (b) Yb/Ca ratios, and (c) La/Yb ratios. The purple line shows La/Yb baseline values from an open South China Sea seawater station. (d) Ba/Ca ratios, (e) Al/Ca ratios, and (f) monthly instrumental precipitation from 1990 to 1993 (from Da Nang Weather Station). The pink bar indicates the duration of a coral growth hiatus. The dark yellow line denotes the climactic eruption of Pinatubo on 15 June 1991. The green, grey, and blue circles represent the layers corresponding to the rare earth element patterns.

Citation: Wu, C -C, Shen, C C*, Lo, L, Hsin, Y C, Yu, K, Chang, C C, Lam, D D, Chou, Y M, Liu Y, Pallister, J, Song, S -R., Chiang, H W, and Burr G S (2018), Pinatubo volcanic eruption exacerbated an abrupt coral mortality event in 1991 summer, Geophysical Research Letters, 45(22), 12396-12402, doi:10.1029/2018GL079529.

(2) Remote coral reef in the northern South China Sea recorded the anthropogenic nitrogen deposition signal

It is well known that the pollution-associated nitrogen is an important nutrient input in the coast of western Pacific Ocean. It has been suggested that open ocean would also be affected. This study used a coral core from Dongsha Atoll, a remote coral reef ecosystem, to show an observable decline in the $^{15}N/^{14}N$ of coral skeleton-bound organic matter. Such a result was due to the increase of anthropogenic atmospheric N deposition. The deposition of anthropogenic nitrogen began at the end of the 20th century, and this pathway supplied 20 ± 5% of the annual N input to the surface ocean in this region.

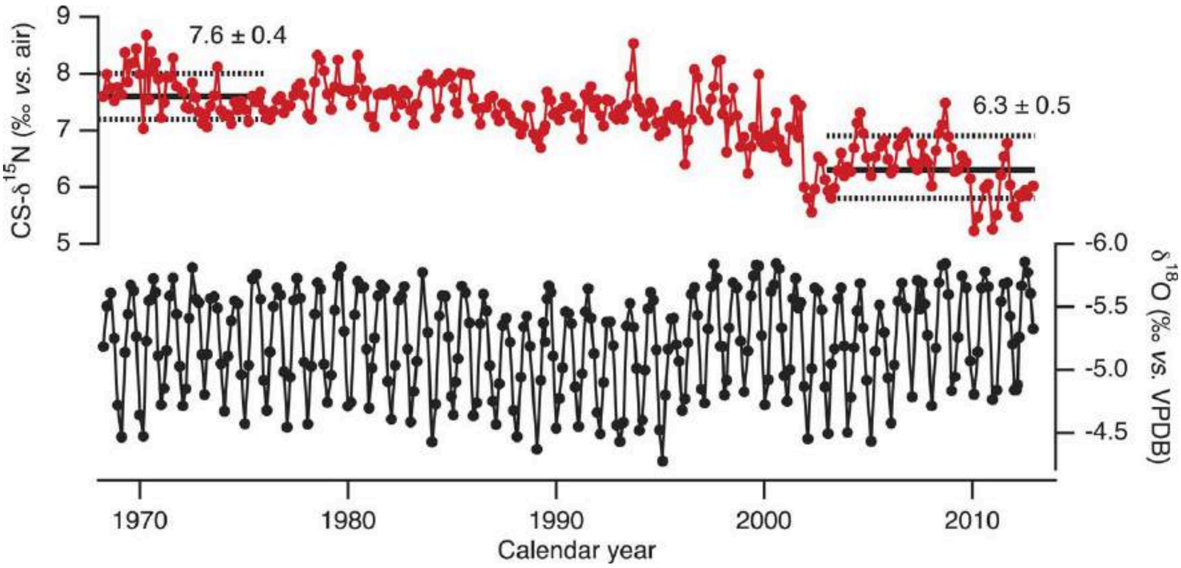


Figure
The 45-year records of CS-$\delta^{15}N$ and skeletal carbonate $\delta^{18}O$. CS-$\delta^{15}N$ declined across the record, with a 1.3‰ difference between the average $\delta^{15}N$ values from 1968–1977 and 2003–2012. The major decline in CS-$\delta^{15}N$ occurred in the 21st century. VPDB refers to Vienna Pee Dee Belemnite standard.

Citation: Ren, H, Chen, Y C, Wang, X T, Wong, G T F, Cohen, A L, DeCarlo, T M, Weigand, M A, Mii, H S, Sigman, D M (2017) 21st-century rise in anthropogenic nitrogen deposition on a remote coral reef, Science, 356(6339), 749-752, DOI: 10.1126/science.aal3869.

(3) Reduced ventilation of the oceans under warming might accelerate the deep-ocean acidification

Oceans worldwide are undergoing acidification due to the dissolution and penetration of anthropogenic CO_2 from the atmosphere. Generally, the rate of seawater acidification diminishes with increasing depth. Yet, the pH in the deep oceans could be reduced due to the slowdown of the thermohaline circulation (reduced ventilation) under the influence of global warming, as more organic material would decompose with a longer residence time. This study shows that deep waters in the Sea of Japan are undergoing reduced ventilation. Consequently, the acidification rate near the bottom of the Sea of Japan is 27% higher than that of the surface. As an oceanic microcosm with its own deep- and bottom-water formations, the Sea of Japan provides an insight into how future warming might alter the deep-ocean acidification.

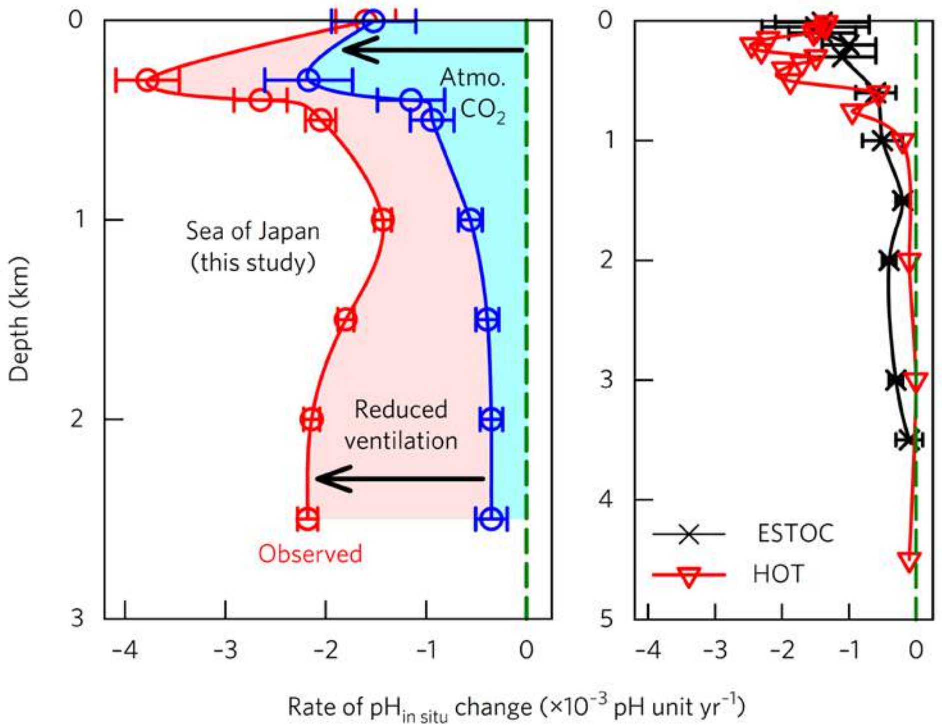


Figure
Rate of temporal changes of pH at various depths between 1965 and 2015. The arrows and the coloured regions represent the magnitudes of changes due to the increasing atmospheric CO_2 and reducing seawater ventilation. The blue circles show the rate of pH change due to increasing atmospheric CO_2, while the red circles show the results with additional considerations of the reduced seawater ventilation. The acidification rates at the ESTOC (taken from Santana-Casiano et al.2007, *Glob. Biogeochem. Cycle,* 21, GB1015) and HOT (from Dore et al. 2009, *Proc. Natl Acad. Sci. USA,* 106, 12235–12240) stations are shown in the right panel for comparison. The dashed lines show the zero rate of change of pH.

Citation: Chen, C T A, Lui, H K, Hsieh, C H, Yanagi, T, Kosugi, N, Ishii M. and Gong, G C (2017). Deep oceans may acidify faster than anticipated due to global warming, *Nature Climate Change*, 7, 890-894, DOI: 10.1038/s41558-017-0003-y.

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

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

Wu, C -C, Shen, C C, Lo, L, Hsin, Y C, Yu, K, Chang, C C, Lam, D D, Chou, Y M, Liu Y, Pallister, J, Song, S -R., Chiang, H W, and Burr G S (2018), Pinatubo volcanic eruption exacerbated an abrupt coral mortality event in 1991 summer, *Geophysical Research Letters*, 45(22), 12396-12402, DOI:10.1029/2018GL079529.

Ren, H, Chen, Y C, Wang, X T, Wong, G T F, Cohen, A L, DeCarlo, T M, Weigand, M A, Mii, H S, Sigman, D M (2017) 21st-century rise in anthropogenic nitrogen deposition on a remote coral reef, Science, 356(6339), 749-752, DOI: 10.1126/science.aal3869.

Chen, C T A, Lui, H K, Hsieh, C H, Yanagi, T, Kosugi, N, Ishii M. and Gong, G C (2017). Deep oceans may acidify faster than anticipated due to global warming, *Nature Climate Change*, 7, 890-894, DOI: 10.1038/s41558-017-0003-y.

Liao, W H and Ho, T Y (2018) Particulate trace metal composition and sources in the Kuroshio adjacent to the East China Sea: the importance of aerosol deposition. *Journal of Geophysical Research*: Oceans, 123(9), 6207-6233, DOI:10.1029/2018JC014113.

Chen, H Y and Huang, S Z (2018) Effects of atmospheric dry deposition on external nitrogen supply and new production in the northern South China Sea. *Atmosphere, 9(10),* DOI:10.3390/atmos9100386

Wang, Y L, Wu, C. R. (2018) Discordant multi-decadal trend in the intensity of the Kuroshio along its path during 1993-2013. *Scientific Reports,* 8:14633, DOI: 10.1038/s41598-018-32843-y.

Huang, W J, Kao, K J, Liu, L L, Liao, C W, and Han, Y L (2018). An assessment of direct dissolved inorganic carbon injection to the coastal region: A model result. *Sustainability,* 10(4), 1174. DOI:10.3390/su10041174

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

PART 2 - Planned activities for 2019/2020 and 2021

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

The Taiwan representative plans to join scientists related to SOLAS in Taiwan together, integrating individual teams from different disciplines, co-designing and proposing a multidisciplinary research project of SOLAS. The project is planned to submit to the Sustainable Development discipline of the Ministry of Science and Technology (MOST) of Taiwan before the end of 2019.

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

The Taiwan representative plans to propose and chair a session for SOLAS in Taiwan in the Annual Ocean Meeting in Taiwan in May, 2020.

3. Funded national and international projects / activities underway.

The funding is expected to come mainly from the MOST, various universities and Academia Sinica of Taiwan, as well as different industry-academia cooperative research projects of the participants.

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

Based on the current situation, the projects in 2020 plans to focus mainly in ocean acidification **(**Greenhouse gases and the oceans), fate of aerosol (Atmospheric deposition and ocean biogeochemistry), as well as popular science promotion (science and society). The project will try to meet the common interests and scopes of the MOST of Taiwan, SOLAS, and the Future Earth by Science and Technology Alliance for Global Sustainability.

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

Comments

surface ocean solas lower atmosphere study

Report for the year 2018 and future activities

SOLAS *Finland*

compiled by: Lauri Laakso / FMI, with contributions from University of Helsinki, Åbo Academy University, Geological Survey of Finland.

Themes or Cross-Cutting Themes.

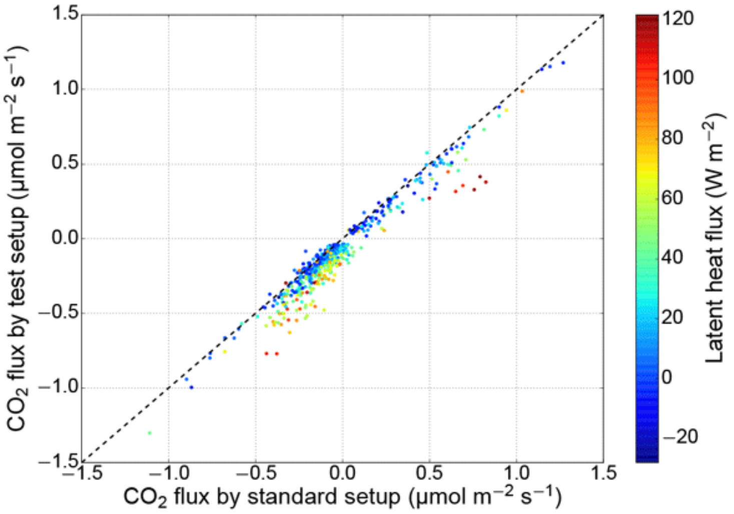
1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies;
Environmental impacts of geoengineering;
Science and society.

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

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

1. Scientific highlight

CO_2 infrared gas analyzers are known to be prone to water vapor interference. Honkanen et al. (2018) tested two closed-path infrared gas analyzers, one of which was equipped with a drier and a virtual impactor, for measuring the CO_2 exchange between the sea and the atmosphere. The undried setup showed a positive bias that increased with increasing water vapor flux.



Reference: Honkanen, M., Tuovinen, J.-P., Laurila, T., Mäkelä, T., Hatakka, J., Kielosto, S., and Laakso, L.: Measuring turbulent CO2 fluxes with a closed-path gas analyzer in a marine environment, Atmos. Meas. Tech., 11, 5335-5350, https://doi.org/10.5194/amt-11-5335-2018, 2018

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

The first submarine groundwater discharge site described in Finland, in the Hanko Peninsula. This is the third such site described in the Baltic Sea (there is one in Eckernförde Bay in Germany, and one in Puck Bay in Poland). The direct discharge of groundwater causes an as yet unquantified flux of methane from the seafloor.

Completion of BONUS SHEBA and KAMON projects

Participation in IMO MEPC73 meeting (International Maritime Organisation Marine Environment Protection Committee), London, Oct 2018

Participation in TFEIP meeting (Task Force for Emission Inventories and Projections), Sofia, May 2018

Three submissions to HELCOM Maritime18 meeting (4.3/INF Air emissions from ships; 12.4/INF Discharges from ships to sea; 12.5/INF Underwater noise from ships). Annual reporting of these quantities from 2018 onwards.

FMI holds a seat at the European Sustainable Shipping Forum as a science advisor.

Onboard measurements of SOx scrubber efficiency within EnviSum project

Delivery of global and regional ship emissions inventories for EU Commission (Copernicus Atmospheric Monitoring Services)

Networking with Baltic Earth group

A Profiling cabled observatory installed (in April 2018) 2 km south of Utö Atmospheric and Marine Research Station

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

Five top publications in each theme indicated with (*)

Theme 1:

* Fransner, F., Gustafsson, E., Tedesco, L., Vichi, M., Hordoir, R., Roquet, F., ... Nycander, J. (2018). Non-Redfieldian Dynamics Explain Seasonal pCO(2) Drawdown in the Gulf of Bothnia. Journal of Geophysical Research : Oceans, 123(1), 166-188. https://doi.org/10.1002/2017JC013019

* Glippa, O., Engström-Öst, J., Kanerva, M., Rein, A., & Vuori, K. (2018). Oxidative stress and antioxidant defense responses in Acartia copepods in relation to environmental factors. PLoS One, 13(4), [0195981]. https://doi.org/10.1371/journal.pone.0195981

* Honkanen, M., Tuovinen, J.-P., Laurila, T., Mäkelä, T., Hatakka, J., Kielosto, S., and Laakso, L.: Measuring turbulent CO2 fluxes with a closed-path gas analyzer in a marine environment, Atmos. Meas. Tech., 11, 5335-5350, https://doi.org/10.5194/amt-11-5335-2018, 2018

* Jilbert, T, Asmala, E, Schröder, C, Tiihonen, R, Myllykangas, J P, Virtasalo, J J, Kotilainen, A, Peltola, P, Ekholm, P, Hietanen, S, 2018, Impacts of flocculation on the distribution and diagenesis of iron in boreal estuarine sediments, Biogeosciences, 15, 1243–1271, doi: 10.5194/bg-15-1243-2018.

* Jokinen, S A, Virtasalo, J J, Jilbert T, Kaiser, J, Dellwig, O, Arz, H W, Hänninen, J, Arppe, L, Collander, M, Saarinen, T, 2018, A 1500-year multiproxy record of coastal hypoxia from the northern Baltic Sea indicates unprecedented deoxygenation over the 20th century, Biogeosciences, 15, 3975–4001, doi: 10.5194/bg-15-3975-2018.

Theme 2:

* Druzhinin O., Troitskaya Y., Zilitinkevich S., 2018: The study of momentum, mass and heat transfer in a droplet-laden turbulent air-flow over a waved water surface by direct numerical simulation. Journal of Geophysical Research (JGR) – Oceans, 123, 11, 8346-8365, DOI10.1029/2018JC014346

Henriksson, S. V., Interannual oscillations and sudden shifts in observed and modeled climate, Atmos. Sci. Lett. 19, e850, doi:/10.1002/asl.850, 2018. (interaction between ocean and atmosphere)

* Högström, U., Sahlée, E., Smedman, A.-S. Rutgersson, A., Nilsson, E., Kahma, K., Drennan, W.M.: The Transition from Downward to Upward Air–Sea Momentum Flux in Swell-Dominated Light Wind Conditions, Journal of the Atmospheric Sciences, Vol 75, pp. 2579-2588, https://doi.org/10.1175/JAS-D-17-0334.1 ,2018

* Mengis, N., Partanen, A.-I., Jalbert, J., Matthews, H. D.: 1.5 °C carbon budget dependent on carbon cycle uncertainty and future non-CO2 forcing, Sci. Rep., 8, 5381, doi:10.1038/s41598-018-24241-1, 2018. (related to uncertainty in ocean carbon uptake)

Myslenkov S., Medvedeva A., Arkhipkin V., Markina M., Surkova G., Krylov A., DobrolyubovS., Zilitinkevich S., Koltermann P., 2018: Long-term Statistics of Storms in the Baltic, Barents and White Seas and Their Future Climate Projections. Geography, Environment and Sustainability, 11(1):93-112, DOI 10.24057/2071-9388-2018-11-1-93-112

* Troitskaya Y., Kandaurov A., Ermakova O., Kozlov D., Sergeev D., and Zilitinkevich S., 2018: The “bag breakup” spume droplet generation mechanism at high winds. Part I. Spray generation function.. J. Phys. Oceanogr., 48, 2167–2188, DOI 10.1175/JPO-D-17-0104.1

* Troitskaya Y., Druzhinin O., Kozlov D., Zilitinkevich S., 2018: Bag-breakup spume droplet generation mechanism at high winds. Part II: The impact on momentum and enthalpy transfer. J. Phys. Oceanogr., 48, 2189–2207, DOI 10.1175/JPO-D-17-0105.1

Theme 5

* Alvarez-Fernandez, S., Bach, L. T., Taucher, J., Riebesell, U., Sommer, U., Aberle, N., Brussaard, C.P.D., Boersma, M. (2018). Plankton responses to ocean acidification: The role of nutrient limitation. Progress in Oceanography, 165, 11-18. https://doi.org/10.1016/j.pocean.2018.04.006

* Boxhammer, T., Taucher, J., Bach, L. T., Achterberg, E. P., Alguero-Muniz, M., Bellworthy, J., ... Anderson, L. G. (2018). Enhanced transfer of organic matter to higher trophic levels caused by ocean acidification and its implications for export production: A mass balance approach. PLoS One, 13(5), [0197502]. https://doi.org/10.1371/journal.pone.0197502

* Ding J et al, 2018, Maritime NOx emissions over Chinese seas derived from satellite observations, Geophysical Research Letters, 45, 2031-2037, https://doi.org/10.1002/2017GL076788

Jalkanen J-P et al, 2018, Modeling of ships as a source of underwater noise, Ocean Science, 14, 1373-1383, https://doi.org/10.5194/os-14-1373-2018

* Sofiev M et al, 2018, Cleaner fuels for ships provide public health benefits with climate tradeoffs, Nature Communications, 406, 1-12, DOI: 10.1038/s41467-017-02774-9

* Wilewska-Bien M et al, 2018, Phosphorus flows on ships: Case study from the Baltic Sea, Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment, May, 1-12, DOI: 10.1177/1475090218761761

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

Finnish Transport Safety Agency, HELCOM secretariat, EU flag state representatives, European Community Shipowners' Association, European Sea Port Organisation, Hapag-Lloyd, MAN Diesel & Turbo, Wartsila, Transport & Environment (NGO), Shell, Finnish Communication Authority, Finnish Transport Agency. Regular dialogue with our national IMO delegates, joint research efforts with HELCOM secretariat, communication of research result summaries at the European Sustainable Shipping Forum, cooperation with Finnish Communication Authority and Finnish Transport Agency concerning ship navigational systems. Several University rectors and chancellors, National Broadcasting company (YLE) director, and stake holders from ministries visited Utö Atmospheric and Marine Research Station in August 2018.

PART 2 - Planned activities for 2019/2020 and 2021

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

GTK will participate in the Aranda FINMARI cruise, 28 Aug to 7 Sep 2019 to the western Gulf of Finland.

Bonus-Integral winter cruise for observing the pCO_2, pCH_4 and pN_2O concentrations on ice-covered sea areas in the Northern Baltic Sea. Joint effort of FMI (Finland), IOW (Germany) and IOPAN (Poland)

The implementation of a new wave-dependent CO_2-flux parameterization into the WAM wave model in the Baltic Sea. The work is done within the Bonus INTEGRAL project during 2019.

Continuation of Copernicus work, work within H2020/SCIPPER project to understand Black Carbon emissions and scrubber efficiency better. Validation of ship emission inventories with on-board and remote sensing measurements. Continued development of vessel discharge and underwater noise modelling capabilities. Continue working on nine shipping related projects (5 current, 4 new).

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

Organizing:

FINMARI (Finnish marine Research Infrastructure) Researcher Days 26 February 2019, Helsinki, Finland

Participation in e.g. the following conferences:

Transport & Air Pollution 2019 Conference, Thessaloniki, May 2019

International Technical Meeting (ITM2019) of Air Pollution and Applications, Hamburg, Sep 2019

Shipping & Environment 2 conference, Gothenburg, Sep 2019

Underwater noise workshop at IMO, London, 29.1-1.2.2019

Intersessional working group meeting of Greenhouse Gas emissions from ships (ISWG), IMO, London, March 2019

Pollution Prevention and Readiness meeting, IMO, London, May 2019

Marine Environment Protection Committee 75th meeting, IMO, London, Oct 2019

AGU, USA

Global Emissions Initiative (GEIA19), Santiago, Chile, Nov 2019

3. Funded national and international projects / activities underway.

H2020, Jerico-Next (2015-19), project coordinated by IFREMER/France. Joint European Research Infrastructure Network for Coastal Observatory – Novel European expertise for coastal observatories.

Bonus-Integral (2018-20), project coordinated by IOW/Germany: Integrated carbon and trace gas monitoring for the Baltic Sea.

Academy of Finland, SEASINK (2018-22), project coordinated by SYKE and FMI/Finland: Project "Evolving carbon sinks and sources in coastal seas – will ecosystem response temper or aggravate climate change?"

H2020/Aircoat, ShipNOEm(national funding)

GLORIA(Academy of Finland)

CAMS-81 (ECMWF)

CSHIPP (Interreg)

EnviSum(Interreg)

EPITOME(Nordic Council of Ministries)

BioDiv Support (Belmont Forum; 2019-)

H2020/SCIPPER (2019-)

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

A.-I. Partanen, R. Makkonen, and A. Perrels are part of Ocean NETs consortium for a H2020 application. The proposal is focused on ocean based negative emission technologies. The submission of first stage proposal is in February 2019.

Detection of small boats using coastal radars

Antifouling paint leeching from vessel hulls

Extension of ship underwater noise studies

The profiling buoy (as reported in an earlier SOLAS report) will be installed near TZS in spring 2019.

- The MONCOAST coastal observatory network of loggers is being developed; now we have purchased a total of five YSI Exo 2 loggers (T, S, O2, pH, Turb) and they will eventually all send data to a public online portal:

https://www.helsinki.fi/en/research-stations/tvarminne-zoological-station/research/monicoast

- a new research vessel (18 m catamaran) will be delivered to TZS in September 2019.

- a H2020n application for Continuation of infra project Jerico-Next submitted in spring 2019.

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

Transport Canada, several universities in USA, China, Europe. Cooperation with Baltic Earth network, DG Environment, European Maritime Safety Agency. Co-operation and projects especially wrt data with EMODNET, CMEMS, HELCOM, BOOS, SeaDataCloud etc

Comments

surface ocean solas lower atmosphere study

Report for the year 2018 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 2018 – Jan-Feb 2019*
- Part 2: *reporting on planned activities for 2019/2020 and 2021.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies;
Environmental impacts of geoengineering;
Science and society**.**

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

PART 1 - Activities from January 2018 to Jan/Feb 2019
1. Scientific highlight
1. Aliphatic amines at the Cape Verde Atmospheric Observatory: abundance, origins and sea-air fluxes (Theme 5) *Manuela van Pinxteren, Khanneh Wadinga Fomba, Dominik van Pinxteren, Nadja Triesch, Erik Hans Hoffmann, Charlotte Cree, Mark Fitzsimons, Wolf von Tümpling, Hartmut Herrmann* Aliphatic amines are important constituents of the marine environment. However, their biogenic origins, formation processes and roles in atmospheric chemistry are still not well understood. Within two intensive sampling campaigns at the Cape Verde Atmospheric Observatory (CVAO), a remote marine station in the tropical Atlantic Ocean, amines were measured in all relevant marine compartments, the bulk seawater, the sea surface micro layer (SML), the gas and the submicron aerosol phase. In seawater, the amines were almost exclusively detected in the SML, leaving the question open, if the amines are formed at the ocean surface or transported there due to physical processes (e.g. rising bubbles). Amines in the SML and in the gas phase both showed a positive correlation towards biological (phytoplankton) indicators which suggests their close linkage and indicates that the amine abundance in the atmosphere (gas phase) partly reflects biological processes in seawater. In contrast, particulate amine concentrations did not show such a direct response and might have other significant sources and environmental drivers. Sea to air fluxes of the amines indicated that 2-way transport may be occurring. Overall, these results contribute to reduce the gap of knowledge about amines in the marine environment. Beyond that, it could be shown that aliphatic amines are

present as a source of atmospheric base in the remote, often oligotrophic, region of the Cape Verde islands in all marine compartments.

Citation: *Manuela van Pinxteren, Khanneh Wadinga Fomba, Dominik van Pinxteren, Nadja Triesch, Erik Hans Hoffmann, Charlotte Cree, Mark Fitzsimons, Wolf von Tümpling, Hartmut Herrmann*
Atmos. Environ. 2019, *in press*

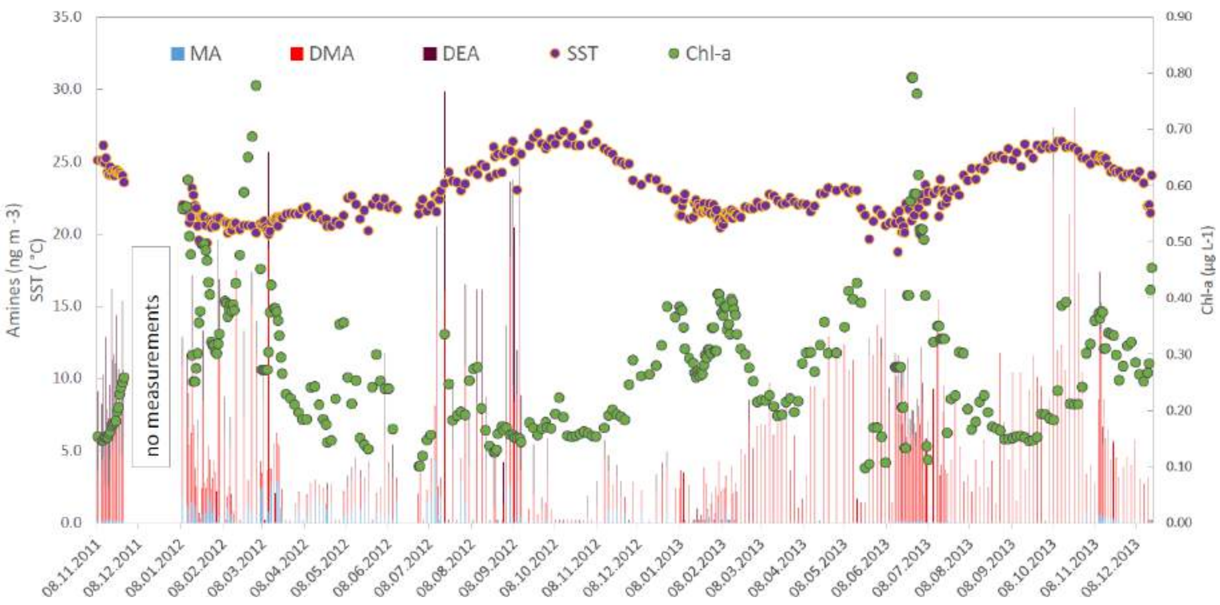
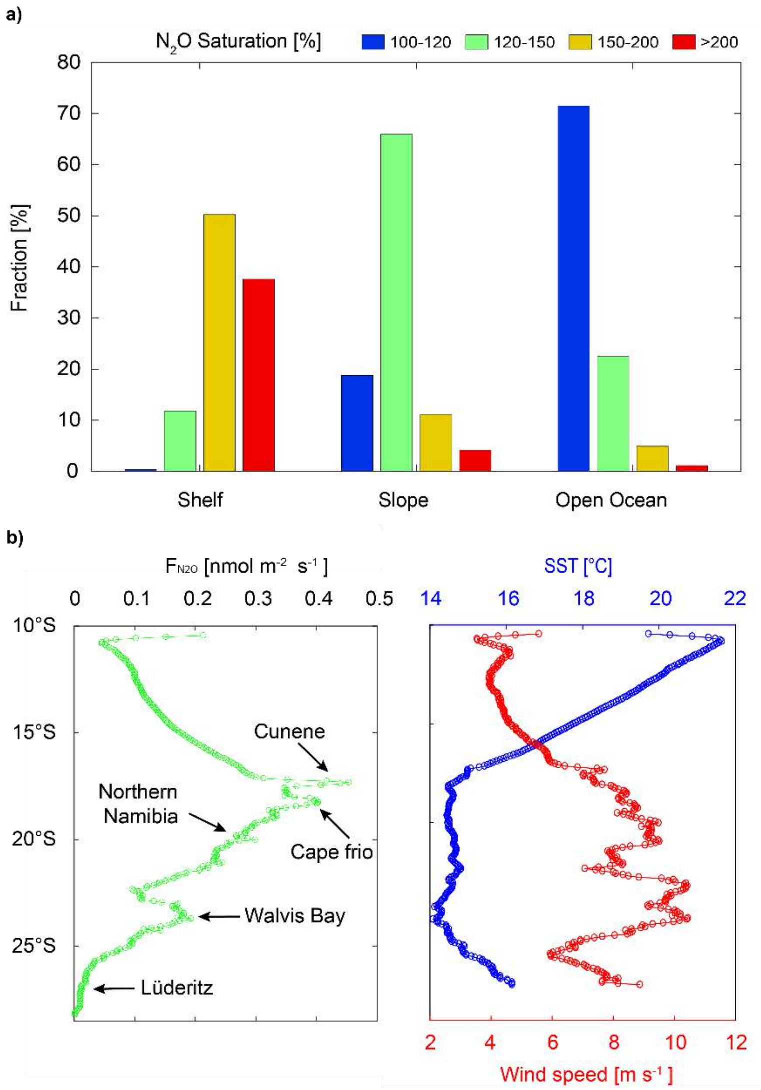


Figure 1: Time series of the particulate amine concentrations, in detail: MA – monomethyl amine, DMA - diethyl amine and DEA - diethyl amine (ng m^{-3}) together with chl-a (µg L^{-1}) and the SST (°C) for the 24-month time series measured at the CVAO.

2. N_2O Emissions from the Benguela upwelling system (Theme 1); Integrated studies)

Nitrous oxide (N_2O) is a potent greenhouse gas that contributes both to Earth's warming and stratospheric ozone depletion. In the marine environment N_2O is produced at mid-depth as a result of microbial decay of organic matter (under low oxygen conditions), and it is transferred to the atmosphere through air-sea gas exchange. The Benguela Upwelling System (BUS) is the most productive of all eastern boundary upwelling ecosystems and it hosts a well-developed oxygen minimum zone. Hence, the BUS is a potential hotspot for production and emissions of N_2O. In order to elucidate the large-scale distribution and variability of air-sea fluxes of this gas, as well as the impact of upwelling filaments on the total emissions, we conducted extensive, high-resolution measurements of dissolved and atmospheric N_2O during three expeditions in 2013. We found strong gradients with a threefold increase in N_2O concentrations near the coast as compared with open ocean waters. Our observations showed enhanced sea-to-air fluxes of N_2O (up to 1.67 nmol·m^{-2}·s^{-1}) in association with local upwelling cells. Based on our data we suggest that the high emissions area for the northern BUS is larger than previously thought and that it accounts for 13% of the total coastal upwelling source of N_2O to the atmosphere.



Spatial variability of N_2O in July-September 2013. (a) Histogram showing the variable contribution of different areas to N_2O outgassing (expressed as saturation percentage) from the northern Benguela upwelling system. (b) Latitudinal distribution of N_2O fluxes (F_{N2O}), sea surface temperature (SST), and wind speeds across the Benguela upwelling system (expressed as zonal means at 1/32° spacing; 10.5-15°E). The major upwelling cells are indicated in b (left).

Citation:
Arévalo-Martínez, D.L., Steinhoff, T., Brandt, P., Körtzinger, A., Lamont, T., Rehder, G., and Bange, H. W., 2019, N_2O emissions from the northern Benguela upwelling system, *Geophysical Research Letters*, 46, https://doi.org/10.1029/2018GL081648.

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

- **MarParCloud: Organic Matter in the marine tropical environment: Amino acids**
  Manuela van Pinxteren, Nadja Triesch, Hartmut Herrmann

  The export of organic matter (OM) from the oceans into aerosol particles can establish a significant carbon flux in the Earth system, although the functional relationships of OM in the water column via the SML to the atmosphere are still poorly understood. Within the ocean-atmosphere related project MarParCloud the process chain of biological production of organic matter in the oceans, its export to marine aerosol particles and finally their abilities to act as ice nuclei and cloud condensation nuclei is currently investigated. The project is organized in a network between the TROPOS, the ZMT, the

IOW and the Universities of Oldenburg (ICBM) and Hamburg. Thereby one focus is on the role of the sea surface microlayer (SML) as the direct interface between ocean and atmosphere.
The main event of MarParCloud was a recent intensive field campaign at the Cape Verde Atmospheric Observatory (CVAO), comprising a wide range of sampling and analytical techniques for studying marine aerosol particles as well as sea- and cloud water. As a first step, a detailed characterization of atmospheric relevant organic matter in all marine compartments, e.g. the bulk seawater, the SML, the ground based aerosol particles as well as the aerosol particles at the mountain site (where clouds are present) was conducted. Figure 1 shows the concentrations of amino acids, as important nitrogen containing OM compounds in all relevant marine compartments. Their abundance and varying concentration and composition suggests a selective transfer of the amino acids from the ocean to the atmosphere. Further studies, including biogeochemical parameters will help to reveal sources, fate and effects of OM, such as amino acids in the tropical marine environment. (Themes 2, 4)

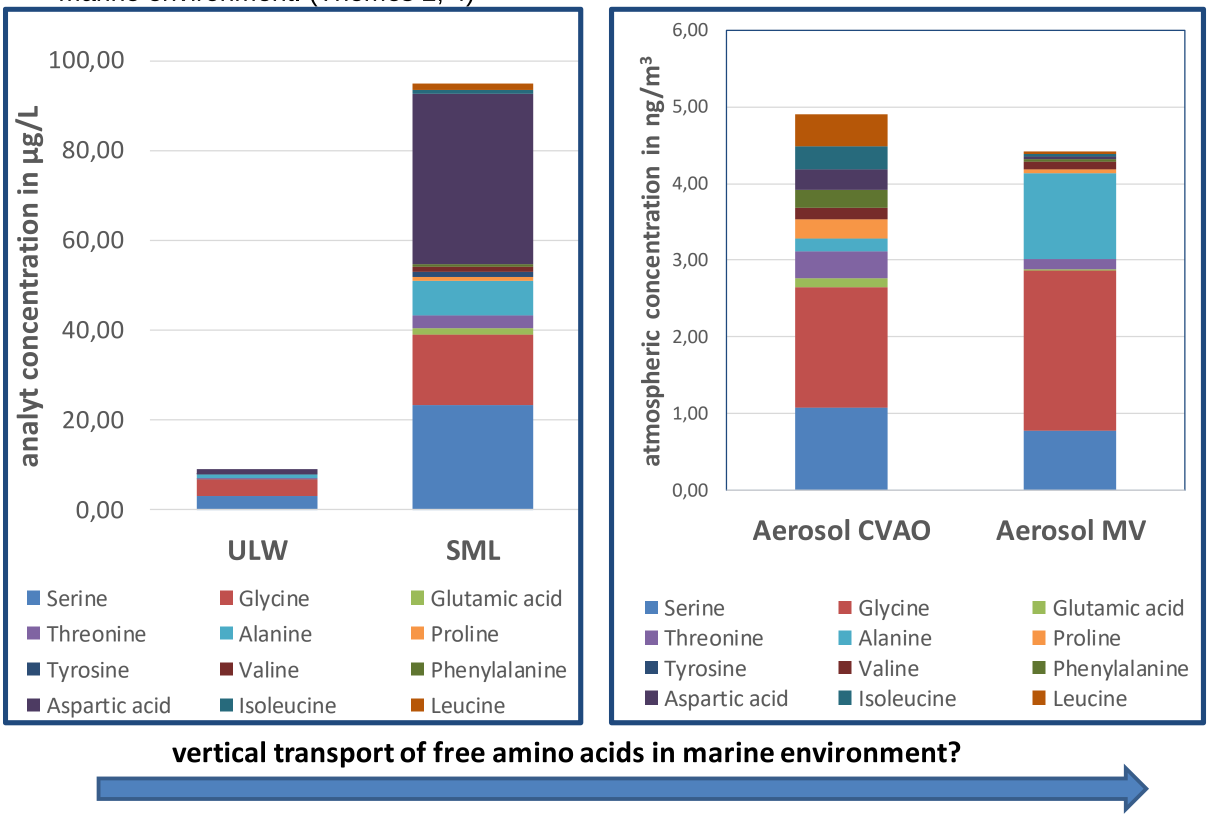


Figure 1: Concentrations of free amino acids in the several marine compartments sampled at the CVAO: in the bulk- or underline water (ULW) , the sea surface microlayer (SML), the ground based aerosol particles sampled at the CVAO and in the aerosol particles at the mountain side during marine conditions.

- Cruise EMB184 (chief scientist: Christian Stolle, IOW; involved institutes: IOW, ICBM, TROPOS, Uni Stockholm) –SML properties, CO_2 gas exchange, aerosol particles (Themes 1, 2, 4)
- Cruise Poseidon POS519 (chief scientist: Tobias Steinhofff, GEOMAR; involved institutes: GEOMAR, Dalhousie Uni) - the cruise POS519 took place between January, 23 and February, 10. We identified a fresh upwelled water mass off the coast of Mauritania and deployed a surface drifter within the water mass. The drifter was equipped with a surface element and a sensor cage at 10 m depth with sensors for temperature, salinity, pCO_2, chlorophyll, oxygen, gas tension and nitrate. Underway measurements of surface water were performed on board for standard variables like temperature and salinity and in addition CO_2, N_2O, COS, Chlorophyll and oxygen while the ship was following the drifter. In addition we installed a “direct flux” instrumentation at the bow of the ship that measured the CO_2 exchange between the ocean and the atmosphere. Furthermore, we sampled the surface micro layer (SML) to observe its development. The overall goal was to determine the variability of such an upwelling patch and to study the impact of the SML on gas exchange. Over 40 stations we sampled the water column for various parameters and conducted microstructure profiles. (Themes 1, 2)
- Cruises Baltic GasEx (chief scientist: Dennis Booge/Christa Marandino, GEOMAR; involved institutes: GEOMAR, University of Hawaii, Kiel University, TROPOS) Air-water gas exchange influences the cycling of biogeochemically important trace gases on global and regional scales (CO_2,

DMS, halocarbons, and non-methane hydrocarbons), and affects water quality on local scales (e.g., oxygen exchange). Wind speed is typically used to parameterize gas transfer and, in the last few decades, advancements in field and analysis techniques have enabled us to narrow the list of reasonable wind speed/gas exchange parameterizations that are applicable in most circumstance over the ocean. However, there are environments and conditions where existing parameterizations might not be applicable. One of these environments is inland seas where surfactants might have a more dominant effect on gas exchange.

All the studies published to date that have investigated the effects of surfactants on air-sea exchange have either used artificial surface active compounds or have only measured surfactant and wave properties under natural conditions, rather than gas transfer or flux directly. Baltic GasEx was conducted in two parts, June and September, during which direct air-sea transfer measurements in the presence of a natural surfactant patch at the Baltic Sea time series station, Boknis Eck (BE), took place. Natural surfactant measurements have been recorded at BE from 2009-2014 using surface-sensitive sum-frequency generation spectroscopy. We used two different methods, simultaneously, to directly measure exchange: 1) $^{3}He/SF_6$ tracer release experiments and 2) trace gas eddy covariance. In conjunction with gas exchange measurements, the abundance of surface active compounds was quantified and characterized in order to determine the influence of surfactants/microlayer on the air-sea fluxes. Gas transfer parameterizations based on wind speed will be evaluated, both for the influence of surfactants and the difference between the open ocean and inland seas. (Theme 2)

- German Committee for Sustainability group on ship emissions (funded by the DFG, W. Rickells, C. Marandino speakers) (Theme 3; Science and society)
- Blue Carbon (from the SOLAS Science and Society meeting in Brussels/Monaco) presentation at EGU 2018 by Helmuth Thomas (Science and society)
- Participation in OCB workshop on N_2O and CH_4, Lake Arrowhead, USA; 28 – 31 October 2018 (Damian Arévalo-Martínez, Hermann Bange and Annette Kock, GEOMAR). (Theme 1)
- IIOE-2 WG1 'Science and Research' Meeting, Kiel, GEOMAR, 28 – 30 November 2018 (organized by HW Bange, GEOMAR) (All themes)
- H. Bange Lab Group Field campaigns:
- Cruise P519 (Eastern tropical North Atlantic, January-February 2018, SOLAS Theme 1)
- Cruise M148 (Tropical Atlantic, southeast Atlantic, May-June 2018, SOLAS Theme 1)
- Cruise PS114 (Fram Strait, east Greenland, July 2018, SOLAS Theme 1)
- Cruise Al516 (Baltic Sea, September 2018, SOLAS Theme 1)

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

1. Fiehn, A., Quack, B, Marandino, C A, Krüger, K, 2018, Transport Variability of Very Short Lived Substances From the West Indian Ocean to the Stratosphere. *Journal of Geophysical Research: Atmospheres,* 123, 5720-5738, DOI 10.1029/2017JD027563.
2. Lutterbeck, H E, Arévalo-Martínez, D L, Löscher, C R, Bange, H W, 2018, Nitric oxide (NO) in the oxygen minimum zone off Peru, *Deep-Sea Research Part II*, 156, 148-154.
3. Miranda, M L, Mustaffa, N I H, Robinson,T B, Stolle, C, Ribas-Ribas,M, Wurl,O, Zielinski, O, 2018, Influence of solar radiation on biogeochemical parameters and fluorescent dissolved organic matter (FDOM) in the sea surface microlayer of the southern coastal North Sea, *Elementa Science of the Anthropocene*, DOI: 10.1525/elementa.278.
4. Wilson, S T, Bange, H W, Arévalo-Martínez, D L, Barnes, J, Borges, A V, Brown, I, Bullister, J L, Burgos, M, Capelle, D W, Casso, M, de la Paz, M, Farías, L, Fenwick, L, Ferrón, S, Garcia, G, Glockzin, M, Karl, D M, Kock, A, Laperriere, S, Law, C S, Manning, C C, Marriner, A, Myllykangas, J P, Pohlman, J W, Rees, A P, Santoro, A E, Tortell, P D, Upstill-Goddard, R C, Wisegarver, D P, Zhang, G L, Rehder, G, 2018, An intercomparison of oceanic methane and nitrous oxide measurements, *Biogeosciences*, 15, 5891-5907.
5. Zavarsky, A, Goddijn-Murphy, L, Steinhoff, T, Marandino, C A, 2018, Bubble-Mediated Gas Transfer and Gas Transfer Suppression of DMS and CO_2, *Journal of Geophysical Research: Atmospheres,* 123, 6624-6647, DOI 10.1029/2017JD028071.

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

German Committee for Sustainability group on ship emissions (funded by the DFG, W. Rickells, C. Marandino speakers)– began the planning of an international round table discussion with stakeholders (e.g. Hamburg ports, shipping companies, etc.) to be held in 2019 (Theme 3; Science and society)

PART 2 - Planned activities for 2019/2020 and 2021
1. Planned major field studies and collaborative laboratory and modelling studies, national and international (incl. all information possible, dates, locations, teams, work, etc.).
• PI-ICE campaign, Antarctica: Jan-March 2019: *Polar atmosphere-ice-ocean Interactions: Impact on Climate and Ecology,* Team: Dall´Osto, Berdalet , Vaque , Vidal, van Pinxteren, Šantl-Temkiv, Beddows, Rinaldi • Proposal of an Inter- journal special issue in the journals ACP and OS with the topic: "*Marine organic matter: From biological production in the ocean to organic aerosol particles and marine clouds"* • Field campaigns: - Cruise POS533 (Canary Islands, Cape Verde Islands, February-March 2019, SOLAS Themes 1, 4, 5) - EU BONUS INTEGRAL cruises (Baltic Sea, February-March 2019 and May/June 2019, SOLAS Theme 1) - North Pole 2019 (Barents Sea, March-May 2019, SOLAS Theme 1) - Cruise MSM85 (Eastern coast of Greenland, July-August 2019, SOLAS Theme 1) - GLACE (Circumnavigation around Greenland, July-September 2019, SOLAS Theme 1) - Cruise M158 (Equatorial Atlantic, Benguela region, September-October 2019, SOLAS Theme 1) - ODEN cruise 2019 (Northwest Greenland, June-August 2019, SOLAS Theme 1) - Cruise SO276 (GEOTRACES, Southern Indian Ocean, July-August, 2020, SOLAS Theme 1) - Cruise SO280 (BIOCAN-IIOE2; Arabian Sea, December 2020-January 2021, SOLAS Theme 1) - Meteor/Merian cruise (Equatorial Atlantic, Benguela region, 2021 (proposed), SOLAS Theme 1) - Meteor/Merian cruise (Benguela region, 2021 (proposed), SOLAS Theme 1) - CHINARE 2019 and 2020 (Southern Ocean, SOLAS Themes 1, 4. 5)
2. Events like conferences, workshops, meetings, schools, capacity building etc. (incl. all information possible).
• German Committee for Sustainability group on ship emissions (funded by the DFG, W. Rickells, C. Marandino speakers)– international round table discussion with stakeholders (e.g. Hamburg ports, shipping companies, etc.), March 2019 • International Indian Ocean Conference (H. Bange), at NIO, Goa, India, March 2020 (SCOR, IOGOOS; IOC), planning is ongoing. • SOLAS International Summer School, 2021 (C. Marandino) – planned to be held in Cape Verde
3. Funded national and international projects / activities underway.
• PETRA: Pathways and emissions of climate-relevant trace gases in a changing Arctic Ocean (Integrated projects) • NITROSO: Effects of ocean acidification on the emission and production pathways of NITRous Oxide in the Southern Ocean (Antarctic) (Theme 1) • Integrated carboN and TracE Gas monitoRing for the bALtic sea (EU BONUS INTEGRAL) (Theme 1) • SCOR Working Group 143: *"Dissolved N_2O and CH_4 measurements: Working towards*

a global network of ocean time series measurements of N_2O and CH_4" (Theme 1)

- 2nd International Indian Ocean Expedition: HW Bange is member of the steering committee and co-chairing WG1 'Science and Research' (All themes)
- 3 new upwelling projects funded by the BMBF: REEBUS, CUSCO (A., Körtzinger, U. Riebesell GEOMAR), EVAR (H. Schulz-Vogt IOW) (Integrated projects)

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

- Helmholtz International Ocean Atmosphere Network (HI-OceAN), C. Marandino, A. Engel, A. Körtzinger, Helmholtz Association submitted March 2019, to be located on Cape Verde
- German-Israel Partnership, A. Engel, C. Marandino, DFG submitted March 2019, to study the influence of the sea surface microlayer on air-sea exchange of gases and particles
- Transdisciplinarity in Ocean Research, C. Marandino, E. van Doorn, Belmont Forum submitted January 2019, to study the influence of ship emissions from natural science, legal, and economic perspectives
- Ship proposal for follow up to Baltic GasEX, G. Rehder, C. Marandino, submitted February 2019

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

- Projects
  - 2nd International Indian Ocean Expedition (IIOE-2)
  - RINGO
  - ICOS
  - SCOR
  - Boknis Eck Time Series Station
  - CVOO/CVAO
  - SFB754
  - and many more
- Partner Institutions
  - INDP, Mindelo, Cape Verde
  - Ocean University China, Qingdao, China
  - Third Institute of Oceanography, Xiamen, China
  - York University
  - Dalhousie University
  - and many more
- International Organisations
  - IPCC
  - Future Earth/Belmont Forum
  - and many more

Comments

surface ocean **solas** lower atmosphere study

Report for the year 2018 and future activities

SOLAS *Israel*
compiled by: Yoav Lehahn

This report has two parts:

- Part 1: *reporting of activities in the period of January 2018 – Jan-Feb 2019*
- Part 2: *reporting on planned activities for 2019/2020 and 2021.*

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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 2018 to Jan/Feb 2019
1. Scientific highlight
Atmospheric dust/aerosol deposition is an important source of external nutrients to the surface of the ocean. This study shows high resolution observational data gathered *in-situ* over a period of 4-years on bacterial and phytoplankton abundance and activity (i.e., primary production, bacterial production, N_2 fixation) during typical-background atmospheric conditions (median Al= 381 ng m^{-3}), and during intense dust storm events (median Al= 3844 ng m^{-3}) in the low nutrient low chlorophyll coastal waters of the southeastern Mediterranean Sea. Chlorophyll *a* (an estimate for phytoplankton biomass) and bacterial abundance show moderate changes in response to dust deposition/events (-10% and +20%, respectively), while rate measurements such as primary production, bacterial production and N_2 fixation rates were all significantly and positively affected (+25 to +40%; $p<0.05$) by deposition (see Fig. 1 for comparison between chlorophyll and primary production). The rapid changes in bacterial and/or phytoplankton rate parameters suggest that the released micro/macronutrients from atmospheric deposition are tunneled directly in metabolic processes and, to a lesser extent, for biomass accumulation. We further suggest that the intensity of the metabolic rate change following dust deposition is a function of the degree of oligotrophy, defined here by the initial (pre-deposition) concentrations of

Chlorophyll a. When ultra-oligotrophic conditions prevailed (usually during summertime, Chlorophyll a <0.07 µg L^{-1}, Figure 1A and see Uitz et al., 2010), stronger increases were recorded in primary production (maximum 100%), bacterial production (maximum 256%) or N_2 fixation (maximum 101%). This observation is strengthened by additional data from other studies across different marine provinces (not shown).

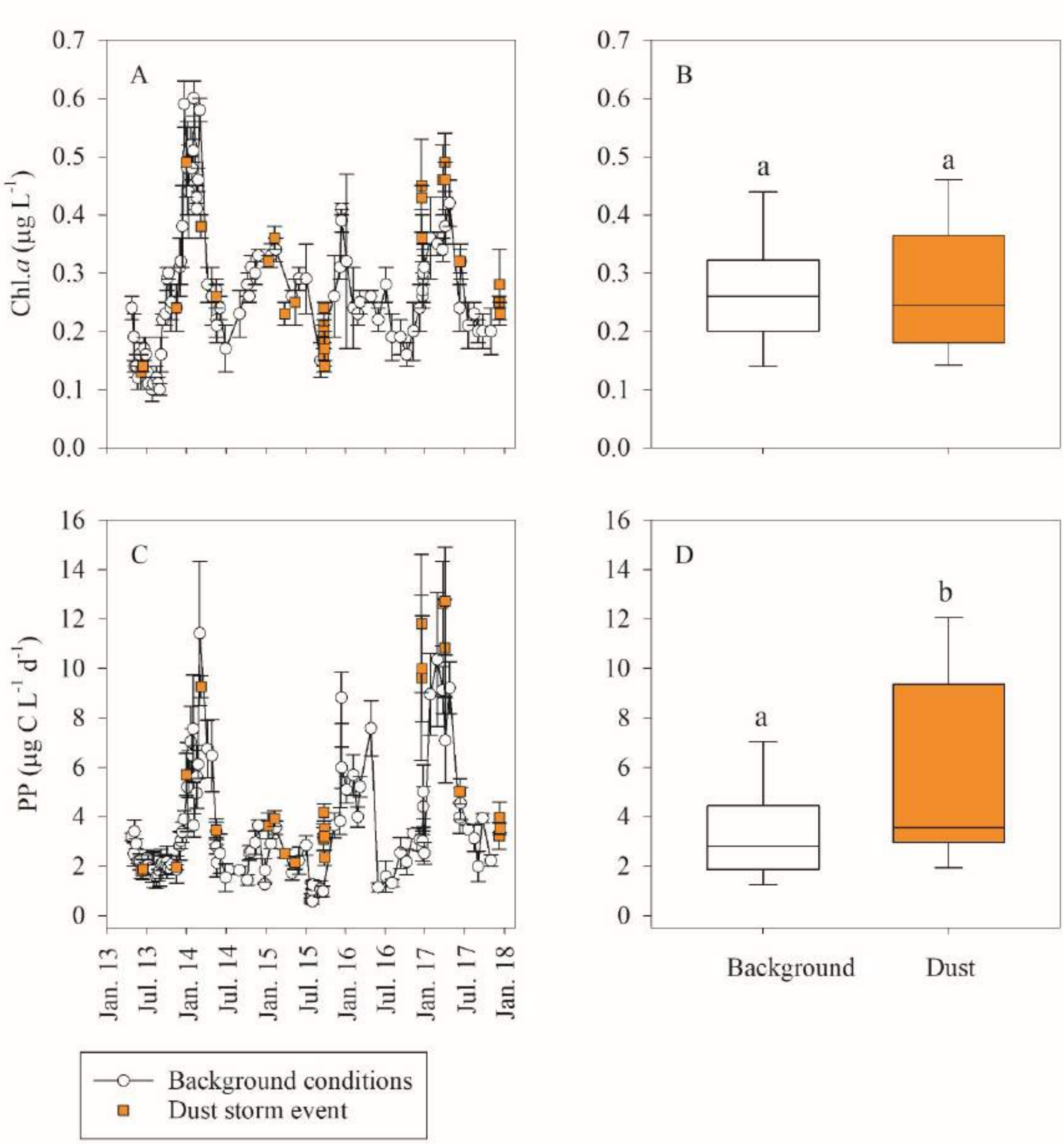

Figure 2 – Surface (1-2 m) chl.*a* (A,B) and PP (C,D) temporal variability (A,C) and distribution (B,D) at the coastal southeastern Mediterranean Sea between 2013-2017. Measurements were taken during 'typical' days (white, n=89) and during dust storms (orange, n=29). Box-Whisker plots shows the interquartile range (25th to 75th percentile) of the data set. The horizontal line within the box represent the median value. The letters above the box-plots represent significant differences (t-test, P <0.05) for mean values between the 'background' and 'dust' measurements.

Rahav, E., Belkin, N., Paytan, A and Herut, B. (2018). Phytoplankton and bacterial response to desert dust deposition in the coastal waters of the southeastern Mediterranean Sea; A four year in-situ survey. *Atmosphere*, 9:305.

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

sraeli scientists are involved in SOLAS-related activities in the adjacent Mediterranean and Red sea, as well as in other parts of the 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 during the month of March, 2019. 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) have been 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.

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

Torfstein A, SS Kienast (2018), No Correlation Between Atmospheric Dust and Surface Ocean Chlorophyll-a in the Oligotrophic Gulf of Aqaba, Northern Red Sea, J*ournal of Geophysical Research: Biogeosciences* 123 (2), 391-405.

Basu S., Y Shaked (2018), Mineral iron utilization by natural and cultured Trichodesmium and associated bacteria, *Limnology and Oceanography* 63 (6), 2307-2320.

Trainic M, Koren I, Sharoni S, Frada M, Segev L, Rudich Y, Vardi A: Infection Dynamics of a Bloom-Forming Alga and Its Virus Determine Airborne Coccolith Emission from Seawater, *iScience* 6, 327-335, 2018.

Dror T, Lehahn Y, Altaratz O, Koren I (2018), Temporal-Scale Analysis of Environmental Controls on Sea Spray Aerosol Production Over the South Pacific Gyre, *Geophysical Research Letters* 45 (16), 8637-8646.

Rahav, E., Belkin, N., Paytan, A and Herut, B. (2018). Phytoplankton and bacterial response to desert dust deposition in the coastal waters of the southeastern Mediterranean Sea; A four year in-situ survey. *Atmosphere*, 9:305.

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

PART 2 - Planned activities for 2019/2020 and 2021

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

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-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

surface ocean solas lower atmosphere study

Report for the year 2018 and future activities

SOLAS JAPAN
compiled by: Yuzo Miyazaki

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

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

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

1. Scientific highlight

The GESAMP atmospheric iron deposition model intercomparison study

Intercomparisons of the global modelling of iron (Fe) deposition fluxes and atmospheric concentrations were made, in the framework of the United Nations Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) WG 38, "The Atmospheric Input of Chemicals to the Ocean". The intercomparison indicates that the representation of the atmospheric Fe cycle varies among models, in terms of both the magnitude of natural and combustion Fe emissions and the atmospheric processing parameterizations of Fe-containing aerosols. The comparison with the observations over oceans indicates that most models overestimate total Fe (TFe) mass concentrations at surface level near dust source regions and underestimate the low concentrations in remote oceans. All models can simulate the tendency of higher Fe concentrations near/downwind from the dust source regions, with the mean normalized bias for the Northern Hemisphere (~14), larger than that of the Southern Hemisphere (~2.4) for the ensemble model mean. This study reveals two critical issues in the mean global labile Fe (LFe) simulations that require further exploration: (1) the Fe-containing aerosol size distribution and (2) the relative contribution of dust and combustion sources of Fe to labile Fe in atmospheric aerosols over the remote oceans.

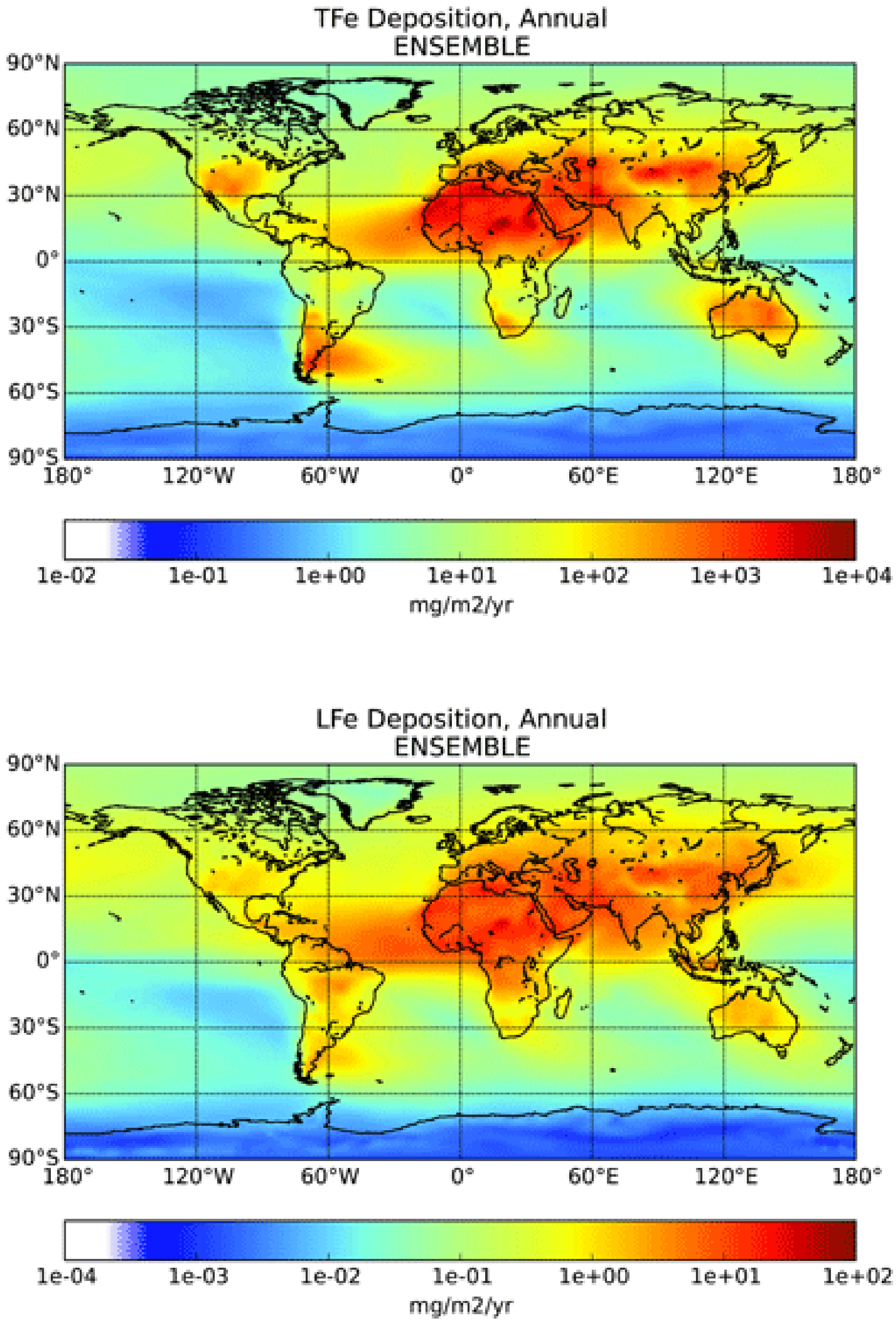


Figure: Ensemble model results for annual deposition fluxes (mg m^{-2} yr^{-1}) for TFe (top) and for LFe (bottom).

Citation: Myriokefalitakis, S., Ito, A. et al., The GESAMP atmospheric iron deposition model intercomparison study, *Biogeosciences*, 15, 6659–6684, (2018).

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

Theme 1: Greenhouse gases and the oceans

Cruise/Field campaigns

- Seisui-maru SE18-33 cruise at Ise Bay and coastal area of western North Pacific (chief scientist: Urumu Tsunogai) (Nov 20-22, 2018).

- 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)

- Deployment of drifting buoys with pCO2 sensor in the Pacific Ocean founded by the Ministry of Environment of Japan (PI, A Murata; 2016-2021)

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

Meetings/collaboration/ workshop

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

Cruise/field campaigns

- July – August 2018: Aerosol and gas observation over the Western Pacific Ocean cruise by R/V Mirai (MR18-04)

- November – December 2018: Aerosol and gas observation over the Indian Ocean cruise by R/V Hakuho-maru (KH-18-6 leg2)

- October – December 2018: Aerosol and gas observation over the Arctic Ocean, Bering sea and North Western Pacific Ocean cruise by R/V Mirai (MR18-05C) as part of the ArCS project

- 6 November - 3 December 2018: Gas, aerosol and rainwater observation during R/V Hakuho Maru cruise (KH-18-6 Leg 2 led by H. Saito) which sailed Bay of Bengal and Southeastern Indian Ocean (from Phuket to Jakarta) (PI: F Taketani)

Theme 5: Ocean biogeochemical control on atmospheric chemistry

Cruise/field campaigns

- Mar-June 2018: 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: Yuzo Miyazaki)

-6 November - 3 December 2018: Aerosol and microlayer observation during R/V Hakuho Maru cruise (KH-18-6 Leg 2 led by H. Saito) which sailed Bay of Bengal and Southeastern Indian Ocean (from Phuket to Jakarta) as part of SSMAP project (PI: K Hamasaki)

Meetings/international collaboration/workshop

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

- Oxygenated Compounds in the Tropical Atmosphere– Variability and Exchanges (OCTAVE) Intensive Field Campaign Workshop, Brussels, Oct. 2018 (Organizers: T. Stavrakou, J. Brioude, Presentation: Y. Miyazaki)

Cross-Cutting Theme:

Cruise/field campaigns

- R/V Pro. Multanovskiy (Russian research vessel) cruise (Japan-Russia Joint expedition), Biogeochemistry-marine ecosystem observation in the western Bering Sea, (On board: Jun Nishioka (PI), Daiki Nomura, Maki Noguchi, Yohei Yamashita, Kyumei Waga) (July-Sep, 2018)

General SOLAS

Meetings/international collaboration/workshop

- Japanese-SOLAS committee have launched Local organizing committee and had meetings for preparing SOLAS OSC in Sapporo 2019 with SOLAS IPO (in April) and SOLAS chair (Lisa Millar in Nov.)

- 2018 Japan-SOLAS committee meeting, 22 May, 2018

- Institute of Low Temperature Science (ILTS) Workshop on Biogeochemical Interactions between Ocean and Atmosphere, ILTS, Hokkaido University, Nov. 1-2, 2018 (Organizer: Y. Miyazaki)

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

Nelson, D. M., Tsunogai, U., Dong, D., Ohyama, T., Komatsu, D. D., Nakagawa, F., Noguchi, I., and Yamaguchi, T. (2018) Triple oxygen isotopes indicate urbanization affects sources of nitrate in wet and dry atmospheric deposition. *Atmospheric Chemistry and Physics*, 18, 6381-6392, doi:10.5194/acp-18-6381-2018.

Yasunaka, S., Siswanto, E., Olsen, A., Hoppema, M., Watanabe, E., Fransson, A., Chierici, M., Murata, A., Lauvset, S. K., Wanninkhof, R., Takahashi, T., Kosugi, N., Omar, A. M., van Heuven, S., Mathis, J. T. (2018), Arctic Ocean CO2 uptake: an improved multi-year estimate of the air-sea CO2 flux incorporating chlorophyll-a concentrations, *Biogeosciences*, 15, 1643-1661, doi:10.5194/bg-15-1643-2018.

Taketani, F., Aita, M. N., Yamaji, K., Sekiya, T., Ikeda, K., Sasaoka, K., Hashioka, T., Honda, M. C., Matsumoto, K. and Kanaya, Y. (2018) Seasonal response of North Western Pacific marine ecosystems to deposition of atmospheric inorganic nitrogen compounds from East Asia, *Scientific Reports*, 8, 9324, doi:10.1038/s41598-018-27523-w.

Nagao, I., Eum, Y-J., Iwamoto, Y., Tada, Y., Suzuki, K., Tsuda, A., Toratani, M., Hamasaki, K., Uematsu, M. (2018) Biogenic sulfur compounds in spring phytoplankton bloom in the western North Pacific off the coast of northern Japan, *Progress in Oceanography*, 165, 145-157, doi:10.1016/j.pocean.2018.05.006.

Miyazaki, Y., Yamashita, Y., Kawana, K., Tachibana, E., Kagami, S., Mochida, M., Suzuki, K., and Nishioka, J. (2018), Chemical transfer of dissolved organic matter from surface seawater to sea spray water-soluble organic aerosol in the marine atmosphere, *Scientific Reports*, 8, 14861, doi:10.1038/s41598-018-32864-7.

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

- OCEAN-KAN discussion session have been preparing for the SOLAS OSC by Mitsuo Uematsu and Anna Zivian.

PART 2 - Planned activities for 2019/2020 and 2021

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

General SOLAS

- Seisui-maru (Mie University) cruise in Ise Bay, Mikawa Bay, and coastal area of western North Pacific (chief scientist: Fumiko Nakagawa) (Sep 3-5, 2019).

- Shinsei-maru (JAMSTEC) cruise in Japan sea (chief scientist: Urumu Tsunogai) (Jun 25-29, 2019).

- Shinsei-maru (JAMSTEC) cruise in Japan sea (chief scientist: Urumu Tsunogai) (Oct 20-23, 2019).

- SOLAS session (C4) at the Forth Xiamen Symposium on Marine Environmental Sciences (XMAS-IV) , Xiamen, 9 January 2019 (Co-convener: J. Nishioka, Invited speaker: Y. Miyazaki)

-January 2019, Workshop for Role of Atmospheric Species at Atmosphere-Ocean Boundary from the View Point of Field Study (46 participants(3 oral, 30poster presentation)) Organizer: F. Taketani, Y. Iwamoto, T. Nakamura, M. Yoshizue, K. Miura and M. Uematsu.

Theme 1: Greenhouse gases and the oceans

- Continuous measurements of atmospheric and surface seawater pCO2 and CH4 by R/V Mirai in the Arctic Ocean and subpolar region of the North Pacific (Sep- Nov 2019; by A. Murata).

- Continuous measurements of atmospheric and surface seawater pCO2 by R/V Mirai in the Indian Ocean (Dec 2019- Feb2020; by A. Murata).

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

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

- March 2019: Aerosol and gas observation over the Pacific Ocean cruise by R/V Mirai (MR18-06 leg4) (Papeete -> Japan) (on board: Fumikazu Taketani, Kazuhiko, Matsumoto, and Kaori, Kawana)

- September - November 2019: 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

Theme 5: Ocean biogeochemical control on atmospheric chemistry

-28 Feburuary-3 March 2019: Sampling of aerosol and reactive oxygen spices in seawater during R/V Toyoshio Maru cruise in Seto Inland Sea, Japan (PI: Y. Iwamoto)

-8-12 July 2019: Sampling of aerosol and reactive oxygen spices in seawater during R/V Toyoshio Maru cruise in Seto Inland Sea, Japan (PI: Y. Iwamoto)

- Oxygenated Compounds in the Tropical Atmosphere– Variability and Exchanges (OCTAVE) Intensive Field Campaign Workshop, Brussels, May 2019 (Organizers: T. Stavrakou, Presentation: Y. Miyazaki)

Cross-Cutting Theme:

- February 2019: Southern Sea of Okhotsk, ice breaker SOYA, Sea ice Ocean biogeochemical dynamics and flux (On board: Daiki Nomura, Jun Nishioka, Koji Suzuki, Yohei Yamashita).

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

- April 21-25, 2019: SOLAS Open Science Conference in Sapporo 2019

- April 21, 2019: Early Career Scientist Day in SOLAS Open Science Conference in Sapporo 2019, Organizer M. Lizzote, S. Kameyama, Y. Iwamoto

-"Biogeochemical linkages between the surface ocean and atmosphere" session at Japan Geoscience Union (JpGU) meeting 2019, May 2019 (conveners: Y. Miyazaki, J. Nishioka, K. Suzuki, Y. Iwamoto)

- May 2019 Japan-SOLAS committee meeting,

3. Funded national and international projects / activities underway.

- 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).

- A simple tracer assay for denitrification rates using natural stable isotopes, MEXT/JSPS Grant-in-Aid for Challenging Research (Exploratory) (PI: F. Nakagawa, FY2018-2019).

- Air-sea interaction of non-volatile organic sulfur, (JSPS Research Fellowships for Young Scientists, PI: K. Sakata, 2018-2021)

- Biogeochemical linkage between polar and subpolar ocean. KAKENHI Grant-in-Aid for Scientific Research A, PI: Jun Nishioka, FY2017-2020

- Grant-in-Aid for Scientific Research (A), 18H04143, PI: Yugo KANAYA, FY2018-2020, Origins and ice nucleating abilities of bioaerosols in the marine atmosphere: Links among ecosystems, chemical substances, and clouds explored with fluorescence properties

- Grant-in-Aid for Scientific Research (B), 18H03369, PI: Fumikazu TAKETANI, FY2018-2020, Influence of deposition of atmospheric nitrogen compounds on the marine ecosystem at North East Indian Ocean

- GO-SHIP: Global Ocean Ship-based Hydrographic Investigations Program Co-chair: E McDonagh, R Wanninkhof 2007-

- ArCS: Arctic Challenge for Sustainability Project , Project Director: M. Fukasawa 2015-202

- NIES grant confirms to support NIES VOS Program at least for 2 years (Atmospheric/Oceanic Greenhouse Gas Observation: Japan-North America, Japan-Oceania; Atmospheric Greenhouse Gas Observation: Japan-Southeast Asia)

- Grant-in-Aid for Scientific Research (B), 16H02931, PI: Yuzo Miyazaki, FY2016-2019, Origin of organic nitrogen in atmospheric aerosols

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

- 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)

4. Plans / ideas for future projects, programmes, proposals national or international etc. (please indicate the funding agencies and potential submission dates).
- TPOS 2020; Tropical Pacific Observing System 2020 Co-chair: S Wijffels, S. Cravatte 2014-2020

5. Engagements with other international projects, organisations, programmes etc.
- IOCCP SOCONET:International Ocean Carbon Coordination Project / Surface Ocean Carbon Observing Network Proposer: R Wanninkhof, U Schuster, A Sutton, K Tedesco, M Telszewski 2018-

Comments

surface ocean solas lower atmosphere study

Report for the year 2018 and future activities

SOLAS *'Korea'*

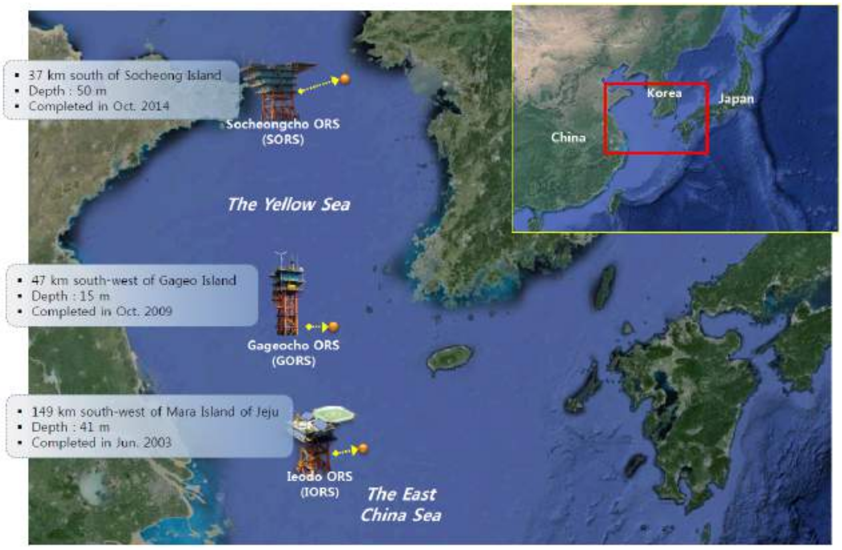
Compiled by: Kitack Lee (Pohang University of Science and Technology
Eunil Lee (Korea Hydrographic and Oceanographic Agency), and
Jinyong Jeong (Korea Institute of Ocean Science and Technology)

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

1. Scientific highlight

The Ocean Research Stations in the Yellow Sea and East China Sea:

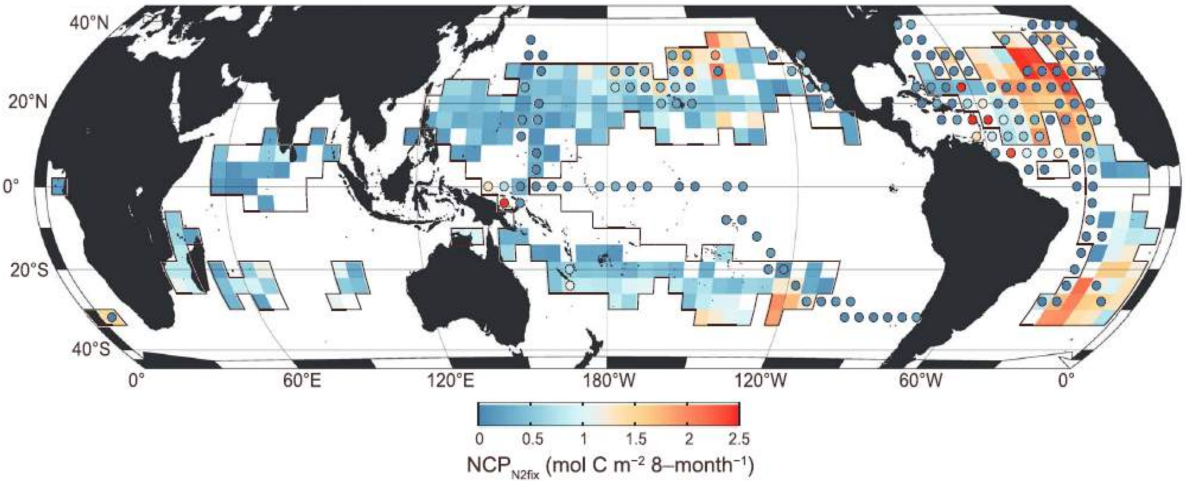
Two research platforms have been additionally built in the Yellow Sea since the first platform (the Ieodo Ocean Research Station) was built in 2003 on the submerged Ieodo Rock in the East China Sea. All three research platforms were designed to detect various environmental parameters over the long term including ocean pH, sea level rise, and ocean temperature. Moreover, the research conducted on the platforms has expanded to include studies of air-sea interactions related to variables such as heat, and anthropogenic gases. Most notably, in the parts of the Yellow and East China seas surrounding these research platforms, the levels of nitrogen from anthropogenic sources have increased acutely due to the rapid growth of population and industrial activity in northeast Asian countries. These unparalleled perturbations in northeast Asia have markedly increased reactive nitrogen fluxes into the Yellow and East China seas, via atmospheric transport and deposition and riverine flux. The increasing addition of reactive nitrogen to these seas is expected to lead to significant changes in the upper ocean nitrogen and carbon cycles and in phytoplankton biomass. Therefore, all three stations will serve as the research platforms for investigating how anthropogenic input of nitrogen changes the ocean nitrogen and carbon cycles. The three research platforms are open to international collaborations and are jointly maintained by Korea Hydrographic and Oceanography Agency and the Korea Institute of Ocean Science and Technology.



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

Global net community production in ocean gyres (international collaboration):

An international team comprised of researchers from Korea (Young-Ho Ko and Kitack Lee, Pohang University of Science and Technology; Sung-Ho Kang, Korea Polar Research Institute; and Eunil Lee, Korea Hydrographic and Oceanographic Agency) and the USA (Taro Takahashi, Columbia University; and David Karl, University of Hawaii) assessed net community production across the vast, nitrate-depleted ocean gyres. This international research used large data sets of seawater pCO_2 comprising approximately 6.5 million data; this enabled accurate resolution of the seasonal evolution of pCO_2 in the oligotrophic gyres. In particular, the combination of this data set with a surface alkalinity data set and the established thermodynamic model for the seawater carbonate system should enable the seasonal evolution of dissolved inorganic carbon in the ocean gyres to be accurately resolved. The analysis was based on summing the seasonal reduction in the concentration of dissolved inorganic carbon in the surface mixed layer, corrected for changes associated with various factors (salinity variation, net air-sea CO_2 flux, horizontal C advection, non-Redfield diffusive C and N fluxes and anthropogenic nitrogen deposition. Their analysis yielded a value of 0.6 ± 0.2 Pg of C, which occurred during the warming period in the nitrate-depleted ocean. This value is consistent with the previously reported global N_2 fixation rates and suggests that N_2 fixation by microorganisms is a major driver for this NCP



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

Nam, S., Kim, D.-j., Lee, S.-W., Kim, B. G., Kang, K.-m., & Cho, Y.-K. (2018). Nonlinear internal wave spirals in the northern East China Sea. *Scientific Reports, 8*(1), 3473. doi:10.1038/s41598-018-21461-3

Kim, D., Jeong, J.-H., Kim, T.-W., Noh, J. H., Kim, H. J., Choi, D. H., 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

Ko, Y. H., Lee, K., Takahashi, T., Karl, D. M., Kang, S.-H., & Lee, E. (2018). Carbon-Based Estimate of Nitrogen Fixation-Derived Net Community Production in N-Depleted Ocean Gyres. *Global Biogeochemical Cycles, 32*(8), 1241-1252. doi:10.1029/2017GB005634

Kwon, H. K., Kim, G., Hwang, J., Lim, W. A., Park, J. W., & Kim, T.-H. (2018). Significant and conservative long-range transport of dissolved organic nutrients in the Changjiang diluted water. *Scientific Reports, 8*, 12768. doi:10.1038/s41598-018-31105-1

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?

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).

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 2018 and future activities

SOLAS *'The Netherlands'*
compiled by: 'Jacqueline Stefels & Jan-Berend Stuut'

This report has two parts:

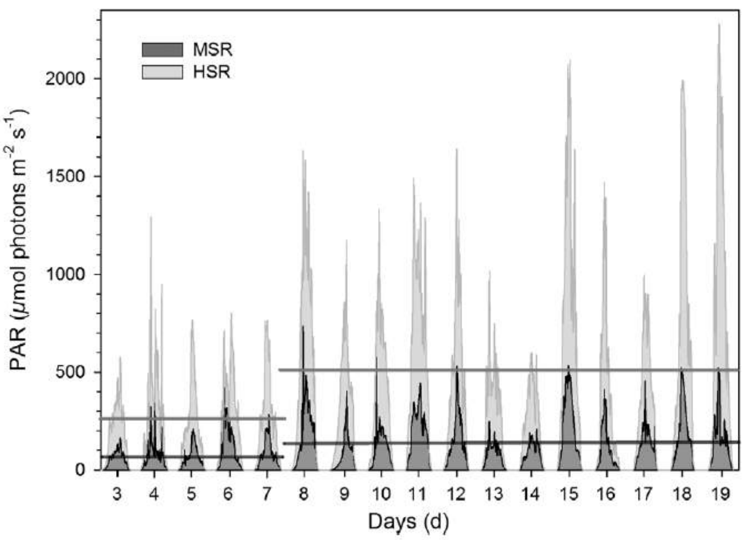
- Part 1: *reporting of activities in the period of January 2018 – Jan-Feb 2019*
- Part 2: *reporting on planned activities for 2019/2020 and 2021.*

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

1. Scientific highlights

Highlight I (Theme I) **CO_2 and light effects on Antarctic phytoplankton**

To assess the potential for future biological CO_2 sequestration around the Western Antarctic Peninsula, a natural phytoplankton assemblage from Ryder Bay, was incubated under a range of pCO_2 levels (180 µatm, 450 µatm, and 1000 µatm) combined with either moderate or high natural solar radiation (MSR: 124 µmol photons m^{-2} s^{-1} and HSR: 435 µmol photons m^{-2} s^{-1}, respectively). The initial and final phytoplankton communities were numerically dominated by the *prymnesiophyte Phaeocystis antarctica*, with the single cells initially being predominant and solitary and colonial cells reaching similar high abundances by the end. Only when communities were grown under ambient pCO_2 in conjunction with HSR did the small diatom *Fragilariopsis pseudonana* outcompete *P. antarctica* at the end of the experiment. Such positive light-dependent growth response of the diatom was, however, dampened by OA. These changes in community composition were caused by an enhanced photosensitivity of diatoms, especially *F. pseudonana*, under OA and HSR, reducing thereby their competitiveness toward *P. antarctica*. Moreover, community primary production (PP) of all treatments yielded similar high rates at the start and the end of the experiment, but with the main contributors shifting from initially large to small cells toward the end. Even though community PP of Ryder Bay phytoplankton was insensitive to the changes in light and CO_2 availability, the observed size-dependent shift in productivity could, however, weaken the biological CO_2 sequestration potential of this region in the future.



Two outdoor incubators were covered with ~30% and ~10% neutral density light filters generating two distinct light conditions of MSR and HSR. Lines indicate the mean daily irradiances over the two experimental phases of the MSR treatment in black and for the HSR treatment in dark gray. During the first experimental phase, which lasted until day 7, MSR and HSR treatments were exposed to a lower daily irradiance than after day 7.

Citation: **Impact of ocean acidification and high solar radiation on productivity and species composition of a late summer phytoplankton community of the coastal Western Antarctic Peninsula**
Heiden, J P; Völkner, C; Jones, E M; Van de Poll, W H; Buma, A G J; Meredith, M P; De Baar, H J W; Bischof, K; Wolf-Gladrow, D; Trimborn, S 2019 *Limnology & Oceanography* 9999, 1-21 doi:10.1002/lno11147

Highlight II (Integrated) **Temporal & spatial variability of glacial meltwater effects on phytoplankton**

Glacial meltwater discharge in fjords on the west coast of Spitsbergen is increasing due to climate change. The influence of this discharge on phytoplankton nutrient limitation, composition, productivity and photophysiology was investigated in central (M) and inner (G) Kongsfjorden (79°N, 11°40'E). Freshwater influx intensified stratification during June 2015, coinciding with surface nutrient depletion. Surface nutrient concentrations were negatively correlated with stratification strength at station M. Here, nitrate addition assays revealed increasing N limitation of surface phytoplankton during the second half of June, which was followed by a pronounced compositional change within the flagellate-dominated phytoplankton community as dictyochophytes (85% of chl a) were replaced with smaller haptophytes (up to 60% of chlorophyll a) and prasinophytes (20% of chlorophyll a). These changes were less pronounced at station G, where surface phosphate, ammonium and nitrate concentrations were occasionally higher, and correlated with wind direction, suggesting wind-mediated transport of nutrient-enriched waters to this inner location. Therefore, glacial meltwater discharge mediated nutrient enrichment in the inner fjord, and enhanced stratification in inner and central Kongsfjorden. Surface chlorophyll a and water column productivity showed 3–4-fold variability, and did not correlate with nutrient limitation, euphotic zone depth, or changed taxonomic composition. However, the maximum carbon fixation rate and photosynthetic efficiency showed weak positive correlations to prasinophyte, cryptophyte, and haptophyte chlorophyll a. The present study documented relationships between stratification, N limitation, and changed phytoplankton composition, but surface chlorophyll a concentration, phytoplankton photosynthetic characteristics, and water column productivity in Kongsfjorden appeared to be driven by mechanisms other than N limitation.

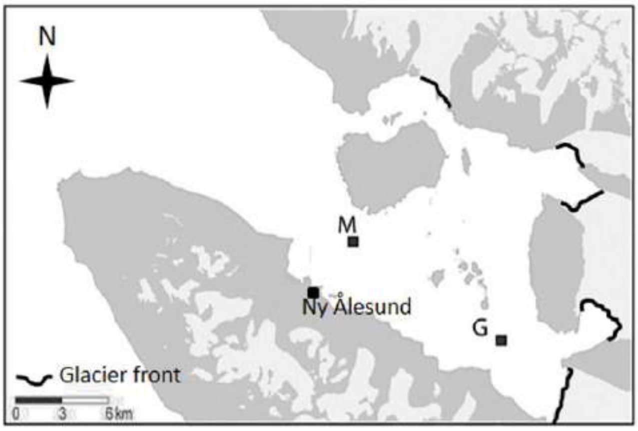
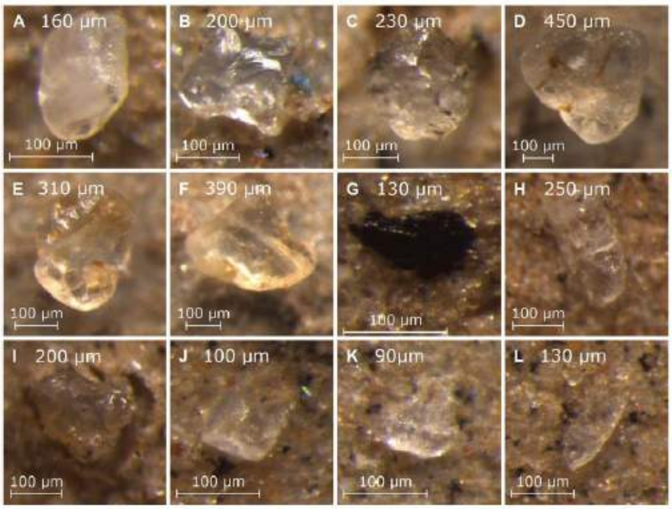


Figure 1: Map of Kongsfjorden, Spitsbergen (79°N, 11°40'E). Indicated are two stations M and G at which the experiments were carried out. doi:10.1525/elementa.307.f1

Citation: **Contrasting glacial meltwater effects on post-bloom phytoplankton on temporal and spatial scales in Kongsfjorden, Spitsbergen** Van de Poll, W H; Kulk, G; Rozema, P D; Brussaard, C P D; Visser, R J W; Buma, A G J 2018 Elementa Science of the Anthropocene 6(50) 1-13 doi:10.1525/elementa.307

Highlight III (Theme III) **'Giant' aerosol particles**

Giant mineral dust particles (>75 mm in diameter) found far from their source have long puzzled scientists. These wind-blown particles affect the atmosphere's radiation balance, clouds, and the ocean carbon cycle but are generally ignored in models. Here, we report new observations of individual giant Saharan dust particles of up to 450 mm in diameter sampled in air over the Atlantic Ocean at 2400 and 3500 km from the west African coast. Past research points to fast horizontal transport, turbulence, uplift in convective systems, and electrical levitation of particles as possible explanations for this fascinating phenomenon. We present a critical assessment of these mechanisms and propose several lines of research we deem promising to further advance our understanding and modeling.



'Giant' Saharan-dust particles sampled from the air by autonomous dust-collecting buoys at >2,500 km from the African west coast.

Citation: **The mysterious long-range transport of giant mineral dust particles** Van der Does, M; Knippertz, P;. Zschenderlein, P; Harrison, G R; Stuut, J-B W 2018, *Science Advances*, *4*(eaau2768).

Highlight IV (Environmental impacts of geoengineering) **Ocean Solutions**

The Paris agreement target of limiting global surface warming to 1.5-2°C compared to pre-industrial levels by 2100 will heavily impact the ocean. While ambitious mitigation and adaptation are both needed, the ocean provides major opportunities for action to reduce climate change globally and its impacts on vital ecosystems and ecosystem services. A comprehensive and systematic assessment of 13 global- and local-scale, ocean-based measures was performed to help steer the development and implementation of technologies and actions towards a sustainable outcome. We show that (1) all measures have tradeoffs and multiple criteria must be used for a comprehensive assessment of their potential, (2) greatest benefit is derived by combining global and local solutions, some of which could be implemented or scaled-up immediately, (3) some measures are too uncertain to be recommended yet, (4) political consistency must be achieved through effective cross-scale governance mechanisms, (5) scientific effort must focus on effectiveness, co-benefits, disbenefits, and costs of poorly tested as well as new and emerging measures.

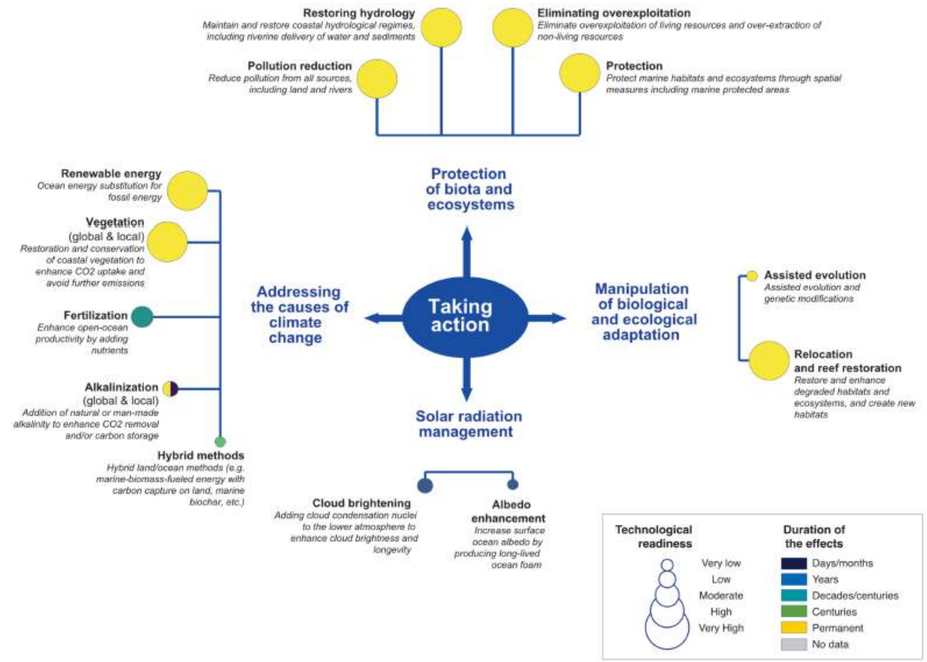


FIGURE 2 | Potential ocean solutions. Four main groups are considered: addressing the causes of climate change (i.e., reducing anthropogenic greenhouse gas emissions or increasing the long-term removal of greenhouse gases, primarily CO_2), solar radiation management, protection of biota and ecosystems (habitats, species, resources, etc.), and manipulation of biological and ecological adaptation.

Citation: **Ocean Solutions to Address Climate Change and Its Effects on Marine Ecosystems**
Gattuso, J-P, et al. 2018 Frontiers in *Marine Science 5*(337) doi:10.3389/fmars.2018.00337.

Highlight V (Theme II) Extreme spikes in DMS flux from Antarctic coastal waters

Biogenic dimethylsulfide (DMS) is a significant contributor to sulfur flux from the oceans to the atmosphere, and the most significant source of aerosol non-sea-salt sulfate (NSS-SO_4^{2-}), a key regulator of global climate. In Webb et al. (2019) we present the longest running time-series of DMS-water (DMS_W) concentrations in the world, obtained at the Rothera Time-Series (RaTS) station in Ryder Bay, West Antarctic Peninsula (WAP). We demonstrate the first ever evaluation of interseasonal and interannual variability in DMS_W and associated flux to the atmosphere from the Antarctic coastal zone and determine the scale and importance of the region as a significant source of DMS. Impacts of climate modes such as El Niňo/Southern Oscillation are evaluated. Maximum DMS_W concentrations occurred annually in January and were primarily associated with sea-ice break-up. These concentrations resulted in extremely high (up to 968 µmol m^{-2} d^{-1}) DMS flux over short timescales, which are not parameterised in global-scale DMS climatologies. Calculated DMS flux stayed above the aerosol nucleation threshold of 2.5 µmol m^{-2} d^{-1} for 60% of the year. Overall, using flux determinations from this study, the total flux of DMS-sulfur from the Austral Polar Province (APLR) was 1.1 Tg sulfur yr^{-1}, more than double the figure suggested by the most recent DMS climatologies.

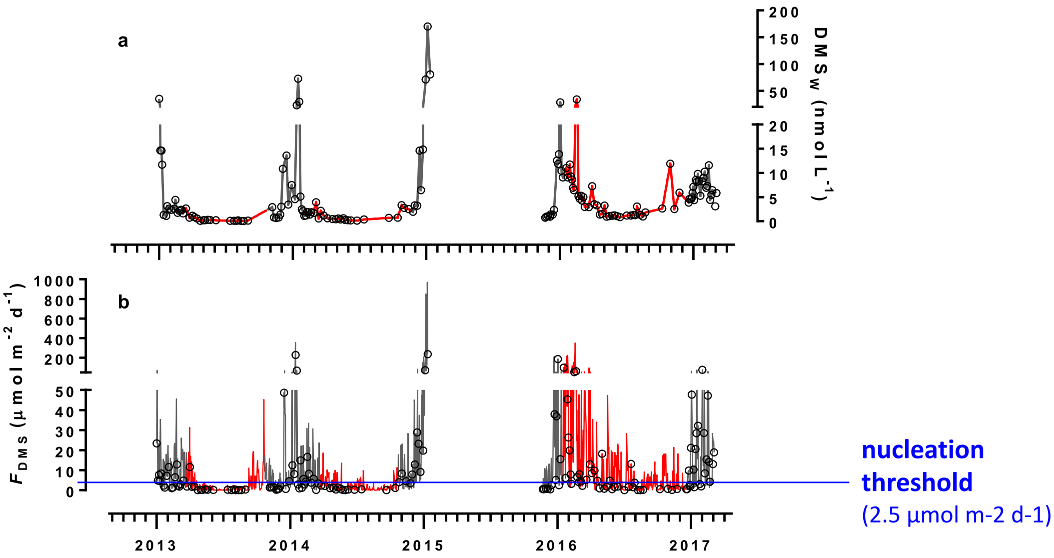


Figure. (**a**) DMS (nmol L^{-1}) over the 5-year time-series in Ryder Bay at the West Antarctic Peninsula, presented as the mean over the surface 15 m and **b)** DMS flux (µmol m^{-2} d^{-1}), calculated from DMS concentration, daily average wind speed and SST. Black solid lines represent summer (Nov–Mar) interpolated values calculated from *in-situ* measured DMS and red solid lines represent winter (Apr–Oct) interpolated values based on stored DMSPd samples analysed the following summer.

Citation: **Extreme spikes in DMS flux double estimates of biogenic sulfur export from the Antarctic coastal zone to the atmosphere** Webb, A L; Van Leeuwe, M A; Den Os, D; Meredith, M P; Venables, H J; Stefels, J 2019 *Scientific Reports* 9:2233 doi:10.1038/s41598-019-38714-4

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

- RV *Pelagia* expedition 64PE443: Saharan-dust monitoring in the Mediterranean, August 2018. Chief scientist: Dr. Jan-Berend Stuut, NIOZ, the Netherlands.
- RV *Maria S. Merian* expedition MSM79: “MacPie”, a joint German-Dutch cruise studying SOLAS related process studies off the African west coast, November 2018. Chief scientist: prof Karin Zonneveld, MARUM-Bremen, Germany.
- RV *Polarstern* expedition PS117 to the Weddell and Lazarev Sea (Antarctica) December 2018 – February 2019. Chief scientist: Dr. Olaf Boebel, AWI-Bremerhaven, Germany (GEOTRACES PI: Dr. Rob Middag, NIOZ, the Netherlands)

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

Bitanja, R; Katsman, C; Selten, F (2018) **Increased Arctic precipitation slows down sea ice melt and surface warming** *Oceanography* 31(2) doi:10.5670/oceanog.2018.204

Kim, H; Ducklow, H W; Abele, D; Ruiz Barlett, EM; Buma, AGJ; Meredith, MP; Rozema, PD; Schofield, OM; Venables, HJ; Schloss, IR (2018) **Inter-decadal variability of phytoplankton biomass along the coastal West Antarctic Peninsula** *Philosophical Transactions of the Royal Society* 376 (2122) doi:10.1098/rsta.2017.0174.

Middelburg, J J (2019), **Marine Carbon Biogeochemistry - a primer for earth system scientists**, 118 pp., Springer, Dordrecht. doi: 10.1007/978-3-030-10822-9

Van der Does, M; Pourmand, A; Sharifi, A; Stuut, J-B W (2018), **North African mineral dust across the tropical Atlantic Ocean: Insights from dust particle size, radiogenic Sr-Nd-Hf isotopes and rare earth elements (REE)**, *Aeolian Research*, *33*, 106-116, doi:https://doi.org/10.1016/j.aeolia.2018.06.001.

Webb, A L; Van Leeuwe, M A; Den Os, D; Meredith, M P; Venables, H J; Stefels, J (2019) **Extreme spikes in DMS flux double estimates of biogenic sulfur export from the Antarctic coastal zone to the atmosphere** *Scientific Reports* 9:2233 doi:10.1038/s41598-019-38714-4

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

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PART 2 - Planned activities for 2019/2020 and 2021

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

In 2019-2020, the Netherlands will participate in the international MOSAiC campaign (***M**ultidisciplinary drifting **O**bservatory for the **S**tudy of **A**rct**ic** **C**limate*; https://www.mosaic-expedition.org) with three projects:

1. Arctic Sea Ice-Pelagic Coupling of the Carbon and Sulfur Cycles (Stefels, University of Groningen)
2. The role of sea ice in the life cycle of polar cod (Boreogadus saida) and its prey (van Franeker, Wageningen Marine research)
3. Multi-scale model analysis of Arctic surface-boundary layer exchange of climate-active trace gases and aerosol precursors (Ganzeveld, Wageningen University)

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

- Scientific session at the European Geosciences Union, Vienna, 8-12 April 2019 Dusty Session CL4.28/AS3.6/GM10.2/SSP3.25: **Aeolian dust**

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).

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

Comments

The SOLAS community in the Netherlands is very active on a personal basis; there are many scientists that are involved in SOLAS-related studies, without being organised as SOLAS-NL. With the installation of a new national coordinator, we strive to improve the visibility of Dutch SOLAS-related science.

surface ocean **solas** lower atmosphere study

Report for the year 2018 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 2018 – Jan-Feb 2019*
- Part 2: *reporting on planned activities for 2019/2020 and 2021.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies;
Environmental impacts of geoengineering;
Science and society**.**

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

PART 1 - Activities from January 2018 to Jan/Feb 2019
1. Scientific highlight

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

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

Samples in the project were segregated in size by cascade impaction between “coarse” > 1µm and “fine” <1µm modes, by air sector as solely marine compared with all wind sectors (which include, marine, terrestrial and urban influences) and by ion chemistry into sea-salt and non-sea salt components. The results provide independent support for marine biogenic sulfur being the dominant precursor to climatically important secondary sulfate aerosols that have a regionally important role as Cloud Condensation Nuclei. Marine biogenic sources dominate and are strongly seasonal with a peak in spring/summer. The isotopic ratio δ34S is well established at +21‰ and biogenic DMS derived sulfate lies in the range +15‰ to +19‰ At Baring Head, fine aerosol sulfate was found to be in the range +10‰ to +15‰ over autumn/winter due to a isotopically “lighter” fossil fuel influence accounting for about half of the all-sector sub-micron sulfate in winter with shipping emissions thought to contribute significantly here.

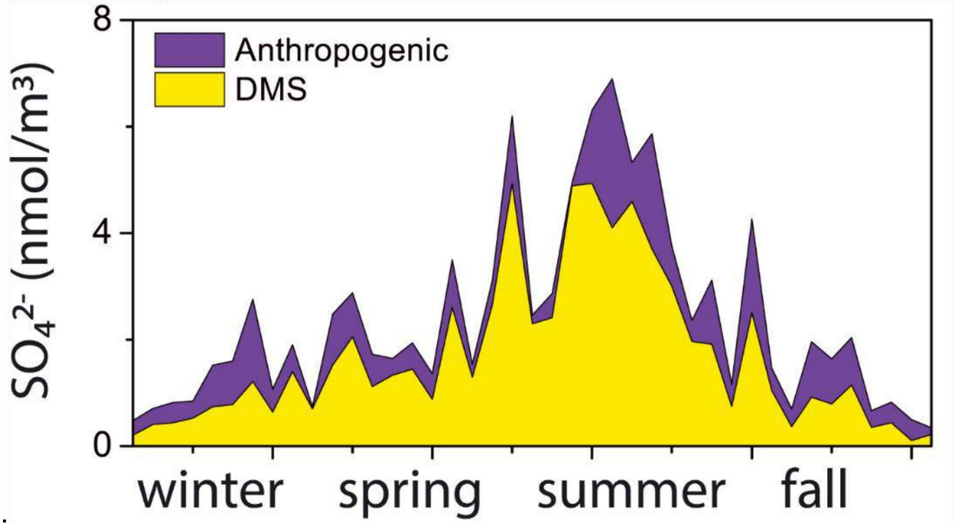

Figure: estimated anthropogenic and DMS contribution to NSS-sulfate in ambient fine aerosol from

Li et al., GRL 2018; https://doi.org/10.1002/2018GL077353

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

SOLAS Theme 1

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

A coastal observing network comprising 14 sites throughout New Zealand was sampled fortnightly in collaboration with partners from local councils, research institutes, Mãori 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 ROMS model further developed for Firth of Thames
RA3 – 4 mesocosm experiments completed examining responses of coastal plankton to ocean acidification and warming
RA4 – Experiments completed examining impact of low pH on mussel and paua adults, larvae and fertilisation, including adult pre-exposure assessments
RA5 – determination of adaptation potential to low pH in different families of Greenshell Mussel & Paua
There has been significant engagement with NZ stakeholders on ocean acidification and warming, including a presentation to Members of Parliament in the Beehive (NZ Parliament). NZ Ocean Acidification. Invited presentations on national OA research coordinated were also given at three side events during COP24 (Katowice, Poland, December 2018).

SOLAS Theme 4

1. Surface Ocean Aerosol Production (SOAP)

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

10 papers published to date, with 8 in a Special Issue in Ocean Science and Atmospheric Chemistry & Physics and Ocean Science at http://www.ocean-sci.net/special_issue10_333.html

Invited presentation, SOLAS Marine aerosols workshop, Rome, November 2018

2. Development of the Sea2Cloud voyage (see below)

3. Deep South National Science Challenge

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

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

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

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

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

In collaboration with the Australian SOLAS activity PI: Ristovski, QUT, a new method was developed to investigate particulate emissions from ships using airborne in-situ profiling sensors deployed from tethered balloons and RPAS through measurement of ship exhaust plume CO2 and particulates

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

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

6. Southern Ocean/Ross Sea Voyage

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

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

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

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

7. Low background aerosol in the tropical western Pacific

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

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

Cross-Cutting Theme: Science & Society

1. Mitigation of Coastal Acidification around Mussel Farms

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

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

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

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

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

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

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

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

SOLAS Theme 1:

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

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

2. The New Zealand Ocean Acidification Observing Network (NZOA-ON) https://marinedata.niwa.co.nz/nzoa-on/

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

3. 12th New Zealand National Ocean Acidification Workshop http://nzoac.nz/workshops/

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

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

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

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

SOLAS Theme 4

5. Black Carbon Workshop (3 October 2018)

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

6. The 14th Annual Australia-New Zealand Aerosol Assembly (18 – 19 Oct 2018)

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

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

PART 2 - Planned activities for 2019/2020 and 2021

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

SOLAS Theme 1

1. CARIM

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

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

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

3. Munida Transect – continuing into its 22nd year

SOLAS Theme 4

4. Sea2Cloud

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

SOLAS Cross-Cutting Theme: Science & Society

Mitigation of Coastal Acidification around Mussel Farms

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

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

SOLAS Theme 1

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

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

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

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

SOLAS Cross-Cutting Theme: Environmental impacts of geoengineering
NZ scientists are coordinating a Special Session on Marine Geoengineering at the SOLAS Open Science Conference in Sapporo, Japan in April 2019

3. Funded national and international projects / activities underway.

SOLAS Theme 1

1. HYDEE (Economic opportunities & environmental implications of energy extraction from gas hydrates) - A voyage will take place on the south-east shelf of the NZ North Island in June to look at the biogeochemical and biological impacts of seabed methane seeps

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

3. Munida Transect

4. Mitigation of Coastal Acidification around Mussel Farms

SOLAS Theme 4

5. Sea2Cloud (see above)

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

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

:

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

SOLAS Theme 1

SCOR Working Groups:
WG 143 Dissolved N2O and CH4 measurements: Working towards a global network of ocean time series measurements of N2O and CH4

IOCCP Scientific Steering Group
SOCAT Global QC Group
OA-ICC Advisory Board and member of SOLAS-IMBER Working Group on Ocean
Trainer at two ocean acidification capacity building workshops for Pacific Island States and Nations

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

SOLAS Theme 4
CSIRO Access ESM and Southern Ocean Aerosol-Cloud Research
Australia/New Zealand aerosol assembly (ANZAA), a special interest group of CASANZ https://www.casanz.org.au/casanz-sigs/australia-and-new-zealand-aerosol-assembly/ includes background aerosol processes
New Zealand Earth System Model development is collaborating with CSIRO and the Australian Community Climate and Earth System Simulator (Access) with GLOMAP aerosol model (PI: Dr.Matthew Woodhouse) for Surface Ocean aerosol production and the Southern Ocean Aerosol-Cloud Research.
The Deep South National Science Challenge: http://www.deepsouthchallenge.co.nz/ polar aerosol processes.

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

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

Comments

Comments

Report for the year 2018 and future activities

SOLAS *Norway*
compiled by: Siv K. Lauvset

This report has two parts:

***- Part 1:** reporting of activities in the period of January 2018 – Jan-Feb 2019*
***- Part 2:** reporting on planned activities for 2019/2020 and 2021.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies;
Environmental impacts of geoengineering;
Science and society**.**

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

PART 1 - Activities from January 2018 to Jan/Feb 2019
1. Scientific highlight
Concentrations of dissolved ^{230}Th in the ocean water column increase with depth due to scavenging and downward particle flux. Due to the ^{230}Th scavenging process, any change in the calcium carbonate ($CaCO_3$) fraction of the marine particle flux due to changes in biological $CaCO_3$ hard-shell production as a consequence of progressing ocean acidification would be reflected in the dissolved ^{230}Th activity. Our prognostic simulations with a biogeochemical ocean general circulation model using different scenarios for the reduction of $CaCO_3$ production under ocean acidification and different greenhouse gas emission scenarios – the Representative Concentration Pathways (RCPs) 8.5 to 2.6 – reveal the potential for deep ^{230}Th measurements to detect reduced $CaCO_3$ production at the sea surface. The time of emergence of an acidification-induced signal on dissolved ^{230}Th is of the same order of magnitude as for alkalinity measurements. Interannual and decadal variability in factors other than a reduction in $CaCO_3$ hard-shell production may mask the ocean-acidification-induced signal in dissolved ^{230}Th and make detection of the pure $CaCO_3$-induced signal more difficult so that only really strong changes in marine $CaCO_3$ export would be unambiguously identifiable soon. Nevertheless, the impacts of changes in $CaCO_3$ export production on marine ^{230}Th are stronger than those for changes in POC (particulate organic carbon) or clay fluxes.

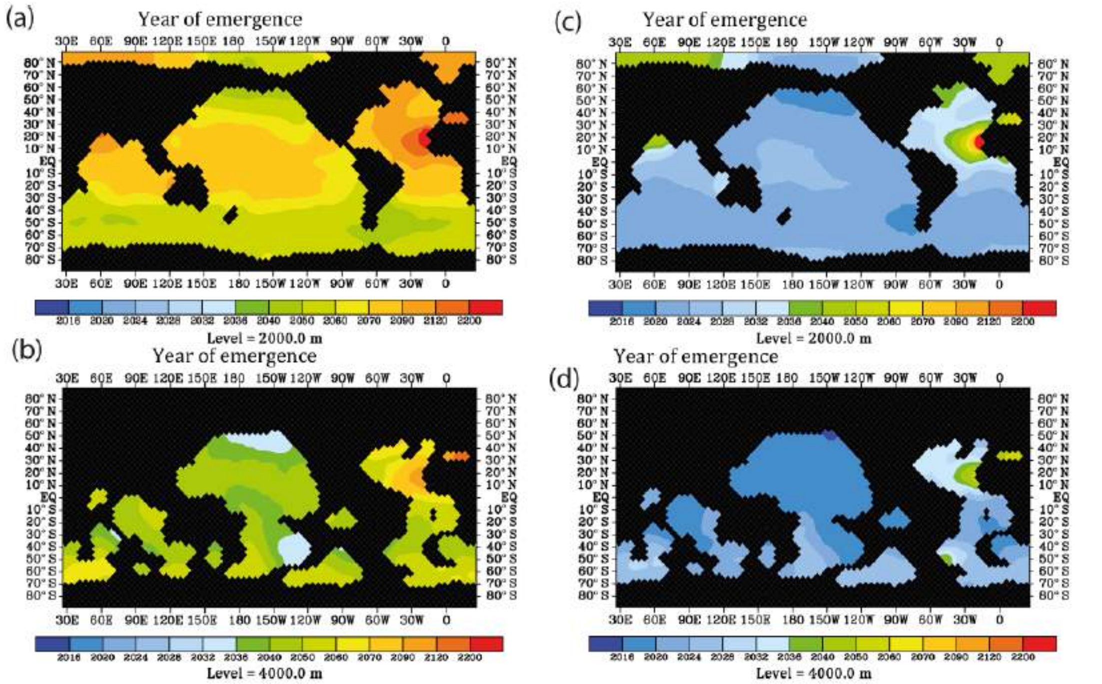

Figure 1. Prospective year of emergence for an ocean-acidification-induced signal in dissolved ^{230}Th activity as derived from the model runs. Shown are the calendar years of emergence for the depth levels at 2000 and 4000 m. All figures are shown for the strong RCP8.5 scenario concerning atmospheric CO_2 concentration and the moderate scenario of calcification decrease with saturation state, with the year 2010 as a reference year for ^{230}Th activity and 0.075 dpm/1000 L as analytical threshold between different samples. (a) For the moderate calcification scenario, at 2000m depth. (b) Same as panel (a) but for depth level 4000 m. (c) For the extreme calcification scenario, at 2000m depth. (d) Same as panel (c) but for depth level 4000 m.

Heinze, C., T. Ilyina, and M. Gehlen (2018), The potential of 230Th for detection of ocean acidification impacts on pelagic carbonate production, *Biogeosciences*, *15*(11), 3521-3539.

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

OTC workshop 7-9 March, 2018 (capacity building)

Model and data comparison for CO2-flux in North Atlantic

Participation in several Community White Papers for OceanObs’19

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

- *Le Quere et al. 2018a,* Global Carbon Budget 2018, *Earth Syst. Sci. Data*, 10, 1-54, doi: 10.5194/essd-10-2141-2018.
- *Le quere et al. 2018b,* Global Carbon Budget 2017, *Earth Syst. Sci. Data*, 10, 405-448, doi: 10.5194/essd-10-405-2018, 2018.
- Goris et al., 2018, Constraining Projection-Based Estimates of the Future North Atlantic Carbon Uptake, *Journal of Climate*, Volume 31 (10). s. 3959-3978
- Tjiputra et al., 2018 Mechanisms and early detections of multidecadal oxygen changes in the interior subpolar North Atlantic, *Geophysical Research Letters*; Volume 45. s. 4218-4229

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

PART 2 - Planned activities for 2019/2020 and 2021

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

Research cruise with R/V Johan Hjort in May-June 2019 to deploy several BGC-Argo floats. Full carbon chemistry and trace gas analyses will be undertaken

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

- Training course on a suite of biogeochemical sensors, Sweden, 10-19 June 2019 (http://www.ioccp.org/2019-training-course#about)
- OTC – intercalibration effort winter 2020 (CO2 instrumentation)
- SEACRIFOG workshop on practical oceanography and data management , Bergen 1-10 April 2019 (https://www.seacrifog.eu/news-events/news/)
- Workshop “A gentle introduction to CMIP5 for ecological modellers”, May 2019

3. Funded national and international projects / activities underway.

- **ICOS Norway and OTC**, funded by Research Council of Norway until March 2021. Continuation until 2024 applied for in Oct 2018
- **EU project Seacrifog (**Supporting EU-African Cooperation on Research Infrastructures for Food Security and Greenhouse Gas Observations)
- **Norwegian Ocean Acidification Monitoring program**
- **NorArgo**

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.

Participates as Ocean Acidification expert in OSPAR

IOCCP SSC member responsible for ocean carbon synthesis products, including SOCAT.

Comments

surface ocean solas lower atmosphere study

Report for the year 2018 and future activities

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

This report has two parts:

- Part 1: *reporting of activities in the period of January 2018 – Jan-Feb 2019*
- Part 2: *reporting on planned activities for 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* ***<u>entire country</u>*** *you are representing (all universities, institutes, lab, units, groups, cities).*

PART 1 - Activities from January 2018 to Jan/Feb 2019
1. Scientific highlight
As part of International Ocean Carbon Coordination Project (IOCCP; www.ioccp.org) with headquarters at IOPAN in Sopot, Maciej Telszewski (Director) and Artur Palacz (Project Officer) engaged in a number of coordination and communication activities promoting the development of a global network of ocean carbon and biogeochemistry observations, supporting in part the implementation of the 2015-2025 SOLAS Science Plan. In 2018, IOCCP and SOLAS together with representatives of other scientific partners, have worked to develop a science-based strategy for future marine carbon cycle research as part of the newly appointed IOC-UNESCO Working Group on Integrated Ocean Carbon Research. Together with Véronique Garçon (2018 SOLAS SSC member and former Chair) as the newly appointed IOCCP Scientific Steering Group member responsible for Oxygen Essential Ocean Variable (EOV) measurements, we developed a new website for Oxygen EOV and engaged in a number of oxygen-related activities (see publications and workshops below and on www.ioccp.org/oxygen). Most importantly, we held the second Science Workshop of the Variability in the Oxycline and Its Impacts on the Ecosystem (VOICE) project, which resulted in submission of a Community White Paper for the OceanObs'19 Conference. Through continued collaboration between VOICE and the Global Ocean Oxygen Network (GO2NE), IOCCP contributed to enhanced coordination of oxygen-related ocean observation, research and dissemination efforts

(e.g. Breitburg et al., 2018; Kiel Declaration on Deoxygenation - https://www.ocean-oxygen.org/declaration).
Last but not least, IOCCP and SOLAS have worked together in the capacity building domain, e.g. by co-sponsoring an international summer school on global ocean oxygen observations (http://mel.xmu.edu.cn/summerschool/go2ne/index.asp) to be held in Xiamen, China in September 2019. A number of sessions planned for the June 2019 IOCCP-BONUS INTEGRAL training course on a suite of biogeochemical sensors (http://www.ioccp.org/2019-training-course) will also have direct relevance to the main themes of SOLAS, e.g. on air-sea interactions.

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

Membership in the Board of Directors of the Centre for Polar Studies.

Organization of an international symposium called the Sopot Forum for Young Scientists.

Presidency in EurOcean.

Leaders in the POLAND-AOD network.

Polish coordination in the NASA Maritime Aerosol Network.

Membership in the Scientific Council of the Climate Forum – Science on Climate.

Coordination of the Sopot Association for the Advanced Sciences activities.

Organization of a number of public events, promoting science.

1-2 September 2018 Kiel, Germany	Global Ocean Oxygen NEtwork (GO$_2$NE) annual workshop Meeting report
8-9 December 2019 Washington, DC, USA	Ocean Carbon Uptake in CMIP6 Models: Synthesis and Intercomparison
24-26 October 2018 Tokyo, Japan	13th Session of the International Ocean Carbon Scientific Steering Group
22-24 October 2018 Tokyo, Japan	6th Argo International Workshop
11-13 September 2018 Prague, Czech Rep.	3rd Integrated Carbon Observing System (ICOS) Conference
8-9 September 2018 Kiel, Germany	2nd Science Plan Workshop of the Variability in the Oxycline and Its Impacts on the Ecosystem (VOICE) project
3-7 September 2018 Kiel, Germany	Ocean Deoxygenation Conference
1-2 September 2018 Kiel, Germany	Global Ocean Oxygen NEtwork (GO$_2$NE) annual workshop Meeting report
13-15 June 2018 Santa Marta, Colombia	7th Session of the GOOS Steering Committee (GOOS-SC-7) Meeting website Meeting report (pending)
12 June 2018 Santa Marta, Colombia	GOOS South American Regional Workshop Meeting report

4-8 June 2018 Washington, DC, USA	4th International Symposium on the Effects of Climate Change on the World's Oceans
4-5 June 2018 Brussels, Belgium	A European Vision for an Atlantic Ocean Observing System - AtlantOS workshop
28-30 May 2018 Sopot, Poland	Global Ocean Acidification Observing Network (GOA-ON) Executive Council Meeting
14-17 May 2018 Plouzane, France	Ninth meeting of the JCOMM Observations Coordination Group (OCG-9) Meeting website Action items (draft)
7-8 March 2018 Bergen, Norway	ICOS Ocean Thematic Centre workshop on ocean CO_2measurements
28 Feb-5 Mar 2018 Hobart, TAS, Australia	GOOS Cross-Panel and Executive Committee Meeting Meeting website and report
11-16 February 2018 Portlant, OR, USA	2018 AGU Ocean Sciences Meeting Meeting website
11 February 2018 Portlant, OR, USA	Surface Ocean CO_2 Global Observations Network Kick-Off meeting
16-18 January 2018 Paris, France	Development of the SDG 14.3.1 indicator methodology - Expert Workshop Methodology document

3. Top 5 publications in 2018 (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. *Bossier S, Palacz AP, Nielsen JR, Christensen A, Hoff A, Maar M, et al. 2018. The Baltic Sea Atlantis: an integrated end-to-end modelling framework evaluating ecosystem-wide effects of human-induced pressures. PLOS ONE 13(7): e0199168. https://doi.org/10.1371/journal.pone.0199168*
3. *Telszewski M, Palacz AP, Fischer A, 2018: Biogeochemical in situ observations – Motivation, status, and new frontiers. In "New Frontiers in Operational Oceanography", E. Chassignet, A. Pascual, J. Tintoré, and J. Verron, Eds., GODAE OceanView, 131-160, doi:10.17125/gov2018.ch06.*
4. *Palacz AP. (2018). A Report of Meeting of the Global Ocean Observing System Expert Panels (GOOS Cross-Panel 2018). GOOS Report No. 228. UNESCO, Paris, France.*
5. *Telszewski M, Palacz AP. International Ocean Carbon Coordination Project (IOCCP) Conveyor Newsletter Nr 39, Sopot, Polska. Biuro Projektu IOCCP, 2018, pp. 13, http://www.ioccp.org/images/Cconveyor/March-2018/The-IOCCP-Conveyor-39_March-2018_FINAL.pdf*

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

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 2019:

1. Organization of Open Science Days 6-8 June 2019.
2. Organization of an international conference for young scientists entitled: Where the World is Heading (7 June 2019).

3. Funded national and international projects / activities underway.

A number of projects to be submitted during 2019/20.

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 2019. 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 2029).

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. EurOcean.

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

Comments

surface ocean solas lower atmosphere study

Report for the year 2018 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 2018 – Jan-Feb 2019*
- Part 2: *reporting on planned activities for 2019/2020 and 2021.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies;
Environmental impacts of geoengineering;
Science and society**.**

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

PART 1 - Activities from January 2018 to Jan/Feb 2019
1. Scientific highlight
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). Atmospheric iodine causes tropospheric ozone depletion and aerosol formation, both of which have significant climate impacts, and is an essential dietary element for humans. However, the evolution of atmospheric iodine levels at decadal and centennial scales is unknown. Recently, measurements of iodine concentrations in the RECAP ice-core (coastal East Greenland) have investigated how atmospheric iodine levels in the North Atlantic have evolved over the past 260 years (1750–2011). The levels of iodine tripled from 1950 to 2010. The results suggest that this increase is driven by anthropogenic ozone pollution and enhanced sub-ice phytoplankton production associated with the recent thinning of Arctic sea ice. Increasing atmospheric iodine has accelerated ozone loss and has considerably enhanced iodine transport and deposition to the Northern Hemisphere continents. Future climate and anthropogenic forcing may continue to amplify oceanic iodine emissions with potentially significant health and environmental impacts at global scale.

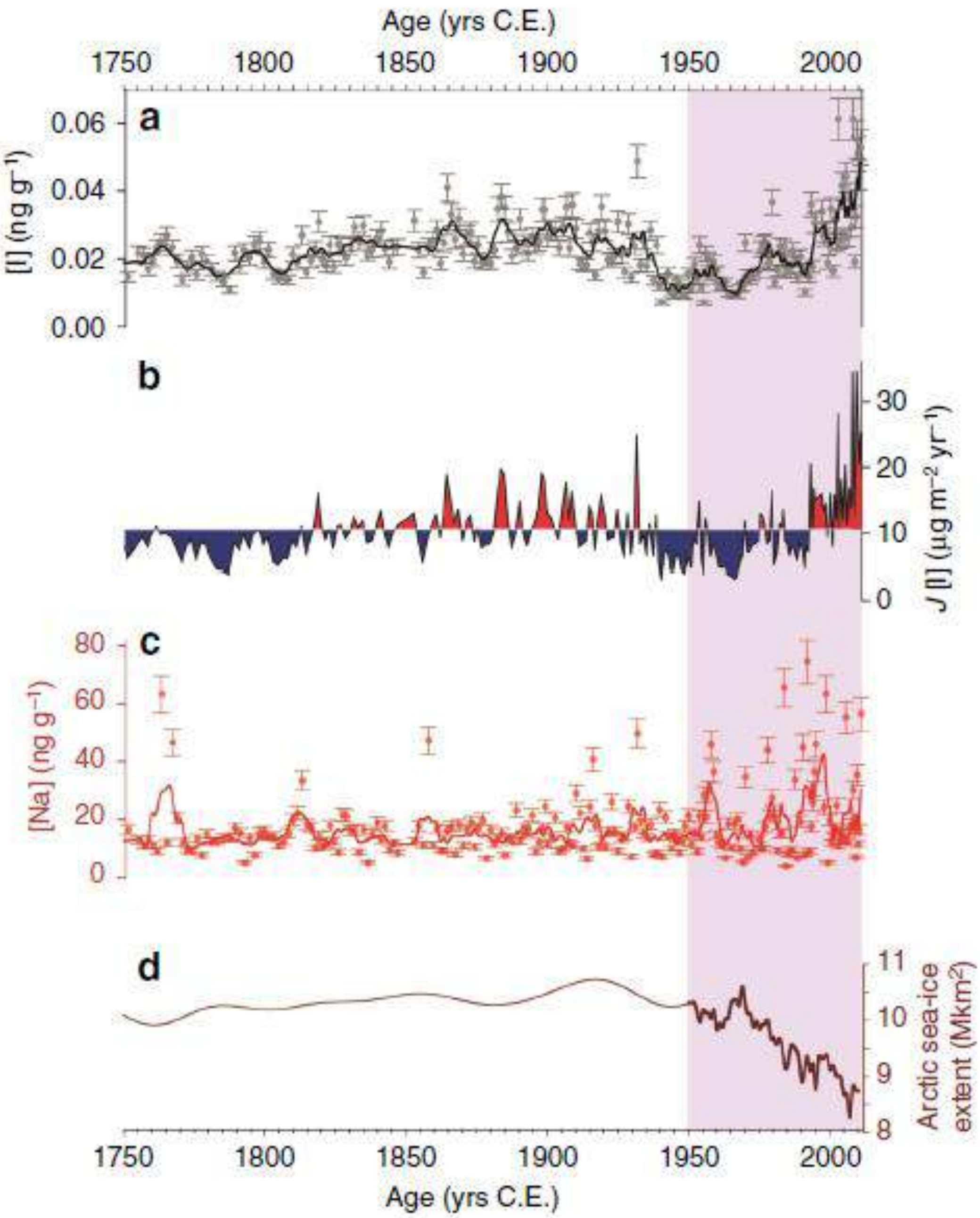

Figure: Time series of geochemical elements in the Renland ice-core during the Industrial Period. a) Iodine [I] concentration and standard deviation, b) positive (red) and negative (blue) variation of iodine depositional fluxes J[I] with respect to the 1750–2010 average and c) sodium [Na] concentrations and standard deviation from Renland ice core (black and red lines represent the 5-samp. running averages for iodine and sodium, respectively); d) Arctic sea ice extent reconstruction.

Citation: C. A. Cuevas, N. Maffezzoli, J. P. Corella, A. Spolaor, P. Vallelonga, H. A. Kjær, M. Simonsen, M. Winstrup, B. Vinther, C. Horvat, R. P. Fernandez, D. Kinnison, J.-F. Lamarque, C. Barbante, A. Saiz-Lopez, Rapid increase in atmospheric iodine levels in the North Atlantic since the mid-20th century. *Nature Communications* **9**, 1452 (2018).

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

SOLAS-related funded projects:

Effects of ocean acidification, temperature and organic matter on Fe(II) persistence in the Atlantic Ocean (ATOPFe), funded by the Spanish Ministry of Economy and Competitiveness running during 2018-2020.

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

Other research activities:

OVIDE line cruise Jun-Jul 2018. pCO_2 measurements.

FICARAM-18 from Ushuaia-Cartagena: pCO_2 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. (UC Berkeley . April 4 to 27, 2018).

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

PAPERS:

C. A. Cuevas, N. Maffezzoli, J. P. Corella, A. Spolaor, P. Vallelonga, H. A. Kjær, M. Simonsen, M. Winstrup, B. Vinther, C. Horvat, R. P. Fernandez, D. Kinnison, J.-F. Lamarque, C. Barbante, A. Saiz-Lopez, Rapid increase in atmospheric iodine levels in the North Atlantic since the mid-20th century. Nature Communications **9**, 1452 (2018).

Abrahamsson, K., Granfors, A., Ahnoff, M., Cuevas, C. A., & Saiz-Lopez, A. (2018). Organic bromine compounds produced in sea ice in Antarctic winter. Nature Communications, 9(1), (2018). https://doi.org/10.1038/s41467-018-07062-8

Huertas IE, Flecha S, Navarro G, Perez FF, de la Paz M. Spatio-temporal variability and controlling parameters of methane and nitrous oxide in the Guadalquivir estuary, Southwestern Europe. Aquatic Sciences 80 (3), 29-45. DOI: 10.1007/s00027-018-0580-5, (2018).

Samperio-Ramos, G., Santana-Casiano, J.M., González-Dávila, M. Effect of Organic Fe-Ligands, Released by Emiliania huxleyi, on Fe(II) Oxidation Rate in Seawater Under Simulated Ocean Acidification Conditions: A Modeling Approach. Front. Mar. Sci. 5, 210. https://doi.org/10.3389/fmars.2018.00210, 2018.

Paulo Casal, Ana Cabrerizo, Maria Vila-Costa, Mariana Pizarro, Begoña Jimenez, and Jordi Dachs. Pivotal role of snow deposition and melting driving fluxes of polycyclic aromatic hydrocarbons at coastal Livingston Island (Antarctica). Environ. Sci. Technol., 52, 12327, 2018.

DATASETS:

1. https://digital.csic.es/handle/10261/173204 doi: 10.20350/digitalCSIC/8588. Methane emissions in Doñana saltmarshes over 2016-2018. Huertas IE and de la Paz M.

2. https://digital.csic.es/handle/10261/160022, doi:10.20350/digitalCSIC/8528. Methane and Nitrous Oxide in the Guadalquivir estuary (SW Spain) over 2016-2017. Huertas IE and de la Paz M.

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

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 2019/2020 and 2021

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

CSIC has planned modelling studies in collaboration with Shanghai Key Laboratory of Atmospheric Particle Pollution and Prevention: Studying coastal atmospheric chemistry using the WRF-Chem model.

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

Several Spanish groups will be presenting research at the EGU and AGU 2019.

3. Funded national and international projects / activities underway.

1. Our common future ocean –quantifying coupled cycles of carbon, oxygen, and nutrients for determining and achieving safe operating spaces with respect to tipping points (COMFORT, project# 820989). Funding agency: European Commission (H2020), Call H2020-LC-CLA-2018-2019-2020. Building a low-carbon, climate resilient future: climate action in support of the Paris Agreement. International consortium formed by 32 partners. (2019-2023)

2. 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)

3. 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).

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

- Several Spanish groups are involved in the MOSAiC project.
- Contribution to the Global Ocean Acidification Observing Network (GOA-ON) through the monitoring program at the Strait of Gibraltar. (http://portal.goaon.org/Explorer?action=oiw:mobile_platform:STS_235:details)

Comments

surface ocean solas lower atmosphere study

Report for the year 2018 and future activities

SOLAS *'Turkey'*
*compiled by: 'Nazlı OLGUN KIYAK'**

This report has two parts:

***- Part 1:** reporting of activities in the period of January 2018 – Jan-Feb 2019*
***- Part 2:** reporting on planned activities for 2019/2020 and 2021.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan.

***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)!*

***Dr. Nazlı OLGUN KIYAK**, Eurasia Institute of Earth Sciences, Istanbul Technical University (ITU), Istanbul, Turkey. (SOLAS Turkish Representative, E-mail: nazliolgun@gmail.com).

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

1. Scientific highlight

- **Scientific Highlight 1: Atmospheric water-soluble organic nitrogen (WSON) in the eastern Mediterranean: origin and ramifications regarding marine productivity.**

  Related to **SOLAS Theme 3**: Atmospheric Deposition and Ocean Biogeochemistry

  ***Citation:** Nehir, M and Koçak, M., 2018, Atmospheric water-soluble organic nitrogen (WSON) in the eastern Mediterranean: origin and ramifications regarding marine productivity, Atmospheric Chemistry and Physics, 18, 3603-3618,*

Aerosol and rain sampling in two size fractions was carried out at a rural site located on the coast of the eastern Mediterranean, Erdemli, Turkey. A total of 674 aerosol samples in two size fractions (337 coarse, 337 fine) and 23 rain samples were collected between March 2014 and April 2015. Samples were analyzed for NO_3^-, NH_4^+ and ancillary water-soluble ions using ion chromatography and water-soluble total nitrogen (WSTN) by applying a high-temperature combustion method. The mean aerosol water-soluble organic nitrogen (WSON) was 23.8 ± 16.3 nmol N m^{-3}, reaching a maximum of 79 nmol N m^{-3}, with about 66 % being associated with coarse particles. The volume weighted mean (VWM) concentration of WSON in rain was 21.5 µmol N L^{-1}. The WSON contributed 37 and 29 % to the WSTN in aerosol and rainwater, respectively. Aerosol WSON concentrations exhibited large temporal variation, mainly due to meteorology and the origin of air mass flow. The highest mean aerosol WSON concentration was observed in the summer and was attributed to the absence of rain and resuspension of cultivated soil in the region. The mean concentration of WSON during dust events (38.2 ± 17.5 nmol N m^{-3}) was 1.3 times higher than that of non-dust events (29.4 ± 13.9 nmol N m^{-3}). Source apportionment analysis demonstrated that WSON was originated from agricultural activities (43 %), secondary aerosol (20 %), nitrate (22 %), crustal material (10 %) and sea salt (5 %). The dry and wet depositions of WSON were equivalent and amounted to 36 % of the total atmospheric WSTN flux.

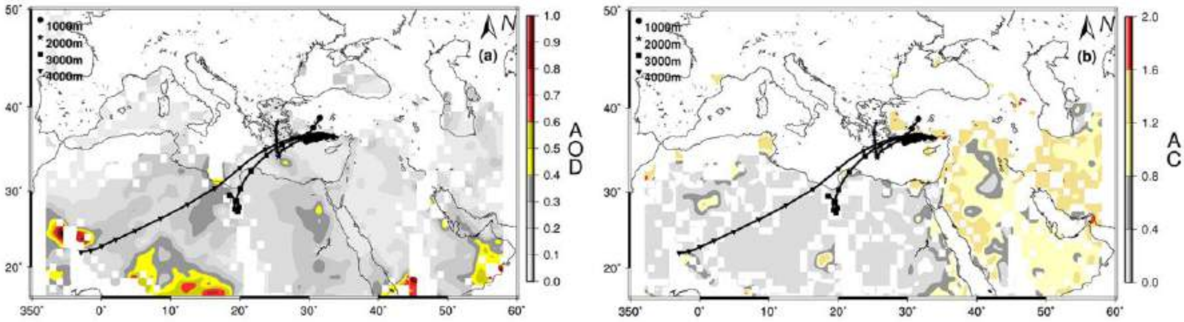

Figure 1: Three-day back trajectories showing the transport of air masses 1000 m (black circle), 2000 m (black star), 3000 m (black square) and 4000 m (black triangle) on 20 January 2015 for Erdemli. The aerosol optical depth (AOD, a) and Ångström component (AC, b) from MODIS (Moderate Resolution Imaging Spectroradiometer) distribution are also demonstrated with a color bar from grey to dark red.

Arithmetic mean concentrations together with corresponding standard deviations for water-soluble nitrogen species and nssCa 2+ in aerosol samples according to categorized air mass sectors (at 1 km) are presented in Table 5. WSON concentrations for the Middle East, north Africa and Turkey were comparable and arithmetic mean values were, respectively, 33, 36 and 32 nmol m^{-3}. Correspondingly, mean WSON concentrations for eastern Europe, western Europe and the Mediterranean Sea were 26, 26 and 22 nmol m^{-3} being at least 1.2 times lower than those observed for the Middle East, north Africa and Turkey (Mann–Whitney U test, $p < 0.05$). Coarse-mode contributions of WSON for air flow from the Middle East (61 %), north Africa (58 %) and Turkey (63 %) ranged from 58 to 63 %.

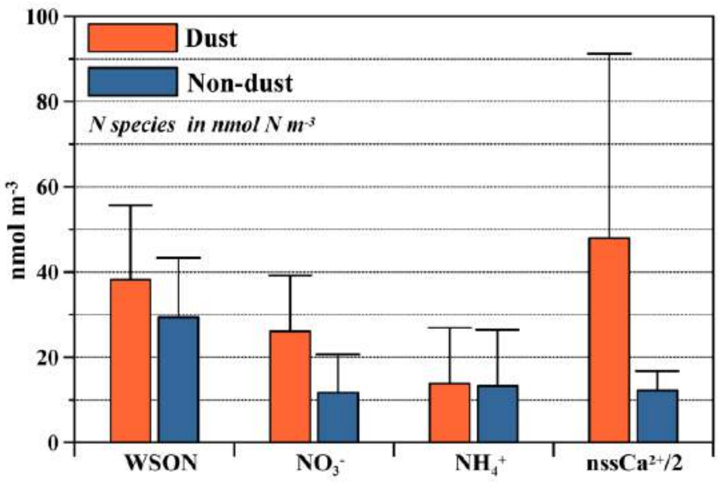

Figure 2: Arithmetic means together with corresponding standard deviations of WSON, NO_3^-, NH_4^+ and $nssCa^{2+}$ for dust and non-dust events at the Erdemli site. Orange and blue bars denote arithmetic means for dust and non-dust, respectively. The black vertical line shows standard deviation.

Lower coarse- mode contributions were observed when air flow originated from eastern Europe (49 %), western Europe (48 %) and the Mediterranean Sea (27 %). The highest NO_3^- concentrations were associated with airflow from north Africa and Turkey, with a value of 18 and 15 nmol N m^{-3}, respectively, and there was a statistically significant difference compared to the remaining air mass sectors ($p > 0.05$). The mean concentrations of NO_3^- for air masses derived from north Africa and Turkey were at least 1.3 times larger than those calculated for the Middle East, eastern Europe, western Europe and Mediterranean Sea air sectors ($p > 0.05$). NH_4^+ had the highest concentration under the influence of airflow derived from Turkey. For this airflow, detected concentration was 1.5–2.4 times greater than that calculated for other air mass sectors. In this study, water-soluble organic nitrogen in aerosol and rain samples obtained over the eastern Mediterranean has been investigated. From this investigation the following summary may be made.

1. Of the nitrogen species, aerosol WSON (23.8 ± 16.3 nmol N m $^{-3}$) exhibited the highest arithmetic mean, followed by ammonium (23.3 ± 14.4 nmol N m −3) and then nitrate (17.9 ± 15.7 nmol N m^{-3}). Aerosol WSON was mainly associated with coarse particles (66 %). The WSTN was equally influenced by WSON and NH+4, each contributing 37 and 35 %, respectively, whereas the contribution to WSTN of NO_3^- was 28 %. In rainwater, the VWM concentrations of water-soluble nitrogen species were comparable. WSON and NO −3 accounted for 29 and 32 % of the WSTN, whilst NH_4^+ elucidated 39 % of the WSTN.

2. Aerosol WSON concentrations exhibited large variation from one day to another day. Generally, lower concentrations were observed during rainy days. Higher concentrations of aerosol WSON were associated with different airflow. The three highest concentrations were related to (i) mineral dust transport from Sahara and Middle Eastern deserts, (ii) north/north-westerly airflow from Turkey's largest cultivated plain, Konya, and (iii) mid-range pollution transport from the Turkish coast.

3. Influence of mineral dust transport on aerosol WSON concentrations was assessed. The crustally derived nssCa^{2+} and anthropogenic NO – 3 for dust events had arithmetic means of 95.8 nmol m $^{-3}$ and 26.1 nmol N m $^{-3}$, which were almost 4 and 2 times higher than those of observed for non-dust events. The arithmetic mean of WSON (38.2 nmol m^{-3}) for dust events was 1.3 times higher compared to that observed for non-dust events (29.4 nmol m^{-3}).

4. Source apportionment suggested that aerosol WSON was mainly originated from anthropogenic sources, including agricultural (43 %), secondary aerosols (20 %) and nitrate (22 %); whereas the two natural sources, crustal material (10 %) and sea salts (5 %), contributed 15 % to the WSON.

5. The total atmospheric deposition of water-soluble nitrogen (57.8 mmol N m $^{-2}$ yr $^{-1}$) was mainly via wet deposition (36.7 mmol N m $^{-2}$ yr^{-1}). In contrast, the atmospheric fluxes of WSON and NO−3were equally influenced by the dry and wet deposition modes. On average, WSON accounted for 36 % of the total atmospheric deposition of WSTN. From the beginning of the 2000s to 2015, the atmospheric deposition of the dissolved inorganic nitrogen declined about 45 %; as a consequence, there is a need to understand how the DIN flux changed.

- **Scientific Highlight 2: 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 KIYAK 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 2018 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, etc.)

Submitted Project: 'Assessment of spatial and temporal changes in the Marmara Sea marine primary productivity by using satellite data and sediment bio-geochemistry' submitted to The Scientific and Technological Research Council of Turkey (TUBITAK), Coordinator: N. **OLGUN KIYAK**

Related to SOLAS **Theme 3**: Atmospheric deposition and ocean biogeochemistry

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

Nehir, M and Koçak, M., 2018, Atmospheric water-soluble organic nitrogen (WSON) in the eastern Mediterranean: origin and ramifications regarding marine productivity, Atmospheric Chemistry and Physics, 18, 3603-3618. (SOLAS Theme 3).

Yücel N., 2018, Spatio-temporal variability of the size-fractionated primary production and chlorophyll in the Levantine Basin, northeastern Mediterranean), Oceanologia, 60, 288-304. (SOLAS Theme 3)

Lambert, E., Nummelin, A. Pemberton P., **Ilıcak M**, 2018, Tracing the river imprint of river runoff variability on Arctic water mass transformation, Journal of Geophysical Research: Oceans, 124, 302-319. (SOLAS Theme 2).

Froese R., Winker H., Coro H., **Demirel N**, Athanassios C.T, Dimarchopolou D., Scarcella G., QuassM., Matz-Lück N., 2018, Status and rebuilding of European Fisheries, Marine Policy, 93, 159-170. (SOLAS Theme 4)

Dursun F., Ünlü S. and Yurdun T., Determination of Domoic Acid in Plankton Net samples from Golden Horn Estuary, Turkey, Using HPLC with Flouresence Detection, 2018, Bulletin of Environmental Contamination and Toxicology, 100, 457-462. (SOLAS Theme 3).

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

Turkish SOLAS Representative Nazlı OLGUN KIYAK, is going to attend the SOLAS Open Science Conference on in Sapporo Japan 21-25 April 2019. Travel and hotel costs are covered by SCOR.

PART 2 - Planned activities from 2019/2020 and 2021

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

Surface seawater sampling is planned for the Marmara Sea for chlorophyll-a measurements. Sampling interval is planned to be twice a year, in collaboration with MAREM (Marmara Environmental Monitoring Project). Chlorophyll-a measurements will be conducted with the context of the submitted project 'The Assessment of spatial and temporal changes in the Marmara Sea marine primary productivity by using satellite data and sediment bio-geochemistry'.

2. Events like conferences, workshops, meetings, schools, capacity building etc. (incl. all information possible)
A 1-day workshop was planned in the Istanbul Technical University for the project Assessment of spatial and temporal changes in the Marmara Sea marine primary productivity by using satellite data and sediment bio-geochemistry' submitted to The Scientific and Technological Research Council of Turkey (TUBITAK).

3. Funded national and international projects / activities underway (if possible please list in order of importance and indicate to which part(s) of the SOLAS 2015-2025 Science Plan and Organisation (downloadable from the SOLAS website) the activity topics relate – including the core themes and the cross cutting ones)
Investigation of marine microbial reactions by using novel approaches including genetics, biogeochemistry and modelling, Project Coordinator: **B. Salihoğlu**, Middle East Technical University Institute of Marine Sciences, Project duration:2016-2018. Development of Integrated Modelling System for the Marmara Sea, **B. Salihoğlu,** International Project**.**

4. Plans / ideas for future projects, programmes, proposals national or international etc. (please precise to which funding agencies and a timing for submission is any)
Submitted Project to The Scientific and Technological Research Council of Turkey (TUBITAK 3501). 'Assessment of spatial and temporal changes in the Marmara Sea marine primary productivity by using satellite data and sediment bio-geochemistry', Coordinator**: N. OLGUN KIYAK** Related to SOLAS **Theme 3**: Atmospheric deposition and ocean biogeochemistry

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

Comments

Report for the year 2018 and future activities

SOLAS *USA*
compiled by: Rachel Stanley

This report has two parts:

- Part 1: *reporting of activities in the period of January 2018 – Jan-Feb 2019*
- Part 2: *reporting on planned activities for 2019/2020 and 2021.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies;
Environmental impacts of geoengineering;
Science and society**.**

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

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

1. Scientific highlight

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).

Storms influence high-latitude oceans by stirring the upper ocean nearly continuously. This wind mixing is usually expected to homogenize properties within the upper layer of the ocean, known as the mixed layer. New water column observations from floats and elephant seal tag confirm homogenization of hydrographic properties that determine density of seawater (e.g., temperature and salinity); however, biogeochemical properties are not necessarily homogenized (Carranza et al., 2018). Most of the time optical measurements of biological properties within the *mixed layer* show vertical structure, which is indicative of phytoplankton biomass. These vertical inhomogenities are ubiquitous throughout the Southern Ocean and may occur in all seasons, often close to the base of the mixed layer. Within the mixed layer, observations suggest that biological processes create inhomogenities faster than mixing can homogenize. Carranza and co-authors hypothesize that 3- to 5-day periods of quiescence between storm events are long enough to allow *bio-optical* structure to develop without perturbing the mixed layers' uniform density. This may imply that phytoplankton in the Southern Ocean are better adapted to the harsh environmental conditions than commonly thought.

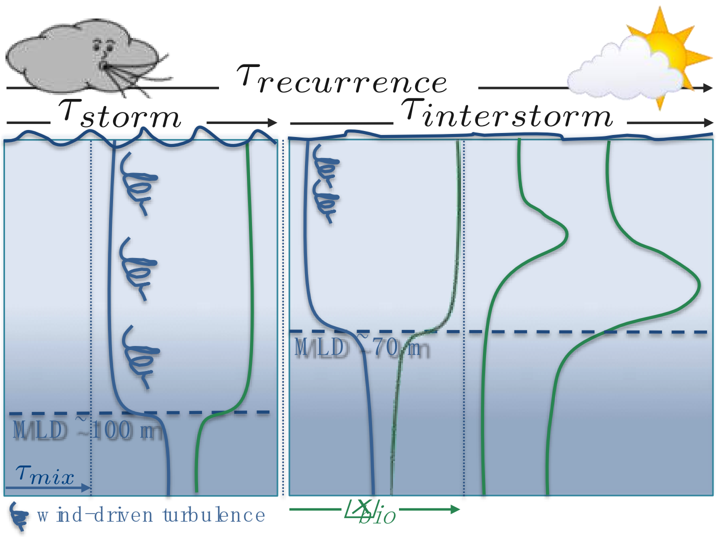

Figure: Schematic illustrating the relationship between storm-mixing and biological timescales, with density profiles depicted in blue and Chl-a fluorescence in green. Interstorm periods are on average longer than storm durations, particularly in summer, allowing for bio-optical gradients to form within mixed layers. Storms are defined to have winds > 10m/s. Mixed-layer depth (MLD) estimates for storm and interstorm periods are means from wind-profile matchups and based on the 0.03 kg/m density threshold criterion.

Reference:

Carranza, M. M., S. T. Gille, P. J. S. Franks, K. S. Johnson, R. Pinkel, and J. B. Girton (2018), When Mixed Layers Are Not Mixed. Storm-Driven Mixing and Bio-optical Vertical Gradients in Mixed Layers of the Southern Ocean, *Journal of Geophysical Research Oceans*, *123*(10), 7264–7289, doi:10.1364/OE.17.005698.

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

EXPORTS: The first EXPORTS (Export Processes in the Ocean from RemoTe Sensing) field campaign took place in August and September, 2018. EXPORTS is a NASA funded project that is seeking to develop a predictive understanding of the export of global ocean net primary productivity.https://oceanexports.org/about.html

New committee: The Ocean-Atmosphere Interaction (OAIC) Committee was formed in 2018 as a topical subcommittee of the OCB Scientific Steering Committee (SSC) to strengthen communication and collaboration between ocean and atmospheric scientists within the U.S. The committee primarily seeks to provide a support system for scientists working at the air-sea interface, especially to overcome the disciplinary segregation that can result from separate atmospheric or oceanic science community platform. The chair of the committee is Rachel Stanley (rachel.stanley@wellesley.edu) and members are Yuan Goa, Cassanra Gason, David Ho, David Kieber, Kate Mackey, Nicholas Meskhidze, Bill Miller, Henry Potter, Penny Vlahos, and Thomas Bell. https://www.us-ocb.org/about/ocb-subcommittees/subcommittee-on-ocean-atmosphere-interactions/

Iron Speciation Workshop: A workshop on Identifying and Characterizing the Processes Controlling Iron Speciation and Residence Time at the Atmosphere-Ocean Interface, organized by Ncholas Meskhidze and Christoph Volker took place in early August, 2018 in order to discuss the physicochemical speciation of Fe at the atmosphere-ocean interface and its cycling between the two oxidation states in soluble, colloidal, dissolved, amorphous, and crystalline forms, in the presence/absence of atmospheric/oceanic organic compounds and sunlight. A perspective paper in Marine Chemistry will be forthcoming.

Methane and Nitrous Oxide Workshop: A workshop on Oceanic Methane and Nitrous Oxide, sponsored by the Ocean Carbon and Biogeochemistry program, took place in October, 2018. T he workshop was designed to sit at the interface between laboratory analysis of trace gases, comprehension of the relevant microbial processes, and observational and predictive capacity to resolve spatial-temporal variability associated with methane and nitrous oxide in the oceans. A report will be forthcoming. https://web.whoi.edu/methane-workshop/

Aquatic Primary Productivity Workshop: A NASA/IOCCG workshop on building consensus on protocols for contemporary aquatic primary productivity field measurements took place in December, 2018. The workshop brought together 26 researchers from 16 institutions to discuss the key differences, nuances, scaled, uncertainties, definitions and best practices for measurements of primary productivity from many different techniques. The specific deliverable resulting from of this activity will be a living, community-vetted (open public comment period) protocol document, published in coordination with ongoing IOCCG protocol series.

Role of bubbles: Steven Emerson and co-authors have analysed in situ N_2 gas measurements from 10 years in the subarctic Pacific to calculate bubble fluxes and used them to evaluate existing bubble flux models. A paper will be forthcoming in Journal of Geophysical Research Oceans.

Dust Effects: Kate Mackey and co-authors are investigating the effects of playa dust on phytoplankton in the Salton Sea. As the Sea continues to evaporate, more playa sediment that is contaminated with metals and pesticides is exposed to the atmosphere and is transported with winds. Mackey is investigating whether the dust is harmful to planktonic communities in the Sea.

Gas exchange in the Baltic Sea: David Ho and colleagues, including SOLAS scientists from Germany, conducted the Baltic Sea Gas Exchange Experiment (Baltic GasEX) in 2018 whose main goals are to determine the influence of surfactants on gas exchange and also to see whether the influence of wind on gas exchange is different in an inland sea.

Air-sea chemical exchange in Antarctic: Yuan Gao and co-workers have been conducting research on the air-sea chemical exchange in high-latitude ocean, particularly on atmospheric iron deposition over the West Antarctic Peninsula. The Gao group finished field sampling at Palmer Station in Spring 2017. In 2018, they performed the analyses of aerosol samples collected in coastal Antarctic peninsula by ICPMS for total Fe, by UV/Vis spectrophotometry for Fe solubility, and by synchrotron X-ray spectroscopy for Fe oxidation state and aerosol composition.

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

Harding, K., K. A. Turk-Kubo, R. E. Sipler, M. M. Mills, D. A. Bronk, and J P Zehr (2018), Symbiotic unicellular cyanobacteria fix nitrogen in the Arctic Ocean, *Proceedings of the National Academy of Sciences of the United States of America,* 115(52), 13371-13375.

Ho, D. T., E. H. De Carlo, P. Schlosser. (2018) “Air sea gas exchange and CO2 fluxes in a tropical coral lagoon”. *Journal of Geophysical Research: Oceans.* 123. 8701-8713. https://doi.org/10.1029/2018JC014423

Howard, E. M., I. Forbrich, A. E. Giblin, D. E. Lott III, K. L. Cahill. R. H. R. Stanley, (2018) Using Noble Gases to Compare Parameterizations of Air-Water Gas Exchange and to Constrain Oxygen Losses by Ebullition in a Shallow Aquatic Environment. *Journal of Geophysical Research: Biogeosciences.* 123,2711–2726. doi: 10.1029/2018JG004441

Sedwick, P.N., P. W. Bernhardt, M. R. Mulholland, R. G. Najjar, L. M. Blumen, B. M. Sohst, C. Sookhdeo, and 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* 45, no. 7: 3203-3211.

W. Tang, S. Wang, D. Fonseca-Batista, F. Dehairs, S. Gifford, A. G. Gonzalez, M. Gallinari, H. Planquette, G. Sarthou, N. Cassar. (2018). Revisiting the distribution of oceanic N_2 fixation and estimating diazotrophic contribution to marine production**.** *Nature Communications*, 2019; 10 (1) DOI: 10.1038/s41467-019-08640-0

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

PART 2 - Planned activities for 2019/2020 and 2021

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

EXPORTS: The NASA EXPORTS program will continue its modelling efforts and will conducting sample and data analysis from data collected on its first cruise 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) in 2019 and 2020, and in the Atlantic Ocean (A13.5) in 2020.

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).

Ocean Carbon Biogeochemistry Workshop: June 24-27, 2018, Woods Hole, Massachusetts. Annual workshop that highlights research and includes substantial time for community discussion of new directions. Themes for this year's workshop include anthropogenic changes in ocean oxygen, approaches and challenges to understanding biogeochemical cycling across the land-ocean aquatic continuum, calcification and the carbon cycle, carbon cycle feedbacks from the seafloor, and the effect of size on ocean processes and implications for export.

Ocean Circulation Inverse Model (OCIM) workshop: June 23, 2019. Woods Hole, MA This 1 day workshop is for those interested in using OCIM in their research. The OCIM is a data-constrained, lightweight, MATLAB-based ocean circulation model for global modeling of biogeochemical tracers.

Cornell Satellite Remote Sensing Training Program: June 3-June 14, 2019. The goal of the course is to teach participants the basic skills needed to work independently to acquire, analyze and visualize data sets derived from a variety of satellite sensors (e.g., SeaWiFS, MODIS, MERIS, VIIRS, OLI on Landsat-8, OLCI on Sentinal-3, AVHRR, SeaWinds, SSM/I and AVISO Merged Altimetry).

Ocean-Atmosphere Interactions: Scoping directions for U.S. research - October 1-3, 2019: Sterling, VA. This workshop will gather U.S. scientists working at the air-sea interface to identify research priorities and facilitate the communication and collaboration required for future significant research advances. Leadership for this workshop will be provided by the Ocean Atmosphere Interaction Committee (OAIC). The workshop will serve as a critical next step in strengthening the U.S. air-sea interaction research community and encouraging synergistic activities across disciplines and nations. This 3-day scoping workshop will be open to interested members of the community, but attendance will be limited to ~60-65 scientists who are prepared to contribute to in-depth discussions about research priorities and engagement with international SOLAS. Participants will present and share cutting edge research and participate in discussions to identify key knowledge gaps and prioritize research needed to advance the field. From the discussions at the workshop, the OAIC will assemble a "grassroots" document to help coalesce the U.S. air-sea interaction research community around a common set of science goals and research priorities. The workshop and its outcomes are expected to strengthen ties between the ocean and atmosphere research communities and foster a more cohesive U.S. contribution to international SOLAS.

Gordon Research Conference on Coastal Ocean Dynamics: Advances in Coastal and Estuarine Physics from Nearshore to Continental-Margin Scales. June 16-21, Manchester NH

Gordon Research Conference on Atmospheric Chemistry: New Science in Quality and Climate from Charney to AR6. July 28-Aug 2, 2019. Newry, ME.

Gordon Research Conference on Chemical Oceanography: Discovering Chemical Processes and Mechanisms in a Changing Ocean. July 14-19 Holderness, NH

Fall American Geophysical Union (AGU) Meeting: Dec. 9-13, 2018. San Francisco, A,

American Meteorological Society Annual Meeting: Jan 12-16, Boston MA

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