National SOLAS networks 2016 annual reports and future activities

Version of 10 July 2017 by Dr Emilie Brévière

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Report for the year 2016 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 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

The SOLAS-endorsed Reef to Rainforest campaign: The Great Barrier Reef as a significant source of climatically relevant aerosol particles

Reef To Rainforest

In September – October 2016 an international campaign was undertaken on board the RV Investigator to investigate the impact of the Great Barrier Reef as a source of climatically active particles. The campaign included scientists from 7 Australian institutions (QUT, CSIRO, BoM, University of Melbourne, Southern Cross University, University of Technology Sydney, University of Tasmania) 7 international institutions (Uni of Tsukuba, Japan; NIES, Japan; NIWA, New Zealand; Auckland University of Technology, New Zealand; Fudan University, China; NOAA; University of California, USA).

The main objective of the voyage was to acquire observations to address four key science questions:

1. Do marine aerosols along the north Queensland coast have a significant signature that is coral-derived?
2. How does this aerosol change its physicochemical properties, especially its capacity to act as CCN, as winds carry it from the reefs to the north Queensland rainforests?

3. What is the significance of this ecosystem as a source of aerosol particles and will potential degradation of the reef cause significant variations in particle number being generated over the reef?
4. Should changes in this aerosol, associated with reef degradation, be taken into account when modelling the radiative climate and rainfall?

Aerosol and atmospheric composition data was collected on board the RV Investigator at three dedicated atmospheric measurement stations, and during transient parts of the voyage. Special interest was paid to the transects through the reef that were repeated several times (see Figure 1 below and also available online at http://www.cmar.csiro.au/data/underway/?survey=in2016_v05). Detailed water composition data was also acquired including the DMSP lyase assay (DLA) to assess the relative contribution of phytoplankton and bacteria to DMS production, and DNA/RNA extractions and bacterial community analyses.

An opportunistic voyage objective was to testing UAVs to measure the emissions from the ship diesel engines and study their dispersion in the marine atmosphere.

In addition to the measurements on board the RV Investigator a measurement station (AIRBOX mobile air chemistry laboratory) was setup on the shore 20m from the waterline at Mission Beach.

The voyage attracted significant media attention with an Australian Broadcasting Corporation (ABC) crew filming on board for one week. This resulted in a number of live coverages from the RV Investigator as well as a number of articles both online and on ABC TV (see Section 4 below)

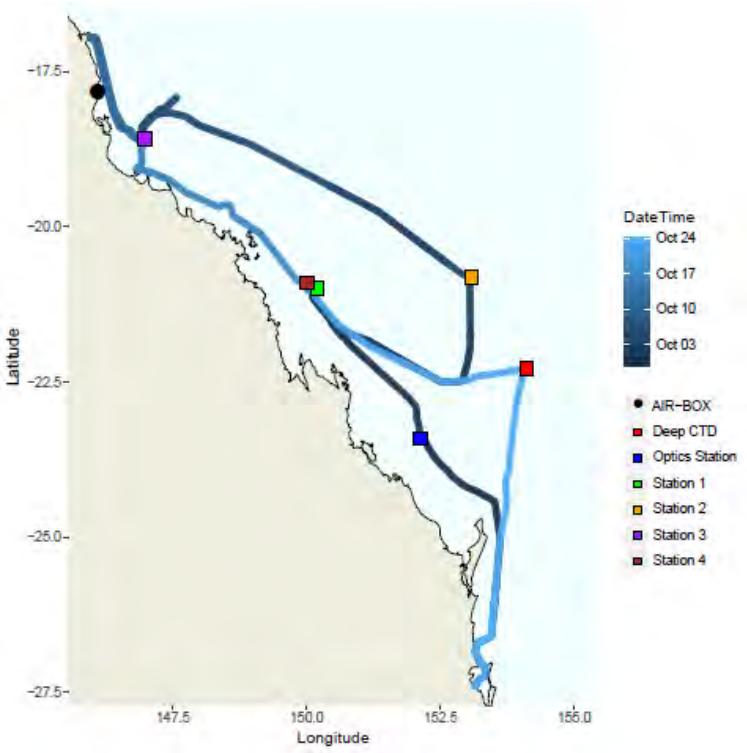

Figure 1 – voyage path from the Rainforest to Reef campaign

2. Activities/main accomplishments in 2016 (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.)

Four major atmospheric measurement campaigns were undertaken on the RV Investigator during this period including

1. IN2016_V02 - CAPRICORN (Cloud aerosol precipitation, radiation and atmospheric composition over the southern ocean). Southern Ocean location.
2. IN2016_V03 - aerosol, cloud and atmospheric composition measurements on transect between ice edge to equator
3. IN2016_V05 - Great Barrier Reef study of aerosols and precursors (see science feature above)
4. IN2017_V01 - PCAN (Polar Cell Aerosol Nucleation) - study of aerosols and clouds off the East Antarctic coastline.

In addition, aerosol and precipitation sampling for trace metals and major ions was conducted on voyages IN2016_T02, IN2016_V04 and IN2016_V05, in waters off the eastern coasts of Australia from Hobart to the Great Barrier Reef.

Long term aerosol-cloud measurements are being made at Macquarie Island for two years – one year of data has been collected to date.

An on-going aerosol trace metal and major ion sampling program at land-based locations around Australia has been extended to new stations on Lord Howe Island and at Mt Wellington (southern Tasmania), and a short campaign was conducted at Mission Beach (Queensland) to coincide with ship-based observations in voyage IN2016_V05.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Gras, JL. and Keywood, M (2016): Cloud condensation Nuclei over the Southern Ocean: wind dependence and seasonal cycles, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-998, accepted for publication.

Swan, H.B., Crough, R.W., Vaattovaara, P. et al. J Atmos Chem (2016) 73: 303. doi:10.1007/s10874-016-9327-7

Swan, H. B., Jones, G. B., Deschaseaux, E. S. M., and Eyre, B. D (2017): Coral reef origins of atmospheric dimethylsulfide at Heron Island, southern Great Barrier Reef, Australia, Biogeosciences, 14, 229-239, doi:10.5194/bg-14-229-2017.

Winton, V., Dunbar, G., Atkins, C., Bertler, N., Delmonte, B., Andersson, P., Bowie A.R., Edwards, R. (2016). The origin of lithogenic sediment in the south-western Ross Sea and implications for iron fertilization. Antarctic Science, 28(4), 250-260. doi:10.1017/S095410201600002X

Winton, V. H. L., Edwards, R., Bowie, A. R., Keywood, M., Williams, A. G., Chambers, S. D., Selleck, P. W., Desservettaz, M., Mallet, M. D., and Paton-Walsh, C.: Dry season aerosol iron solubility in tropical northern Australia, Atmos. Chem. Phys., 16, 12829-12848, doi:10.5194/acp-16-12829-2016, 2016.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

Media coverage of Great Barrier Reef voyage:

How the corals of the Great Barrier Reef affect Queensland's climate, The Science Show
http://www.abc.net.au/radionational/programs/scienceshow/how-the-corals-of-the-great-barrier-reef-affect-queensland%E2%80%99s-cl/8086844

Qld research raises fears a dying reef could impact weather patterns (PM Radio)
http://www.abc.net.au/pm/content/2016/s4555969.htm

Does coral create rain? ABC News
http://www.abc.net.au/news/2016-10-14/how-the-great-barrier-reef-coral-impacts-rainfall/7928714

Australia's Young Climate Scientists. ABC News
http://www.abc.net.au/news/2016-11-07/the-young-climate-scientists-aboard-the-rv-investigator/7997864

Media coverage of PCAN voyage:

https://www.theguardian.com/world/2017/feb/22/antarctic-study-examines-impact-of-aerosols-on-climate-change

https://sites.google.com/site/sabrinaseafloorsurvey/school-pages/atmospheric-aerosols

http://www.uowblogs.com/2017antarcticatmosphere/

PART 2 - Planned activities from 2017/2018 and 2019

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

RV Investigator Voyages IN2017_T01 and IN2017_V05 September – November 2017. Natural iron fertilisation of oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry. Two voyages around the north and west coasts of Australia from Sydney to Broome and Broome to Fremantle.

RV Investigator voyage IN2018_V01 January – February 2018. Two combined projects: (i) Detecting Southern Ocean change from repeat hydrography, deep Argo and trace element biogeochemistry, and (ii) CAPRICORN-II: Clouds, Aerosols, Precipitation, Radiation, and atmospherIc Composition Over the southeRn oceaN

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

Atmospheric Composition Observations and Modelling Conference & Cape Grim Annual Science Meeting and 8th Australia and New Zealand Aerosol Workshop, Murramarang Beachfront Nature Reserve, Australia, 28 - 30 November 2017

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)

Data workshops are planned for 2017 on Heron Island to examine data from the Great Barrier Reef as a Source of Climatically Active particles campaign (science feature).

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)

Proposal for the Australian Antarctic Science Program (AASP) called “CAMMPCAN – Chemical and Mesoscale Mechanisms of Polar Cell Aerosol Nucleation” is currently being considered for a grant and logistical support for the 2016/17 round. If successful campaign will be undertaken in Southern Ocean.

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

The IGAC Scientific Steering Committee will be held in Murramarang Australia in 2017 in conjunction with the Atmospheric Composition Observations and Modelling Conference & Cape Grim Annual Science Meeting

Comments

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Report for the year 2016 and future activities

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

This report has two parts:

- Part 1: *reporting of activities in the period of January 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

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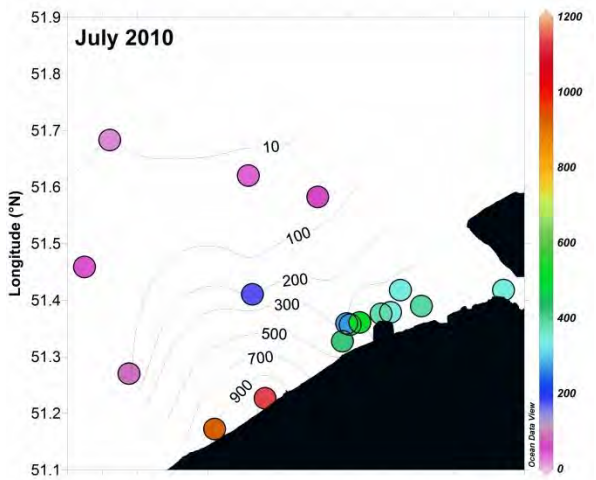
PART 1 - Activities from January 2016 to Jan/Feb 2017

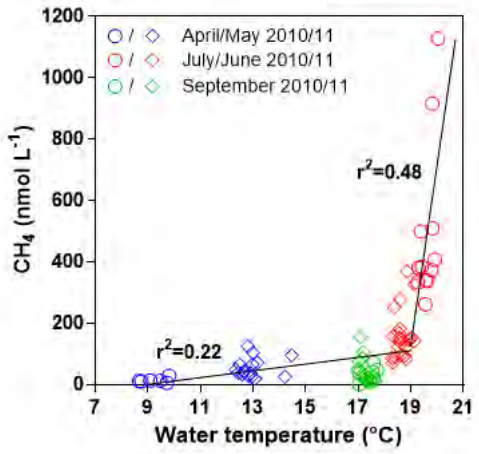
1. Scientific highlight

Massive marine methane emissions from near-shore shallow coastal areas

A)

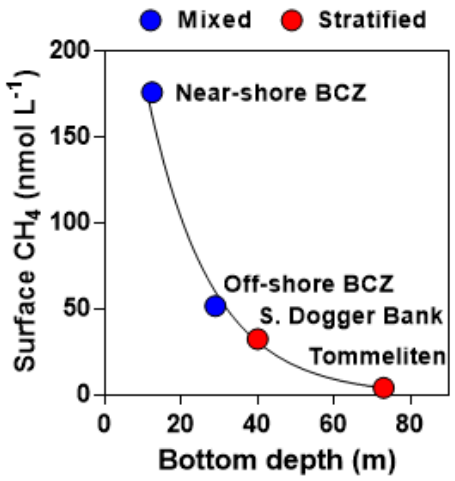


B)



A) Hot-spot of dissolved CH_4 concentration in the near-shore North Sea (up to ~300 times higher than in the open ocean) in summer 2010. **B)** Increasing temperature enhances dissolved CH_4 levels in the near-shore North Sea, due to enhanced microbial activity in the sediments, and also decrease in solubility (enhanced bubbling). **C)** Depth controls stratification and dissolved CH_4 levels across the North Sea. The water column is vertically homogeneous (mixed) in the shallow Belgian coastal zone (BCZ) and seasonally thermally stratified in the other two deepr North Sea sites (south of the Dogger Bank and Tommeliten).

C)



Citation: Borges AV, W Champenois, N Gypens, B Delille, J Harlay (2016) Massive marine methane emissions from near-shore shallow coastal areas, Scientific Reports, 6:27908, doi:10.1038/srep27908

2. Activities/main accomplishments in 2016 (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.)

Field campaigns:

- Experiment at the Roland von Glasow air-sea-ice chamber of the University of East Anglia in Norwich. Collaboration with James France and Max Thomas (CO2, N2O dynamics) and E. Damm (Alfred Wegner Institute). Belgian Partners: Bruno Delille (Université de Liège) and Jean-Louis Tison (Université Libre de Bruxelles)
- Optimist 2016 sea ice survey in Storefjord in April 2017. This survey was carried out in in the frame of the project OPTIMIST-bio (Observing Processes impacting The sea Ice Mass balance from In Situ Measurements: from physics to its impacts on biology) funded by the

CNRS (France) and led by F. Viviers. We will measured greenhouse gases (CO2, CH4, N2O) concentration and air-ice fluxes. We will also collect sea ice for measurement of related physical and biogeochemical parameters. Belgian Partner Bruno Delille (Université de Liège)

- Storfjorden Polynya Multidisciplinary Study (STeP) in the Storfjorden in July 2016 onboard the RV Atalante. STeP is a project organized in the frame of the French Arctic Initiative and led by Elisabeth Michel. The aim of the project was to increase the current knowledge on the formation of brine-enriched shelf water (BSW) and its impact on ocean circulation and greenhouse gas (GHG) cycles through the solubility and biological ocean pumps. To this end, the project investigate processes governing the inter-annual variability of the physical and chemical properties of the newly formed BSW within a polynya, through a multidisciplinary approach, combining 2 years of observations and high-resolution regional modeling. Belgian Partners Bruno Delille (Université de Liège) and Jean-Louis Tison (Université Libre de Bruxelles)
- A biogeochemical cruise was conducted in May 2016 on board the RV Mare Nigrum in the Black Sea on the Ukrainian shelf. The campaign was performed in the framework of the BENTHOX project funded by the Fund for Scientific Research - FNRS (Belgium) and in collaboration with the EMBLAS-II project funded by UNDP and EU. The objective is 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 Rhizon technique under N2 atmosphere for laboratory dissolved nutrients and major ions. Although the bottom waters were not hypoxic, the sediments have an oxygen layer only in the upper 2 cm.

Laboratory Experiments

Laboratory incubation experiments using *Trichodesmium* were conducted in 2016 to study the influence of pCO_2 and temperature on the biological nitrogen fixation of this filamentous cyanobacterium. Phosphate and dust addition bioassays in nitrate depleted media were carried out to investigate the effect of this nutrient and dissolved Fe on N_2 fixation. Special attention was given to studying the effects of mineral dust deposition which is believed to promote N_2 fixation through increasing availability of both Fe and P.

Networking

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

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

Ongoing Projects:

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

- Iodide and halocarbons Dynamics in sea IcE (IODInE, CDR J.0262.17, 2017-2018, 41 kEur) Research Project funded by the F.R.S.-FNRS, partners: Bruno Delille (Université de Liège)

Conferences

Li X., D. Fonseca-Batista, J. Brouwers, N. Roevros, F. Dehairs and L. Chou (2016) The marine diatom and diazotroph under future climate: Role of Iron. EGU General Assembly 2016, 17-22 April 2016, Vienna, Austria. Poster presentation.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Borges AV, W Champenois, N Gypens, B Delille, J Harlay (2016) Massive marine methane emissions from near-shore shallow coastal areas, Scientific Reports, 6:27908, doi:10.1038/srep27908

Carnat G., Brabant F., Dumont I., Vancoppenolle M., Ackley S.F., Fritsen C., Delille B., Tison J.-L., 2016. Influence of short-term synoptic events and snow depth on DMS, DMSP, and DMSO dynamics in Antarctic spring sea ice, *Elementa*, 4:000135, doi: 10.12952/journal.elementa.000135

Kotovitch M., Moreau S., Zhou J., Vancoppenolle M., Dieckmann G.S., Evers K.-U., Van der Linden F., Thomas D.N., Tison J.-L., Delille B. , 2016. Air-ice carbon pathways inferred from a sea ice tank experiment, Elementa: Science of the Anthropocene, 4:000112, doi:10.12952/journal.elementa.000112

Tseng H-C, C-T A Chen, AV Borges, C-M Lai, TA DelValls & T-Y Chen (2016) Distributions and Sea-to-air Fluxes of Nitrous Oxide in the South China Sea and the West Philippines Sea, Deep-Sea Research I, 115, 131-144

Zhou, J., M. Kotovitch, H. Kaartokallio, S. Moreau, J. Tison, G. Kattner , G. Dieckmann, D.N. Thomas, B. Delille, 2016. The impact of dissolved organic carbon and bacterial respiration on pCO2 in experimental sea ice, *Progress in Oceanography*, 141, 156-167, doi:10.1016/j.pocean.2015.12.005

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

PART 2 - Planned activities from 2017/2018 and 2019

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

Field campaign and projects

- Jean-Louis Tison (Univesité Libre de Bruxelles) and Bruno Delille (Université de Liège) are involved in the project Polynyas, Ice production and seasonal evolution in the Ross Sea (PIPERS) funded by the NSF and led by S. Ackley. The principle objective of PIPERS is to quantify the full 3-D Suite of Atmosphere-Ocean-Ice (AOI) interactions within the Ross sea polynya. This includes transfer of heat, momentum, and CO_2 together with sea ice formation rate. This project has a strong multiple plateforms approach (including AUV, UAV, buoys, mooring and cruise on the NB Palmer. 6 Belgian researchers (B. Delille, J.-L. Tison, F. Van der Linden, G. Carnat, C. Sapart, J. De Jong) will take part of the NB Palmer where will deal with sea ice biogeochemistry. This cruise is schedule in April-June 2017

- Bruno Delille (Université de Liège), Frank Dehairs (Vrije Universiteit Brussel), Jean-Louis Tison (Université Libre de Bruxelles) are also involved in survey of N2O and nitrogen cycling in the Pridz Bay in Collaboration with the Third Institute of Oceanography of People's Republic of China
- A second cruise in the framework of the BENTHOX project, in collaboration with the EMBLAS-II project, is planned in August 2017 also on board the RV Mare Nigrum on the Ukrainian shelf to study the benthic hypoxia. Microprofiling of geochemical gradients of dissolved gases (O2, H2S, N2O) in the sediments will be taken on board the ship. Porewaters will be in addition extracted on board the ship using Rhizon technique under N2 atmosphere for laboratory dissolved nutrients and major ions.

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

Conferences:

Gypens N, A. V Borges, Ghyoot C (2017). How phosphorus limitation can control climatic gas sources and sinks. EGU General Assembly.

Plant A., N. Roevros, A. Capet, M. Grégoire, N. Fagel and L. Chou (2017) Benthic hypoxia and early diagenesis in the Black Sea shelf sediments. EGU General Assembly.

Plant A., N. Roevros, O. Roman Romin, A. Capet, M. Grégoire, N. Fagel and L. Chou (2017) Hypoxia evolution on the Ukrainian shelf of the Black Sea. Goldschmidt conference.

Li X., D. Fonseca-Batista, F. Dehairs and L. Chou (2017) Environment and nutrient control of nitrogen fixation. Goldschmidt conference.

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)

Ongoing Projects:

- ISOtopic Investigation of Greenhouse GAses in Polar regions: An Ocean Ice-Atmosphere Continuum (ISOGGAP) funded by the FRS-FNRS (2016-2019, 432 kEur). This project covers the theme 8 "High Sensitivity Systems- HS2" but will focus on arctic systems. ISOGGAP will address: 1) Gas exchange monitoring and process studies; 2) Regional dynamics of stressors and their effect in sea ice systems; 3) Improvement of the representation of biogeochemistry in regional models of sea ice 4) Identification of the elements of HS² that are key parameters to global change and incorporate them into Earth System Models. Partners: Jean-Louis Tison (Univesité Libre de Bruxelles) Bruno Delille (Université de Liège) relates to core theme 1
- 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) relates to core theme 1
- Iodide and halocarbons Dynamics in sea IcE (IODInE, CDR J.0262.17, 2017-2018, 41 kEur) Research Project funded by the F.R.S.-FNRS, partners: Bruno Delille (Université de Liège) relates to core theme 5

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)

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

Comments

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Report for the year 2016 and future activities

SOLAS *Brazil*
compiled by: L. Cotrim da Cunha (UERJ – National contact), R. Kerr (FURG), I. B. M. Orselli (FURG), R. Buss de Souza (INPE)

This report has two parts:

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PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

Carbonate system properties in the Gerlache Strait, Northern Antarctic Peninsula (February 2015): I. Sea–Air CO2 fluxes

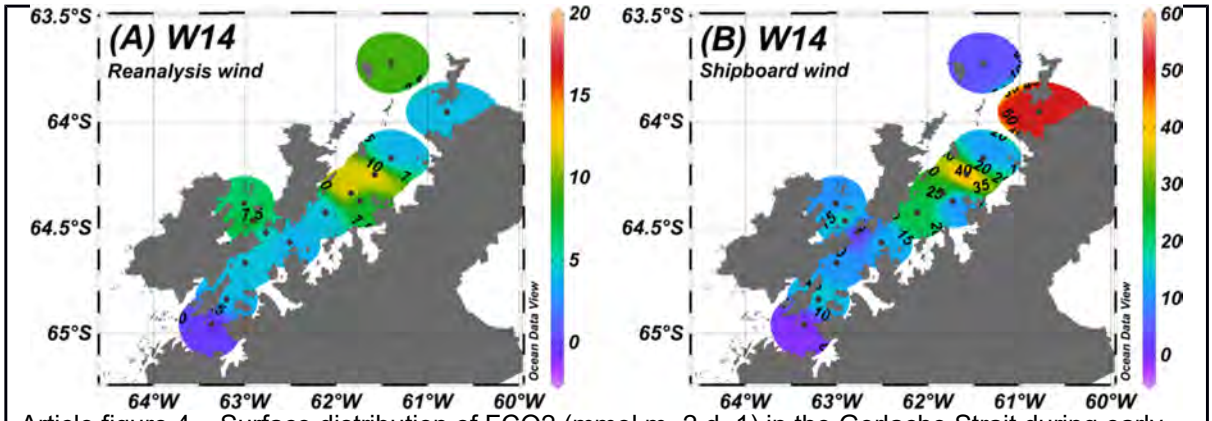
Rodrigo Kerr, Iole B.M. Orselli, Jannine M. Lencina-Avila, Renata T. Eidt, Carlos Rafael B. Mendes, Leticia C. da Cunha, Catherine Goyet, Mauricio M. Mata
http://dx.doi.org/10.1016/j.dsr2.2017.02.008 Deep-Sea Research II, in press

Highlights:

• We have measured the hydrographic, CO2-carbonate system, and phytoplankton properties in waters of the Gerlache Strait.

• CO2 flux was computed comparing eight distinct parameterizations for the gas transfer velocity coefficient depending upon wind speed.

• The Gerlache Strait was a CO2 net source for the atmosphere in early February 2015.



Article figure 4 – Surface distribution of FCO2 (mmol m−2 d−1) in the Gerlache Strait during early February 2015. FCO2 was estimated considering the W14 gas transfer velocity relationship (see Table 1) and following two wind approaches: ECMWF reanalysis wind (a) and shipboard measured instantaneous wind (b). Note that the plots have different colour scales.

2. Activities/main accomplishments in 2016 (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.)

Research projects (Approved projects in 2016 and ongoing projects)

1) The ongoing project "New autonomous technologies investigation and monitoring of AABW transformations in the Weddell Sea and Antarctic Peninsula: a contribution to the study of those implications in ocean circulation and climate" (Portuguese acronym **NAUTILUS**) aims to contribute to international initiatives observing the ocean circulation and water masses properties. In this context, samples for C_T, A_T and pH were collected in the last summer, and surface pCO_2 was also sampled in the 2016 cruise – Figure 1. Reconstruction of the carbonate system in the Bransfield Strait is being executed through a PhD thesis.

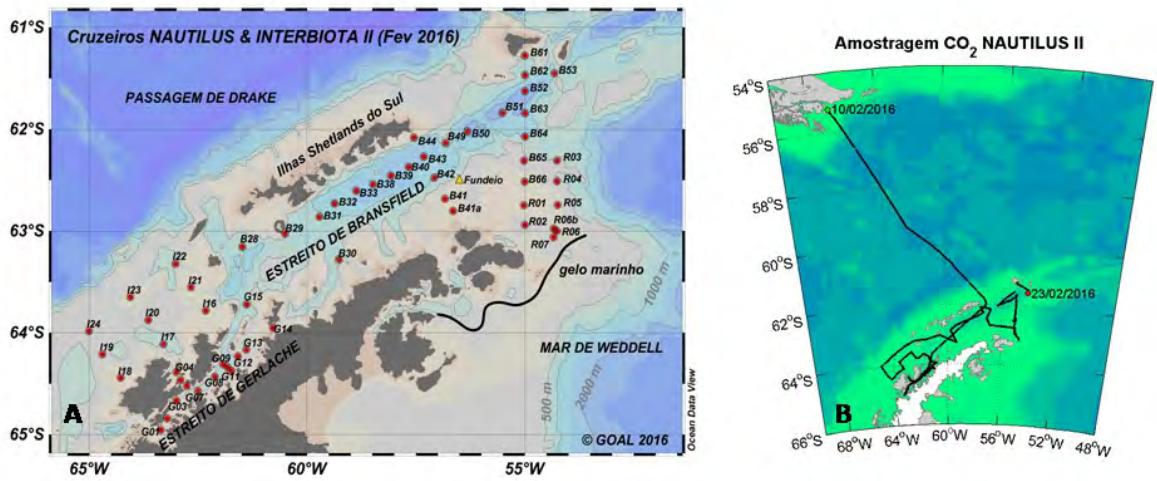


Figure 1. The working area of the NAUTILUS 2 cruise. **(A)** Sampled stations (red dots). **(B)** underway CO2 system track.

2) The ongoing project "Long term ecological research" (Portuguese acronym PELD) aims to understand natural phenomena influence and human impacts on biota and ecological processes in the Patos Lagoon Estuary. This project is being developed since 1998, and in 2015 monthly samples for C_T and A_T started to be collected – Figure 2 – and will be used to reconstruct the carbonate system in this ecosystem.

Figure 2. PELD oceanographic stations (yellow pins; Barra and museu) where C_T and A_T samples are monthly collected since 2015.

3) The **LTER/PELD Baía de Guanabara** – Rio de Janeiro, SE Brazil has been renewed in 2016. It aims at understanding the ecosystem structure at the heavily polluted Guanabara Bay, and its response to climate and anthropogenic stress. In its new phase, PELD-Guanabara now includes volatile organic carbon (VOC) measurements, as well as carbonate-system measurements (pH and alkalinity). Coordination: UFRJ, with participation of UERJ (Prof. Luana Pinho, Prof. Gleyci Moser, Prof. Leticia Cotrim da Cunha)

4) The **CAPES Ciências do Mar Baía de Guanabara** – Rio de Janeiro, SE Brazil has had its final campaign in 2016. It aims at understanding the exchange of water, particulate organic matter, nutrients, plankton and dissolved carbon between the Guanabara Bay and the inner shelf. It has included organic carbon, nutrients, and carbonate-system measurements (pH and alkalinity). Coordination: UERJ and UFRJ.

Research cruises:

1) NAUTILUS 2 - 2016 (Biogeochemistry, Acidification and Anthropogenic Carbon at the North Antarctic Peninsula)
R/V: NPo Almirante Maximiano (H41), Brazilian Navy
Period: 06 to 28 February 2016 (Figure 1)
Chief Scientist: Rodrigo Kerr, with a team of 16 FURG and UERJ researchers.
Measurements/samplings: u-ADCP, vertical CTD+Rosette profiles at 66 stations; underway pCO2 measurements along cruise track with the General Oceanics "ferry box" system, dissolved oxygen, pH, A_T, C_T, DOC, POC/PN, nutrients, pigments, cetacean survey (sight).
Goals:
i) Antarctic Bottom Water variability and implications for oceans and climate.
ii) Improve current knowledge on physical and biogeochemical processes controlling the carbon fluxes in the region;
iii) Quantify and characterize the distribution of anthropogenic carbon (Cant) in the region;
iv) Monitor CO2 system parameters in the region in order to understand ocean acidification effects;
v) Capacity building for marine carbon fluxes, and ocean acidification in Brazil.

2) SACROSS - M133 (Physical and chemical sampling of oceanographic and meteorological underway data at the South Atlantic Ocean in the framework of AtlantOS WP5)
R/V: Meteor, Germany
Period: December 15th 2016 to January 13th 2017 (Figure 3)
Chief Scientist: Martin Visbeck, with a team of 26 researchers and students including 1 FURG researcher.
Measurements/samplings: u-ADCP, underway-CTD, RapidCast CTD, vertical CTD+Rosette stations, XBT, underway pCO2 measurements along cruise track with the General Oceanics "ferry box" system, dissolved oxygen and salinity samples.

Goals:
i) The South Atlantic crossing will focus on a multidisciplinary ocean survey of the South Atlantic gyre roughly along 34.5°S a region also covered by the SAMOC moored array and also the path of the X18 XBT line;
ii) a practical sea going training opportunity covering mainly the field of physical oceanography with limited additional experiences in marine meteorology, surface layer biogeochemistry and plankton ecology to Masters and PhD students from countries bordering the South Atlantic Ocean.

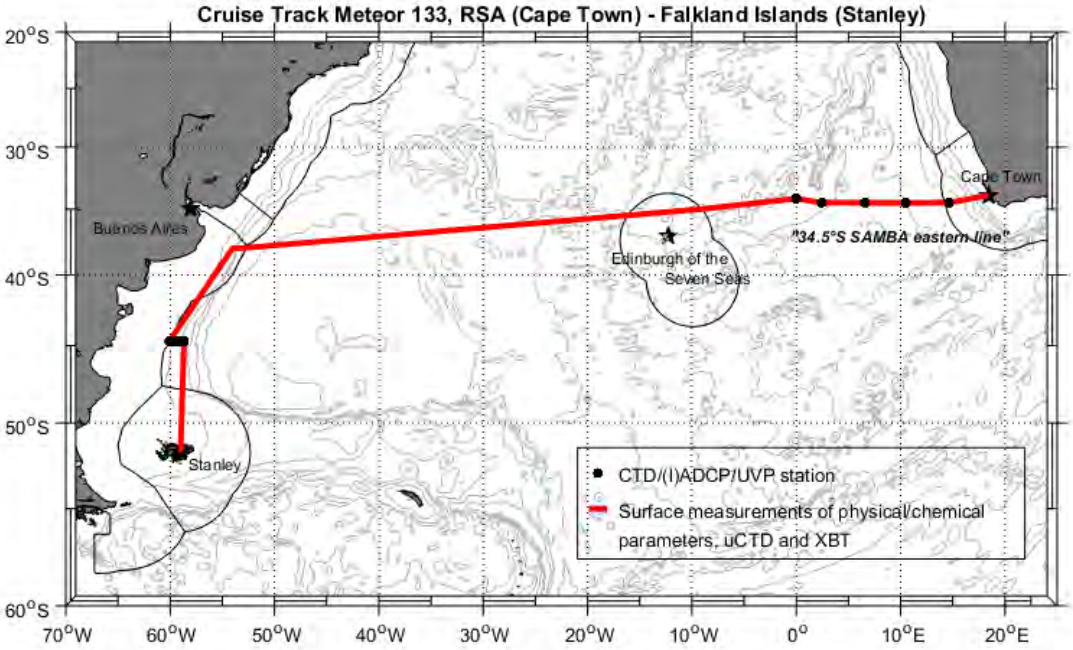


Figure 3. The working area of the M133 cruise.

3) SACROSS - MSM60 (Physical and biogeochemical sampling of oceanographic and meteorological underway data at the South Atlantic Ocean in the framework of AtlantOS)
R/V: Meteor, Germany
Period: 04 January to 01 February 2017 (Figure 4)
Chief Scientist: Johannes Karstensen, with a team of 22 researchers and students including 1 FURG, 1 UERJ and 3 USP researchers.
Measurements/samplings: u-ADCP, underway-CTD, vertical CTD+Rosette stations, XBT, dissolved oxygen, salinity, A_T, C_T, CFC, SF_6, fluorescence, DOC, POC/PN and nutrients samples.
Goals:
i) For the first time get a (nearly) synoptic picture of physical, biogeochemical and ecosystem parameter distribution along the SAMOC (34.5°S) line in the South Atlantic Ocean;
ii) Estimate the meridional heat- and freshwater transport across the SAMOC line;
iii) Determine circulation and ventilation pathways using physical and chemical data;
iv) Fill existing gaps in the knowledge of the carbonate system of the South Atlantic, including an estimate of anthropogenic carbon content;
v) Estimate the functional composition of Chlorophyll and particle composition along the 34.5°S section.

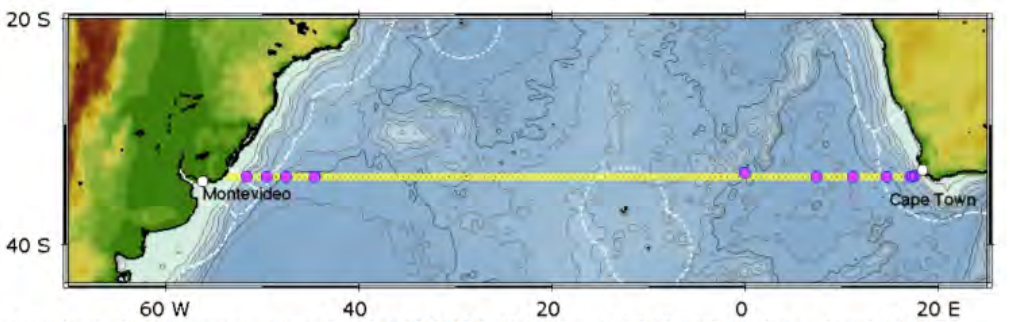


Figure 4. The working area of the M133 cruise.

Events:

1) 4TH INTERNATIONAL SYMPOSIUM ON THE OCEAN IN A HIGH-CO2 WORLD. 03 to 06 May 2016, Hobart, Australia.
Main contributions from SOLAS-BR community:
i) Anthropogenic carbon distribution and ocean acidification state in the Patagonian shelf break region; Iole B. M. Orselli, Rodrigo Kerr, Rosane G. Ito, Virgínia M. Tavano and Carlos A. E. Garcia.
ii) CO2 net fluxes along south and southeast Brazilian continental shelf and slope; Ana G. Correa, Iole B. M. Orselli, Rodrigo Kerr
iii) Spatial variability of CO2 fluxes in the Gerlache Strait, Antarctica, during austral summer 2015; Eidt, Renata T., Kerr, Rodrigo, Orselli, Iole B. M.
iv) Spatial variation of total alkalinity and total dissolved inorganic carbon along the Brazilian continental shelf-break and slope: preliminary results; Mariah Borges, Iole Orselli, Rodrigo Kerr
v) Surface total alkalinity, salinity and temperature: a study case in the Southwestern Atlantic Ocean; Leticia COTRIM DA CUNHA, Cintia ALBUQUERQUE, Rodrigo KERR, Iole ORSELLI

2) XXXIV SCAR 2016 Open Science Conference. 20 to 30 August 2016, Kuala Lumpur, Malasia.
i) CO2 fluxes in the Gerlache Strait (Antarctica) during austral summer 2015; Kerr, Rodrigo, Eidt, Renata T., Orselli, Iole B. M.
ii) Distribution of anthropogenic carbon in the Bransfield and Gerlache Straits (Antarctic) waters during austral summer 2015; Orselli, Iole B. M.**,** Lencina-Avila, Jannine M., Kerr, Rodrigo.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

1) Santos, G. C., Kerr, R., Azevedo, J. L. L., Mendes, C. R. B. and da Cunha, L. C.: Influence of Antarctic Intermediate Water on the deoxygenation of the Atlantic Ocean, Dyn. Atmos. Ocean., 76, 72–82, doi:10.1016/j.dynatmoce.2016.09.002, 2016.

2) Ito, R. G., Garcia, C. A. E. and Tavano, V. M.: Net sea-air CO2 fluxes and modelled pCO2 in the southwestern subtropical Atlantic continental shelf during spring 2010 and summer 2011, Cont. Shelf Res., 119, 68–84, doi:10.1016/j.csr.2016.03.013, 2016.

3) Cotovicz, L. C., Knoppers, B. A., Brandini, N., Poirier, D., Costa Santos, S. J. and Abril, G.: Spatio-temporal variability of methane (CH 4) concentrations and diffusive fluxes from a tropical coastal embayment surrounded by a large urban area (Guanabara Bay, Rio de Janeiro, Brazil), Limnol. Oceanogr., 61(S1), S238–S252, doi:10.1002/lno.10298, 2016.

4) Pezzi, L. P., R. B. Souza, P. C. Farias, O. Acevedo, and A. J. Miller (2016), Airsea interaction at the Southern Brazilian Continental Shelf: In situ observations, J. Geophys. Res. Oceans, 121, doi:10.1002/2016JC011774.

5) Lencina-Avila, J. M., Ito, R. G., Garcia, C. A. E. and Tavano, V. M.: Sea-air carbon dioxide fluxes along 35°S in the South Atlantic Ocean, Deep Sea Res. Part I Oceanogr. Res. Pap., 115, 175–187, doi:10.1016/j.dsr.2016.06.004, 2016.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

a) In February 2017, the Chemical Oceanography Laboratory has established an informal partnership with ProOceano, a technology-based Brazilian company focused on offshore and coastal oceanography, water bodies and environment (http://www.prooceano.com.br/site/en/), in order to collect surface seawater samples daily at Guanabara Bay – Rio de Janeiro. Here we aim at training undergraduate students in sampling and analysing salinity (SSS) and total alkalinity (TA), to further construct a solid regression model of TA vs. SSS for this coastal area. We are looking forward to including these daily (Monday to Friday) results in the concerned project web-page.

PART 2 - Planned activities from 2017/2018 and 2019

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

1) NAUTILUS 3 - 2017 (Biogeochemistry, Acidification and Anthropogenic Carbon at the North Antarctic Peninsula)
R/V: NPo Almirante Maximiano (H41), Brazilian Navy
Period: February 2017
Chief Scientist: José Luiz Lima de Azevedo, with a team of 11 FURG and UERJ researchers.

2) NAUTILUS 4 - 2018 (Biogeochemistry, Acidification and Anthropogenic Carbon at the North Antarctic Peninsula)
R/V: NPo Almirante Maximiano (H41), Brazilian Navy
Period: February 2017
Chief Scientist: Rodrigo Kerr, with a team of 11 FURG and UERJ researchers.

3) PIRATA XVII – 2017 (Ocean – atmosphere interactions → heat, momentum budgets, micrometeorology, eddy-covariance CO2 measurements; Biogeochemistry (dissolved oxygen, pH, underway pCO2, nutrients, dissolved Rare Earth elements (REE – Brazil GEOTRACES), physical oceanography
R/V: Nho Vital de Oliveira (H39), Brazilian Navy
Period: June/July 2017
Chief Scientist: Paulo Arlino, with a team of researchers from UERJ, UFBA, INPE, UFSM and UFPE distributed in 3 legs

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

MSc. Dissertation: Mariah de Carvalho Borges. *"Distribuição de Carbono Antropogênico na Região de Plataforma e Quebra de Plataforma Continental do Oceano Atlântico Sudoeste (Anthropogenic Carbon distribution in the shelf and shelf-breake region of the Western South Atlantic)"*. 2017. MSc in Physical, Chemical and Geological Oceanography - Universidade Federal do Rio Grande (FURG). ***Advisor: Rodrigo Kerr.***

MSc. Dissertation: **Thiago Monteiro da Silva.** "Variabilidade dos Fluxos Líquidos de CO2 no Estreito de Gerlache entre 2004-2016 (CO2 net fluxes variability in the Gerlache Strait between 2014-2016)" 2018. MSc in Physical, Chemical and Geological Oceanography - Universidade Federal do Rio Grande (FURG). ***Advisor: Rodrigo Kerr.***

Msc. Dissertation: **Cintia Albuquerque.** "Alcalinidade e salinidade na região de quebra da plataforma continental S-SE brasileira". June 2017. Msc in Oceanography – Universidade do Estado do Rio de Janeiro (UERJ). ***Advisor: Leticia Cotrim da Cunha***

Msc. Dissertation: Ludmila Caetano. "Controles sinérgicos da temperatura sobreo CO2 em mares do sul: heterogeneidade em uma Baía Antártica". March 2017. Msc. In Geochemistry – Universidade Federal Fluminense (UFF). ***Advisor: Humberto Marotta***

Msc. Dissertation: Rafael Afonso do Nascimento Reis. "Fugacidade de CO2, Massas d´Água e Bombeamento de Ekman no Oceano Atlântico Sudoeste". December 2016. Msc. In Remote Sensing and Meteorology – Universidade Federal do Rio Grande do sul (UFRGS). ***Advisor: Ronald Buss de Souza***

PhD. Thesis: Luiz Cotovicz Junior. "CONCENTRAÇÕES E TROCAS ATMOSFÉRICAS DE DIÓXIDO DE CARBONO (CO2) E METANO (CH4) EM UM ESTUÁRIO TROPICAL EUTROFIZADO, BAÍA DE GUANABARA, RJ, BRASIL". March 2016. PhD in Geochemistry – Universidade Federal Fluminense (UFF). ***Advisors: Bastiaan Knoppers & Gwenäel Abril***

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)

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

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

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

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

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 in July 2016 to CAPES (waiting for response):
Application of the Brazilian Earth System Model to assess the effects of anthropogenic CO2 emissions in the Atlantic Ocean biogeochemistry (Aplicação do BESM para estudo de processos biogeoquímicos marinhos sob efeito de emissões antropogênicas de CO2)
Possible PI: L. Cotrim da Cunha (UERJ), with participation of INPE and FURG

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

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

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

c) GEOMAR (Kiel, Germany – Prof. Arne Körtzinger and Dr. Tobias Steinhoff) – Partnership with UERJ through a DFG-FAPERJ (Brazil call) and a BMBF call (Germany) d) University of Exeter (Dr. Ute Schuster) – Partnership with FURG and UERJ during the MSM60 Cruise – ocean carbon biogeochemistry measurements
Comments

surface ocean solas lower atmosphere study

Report for the year 2016 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 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

Describe one scientific highlight with a title, text (max. 200 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in international collaboration. (If you wish to put more than one, feel free to do so).

Dynamic summertime DMS cycling in the Arctic related to sea-ice processes (Levasseur and Lizotte, Laval U)

Sea-ice dynamics exert a strong influence on arctic microbial communities and their production of the climate-active gas dimethylsulfide (DMS) in the Arctic. High-frequency measurements made in summer 2016 using an automated instrument (ACT-MIMS) during an oceanographic campaign in the Canadian Arctic Archipelago corroborates the hypothesis suggesting that the Arctic Ocean is a nexus of biogenic DMS production associated with diversified niches linked with dynamic sea-ice during the productive season. Results reveal that microbial communities thriving in marginal ice zones significantly contribute to reservoirs of DMS. Furthermore, waters underlying sea-ice are as rich in DMS as their ice-free counterparts suggesting potentially important pulsed fluxes of DMS during ice break-up and the establishment of leads and cracks. High DMS concentrations were measured while transiting through a giant decaying ice floe suggesting that strong haline stratification under melting floes may result in the entrapment of microbial communities within highly irradiated under-ice waters and a resulting up-regulation of photo-protective mechanisms including DMS production. Large variability in DMS and strong near-surface DMS gradients were detected across hydrographic fronts and transitional areas between open water and oceanic inlets and fjords. Further investigation and monitoring of these near-terrestrial regions is needed to

substantiate the suggestion that they may represent significant emitters of DMS during summer.

Citation: M Lizotte, M Levasseur, G Massé, R Bénard, M Gosselin et al. (in preparation). Large-scale spatial distributions of near-surface concentrations of DMS during summer in the Arctic Ocean.

2. Activities/main accomplishments in 2016 (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.)

Individual accomplishments/activities are indicated below (PI name in brackets):

- Laboratory experiments on the role of sea ice in CO2 drawdown. A Canadian-Swiss collaboration (Institute of Ocean Sciences and ETH Zurich) are examining the impact of sea-ice formation rate on CO_2 export with rejected brines using temperature-controlled experiments. (Miller)
- Launch of Biogeochemical Exchange Processes at Sea-Ice Interfaces (BEPSII) as an international research coordination body under the joint sponsorship of SOLAS, CliC, IASC, and SCAR. The first meeting was held in Paris, March 16-18, 2016, to develop the new program and terms of reference. Canadian leadership includes 1 co-chair and 1 additional member of the steering committee. (https://sites.google.com/site/bepsiiwg140/home; Twitter @BEPSII_seaice) (Miller)
- New SCOR working group, #152, on Measuring Essential Climate Variables in Sea Ice (ECV-Ice). This new international working group (with three Canadian members, including a co-chair) is focused on designing and conducting intercalibration experiments on the methods used to study sea-ice biogeochemistry, towards the ultimate goal of establishing best practices for the community. Linked to BEPSII. (Miller)
- International capacity building: IOS hosted an intern from the Polytechnic University of Sinaloa, Mexico, who acquired direct experience conducting research in marine carbon cycling, air-sea exchange, and sea-ice biogeochemistry. (Miller)
- GreenEdge oceanographic cruise June-July 2016, Baffin Bay (3 week participation of M. Galí) (Levasseur/Lizotte)
- Joint NETCARE/ArcticNet oceanographic cruise July-August 2016, Canadian Arctic Archipelago. This was a large research endeavor motivated by multiple scientific goals including better understanding of Arctic DMS dynamics in the ocean, DMS in the atmosphere, primary and secondary aerosol, ammonia sources, CCN, INPs, properties of the ocean microlayer, fog and precipitation characterization (Multiple PIs – Abbatt, Bertram, Chang, Levasseur/Lizotte, Gosselin, Norman, Murphy)
- Research cruise on R/V Endeavour (Sep 25 – Oct 25, 2016) in North Atlantic to study the role of primary marine organic aerosol on the ocean carbon cycle (PI – Dave Kieber, SUNY Albany) (Chang)
- On-going studies of properties of artificially-generated primary marine aerosol from water sampled from the Atlantic Zone Monitoring Program (Mar 2016 & Sep 2016) off the coast of Nova Scotia (PI – Andrew Cogswell, DFO) (Chang)

- On-going studies of the hygroscopic properties of sea-water (Chang)
- Coastal fog study in Sambro, Nova Scotia (May – July 2016) to study effects of marine aerosol on visibility and fog (Chang)
- During the spring 2016, we carried out a 1-month long field campaign at Alert, Canada, to determine concentrations and size distributions of ice nucleating particles in the region. We have also been focusing on writing and analysing INP data collected in the Arctic during 2014-2016 (Bertram)
- We conducted a field campaign at Alert, NU, jointly between University of Toronto and Environment and Climate Change Canada, to investigate the nature of aerosol, ammonia, and VOCs in that remote environment. The campaign was in mid-summer and marine signatures were examined (Abbatt, Liggio, Leaitch, Murphy)

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

N. Steiner, C. Deal, D. Lannuzel, D. Lavoie, F. Massonnet, L.A. Miller, S. Moreau, E. Popova, J. Stefels, and L. Tedesco, 2016. *Elem*. *Sci. Anth.* **4**: 000084, doi: 10.12952/jounal.elementa.000084. What sea-ice biogeochemical modellers need from observers.

Ghahremaninezhad R, Norman A-L, Abbatt JPD, Levasseur M, Thomas JL (2016). Biogenic, anthropogenic and sea salt sulfate size-segregated aerosols in the Arctic summer. Atmos.Chem. Phys. 16:5191-5202.

Hussherr R., Levasseur M, Lizotte M, Tremblay JE, Mol J, Thomas H, Gosselin M, Starr M, Miller LA, Jarnikova T, Schuback N, Mucci A (2016). Impact of ocean acidification on Arctic phytoplankton blooms and dimethylsulfide production under simulated ice-free and under-ice conditions. *Biogeosciences Discussions* DOI 10.5194/bg-2016-501

Mungall EL, Croft B, Lizotte M, Thomas JL, Murphy JG, Levasseur M, Martin RV, Wentzell JJ B, Liggio J, Abbatt JPD (2016). Dimethyl sulfide in the summertime Arctic atmosphere: measurements and source sensitivity simulations. *Atmospheric Chemistry and Physic*s, 16(11): 6665-6680, DOI 10.5194/acp-16-6665-2016.

Vergara-Temprado, J, Wilson, TW, O'Sullivan, D, Browse, J, Pringle, KJ, Ardon-Dryer, K, Bertram, AK, Burrows, SM, Ceburnis, D, DeMott, PJ, Mason, RH, O'Dowd, CD, Rinaldi, M, Murray, BJ, Carslaw, KS, 2016, Contribution of feldspar and marine organic aerosols to global ice nucleating particle concentrations, *Atmospheric Chemistry and Physics Discussions*, doi:10.5194/acp-2016-822

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

- Daniel Kunkel and Heiko Bozem, Institute for Atmospheric Physics, Johannes Gutenberg University, Mainz, Germany. Calculation of Flexpart trajectories over the Canadian Arctic in summer 2016, for the NETCARE cruise
- Several of our publications are co-authored with researchers at Environment and

Climate Change Canada, including modelers at the Canadian Centre for Modelling and Analysis.

PART 2 - Planned activities from 2017/2018 and 2019

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

- Joint ArcticNet/Sentinel North oceanographic cruise in the Canadian Arctic Archipelago (July 6 -August 17, 2017)
- Greenland Circumnavigation oceanographic cruise summer 2018 in collaboration with ArcticNet and Sentinel North projects (Canada First Research Excellence Fund).
- GESAMP WG 38 community paper "*Changing ocean acidity as a modulator of atmospheric biogeochemistry and climate*" (to be submitted to PNAS, October 2017).
- NETCARE Arctic DMS modelling community paper. Reassessing the climatic role of DMS in the Arctic by integrating new in situ measurements, remote sensing models, and prognostic models of the ocean, ice and atmosphere.

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

- The Cryosphere and Atmospheric Chemistry (CATCH) Emerging IGAC activity on chemistry, biology and physics in cold regions, April 19-20 Guyancourt, France. (Participation of scientists - M. Lizotte, J. Murphy, M. Willis)
- Canadian Meteorological and Oceanographic Society's (CMOS) 51st Congress and annual meeting, June 4-8 June 2017,Toronto, ON, Canada. (Participation of M. Lizotte)
- NETCARE final workshop on 'The Status and Future of Arctic Aerosol Research', Toronto, Canada, November 13-14, 2017 (Participation the full NETCARE community and 12 international invited speakers)
- Canadian Society for Chemistry annual meeting, Toronto, May 2017, special session on "Arctic Chemistry and Biogeochemistry" (organized by Wang and Murphy)

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)

- 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.

- 2015-2018. ArcticNet funded project "Marine biogeochemistry and surface exchange of climate active gases". Relevant to SOLAS 2015-2025 Science Plan Core Themes 1 and 4.
- 2012-2017 NETCARE, Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environment. Relevant to SOLAS 2015-2025 Science Plan Core Themes 1 and 4.

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)

- We are anticipating a new call for proposals from NSERC's Climate Change and Atmospheric Research Program, which has funded NETCARE
- An effort is underway to get a Canadian Antarctic program underway

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

- BEPSII/ECV-Ice annual meeting: La Jolla, California, April 3-5, 2017
- Participation in CATCH (the Cryosphere and Atmospheric Chemistry), an emerging activity from IGAC. Workshop in Paris in April 2017

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 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 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017
1. Scientific highlight
Describe one scientific highlight with a title, text (max. 200 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in international collaboration. (If you wish to put more than one, feel free to do so).
This report focuses on studying generation and/or evolution of sea-salt aerosols (SSA) on basis of measurements in the Northwest Pacific Ocean (NWPO), the marginal seas of China, at sea-beach sites and a semi-urban coastal site in 2012-2015. From measurements in the NWPO, we obtained the smallest generation function of the super-micron SSA mass ([M_{SSA}]) by the local wind comparing to those previously reported. Vessel-caused wave-breaking was found to greatly enhance generation of SSA and increase [M_{SSA}], which was subject to non-natural generation of SSA. However, naturally enhanced generation of SSA was indeed observed in the marginal seas and at the sea-beach site. The two enhancement mechanisms may explain the difference among this and previous studies. Size distributions of super-micron SSA exhibited two modes, i.e., 1-2 μm mode and ~5 μm mode. The 1-2 μm mode of SSA was enhanced more and comparable to the ~5 μm mode under the wind speed > 7 m/s. However, the smaller mode SSA was largely reduced from open oceans to sea-beach sites with reducing wind speed. The two super-micron modes were comparable again at a semi-urban coastal site, suggesting that the smaller super-micron mode SSA may play more important roles in atmospheres.

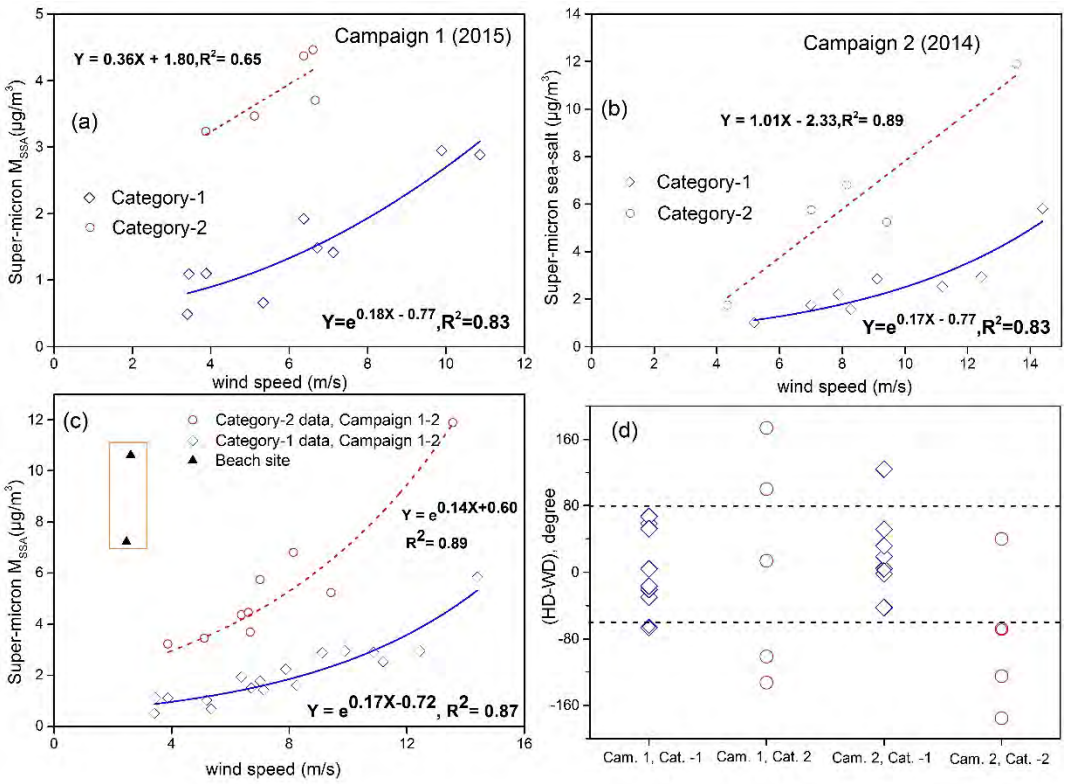


Figure: The relationship between super-micron MSSA and wind speed, (a)-(b): the estimated MSSA values in super-micron particles against the wind speed in the Campaign 1-2 (the NWPO campaign, including roundtrip samples); (c) the estimated super-micron MSSA in category-2 data of campaign 1-2 against the wind speed; (d): wind direction (WD) relative to vessel's heading direction (HD), i.e., HD-WD.

Citation: Feng, L. et al. Insight into Generation and Evolution of Sea-Salt Aerosols from Field Measurements in Diversifed Marine and Coastal Atmospheres. Sci. Rep. 7, 41260; doi: 10.1038/srep41260 (2017).

2. Activities/main accomplishments in 2016 (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.)

2.1 Cruise and field experiment

The air–sea CO2 fluxes and carbonate system in the northern South China Sea were investigated based on large-scale observations of a cruise conducted onboard R/V *Dongfanghong II* during May 17-June 2, 2016. This cruise was supported by NSFC through its Shiptime of Sharing Program (NORC2015-05). Data are used to evaluate the effect of El Nino on the intrusion of Kuroshio, which might affect the CO_2 fluxes in this regime.

Three CO_2 and ocean acidification monitoring buoys have been deployed since 2012 in the inner-shelf (122.8°E, 31°N) and the outer shelf (124°E, 31°N) of the East China Sea and the Pearl River plume region (113.975°E, 21.958°N). Monitored parameters include current, surface water and air pCO_2, SST, SSS, velocity, DO, pH, Chl a and CDOM. Data are continuously transmitted back in real-time to the land-based data center and are used to evaluate regional carbon

models.

2.2 Projects

1) CHOICE-C II, the renewed SOLAS-Endorsed Project: CHOICE-C, passed its mid-term evaluation by the Ministry of Science and Technology (MOST) of China.
2) A new project entitled "Biogeochemical processes and climate effect of marine biogenic trace gases in the east marginal seas of China" was funded through the National Key Research and Development Program. The project is for July 2016 to June 2021 with a budget of 25.86 million CNY. The leading PI is Dr. Guipeng Yang from the Ocean Univeristy of China. The research contents include spatio-temporal variation trends and sea-to-air fluxes of biogenic trace gases in the east marginal seas of China, biogeochemical cycling processes and ecological responses of marine biogenic trace gases, role and mechanism of microorganisms in marine biogenic gases cycle, emission and transformation of marine biogenic gases in atmosphere and their effect on climate.
3) Project entitled "Atmospheric deposition and its impact on marine primary production and nitrogen cycle" was funded by Major national scientific research program for 5 years from 2013 to 2018. This project focuses on atmospheric deposition of nitrogen and its contribution to primary production, key processes of marine nitrogen cycles, marine biogenic aerosol and its impact on climate.

2.3 Infrastructure

- A 78-m long new research vessel with the capacity of SOLAS and trace metal researches was launched by Xiamen University on May 8th, 2016 and is under sea trails from December 30, 2016. The vessel will be formally delivered to Xiamen University in early 2017 after sea worthiness trials.
- A new research vessel Dong Fang Hong 3 of Ocean University of China is under construction.

2.4 Workshop organized

- AOGS Annual Assembly, Beijing, China, July 31-August 5, 2016.
- International SOLAS SSC meeting, Qingdao, China, October 24-26, 2016.
- SOLAS in Asia: A Future SOLAS Symposium, Qingdao, China, October 27-28, 2016.
- CHOICE-C II mid-term review meeting, Xiamen, China, July 26-27, 2016.
- Ocean Acidification research in China: an international workshop, Shanghai, China, April 28-29, 2016.
- The third Xiamen Symposium on Marine Environmental Sciences (3rd XMAS), Xiamen, China, January 9-11, 2017.

2.5 International interactions and collaborations

- Minhan Dai, Observational challenges: from global to local, May 3-7, 2016, the 4th Oceans in a High CO_2 World Symposium, Hobart, Tasmania, Australia (Plenary Talk).
- Minhan Dai, SOLAS in Asia, Jan 23-25, 2017, The 5th workshop on Future Earth in Asia, Kyoto, Japan.
- The State Key Laboratory of Marine Environmental Science (Xiamen University) participates in the IAEA interregional project "Supporting a Global Ocean Acidification Observing Network towards Increased Involvement of Developing States".

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

The 5th Xiamen University Ocean Sciences Open House was held on November 13, 2016, Zhou-Long-Quan Building, Xiang'An Campus, Xiamen University, China.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

- Feng, L, Shen, H, Zhu, Y, Gao, H, Yao, X, 2017, Insight into Generation and Evolution of Sea-Salt Aerosols from Field Measurements in Diversifed Marine and Coastal Atmospheres, *Scientific Reports,* 7, 41260; DOI: 10.1038/srep41260.
- Guo, T, Li, K; Zhu, Y J, Gao, H W, Yao, X H, 2016, Concentration and size distribution of particulate oxalate in marine and coastal atmospheres - Implication for the increased importance of oxalate in nanometer atmospheric particles, *Atmospheric Environment*, 142, 19-31, DOI: 10.1016/j.atmosenv.2016.07.026
- Lin, H, Dai, M H, Kao, S -J, Wang, L, Roberts, E, Yang J –Y T, Huang, T, He, B, 2016, Spatiotemporal variability of nitrous oxide in a large eutrophic estuarine system: The Pearl River Estuary, China, *Marine Chemistry*, 182, 14-24, DOI: 10.1016/j.marchem.2016.03.005.
- Luo, L, Yao, X H, Gao, H W, Hsu, S C, Li, J W, Kao, S J, 2016, Nitrogen speciation in various types of aerosols in spring over the northwestern Pacific Ocean. *Atmospheric Chemistry and Physics*, 16, 325–341, DOI: 10.5194/acp-16-325-2016.
- Yu, P R, Hu, Q J; Li, K; Zhu, Y J; Liu, X H ; Gao, H W ; Yao, X H.,2016, Characteristics of dimethylaminium and trimethylaminium in atmospheric particles ranging from supermicron to nanometer sizes over eutrophic marginal seas of China and oligotrophic open oceans, *Science of the Total Environment*, 572, 813-824, DOI: 10.1016/j.scitotenv.2016.07.114.

For journal articles please follow the proposed 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 2016? If yes, who? How did you engage?

PART 2 - Planned activities from 2017/2018 and 2019

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

Cruises:

1) There will be a cruise focusing on the water exchange of Luzon Strait during July 2017. The parameters related to the air–sea CO_2 fluxes and carbonate

system will be collected onboard R/V Dongfanghong II. This cruise will be supported by NSFC Open Research Cruise, which is funded by Shiptime Sharing Project of NSFC.

2) There will be a summer cruise conducted onboard R/V TAN KAH KEE in the Southern South China Sea, from where there are sparse data on the carbon budget and ocean acidification. This cruise will be supported by CHOICE-C II project funded by the Ministry of Science and Technology (MOST) of China.

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

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)

CHOICE-C (Carbon cycling in China Seas-budget, controls and ocean acidification) project was renewed by the Ministry of Science and Technology (MOST) of China for another 5 years from January 2015 to December 2019. This renewed project is termed as CHOICE-C II with a budget of 25 million CNY. Through comparative study of carbon cycling in River-Dominated-Ocean-Margins (RioMars, the northern South China Sea shelf being a case) and the Ocean-Dominated-Ocean-Margin (OceMars, the South China Sea basin being a case), CHOICE-C II is focusing on the carbon cycle in South China Sea in terms of its budget, controls and global implications. It is related to Theme 1: Greenhouse gases and the oceans of the SOLAS 2015-2025 science plan.

National Key Research and Development Program: Biogeochemical processes and climate effect of marine biogenic trace gases in the east marginal seas of China. Leading PI: Gui-Peng Yang. Institution: Ocean University of China. Budget: 25.86 million CNY. Research Duration: 5 years (2016.7-2021.6). It is related to Theme 2: Air-sea interface and fluxes of mass and energy.

Major national scientific research program: Atmospheric deposition and its impact on marine primary production and nitrogen cycle (2013-2018), leading PI: Huiwang Gao. It is related to Theme 3: Core Theme 3: Atmospheric deposition and ocean biogeochemistry.

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)

- Proposal entitled “Transient enhancement and decoupling of carbon export vs opal in cyclonic eddies: overprints of submesoscale interactions and eddy evolution” has been submitted to the National Natural Science Foundation of China in March 2017. This proposal chose a prominent cyclonic eddy in the Northwest Pacific Ocean off Taiwan in spring (Eddy SILICON) to examine the eddy evolution and its submesoscale variability and how these spatial-temporal variability modulate the exports of carbon and opal and their coupling. Through intensive and high spatial-temporal resolved field observations and numerical modeling, following critical questions are to be

answered: (1) How do submesoscale processes of a cyclonic eddy modulate the spatial variability of carbon and opal exports? (2) how does eddy evolution affect carbon and opal exports? (3) Are the exports of carbon and opal coupled or decoupled on the spatial scale during the submesoscale variability and on the temporal scale during eddy evolution? The proposed research is crucial in better understanding the biological carbon pump and its role in the global carbon cycle.

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

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

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *Denmark*
compiled by: Lise Lotte Sørensen

This report has two parts:

- Part 1: *reporting of activities in the period of January 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017
1. Scientific highlight
Describe one scientific highlight with a title, text (max. 200 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in international collaboration. (If you wish to put more than one, feel free to do so). No strong international SOLAS collaboration in 2016
2. Activities/main accomplishments in 2016 (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.)
In spring 2016 Aarhus University (Arctic Research Centre including Dep. Bioscience, Dep. Chemistry and Dep. Environmental Science) carried out field work in Nuuk fjord. The specific objective of the field campaign were to investigate to which extent surface fluxes of GHG's in the coastal marine system are influenced by sea spray. The original plan was to carry out measurement of CO_2 and water vapor fluxes as well as fluxes of sea spray over Nuuk Fjord, but due to instrument failure, we did not measure CO_2 fluxes over the Nuuk Fjord. Only sea spray fluxes were measured which gave us experience in sea spray flux measurements and some insight in sea spray flux processes at coastal sites. Both upward and downward sea spray fluxes were found. At a low measurement height (here 3.5 meter) and in an area with ship traffic (the site is close to Nuuk) it is likely we find downward fluxes of locally produced anthropogenic particles. Furthermore, we might see the effect from downward flux of larger sea spray particles at this low height. However, it is not possible to determine from the field experiment in Nuuk Fjord, if a connection between sea spray fluxes and CO_2 fluxes is present in Arctic environments. Thus we also participated in a cruise on Amundsen in Baffin Bay where both CO_2 and sea spray fluxes were measured. We are still analyzing the data form Baffin Bay. The field and laboratory work in 2015/16 resulted in two master thesis: 1) Ida Alexandra Rosendahl, 60 ECTS, "FIELD STUDIES OF SEA SPRAY PARTICLE FLUXES - Testing the Cospectral Peak method Defense November 7 2016, grade 10. Supervisors: Merete

Bilde and Lise Lotte Sørensen.

2) Berit Brøndum Rasmussen, 60 ECTS, "Surfactants in Seawater and Sea Spray Aerosols. Lab and field studies of physico-chemical properties. Defense January 8 2016, grade 12. Supervisor: Merete Bilde

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Mørk, E T, Sejr; M K, Stæhr; P A, and Sørensen, L L, 2016, Variability of air-sea CO_2 exchange in a low-emission estuary. *Estuarine, Coastal and Shelf Science*, 176, 1-11. doi:10.1016/j.ecss.2016.03.022

Grimm R, Notz D, Glud R N, Rysgaard S, Six, K D, 2016, Assessment of the sea-ice carbon pump: Insights from a three-dimensional ocean-sea-ice-biogeochemical model (MPIOM /HAMOCC). *Elementa*, 4:000136, doi:10.12952/journal.elementa.00136.

Crabeck C, Galley R, Delille B, Geilfus N-X, Lemes M, Else B, Tison J-L, Francus P, Rysgaard S, 2016, Imaging air volume fraction in sea ice using non-destructive x-ray tomography. *The Cryosphere*. 10, 1125–1145, doi:10.5194/tc-10-1125-2016.

For journal articles please follow the proposed 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 2016? If yes, who? How did you engage?

PART 2 - Planned activities from 2017/2018 and 2019

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

A coastal Danish ICOS atmospheric station measuring CO2 and CH4 will be established At Station Nord in 2017 and an associate CO2 air-sea flux site will be established in Daneborg (Northeast Greenland in summer 2017).

A field study involving Aarhus University (PI: Lise Lotte Sørensen) and Greenland Institute of Natural Resources (PI: Dorte Søgaard) is planned to take place in July 2017 at Young Sound, Daneborg. The aim of the study is to enhance the understanding of the local and regional processes controlling the climate changes in the Arctic, and to contribute to a qualified assessment of future climate changes and consequences. We will focus on the distribution of the sea ice and the project goal is to contribute to the knowledge of the interaction between variation in greenhouse gases and the sea ice distribution in the Arctic. As a part of this project, we aim to answer following questions: To which extent is the distribution of the sea ice affecting the development of the greenhouse gas concentration in the Arctic and how large is the present uptake of CO_2 in an Arctic ice covered fjord?

Furthermore, a cruise on the Danish research Vessel Dana will take place in August 2017 in Fram strait. During the cruise surface pCO2 will be measured using a Contros by Mikael Sejr (Aarhus

University).

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

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)

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)

SOLAS-DK is submitting a proposal to the NordForsk together with the Nordic SOLAS partners to establish a Nordic SOLAS network. The proposal is coordinated by Anna Rutgersson from SOLAS-Sweden.

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

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *Finland*
compiled by: Lauri Laakso/ Finnish Meteorological Institute

This report has two parts:

- Part 1: *reporting of activities in the period of January 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017
1. Scientific highlight
Describe one scientific highlight with a title, text (max. 200 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in international collaboration. (If you wish to put more than one, feel free to do so).
Partanen et al. (2016) used an intermediate complexity University of Victoria Earth System Climate Model to study how solar radiation management by sea spray injections into marine clouds would affect ocean biogeochemistry. The study is the first global assessment of marine ecosystem impacts of sea spray geoengineering. In general, ecosystem impacts of geoengineering are highly important and largely unexplored field of research. The major scientific advance of the study was to show that sea spray geoengineering can significantly alter regional primary production of oceans when change in temperature is considered in addition to the reduced light availability. A novel result was also that solar radiation management resulted in decrease of the carbon uptake of oceans in a context of low CO_2 emission scenario.

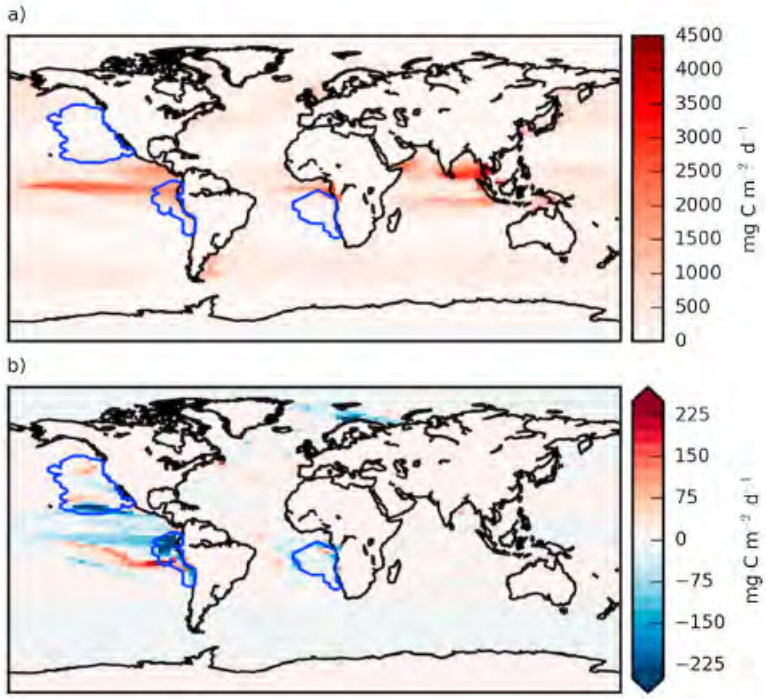


Figure 1: Vertically integrated mean ocean net primary productivity at year 2030 in (a) Control simulation based on RCP4.5 scenario (CRTL) and (b) difference from the CTRL when Solar Radiation Management (SRM) is started in 2020. SRM is a geoengineering method, where sea spray particles are injected into marine clouds to enhance their reflectivity.
The blue lines in the figure encircle the SRM regions.

2. Activities/main accomplishments in 2016 (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.)

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

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

FINMARI organized national science conference in Helsinki and Tvärminne Zoological Station 1 - 3 November 2016. More than 60 scientists and the Scientific Advisor Board of FINMARI participated in the meeting. Presentations covered full range research topics from automatic glider observations at the Bothnian Sea to sediment biogeochemistry, bio-optical and automated imaging tools, and survival of white fish roe in a changing climate.

According to the international Scientific Advisor Board, the atmosphere within the Finnish marine research community is enthusiastic, collaborative spirits high, and the overall coordination of scientific resources and research is ahead of many other countries.

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

FINMARI partner reports for SOLAS-relevant activities:

Arctia Shipping Ltd: nothing to report

Finnish Environment Institute (SYKE):

Finnish Environment Institute, together with Finnish Meteorological Institute carried out several field campaigns at Utö Atmospheric and Marine Research Station focusing on biological carbon cycle. These field campaigns were part of preparations for an intensive carbon observing period (04/2017 – 04/2018) within the H2020 INFRAIA project "Joint European Research Infrastructure network for Coastal Observatory – Novel European eXpertise for coastal observaTories" (JERICO-NEXT).
http://www.jerico-ri.eu/

Finnish Meteorological Institute (FMI):

The SOLAS-relevant research at FMI includes both atmospheric and marine research.

The main focus of marine research has been in the development of Utö Atmospheric and Marine Research Station (http://en.ilmatieteenlaitos.fi/uto) and especially in testing and validating different marine carbon cycle and emission observations. One of the main focus areas has been the development of sea spray removal system on a coastal eddy covariance flux tower. This research is part of a H2020 infrastructure project Jerico-next (2015-19).

Important part of experimental SOLAS studies has been carried out based on more than 15 research cruises during the 21'st century on board RV Aranda. The focus of these studies in on sea surface gas exchange, waves and sea surface turbulence. Currently, data gathered is analysed and published (see e.g. Kahma et al., 2016).

On atmospheric research side, one of the research topics has been the influence of geoengineering on marine ecosystems (please see highlights of the research).

The fourth important research topic has been the emissions by ship traffic (Jalkanen et al., 2016)

Geological Survey of Finland: nothing to report

University of Helsinki, Tvärminne Zoological Station:

In 2016, nine articles on the effects of ocean acidification on the plankton community and pelagic biogeochemistry in the northern Baltic Sea were published in a special issue of Biogeosciences (http://www.biogeosciences.net/special_issue204.html). All of these articles are based on the KOSMOS 2012 campaign that Prof. Ulf Riebesell (GEOMAR) and his team, including Finnish colleagues, conducted at Tvärminne Zoological Station (University of Helsinki, Finland) in June-July 2012.

University of Helsinki, Viikki Campus

2016 work (relates to core themes 1 and 5) of research group Nutrient cycles in aquatic ecosystems (Susanna Hietanen, University of Helsinki)

1) In 2016 N2O and CH4 concentration samples were collected in April, June, August and October at two coastal station in Hanko archipelago. Samples were collected from water column and sediments and accompanied by CTD casts for temperature, salinity and oxygen and sampling of water column and sediment porewater for dissolved nutrients and H2S. In addition a spatial transect from river mouth at Pojo bay to outer archipelago was analysed for same parameters in June. This project is part of an ongoing spatial and temporal study of N2O and CH4 dynamics in coastal ecosystem, started in 2015.

2) In 2016 the N2O and CH4 concentration data collected from Gotland Basin 2015 following the Major Baltic Inflow was analysed and summarized in a scientific manuscript that is currently in review in Earth System Dynamics. Another paper is in prep.

3) Research group Nutrient cycles in aquatic ecosystems (Susanna Hietanen, University

of Helsinki) participated in N2O and CH4 concentration analysis intercalibration organized by Hermann Bange (Geomar) and Gregor Rehder (IOW); we have not yet received any intercomparison results but have submitted our own data to organizers.

University of Turku: nothing to report

Åbo Akademi University:

A vertical profiling buoy was deployed in the NW Åland measuring basic oceanographic parameters such as temperature, salinity and oxygen content from 4 to 40 metres. The profiling is to be continued early spring 2017.

Natural Resources Institute Finland LUKE: nothing to report

3. Top 7 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

University of Helsinki, Tvärminne zoological station:

1) Webb AL, Leedham-Elvidge E, Hughes C, Hopkins FE, Malin G, Bach LT, Schulz K, Crawfurd K, Brussaard CPD, Stuhr A, Riebesell U, Liss PS., Effect of ocean acidification and elevated f CO_2 on trace gas production by a Baltic Sea summer phytoplankton community. Biogeosciences 13:4595-4613, 2016.

Finnish Environment Institute:

2) Spilling K, Paul AJ, Virkkala N, Hastings T, Lischka S, Stuhr A, Bermudez R, Czerny J, Boxhammer T, Schulz KG, Ludwig A, Riebesell U., Ocean acidification decreases plankton respiration. Biogeosciences 13:4707-4719, 2016

FMI:

3) Partanen, A.-I., D. P. Keller, H. Korhonen, and H. D. Matthews, Impacts of sea spray geoengineering on ocean biogeochemistry, Geophys. Res. Lett., 43, doi:10.1002/2016GL070111., 2016
4) JP Jalkanen, L Johansson, J Kukkonen, A comprehensive inventory of ship traffic exhaust emissions in the European sea areas in 2011, Atmospheric Chemistry and Physics 16 (1), 71-84, 2016
5) Kahma, K.K., Donelan, M.A., Drennan, W. M., Terray, E. A. Evidence of energy and momentum flux from swell to wind, Journal of Physical Oceanography, DOI: http://dx.doi.org/10.1175/JPO-D-15-0213.1, 2016
6) Albert, M. F. M. A., Anguelova, M. D., Manders, A. M. M., Schaap, M., and de Leeuw, G.: Parameterization of oceanic whitecap fraction based on satellite observations, Atmos. Chem. Phys., 16, 13725-13751, doi:10.5194/acp-16-13725-2016, 2016.
7) Sipilä et al. "Molecular-scale evidence of aerosol particle formation via sequential addition of HIO3", Nature 537, 532-534, 2016.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

1) Most of the involvement of stake holders has been carried out trough FINMARI board, and advisory board: https://www.finmari-infrastructure.fi/management/ .

2) Very strong interaction with stakeholders has been organized through a national “SmartSea”-project (http://smartsea.fmi.fi/what-is-smartsea-project/). The objective of the SmartSea project (2015 - 2021) is to provide science-based guidance and new innovations for the sustainable use of the Finland's marine resources. SmartSea is part of Finnish Strategic Research framework http://www.aka.fi/en/strategic-research-funding/

PART 2 - Planned activities from 2017/2018 and 2019

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

Some of the planned activities for 2017:

1) Jerico-next intensive observing period (2017/04 – 2018/04) focusing on biological carbon cycle (FMI and SYKE)

2) Beginning of Baltic Sea carbon observing project “Integral - Integrated Carbon and Trace Gas Monitoring for the Baltic Sea” coordinated by IOW, Germany and funded by Bonus. (FMI)

3) Deployment and set-up of new instruments obtained through FINMARI funding scheme:

   Major new investments of the FINMARI consortium during 2017-2018 will extend the current profiling buoy network to the Western Gulf of Finland (UHEL/Tvärminne), create a fleet of 6 Bio-Argo floats and a bottom-landing Argo (FMI), build a new flume aquaria system for experimentation (ÅAU/Husö), upgrade zooplankton sampling systems (UTU/Seili), enhance seabed studies with a multibeam sonar and a free-fall cone penetrometer (GTK) and fish stock studies with a horizontal sonar (Luke), as well as develop a cutting-edge indoor mesocosm facility with advanced control and real-time flow-through measurement instrumentation (SYKE/MRC).

   Several partners (UHEL/Tvärminne, ÅAU/Husö, UTU/Seili, Luke) will acquire side-scan sonar equipment to pursue a national effort for seafloor habitat mapping (coordinated by GTK), and the Utö station (FMI, SYKE/MRC) flow-through system and cabled observatory will be upgraded, with e.g. purchases of an on-line laser diffraction particle analyzer and a holographic particle imaging system (SYKE/MRC).

4) Verification of Wave model WAM against wave buoy observations as a part of Copernicus activities. (FMI)

5) 2017 plans (relates to core themes 1 and 5) of research group Nutrient cycles in aquatic ecosystems (University of Helsinki):
   - there will be two field campaigns (early summer and late summer) to study the sources and sinks of N2O in Pojo Bay, a coastal embayment in Hanko archipelago; the results will be presented in PPNW workshop in autumn 2017
   - A method to study anaerobic oxidation of methane will be established in the group and tested and subsequently used in Pojo Bay, a coastal embayment in Hanko archipelago this summer

Campaigns in which University of Helsinki / Dept. of Physics, together with FMI, participates:

6) Ny Ålesund, Svalbard February-March 2017, "Marine aerosol impact on clouds in the arctic (MACA)" RIS (Research in Svalbard http://www.researchinsvalbard.no) ID: 10713

7) We participate the mesocosms experiment which is part of MACA. Performed in collaboration with CNRS, France.

8) Ny Ålesund, Svalbard: March-August 2017 "Molecular steps of new particle formation in the arctic atmosphere (NPFARCTIC)" RIS ID: 10732 Our own project, performed in collaboration with CNR, Italy and Stockholm University

9) November/December 2017 February 2018: Marambio Base, Antarctic Peninsula in collaboration with Eija Asmi / FMI and Servicio Meteorológico Nacional Argentina. Campaign has no official project status yet.

   During these (# 6-9) campaigns (funded by Finnish academy researcher project: 296628 and ERC-StG project: Grant agreement No 714621.), we'll sample the air chemical composition and particle and cluster distributions ann cluster chemical composition aiming to understand the role of DMS derived Sulphuric acid and the iodine vapours from sea ice emissions and the potential of iodine containing vapours to form new particles

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

1) Jerico-next General Assembly in Helsinki (13-16 March 2016)
2) A summer school: “Environmental impacts of catchment from headwaters to the sea", 8.-24.8.2017. Location: Lammi Biological Station, Finland; Tvärminne Zoological Station, Finland, Askö Laboratory, Stockholm, Sweden.

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)

FINMARI obtained 2 M€ national infrastructure funding for the years 2017-18 from Finnish Academy. In addition, FMI received 260k€ SOLAS-relevant funding from BONUS for a three-year project for the period 2017/07-2020/07. All individual FINMARI partners have received significant amount of national and international funding together with a large number of national and international partners.

Funding obtained will cover the Core Themes 1, 2, 3 and 4 together with all three cross-cutting themes.

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)

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

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

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

Comments

Report for the year 2016 and future activities

SOLAS *France*

compiled by: R. Losno

This report has two parts:

- ***Part 1:*** *reporting of activities in the period of January 2016 – Jan-Feb 2017*
- ***Part 2:*** *reporting on planned activities for 2017/2018 and 2019.*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

VAHINE project special issue

A special issue on the project VAHINE (VAriability of vertical and tropHIc transfer of diazotroph derived N in the south wEst Pacific) conducted by Sophie Bonnet is released (http://www.biogeosciences.net/special_issue193.html). In the ocean, the availability of N is one of the most influential factors controlling primary productivity. Biological N_2 fixation, i.e., the reduction of atmospheric N_2 gas to biologically available ammonium (NH_4^+), constitutes the major source of new N for the surface ocean (140 ± 50Tg N yr^{-1}), significantly larger than riverine and atmospheric inputs. By maintaining a pool of bioavailable N, this process sustains oceanic productivity over broad timescales and space scales. However, a critical question that has been poorly studied is the transfer and fate of diazotroph-derived N (DDN) in the pelagic food webs. The actual flux of DDN that supports the growth of different groups of autotrophic and/or heterotrophic plankton and can be transferred up the trophic chain, remineralized and/or exported from the euphotic zone is unknown. To answer these questions, a triplicate mesocosm (55 000L) experiment was conducted in the southwest Pacific (New Caledonia; 22°29.073 S, 166°26.905 E) in January–February 2013 within the framework of the ANR–INSU–IRD–GOPS-funded VAHINE project. This study, which involved 25 scientists from 7 institutes, yielded a comprehensive data set on community-level responses to a diazotroph bloom and its impact on community changes, biogeochemical cycles and export.

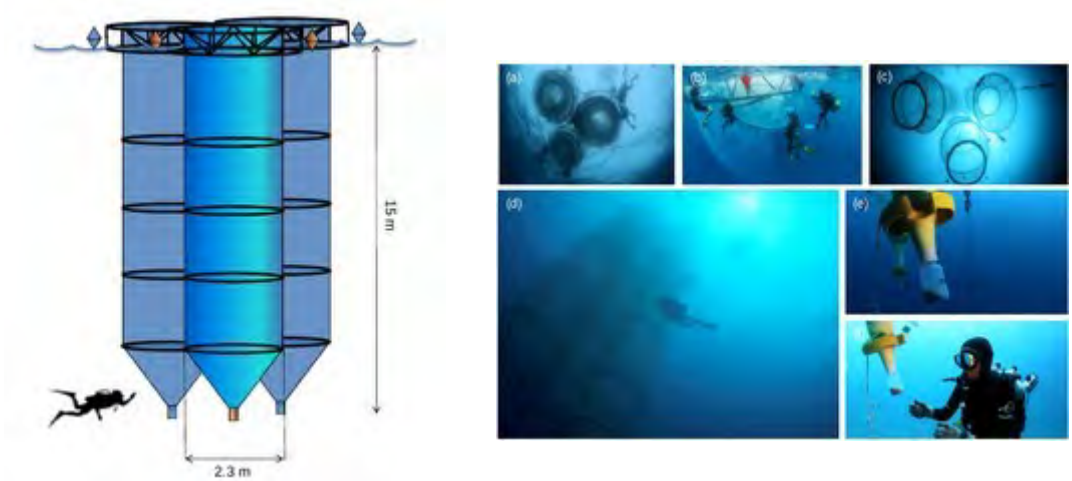


Figure 1: Drawing representing the main features of the mesocosms (left) and Right View of the experiment from the side and the seafloor: during (a–c) and after the deployment (d). Panels (e, f): collection of sediment traps by the scuba divers (photos: J. M. Boré and E. Folcher, IRD).

From: Bonnet, S., Moutin, T., Rodier, M., Grisoni, J.-M., Louis, F., Folcher, E., Bourgeois, B., Boré, J.-M., and Renaud, A.: Introduction to the project VAHINE: VAriability of vertical and tropHIc transfer of diazotroph derived N in the south wEst Pacific, Biogeosciences, 13, 2803-2814, doi:10.5194/bg-13-2803-2016, 2016.

2. Activities/main accomplishments in 2016 (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.)

Nitrogen and Phosphorous Atmospheric deposition and its biogeochemical impact in the Mediterranean basin (MERMEX-CHARMEX, Camille Richon, François Dulac):
Atmospheric deposition represents a significant source of nutrients at the Mediterranean basin scale. We apply natural anthropogenic nitrogen deposition fields simulated with the global model LMDz-INCA and the natural desert dust deposition simulated with the regional model ALADIN-Climat as additional nutrient sources to the high resolution oceanic biogeochemical model NEMOMED12/PISCE. Time series of modeled deposition fluxes are compared to available measurements. This comparison with measurements shows that both variability and intensity ranges are realistic enough for our main purpose of estimating the atmospheric deposition impact on Mediterranean biogeochemical tracers such as surface nutrient concentrations, chlorophyll a and plankton concentrations. Our results show that atmospheric deposition is one of the major sources of nitrogen and phosphorus for some regions of the oligotrophic Mediterranean Sea. More than 18 10^9gN month^{-1} are deposited to the whole Mediterranean Sea. This deposition is responsible for an average increase of 30 to 50 % in primary production over vast regions.
Natural dust-derived deposition of phosphorus is sparser in space and time (0.5 10^9g month^{-1} on average over the entire basin). However, dust deposition events can significantly affect biological production. We calculate fertilizing effects of phosphate from dust to be low on average (6 to 10 %) but up to 30% increase in primary productivity can be observed during the months when surface water stratification occurs. Finally, these fertilizing effects are shown to be transmitted along the biological chain (primary production, Chl a, phytoplankton, zooplankton, grazing, see Figure 2).

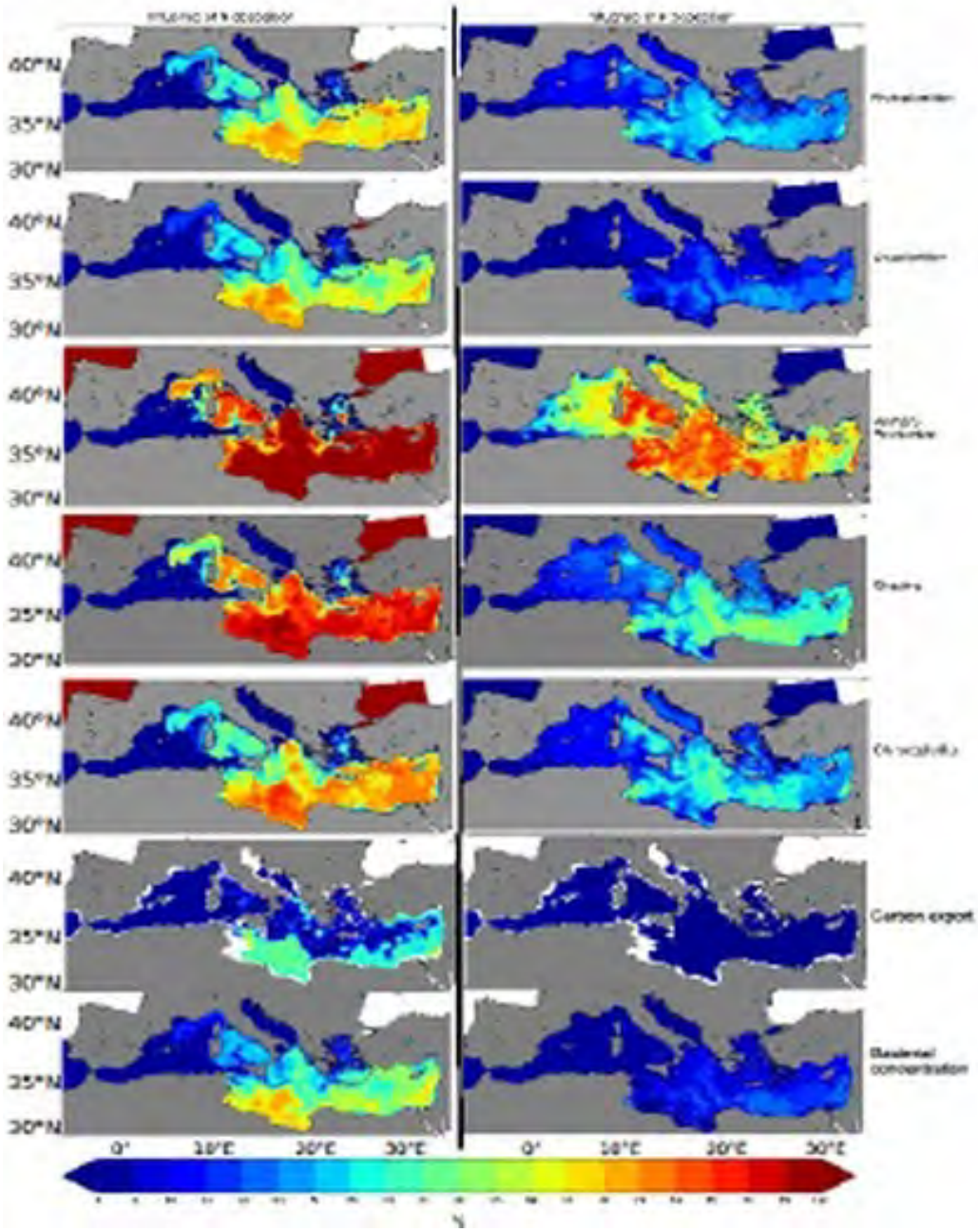


Figure 2: *Relative influence (%) of atmospheric deposition on biological tracers for the summer season (JJA)*

Variability of mineral dust deposition in the western Mediterranean basin and south-east of France (DEMO project, G. Bergametti and B. Laurent, funded by ADEME and INSU, MISTRALS - ChArMEx).

To investigate dust deposition dynamics at the regional scale, five automatic deposition collectors named CARAGA (Collecteur Automatique de Retombées Atmosphériques insolubles à Grande Autonomie in French, see Laurent et al., 2015 for more details) have been deployed in the western Mediterranean region during 1 to 3 years depending on the station. The sites include, from south to north, Lampedusa, Majorca, Corsica, Frioul and Le Casset (southern French Alps) (Figure 3). Deposition measurements are performed on a common weekly period at the five sites (Vincent et al., 2016). The mean dust deposition fluxes are higher close to the northern African coasts and decrease following a south–north gradient, with values from 7.4 $gm^{-2}.year^{-1}$ in Lampedusa (35°31' N, 12°37' E) to 1 $gm^{-2}.year^{-1}$ in Le Casset (44°59' N, 6°28' E). The maximum deposition flux recorded is of 3.2 $gm^{-2}.wk^{-1}$ in Majorca with only two other events showing more than 1 $gm^{-2}.wk^{-1}$ in Lampedusa, and a maximum of 0.5 $gm^{-2}.wk^{-1}$ in Corsica. The maximum value of 2.1 $gm^{-2}.year^{-1}$ observed in Corsica in 2013 is much lower than existing records in the area over the 3 previous decades (11–14 $gm^{-2}.year^{-1}$). From the 537 available samples, 98 major Saharan dust deposition

events have been identified in the records between 2011 and 2013. Vincent et al. (2016) used complementary observations provided by both satellite and air mass trajectories to identify the dust provenance areas and the transport pathways from the Sahara to the stations for the studied period. Despite the large size of African dust plumes detected by satellites, more than 80% of the major dust deposition events are recorded at only one station, suggesting that the dust provenance, transport and deposition processes (i.e. wet vs. dry) of dust are different and specific for the different deposition sites in the Mediterranean studied area (Vincent et al., 2016). The results tend to indicate that wet deposition is the main form of deposition for mineral dust in the western Mediterranean basin, but the contribution of dry deposition (in the sense that no precipitation was detected at the surface) is far from being negligible, and contributes 10 to 46% to the major dust deposition events, depending on the sampling site.

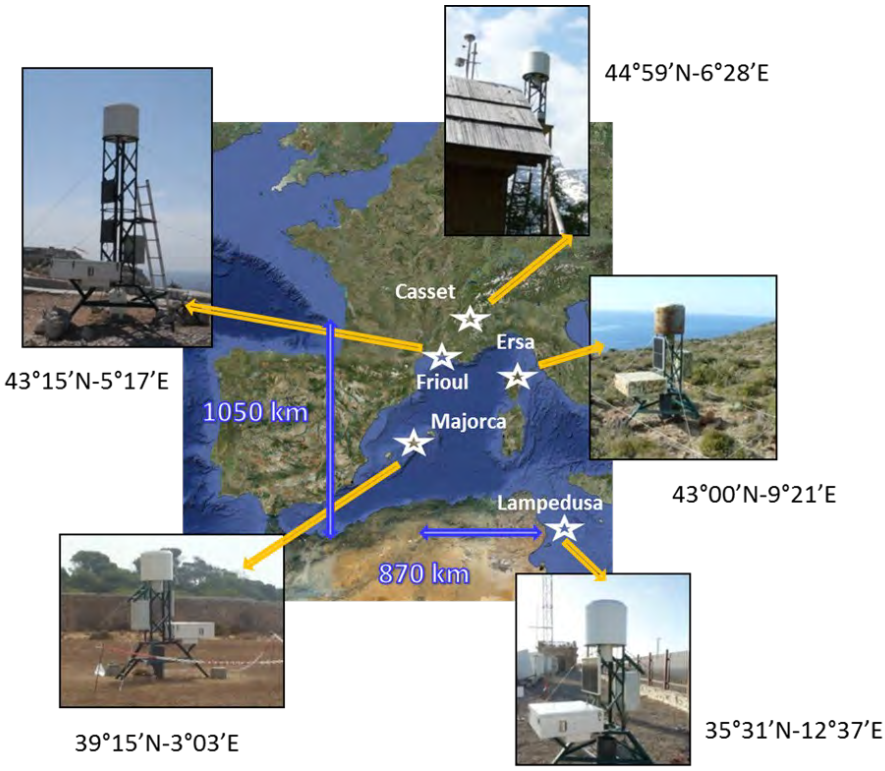


Figure 3: *Location of the CARAGA samplers constituting the deposition network deployed in the western Mediterranean basin and southern of France.*

The GEOVIDE project / link with the SOLAS project: Quantification of trace element atmospheric deposition fluxes (Shelley et al., 2017)

Atmospheric deposition is an important input route of trace elements (TEs) to the global ocean. As atmospheric inputs impact phytoplankton community health and dynamics, atmospheric TE fluxes, and in particular atmospheric iron fluxes, are a key component of marine biogeochemical models. Trace element concentrations were determined in dry (aerosols) and wet (precipitation) deposition samples from the North Atlantic, north of 40°N, during the GEOVIDE cruise (GEOTRACES cruise GA01) in May/June 2014. Atmospheric aerosol loading in the study region was low (~ 2–500 ng m^{-3}) throughout the cruise, as inferred from the very low aerosol Ti concentrations determined (0.0084–1.9 ng.m^{-3}). Wet deposition appeared to be of roughly equal or greater importance than dry deposition to the total depositional flux of TEs, which is consistent with other regions of the Atlantic Ocean outside of the influence of the Saharan plume. It can be challenging to convert aerosol chemical composition data into reliable flux estimates, due to the uncertainties associated with the parameterisation of dry deposition velocity, and precipitation rate. Therefore, the goal of this study was to compare TE flux estimates derived from two different techniques: (1) the traditional approach of summed wet and dry deposition TE fluxes, using concentration data, precipitation rates, and dry deposition velocities and, (2) using the inventory of the cosmogenic radioisotope beryllium-7 (^{7}Be) in the upper ocean as a proxy for atmospheric deposition. These two approaches yielded TE flux estimates that were in excellent agreement (within one standard deviation) for about half of the TEs under investigation. However, for the remaining TEs differences between the flux estimates ranged from two to forty times, with the traditional approach generally

being the higher of the two estimates. Therefore, factors that may contribute to this variation, such as differences in the timescale of integration and selection of representative deposition velocities and precipitation rates, are discussed. Our results suggest that the ^{7}Be approach continues to show promise in this application, particularly in regions where precipitation samples cannot be routinely collected (Figure 4).

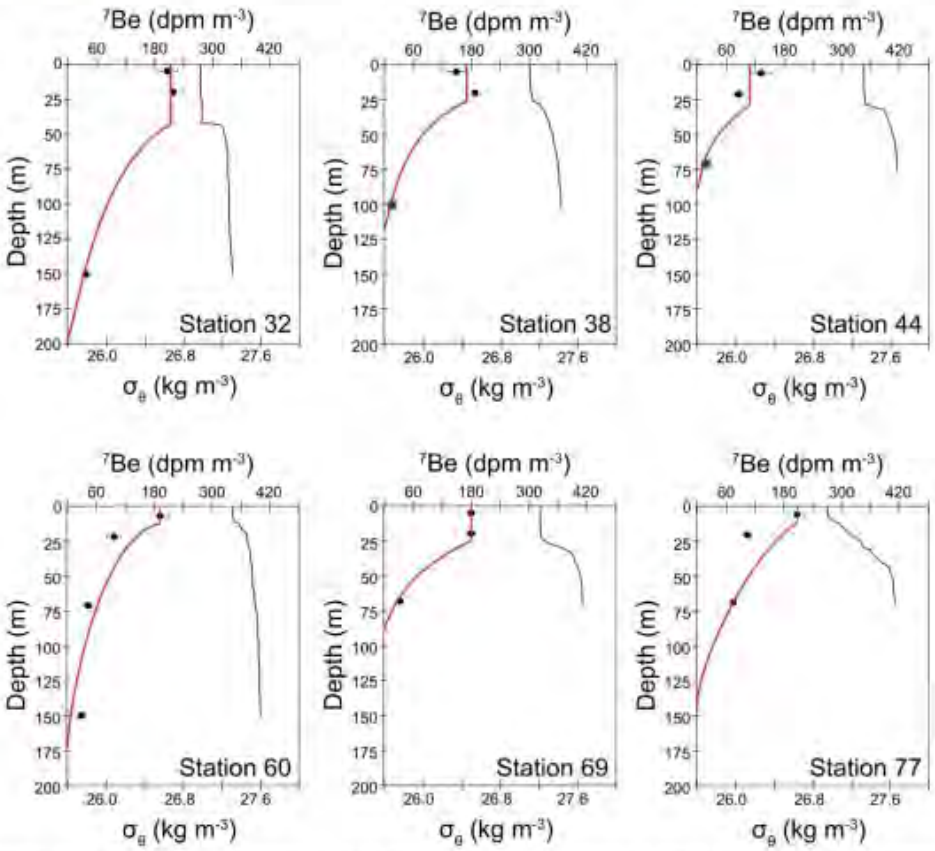


Figure 4: *Concentration profiles (black dots), integrated inventory of 7Be (red continuous line) in the water column and potential density anomaly (σθ, black continuous line) for all stations sampled during the GEOVIDE cruise (Shelley et al., 2017)*

Dust from Patagonia (DFP) project (R. Losno):
Zihan Qu defended his PhD on the dust emission from Patagonia and South Africa. After three years of continuous weekly based aerosol sampling for chemical analyses, we have replaced in may at Rio Gallegos (Argentina) aerosol sampling with an optical particle counter operating at one hour frequency. During 2016, we have observed a very low background of about 1µg.m^{-3} of atmospheric aerosol with frequent and short pulses up to 50µg.m^{-3} (Figure 5). These pulses occur during dry periods when fine particles present in the soil are no longer sicked by humidity. A seasonality is observed with higher emission in summer time.

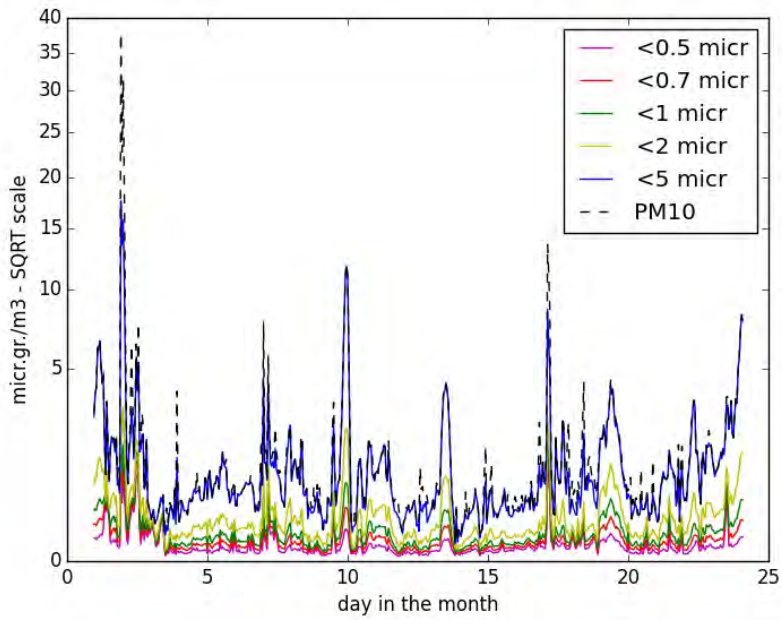


Figure 5: *example of particle emission pulses in measured in Southern PatagoniaMajor peaks are related to the air dryness and temperature, telling that dust emission in Southern Patagonia is strongly dependent on the soil wetness conditions.*

PARCS and MACA mesocosm projects (Karine Sellegri):

The joint PARCS (WP3) and IPEV MACA project mesocosm experiment is underway in Svalbard during the first 2 weeks of March 2017. Coordinated by Karine Sellegri (LaMP) and Barbara d'Anna (IRCELYON), 3 mesocosms have been set up in a habour. Doses of pollutants (sulphate, ammonium and nitrate) are being added to examine effects on marine biology and primary/secondary aerosol emissions.

Figure 6: *Picture of mesocosms installation*

SAM Project (K. Sellegri):

Abstract Earth, as a whole, can be considered as a living organism emitting gases and particles into its atmosphere, in order to regulate its own temperature. In particular, oceans may respond to climate change by emitting particles that ultimately will influence cloud coverage. At the global scale, a large fraction of the aerosol number concentration is formed by nucleation of gas-phase species, but this process has never been directly observed above oceans. Using semicontrolled seawater-air enclosures, we show evidence that nucleation may occur from marine biological

emissions in the atmosphere of the open ocean. We identify iodine-containing species as major precursors for new particle clusters' formation, while questioning the role of the commonly accepted dimethyl sulfide oxidation products, in forming new particle clusters in the region investigated and within a time scale on the order of an hour. We further show that amines would sustain the new particle formation process by growing the new clusters to larger sizes. Our results suggest that iodine-containing species and amines are correlated to different biological tracers. These observations, if generalized, would call for a substantial change of modeling approaches of the sea-to-air interactions.

AMOP (PI: A. Paulmier, co-PIs: B. Dewitte, C. Maes and V. Garçon):

AMOP is a trans-disciplinary project based on a cruise, a fixed mooring, and modeling activities, associated with an effort of experimental development (instrumentation, sensors). It is aimed at better understanding the Oxygen Minimum Zones (OMZs) and the ocean deoxygenation, with a focus on the OMZ off Peru (Figure 7). It gathers a consortium of scientists from Peruvian and French institutions (IMARPE, IGP, UNAC; LEGOS, MIO, OOV, MARBEC, LATMOS, LEMAR, LPO, OOB, EPOC, LOCEAN, ISTO, US IMAGO, DT INSU) and benefit from a collaboration Germany (SFB754 «Climate-biogeochemistry Interactions in the Tropical Ocean») and other countries: Mexico (CICESE; UABC); Denmark (University of Aahrus); Spain (IEO, CO-Malaga); Chile (CEAZA); USA (UCLA). It is in the line with international programs (Integrated topics of SOLAS Science Plan 2015-2025) and regional networks (LMIs DISCOH and PALEOTRACES 2).

Work in progress

- Final O_2 CTD calibration with Winkler data and on the STOX-zero adjustment for cruise and mooring data: under progress (contribution: Jacques Grelet, Carole Saout / GLAZEO, Emilio Garcia-Robledo, Aurélien Paulmier);

- Ocean Science Meeting: New Orleans (USA) on February 21-26th, 2016, including an AMOP side meeting.

- Two full days AMOP workshop: at the MIO (Marseille, FRANCE) on October 12-13th, 2016, for discussions and organization of the preliminary scientific results and for the definition of the different tasks in 2017.

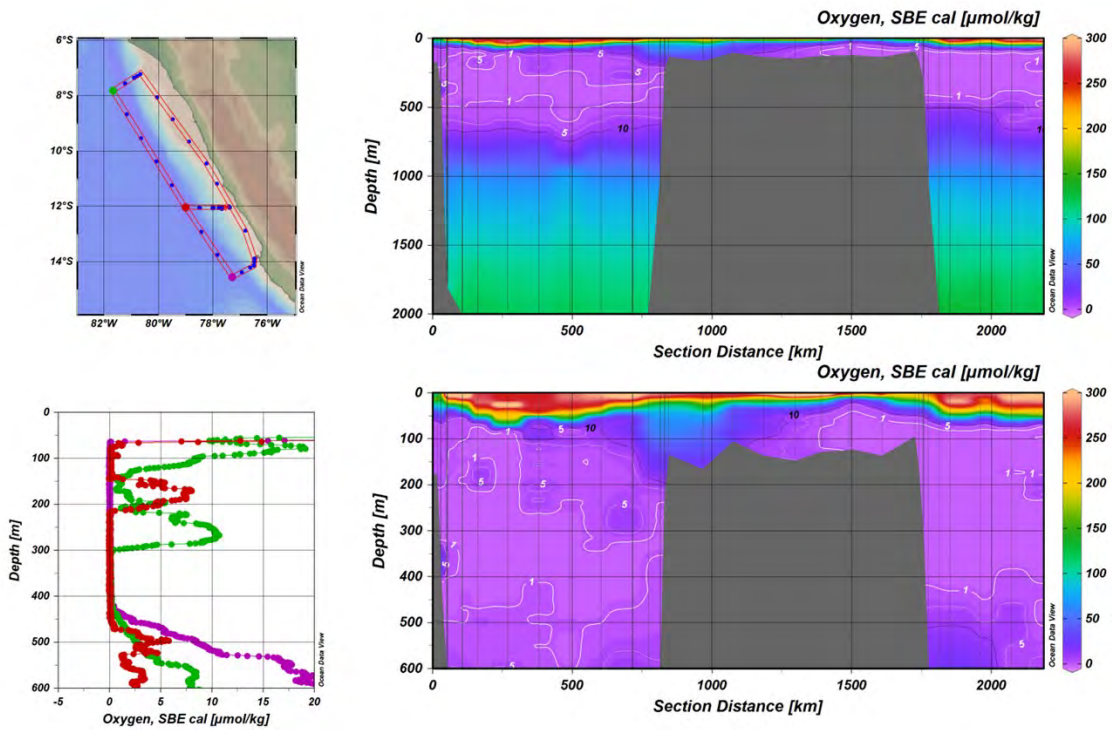


Figure 7: *O_2 distribution during AMOP cruise off Peru with a low O_2 adjustement (Pers. Com.: E. Garcia-Robledo)*

BIOAMAZON (IRD-FAPEMA, Brésil), EU F7 CARBOCHANGE (N. Lefevre):

The Amazon is a CO_2 source for the atmosphere with fugacities (fCO_2) in the river about 10 times stronger than the surface fCO_2 values in the tropical Atlantic. When Amazonian water mixes with the ocean, its turbidity decreases and it brings nutrient salts to the poor waters of the ocean. A significant biological activity develops itself and photosynthesis leads to high concentrations of chlorophyll in the surface ocean, detectable by satellite, with CO_2 consumption. The oceanic values of fCO_2 then become significantly lower than the atmospheric fCO_2 value, which creates a CO_2 sink. The ship MN Colibri, a ship traveling between France and Guyana (Kourou) for space programs, is equipped with an autonomous system for measuring fCO_2 in the ocean and the atmosphere since 2006. From 30 trips Of the MN Colibri (2006-2013), the air-sea flow of CO_2 in the Amazon plume is estimated and shows a strong CO_2 sink, especially in May at the time of the Amazon flood (Figure 8 **a-j**, negative values in blue). The current climate of CO_2 does not reproduce the Amazon plume (Figure 8, **k-1**, **m-n**, positive values in green-yellow). The CO_2 flux of the tropical Atlantic recalculated by taking into account the Amazon plume shows that current estimates overestimate the balance of about 10% (Ibánhez et al., 2015, 2016).

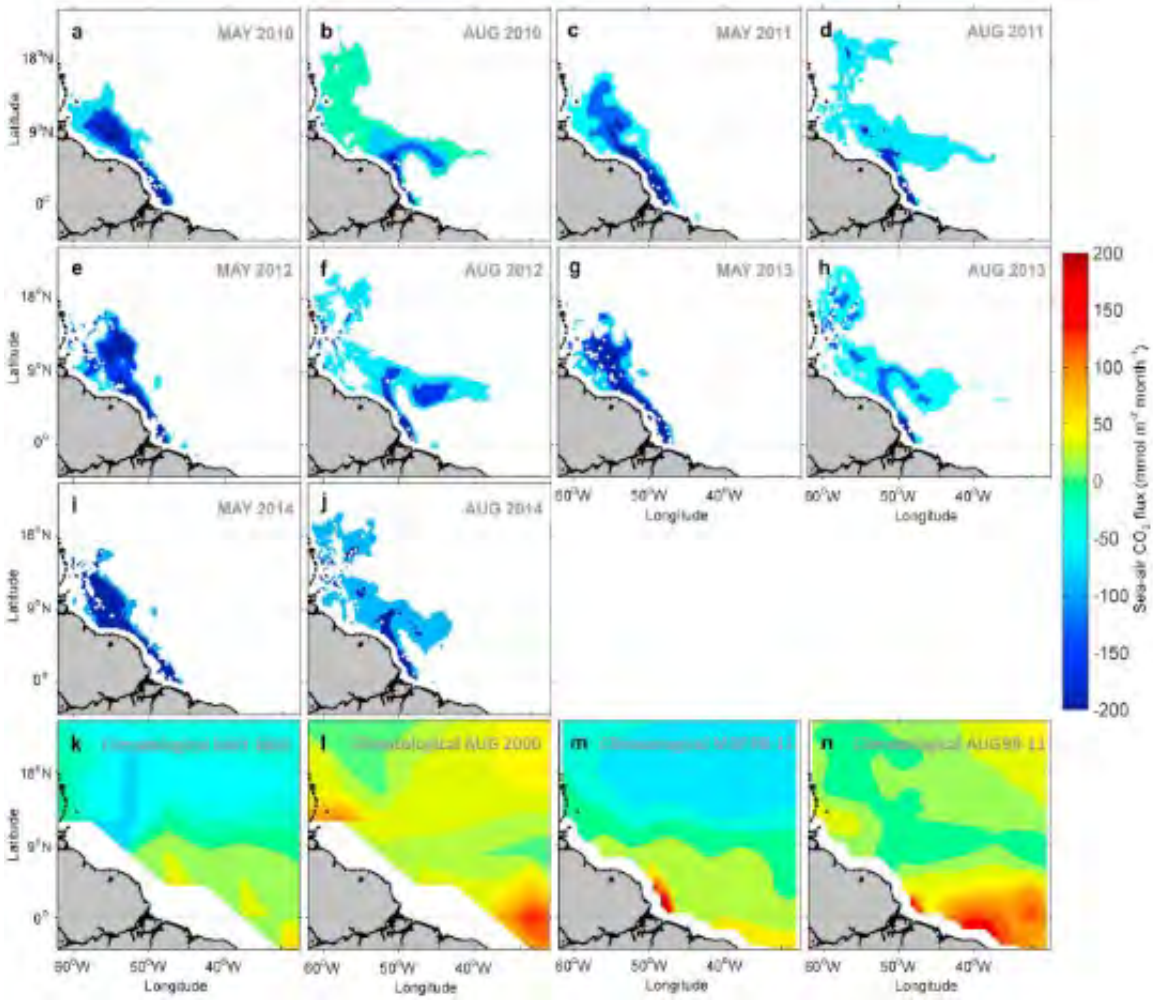


***Figure 8: a-j** Distribution of fCO_2 (in µatm) in the Amazon plume (salinity <35) from 2010 to 2014 for May (Amazon rainfall) and August (retroflection of the North Brazil current).**k-l.** Distribution of climatological fCO_2 Takahashi et al. (2009) with reference year 2000.**m-n**. Distribution of fCO2 from the climatology of Landschützer et al. (2014).*

Atmospheric Iodine Chemistry, part of MiRE project, ANR (F. Louis, florent.louis@univ-lille1.fr, et al.):

Marine iodine is known to react with hydroxyl (OH) and hydroperoxyl (HO_2) radicals to form iodine oxides (I_xO_y), thus affecting the HO_2/OH ratio in the atmosphere (Figure 9). Small iodine oxides include iodine monoxide and dioxides (IO and OIO) and their hydrated counterparts, hypoiodous and iodous acids (HOI, HOIO). Bigger iodine oxides have been detected in the atmosphere that include I_2O_2, I_2O_3, I_2O_4, and diiodine pentoxide (I_2O_5). Iodic acid HIO_3, whose most stable conformer is $HOIO_2$, was identified as one of the product of the IO + HO_2 reaction and has been shown to also

be formed by the simple addition of OH to OIO. Moreover, HIO_3 corresponds to the hydrated form of I2O5. Very recently (Sipilä et al.) reported evidence of iodine oxide particle formation through addition of iodic acid followed by restructuration to I_2O_5; high HIO_3 concentrations were observed at Mace Head (Ireland) with a gas phase peak concentration greater than 108 molecules cm^{-3}.

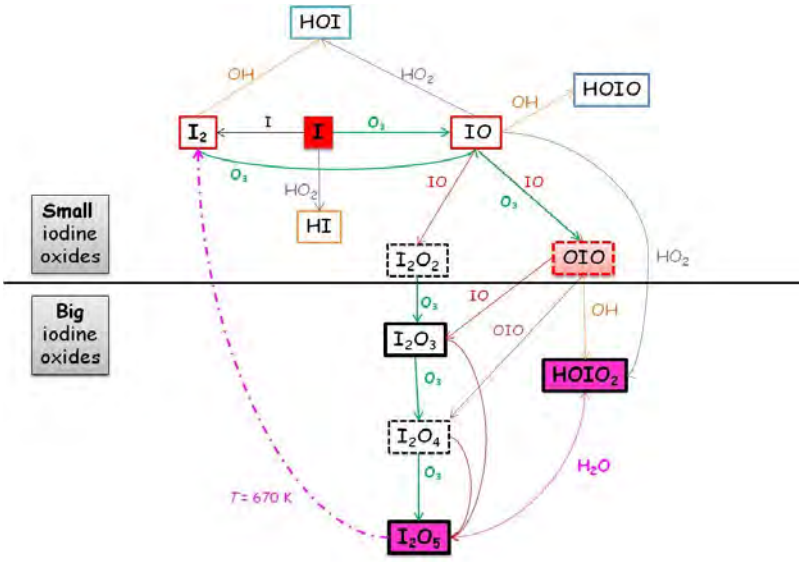


Figure 9: *Gas-phase iodine chemistry leading to the formation of I_xO_y species*

Very little is known about the gas phase properties of iodic acid. In 2016, we performed high-level ab initio calculations to characterize the microhydration processes of iodic acid containing one and two water molecules (Khannische et al., 2016a). The relevance of such investigations is underlined by the high solubility of HIO_3 species, which will dissolve in water and form aqueous solutions of iodate (IO_3^-). Mono- and di-hydration of iodic acid are favored processes at tropospheric and ambient conditions with the formation of molecular clusters $HOIO_2$_1wa and $HOIO_2$_2wa (Figure 10) at T below 310 K.

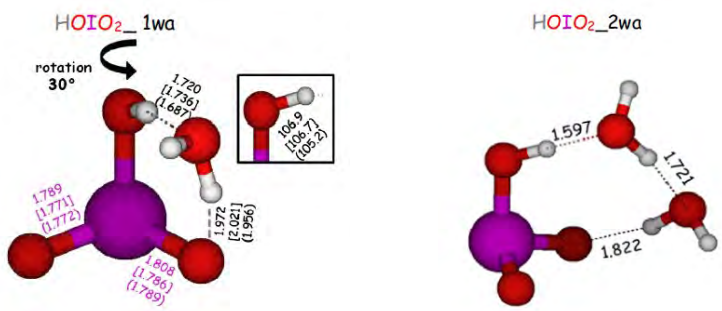


Figure 10: *Optimized structures of HOIO2 with one and two water molecules*

Iodine pentoxide and HIO_3 correspond to the anhydride and hydrated forms, respectively and are key species of iodine (V) oxides. However, to date the kinetics of the reaction involving I_2O_5 and iodic acid are not explicitly considered in the atmospheric model. To overcome this, high level quantum chemistry tools were used to determine the thermokinetic parameters governing the conversion of I_2O_5 to iodic acid in gas phase upon exposition to water (Khannische et al., 2016b). It can be concluded that at atmospheric conditions, the homogeneous gas phase reaction of hydration of I_2O_5 into HIO_3 is too slow with respect to the nucleation process that leads to the formation of I_2O_5 particles.

This work was part of the MiRE Project (Mitigation of Outside Releases in Case of Nuclear Accident), which is funded by the French National Research Agency (ANR) through the Programme d'Investissement d'Avenir (PIA) under Contract "ANR-11-RSNR-0013-01". The authors also appreciate the support from PIA managed by the ANR under Grant Agreement "ANR-11-LABX-0005-01" called Chemical and Physical Properties of the Atmosphere (CaPPA) and also the support by the Regional Council "Nord-Pas-de-Calais" and the "European Funds for Regional Economic Development".

BISOU : Bioavailability and solubility of iron present in mineral dusts and volcanic ashes (2016-2018).PI: E. Journet (emilie.journet@lisa.u-pec.fr).
The oceanic biological C pump is driven by the efficiency of phytoplanktonic photosynthesis, which depends on nutrient availability. The research focuses on Fe, a limiting nutrient in vast areas of the surface ocean. Deposition of mineral dust and volcanic ash can supply Fe to these regions. The potential of dust and ash to alleviate Fe limitation in the ocean is usually assessed in terms of Fe solubility and its various mineralogical and atmospheric controls. However, Fe solubility measurements do not necessarily reflect Fe bioavailability. Here, we propose to link, for the first time, Fe solubility determinations with Fe bioavailability assessments. The mineralogy and water-soluble Fe fraction of ash and dust will be measured, and their effect via dry and wet deposition processes on starved phytoplankton cultures will be considered (Figure 11). The project will shed light on factors that dictate the short- and long-term impact of dust and ash deposition on the oceanic biological pump.

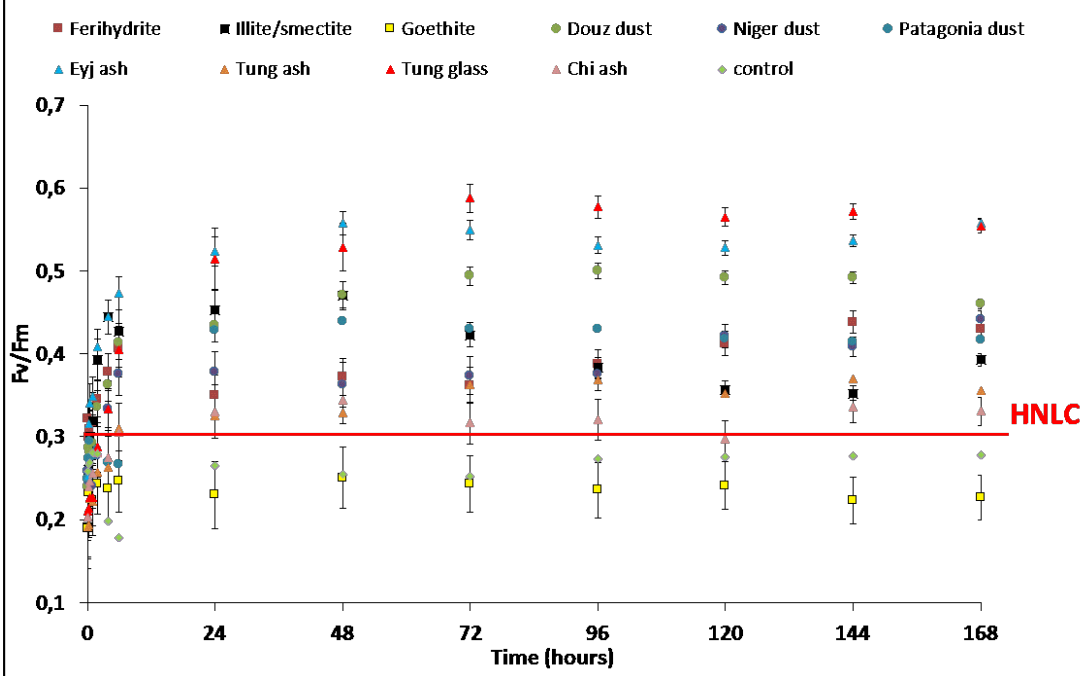


Figure 11: Evolution of cell physiology (quantum photosynthetic efficiency Fv / Fm) of iron starved Dunaliella tertiolecta after addition of "pur" minerals (square plot) of volcanic ash (triangle plot) and desert dust (rhombus plot). (Ammar et al., First results presented at EGU 2017 conferences)

Water isotopes: a tracer of ocean-atmosphere-ice water fluxes (LOCEAN; G. Reverdin, G. Aloisi; Univ. of Iceland Reykjavik, M. Benetti)

In the past year, we have put together an archive of atmospheric boundary layer and surface data in the Atlantic Ocean relevant for water fluxes, including water isotopes in the atmospheric boundary layer (Benetti et al., 2016). We have also compiled our surface observations in sea water over the Atlantic Ocean and western Mediterranean to better understand how air-sea water fluxes (evaporation, precipitation, but also inflow from continents and ice) imprint the surface ocean isotopic properties (Reverdin et al., 2017). In particular, this emphasizes the humidity of the air as a key factor in evaporative flux properties, as well as the special properties of near-equatorial rainfall under the ITCZ.
During the **WAPITI cruise** (P.I. J.-B. Sallée) continuous measurements of water vapour and surface sea water isotopic properties in the Southern Ocean from the Magellan Channel to the southern Weddell Sea (January-March 2017), over a wide range of weather conditions, including some very dry air flowing from the Antarctic continents. The sea water isotopes in the southern Weddell Sea are strongly imprinted by the formation and/or melt of sea ice, evaporation in contact with the very cold continental air, as well as with exchan

Benetti, M., G. Reverdin, A. Loisi, and A. Sveinbjörnsdottir, (2017). Stable isotopes in surface waters of the Atlantic Ocean: indicators of ocean-atmosphere water fluxes and oceanic mixing processes. J. Geophys. Res. Oceans, doi 10.1002/2017JC012712.

Benetti, M., H.C. Steen-Larsen, G. Reverdin, A.E. Sveibjörnsdottir, G. Aloisi, M.B. Berkelhammer, B. Bourlès, D. Bourras, G. de Coëtlogon, A. Cosgrove, A.-K. Faber, J. Grelet, S.B. Hansen, R. Johnson, H. Legoff, N. Martin, A.J. Peters, T.J. Popp., T. Reynaud, et M. Winthe (2017)r. Stable isotopes in the atmospheric marine boundary layer water vapour over the Atlantic Ocean, 2012-2015. Scientific Data/Nature.. doi:10.1038/sdata.2016.128

Ibánhez, J.S.P., Araujo, M., and Lefèvre, N. (2016). The overlooked tropical oceanic CO2 sink. Geophysical Research Letters 43, doi: 10.1002/2016GL068020.

Khanniche, S., F. Louis, L. Cantrel, I. Cernusak (2016a), A Theoretical Study of the Microhydration of Iodic Acid ($HOIO_2$), Comp. Theor. Chem., 1094 98-107.

Khanniche, S., F. Louis, L. Cantrel, I. Cernusak (2016b), Computational study of the $I_2O_5 + H_2O = 2\ HOIO_2$ gas-phase reaction, Chem. Phys. Lett., 662 114-119.

Sellegri, K., et al. (2016), Evidence of atmospheric nanoparticle formation from emissions of marine microorganisms, Geophys. Res. Lett., 43, doi:10.1002/2016GL069389.

Shelley R. U., Roca-Martí M., Castrillejo M., Sanial V., Masqué P., Landing W. M., van Beek P., Planquette H., Sarthou G. Quantification of trace element atmospheric deposition fluxes to the Atlantic Ocean (>40°N; GEOVIDE, GEOTRACES GA01) during spring 2014. Deep Sea Research Part I: Oceanographic Research Papers, 119, 34–49. http://doi.org/10.1016/j.dsr.2016.11.010

Vincent J., Laurent B., Losno R., Bon Nguyen E., Roullet P., Sauvage S., Chevaillier S., Coddeville P., Ouboulmane N., Giorgio di Sarra A., Tovar-Sánchez A., Sferlazzo D., Massanet A., Triquet S., Morales Baquero R., Fornier M., Coursier C., Desboeufs K., Dulac F. and Bergametti G. (2016), Variability of mineral dust deposition in the western Mediterranean basin and south-east of France, *Atmospheric Chemistry and Physics*, 16 (14), 8749-8766. doi:10.5194/acp-16-8749-2016

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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.

ges of water (and melt) of the continental ice shelves (Fichner ice shelf).

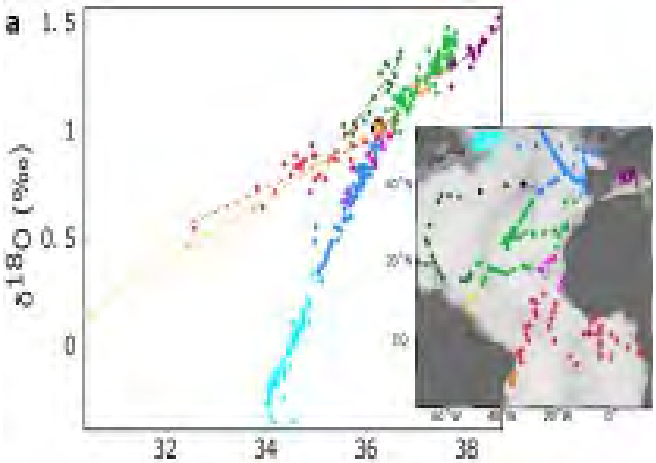

Figure 12: *from Benetti et al. (2017) showing the surface sea water d^{18}O distribution as a function of salinity in the tropical and northern Atlantic Ocean. The dashed lines are linear regressions on subsets of the data. They outline different fresh water sources (light blues: from higher latitudes; yellow and red from equatorial South America and equatorial Atlantic). Notice also the smaller slope in the western Mediterranean indicative of the low humidity of the evaporative flux in this region.*

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Benetti, M., G. Reverdin, A. Loisi, and A. Sveinbjörnsdottir, (2017). Stable isotopes in surface waters of the Atlantic Ocean: indicators of ocean-atmosphere water fluxes and oceanic mixing processes. J. Geophys. Res. Oceans, doi 10.1002/2017JC012712.

Benetti, M., H.C. Steen-Larsen, G. Reverdin, A.E. Sveibjörnsdottir, G. Aloisi, M.B. Berkelhammer, B. Bourlès, D. Bourras, G. de Coëtlogon, A. Cosgrove, A.-K. Faber, J. Grelet, S.B. Hansen, R. Johnson, H. Legoff, N. Martin, A.J. Peters, T.J. Popp., T. Reynaud, et M. Winthe (2017)r. Stable isotopes in the atmospheric marine boundary layer water vapour over the Atlantic Ocean, 2012-2015. Scientific Data/Nature.. doi:10.1038/sdata.2016.128

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Khanniche, S., F. Louis, L. Cantrel, I. Cernusak (2016b), Computational study of the $I_2O_5 + H_2O = 2\ HOIO_2$ gas-phase reaction, Chem. Phys. Lett., 662 114-119.

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4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

PART 2 - Planned activities from 2017/2018 and 2019

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

Exploitation of the OUTPACE campaign (Oligotrophy to UlTra-oligotrophy PACific Experiment): Special issue in Biogeosciences.

The OUTPACE oceanic cruise was undertake between February 18 and April 3, 2015 in the Pacific Ocean on board the R/V L'Atalante.

The overall goal of OUTPACE (Oligotrophy to UlTra-oligotrophy PACific Experiment) was to obtain a successful representation of the interactions between planktonic organisms and the cycle of biogenic elements in the western tropical South Pacific Ocean across trophic and N_2 fixation gradients. Within the context of climate change, it is necessary to better quantify the ability of the oligotrophic ocean to sequester carbon through biological processes. OUTPACE was organized around three main objectives which were: (1) To perform a zonal characterization of the

biogeochemistry and biological diversity of the western tropical South Pacific during austral summer conditions, (2) To study the production and fate of organic matter (including carbon export) on three contrasting trophic regimes (increasing oligotrophy) with a particular emphasis on the role of dinitrogen fixation, and (3) to obtain a representation of the main biogeochemical fluxes and dynamics of the planktonic trophic network. (Extract from the abstract of Moutin, T., Doglioli, A., De Verneil, A., and Bonnet, S.: The Oligotrophy to the UlTra-oligotrophy PACific Experiment (OUTPACE cruise, Feb. 18 to Apr. 3, 2015), Biogeosciences Discuss., doi:10.5194/bg-2017-50, in review, 2017)

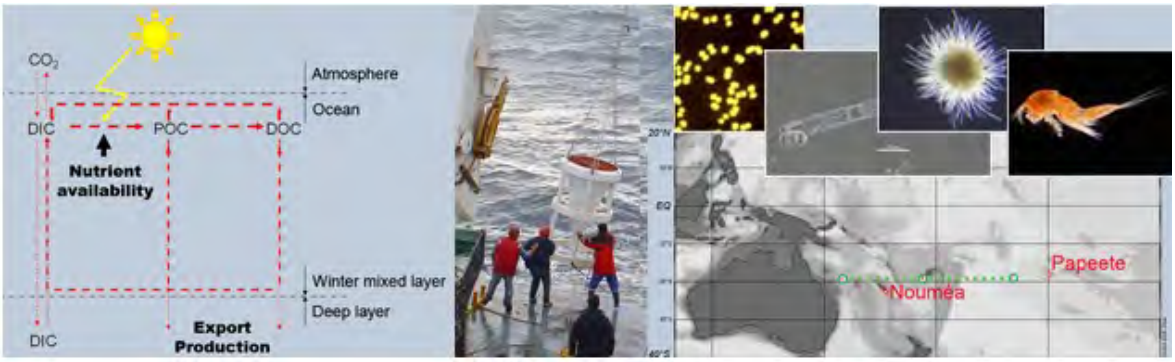

Figure 13: *The OUTPACE web site picture*

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

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

The Cryosphere and Atmospheric Chemistry (CATCH, Jennie Thomas, jennie.thomas@latmos.ipsl.fr**)**:
This is an emerging IGAC activity on Chemistry, Biology and Physics in Cold Regions co-sponsored by SOLAS. French SOLAS researchers are involved.
The CATCH mission is to facilitate atmospheric chemistry research within the international community, with a focus on natural processes specific to cold regions of the Earth. Cold regions include areas which are seasonally or permanently covered by snow and ice, from the high mountains to the polar ice sheets and sea ice zones as well as regions where ice clouds that undergo chemistry are found.

CATCH scientists will aim to understand and predict:

- How aerosols are formed and processed in cold regions;
- How cold region aerosols act as and impact cloud properties;
- Feedbacks between climate change and atmospheric chemistry that are determined by changes in the cryosphere;
- How the ice core record can be used to understand global environmental change;
- How physical, chemical, biological, and ecological changes in sea ice and snow impact atmospheric chemistry;
- How microbiology adapts and impacts biogeochemical cycling of elements in ecosystems of cold environments; and
- Establish background composition (trace gases and aerosols) in cold regions that are undergoing industrialization as well as impacted by climate change.

PEACETIME (ProcEss studies at the Air-sEa Interface after dust deposition in the MEditerranean sea) G. Guieu and K. Desboeufs.

PEAcEtIME proposes to study the fundamental physical, chemical and biological processes and their interactions at this key interface in the MS. Our objective is to assess how these mechanisms impact, and will impact, the functioning of the marine biogeochemical cycles, the pelagic ecosystem and the feedback to the atmosphere. This 4-year project proposes in particular to focus on a crucial mechanism forcing the biogeochemical coupling between the ocean and the atmosphere: atmospheric Saharan dust deposits. The strategy is designed to ensure that the knowledge acquired is used to understand that forcing across the MS today and in the future.

PEAcEtIME strategy is two-fold: (1) a cruise in the central MS in May when strong dust deposition events usually occur and (2) substantial atmospheric and oceanic modeling developments (from 0D to 3-D). PEAcEtIME is structured around 5 scientific tasks (plus a coordination Task 0 and an outreach Task 6) and associated strategies: 3 tasks address the main fundamental processes put into action by atmospheric deposition that will be studied mainly during the PEAcEtIME cruise, i.e. impact of atmospheric deposition on (Task 1) marine nutrient budget, (Task 2) biogeochemical processes in today and future climate conditions, and (Task 3) radiative budget. Task 4 will be dedicated to track a Saharan dust deposition event during the cruise. Task 5 will enhance our understanding of dust deposition forcing on marine biogeochemical cycles, the functioning of the pelagic ecosystem and the feedback to the atmosphere, taking benefit from atmospheric modeling and from the data acquired during the cruise to improve coupled dynamical/biogeochemical model. Finally, all proposed activities, during the cruise and in the laboratories in France and abroad, will nourish an important effort in outreach and communication (Task 6). During the cruise, in addition to the work performed at stations, continuous sampling will be operated along the whole transect (~2000 miles) to follow intensively a group of relevant parameters in very contrasted areas, from the European coasts to North off Africa. The strategy is completed by original on-board perturbation experiments (by the mean of minicosms).

The project is supported by a large consortium consisting of leading French institutions as well as several international collaborators with expertise on the topic. Sea going scientists as well as land based observations and modelers are involved. The synergy and expertise in the complementary disciplines along with the main responsibilities of the groups involved is made explicit in the table below. In total, PEAcEtIME associates ~80 people (of which 39 will embark the cruise + 1 film maker) from 14 research laboratories in France and 12 research laboratories abroad (6 embarking people, funding support by MISTRALS: MERMEX and CHARMEX joint project).

Figure 14: *Cruise track of the campaign to be held in May 2017 on R/V Pourquoi Pas ?*

The PEACETIME cruise is departing from La Seyne (France). Onboard the French oceanographic research vessel "Pourquoi Pas ?", a team of 40 scientists will study the impact of atmospheric deposition on the ocean during 33 days. (Twitter: @peacetimecruise, Website : http://peacetime-project.org/). An international and multidisciplinary scientific team will travel the central and western Mediterranean in search of atmospheric deposition of Saharan dust. Their aim is to study processes at the interface between the atmosphere and the ocean in this region of the world where atmospheric input plays a key role as a nutrient source for the marine biosphere. This campaign will allow to better understand how atmospheric deposition affects the functioning of the pelagic ecosystem in order to more accurately predict the future of biodiversity in the Mediterranean.

On board, the scientific team will combine in situ observations in the atmosphere and ocean with process studies in the water column. This will allow to characterize the chemical, biological and

physical properties of the atmosphere, the marine surface micro-layer, and the deeper layers of the Mediterranean. In order to optimize the chances of observing a deposition of Saharan dust in situ during the cruise, the cruise track is in a zone where the probability of this type of event is greatest. In the event of such an occurrence, the vessel will be diverted from its original transect to the identified deposit area. Another specific features of this campaign is to embark "climatic reactors" that are devices reproducing on a small scale the air-sea exchanges under current and future environmental conditions (acidification and increase of the temperature of the sea water).

This coordinated multidisciplinary effort will better characterize the impact of atmospheric deposition in the ocean and their feedback to the atmosphere in a nutrient-poor system such as the Mediterranean Sea. PEACETIME is a GEOTRACES Process-study (GApr09) and received support from SOLAS and IMBER.

Surface water isotopes and air-sea exchanges around Anrtarctica (G. Reverdin): At the beginning of 2017, surface water isotopic composition was measured on different cruises around Antarctica (in particular, ACE) and in the Weddell Sea (WAPITI), as well as atmospheric measurements to document air-sea exchanges of water isotopes (through evaporation/precipitation) and to separate this contribution from inputs from the continent and ice shelves in the ocean heat and freshwater budget. One objective is to clarify the mechanisms of formation of shelf water and deep Weddell Sea water.

The BIOCAP project / link with the SOLAS project:

1- **A potential source of Fe binding organic ligands to the surface ocean from wet deposition. This abstract will be presented at the ATMOCHEMBIO meeting (19-June 2017, Clermont-Ferrand)**

M. Cheize, A.C. Baudoux, E. Bucciarelli, A. Tagliabue, K. Desboeufs, A.R. Baker, G. Sarthou

Iron (Fe) is an essential micronutrient for all marine organisms. More than 99% of Fe (III) is bound to natural organic ligands in seawater. One of the main inputs of iron to the surface open ocean is dry and wet aerosol deposition. We measured for the first time Fe organic speciation by voltammetry (CLE-ACSV) in seven rainwater samples collected over the Eastern Tropical North Atlantic Ocean during the AMT 19 Cruise (2009). The potential involvement of bioaerosols on Fe organic speciation in wet deposition was also investigated. In these rainwaters, concentrations of total dissolvable Fe (unfiltered) ranged from 25 nM to 635 nM, while concentrations of Fe organic ligands varied between 40 and 1100 nM. Conditional stability constants were characteristic of strong Fe-binding ligands (~10^{22} M^{-1}). The highest Fe and organic ligand concentrations were associated with the highest aluminium and silicon concentrations from a Saharan dust wet deposition event. Genomic approach revealed the presence of bacteria and yeast in the rainwater events. Their capacity to produce siderophores was tested, highlighting their ability to produce strong Fe specific organic ligands in different environmental conditions including in salty, nutrient rich and depleted media. This suggests that bioaerosols may be a source of Fe organic ligands to the open ocean that has not been considered yet. Preliminary global modeling experiments will also be discussed in terms of potential atmospheric input of Fe organic ligands to the surface of the ocean.

2- **Iron Organic Complexation In Cloud Water Samples From The Puy De Dôme Station (France). This abstract will be presented at the ATMOCHEMBIO meeting (19-June 2017, Clermont-Ferrand)**

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

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

higher for the two lowest pH values (~ 0.3 nM) compared to the one at pH 6 (0.05 nM). We then analysed six natural cloudwater samples collected at the Puy de Dôme station (France) at pH 6. Total Fe concentrations measured by SF-ICP-MS varied between 40 and 226 nM. Results clearly evidenced the presence of Fe-binding ligands in excess to the total Fe concentration in two of the cloudwater samples. The excess Fe-binding ligand concentrations ranged from 80 to 100 nM. Our results showed, for the first time, that Fe present in cloudwater could be bound to organic ligands, with conditional stability constants close to the pyoverdin, a siderophore excreted by bacteria. These results are consistent with the potential production of siderophores by cloud microorganisms ([5]). Iron complexation by siderophores could have a significant impact on the cloud chemistry and its oxidant capacity ([8]), as well as on the global Fe biogeochemical cycle.

References

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[3] Cheize, M. et al., Anal. Chim. Acta, 2012, 736, 45– 54
[4] Willey et al., Atmos. Environ., 2015, 107, 187-193
[5] Vinatier et al., Environ. Sci. Technol., 2016, 50, 9315-9323
[6] Huang W. et al., J. Photochem. Photobiol. A, 2012, 239, 17-23
[7] Li J. et al., J. Photochem. Photobiol. A, 2010, 212, 1-7
[8] Passananti, M. et al., Environ. Sci. Technol., 2016, 50, 9324–9332

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

Ocean Acidification Workshop, organized in Dakar, Senegal, Februry 2017, co-sponsored by SOLAS, Future Earth Coast, OA-ICC, IRD, etc..

SOLAS-France meeting, July 5th 2017, IPGP, Paris.

SOLAS-Summer School at Cargèse (France, Corsica) in preparation planned July 23th to August 3th, 2018, including french SOLAS scientists (Cécile Guieu, Aurelien Paulmier, Véronique Garçon) in the organization and scientific committees.

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)

Sorry, this is not an extensive list

ANR-BIOCAP (2013-2017, ANR13BS060004)

ANR-GEOVIDE (2014-2018, ANR13BS060014)

PRIMEQUAL-ADEME (contract no. 0962C0067)

MISTRALS (Mediterranean Integrated Studies at Local and Regional Scales) programme as part of the Chemistry-Aerosol Mediterranean Experiment (ChArMEx) and Marine Ecosystem Response Mediterranean Experiment (MERMEX)

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)

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

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 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 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

Future emissions of marine halogenated very-short lived substances under climate change
Ziska et al., 2016

Halogenated Very Short-lived Substances (VSLS, e.g. bromoform, dibromomethane, methyl iodide) are naturally produced in the oceans and are involved in tropospheric and stratospheric ozone depletion. The effect of climate change on the oceanic emissions of these compounds is not well quantified. Based on present-day observed global oceanic and atmospheric concentrations and future data from three CMIP5 models, future sea-to-air fluxes of these VSLS are calculated. The simulations are used to infer possible effects of projected changes of physical forcing on emissions in different oceanic regimes. The RCP scenarios 2.6 and 8.5 are used as input data for the emission calculations. Of the parameters that have the main influence on the sea-to-air fluxes, the global sea surface temperatures show a steady increase during the twenty-first century, while the projected changes of sea surface wind speed is very small. The future sea-to-air fluxes of VSLS generally increase during the twenty-first century under the assumption of constant concentration fields in the ocean and atmosphere. The multi-model mean global emissions of bromoform increase by 9.0% between 2081–2100 under RCP 8.5 (2.6) and dibromomethane and methyl iodide emissions increase by 23.3% (6.4%) and 5.5% (1.5%),respectively.

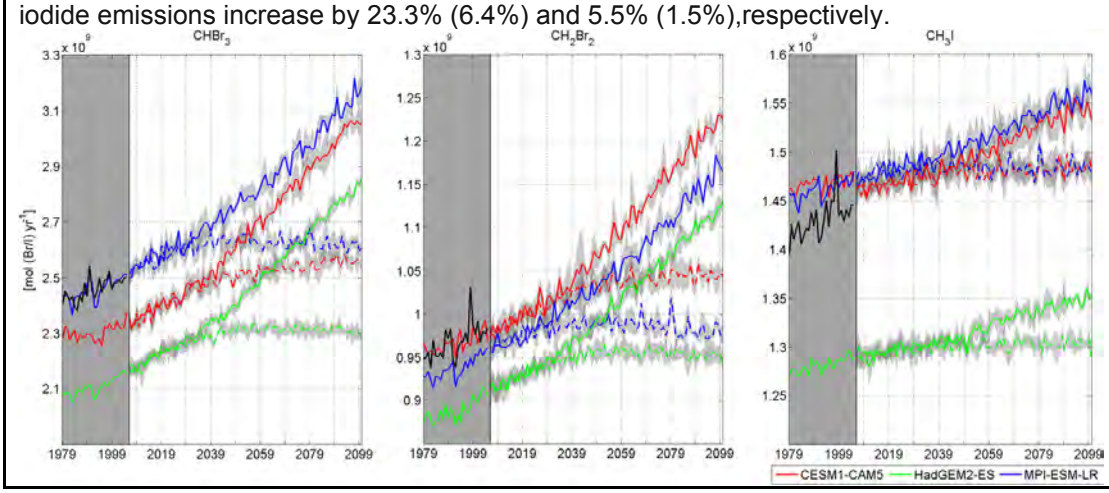

Fig. 5 from paper. Modeled global sea-to-air fluxes time series of $CHBr_3$ (left), CH_2Br_2 (middle) and CH_3I (right) in pmol m^{-2} h^{-1} calculated with the CMIP5 model output fields of CESM1-CAM5 (red), HadGEM2-ES (green) and MPI-ESM-LR (blue), using the mean of the historical ensemble runs from 1979 to 2005 (grey shading) and RCP 2.6 scenario (dashed lines) and RCP 8.5 scenario (solid lines) for the time period 2006–2100. Additionally, the standard deviation of the ensemble means (shaded area) and the ERA-Interim dataset from 1979 to 2005 (black line) are included.

Latitudinal and Seasonal Distribution of Particulate MSA over the Atlantic using a Validated Quantification Method with HR-ToF-AMS

Huang, S et al.

ENVIRONMENTAL SCIENCE & TECHNOLOGY 51 (1), 418-426, 10.1021/acs.est.6b03186,

Published: JAN 3 2017

Methanesulfonic acid (MSA) has been widely used as a proxy for marine biogenic sources, but it is still a challenge to provide an accurate MSA mass concentration with high time resolution. This study offers an improved MSA quantification method using high resolution time of-flight aerosol mass spectrometer (HR-ToF-AMS). Particularly, the method was validated based on an excellent agreement with parallel offline measurements (slope = 0.88, R-2 = 0.89). This comparison is much better than those using previously reported methods, resulting in underestimations of 31-54% of MSA concentration. With this new method, MSA mass concentrations were obtained during 4 North/South Atlantic cruises in spring and autumn of 2011 and 2012. The seasonal and spatial variation of the particulate MSA mass concentration as well as the MSA to non-sea-salt sulfate ratio (MSA:nssSO(4)) over the North/South Atlantic Ocean were determined for the first time. Seasonal variation of the MSA mass concentration was observed, with higher values in spring (0.03 mu g m(-3)) than in autumn (0.01 mu g m(-3)). The investigation of MSA:nssSO(4) suggests a ubiquitous and significant influence of anthropogenic sources on aerosols in the marine boundary layer.

2. Activities/main accomplishments in 2016 (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.)

SOLAS SCIENCE AND SOCIETY WORKSHOP - organized by Kiel scientists, took place in Brussels, discussed topics: Valuing carbon and the ocean's role, policy across the air-sea interface, and biogeochemistry and the shipping industry

GEOMAR PLYMOUTH COLLABORATION – between Anja Engel and the Marine Biological Association, Plymouth, UK (Dr. Michael Cunliffe) on microbial community composition in SML and ULW off the Peruvian coast

IRON MODEL INTERCOMPARISON - resulted in a paper in GBC, 2016 (see below)

BIOACID GOES COP22 -The German research network on ocean acidification and its partners speak up for the ocean at the climate change negotiations. Together with Plymouth Marine Laboratory, Labex MER, Scripps Institution of Oceanography, the Ocean and Climate Platform and the Ocean Acidification International Coordination Centre, the German research network on ocean acidification, BIOACID (Biological Impacts of Ocean Acidification) draws negotiators' attention to ocean change at the Marrakech *Climate Change* Conference COP22.

PHOTO EXHIBITION ABOUT OCEAN ACIDIFICATION PREMIERED AT GEOMAR - In a photo exhibition by the German research network on ocean acidification BIOACID, the two nature photographers Solvin Zankl and Nick Cobbing present BIOACID members at their work and introduce organisms that current ocean acidification research focuses on. The exhibition is a contribution to the Science Year 2016*17 – Seas and Oceans and is presented at GEOMAR Helmholtz Centre for Ocean Research Kiel, east shore campus, until 21 October. A website and a

web app with further information complement the exhibition (more information here).

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

1) Ziska, F., Quack, B., Tegtmeier, S., Stemmler, I. and Krüger, K., 2016, Future emissions of marine halogenated very-short lived substances under climate change, *Journal of Atmospheric Chemistry*, pp.1-16, DOI 10.1007/s10874-016-9355-3.
2) Wurl, O., Stolle, C., Van Thuoc, C., Thu, P. T., Mari, X., 2016, Biofilm-like properties of the sea surface and predicted effects on air-sea CO_2 exchange, *Progress in Oceanography*, 144, pp. 15-24, DOI: 10.1016/j.pocean.2016.03.002.
3) Tagliabue, A., Aumont, O., DeAth, R., Dunne, J.P.,Dutkiewicz, S., Galbraith, E.,Misumi, K., Moore, J.K., Ridgwell, A., Sherman, E., Stock, C., Vichi, M., Völker, C., Yool, A., 2016, How well do global ocean biogeochemistry models simulate dissolved iron distributions?, *Global Biogeochemical Cycles*, 30, pp. 149–174, doi:10.1002/2015GB005289.
4) Hauck, J. , Köhler, P. , Wolf-Gladrow, D. and Völker, C., 2016, Iron fertilisation and century-scale effects of open ocean dissolution of olivine in a simulated CO_2 removal experiment, *Environmental Research Letters*, 11 (2), 024007, doi:10.1088/1748-9326/11/2/024007.
5) Engel, A. and Galgani, L., 2016, The organic sea-surface microlayer in the upwelling region off the coast of Peru and potential implications for air–sea exchange processes *Biogeosciences*, 13 (4). pp. 989-1007. DOI 10.5194/bg-13-989-2016.

NEW VIDEO ON OCEAN ACIDIFICATION RESEARCH

BIOACID - Exploring Ocean Change

A new video shows how oceanographers, marine biologists and chemists, economists and social scientists of the BIOACID project investigate impacts of ocean acidification.

From the Arctic to the tropics, ocean acidification changes life in the sea. By absorbing carbon dioxide (CO_2) from the atmosphere, the ocean slows down global climate change. But in seawater, the greenhouse gas causes a chemical reaction with far-reaching consequences: carbonic acid is formed, and the pH drops.

A new video reveals how members of the German research network BIOACID examine the effects of acidification on the life and biogeochemical cycles in the ocean - and on all those who depend on it.

The international version with subtitles in English, German and French is available on YouTube at https://youtu.be/pnp8uQh6VAI

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

BIOACID - scientists from Bremen develop ecosystem model in cooperation with stakeholders in Norway

HOW OCEAN ACIDIFICATION AFFECTS SOCIETY

In cooperation with potentially affected stakeholders, Scientists from the University of Bremen have developed an ecosystem model that integrates the relevant environmental processes and examines ecological changes and their socio-economic implications.

Climate change does not only lead to global warming and an increase in weather extremes: The ocean is also affected by the uptake of carbon dioxide from the atmosphere: Chemical reactions reduce the pH of the sea water. While the process of ocean acidification is taking place already, possible consequences for marine ecosystems and human societies are not fully understood yet.

Scientists at the University of Bremen have now published first findings about the expected environmental changes and their impact in Norway. In cooperation with potentially affected stakeholders, they have developed an ecosystem model that integrates the relevant environmental processes and examines ecological changes and their socio-economic implications. The

researchers describe their participatory method in their article "Stakeholder-Informed Ecosystem Modeling of Ocean Warming and Acidification Impacts in the Barents Sea region" in the open access journal "Frontiers in Marine Science" (DOI: 10.3389/fmars.2016.00093), more information here.

Integrated Carbon Observing System (ICOS)

Underway CO_2 measurements onboard a container ship crossing the North Atlantic, representing one oceanic component of ICOS, were presented during the annual meeting of German ICOS (April 2016, meeting was in Kiel). Delegates from the German ministry for research and education (BMBF) and the ministry for traffic and infrastructure (BMVI), important ICOS stakeholders, were also present during this meeting. Data usage and planning for the next years of ICOS is an outcome from this (and similar) meetings.

PART 2 - Planned activities from 2017/2018 and 2019

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

Baltic GasEx 2018 project (GEOMAR, Uni Kiel) with USA partners (University of Hawaii, Manoa and Columbia University); Jun and Sep R/V Alkor cruises to Boknis Eck to investigate surfactant influence on gas exchange

Eddy covariance measurements of CO_2 on the N. Atlantic VOS line operational 2017 (GEOMAR)

MarParCloud campaign at the CVAO; Investigation of organic matter in the marine environment, characterization of the processes of organic matter from the (biological) formation in seawater, enrichment in the sea surface microlayer, transfer to aerosol particles and function as INP, Activities: sampling of bulk water, sea surface microlayer, aerosol particles, ice nucleating particles, cloud water, Dates: 28.09.2017-13.10.2018 at the CVAO and OSCM in Mindelo, Team: TROPOS, ICMB Wilhelmshaven, IOW, ZMT

MILAN experiment in Wilhelmshaven initiated by Dr. Mariana Ribas-Ribas and Dr. Christian Stolle from ICBM with national (GEOMAR) and international collaborations, 01. April - 13. April 2017 - sea surface microlayer functioning during the night

PEACETIME cruise from La Seyne-sur-mer to La Seyne-sur-mer with cruise leaders Dr. Cécile Guieu and Dr. Karine Desboeufs (GEOMAR participation), 10. May - 11. June 2017 - analysing the impact of dust input events on the sea surface microlayer

BIOACID Integrated assessment of the elapsed 8-year investigation period , modelling of the results and information for policy makers (GEOMAR and partners)

Several research cruises and mesocosm experiments in the upwelling system off Peru (GEOMAR and partners)

Wave pump deployment and several research cruises in the oligotrophic waters off Gran Canaria (GEOMAR and partners)

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

SOLAS Summer School Cargese 2018 (German scientists on organizing committee)

SESAC III in 11/2017: Sino-European Summer School on Atmospheric Chemistry (German scientists on organizing committee)

Final Meeting of BIOACID with combined Integrated Assessment Workshop in Kiel (May 29 – 31 2017)

COP 23: The Bonn 2017 UN climate change conference (6 - 17 November 2017), more information here

Ocean deoxygenation: drivers and consequences, past, present, future: https://www.sfb754.de/o2conference2018

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)

Project Title	**Funding Source**	**Period**	**Other information**
WG 151 – Iron Model Intercomparison Project (FEMIP)	SCOR	Granted in 2016	http://www.scor-int.org/SCOR_WGs_WG151.htm
German-Peruvian bilateral collaboration	BMBF	2015 - 2017	Coordinator (GEOMAR)
BIOACID III (**B**iological **I**mpacts of **O**cean **Acid**ification)	BMBF	2015 - 2017	coordinator, subproject leader (GEOMAR)
SFB754 – Climate-Biogeochemistry Interactions in the Tropical Ocean	DFG	2015 - 2019	subproject leader (GEOMAR)
Ocean Artificial Upwelling, Ocean artUp	EU, ERC Advanced Grant	2016 - 2021	Coordinator (GEOMAR)
AQUACOSM (**AQUA**tic Meso**COSM** Facilities)	EU	2017 - 2021	subproject leader (GEOMAR)
Humboldt-Tipping (Tipping points of the Humboldt Current Upwelling System and Economic Repercussions, preparation phase)	BMBF	2017 - 2018	coordinator, subproject leader (GEOMAR)
Feasibility study of a deep water pump driven by wave energy	BMBF, WTSH	2017	Coordinator (GEOMAR)
Marine biological production, organic aerosol particles and marine clouds: a process chain (MarParCloud)	Leibniz Association SAW funding	05/2016 - 10/2019	partners: TROPOS, ICBM Wilhelmshaven, IOW, ZMT
Phytoplanton Community Composition in the water and on Transparent Exopolymer Particles of the Sea Surface Microlayer in the	FO/DFG	April – December 2017	GEOMAR

Mediterranean Sea			
PhotoSOA	DFG-ANR	10/2017 – 09/2020	TROPOS Leipzig & IRCELYON, Lyon

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)

Project Title	**Funding Source**	**Note**	**Role of the PI**
CUSCO (**C**oastal **U**pwelling **S**ystem in a **C**hanging **O**cean)	BMBF	submitted	GEOMAR coordination, subproject leader
Humboldt-Tipping (Tipping points of the Humboldt Current Upwelling System and Economic Repercussions, preparation phase)	BMBF	Invitation for application in 2018	GEOMAR coordination, subproject leader
Upwelling systems and their influence on atmospheric reactive trace gases and aerosol particles (UPSTART)	BMBF	submitted	GEOMAR coordination, subproject leader, project partners: TROPOS, MPI Mainz, IOW

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

- Projects
  - BIOACID
  - InGOS
  - SCOR WGs #141, #142, and #143
  - Boknis Eck Time Series Station
  - CVOO/CVAO
  - SFB754
  - and many more

- Partner Institutions
  - INDP, Mindelo, Cape Verde
  - IMARPE, Callao, Peru
  - Ocean University China, Qingdao, China
  - PLOCAN
  - Universidad de Las Palmas de Gran Canaria
  - and many more

- International Organisations
  - IPCC
  - and many more

Comments

This is the first year that Christa Marandino and Hartmut Herrmann take over as the German SOLAS reps. It is also the first year after the German SOLAS project, SOPRAN, is finished. We hope to use the SOPRAN network to continue joint SOLAS activities in Germany and to stay updated, as well as update, the German SOLAS community.

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *'INDIA'*
compiled by: 'VVSS Sarma'

This report has two parts:

- Part 1: *reporting of activities in the period of January 2016 – Mar-Apr 2017*
- Part 2: *reporting on planned activities for 2017 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

Describe one scientific highlight with a title, text (max. 200 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in international collaboration. (If you wish to put more than one, feel free to do so).

Orography and meteorological factors facilitate increase in finer particles over Visakhapatnam 'bowl' area

Amount of fine particles in air is of concern because of its potential hazard to human health. It is not yet mandatory to monitor $PM_{2.5}$ (particles<2.5 μm) levels in our country and therefore very limited information is available on its amounts and distributions. It is also important to study air particles of other sizes and the role of meteorological and other topographic conditions in determining the particle concentrations and variations. We report here abundances and changes in $PM_{2.5}$, PM_{10} (particles<10 μm) and PM>10 (particles >10 μm) sized particles during winter and transition to summer periods in the Visakhapatnam city to examine the potential sources and influence of unique orographic features of the city. Our results suggest the occurrence of alarming levels of $PM_{2.5}$, and PM_{10} that will have serious implications to respiratory issues and lung diseases. Despite less populated and low industrial activities in Visakhapatnam, the concentration of $PM_{2.5}$ and PM_{10} were higher than other major Indian coastal cities (eg: Mumbai, Kolkata and Chennai), which are heavily populated as well as industrially active cities. Visakhapatnam city has a unique orography (bowl shape, surrounded by hill ranges) and atmospheric temperature inversion during winter limits the transport of particles, therefore, increases the particle residence time over the city. Relations of particles abundances with meteorological properties revealed that increase in temperature and winds blowing from southwest facilitate transport of particles from the industrialized hub to the 'bowl' area and the prevalence of finer particles aided by poor flushing due to orography. This study highlights the dominant effect of orography over other factors and potential impacts of fine particles on human health of the city.

Table 1 — Ratio of $PM_{2.5}$ and PM_{10} at different geographical locations

Location	$PM_{2.5}$(μgm^{-3})	PM_{10}(μgm^{-3})	$PM_{2.5}/PM_{10}$
World			
Switzerland	25	40	0.61
Spain	17	28	0.63

United States			0.3-0.27
Manila	45		0.45
South Korea			0.38-0.89
China	57	73	0.78
Saudi Arabia	28	87	0.33
Greece	40	76	0.53
Turkey	64	80	0.80
Lahore		900	
Nepal	225		
Colombo		60	
Egypt	59	136	0.43
Italy			0.61
Taiwan	22	40	
India			
Punjab	66	157	0.42
Delhi	99	113	0.86
Mumbai	52	83	0.62
Chennai	73	135	0.54
Calcutta	313	445	0.70
Lucknow	113	171	0.65
Anantpur	17	10	0.9
Kanpur	165	225	0.74
Agra	98	163	0.6
Udaipur	8-111	28-350	0.3
Chhattisgarh	125	189	0.66
Hyderabad	50	135	0.4
Patiala	57	97	0.59
Visakhapatnam (present study)	93	227	0.66

17, Current Science, in review

tmospheric dry deposition of inorganic nutrients on phytoplankton biomass in the Bengal

rom continents contain relatively higher amounts of inorganic nutrients than those of marine make a notable contribution to the coastal biological productivity. To test this hypothesis, on of aerosols over the city of Visakhapatnam (central east coast of India) were studied ntal flow was dominant and its impact on phytoplankton biomass was estimated through periments between September 2013 and November 2014. Higher nitrate (NO_3^-) and NH_4^+) concentrations were observed in the aerosols collected in January while higher O_4^{3-}) was observed in September. Simultaneous observations of aerosols over the city and oastal waters revealed that the concentrations of nitrate in ambient aerosols ranged from g m^{-3} and 0.09 to 0.86 µg m^{-3}, respectively. Our results suggest that 52-89% of city's aerosols n deposited over waters within 10 km from the coastline. Microcosm experiments were spiking the surface water samples, collected from the coastal Bay of Bengal (BoB), with the trients. Upon spiking, dissolved inorganic nitrogen (NO_3^- + NH_4^+) increased from 0.3 to $^{-1}$ and the N:P ratio increased from 2 to 97. This led to enhanced phytoplankton to 4 times) upon spiking. The increase in phytoplankton biomass was linearly related to ratios in water as aerosol deposition increased the N: P ratios in the microcosms, leading to growth. Though aerosols did not contribute to bioavailable silicate, our microcosm showed linear relationships between ambient silicate phytoplankton biomass, and of Fucoxanthin (a marker pigment for diatoms). This indicates that the availability of silicate ers facilitated dominant diatom growth in the presence of higher N: P ratios due to aerosol e deposition of soluble aerosol nitrogen appears to support ~3 to 33% of the biological the coastal waters off Visakhapatnam with higher contribution in winter (~33%) than in). This study suggests that atmospheric deposition of nutrients enhances phytoplankton aters along the central east coast of India during the winter monsoon period, in particular, he hypothesis stated above.

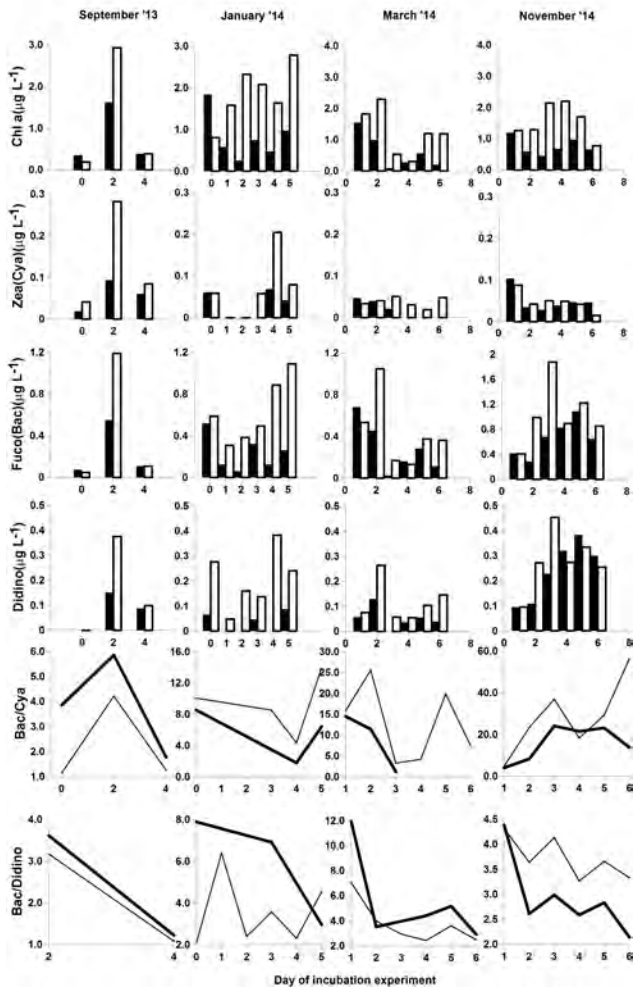

Figure: Variations in the concentrations of pigments in water observed during the incubation experiments after spiking with the dust collected for each season. Filled bars/ thick line show results from control experiments while hollow bars/ thin lines show data from the spiked microcosms.

Yadav et al., 2016, Marine Chemistry, 187, 25-34.

Atmospheric dust acidifies coastal Bay of Bengal and enhances CO_2 flux to the atmosphere

Enhanced atmospheric deposition of nitrogen and sulphur due to anthropogenic activities may acidify coastal waters and change direction of CO_2 exchange at air-sea interface.In order to test this hypothesis, simultaneous observations of atmospheric dust and coastal water pH was measured over two years at weekly and monthly intervals respectively to examine the impact of atmospheric deposition on surface water pH. The composition of atmospheric dust over study region suggests significant contribution of acidic aerosols, such as sulphates and nitrates and their concentrations were relatively higher during winter followed by spring and summer. The mean [NO_3^-/SO_4^{2-}] ratio in the study region (0.8±0.2)suggests greater contribution of SO_4^{2-} from stationary sources (industrial activities) over vehicular activity. The acidity of the anions was not balanced by cations during winter while closer balance occurred during other seasons. The atmospheric deposition of aerosols relatively decreased more pH of surface seawater during winter (0.020±0.003) than summer (0.011±0.003) and spring (0.007±0.002) and it is consistent with the concentrations of sulphate and nitrate in the dust deposited. The decrease in pH due to atmospheric deposition of dust elevated pCO_2 levels by 5.1 to 19.7 µatm resulting in enhanced CO_2 flux (by 0.12 to 0.54 mmol m^{-2} d^{-1}) to the atmosphere from the coastal Bay of Bengal. This study suggests that atmospheric deposition has significant impact on acidification of coastal Bay of Bengal, however, its impact on ecosystem needs integrated studies.

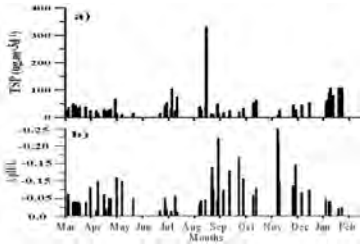

Figure: Weekly variations in concentrations of TSP (μg/m^3/d) (top panel) and change in pH due to dissolution of 1 μg/m^3/d of atmospheric dust to one liter of filtered (0.2 μm) surface seawater.

Kumari et al., 2017. Tellus-B, submitted

Carbon isotope-constrained seasonality of carbonaceous aerosol sources from an urban location (Kanpur) in the Indo-Gangetic Plain: 14Capportionment of carbonaceous aerosol

The Indo-Gangetic Plain (IGP) in northern India, Pakistan and Bangladsh is a major source of carbonaceous aerosols in South Asia. However, poorly constrained seasonality of their sources over the IGP leads to large uncertainty in climate and health effects. Here, we present a first dataset for year-round radiocarbon (^{14}C) and stable carbon (δ^{13}C) based source apportionment of total carbon (TC) in ambient PM10 collected from an urban site (Kanpur: 26.5N, 80.3E) in the IGP during January 2007-January 2008. The year-round 14C based fraction biomass (fbio-TC) estimate at Kanpur averages ~77±7%, emphasize an impact of biomass burning emissions (BBEs). The highest fbio-TC (%) is observed in fall season (October-November: 85%±6%) followed by winter (December-February: 80±8%) and spring (March-May: 75±8%), while lowest values found in summer (June-September: 69±2%). Since biomass/coal combustion and vehicular emissions mostly contribute to carbonaceous aerosols over the IGB, we predict δ13CTC (δ13TCpred) over Kanpur using nown δ13C source signatures and the measured Δ14C value of each sample. The seasonal variability of δ13Cobs- δ13Cpred versus Δ14CTC together with air mass back trajectories and MODIS fire count data reveal that carbonaceous aerosols in winter/fall are significantly influenced by atmospheric aging (downwind transport of crop-residue burning/wood combustion emissions in the northern IGP), while local sources (wheat residue combustion/vehicular emissions) dominate in spring/summer. Given the large temporal and seasonal variability in sources and emission strength of TC over the IGP, 14C-based constraints are, thus, crucial for reducing their uncertainties in carbonaceous aerosol budgets in climate models.

Srinivas et al., 2017. Journal of Geophysical Research (Atmosphere) Doi:10.1002/2016JD025634.

2. Activities/main accomplishments in 2016 (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.)

Two projects (GEOTRACES and Ocean finder) have been completed. However, we are anticipating extension of GEOTRACES project for another 5 years.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Yadav K., Sarma VVSS, and Kumar MD. 2016. Influence of atmospheric dry deposition of inorganic nutrients on phytoplankton biomass in the coastal Bay of Bengal, *Marine Chemistry*,187, 25-34 .

Srinivas B, Andersson A, Ram K, Gustafsson, O, Sarin MM, Sheesley RJ, Kirillova E, Rengarajan, R, Sudheer AK, Gustafsson O. 2017. Carbon isotope-constrained seasonality of carbonaceous aerosol sources from an urban location (Kanpur) in the Indo-Gangetic Plain: 14Capportionment of carbonaceous aerosol. Journal of Geophysical Research (Atmosphere) Doi:10.1002/2016JD025634.

Srinivas B, Kawamura K, Sarin MM. 2017. Secondary organic aerosol formation over coastal ocean: Inferences from atmospheric water soluble low molecular weight organic compounds. Environmental Science and Technology, Doi: 10.1021/acs.est.6b05986.

Baker AR, Kanakidou M, Altieri KE, et al. 2017. Observation and model based estimates of particulate dry nitrogen deposition to the oceans, Atmospheric Chemistry and Physics, doi: 10.5194/acp-2016-1123.
Jickells TD, Buitenhuis E, Altieri KE et al. 2017. A re-evaluation of the magnitude and impacts of

anthropogenic atmospheric nitrogen inputs on the ocean: Duce et al revisited, Global Biogeochemical cycles, doi: 10.1002/2016GB005586

Srinivas B, Kawamura K, Sarin MM, 2016. Stable carbon and nitrogen isotopic composition of fine mode aerosols (PM2.5) over the Bay of Bengal: Impact of continental sources, Tellus B, 68, doi: 10.3402/Tellusb. v68.31518.

Srinivas B, Andersson A, Sarin MM et al. 2016. Dual-carbon-Isotope characterization of total organic carbon in wintertime carbonaceous aerosols from northern India. Journal of Geophysical Research (Atmosphere), doi:10.1002/2016JD024880.

Ram K, Singh S, Sarin MM et al. 2016. Variability in aerosol optical properties over an urban site, Kanpur, in the Indo-Gangetic Plain: A case study of fog and haze events. Atmospheric Research, doi: 10.1016/j.atmosres.2016.01.014.

Boreddy SKR, Kawamura, K, Srinivas B, Sarin MM, 2016. Hygroscopic growth of particles nebulized from water-soluble extracts of PM2.5 aerosols over the Bay of Bengal: Influence of heterogeneity in air masses and formation pathways, Science of the total environment, 544: 661-669, doi: 10.1016/j.scitotenv.2015.11.164.

Rastogi N, Singh A, Sarin MM, Singh D. 2016. Temporal variability of primary and secondary aerosols over Northern India: Impact of biomass burning emissions, Atmospheric Environment, 125, 396-403, doi: 10.1016/j.atmosenv.2015.06.010.

For journal articles please follow the proposed 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 2016? If yes, who? How did you engage?

No

PART 2 - Planned activities from 2017/2018 and 2019

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

No

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

No

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)

In India, we are at the end of five year plan (2012-2017) and all existing projects have been closed and new proposals are under review.

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)

A proposal entitled “Impact of atmospheric dust on coastal ecosystem” is proposed to Council of Scientific and Industrial Research (CSIR) for possible funding. This proposal is under review.

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

No

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *Israel*
compiled by: Yoav Lehahn

PART 1 - Activities from January 2016 to Jan/Feb 2017
1. Scientific highlight

The impact of dry atmospheric deposition on the sea-surface microlayer in the SE Mediterranean Sea: an experimental approach

For more details see Astrahan et al. (2016).

The oligotrophic southeastern Mediterranean Sea (SEMS) is frequently exposed to desert-dust deposition which supplies nutrients, trace metals and a wide array of viable airborne microorganisms to the surface seawater layer. In this study, we experimentally examined the impact of aerosol addition, collected during an intense dust storm event in early September 2015, on the biomass and activity of pico-phytoplankton and heterotrophic bacterial populations at the sea-surface micro layer (SML) relative to the sub surface layer (SSL). We hypothesized that due to the physiochemical and biological differences between the SML and SSL, any external atmospheric addition may trigger distinct responses in these two layers.

To this end, aerosol (1.5 mg L^{-1}) was added to SML and SSL water samples in microcosms (4.5 L) and the water was frequently sampled for *Synechococcus* abundance, pico-eukaryotes abundance, nano-eukaryotic abundance, heterotrophic bacterial abundance, primary production and bacterial production measurements at 0, 1.5, 5, 9, 17, 21, 26 and 44 h after the aerosol addition. Unamended control microcosms were also carried out.

While the aerosol amendment triggered a moderate 1.5-2 fold increase in primary production in both the SML and the SSL, bacterial production increased by ~3 and ~7 folds in the SSL and SML, respectively (Figure 1). Concurrently, the abundance and flow-cytometric characteristics (green fluorescence and side scatter signals) of high nucleic acid (HNA) and low nucleic acid (LNA) bacterial cells showed a significant increase in the %HNA, in both SML and SSL samples following aerosol amendment. This shift in nucleic acid content took place at a much faster rate in the SML, suggesting a more active heterotrophic community or a more opportunistic population in the SML.

This study demonstrates the opportunistic character of the bacterioneuston communities (SML bacterial population) once nutrient-carrying airborne particles are introduced to the SML. Specifically, our results highlight that the heterotrophic microbial community inhabiting the SML is more efficient in utilizing aerosol associated constituents than the community in the SSL.

We suggest that studies of the seasonal changes in the biodiversity and physiology of these communities in relation to atmospheric deposition from different sources are needed. Furthermore, the nature and dynamics of nutrients, metals (and microorganisms) exchange between the SML and SSL is currently unknown and warrants more study.

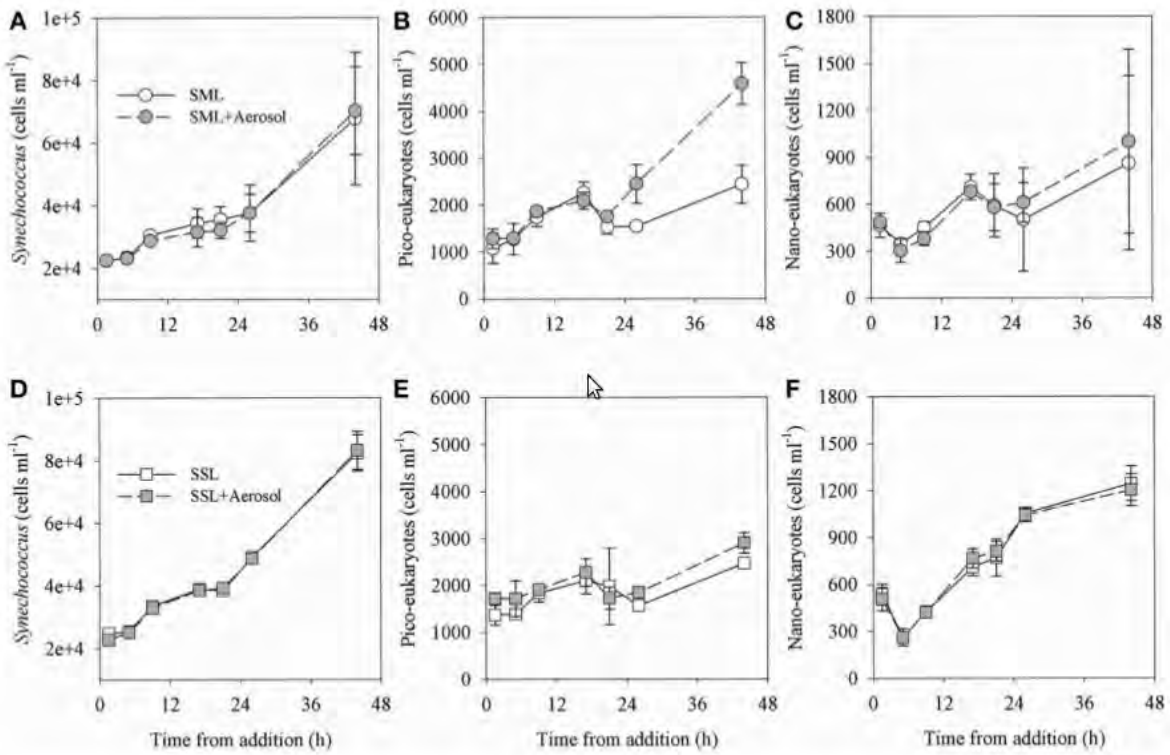

Figure 1. The temporal dynamics of Synechococcus (A,D), pico-eukaryotes (B,E) and nano-eukaryotes (C,F) in the SML (top panels) and SSL (bottom panels) microcosms. Experiments including aerosol additions (1.5 mg L^{-1}) are presented in gray, control experiments (containing no additions) are colored white. Values are the averages and standard deviation from 3 biological replicates (n = 3).

2. Activities/main accomplishments in 2016 (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.)

A group from Weizmann Institute of Science is currently part of the TARA PACIFIC expedition, leading the atmospheric research during the 2.5 year mission. The group explores the chemical, physical, and biological properties of marine aerosols across the Atlantic and Pacific Oceans. TARA-expeditions is one of the most important large-scale experiments in Earth sciences and oceanography, as part of an international effort to assess the biogeochemistry of the ocean. The objective of the project is to investigate how marine aerosols are influenced by the biological and chemical properties of surface seawater across the Atlantic and Pacific oceans. Specifically, the scientists aim to better understand which marine organisms are emitted to the lower atmosphere, and how they affect the marine ecosystem. The TARA PACIFIC project allows for a unique opportunity to explore transects of the Atlantic and Pacific oceans, providing much needed information on the changes in marine aerosol properties along different spatial and temporal scales.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Astrahan P., Herut B., Paytan A., Rahav E. (2016), The impact of dry atmospheric deposition on the sea-surface microlayer in the SE Mediterranean Sea: an experimental approach. *Front Mar Sci* 3:222.

Stockdale, A., Krom, M.D, Mortimer, R.J.G., Benning, L.G., Carslaw, K.S. Herbert, R.J., Shi, Z., Myriokefalitakis, S., Kanakidou, M., and Nenes, A. (2016) understanding the nature of atmospheric acid processing of mineral dusts in supplying bioavailable phosphorus to the ocean. *Proc. Natl. Acad. Sci. USA* 113:14639–14644.

Kranzler, C., Kessler, N., Keren, N. and Y. Shaked. 2016. Enhanced ferrihydrite dissolution by a unicellular, planktonic cyanobacterium: insights into the bioavailability of particulate iron. *Environmental Microbiology and Environmental Microbiology Reports*. Doi:10.1111/1462-2920.13496.

Schoffman H, Lis H, Shaked Y and N. Keren .2016. Iron–Nutrient Interactions within Phytoplankton. *Frontiers in Plant Sciences* 7(1223). doi: 10.3389/fpls.2016.01223.

Lehahn Y., I. Koren, S. Sharoni, F. d'Ovidio, A. Vardi and E. Boss. Dispersion/dilution enhances phytoplankton blooms in nutrient-limited waters, *Nat. Commun. DOI: 10.1038/ncomms14868.*

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

PART 2 - Planned activities from 2017/2018 and 2019

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

Important contribution to SOLAS activities in Israel is expected to come from the oceanographic observatory THEMO (Texas A&M – University of Haifa Eastern Mediterranean Observatory) - a joint project of University of Haifa and Texas A&M University - that is expected to be operational in 2017. The observatory will include a shallow mooring (125m) in the coastal zone and a deeper one 60 km offshore in the Levant Basin of the Mediterranean Sea and will comprise of two sensor arrays attached to 2.25m diameter surface buoys. The deeper mooring (1425m) will be equipped with a profiler which will communicate to a subsea float and from there to a surface buoy. This array will also have a time-series sediment trap at 1000m. Both arrays will have acoustic capabilities, standard sensor and inductively-coupled thermistor chains. The data will be received at a shore station through a fast two-way communication link.

We expect to achieve valuable information on the impact of ocean biology on fluxes of particles across the ocean-atmosphere interface from the second of the TARA PACIFIC expedition, where continuous measurements of aerosols are conducted by researchers from the Weizmann Institue of Science.

Valuable information on ocean dynamics and biogeochemistry will be delivered by an array of three gliders, that are planned to operate continuously in the Levantine basin on of the Mediterranean.

The Gliders are operated by scientist from the Bar-Ilan University, Hebrew University, Weizmann Institute of Science and Israel Oceanographic and Limnological Research.

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

As part of the annual meeting of the Israeli Association for Aquatic Sciences, we intend to have a session dedicated at SOLAS-related issues. The focus will be on the way by which the marine ecosystem affects, and is affected by, fluxes of particles across the ocean-atmosphere interface.

Researchers and students engaged with SOLAS activities in Israel will be involved in the upcoming workshop “Preparing next generation fine scale experiments in the Mediterranean sea”, aimed at identifying current trends for high resolution, biophysical satellite observations and in situ experiments in the Mediterranean.

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)

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)

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

Scientists working on SOLAS-related projects are engaged with the International Global Atmospheric Chemistry (IGAC), The International Commission on Clouds and Precipitation (ICCP) and the International study of the marine biogeochemical cycles of trace elements and their isotopes (GEOTRACES.

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

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

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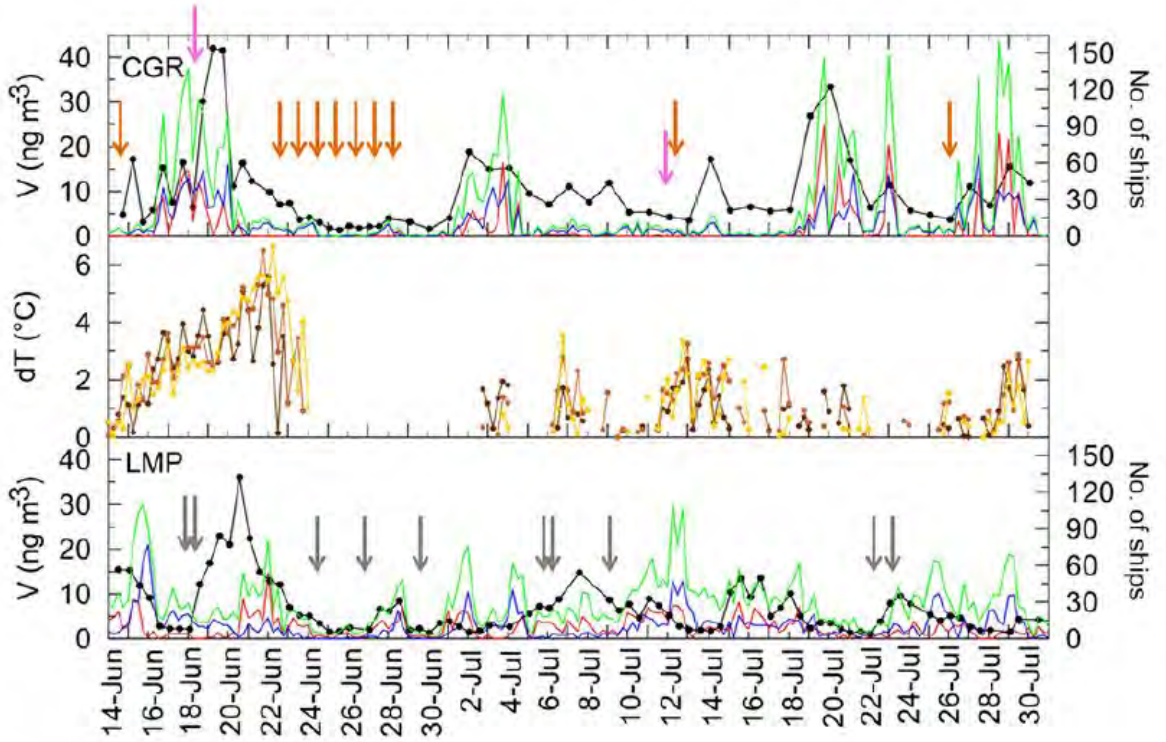
IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

CONSTRAINING THE SHIP CONTRIBUTION TO THE AEROSOL OF THE CENTRAL MEDITERRANEAN

PM10 (Particulate Matter with aerodynamic diameters lower than 10 μm) aerosol samples were collected during summer 2013, 12 h time resolutions, within the framework of the Chemistry and Aerosol Mediterranean Experiment (ChArMEx) at two sites located north (Capo Granitola) and south (Lampedusa Island) of the main Mediterranean shipping route in the Strait of Sicily. The evolution of soluble V and Ni concentrations (typical markers of heavy fuel oil combustion) was related to meteorology and ship traffic intensity in the Strait of Sicily, using a high-resolution regional model for calculation of back trajectories. The combination of the analyses based on chemical markers (in particular rare earth elements, which help distinguishing between refinery and ship emissions), air mass trajectories and ship routes allows us to unambiguously identify the large role of the ship source in the Strait of Sicily. Based on the sampled aerosols, ratios of the main aerosol species arising from ship emission with respect to V were estimated with the aim of deriving a lower limit for the total ship contribution to PM10. The estimated minimum ship emission contributions to PM10 were 2.0 μg/m^3 at Lampedusa and 3.0 μg/m^3 at Capo Granitola, corresponding with 11 and 8.6% of PM10, respectively.

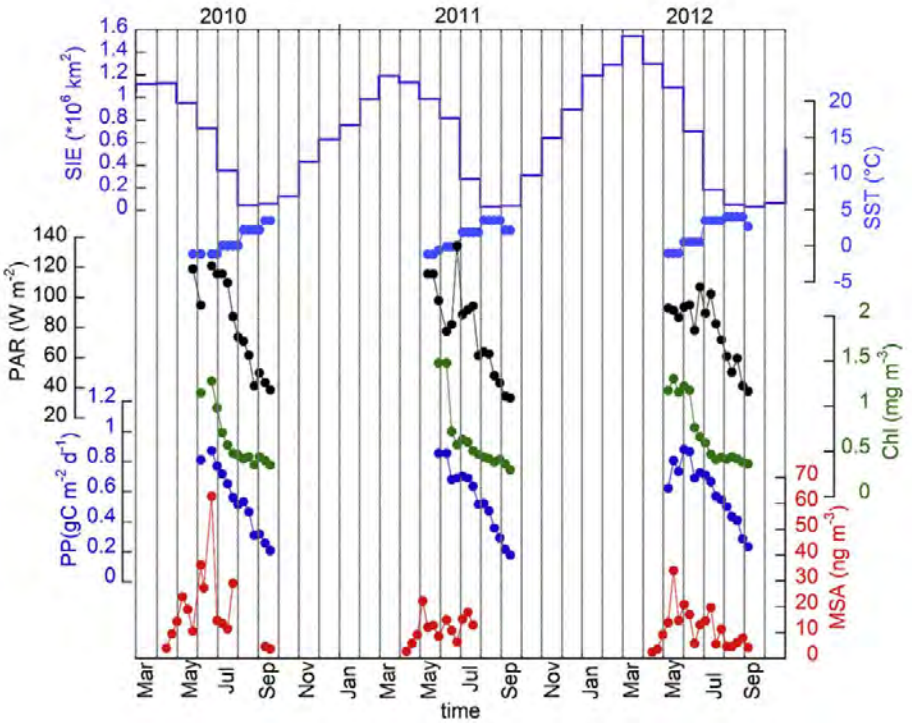


Time series of Vanadium concentration (black line with dots) and number of ships affecting the air masses sampled at Capo Granitola (upper panel) and Lampedusa (lower panel). Green, red and blue lines indicate, respectively, the total number of ships and the number of merchant (i.e. cargo and tanker) and fishing vessels. The time evolution of the temperature inversion index (dT in the figure) at three different locations in the Strait of Sicily is shown in the middle panel; brown, red and yellow curves show the behaviour at three sites in the Strait. The orange arrows identify samples classified as crustal, based on the La-Ce-V concentration; pink and gray arrows identify samples with Lanthanium to Cerium ratio > 1, possibly influenced by refineries.

Becagli, S, Anello F, Bommarito C, Cassola F, Calzolai G, Di Iorio T, di Sarra A, Gómez-Amo J L, Lucarelli F, Marconi M, Meloni D, Monteleone F, Nava S, Pace G, Severi M, Sferlazzo D M, Traversi R, Udisti R, 2017, Constraining the ship contribution to the aerosol of the Central Mediterranean, Atmospheric Chemistry and Physics, 17, 2067–2084, DOI: 10.5194/acp-17-2067-2017

RELATIONSHIPS LINKING PRIMARY PRODUCTION, SEA ICE MELTING, AND BIOGENIC AEROSOL IN THE ARCTIC

The relationships linking methanesulfonic acid (MSA), satellite-derived chlorophyll a (Chl-a), and oceanic primary production (PP) in the Arctic, are investigated. MSA was determined in PM10 samples collected at the two Arctic sites of Ny Ålesund (Svalbard islands) and Thule (Greenland) in 2010-2012. Chl-a peaks in May in the Barents Sea and in the Baffin Bay, and has maxima in June in the Greenland sea; PP follows the same seasonal pattern of Chl-a, although the differences in absolute values of PP during the blooms are less marked than for Chl-a. MSA shows a better correlation with PP than with Chl-a. The source intensity (expressed by PP) is able to explain more than 30% of the MSA variability. The other factors explaining the MSA variability are taxonomic differences in the phytoplankton assemblages, and transport processes from the *dimethylsulfide* source areas to the sampling sites. The sea ice dynamic plays a key role in determining MSA concentration in the Arctic, and a good correlation between MSA and *sea ice melting (SIM)* and between MSA and *marginal ice zone (IF-MIZ)* is found for the cases attributable to bloom of diatoms in the MIZ. Such relationships suggest that PP is related to sea ice melting and to the extension of marginal sea ice areas, and that these factors are the main drivers for MSA concentrations at the considered Arctic sites.

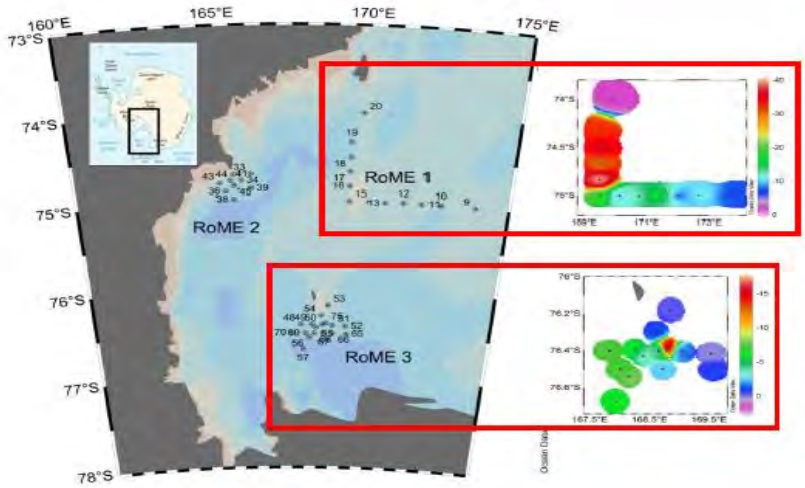


Three-year evolution of sea ice coverage area (SIE, monthly average), sea surface temperature (SST), photosynthetic active radiation (PAR), Chlorophyll a (Chl-a), primary production (PP) calculated for the Baffin Bay, and MSA at Thule. SST, PAR, Chl-a and PP and MSA are calculated as 8-day averages.

Becagli S, Lazzara L, Marchese C, Dayan U, Ascanius S E, Cacciani M, Di Biagio C, Di Iorio T, di Sarra A, Eriksen P, Fani F, Frosini D, Meloni D, Muscari G, Pace G, Severi M, Traversi R, Udisti R, 2016, Relationships linking primary production, sea ice melting, and biogenic aerosol in the Arctic, Atmospheric Environment, 136, 1-15, DOI: 0.1016/j.atmosenv.2016.04.002

MESOSCALE VARIABILITY IN THE CARBONATE SYSTEM CHEMISTRY AND CO_2 AIR–SEA FLUXES OF THE ROSS SEA (ANTARCTICA) SHELF AREA

Data on mesoscale variability in the carbonate system chemistry and CO_2 air–sea fluxes observed in the Ross Sea (Antarctica) shelf area during austral summer 2013-14 were presented at the XXXIV SCAR Meeting. Carbonate system properties showed significant differences at a mesoscale level depending on both physical properties and biological activity, which was the main cause for the observed pH and Ω_{Ar} variability. The investigated areas acted overall as a sink of CO_2, with fluxes ranging from -0.4 ± 0.4 to -39.0 ± 6.4 mmol m^{-2} d^{-1}. The large range of the CO_2 flux is due both to the spatial variability of pCO_2 in surface sea water and to wind speed irregularity experienced during the survey.



Estimated CO2 flux (mmol m-2 d-1) in RoME 1 and RoME 3 mesoscale experiment.

P. Rivaro, L. Langone, C. Ianni, F. Giglio, G. Aulicino, Y. Cotroneo, G. Spezie, M. Saggiomo, O. Mangoni. Mesoscale variability in the carbonate system chemistry and CO_2 air–sea fluxes of the Ross Sea (Antarctica) shelf area. XXXIV Scientific Committee on Antarctic Research (SCAR) meeting, Kuala Lumpur, 20-30 August 2016.

2. Activities/main accomplishments in 2016 (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.)

1. AIR-SEA LAB MEDITERRANEAN CAMPAIGN

Facchini M.C., Rinaldi M., Gobbi G.P., Bonasoni P., Contini D., Argentini S., Belosi F., Calidonna C.R., Di Sarra A., Fossum K., O'Dowd C.D. and the AIR-SEA LAB research team.

The campaign was held during April 2016 and involved five different measurement sites at coast locations in Southern/Central Italy (Civitavecchia, Lecce, Lamezia Terme, Capogranitola and Lampedusa – in collaboration with ENEA). The aim of the campaign was to characterize aerosol properties and sources and the aerosol-cloud interaction in the central Mediterranean region, as a comparison term for the clean North Atlantic marine boundary layer (MBL), which was investigated during the first year of the Project. Measurement sites were chosen in order to cover different conditions of balance between natural and anthropogenic aerosol sources, from Civitavecchia, which is the most polluted site, to Capo Granitola, which represents the background conditions of the central Mediterranean basin. The Air-Sea Lab partner C-CAPS NUIG (National University of Ireland Galway) participated to the campaign. A list of the main characteristics of the sampling sites and a brief description of the scientific activity carried on at each site can be find below.

- ***Civitavecchia Porto***. Civitavecchia hosts an intensive traffic of ferries, plus a continuous traffic of cruise ships. At the end of this port, ~5km north of the city, there is a coal-powered power station. In spite of rather low levels of the standard pollutants (PM10, NO2, etc.), Civitavecchia shows a larger mortality and morbidity with respect to the regional average. Aerosol optical properties and chemical composition measurements were carried on through online and offline techniques. PM oxidative potential was evaluated by the DTT (Dithiothreitol) assay, in order to investigate the relationship between PM-induced generation of reactive oxygen species (ROS) and PM composition.
- ***Lecce.*** The CNR-ISAC Environmental-Climate Observatory, regional station of the Global Atmosphere Watch (GAW) network, is an urban background station in Lecce (40°20'8''N-18°07'28''E, 37 m asl) at about 4 km (SW) of the urban area. The site is located at about 30 km and 80 km from the most important industrial centers of the Puglia Region (Taranto and

Brindisi). Online aerosol physical characterization (aerosol number concentration, distribution and fluxes, aerosol mass) and offline chemical characterization (OC-EC and ions) were carried on during the campaign.

- ***Lamezia Terme.*** Lamezia Terme (LT) is a coastal site in the Southern Tyrrhenian Sea, potentially influenced from East North-East direction by urban surrounding small villages anthropic activity and from South-West from Etna volcanoes emission and Saharan dust. Online aerosol physical characterization (aerosol number concentration and distribution, aerosol mass) and offline chemical characterization (OC-EC and ions) were carried on during the campaign.
- ***Capogranitola****.* Capogranitola (CG) is a marine background site in the Strait of Sicily, representative of background conditions in the central Mediterranean Sea, potentially influenced by ship traffic. For the campaign the routine measurements program active at the I-AMICA observatory (meteo, aerosol scattering, equivalent black carbon, PM10 and PM 2.5 aerosol mass, particle number size distribution (0.28-10 µm), O_3, SO_2, NO_x, CO_2, CO, CH_4 and H_20 surface concentration) was integrated by high resolution time of flight aerosol mass spectrometer (HR-ToF-AMS), cloud condensation nuclei (CCN) counter and ice nucleating particles (INP) measurements, providing a complete characterization of the main aerosol physico-chemical propoerties.
- ***Lampedusa****.* Lampedusa is a marine background site and its routine aerosol characterization program were made available through the external collaboration with ENEA and University of Florence.

2. AMERIGO VESPUCCI CRUISE

Rinaldi M., Zanca N., Busetto M., Cristofanelli P., Paglione M., Bonasoni P., Facchini M.C. – CNR-ISAC Bologna; Diliberto L., Ciampichetti S., Gobbi G.P. – CNR-ISAC Roma; Ielpo P. – CNR-ISAC Lecce

The Air-Sea Lab Mediterranean intensive observation period was integrated with measurements performed by Air-Sea Lab partners on-board the Italian Navy Vessel *"Amerigo Vespucci",* cruising around the Italian peninsula. This cruise was held under the framework of the CNR-Navy joint activity "Vespucci Dual Use" between May and June 2016 and allowed to extend the observations performed at the coastal stations during Air-Sea Lab, with both open sea and port measurements. The "Vespucci Dual Use" born by an agreement between CNR and the Italian Navy, aimed to monitor air quality among Italian costs and the Mediterranean Sea by means of different observation techniques. Amerigo Vespucci sailed around the Italian peninsula (Fig. 1) and stopped in 12 Italian harbors, collecting measurements in Adriatic and Tyrrhenian Sea for roughly 2 months (http://www.isac.cnr.it/it/content/la-ricerca-isac-sullamerigo-vespucci). Instrumentation installed onboard by CNR-ISAC consisted in:

1) **Aerosol Chemical Speciation Monitor (ACSM):** for on-line measurements of fine particulate matter (PM1): ACSM routinely quantifies the atmospheric concentration of non-refractory submicron particulate matter components (organics, sulfate, nitrate, ammonium and chloride), with a time resolution of 30 minutes.
2) **Aethalometer (Magee A33):** the aethalometer measures aerosol absorption and provides an estimate of the BC concentration.
3) **Thermo 49c Ozone Monitor**: the instrument measures the atmospheric concentration of the gas ozone.
4) **Tecora ECO-Hi-Vol** (PM1 aerosol sampler): it collects aerosol for offline chemical characterization laboratory analyses.

With the advanced instrumentation set installed, it has been possible to achieve an almost complete chemical characterization of sub-micron aerosol particles (including the contribution of the absorbing species BC, which is an important short-lived climate agent and a tracer of combustion processes), monitoring at the same time the tropospheric photochemical processes through ozone trends. The detailed high resolution chemical characterization of OA allowed a detailed source apportionment through statistical analysis (positive matrix factorization, PMF). In particular, it was possible to apportion OA into a primary OA (HOA; hydrocarbon-like OA) from fossil combustion and a secondary fraction (OOA, oxidized OA), originating from chemical reactions in the atmosphere.

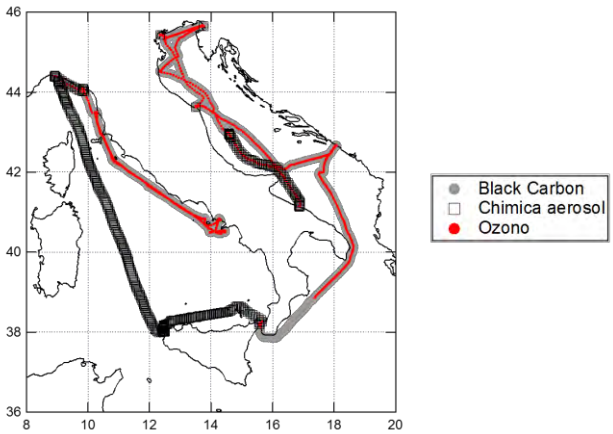


Figure 1: Route of the Amerigo Vespucci cruise around Italy with data coverage of the CNR-ISAC atmospheric chemistry instrumentation.

3. INP PARAMETRIZATION FOR THE NORTH ATLANTIC OCEAN

Rinaldi M., Belosi F., Paglione M., Sandrini S., Facchini M.C. – CNR-ISAC Bologna; Santoleri R.– CNR-ISAC Roma; Ovadnevaite J., O'Dowd C.D. – CCAPS-NUIG Galway

The relation between Ice Nucleating Particles (INP) in the marine boundary layer (MBL) and oceanic biological activity has been investigated through INP measurements performed by CNR-ISAC during the joint AIR-SEA-Lab/BACCHUS campaign at Mace Head (August 2015). The driving hypothesis is that marine biogenic organic matter can modify the ice nucleating properties of sea-spray(Wilson et al., 2015). The correlation between chlorophyll-a and INP observed at Mace Head was investigated, as a function of the delay time between the Chl-a and aerosol time series, following the approach of Rinaldi et al. (2013).

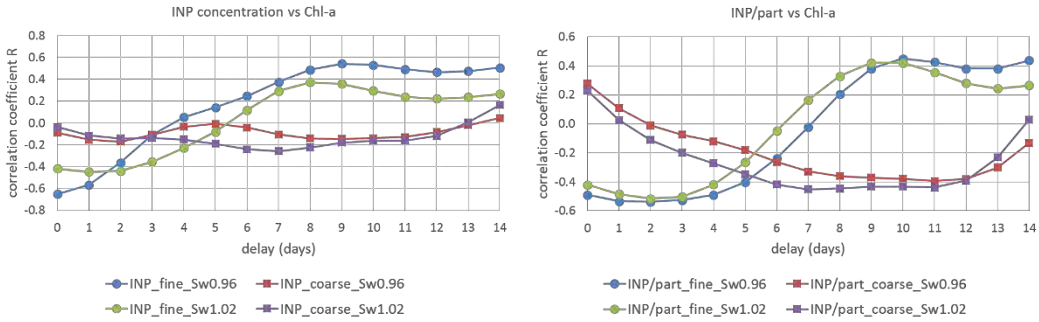


Figure 1: Correlation between Chl-a and INP concentration (left) and Chl-a and INP/part (right) as a function of the delay time between the time series.

The Figure 1 shows that the correlation is dependent on the delay time between the Chl-a and INP time series, with a significant correlation (95% confidence interval) obtained after 8-10 days. This behavior is similar to that observed by Rinaldi et al. (2013) for the enrichment of OM in sea-spray aerosol. The Figure also shows that sub-micron and super-micron INP have very different relations with marine biological activity. Sub-micrometer INP appear more related to biological activity, as expected considering that marine OM is mainly enriched in fine sea-spray (e.g., Facchini et al., 2008; Quinn et al., 2014). This demonstrates that a reliable parametrization for marine INP, based on proxies of the oceanic biological activity and meteorological parameters, for large scale and earth system models, can be achieved. For improving the parameterization, a better space and time data coverage is desirable.

Facchini M. C. et al., Geophys. Res. Lett., 35, L17814, 2008.
Quinn P. K. et al., Nature Geoscience, 7, 2014.
Rinaldi M. et al., J. Geophys. Res., 118, 1–10, 2013.

Wilson T. W., Nature, 525, 234-238, 2015.

4. ARCA project, Svalbard Islands (May 2016)

Azzaro M., Caruso G., Maimone G., Caroppo C., Decembrini F., Azzaro F., La Ferla R. - CNR-IAMC Messina; Miserocchi S., Giglio F. - CNR-ISMAR Bologna; Madonia A., Bonamano S., Piermattei V., Marcelli M. - Laboratory of Experimental Oceanology and Marine Ecology, University of Tuscia, Roma

In the framework of the rewarding Project "ARCA" (ARctic: present Climatic change and pAst extreme events, 2014-2016), coordinated by the Italian National Research Council (Department of Earth System Science and Environmental Technologies) and focusing on climate changes in the Ny Ålesund area, an oceanographic cruise was performed in May 2016 in the Svalbard Islands. The scientific team included the Institute for Coastal Marine Environment (IAMC)-CNR Messina and Taranto, the Institute for Marine Sciences (ISMAR)-CNR Bologna and the Laboratory of Experimental Oceanology and Marine Ecology, Department of Ecological and Biological Sciences (DEB), University of Tuscia, Civitavecchia (Rome). Water samples were collected from a total of 7 surface stations (station 4-5-6-7-8-14 and 23), located along a transect, for the determination of the following parameters: phytoplankton abundance, total bacterioplankton abundance, respiratory activity, nutrients, chlorophyll-a, chromophoric Dissolved Organic Matter (c-DOM), Particulate Organic Carbon (POC) and Total Suspended Matter (TSM), extracellular enzymatic activity and culturable heterotrophic bacterial abundance. Station 4 was also sampled at different depths (surface, 5, 25, 50, 75 and 100 meters). Measurements and data elaboration are still in course.

5. Estimating chlorophyll from continuous fluorescence measurements in North Adriatic (Emilia-Romagna coast) to validate satellite remotely-sensed observations

Ravaioli M., - CNR-ISMAR, Bologna; Riminucci F., -Consorzio-proambiente; *Bohm E., Santoleri R. - CNR-ISAC, Roma*

Continuous fluorescence-derived total chlorophyll measurements are being collected offshore Rimini at the E1 Buoy and south of Po river Delta at the S1-GB site in the framework of cooperative research that see a collaboration between ISAC and ISMAR CNR institutes. This activity aims at constructing a chlorophyll database useful to improve the remote sensing observations. Sensor fluorescence measurements are first validated with in situ sea water sampling as close as possible to the Fluorescence optical sensor followed by lab analysis carried out by ISMAR. This incremental database is aimed at getting reliable fluorescence-derived chlorophyll based on validation points corresponding to each of in situ measurement campaign (i.e. ENV-ADRI-LTER-7 and ENV-ADRI-LTER-8).

1. Total atmospheric deposition of dissolved organic matter (DOM) at the Lampedusa Island

Galletti Y., Santinelli C., - CNR-IBF, Pisa; di Sarra A. – ENEA, Roma; Becagli S. (Univ. Florence)

The main goals of this project are: (1) to gain the first information on the total atmospheric deposition of dissolved organic matter (DOM) at the Lampedusa Island and (2) to gain some qualitative information about the composition of DOM through the analysis of the optical properties (absorption and fluorescence) of its chromophoric fraction (CDOM).

In march 2015, the first Italian total atmospheric deposition sampler for DOM was installed at the Station for Climate Observations “Roberto Sarao” ENEA, Lampedusa Island. Atmospheric depositions were collected between March 19th 2015 and November 3rd 2016 for DOC concentrations and for absorption and fluorescence of CDOM. The concentration of metals was measured in the same samples.

Measured DOC fluxes ranged between 0.07 and 1.81 mmol C m^{-2} day^{-1}, with a marked variability (Fig. 1). These data are in the range of DOC atmospheric fluxes measured at Cap Ferrat in 2006 (0.04-1.2 mmol C m^{-2} day^{-1}) and of total OC (TOC) in rainwater at the island of Crete (0.14 mmol C m^{-2} day^{-1}). Assuming this range valid for the whole basin, a total input of 0.4-4.3·10^{12} g C year^{-1} can be estimated. Two periods were characterized by high DOC fluxes (> 1.20 mmol C m^{-2} day^{-1}). A good linear relationship between DOC, metals and nutrients was found when the samples with the highest DOC concentration were excluded, suggesting a different origin of DOC in these two periods. The study of the air mass back trajectories in the period of the sampling suggests the effect of different sources, terrestrial and marine, from the Atlantic Ocean to Northern Europe, from the UK to the Sahara Desert.

The Parallel Factorial Analysis (PARAFAC) applied to the fluorescence excitation emission matrixes (EEMs), validated a seven-component model. The seven groups of fluorophores were identified by comparison with the literature, and included humic-like and protein-like materials. In addition, one component may be due to the presence of a mixture of PAHs (Polycyclic Aromatic Hydrocarbons) with other organic material. Similar components were observed in the open ocean (Jorgensen et al., 2011), in a previous study on dust inputs on alpine lakes (Mladenov et al., 2011) and more recently in aerosol particles collected at the polar region (Fu et al., 2015).

These preliminary results suggest that atmospheric input can be an important and up to now an overlooked source of DOC and CDOM to the Med Sea.

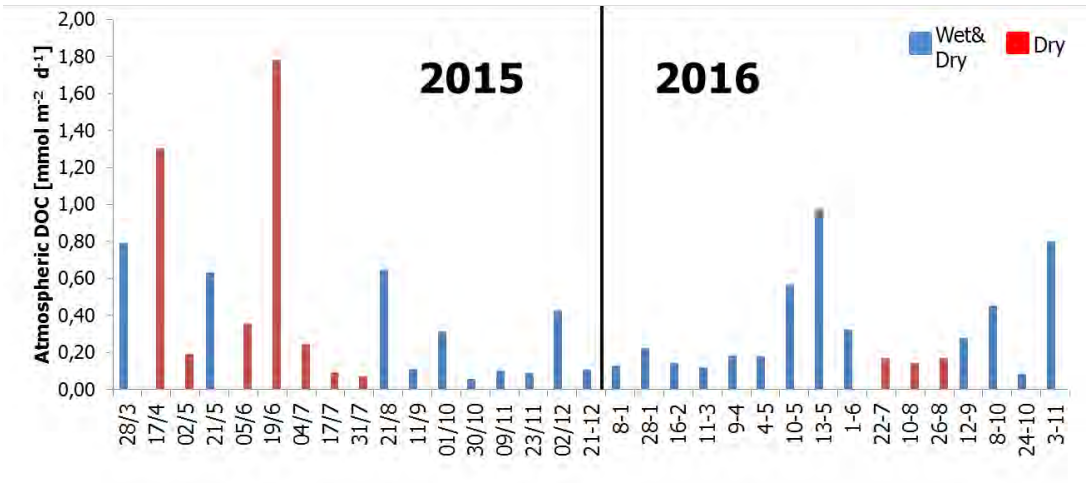


Figure 1. DOC fluxes during the study period.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

1. Ceburnis D, Rinaldi, M, Ovadnevaite J, Martucci, G, Giulianelli, L, O'Dowd, C D, 2016, Marine submicron aerosol gradients, sources and sinks, *Atmospheric Chemistry and Physics*, 16, 19, 12425-12439, DOI: 10.5194/acp-16-12425-2016.
2. Ingrosso G, Giani M, Comici C, Kralj M, Piacentino S, De Vittor C, Del Negro P., 2016, Drivers of the carbonate system seasonal variations in a Mediterranean gulf. *Estuarine, Coastal and Shelf Science*, 168, 58-70. doi:10.1016/j.ecss.2015.11.001
3. Jayarathne T, Sultana C M, Lee C, Malfatti F, Cox J L, Pendergraft M A, Moore K A, Azam F, Tivanski A V, Cappa C D, Bertram T H, Grassian V H, Prather K A, Stone E A., 2016, Enrichment of Saccharides and Divalent Cations in Sea Spray Aerosol During Two Phytoplankton Blooms. *Environmental Science & Technology*, 50 (21), 11511–11520. DOI: 10.1021/acs.est.6b02988
4. Piazzola J, Mihalopoulos N, Canepa E, Tedeschi G, Prati P, Bastianini M, Zampas P, Missamou T, Cavaleri L, 2016. Characterization of aerosols above the Northern Adriatic Sea: case studies of offshore and onshore wind conditions. *Atmospheric Environment*, 132, 153-162. http://dx.doi.org/10.1016/j.atmosenv.2016.02.044
5. Trisolino P, di Sarra A, Meloni D, Pace G, 2016, Determination of global and diffuse Photosynthetically Active Radiation from Multi-Filter Shadowband Radiometer (MFRSR), *Applied Optics, 55*, 8620-8626, DOI: 10.1364/AO.55.008280
6. Vincent J, Laurent B, Losno R, Bon Nguyen E, Roullet P, Sauvage S, Chevaillier S, Coddeville P, Ouboulmane N, di Sarra A G, Tovar-Sánchez A, Sferlazzo D, Massanet A, Triquet S, Morales Baquero R, Fornier M, Coursier C, Desboeufs K, Dulac F, Bergametti G, 2016, Variability of mineral dust deposition in the western Mediterranean basin and South-East of France, *Atmospheric Chemistry and Physics*, 16, 8749–8766, DOI: 10.5194/acp-16-8749-2016

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

PART 2 - Planned activities from 2017/2018 and 2019

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

1. **AIR-SEA LAB MEDITERRANEAN CAMPAIGN DATA ANALYSIS.** The data collected during the Mediterranean campaign described above will be elaborated in a joint effort between the partners of AIR-SEA LAB (CNR-ISAC and NUIG) in order to investigate the physico-chemical properties and origin of the background aerosol characterizing the Mediterranean basin. This is a hot topic both for air-quality issues among the Mediterranean countries and for climate change. Advanced meteorological and chemical transport models will allow the extension of in-situ observation at regional scale (Mediterranean basin).

2. **CRUISE IN THE ROSS SEA** (Antarctica) 30.12.2016-22.02.2017. **CELEBeR Project** (CDW Effects on glaciaL mElting and on Bulk of Fe in the Western Ross sea) - P.I.: P. Rivaro; University of Genoa, University of Naples Federico II and Parthenope, CNR IAMC Messina.

3. **The PAMELA Experiment** (Photosynthetic Actinic radiation Modulation Experiment at Lampedusa) will take place in Lampedusa, at the Station for Climate Observations (http://www.lampedusa.enea.it), from 15 May to 10 June, 2017. The partecipants are: ENEA, IBF/CNR, ISAC/CNR, Universities of Florence (Chemistry and Biology Departments), Rome (Physics Dep.) and Valencia (Dep.of Earth Physics and Thermodynamics,Spain), and PMOD (Switzerland). The experiment will be carried ut in collaboration with Area Marina Protetta delle Isole Pelagie (http://www.ampisolepelagie.it).

   The main objectives of the experiment are:
   - investigate the role and effect of different factors, such as atmospheric and oceanic composition and optical properties, in modulating photosynthetically active radiation (PAR) actinic flux and irradiance, at the surface and underwater;
   - relate actinic flux and irradiance in the PAR spectral range;
   - study the behavior of the PAR actinic flux at the air-sea interface, from the atmosphere to underwater;
   - investigate the role of land and sea albedo on PAR;
   - investigate the role of PAR actinic flux in determining terrestrial and marine productivity;
   - investigate the photosynthetic performance of phytoplankton surface assemblages, through PAM fluorometry, and assess the light and/or nutrient limitation to their productivity.
   - Investigate the biological lability of atmospheric dissolved organic matter (DOM)

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

5. **Oceanic observatory of the station for climate observations at Lampedusa.** Planned activities include the activation of measurements of air-sea interaction at the Oceanic Observatory of the Station for Climate Observations at Lampedusa, in the central Mediterranean. The Oceanic Observatory (OO) (35.49°N, 12.47°E) is an instrumented buoy dedicated to the air-sea interactions which complements the Atmospheric Observatory (http://www.lampedusa.enea.it; 35.52°N, 12.63°E). Measured parameters at the OO include components of the surface heat budget (radiation components, sensible heat), meteorology, broadband and spectral surface albedo, as well as radiation components in the water column, water temperature at different depths, and oceanographic parameters (Temperature, Salinity). The buoy has been developed by ENEA and measurements are conducted in collaboration with the CNR. Measurements at the AO include radiation,

aerosol properties, deposition, meteorology, atmospheric composition, greenhouse gases, etc.

6. **Sea-spray measurements** from the CNR-ISMAR Acqua Alta platform in the Northern Adriatic Sea in collaboration with University of Toulon (France), period March-June 2017. Supported by **JERICO NEXT TNA project**.

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

IAPSO IAMAS IAGA 2017 joint assembly, Cape Town (South Africa) 27-31 August 2017
http://www.iapso-iamas-iaga2017.com/index.php

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)

- **AIR-SEALAB (2015-2017)**. Aerosol-cloud interaction in marine areas. CNR funded Bilateral Project.
- **BACCHUS (2013-2017).** Impact of Biogenic versus Anthropogenic emissions on Clouds and Climate: towards a Holistic UnderStanding. Funded by EU FP7. www.bacchus-env.eu/
- **ADORE (2016-2017).** Atmospheric input of Dissolved ORganic mattEr to the Mediterranean Sea", Italy-France exchange project funded in the framework of the Galileo program, Università Italo-Francese.
- **CELEBeR Project (2016-2017)** (**C**DW **E**ffects on glacia**L** m**E**lting and on **B**ulk of F**e** in the Western **R**oss sea) -PNRA16_00207 - A3 -P.I. Paola Francesca Rivaro funded by Italian Ministry of Research MIUR. (SOLAS Core Theme 5: Ocean biogeochemical control on atmospheric chemistry)
- **FIXO3 (2013-2017).** The Fixed point Open Ocean Observatory network seeks to integrate European open ocean fixed point observatories and to improve access to these key installations for the broader community. OGS is leading the WP2 – Technological harmonization. www.fixo3.eu/wp2/
- **ECCSEL (European Carbon Dioxide Capture and StoragE Laboratory Infrastructure). H2020 INFRADEV-3 Project (2016-2017).** Coordinator: NTNU Norway, Italian partners: OGS Italy, SOTACARBO Italy. The mission of ECCSEL has been of opening access for researchers to a European research infrastructure devoted to **Carbon Capture and Storage (CCS)** technologies in order to combat global climate change. ECCSEL will enable researchers from Europe (and third countries) to access facilities to conduct advanced technological research relevant to CCS. ECCSEL, also finances Transnational Access to the ECCSEL Research Infrastructures, allowing research groups to access free of charge the available ECCSEL facilities as the ECCSEL NatLab-Italy laboratory in Panarea, funded by the Italian Ministry of University and Research and opened on June 2015.. In particular, the transnational access to Panarea NatLab is available for 1 project for a maximum of 5 days during each call (http://www.eccsel.org/Sections.aspx?section=554).
- **JERICO NEXT (2015-2019).** Joint European Research Infrastructure network for Coastal Observatory – Novel European eXpertise for coastal observaTories. CNR-ISMAR is leading the the WP7. http://www.jerico-ri.eu/
- **RITMARE (2012-2017).** Italian Flagship Project, supported by the Italian Ministry of Research and University. www.ritmare.it.
- **PRokaryotes Interactions with Antarctic phytodetritus: a Micro- to macroscale voyage from the surface to the deep Ocean** (**PRIAMO-PNRA Project) (2016-2019)** Coordinator: OGS, Partner: Padova University. The PRIAMO project aims at providing novel information on the metabolism of Ross Sea prokaryotes when supplied with phytodetritus. This area is one of the most productive (CO_2 sink) in the Southern Ocean and is characterized by a pronounced export of particulate organic carbon (POC) to the deep layers of the water column (up to 50% of surface primary production). During the 2016-2017

Italian Expedition in Antarctica in situ samplings and onboard experiments have been performed in order to establish the effect of microalgal-derived POC on prokaryotic growth rates, inorganic and organic carbon uptake, organic matter degradation spectra and velocity. Metagenomic analyses and dedicated experiments aimed to assess microbial interactions with living Antarctic algae on a microscale perspective will be performed in 2017 and following years.

- **Professionalità "Ivano Becchi" Project (2017).** Project supported by Banca del Monte di Lombardia Foundation. PI: Yuri Galletti (PhD. Student at University of Trieste and CNR-IBF), the main goals of this project are: to study the atmospheric input of DOM to the Med sea, and to gain some information about the biological lability of atmospheric DOM.

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)

Greenhouse gases and the oceans

Goals:

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

Future Activities:

- An integrated air-sea observatory has been developped in the central Med Sea at Lampedusa (35.5°N, 12.6°E). Existing observations, mostly dedicated to atmospheric parameters (see http://www.lampedusa.enea.it), will be complemented with air-sea exchange measurements on a buoy close to the atmospheric measurement site on the island. Measurements will include radiation budget, $p(CO_2)$, oceanic optical properties, etc.
- Dissolved and particulate Lipopolysaccharides in surface layer and marine aerosol will be investigated as a biomarker of bacterial biomass. Experiments will be developped in order to analyze bacterial metabolism and to assess the carbon budget (heterotrophic hydrolysis and respiration).
- The LTER time series of physical chemical and biological parameters in the Gulf of Trieste will continue in order to quantify the carbon cycle
- The LTER time series of physical chemical and biological parameters in Po river and Romagna coast will continue in order to validate satellite remotely-sensed observations and meteo-oceanographic forecast models (E1 and S1 systems). LTER sites are key nodes of the E-infrastructure for Biodiversity and Ecosystem Research ERIC - LifeWatch. The S1 system, now configured as an elastic beacon, will be implemented during 2017 with a 'yo-yo' device.
- Carbonate system measurements will be integrated at E2M3A site, South Adriatic Sea
- An integrated air-sea observatory is already working in the North Adriatic Sea (PALOMA station: 35.5°N, 13.6°E) since 7 years. Existing observations (atm pCO_2, dissolved pCO_2 and oxygen) are dedicated to air-sea gas exchanges (CO_2 and O_2), with particular focus on ocean acidification. The observatory is part of GOA-ON and ICOS networks and contributes to ongoing and future projects (PERSEUS, JERICO and JERICO NEXT).
- Data collected in the Kongsfjorden, Svalbard Islands (Norway), in the framework of the project ARCA**,** will allow to explore the microbial assemblages and metabolism in an ocean-glacier melting site.
- pCO2 and carbonate system measurements will continue at Miramare (Mambo buoy) in the northern Adriatic Sea and at E2M3A site in the southern Adriatic Sea

Atmospheric deposition and ocean biogeochemistry

Goals

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

Activities

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

Marine ecosystems, aerosol and clouds: interactions and feedbacks

Goals:

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

Activities

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

Remote sensing of biogeochemical processes

Goals:

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

Activities

- Acquisition of a time series of optical data in continuum by oceanographic platforms already

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

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

- ***Paola Rivaro*** and ***Leonardo Langone*** are Project Partners of the project "Processes Influencing Carbon Cycling: Observations of the Lower limb of the Antarctic Overturning" (PICCOLO) submitted to the U.K. NERC RoSES call.
- The ICOS (Integrated Carbon Observing System) Joint Research Unit which has been constituted in Italy at the end of 2016, includes the research institutes of CNR and OGS in charge of the marine sites sites: Paloma (ISMAR-CNR) and Miramare in North Adriatic Sea (OGS), E2M3A in South Adriatic Sea (OGS) and W1M3A (ISSIA-CNR)in the Tyrrhenian Sea. The objective is to provide the long-term oceanic observations required to understand the present state and predict future behaviour of the global carbon cycle and climate-relevant gas emissions.

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS Japan

compiled by: Jun Nishioka, Hiroshi Tanimoto

This report has two parts:

- ***Part 1:*** *reporting of activities in the period of January 2016 – Jan-Feb 2017*
- ***Part 2:*** *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

Sea-to-air flux of dimethylsulfide in the Pacific by PTR-MS/GF technique

Exchange of dimethylsulfide (DMS) between the surface ocean and the lower atmosphere was examined by using our new system of Proton Transfer Reaction-Mass Spectrometry coupled with Gradient Flux (PTR-MS/GF). We deployed the PTR-MS/GF system and observed vertical gradients of atmospheric DMS just above the sea surface during three cruises by R/V *Hakuho Maru* in the subtropical and transitional South Pacific Ocean and the subarctic North Pacific Ocean. In total, we obtained 370 in situ profiles, and of them we used 46 data sets to calculate the sea-to-air flux of DMS. The DMS flux determined was in the range from 3.2 to 32 μmol m^{-2} d^{-1} and increased with wind speed and biological activity, in reasonable accordance with previous observations in the open ocean. The gas transfer velocity of DMS derived from the PTR-MS/GF measurements was in good agreement with that derived with dual tracer experiments using insoluble gases, but tended to be higher than that determined by eddy covariance techniques and the NOAA/COARE model. This highlights the need of making simultaneous measurements by both the GF and EC techniques to further discuss about their methodological differences.

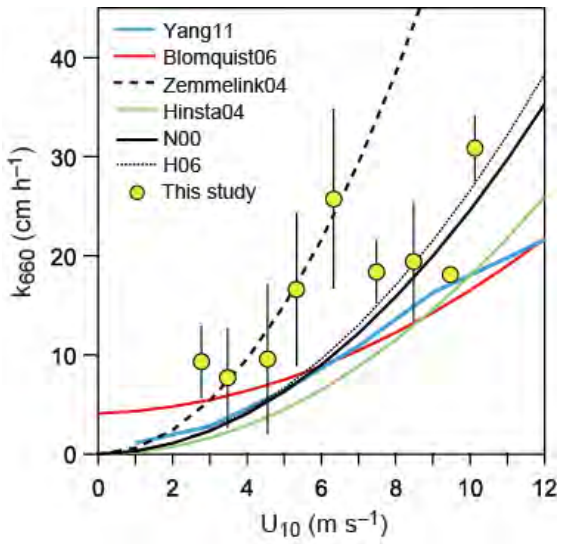


Figure Comparison of k_{660} between the GF and EC methods. The k values in this study (●) are binned at 1 m s^{-1} intervals. Error bars correspond to the standard deviations for the mean values within each bin. Curves indicate k values predicted by parameterizations with insoluble gases [Nightingale et al., 2000 (N00); Ho et al., 2006 (H06)], the EC observations [Yang et al., 2011 (Yang11)], the NOAA/COARE model (A=1.3, B=1.0) [Blomquist et al., 2006 (Blomquist06)], and the GF observations [Hinsta et al., 2004 (Hinsta04), Zemmelink et al., 2004 (Zemmelink04)].

Y. Omori, H. Tanimoto, S. Inomata, T. Iwata, S. Kameyama, M. Uematsu, T. Gamo, H. Ogawa, K. Furuya, Sea-to-air flux of dimethylsulfide in the South and North Pacific Ocean as measured by Proton Transfer Reaction-Mass Spectrometry coupled with Gradient Flux (PTR-MS/GF) technique. (JGR-Atmos., in revision).

2. Activities/main accomplishments in 2016 (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.)

Field campaign:

- February 2016: Southern Sea of Okhotsk, ice breaker SOYA, Surface Ocean CO_2, VOC and Fe dynamics and flux (On board: Daiki Nomura, Naoya Kanna) (Team: Jun Nishioka, Atsushi Ooki, Daiki Nomura, Naoya Kanna, Yohei Yamashita).
- March 2016: Saroma-ko Lagoon, Hokkaido, Japan. Intercalibration experiment for sea ice research with Belgium Scientists (On ice: Daiki Nomura, Francois Fripiat) (Team: Daiki Nomura, Francois Fripiat, Arnout Roukaerts).
- Summer 2016: NIES-Hokkaido Univ-KOPRI joint field work on Arctic observation (H. Tanimoto, S. Kameyama, joint with Jinyoung Jung at KOPRI).
- Summer 2016: Australian cruise around the coastal Great Barrier Reef with Japanese contribution on seawater measurements of VOCs (contributors: H. Tanimoto, Y. Omori).
- Seisui-maru SE16-17 cruise in Ise Bay and Mikawa Bay (chief scientist: Urumu Tsunogai)
- July 2016: Aerosol observation during R/V Shinsei-maru cruise (KS-16-8 led by S. Kawagucci), Izu-Ogasawara region of the western North Pacific.
- August-October 2016: Aerosol and gas observation in Arctic Ocean cruise by R/V Mirai (MR16-06) as part of the ArCS project.
- October-November 2016: “Observation of the sea surface microlayer and sea spray aerosols in the neritic water of Tsukumo Bay” (by K. Hamasaki, S. K. Wong, Y. Iwamoto et al.).
- November-December 2016: Aerosol and gas observation in Western pacific cruise by R/V Mirai (MR16-08).
- Deployment of 7 drifting buoys with pCO_2 sensor in the South Pacific during R/V Mirai cruise (MR16-09 by A Murata).
- 2016, Feb, Mar, Apr, May, Jun, Aug, Oct, Dec, Usio-maru (Hokkaido Univ) cruise, Area: Funka Bay, Hokkaido, Japan, Research: Inorganic - organic iodine speciation in coastal seawater (by Ooki).

Projects:

- The NIES (National Institute for Environmental Studies) VOS program using cargo ships for atmospheric/oceanic CO_2 observations in the North Pacific and the south-eastern Asia (atmospheric only), and frequent and accurate observations of marine phytoplankton pigments and light regimes (by S. Nakaoka, H. Tanimoto, Y. Tohjima, K. Suzuki, Y. Nojiri, et al).
- 2016 NIES VOS program, and collaboration with international partners including IOS (Institute of Ocean Science, Canada), CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia), NIWA (National Institute for Water and Atmosphere, New Zealand) on data sharing and joint analysis.

International collaborative study:

- A study on efficient heterogeneous activation of sea-salt bromide to the gas-phase by the integrated analysis of TORERO halogen radical and aerosol bromide observations (by R. Volkamer, Y. Miyazaki, et al.).

- Lannuzel, D., M. Vancoppenolle, P. van der Merwe, J. de Jong, K. M. Meiners, M. Grotti, J. Nishioka, V. Schoemann, 2016, Iron in sea ice: Review and new insights, Elementa: Science of the Anthropocene, 4: 000130, doi: 10.12952/journal.elementa.000130.

Workshop:
- June 2016: Goldschmidt 2016, Yokohama. 12f: Marine Biogeochemistry at a Range of Scales: The Global Ocean and Polar Atmosphere-Sea Ice-Ocean Systems (Convenors: Daiki Nomura, Martin Vancoppenolle, Markus Frey, Delphine Lannuzel, Jun Nishioka) (Presentation: e.g., Yukihiro Nojiri and Sumito Matoba).
- July 2016: Data management workshop for Hakuho-maru KH-15-1 cruise, biogeochemical linkage between the ocean and the atmosphere (conveners: Jun Nishioka, Koji Suzuki).
- August 2016, Atmosphere-ice interaction workshop, Sapporo, Japan (Convenors: Sumito Matoba, Keiichiro Hara) (Presentation: e.g., Daiki Nomura).

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Ueda, S., K. Miura, R. Kawata, H. Furutani, M. Uematsu, Y. Omori, and H. Tanimoto, 2016, Number–size distribution of aerosol particles and new particle formation events in tropical and subtropical Pacific Oceans, Atmos. Environ., 142, 324-339.

Tsunogai, U., T. Miyauchi, T. Ohyama, D.D. Komatsu, F. Nakagawa, Y. Obata, K. Sato, and T. Ohizumi, 2016, Accurate and precise quantification of atmospheric nitrate in streams draining land of various uses by using triple oxygen isotopes as tracers. Biogeosciences, 13, 3441-3459, doi:10.5194/bg-13-3441-2016.

Yasunaka, S., A. Murata, E. Watanabe, M. Chierici, A. Fransson, S. van Heuven, M. Hoppema, M. Ishii, T. Johannessen, N. Kosugi, S.K. Lauvset, J. T. Mathis, S. Nishino, A.M. Omar, A. Olsen, D. Sasano, T. Takahashi, R. Wanninkho, 2016, Mapping of the air-sea CO_2 flux in the Arctic Ocean and its adjacent seas: Basin-wide distribution and seasonal to interannual variability, Polar Science, 10, 323 – 334.

Miyazaki, Y., S. Coburn, K. Ono, D. T. Ho, B. R. Pierce, K. Kawamura, and R. Volkamer, 2016, Contribution of dissolved organic matter to submicron water-soluble organic aerosols in the marine boundary layer over the eastern equatorial Pacific, Atmos. Chem. Phys., 16, 7695–7707, doi:10.5194/acp-16-7695-2016.

Chen, Q., Y. Miyazaki, K. Kawamura, K. Matsumoto, S. Coburn, R. Volkamer, Y. Iwamoto, S. Kagami, Y. Deng, S. Ogawa, S. Ramasamy, S. Kato, A. Ida, Y. Kajii, and M. Mochida, 2016, Characterization of chromophoric water-soluble organic matter in urban, forest and marine aerosols by HR-ToF-AMS analysis and excitation–emission matrix spectroscopy, Environ. Sci. Tech., 50, 10351−10360, DOI: 10.1021/acs.est.6b01643.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

None

PART 2 - Planned activities from 2017/2018 and 2019

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

Field campaign:

- Seisui-maru (Mie University) cruise in Ise Bay and Mikawa Bay area (chief scientist: Urumu Tsunogai).
- Summer 2017: NIES-Hokkaido Univ-KOPRI joint field work on Arctic observation (H. Tanimoto, S. Kameyama, joint with Jinyoung Jung at KOPRI).
- Underway measurement of sea surface CO_2 and CH_4 during R/V Mirai cruise (ArCS project; by A Murata).
- February 2017: Southern Sea of Okhotsk, ice breaker SOYA, Surface Ocean CO_2, VOC and Fe dynamics and flux (On board: Daiki Nomura, Jun Nishioka) (Team: Daiki Nomura, Jun Nishioka, Atsushi Ooki, Yohei Yamashita).
- August-September 2017: NABOS-II (Nansen and Amundsen Basins Observational System) Cruise. East Siberian Sea and Laptev Sea, Arctic Ocean, ice breaker Akademik Tryoshnikov, Surface Ocean and sea ice CO_2, CH_4, VOC, CDOM and flux (On board: Daiki Nomura, Mats Granskog) (Team: Daiki Nomura, Atsushi Ooki, Ellen Damm, Mats Granskog, Osamu Yoshida, Ilka Peeken, Toru Hirawake).
- Fall 2019- Fall 2020: MOSAiC (Multidisciplinary drifting Observatory for the Study of Arctic Climate) Cruise. Arctic Ocean, ice breaker Polarstern. Surface Ocean and sea ice CO_2, CH_4, VOC, CDOM and flux (On board (one of leg): Daiki Nomura, Mats Granskog) (Team: Daiki Nomura, Atsushi Ooki, Ellen Damm, Mats Granskog, Brice Loose, Jun Inoue).
- 2017 Jun-Jul: Oshoro-maru (Hokkaido Univ.) cruise, Response and biodiversity status of the Arctic ecosystems under, Subarctic N Pacific and Bering sea, environmental change, (PI: A. Ooki).
- June-Aug. 2017: Hakuho-maru KH-17-3 cruise, Fe dust input and the Mg biogeochemical linkage between the ocean and the atmosphere (PI: Y. Takahashi et al.).
- Aug.-Sep. 2017: Hakuho-maru KH-17-4 cruise, Observation of the sea surface microlayer and sea spray aerosols in the subtropical North Pacific Ocean, as part of NEOPS cruise (PI: K. Hamasaki, Y. Iwamoto, Y. Miyazaki).
- Oct.-Dec. 2017: Hakuho-maru KH-17-3 cruise, The biogeochemical linkage between the ocean and the atmosphere (PI: Y. Kondo et al.).

International projects:

- Measurements of halogens and organics in the atmosphere at MAIDO Observatory on Réunion Island in collaboration with the University of Colorado Boulder (NSF fund), International collaborative study.
- NABOSS-II (http://research.iarc.uaf.edu/NABOS2/) (contributor: Daiki Nomura).
- ECV-Ice (Measuring Essential Climate Variables in Sea Ice), SCOR working group 152 (Co-chair: Daiki Nomura, François Fripiat, and Brent Else).
- CATCH (The Cryosphere and ATmospheric CHemistry), IGAC (lead: Jennie Thomas, Thorsten Bartels-Rausch, Markus Frey) (Implementation member: D. Nomura).
- BEPSII (Biogeochemical Processes at Sea Ice Interfaces), SCOR working group 140, and now co-sponsored by CliC (Climate and Cryosphere) and SOLAS (Surface Ocean Lower Atmosphere Study). (Co-chair: Jacqueline Stefels and Nadja Steiner) (Associate Member: Jun Nishioka, Daiki Nomura).

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

Workshops:

- SOLAS session at Geochemical Society of Japan annual meeting, September 2017.

- Ocean and Atmosphere session at Japan Geoscience Union-AGU joint meeting, May 2017, Biogeochemical linkages between the ocean and the atmosphere during phytoplankton bloom (conveners: H. Tanimoto, Y. Miyazaki, K. Suzuki, J. Nishioka).

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)

National projects:
- Studies of ocean surface CO_2 partial pressure and nutrients mappings using international integrated databases (PI: S. Nakaoka), FY2014-2016.
- Long-term, comprehensive observation of long-lived greenhouse gases and short-lived climate pollutants in the Asia-Oceania Regions (PI: H. Tanimoto), FY2012-2016.
- Deployment of drifting buoys with pCO_2 sensor in the Pacific Ocean founded by the Ministry of Environment of Japan (PI: A Murata).
- Determination on the triple oxygen isotopes of tropospheric ozone, MEXT/JSPS Grait-in-Aid for Scientific Research funded to several SOLAS-relevant projects (PI: U. Tsunogai, FY2014-2016).
- Global observations of VOCs dissolved in the surface ocean using novel time- of-flight mass spectrometry, MEXT/JSPS Grait-in-Aid for Scientific Research funded to several SOLAS-relevant projects (PI: H. Tanimoto, FY2015-2018).
- Highly frequent and accurate observations of marine phytoplankton pigments and light regimes for the validation of SGLI/GCOM-C data (PI: Koji Suzuki)
- ArCS project (http://www.arcs-pro.jp/en/index.html) jointly teamed by NIPR, JAMSTEC, and Hokkaido University (Contributers: T. Hirawake, D. Nomura, A. Ooki, J. Nishioka, FY2015-2019).
- Microbiology of the sea surface microlayer and atmospheric aerosols: The frontier of linking biological activities and the climate"(Grant-in-Aid for Scientific Research) (PI: K. Hamasakai, FY2016-2019).

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)

- The SOLAS-Japan National Committee will discuss the transition to Future Earth in collaboration with other National Committees for IGAC, IMBER, LOICZ and GEOTRACES.

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

None

Comments

None

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS New Zealand

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

This report has two parts:

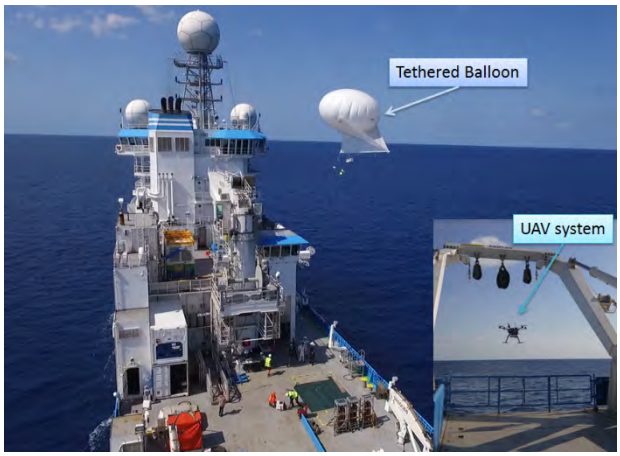
- ***Part 1:*** *reporting of activities in the period of January 2016 – Jan-Feb 2017*
- ***Part 2:*** *reporting on planned activities for 2017/2018 and 2019.*

PART 1 - Activities from January 2016 to Jan/Feb 2017

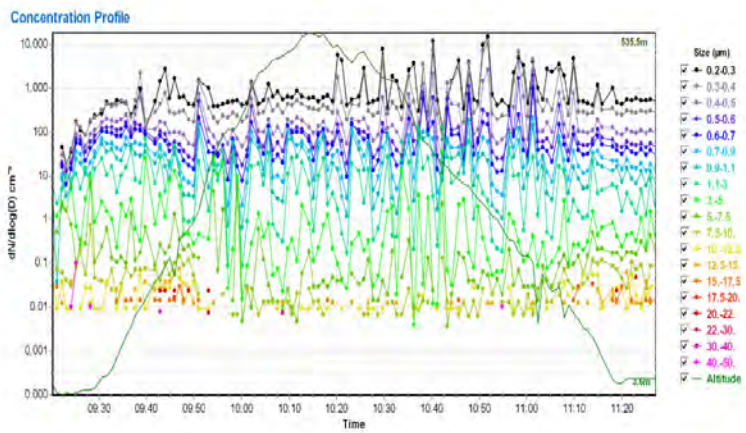
1. Scientific highlight

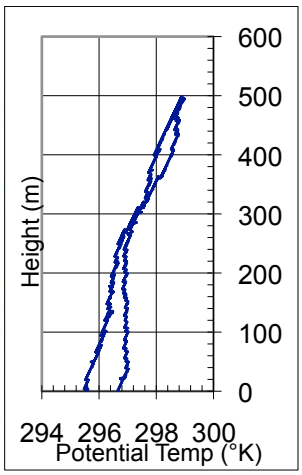
Vertical profiling of atmospheric aerosol by tethered helikyte - Reef to Rainforest (R2R) Spt-Oct 2016 voyage

The R2R voyage took place on RV Investigator, with measurement stations up- and down-wind of the Great Barrier Reef to address: *Is the GBR a significant source of climatically relevant aerosol particles & do emissions from coral symbiotic algae influence cloud properties and rainfall?* The project investigated the influence of aerosol particles on cloud properties and hence implications for climate and the hydrological cycle. Determining the magnitude and drivers of biogenic aerosol production in different ecosystems will ultimately input to the development of earth system models.



Part of the New Zealand focus was to develop ship-based methodologies to collect in situ vertical profiles of aerosol properties. This complemented atmospheric lidar/radar soundings and surface in situ measurements on the ship. We examined vertical mixing of aerosol in the boundary-layer by use of a tethered helikyte (allsopp.co.uk), enabling profile measurement over several hours. The example profile below shows a relatively stable background aerosol spectra (0.2 – 10 µm) between the surface and 500 amsl, altitude (green LH up-down trace), with aerosol size measured by light-weight optical aerosol counter. Analyses are underway, and a post-voyage workshop is planned for later in 2017. *The Reef-to-Rainforest voyage was led by Prof Zoran Ristovski, QUT, Brisbane, with airborne in situ measurements were made in collaboration between the International Laboratory for Air Quality and Health (ILAQH, QUT), Australian Research Centre for Aerospace Automation (ARCAA, QUT), School of Earth Sciences (University Melbourne) & NIWA Wellington*





2. Activities/main accomplishments in 2016 (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.)

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

Ocean acidification in coastal areas can be caused by processes such as terrestrial run-off, local eutrophication, upwelling of deep low pH waters as well as uptake of atmospheric carbon dioxide. These processes vary spatially, so the impact also will vary spatially. The habitat of most species vulnerable to changing carbonate chemistry, such as shellfish, is coastal, therefore establishing existing OA conditions, and monitoring for future changes is important. The New Zealand Ocean Acidification Observing Network (NZOA-ON) consists of 14 sites around the coast, including pristine and impacted sites, sites of importance to the aquaculture and shellfish industries, and sites of cultural importance (Figure 1). Sampling partners collect fortnightly bottle samples which are sent to a central laboratory for analysis of DIC and alkalinity, and subsequent calculation of pH and carbonate saturation states. Sampling partners include research institutes, local councils, aquaculture and fishing industry, and the Department of Conservation. Several of the sites also have SeaFET pH sensors for determination of pH on a higher time frequency to capture diurnal and tidal signals. The NZOA-ON also links to the Munida Time Series Transect, along which the carbonate chemistry had been measured since 1998. The NZOA-ON is also aligned with, and is part of the Global Ocean Acidification Observing Network GOA-ON

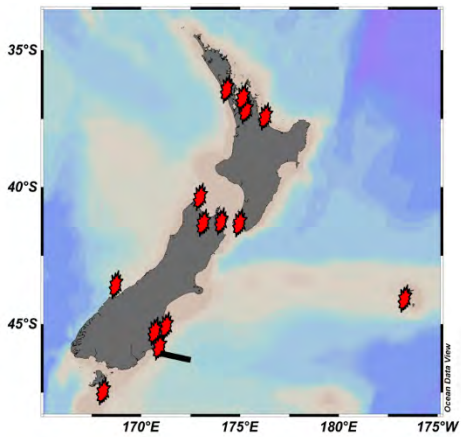


Figure 1: Location of the 14 NZOA-ON sites, with the Munida Time Series Transect shown as a black bar.

Coastal Acidification: Rates, Impact & Management (CARIM)
http://www.carim.nz/

A four-year national project began at the end of 2015 to establish the variability of the carbonate system in New Zealand waters, and use this information to determine ecosystem impacts and develop mitigation solutions. The project was developed by interaction with regional councils, the NZ aquaculture industry and Maori partners, and focuses on three different coastal regions. CARIM includes a monitoring component for pH and the carbonate system at three sentinel sites; this information is being used to develop hydrodynamic models & budgets to identify the main drivers of acidification in the Firth of Thames, which will subsequently inform land and coastal management The impacts of pH change by the end of the century are assessed for coastal

plankton and coralline algae, to determine how primary productivity, food quality and substrate availability. This information wil be combined with physiological response data for all life-history stages of three species – Paua (NZ Abalone), Greenshell Mussel and Snapper – of social, cultural & economic importance. Investigations into the adaptive capacity of the two shellfish species, and development of regional models of the factors driving coastal acidification will inform potential mitigation approaches. CARIM is led by NIWA, with partners at the Cawthron Institute and Universities of Otago and Auckland.

Surface Ocean Aerosol Production (SOAP)
https://www.niwa.co.nz/atmosphere/research-projects/soap

4 papers have been published to date, in a joint Special Issue in *Ocean Science* and *Atmospheric Chemistry & Physics* at:
http://www.ocean-sci.net/special_issue10_333.html

Data analysis
Work in progress on 5 further SOAP papers. This includes examining the complex interplay of primary and secondary aerosol sources through a detailed model representation aimed at understanding the evolution of marine organic carbon (MOC) in the atmosphere and its role in the climate system. In work led by Dr Matthew Woodhouse, CSIRO the ACCESS-UKCA global composition-climate model (incorporating the aerosol microphysics module GLOMAP-mode) is being used to simulate the emissions and role of MOC, firstly with respect to observations on the local scale, comparing against aerosol data from biologically rich waters measured during the SOAP campaign. The chemistry climate model is being used to potential MOC impact on cloud and radiative mechanisms for assessing the role of aerosol in the climate system.

Woodhouse, M., Lawson, S., Luhar, A., Keywood, M., and Harvey, M.: Modelling and observation of organic carbon aerosol in the marine atmosphere AMOS/MSNZ Conference and ANZ Climate Forum 2017 Australasian oceans, weather and climate - past, present and future, Australian National University, Canberra, 7 - 10 Feb, 2017.

Climate Change Impacts on NZ EEZ - Marine Case Study
http://ccii.org.nz/wp-content/uploads/2016/12/RA2-Marine-Case-Study-Synthesis-report.pdf

The report commissioned by the NZ Ministry for Business, Industry & Employment validates existing Earth System Models for the ocean around New Zealand, and then applies the optimal suite of models to project conditions in the mid- and end of the 21st Century under two different scenarios (RCP 4.5 & 8.5) for a range of physical and biogeochemical parameters.

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

Multiple Stressor Workshop (Co-Chair), *Oceans in a High CO_2 World* Symposium, Hobart, Tasmania, May 2016.

New Zealand Marine Sciences Conference Session on Ocean Acidification. July 2016, Wellington.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Walker C F, Harvey M J, Smith M J, Bell T G, Saltzman E S, Marriner A S, McGregor J A., Law C S 2016. Assessing the potential for DMS enrichment at the sea-surface and its influence on air-sea flux. *Ocean Science* 12: 1033-1048, doi:10.5194/os-12-1033-2016.

Burrell T, Maas E W, Teesdale-Spittle P H, Law C S.2016. Assessing approaches to determine the effect of ocean acidification on bacterial processes. *Biogeosciences* 13, 4379-4388, doi:10.5194/bg-13-4379-2016

Stevens C L, Smith M J. 2016. Turbulent mixing in a stratified estuarine tidal channel: Hikapu Reach, Pelorus Sound, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 50 (4): 485-505.

Bakker D C E, Pfeil B, Landa C S, Metzl N, O'Brien K M, Olsen A, Smith K, et al. 2016. A multi-decade record of high-quality fCO 2 data in version 3 of the Surface Ocean CO 2 Atlas (SOCAT). 2016. *Earth System Science Data* 8(2): 383.

Baltar F, Currie K, Meyer M, Verdugo P, 2016. Proportion of marine organic carbon present in self-assembled gels along the subtropical front and its increase in response to reduced pH. *Marine Chemistry* 184: 53-59.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

CARIM
http://www.carim.nz/

The CARIM project has major interaction interaction with maori and other national stakeholders, including the shellfish fishery sector, MPI, regional councils, DOC and the Hauraki Gulf Forum, as well as international scientists in the US and Australia. CARIM scientists presented and discussed the issue of coastal acidification with iwi (Maori tribes) at hui (meeting) in both the North and South Island. In addition, discussions with regional councils and the mussel industry has led to spin off projects and co-funding. Novel research in CARIM, such as into the potential for adaptation within different families of Pāua (NZ Abalone) and Greenshell Mussel will benefit the shellfish industry. The CARIM project also has a major Outreach component that includes an "Oceans Guardians" programme for schools and local communities around the sentinel sites.

The New Zealand Ocean Acidification Observing Network (NZOA-ON)
https://marinedata.niwa.co.nz/nzoa-on/
NZOA-ON – Collaborators collect fortnightly water samples, and are the backbone of the NZOA-ON. Engagement is via email and website; and sampling Partners include Auckland Council, Auckland University, NIWA, Bay of Plenty Regional Council, Cawthron Institute, Aquaculture New Zealand, Paua Industry Council, University of Otago, Fishing Industry, Department of Conservation, Ngai Tahu).

Climate change Impacts on NZ EEZ - Marine Case Study
http://ccii.org.nz/wp-content/uploads/2016/12/RA2-Marine-Case-Study-Synthesis-report.pdf
Research aims were developed in discussion with a variety of stakeholders including Ministry of the Environment, Ministry for Business, Ministry of Primary Industries (Fishing & Aquaculture), Department of Conservation, Statistics New Zealand & regional Councils.

The 9th New Zealand National Ocean Acidification Workshop
http://nzoac.nz/workshops/
A one-day meeting at the (Victoria University Wellington), which included a stakeholder panel discussion session.

Educational resource Unit for Secondary Schools on Ocean Acidification – in development

International: **NZ-USA Joint Science Committee Meeting (JCM): Ocean Acidification**

PART 2 - Planned activities from 2017/2018 and 2019

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

The New Zealand Ocean Acidification Observing Network (NZOA-ON)
https://marinedata.niwa.co.nz/nzoa-on/
Network observations will continue with data made available through a web portal

CARIM
http://www.carim.nz/
Monitoring and data collection will continue at the 3 sentinel sites, including a high-resolution study in the Firth of Thames.

Deep South Aerosol-Cloud interaction observations

As a component of the New Zealand Deep South National Science Challenge: http://www.deepsouthchallenge.co.nz/ one project is examining biases in the representation of clouds and aerosols as a component of the New Zealand Earth System Model (NZESM) development, a derivation of the UK Earth System Model (UKESM). The project has a Southern Ocean focus for both measurement and modelling; this is the region where cloud representation is poor and measurements are sparse. The observational focus is on aerosol-cloud interaction for both ice and cloud-condensation nuclei. A proposal led by Dr Mike Harvey (NIWA) has been developed for an aerosol-cloud interaction voyage into the Ross Sea region in Feb/Mar 2018 with RV Tangaroa. The voyage will overlap in time with other similar Southern Ocean projects including CAPRICORN: clouds, aerosols, precipitation, radiation and atmospheric composition over the Southern Ocean led by Dr Alain Protat, (BOM). A trial voyage TAN1702 (March 2017) has tested some of the planned measurement technologies.

Mitigation of Coastal Acidification around Mussel Farms

A pilot study examining the potential of two different techniques to mitigate coastal acidification at Mussel aquaculture farm scales funded has been funded by the New Zealand Sustainable Seas National Science challenge Innovation Fund. Laboratory experiments will commence in March 2017.

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

The 10th NZ National Ocean Acidification Workshop will take place at the University of Otago in February 2016, and celebrate a decade of NZ research on Ocean Acidification. The meeting will include presentations on national programmes (such as **CARIM),** as well as a Discussion session on Maori and Ocean Acidification. See http://nzoac.nz/workshops/

Educational resource Unit for Secondary Schools on Ocean Acidification published & rolled out.

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)

See above for details on the following projects:-

NZOA-ON

CARIM

Mitigation of Coastal Acidification around Mussel Farms

The Deep South National Science Challenge – process and observation studies of Aerosol-Cloud interactions includes collaborative activity under SOLAS Theme 4- Interconnections between Aerosols, clouds and ecosystems examines biogenic influences on Cloud Condensation nuclei and Ice Nuclei in polar waters and at New Zealand latitudes

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)

NZ MBIE Endeavour Fund proposals (submission Feb 2017):

Methane seeps – Economic opportunities and environmental implications of energy extraction from gas hydrates

Marine Carbon model - *How will climate change alter carbon cycling in New Zealand's oceans?*

Process and observation studies of Aerosol-Cloud: "Sea2Cloud Are marine living microorganisms

influencing clouds?" (PI Karine Sellegri, Laboratoire de Météorologie Physique – CNRS, France

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

SCOR Working Groups:

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

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

IOCCP Scientific Steering Group

SOCAT Global QC Group

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

CSIRO Access ESM and Southern Ocean Aerosol-Cloud Research

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.

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

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

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *Norway*
compiled by: Siv K. Lauvset

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

Omar et al.(2016) determined, for the first time, the seasonal changes and controlling processes of ocean acidification parameters across western Norwegian fjords, based on data obtained mainly with sensors on board a commercial ship, M/S *Trans Carrier*, in 2005–2009. The study fills an important gap in our knowledge on ocean acidification in western Norwegian fjords, which are important ecosystems: important recreation areas, marine pathways, and spawning grounds for different fish species.

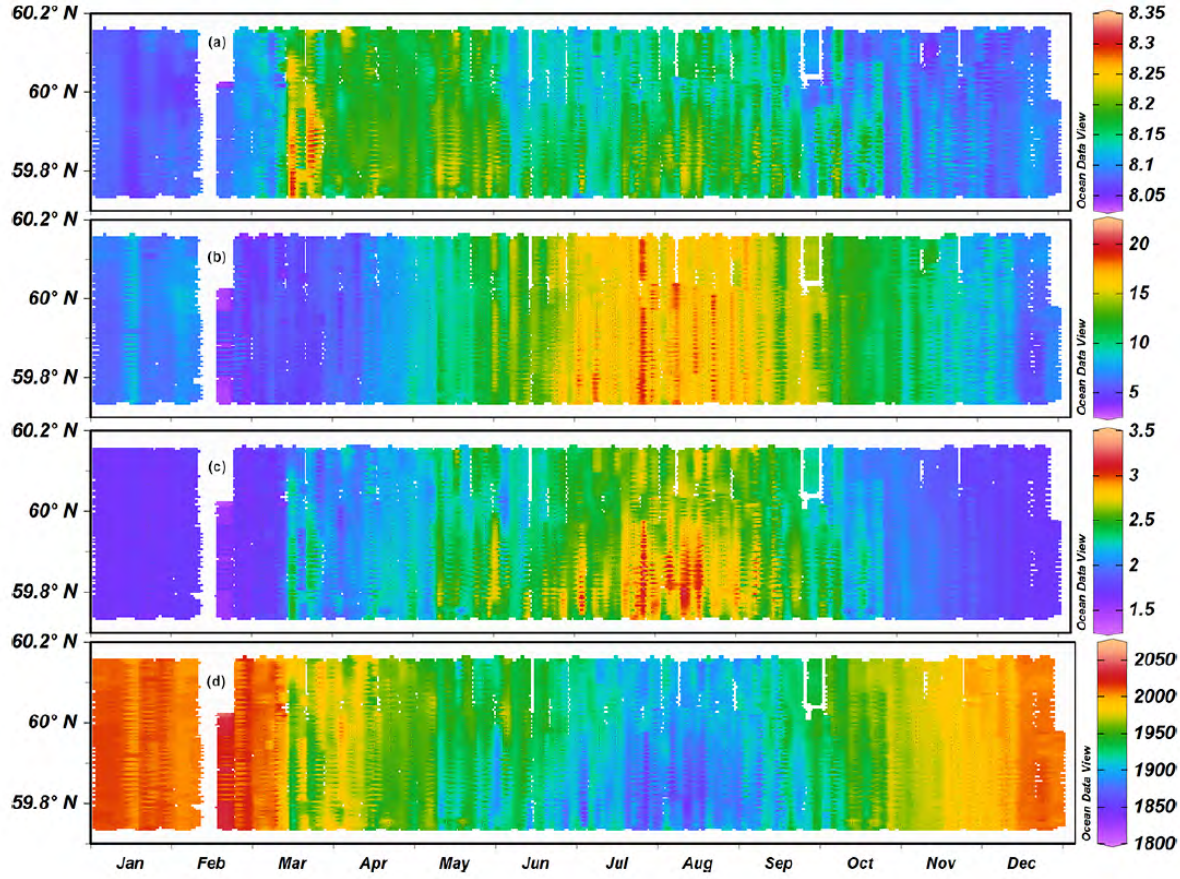


Figure1. a) estimated pH, b) SST, c) estimated Ω_{Ar}, d) estimated $DIC_{S=30.5}$. All data from 2005-2009 have been condensed into one virtual year.

Reference: Omar, A. M., I. Skjelvan, S.R. Erga and A. Olsen, 2016: Aragonite saturation states and pH in western Norway fjords: seasonal cycles and controlling factors, 2005-2009, Ocean Sci., 12, 937-951, 2016. doi:10.5194/os-12-937-2016.

A determination of possible ocean carbon cycle parameter changes under glacial low CO2

conditions (including alterations in rain ratio, Redfield ratio, solubility of CO2, dust input, and circulation changes) was carried out with a combination of forward and inverse modelling and a comprehensive data base of paleoceanographic data. Reference: Christoph Heinze, Babette A. A. Hoogakker, and Arne Winguth, Ocean carbon cycling during the past 130000 years – a pilot study on inverse palaeoclimate record modelling Clim. Past, 12, 1949–1978, 2016, www.clim-past.net/12/1949/2016/ doi:10.5194/cp-12-1949-2016.

2. Activities/main accomplishments in 2016 (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.)

In 2016, the Research Council of Norway funded ICOS-Norway (the Norwegian branch of the European research infrastructure ICOS RI) and the European central facility Ocean Thematic Centre (OTC) with a generous grant to (i) upgrade the Norwegian research infrastructure for observing carbon uptake in the ocean, on land, and in the atmosphere, and (ii) establish and coordinate OTC on a European scale.

The objectives of the OTC are:

- Provide comprehensive coordination of the ICOS marine carbon cycle observing network by providing technical support for observations and data management
- Set and maintain the quality standards of CO2 measurements in marine ICOS through labelling of stations, training, and data quality control
- Collaborate with the Carbon Portal for uniform data handling, quality control, and storage in line with standards established across the international community
- Collaborate with members of the ICOS Research Infrastructure to produce monthly, seasonal, and interannual maps of CO2 sources and sinks in Europe and the adjacent seas
- Collaborate with the Central Analytical Laboratory to analyse flask samples
- Ensure high quality calibrations of gas standards for oceanic measurements in collaboration with the Central Analytical Laboratory

Objectives of ICOS-NORWAY is to:

- Implement a long-term research infrastructure that will provide accurate data on, and integrated assessments of, the Norwegian carbon balance at regional scale, and across land, ocean and atmosphere.
- Be an integral part of pan European ICOS RI.

For further info visit the project web webpages:
https://otc.icos-cp.eu
https://no.icos-cp.eu

Research cruise to the Greenland Sea, 75°N (2-13 August) with full-depth sampling of hydrography, inorganic carbon (DIC and TA), oxygen, transient tracers (CFC-12 and SF_6), and δC^{13}. In addition underway surface measurements of pCO_2 and O_2/Ar.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Fröb, F., Olsen, A., Våge, K., Moore, G.W.K., Yashayaev, I., Jeansson, E., Rajasakaren, B., 2016. Irminger Sea deep convection injects oxygen and anthropogenic carbon to the ocean interior. *Nature Communications* 7, 13244, doi: 10.1038/ncomms13244.

Christoph Heinze, Babette A. A. Hoogakker, and Arne Winguth, Ocean carbon cycling during the past 130000 years – a pilot study on inverse palaeoclimate record modelling Clim. Past, 12, 1949–1978, 2016, www.clim-past.net/12/1949/2016/ doi:10.5194/cp-12-1949-2016

Omar, A. M., I. Skjelvan, S.R. Erga and A. Olsen, 2016: Aragonite saturation states and pH in western Norway fjords: seasonal cycles and controlling factors, 2005-2009, Ocean Sci., 12, 937-951, 2016. doi:10.5194/os-12-937-2016

Schwinger, Jörg; Goris, Nadine; Tjiputra, Jerry; Kriest, Iris; Bentsen, Mats; Bethke, Ingo; Ilicak,

Mehmet; Assmann, Karen Margarete; Heinze, Christoph Evaluation of NorESM-OC (versions 1 and 1.2), the ocean carbon-cycle stand-alone configuration of the Norwegian Earth System Model (NorESM1).Geoscientific Model Development 2016 ; Volume 9 (8). s. 2589-2622, doi:10.5194/gmd-9-2589-2016

Gharamti, M. E., J. Tjiputra, I. Bethke, A. Samuelsen, I. Skjelvan, M. Bentsen, and L. Bertino (2017), Ensemble data assimilation for ocean biogeochemical state and parameter estimation at different sites, *Ocean Model.*, *112*, 65-89, doi:http://dx.doi.org/10.1016/j.ocemod.2017.02.006.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

Christoph Heinze participated in the Workshop on the Development of an Integrated Ocean Research Network. Venue: Kiel, Germany. Dates: 4-5 December 2016. He co-lead a breakout group (Group #3 Oceanic thresholds and save operating spaces, Thorsten Blenckner; Christoph Heinze).

PART 2 - Planned activities from 2017/2018 and 2019

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

Participation in a research cruise to the Greenland and Iceland Seas in Spring 2018 (coordinated by WHOI; Bob Pickart).

Intercalibration activity of pCO_2 and related sensors (details in development). Coordinated within the ICOS Ocean Thematic Centre network.

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

Christoph Heinze is member of the Scientific Steering Committee for the 10th International Carbon Dioxide Conference to be held in Interlaken, Switzerland, 21-25 August 2017
http://www.icdc10.unibe.ch/

Our collaboration with and capacity building at the Red Sea University in Port Sudan, Sudan continues (funded by EU through SEACRIFROG). This will include field work in the Red Sea in 2018 (plans are being developed).

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)

ICOS Norway and OTC (see part 1) (Themes 1 and 2).

RINGO: Readiness of ICOS for Necessities of Integrated Global Observations. An EU Horizon 2020 project aiming to further develop and foster sustainability of the ICOS RI and the ICOS ERIC (Themes 1 and 2).

SEACRIFOG: Supporting EU-African Cooperation on Research Infrastructures for Food Security and Greenhouse Gas Observations. An EU Horizon 2020 project where UNI and UiB (both in Bergen, Norway) are responsible for Task 4.3: “Harmonization of data collection and quality control”

EXPECT – Exploring the Potential and Side Effects of Climate Engineering (‘Geoengineering theme’) – ends mid-2017

INTAROS - Integrated Arctic Observing System (Themes 1 and 2)

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)

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

Siv K. Lauvset was chosen as a new member of the IOCCP scientific steering committee.

Comments

No input was given from other groups in Norway, so the above report summarize the activities of the research community in Bergen only.

Report for the year 2016 and future activities

SOLAS PERU *compiled by:MICHELLE GRACO*

Part 1: *reporting of activities in the period of January 2016 – December 2016*

Part 2: *reporting on planned activities for 2017 to 2018/19.*

PART 1 - Activities from January 2016 to December 2016

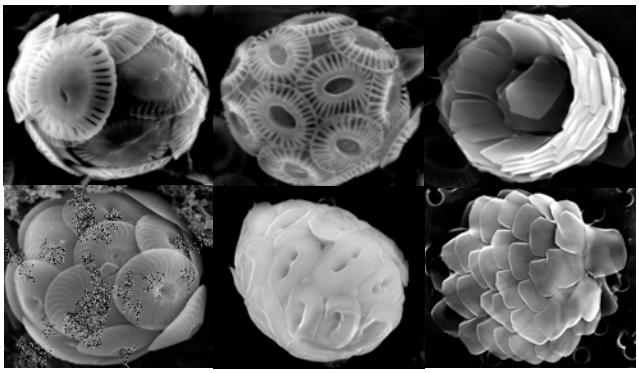
1. Scientific highlight

1- Coastal Upwelling off Perú

During 2016 IMARPE continue with the project **Coastal Upwelling off Peru: An Integrated study approach** as one of the main research lines of the Climate Change and Oceanography research Direction. 2016 year was also under the influence of El Niño Costero during summer and fall period that was observed in the water masses and a direct impact in oxygenation, pH and nutrients. The main results were presented at the Fourth International Symposium on the Ocean in a High-CO2 World Hobart, Tasmania, Australia, 3–6 May 2016. The results shows the impact of the last El Niño event 2014-2015, 2015-2016 in the variability of the OMZ and pH off Callao and the strong impact in the chemistry and the phytoplankton communities. A strong presence of the nanoplankton community and coccolitophorids with different degrees of calcification appears in a coastal open-ocean gradient.

2- Acidification and the Peruvian Upwelling system

In the frame of the IAEA project, the IPEN Energy institute of Peru and the topic The Upwelling of Perú How vulnerable it is? IMARPE has a contract 18007 to develop studies focus in the acidification and the impact in biological communities. In the frame of the contract IAEA two master thesis were finished: 1) Variabilidad espacial y calcificación de las comunidades de cocolitofóridos en el Sistema de Afloramiento costero frente al callao Perú. Diana Angélica Alvites Gutiérrez. Cayetano herdia University. This thesis is under collaboration with the CALHIS Project, LOCEAN-CEREGE France.



Species of Callao *Emiliana huxleyi*, *Florisphaera profunda*, calcidiscus, Heliscophaera carterai. Thanks Alvites, 2016- Master Thesis..

2) “Calcification and growth in juvenile of A. purpuratus under low-pH” (Kathy Córdova– UPCH) in collaboration with IMARPE (E. Fernández, A. Aguirre) and LEMAR-IRD (J. Fly) research scientist, LMI DISCOH 2 and support staff from national universities- J. Vitor (UNMSM) and I. Vasquez (UNALM).

3- **Modelling approaches for the upwelling oceanographic and ocean-atmosphere coupling**

IMARPE and the Instituto Geofísico del Perú IGP continue the efforts to develop different models in order to improve the knowledge about the oceanographic and the coupling between the ocean and atmosphere interaction. An important efforts was associated during 2016 to the El Niño conditions that follow the 2015 Coastal El Niño conditions.

2. Activities/main accomplishments in 2016 (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.)

1- Workshops “ KOSMOS PERU 2017 “AN OMZ MESOCOSM EXPERIMENT”

During 2016 in Kiel, Germany at the GEOMAR institute and in iMARPE take place several workshop In the frame of the project "Future Changes in the ocean upwelling system off Peru, KOSMOS Perú " led by Dr. Ulf Riesebell the German Institute GEOMAR and Michelle Graco from the Instituto del Mar del Peru (IMARPE). This project have the participation of 72 scientist, from Perú, IMARPE, Peruvian universities UPCH, UCSUR, UNI, UNMSM, GEOMAR and many other universities and institutes of several other countries. During 2016 was fix the scientific plan. The experiment will be launch in 2017.

2- LAOCA Latinoamericana NETWORK of Acidification

During 2016 in Lima, Perú take place at IMARPE the first meeting of the LAOCA -Latin American Ocean Acidification network (LAOCA). One of the future activities will be the International Symposium of Acidification at Argentina- November 2017. This symposium will be support by LAOCA, GOA-ON and IAEA.

5-**Low Oxygen Network GO2NE**

During 2016 IOC- UNESCO network focused on oxygen in open and coastal ocean continue the activities with the participation of IGP and IMARPE.

4-Participation in several international conferences / OSC Open Science Conference 2016,
a High-CO2 World realizado en Hobart, Presentación oral. 3 al 6 de Mayo de 2016. Tasmania, AUSTRALIA, CALHIS. Aix en Provence, FRANCIA, Congreso de Ciencias del Mar. Chiclayo, PERU.

Several students and professionals form Perú, IGP, UPCH, IMARPE, UNMSM, UcSUR represent Peruvian research in topics related with the upwelling of Perú.

3. Top 5 publications in 2015 (only PUBLISHED articles) and if any weblinks to models, datasets, products, etc.

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

Graco, M., Purca, S., Dewitte, B., Morón, O., Ledesma, J., Flores, G., Castro, C., and Gutiérrez, The OMZ and nutrients features as a signature of interannual and low frequency variability off t peruvian upwelling system, Biogeosciences Discuss., doi:10.5194/bg-2015-567, in review, 2016.

Graco M., Correa, D., García W., Sarmiento M. (2016). Impactos del ENSO en la biogeoquímica del sistema de afloramiento frente a Perú Central. Febrero 2013-diciembre 2015. BOLETíN

Trimestral oceanográfico. Programa Presupuestal 0068 “Reducción de Vulnerabilidad y Atención de Emergencias por desastres”. Instituto del Mar del Perú. 2(1): 2-6.

Vergara, O., B. Dewitte, I. Montes, V. Garçon, M. Ramos, A. Paulmier, and O. Pizarro: Seasonal Variability of the Oxygen Minimum Zone off Peru in a high-resolution regional coupled model. Biogeosciences. 13, 4389-4410, 2016.

PART 2 - Planned activities from 2016 to 2018/19

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

-The main field study will be the KOSMOS experiment that will take place between January and April 2017, off san Lorenzo Island.

- In the frame of the SFB 754 research cruises off Peru with the Meteor and IMARPE research Vessels. 2017.

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

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 the activity topics relate – including the themes on ‘SOLAS science and society’ and ‘Geoengineering’)

-National with international efforts to curry out multidisciplinary research focus in the SOLAS OMZs-EBUEs Mid-Term Strategy Initiative topics

1- National project of the Upwelling System of Peru- OMZ IMARPE
2- ASLAEL Project KOSMOS 2017 Perú- GERMANY/ GEOMAR/ OMZ IMARPE
3- El Niño and the peruvian upwelling two projects. 1) IGP, LEGOS, 2) IMARPE- IRD-UPCH.
4- IAEA Project- contract- Upwelling and acidification IMARPE, UPCH
5- LMI DISCOH IRD- Upwelling, modelling- several partners from France LOCEAN, CEREGE, TOULOUSE and IMARPE.

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)

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

1- ASLAEL Project KOSMOS 2017 Perú- GERMANY/ GEOMAR/ OMZ IMARPE
2- El Niño and the peruvian upwelling two projects. 1) IGP, LEGOS, 2) IMARPE- IRD-UPCH.
3- IAEA Project- contract- Upwelling and acidification IMARPE, UPCH
4- LMI DISCOH IRD- Upwelling, modelling- several partners from France LOCEAN, CEREGE, TOULOUSE and IMARPE.

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

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

This report has two parts:

- Part 1: *reporting of activities in the period of January 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

For three land based stations (Longyearbyen, Ny-Alesund, Hornsund) and the Fram Strait area sunphotometric data have been archived. These data were collected during the IO PAN routine Arctic studies, from the AERONET and the MAN projects and from the Ny-Alesund based studies. To enhance the analyses also meteo, satellite and back-trajectories have been analyzed. Very initial data analyses allowed to provide some statistical results, which are presented in Table 1. The extreme values (minimum and maximum) as well as the average values indicate the changes in aerosol optical properties with time and location.
The analyzed aerosol data also show that the AOD values at 500 nm, slightly increase over a period between 2000 and 2012. Some years (2005, 2006, 2008 and 2011) show extremely high AOD values. This is concerned with certain atmospheric events, such as e.g. Arctic Haze, or biomass burning pollution transported to the study area from remote regions.
Table 1. Introductory statistics for AOD at 500 nm and the Ångström Parameter for a period between 2000 and 2012 at three Svalbard stations (LY – Longyearbyen).

	Rok	AOD [500nm]				Ångström exponent			
		Minimum	Maximum	Mean ± StD	Variance	Minimum	Maximum	Mean ± StD	Variance
Hornsund	2005	0.023	0.319	0.073±0.042	0.002	0.370	1.793	1.148±0.277	0.077
	2006	0.022	0.522	0.111±0.099	0.010	0.208	1.951	1.326±0.332	0.110
	2007	0.037	0.256	0.089±0.032	0.001	0.300	1.894	1.269±0.387	0.150
	2008	0.023	0.574	0.102±0.055	0.003	0.211	1.943	1.456±0.253	0.064
	2009	0.041	0.285	0.104±0.039	0.002	0.418	1.806	1.378±0.245	0.060
	2010	0.049	0.305	0.095±0.035	0.001	0.499	1.877	1.234±0.338	0.115
	2011	0.036	0.240	0.087±0.030	0.001	0.235	1.977	1.371±0.419	0.176
	2012	0.025	0.209	0.082±0.032	0.001	0.391	2.105	1.561±0.271	0.073
LYR	2003	0.029	0.365	0.095±0.060	0.004	0.447	2.077	1.609±0.261	0.068

	2004	0.024	0.114	0.048±0.013	0.000	0.491	1.839	1.357±0.251	0.063
Ny-Alesund	2000	0.073	0.195	0.110±0.025	0.001	0.879	1.616	1.317±0.156	0.024
	2001	0.053	0.110	0.077±0.016	0.000	0.206	1.432	1.093±0.148	0.022
	2002	0.037	0.115	0.066±0.015	0.000	0.619	2.080	1.399±0.279	0.078
	2003	0.044	0.139	0.067±0.015	0.000	-0.185	2.164	0.755±0.519	0.269
	2004	0.027	0.245	0.088±0.046	0.002	-0.192	2.318	1.609±0.485	0.235
	2005	0.016	0.633	0.106±0.093	0.009	0.313	2.317	-1.334±0.369	0.136
	2006	0.017	0.264	0.062±0.035	0.001	0.535	1.802	1.493±0.189	0.036
	2007	0.028	0.189	0.075±0.032	0.001	1.025	1.937	1.580±0.164	0.027
	2008	0.025	0.183	0.078±0.038	0.001	1.046	1.875	1.536±0.153	0.023
	2009	0.035	0.208	0.089±0.032	0.001	0.773	1.995	1.360±0.243	0.059
	2010	0.006	0.126	0.049±0.021	0.000	-0.163	2.237	1.382±0.319	0.102
	2011	0.035	0.162	0.067±0.020	0.000	1.065	2.234	1.835±0.147	0.022

2. Activities/main accomplishments in 2016 (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.)

1. Membership in the Board of Directors of the Centre for Polar Studies.
2. Organization of an international symposium called the Sopot Forum for Young Scientists.
3. Co-ordination of the public consultations within the Sea for Society project.
4. Organization and running of a number of meetings with various steakholders within the 7 FP project Sea for Society.
5. Leaders in the POLAND-AOD network.
6. Polish coordination in the NASA Maritime Aerosol Network.
7. Membership in the Scientific Council of the Climate Forum – Science on Climate.
8. Coordination of the Sopot Association for the Advanced Sciences activities.
9. Organization of a number of public events, promoting science.
10. PIs in the iAREA Polish-Norwegian project.
11. ESA OceanFlux Greenhouse Gases Evolution project - participation.
12. Co-organizing of a SOLAS related meeting (membership of the scientific committee and session chairing).

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

1. Markowicz K, Chilinski M, Lisok J, Zawadzka O, Janicka L, Stachlewska I, Makuch P, Pakszys P, Rozwadowska A, Petelski T, Zielinski T, Posyniak M, Pietruczuk A, Szkop A, Westphal A, 2016, Study of aerosol optical properties during long-range transport of biomass burning from Canada to Central Europe in July 2013; *Journal of Aerosol Science*; Vol. 101, 156 -173; http://dx.doi.org/10.1016/j.jaerosci.2016.08.006; **(5 year IF=2.627).**

2. Lisok J, Markowicz K, Ritter Ch, Neuber R, Makuch P, Pakszys P, Markuszewski P, Petelski T, Rozwadowska A, Chilinski M, Stachlewska I, Becagli S, Traversi R, Udisti R, Struzewska J, Kaminski J, Jefimow M, Zielinski T, 2016, 2014 iAREA campaign on aerosol in Spitsbergen Part 1: Study of physical and chemical properties; *Atmospheric Environment*, (140), pp. 150-166 . doi: 10.1016/j.atmosenv.2016.05.051 J **(5 year IF=3.841).**

3. Ritter Ch, Neuber R, Markowicz K, Stachlewska I, Lisok J, Makuch P, Pakszys P, Markuszewski P, Rozwadowska A, Petelski T, Zielinski T, Becagli S, Traversi R, Udisti R, Gausa M, 2016, 2014 iAREA campaign on aerosol in Spitsbergen – Part 2: Optical properties from Raman-lidar and in-situ observations at Ny-Ålesund; *Atmospheric Environment*; vol. 141; 1-19; http://dx.doi.org/10.1016/j.atmosenv.2016.05.053; **(5 year IF=3.841).**

4. Wróbel I, Piskozub J., 2016, Effect of gas-transfer velocity parameterization choice on airsea CO2 fluxes in the North Atlantic Ocean and the European Arctic, *Ocean Science*, 12 (5), 1091-1103, doi:10.5194/os-12-1091-2016.

5. James R.H., Bousquet P., Bussman I., Haeckel M., Kipfer R., Leifer I., Niemann H., Ostrovsky I., Piskozub J., Rehder G., Treude T., Vielstädte L., Greinert J., 2016, Effects of climate change on methane emissions from seafloor sediments in the Arctic Ocean: A review, Limnology and Oceanography, 61(S1), S283-S299, doi:10.1002/lno.10307 (IF = 3.660; IF5 = 4.280)

For journal articles please follow the proposed 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.

Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

Organization and running of a number of meetings with various steakholders within the 7 FP project Sea for Society and our own dissemination activities. The groups of steakholders included participants from general public to school kids. We run workshops and science fairs, open lectures and projects with kids related to marine environment.

PART 2 - Planned activities from 2017/2018 and 2019

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, spring 2017 international campaign.

2. Summer Arctic campaign using the r/v Oceania and in cooperation with an international team of researchers, including the r/v Polarstern.

3. NASA AERONET, ongoing activities.

4. POLAND-AOD, ongoing activities.

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

1. Organization of an international conference for young scientists entitled: Where the World is Heading (26 May 2017).

2. Continuation of work within the POLAND-AOD network.

3.A number of other activities are planned.

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)

None at the moment. A number of projects to be submitted during 2017.

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)

A number of projects to be submitted during 2017. We will seek funding on national and international levels.

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

1. NASA AERONET (agreement until 2019).
2. Ny-Alesund Flagship programs, spring 2016 international campaign.
3. Bilateral agreement with the Alfred Wegener Institute (until September 2016, to be extended).

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 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 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017
1. Scientific highlight
Describe one scientific highlight with a title, text (max. 200 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in international collaboration. (If you wish to put more than one, feel free to do so).
Polycyclic aromatic hydrocarbons (PAHs), and other semivolatile aromatic-like compounds (SALCs), are an important and ubiquitous fraction of organic matter in the environment. The occurrence of semivolatile aromatic hydrocarbons is due to anthropogenic sources like incomplete combustion of fossil fuels or oil spills, and other biogenic sources. However, their global transport, fate and relevance for the carbon cycle have been poorly assessed, especially in terms of fluxes. In this contribution, an assessment of the occurrence and atmosphere-ocean fluxes of 64 polycyclic aromatic hydrocarbons analyzed in paired atmospheric and seawater samples from the tropical and subtropical Atlantic, Pacific and Indian oceans was performed. The global atmospheric input of polycyclic aromatic hydrocarbons to the global ocean is estimated at 0.09 Tg month^{-1}, four-fold greater than the PAH input from the Deepwater Horizon spill. Moreover, the environmental concentrations of total semivolatile aromatic-like compounds (SALCs) were 10^2-10^3 folds higher than those of the targeted polycyclic aromatic hydrocarbons, with a relevant contribution of an aromatic unresolved complex mixture. These concentrations drive a large global deposition of carbon, estimated at 400 Tg C y^{-1}, around 15% of the oceanic CO_2 uptake. Future efforts should focus on a comprehensive assessment of the different fraction of organic matter

contributing to the atmosphere ocean exchange fluxes, and on the elucidation of the biogenic and anthropogenic contribution to these pools of exchangeable organic matter and their fluxes in the environment.

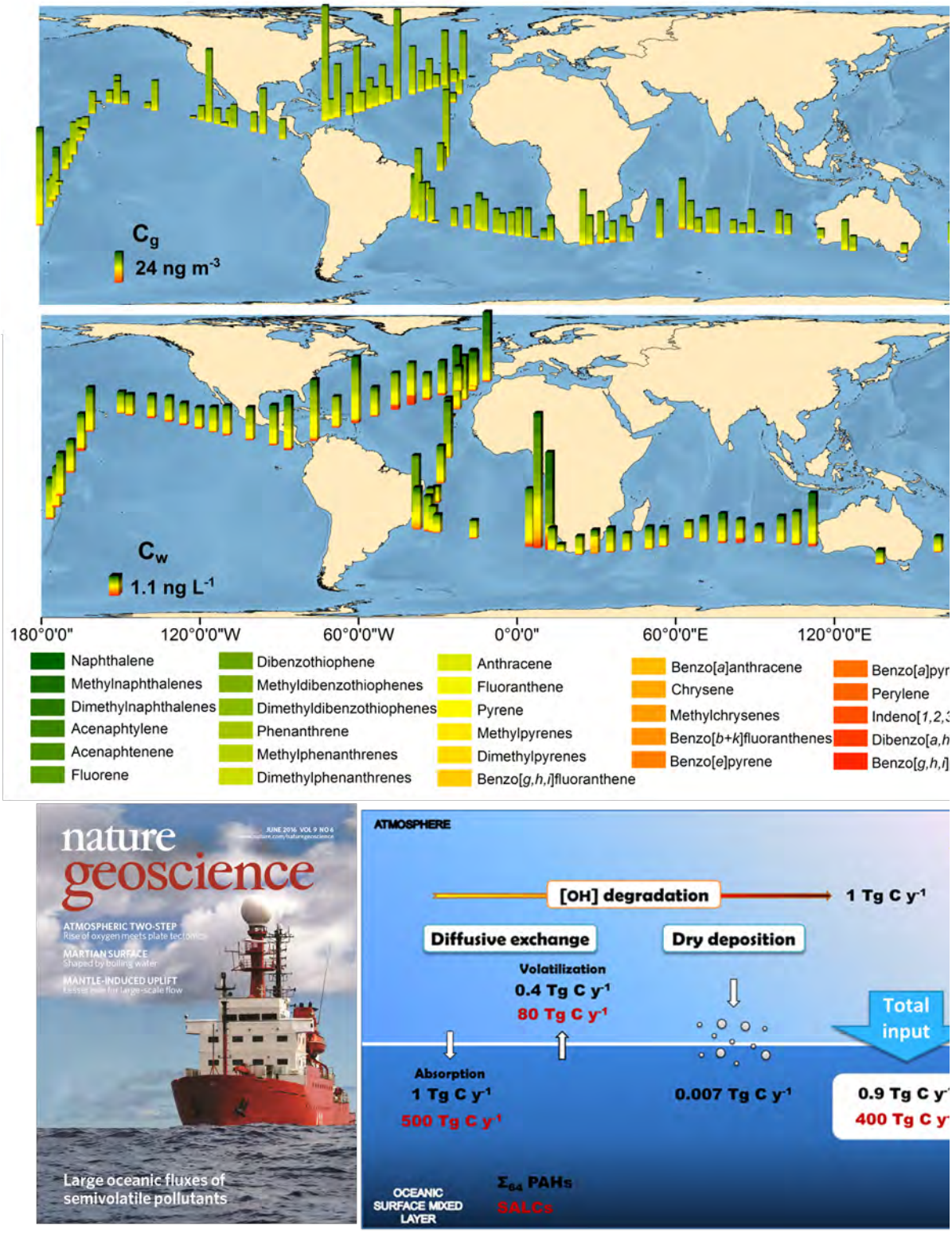


Figure 1. Measured concentrations of 64 polycyclic aromatic hydrocarbons (PAHs) in the gas phase (upper panel) and surface seawater (middle panel) for the global oceans during the

Malaspina Circumnavigation cruise. Lower panel-right shows the estimated global atmosphere-ocean exchange fluxes of PAHs and semivolatile aromatic-like hydrocarbons (SALCs). This paper was highlighted at the cover of Nature Geoscience (lower panel-left) with a picture of RV Hepérides during the Malaspina expedition.

Manuscript citation:
González-Gaya, B., Fernández-Pinos, M.-C., Morales, L., Méjanelle, L., Abad, E., Piña, B., Duarte, C.M., Jiménez, B., Dachs, J. High atmosphere-ocean exchange of semivolatile aromatic hydrocarbons (2016) *Nature Geoscience* 9 (6), pp. 438-442.

2. Activities/main accomplishments in 2016 (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.)

Research Projects:

NICANOR: Nitrogen fixation and diffusive fluxes in the upwelling region off NW Iberia. Xunta de Galicia, PI: Beatriz Mouriño

SCORE: Sediments and cold water Corals to address key questions of the Oceans in the past: two case-study Regions and one Experiment.
Funded by Spain´s Ministerio de Economía y Competitividad. PI: Carles Pelejero

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

- González-Gaya, B., Fernández-Pinos, M.-C., Morales, L., Méjanelle, L., Abad, E., Piña, B., Duarte, C.M., Jiménez, B., Dachs, J. High atmosphere-ocean exchange of semivolatile aromatic hydrocarbons (2016) *Nature Geoscience* 9 (6), pp. 438-442.

- Bunse, C., Lundin, D., Karlsson, C.M.G., Akram, N., Vila-Costa, M., Palovaara, J., Svensson, L., Holmfeldt, K., González, J.M., Calvo, E., Pelejero, C., Marrasé, C., Dopson, M., Gasol, J.M. and Pinhassi, J. (2016) Response of marine bacterioplankton pH homeostasis gene expression to elevated CO_2. *Nature Climate Change*, doi:10.1038/nclimate2914.

- Fernández-Castro B, Pahlow M, Mouriño-Carballido B, Marañón E., Oschlies A (2016). Optimality-based Trichodesmium Diazotrophy in the North Atlantic Subtropical Gyre. *Journal of Plankton Research*, DOI: 10.1093/plankt/fbw047.

- Galí, Martí; Kieber, David; Romera-Castillo, Cristina; Kinsey, Joanna D.; Devred, Emmanuel; Pérez, Gonzalo Luis; Westby, George R.; Marrasé, Cèlia; Babin, Marcel; Levasseur, Maurice; Duarte, Carlos; Agusti, Susana; Simo, Rafel (2016) CDOM sources and photobleaching control quantum yields for oceanic DMS photolysis *Environmental Science & Technology* 50: *13361-13370.*

- Saiz-Lopez, A., and R.P. Fernandez (2016), On the formation of tropical rings of atomic halogens: Causes and implications, Geophys. Res. Lett., 43, 2928-2935, doi:10.1002/2015GL067608.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

PART 2 - Planned activities from 2017/2018 and 2019

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

Field studies

Periodic cruises for data collection at the GIFT time series located at the Strait of Gibraltar to monitor air-sea fluxes of GHGs (CO_2, CH_4, N_2O) and track ocean acidification in the Mediterranean basin.

Seasonal samplings at the coastal fringe comprising the complex Guadalquivir river estuary- Doñana wetlands are scheduled from 2016 to 2018 to compute air-water GHGs (CO_2, CH_4, N_2O) exchange. Close collaboration with University of Liege (Belgium).

PEACETIME: Process studies at the air-sea interface after dust deposition in the Mediterranean sea

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

ICM-CSIC is organizing The Ramon Margalef summer colloquia “A view of the ocean from Barcelona” in Barcelona, Spain, July 2017.

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)

CLIMAHAL: Climate dimension of natural halogens in the Earth system: Past, present, future. Funded by the European Research Council Consolidator Grant, 2017-2023. PI: Alfonso Saiz-Lopez

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)

Several groups are actively seeking funds from national (Spanish National Plan for Research) and international (H2020, ERC, etc).

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

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *Taiwan*

compiled by: Gwo-Ching Gong, Hung-Yu Chen, Wen-Chen Chou

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

pH is an important property of seawater because it affects a wide range of chemical and biogeochemical processes in the ocean, such as chemical reactions, equilibrium conditions, and biological toxicity. More importantly, with growing concern over ocean acidification, the effect of a pH decrease is essential to consider at the present time. Conventionally, pH measurement is generally recommended that seawater samples should be collected directly into 10 cm path-length optical cells and then analyzed onboard as soon as possible after sampling. However, there are an increasing number of occasions when seawater pH samples may need to be preserved and stored for later analysis in land-based laboratories. For instance, due to space limitations on research vessels, particularly small boats, the apparatus for pH measurements cannot be installed onboard. Furthermore, due to increased needs in ocean acidification studies, water samples are often collected by researchers with various backgrounds and shipped to laboratories with appropriate expertise to be analyzed. Therefore, it is important to evaluate the effect of sample storage on pH measurements by comparing pH values measured immediately onboard with those measured later in the shore-based laboratory.

In this study, a comparison experiment between field and laboratory pH measurements was conducted on a total of 88 seawater samples collected on the East China Sea shelf during 16-29 July 2014. The results show that although pH directly measured onboard was statistically higher than the pH later measured onshore with an average residual of 0.0052±0.0057, after correcting for the perturbation caused by the addition of the $HgCl_2$ solution, the observed difference was within the uncertainty in pH measurement. Therefore, our result suggests that, similar to total alkalinity and dissolved inorganic carbon determinations, seawater samples can be stored for pH analysis with a precision that is comparable to the uncertainty of onboard measurement for a period of at least 20 days.

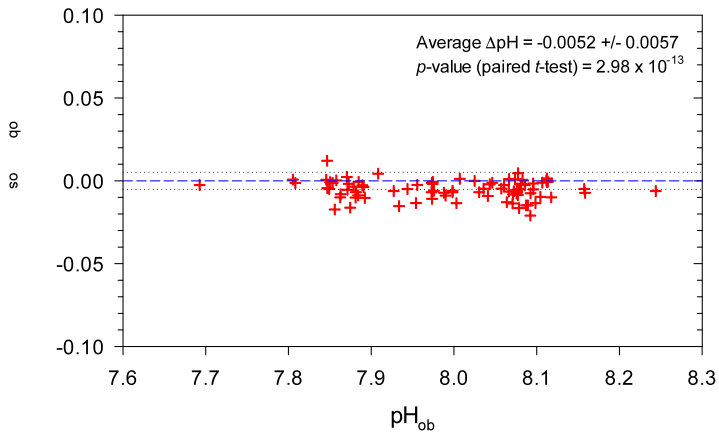


Figure 1. Difference between the onshore measured pH (pH_{os}) and the onboard measured pH (pH_{ob}) as a function of pH_{ob}.

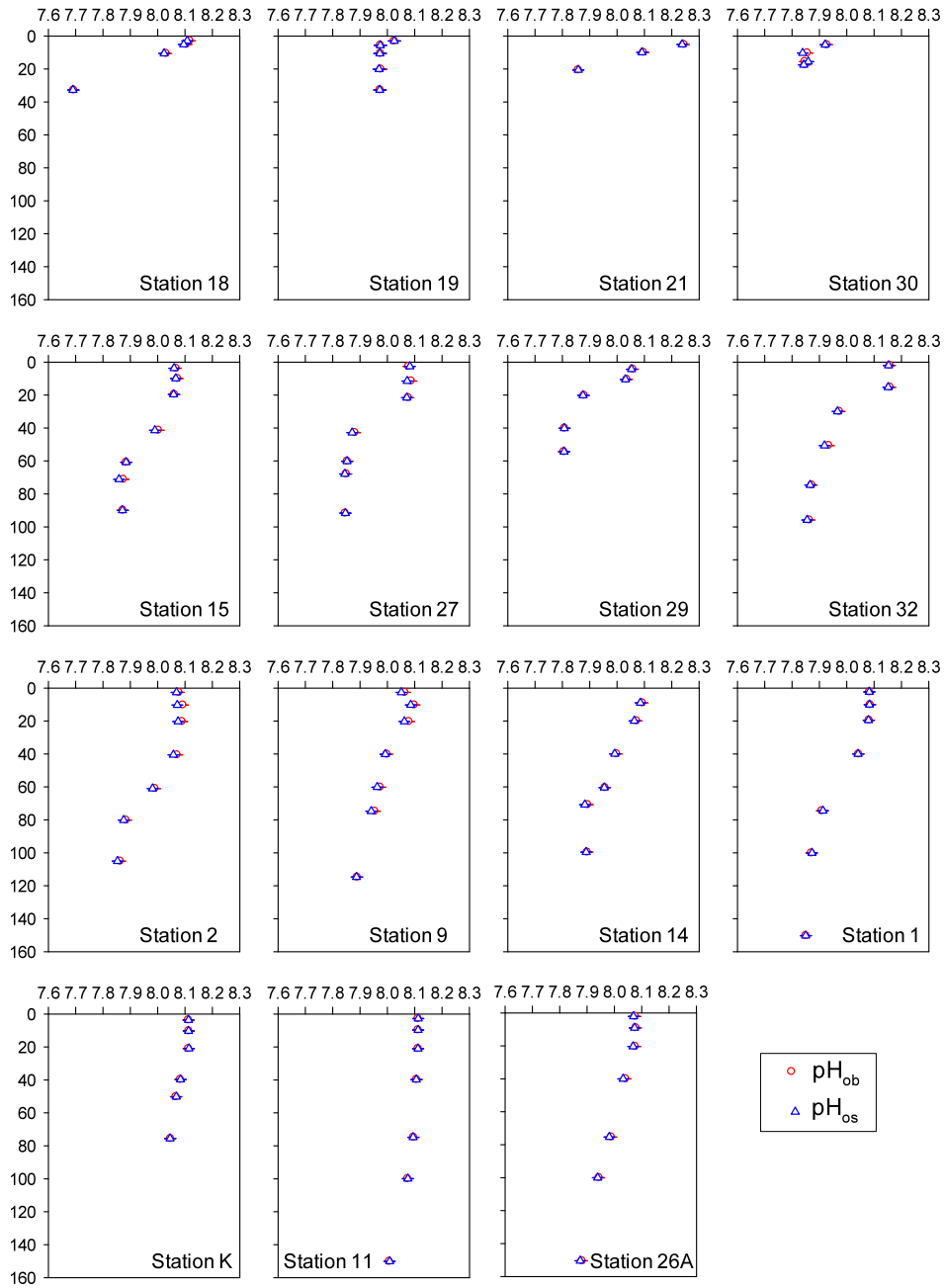


Figure 2. Depth distributions of onboard and onshore measured pH at 15 hydrographic stations on the East China Sea shelf.

Citation: Chou, W.-C., Gong, G.-C., Yang, C.-Y., Chuang, K.-Y., 2016. A comparison between field and laboratory pH measurements for seawater on the East China Sea shelf, Limnology and Oceanography: Methods, 14, 315-322. doi: 10.1002/lom3.10091

2. Activities/main accomplishments in 2016 (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.)

Two SOLAS-related integrated projects were funded by the Ministry of Science and Technology of Taiwan in 2016: (1) Effects of Global Change on Ocean Biogeochemistry and Ecosystems in the Seas surrounding Taiwan in the Northwest Pacific; and (2) Impacts of Typhoons And Internal Waves on Biogeochemical Processes in the Northern South China Sea.

Convening a SOLAS-related session "Effects of Global Change on Marine Biogeochemistry and Ecosystem in Marginal Seas" in the AOGS 13th Annual Meeting 2016, Beijing, China, 31 July-5 August 2016.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Chen, T.-Y., Tai, J.-H., Ko, C.-Y., Chen, C.-C., Hsieh, C.-H., Jiao, N.-Z., Liu, H.-B., Shiah, F.-K. 2016. Nutrient pulses driven by internal solitary waves enhance heterotrophic bacteria growth in the South China Sea. Environmental Microbiology, 12, 4312-4323. doi: 10.1111/1462-2920.13273.

Chou, W.-C., Gong, G.-C., Yang, C.-Y., Chuang, K.-Y., 2016. A comparison between field and laboratory pH measurements for seawater on the East China Sea shelf, Limnology and Oceanography: Methods, 14, 315-322. doi: 10.1002/lom3.10091.

Hung, C.-C., Chen, Y.-F., Hsu, S.-C., Wang, K., Chen, J.-F., Burdige, D.J., 2016. Using rare earth elements to constrain particulate organic carbon flux in the East China Sea. Scientific Reports, 6:33880, doi: 10.1038/srep33880.

Tseng, H.-C., Chen, C.-T.A., Borges, A.V., DelValls, T.A., Chang, Y.-C., 2016. Methane in the South China Sea and the Western Philippine Sea. Continental Shelf Research, 135, 23-34.

Tseng, H.-C., Chen, C.-T.A, Borges, A.V., DelValls, T.A., Lai, C.M., Chen, T.Y., 2016. Distributions and sea-to-air fluxes of nitrous oxide in the South China Sea and the West Philippines Sea. Deep Sea Research Part I, 115, 131–144, doi:10.1016/j.dsr.2016.06.006.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

No

PART 2 - Planned activities from 2017/2018 and 2019

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

One cruise of 10 days is planned to survey the East China Sea in summer of 2017.

One cruise of 6 days is planned to survey the northern South China Sea in summer of 2017.

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

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

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *'Turkey'*
compiled by: 'Nazlı Olgun Kıyak'

This report has two parts:

- Part 1: *reporting of activities in the period of January 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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)!*

SOLAS Community involves scientists from two institutes in Turkey:

Dr. Nazlı Olgun Kıyak, Eurasia Institute of Earth Sciences, Istanbul Technical University (ITU), Istanbul, Turkey (SOLAS Turkey Representative)

Dr. Barış Şalihoğlu, The Institute of Marine Sciences, Middle East Technical University (METU), Mersin, Turkey

Dr. Mustafa Koçak, The Institute of Marine Sciences, Middle East Technical University (METU), Mersin, Turkey

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

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

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

Sea spray aerosols (SSA), which are emitted from the ocean to the atmosphere through wind-driven processes, originate in an aquatic environment that contains varying amounts of organic matter (OM). The presence of OM may have a strong impact on SSA population, both through enrichment of the emitted particles and through altering the efficiency of the aerosol production process. Observed properties of organic marine aerosols is the contribution of marine hydrogels which are emitted during the sea spray production process. Orellana et al. (2011), have shown that marine gels may have an important effect on the chemical and physical properties of the atmosphere, by providing an important source of cloud condensation nuclei during the pristine

arctic summer. Although it is well acknowledged that OM has an important effect of the properties of sea spray aerosols, fundamental questions on the nature of this effect are still open. Importantly, there is an ongoing debate on the dependency of sea spray aerosols on localized (in space and in time) events of enhanced biological activity, and on the efficiency of using chlorophyll-a (Chl, a measure to phytoplankton biomass) data as a proxy for OM enrichment. The manuscript will focus on the use of remote sensing tools to understand the impact of organic matter in the physico-chemical properties of marine boundary layer.

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

- **Scientific Highlight 2: *Methane Emissions in Antarctic lakes (Related to SOLAS Theme 1: Greenhouse gases and the oceans)***

Although lakes cover only 0.9% of the Earth surface, they represent one of the most biogeochemically active environments. For example, 6-16% of the natural methane emissions, which is an important greenhouse gas, is produced by the lake and wetland environments. Recent studies showed the correlation between the primary productivity (algae or phytoplankton) is strongly affecting with the methane production. Most of the algae produced in lakes are deposited in lake bottom as organic substrate (e.g. acetate) and under anoxic conditions transformed into methane by bacterial activity. Organic production is therefore important to understand the methane cycling in lakes. Antarctic, is one of the least studies environments in terms of lake ecosystems. In this study, we performed limnological and biogeochemical investigations in 11 lakes in the Fildes Peninsula in King George Island (62°S) in the Antarctic. Field studies were performed in lakes near the Chilean Escudero Station between 17 February – 07 March 2017. Lake water samples were collected for nutrient and metal contents, phytoplankton species, chlorophyll-a and sediment/soil samples were collected for mineralogical and biogeochemical analyses including bacterial activity, organic carbon content, hydrocarbons, fossil content). New data will improve our understanding of the impacts of Antarctic lake ecosystems on the carbon cycling.

Citation: *In preparation.* **Olgun N.** , Çelik-Balcı N., Kurt M. A., Yakan S. D., Yılmaz A., Astorga M. S., Thalasso F., Cabrol L., Hoffmann L., Methane cycling in Antarctic lakes.

2. Activities/main accomplishments in 2016 (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.)

Projects:

- **Olgun N.,** Istanbul Technical University (ITU) Project 42605 'Investigation of the impacts of primary productivity on methane emissions in lakes in Cape Horn (55° S) ve King George (62° S) Islands in Antarctica' finished 29.03.2017, related to SOLAS Theme 1.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

For journal articles please follow the proposed 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 2016? If yes, who? How did you engage?

PART 2 - Planned activities from 2017/2018 and 2019

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

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

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

3. Funded national and international projects / activities underway (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)

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)

1. Planned Project Proposal: **N. Olgun** 'Evaluating the carbonate chemistry dynamics and the climate change response of The Sea of Marmara, Turkey', to be submitted on **September 2017** to The Scientific and Technological Research Council of Turkey (TUBITAK). The project is related to SOLAS Theme-1, Greenhouse gases and the oceans.

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

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *UK*
compiled by: Tom Bell

This report has two parts:

- Part 1: *reporting of activities in the period of January 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

Describe one scientific highlight with a title, text (max. 200 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in international collaboration. (If you wish to put more than one, feel free to do so).

Effects of pollution on aerosol iron solubility

Li et al. (2017) provide a 'smoking gun' for the theory of acid iron dissolution - acids formed from human-generated pollution and natural emissions dissolve iron in airborne particles. We know that air pollution seriously damages human health and terrestrial ecosystems but this 'new' source of soluble iron can potentially alter the amount of carbon dioxide stored in the oceans.

Individual particles were collected from the Yellow Sea, the northern part of the East China Sea located between mainland China and the Korean Peninsula. Sophisticated microscopic instruments were used to look for iron-containing nanoscale particles. We showed that iron-rich, fly ash, and mineral dust particles had travelled from the Asian continent. Most of the individual iron-rich and fly ash particles contained a significant amount of sulphate containing soluble iron. This provides first observational evidence that iron dissolution takes place in the atmosphere.

Reference:

Li, W., Xu, L., Liu, X., Zhang, J. Lin, Y., Yao, X., Gao, H., Zhang, D., Chen, J., Wang, W., Harrison, R.M., Zhang, X., Shao, L., Fu, P., Nenes, A., Shi, Z., 2016. Aerosol – pollution interaction produces more soluble iron for the ocean ecosystems. Science Advances, 3, e1601749

2. Activities/main accomplishments in 2016 (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.)

Meetings

- *GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) WG 38* held a week long meeting (hosted by A. Baker and T. Jickells, UEA) looking at:
  - Changing Atmospheric Acidity and the Oceanic Solubility of Nutrients
  - Impact of Ocean Acidification on Fluxes of non-CO_2 Climate-Active Species

  25 people came to the meeting from around the world. It was co-sponsored by SOLAS, SCOR GESAMP NSF and UEA and a report of the meeting will be published shortly by SOLAS

- *Air-sea gas flux: Progress and future prospects*
  Science workshop held during 6-9 September 2016 in Brest, France. Organized by the OceanFlux Greenhouse Gases Evolution project.

  Workshop was a forum to bring the international and interdisciplinary air-sea gas flux scientific community together to present recent advances, report results from key initiatives and importantly to identify new goals, challenges and opportunities. The key focal point of the workshop was the synergistic use of models, in situ and remote sensing data and techniques for studying, and furthering this important area of climate research.

  106 participants from 18 countries and 5 continents attended the 4 day workshop. Importantly much of the work and advances that were presented here in 2016 were identified as opportunities and challenges at the first workshop that was held 3 years ago in 2013. The participants included 8 young or early career researchers who received travel bursaries provided by the European Space Agency.

  Open discussions took place during and at the end of the workshop, and have provided clear avenues for future work, that fit within the International Surface Ocean and Lower Atmosphere Study (SOLAS) scientific plans, aims and priorities, whilst also being relevant for agencies like the European Space Agency to support.

Reports

- GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection – IMO /FAO /UNESCO-IOC /WMO /UNIDO /IAEA /UN /UNEP /UNDP) (2016) Pollution in the open oceans: 2009-2013. A report by a GESAMP Task Team. Boelens, R., Kershaw, P. (eds), Task Team members: Angelidis, M., Baker, A., Bakker, D. C. E., Bowmer, T., Hedgecock, I., Tyack, P. GESAMP Reports and Studies 91, 87 pp. http://www.gesamp.org/publications/gesamp-reports-and-studies-91---100/reports-and-studies-91. ISSN 1020-4873.

- Metzl, N., Bakker, D. C. E. (2016) Actualisation de la base internationale Socat de CO2 océanique. La Météorologie 94: 2-3. doi:10.4267/2042/60695.

- Carbon dioxide and ocean acidification observations in UK waters. Synthesis report with a focus on 2010 – 2015 by C. Ostle *et al.* (2016) 44 pp. doi: 10.13140/RG.2.1.4819.4164.

Fieldwork

- The Leeds group (I. Brooks et al) participated in a 6 week cruise in the central Arctic Ocean, including a visit to the North Pole, on the Swedish Icebreaker Oden, during August and September 2016. Our measurements focussed on surface turbulent fluxes of momentum, heat, moisture, and in collaboration with Stockholm University of CO_2 and CH_4.
- Ship emissions testing in Plymouth (T. Smyth et al., PML, in collaboration with GASMET, Valmet and SRT-Marine in March 2017). This work proved the concept of sending data to shore live using AIS technology. This paves the way for mass, large scale reporting of emissions against IMO regulations for individual vessels.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

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

The following alphabetical list of SOLAS-relevant, peer-reviewed 2016 publications (n = 62) with UK authors/co-authors is based on researchers' input and Web of Knowledge searches. There has been no attempt to formally rank the "top 5" in terms of scientific quality or importance.

1. Andrews, S. J., Carpenter, L. J., Apel, E. C., Atlas, E., Donets, V., Hopkins, J. R., Hornbrook, R. S., Lewis, A. C., Lidster, R. T., Lueb, R., Minaeian, J., Navarro, M., Punjabi, S., Riemer, D., and Schauffler, S.: A comparison of very short lived halocarbon (VSLS) and DMS aircraft measurements in the tropical west Pacific from CAST, ATTREX and CONTRAST, Atmos. Meas. Tech., 9, 5213-5225, 10.5194/amt-9-5213-2016, 2016.
2. Baker, A.R. and Jickells, T.D. (2016) Atmospheric deposition of soluble trace elements along the Atlantic Meridional Transect (AMT). Prog. Oceanogr. in press. http://dx.doi.org/10.1016/j.pocean.2016.10.002
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62. Yang, M., Prytherch, J., Kozlova, E., Yelland, M. J., Parenkat Mony, D., and Bell, T. G.: Comparison of two closed-path cavity-based spectrometers for measuring air-water CO_2 and CH_4 fluxes by eddy covariance, Atmos Meas Tech, 9, 5509-5522, 10.5194/amt-9-5509-2016, 2016.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

End user engagement: The parameterisation in Elvidge et al. (2016) is currently being incorporated into the UK Met Office operational forecast model. This work provides the first test of a recently proposed surface drag parameterization over sea ice.

Measurements were obtained from both the FAAM aircraft and BAS Twin Otter over sea ice around Svalbard during the spring field campaign of the NERC ACCACIA project. The measurements were used to tune the theoretically derived parameterization of Lüpkes et al. (2012) for the marginal ice zone. They demonstrate a high degree of spatial variability in surface roughness and drag coefficient dependent upon the sea ice properties.

External research user engagement: Ship atmospheric emissions testing of Plymouth in collaboration with industry (GASMET, Valmet and SRT-Marine). This work was performed in 1st – 2nd March 2017 and proved the concept of sending real-time data to shore using Automatic Identification System (AIS) technology. This paves the way for large scale reporting and monitoring of atmospheric emissions from individual ships. This is

envisaged to be particularly useful given recent and future regulatory controls introduced by the International Maritime Organisation.

Societal UK end user engagement: UK MP's inquiry into ocean acidification (December 2016). The House of Commons Science and Technology Committee announced that it would carry out an inquiry into ocean acidification: "Now that the UK's five year Ocean Acidification Research Programme has ended, we are launching the first parliamentary inquiry on this concerning topic to examine what has been learned and make recommendations to Government." Of the 18 submissions of written evidence (now published on the HoC STC site: https://www.parliament.uk/business/committees/committees-a-z/commons-select/science-and-technology-committee/inquiries/parliament-2015/inquiry5/publications/), 11 were from groups or individuals that had participated in the UK Ocean Acidification (UKOA) programme and a further two from UKOA's main funders (NERC and Defra). Oral evidence at the session on 1 March 2017, involving representatives from Plymouth Marine Laboratory (PML), British Antarctic Survey, National Oceanography Center and the universities of Exeter and Southampton, all of which had involvement in UKOA, as well as a NERC representative. The Department for environment, food and rural affairs (Defra) gave evidence on 22 March 2017.

Societal Intergovernmental end user engagement: UKOA strongly supported international science-to-policy engagement, particularly through outreach activities at the annual Conference of the Parties (COPs) of the UN Framework Convention on Climate Change (UNFCCC) since 2009. That involvement was maintained via the NERC Knowledge Exchange (KE) Open Fellowship to Carol Turley (PML) for a wide range of 'ocean action' events at COP22, held at Marrakech, 6-18 November 2016. PML organised side events in the Britain is Great Pavilion, the EU pavilion, an official UN side event, an official UN press event and another side event with Egypt in the Civil Society area. PML also presenting science evidence and KE information at two exhibition stands (led by PML, and jointly funded by the German BIOACID programme, the Ocean Acidification International Coordination Centre and the University of Brest). Ocean-related issues were given a relatively high profile at COP22, including a high level UN Ocean Action Event which was, for the first time included within the UN sessions.

The work of Li et al. (2017) on the effects of pollution on aerosol iron solubility has been widely reported:

- Interview in BBC Radio 4's *Inside Science* on 2 March 2017 (**http://www.bbc.co.uk/programmes/b08g2tvp**). Also featured on the BBC World Service compilation show of the best of the week's science output.
- |30 international outlets, including *The Smithsonian*, *China.org* and *Voice of America*.

The ESA OceanFlux Greenhouse Gases Evolution project:

- FluxEngine output (PI J. Shutler, U. of Exeter) was covered by the BBC: http://www.bbc.co.uk/news/science-environment-35654938
- D. Woolf also wrote a more 'accessible' piece (Woolf, D.K. 2016 The forgotten carbon sink. Laboratory News http://www.labnews.co.uk/features/forgotten-carbon-sink-27-06-2016/)

PART 2 - Planned activities from 2017/2018 and 2019

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

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

For more details see:

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

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

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

Shipping and the Environment - From Regional to Global Perspectives
An international conference on the environmental impact of shipping and its importance within policy, marine spatial planning and the maritime transport sectors.
Gothenburg, 24-25 October, 2017
http://shipping-and-the-environment-2017.ivl.se/

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)

2016 projects
Ongoing (no specific order)

- Radiatively Active Gases from the North Atlantic Region and Climate Change (RAGNARoCC) – Lead PI: A. Watson (www.greenhouse-gases.org.uk/ragnarocc)
- NERC/Defra Shelf Sea Biogeochemistry programme – Science Coordinator: P. Williamson (http://www.uk-ssb.org/)
- ESA OceanFlux Greenhouse Gases evolution (http://www.oceanflux-ghg.org) – Lead PI J. Shutler
- ESA Pathfinders-Ocean acidification (http://www.pathfinders-oceanacidification.org) – Lead PI J. Shutler
- Atlantic BiogeoChemical fluxes (ABC) – PI: E. McDonagh (http://www.rapid.ac.uk/abc/)
- Coordinated Research in Earth Systems and Climate: Experiments, kNowledge, Dissemination and Outreach (CRESCENDO) H2020 project – PI: C. Jones.
  Aims to improve the representation of key biogeochemical, biogeophysical and aerosol processes and feedbacks in seven European Earth System Models.
- Surface Mixed Layer at Submesoscales (SMILES) – Lead PI: P. Hosegood (http://www.smiles-project.org/)
  Aims to identify the influence of submesoscales upon the structure and properties of the upper ocean, and thereby the transformation of surface water masses, within the Southern Ocean.
- A novel pathway for the production of the climate cooling gas dimethyl sulfide - how important is the mddA gene to global DMS emissions? (NERC) – Lead PI: Jonathan

Todd
- Importance of marine gases and particles for tropospheric chemistry (NERC). PI: Claire Reeves
- Determining the Impact of Seawater Chemistry on the Solubility of Atmospheric Trace metals: DISCOSAT (Marie Curie) – Lead PI: Simon Ussher
- Oceanic Reactive Carbon: Chemistry-Climate impacts: ORC3 (NERC) – Lead PI: Steve Arnold
- Biogeochemical cycling of N-osmolytes in the surface ocean (NERC) – Lead PI: Y. Chen.
- Microbial degradation of dimethylsulfoxide in the marine environment (NERC) – Lead PI: H. Schaefer.
- Trace gases at the Rothera Time-series Site (BAS Collaborative Gearing Scheme, CGS) – Lead PI: C. Hughes
- Marine particles as sources of ice nucleating particles (MarineIce, ERC consolidator grant) –Lead PI: Ben Murray
- The Global Methane Budget (NERC Highlight Topic) – Lead PI: Euan Nisbet
- Eco-interactomics: From microbial interactions to the fate of dissolved organic matter in the oceans (NERC Fellowship for J. Christie-Oleza).
- North Atlantic Climate System: Integrated Study (ACSIS) – Lead PI: Rowan Sutton (https://www.ncas.ac.uk/index.php/en/acsis-home)
- Ocean Regulation of Climate through Heat and Carbon Sequestration and Transports (ORCHESTRA) – Lead PI: Mike Meredith (https://www.bas.ac.uk/project/orchestra/)

Newly-funded (no specific order)
- Bacteria make DMSP - how significant is this process? (NERC) – Lead PI: Jonathan Todd
- Iodide in the ocean: Distribution and impact on iodine flux and ozone loss (NERC) – Lead PI: L. J. Carpenter.
- How do eukaryotic CO_2 fixers co-exist with faster growing prokaryotic CO_2 fixers in the oligotrophic ocean covering 40% of Earth? (NERC) – Lead PI: Mike Zubkov
- A multidisciplinary study of DMSP production and lysis – from enzymes to organisms to process modelling (NERC) – Lead PI: Jonathan Todd
- Does Ozonolysis Chemistry affect Atmospheric Marine Boundary Layer Sulphur Cycling? (NERC) – Lead PI: William Bloss
- Climate and Air Quality Impact of Airborne Halogens (NERC Fellowship for Ryan Hossaini).
- Zinc, iron and phosphorus co-limitation in the Ocean (ZIPLOc). (NERC) – Lead PI: Claire Mahaffey

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)

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

Lucy Carpenter was joint lead author on Chapter 6 (Scenarios and Information for Policymakers) of the 2018 WMO/UNEP Scientific Assessment of Ozone Depletion.

Comments

surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *USA*
compiled by: Rachel Stanley, Wellesley College

This report has two parts:

- Part 1: *reporting of activities in the period of January 2016 – Jan-Feb 2017*
- Part 2: *reporting on planned activities for 2017/2018 and 2019.*

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

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

Coastal waters provide important resources such as economically-important fisheries, but are often susceptible to harmful algal blooms. A recent study by Kate Mackey (University of California, Irvine) and colleagues from Woods Hole Oceanographic Institution, China's Fudan University and Nanjing University, and UC Santa Cruz shows a direct, empirical link between aerosol emissions and increases of bloom-forming species such as dinoflagellates and diatoms in the East China Sea. Mackey and co-authors use observations from bottle incubation experiments of five different aerosols with coastal seawater from two different locations in the East China Sea to determine that dinoflagellates and diatoms were particularly affected by aerosol addition (Fig. 1). They found that dinoflagellates are promoted by the phosphorous limitation induced by the aerosols, which tend to deliver nitrogen and trace metal micronutrients, but not much phosphorous. In contrast, diatoms are promoted by the general increase in nutrients and metals. The effects of the aerosol additions on phytoplankton were muted closer to the mouth of the Yangtzee River, where light limitation from high sediment loading occurs. Mackey and co-authors also examined historical data from HAB events and used satellite measurements of aerosol optical thickness to further characterize the link between HABs and aerosols. They find that aerosol deposition supports dinoflagellates and diatom blooms in the East China Sea but that the response is tempered by sea surface temperatures. In short, this study shows a clear connection between aerosol deposition and increase of HAB-forming phytoplankton from both experiments and remote sensing data, exemplifying an important way that the surface ocean and lower atmosphere are connected.

This study is fully described in the following paper: Mackey, K R M, M T Kavanaugh, F Wang, Y Chen, F Liu, D M Glover, C-T Chien, and A Paytran. Atmospheric and fluvial nutrients fuel algal blooms in the East China Sea, *Frontiers in Marine Science*, 4:2. (2017) doi: 10.3389/fmars.2017.00002

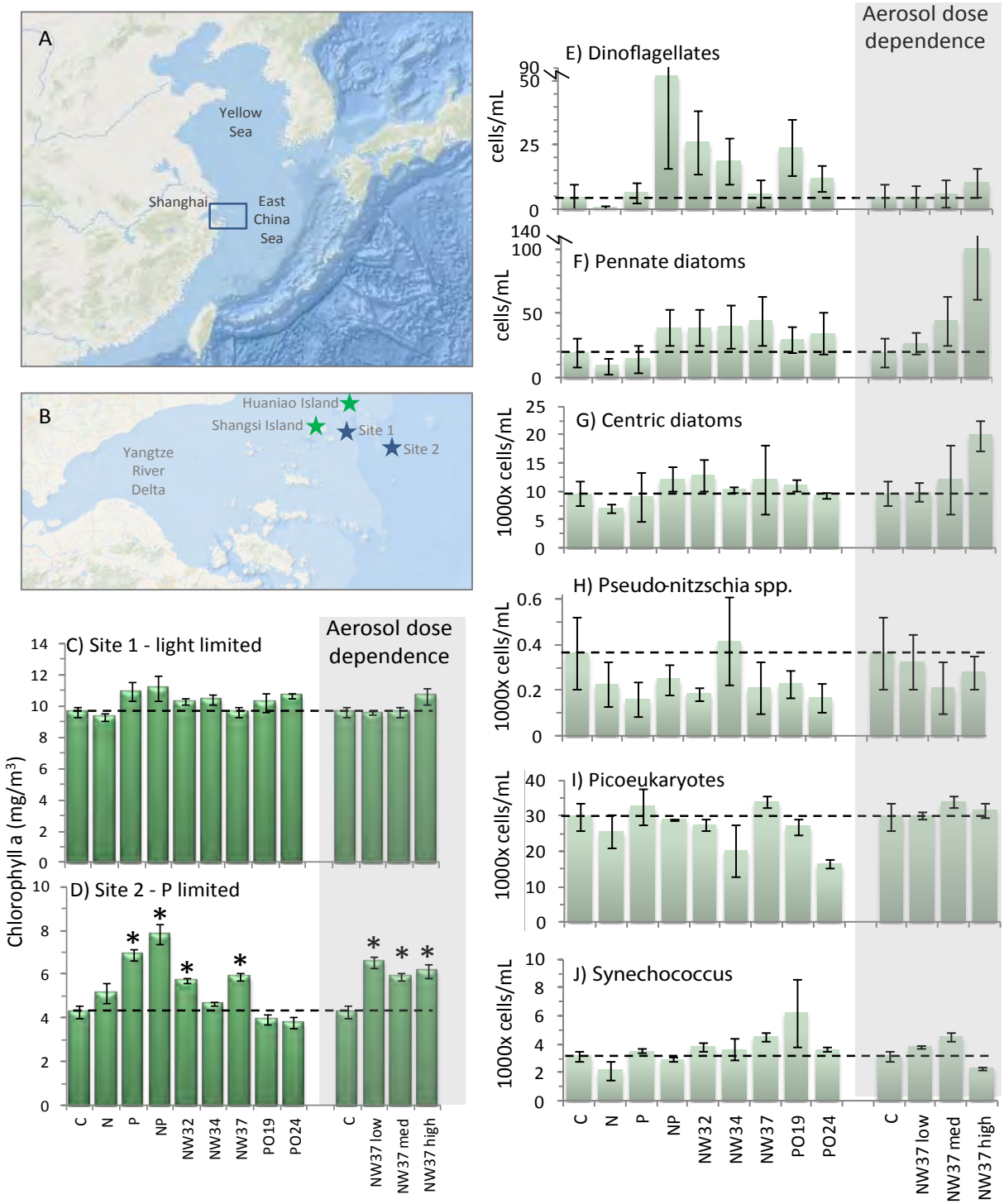

Fig. 1 FIGURE1|Phytoplankton responses from East China Sea bottle incubation experiments. Maps show (A) Chinese marginal seas and (B) the region of the East China Sea sampled near the mouth of the Yangtze River in the Zhoushan Archipelago. Blue stars show site 1 and site 2 water collection stations; green stars show Huaniao-Island where aerosolsamples were collected, and Shengsi Island where the incubation experiments were conducted. (C,D) Chlorophyll a concentrations (±SE) on the final day of the site 1 and site 2 experiments. *Indicates average is significantly different from the control ($p < 0.05$, dashedline) using one-way ANOVA and Bonferroni correction. Cell counts on the final day of the site 2 experiment (±SE) for (E) dinoflagellates, (F) pennatediatoms (notincluding Pseudonitzschia spp.), (G) centric diatoms, (H) Pseudonitzschia spp., (I) picoeukaryotes,and (J) Synechococcus. N = nitrate, P = phosphate, NW32, NW34, NW37, PO16, and PO26 are aerosol additions(1mg/L). Aerosol sample NW37 was also administered at low (0.2mg/L) and high (5mg/L) concentrations to test aerosol dose responses (shadedregions). Dashed lines show control levels at final timepoint. *Figure from Mackey et al., 2017.*

A large number of SOLAS-related research projects were conducted in the USA in 2016. A summary of all the topics would be too long to include. Thus below is simply a selection of several exciting projects, field campaigns, and other significant contributions.

NAAMES: The NASA-funded North Atlantic Aerosols and Marine Ecosystem Study (NAAMES) project completed a ship and aircraft field campaign between May 11 and June 5, 2016 . NAAMES is aimed to study the connection between atmospheric aerosols and key oceanic processes controlling marine ecosystems, with an emphasis on implications for climates. On each cruise, vast amounts of data from the atmosphere and ocean is collected. For example, Emmanuel Boss (University of Maine) and his collaborators are in the process of sorting about 4 milllion plankton images that were collected using IFCP and a UCP and they are using Eco-Taxa (http://ecotaxa.obs-vlfr.fr/explore/), a new Eurpoean open platform, where all their sorted data can be observed (put 'IFCB107 NAAMES01' and 'IFCB107 NAAMES02' in the Project box). For more information on NAAMES and access to data from the cruise, visit https://naames.larc.nasa.gov/

EXPORTS: Phase 1 projects involving data mining and OSSE grants commenced on the NASA-funded EXPORTS project, a large multi-year project aimed at predicting the export and fate of ocean net primary production from satellite and other observations. The projects include mining LIDAR data, combining ecosystem modelling and ocean color measurements, developing of hyperspectral datasets , comparing of phytoplankton function types with optical fingerprints and pigments, modeling net primary productivity from the Subarctic Atlantic, and using submesoscale-resolving 3D models to conduct OSSE's. Fieldwork for the EXPORTS project will begin in 2018 (see future work section of this report). More information on EXPORTS can be found at: https://cce.nasa.gov/ocean_biology_biogeochemistry/exports/index.html

Bubble modelling: Jun-Hong Liang (Louisiana State University) and colleagues developed a computer model that follows millions of bubbles in the upper ocean from their generation under breaking waves to their complete dissolution or bursting at the ocean surface. Combing computer model solutions and mooring observations, they showed that sea state plays an important role in bubble-mediating gas flux when the wind is changing. For the same wind speed, bubble-mediated gas flux is larger during strengthening winds than during falling wind because there are more large breaking waves in a developing sea than in a mature sea. The study highlights the importance of sea state as a parameter in bubble-mediated gas flux parameterizations.

Reactive Halogen Species: The Volkamer group at the University of Colorado at Boulder was funded by the US National Science Foundation to continue SOLAS activities related to "Tropical Ocean tRoposphere Exchange of Reactive Halogen Species and Oxygenated Hyrocarbons" (TORERO) through 2019. This 3-year grant supports field observations, laboratory experiments, and interpretative modeling of tropospheric halogen chemistry and marine sources of organic carbon to the remote marine troposphere. A specific objective is it to assess whether high model bias for bromine radicals in the marine boundary layer applies more broadly, and to investigate possible causes. Laboratory experiments at the National Center for Atmospheric Research (NCAR) investigate reactive pathways of bromine radicals to obtain missing kinetic and product data that inform models. Further, during March 2017 two mountain-top observatories in the remote marine troposphere, i.e., the Maido Observatory at La Reunion Island (2203m a.s.l., 21.1°S, 55.4°E) and Mauna Loa Observatory at Big Island, Hawaii (3397 m a.s.l., 19.5°N, 155.6°W), have been equipped with autonomous MAX-DOAS instrumentation to conduct long-term measurements, investigate seasonal variations, and study hemispheric gradients of tropospheric halogens and oxygenated hydrocarbons. Intensive operating periods are planned at Maido Observatory in 2018, in coordination with the University of La Reunion (PI: Jerome Brioude), and the European project OCTAVE (PI:

Jenny Stavrakou, BIRA). A first project meeting is planned in May 2017 in Brussels, Belgium.

Workshop: Arctic Change & Its Influence on Mid-Latitude Climate and Weather, Feb 1-3, 2017, Washington DC. This workshop was convened by the CLIVAR working group on Arctic change and brought together over 100 US and international scientists who study the atmosphere, ocean, and cryosphere to discuss the current science on changes in the Arctic and its connection to mid-latitudes climate and weather. For a full workshop report see https://usclivar.org/meetings/2017-arctic-mid-latitude-workshop-summary.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Many excellent SOLAS relevant papers were published by US authors in 2016 and early 2017. The selection below, listed in alphabetical order, is of 5 very interesting, extremely high quality papers but the listing of these papers is not meant to claim them as necessarily the best publications of the year.

Chiu, R., L Tinel, L Gonzalez, R Ciuraru, F Bernard, C George, and R Volkamer (2017), UV photochemistry of carboxylic acids at the air-sea boundary: A relevant source of glyoxal and other oxygenated VOC in the marine atmosphere, *Geophys. Res. Lett*., 44, 1079–1087, doi:10.1002/2016GL071240.

Islam, F., DeGrandpre, M., Beatty, C., Timmermans, M.-L., Krishfield, R., Toole, J. and S. Laney (2016). Sea surface pCO2 and O2 dynamics in the partially ice-covered Arctic Ocean, *J. Geophys. Res. – Oceans*, 122, doi:10.1002/2016JC012162.

Martins, D., Najjar, R G , Tzortziou, M., Abuhassan, N., Thompson, A M, Kollonige, D W,, (2016). Spatial and temporal variability of ground and satellite column measurements of NO2 and O3 over the Atlantic Ocean during the Deposition of Atmospheric Nitrogen to Coastal Ecosystems Experiment (DANCE). *Journal of Geophysical Research - Atmospheres* 121, doi:10.1002/2016JD024998

McKinley, G A, A R Fay, N S Lovenduski, D J Pilcher, (2017) Natural Variability and Anthropogenic Trends in the Ocean Carbon Sink, *Annual Review of Marine Science*. 9, 125-150. DOI: 10.1146/annurev-marine-010816-060529

Palevsky, H I, P D Quay, D E Lockwood, and D P Nicholson (2016), The annual cycle of gross primary production, net community production and export efficiency across the North Pacific Ocean, *Global Biogeochemical Cycles*, 30, doi: 10.1002/2015GB005318.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

PART 2 - Planned activities from 2017/2018 and 2019

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

NAAMES: Two more ship and aircraft field campaigns are planned as part of the NASA-funded NAAMES project which aims to investigate how the changing climate will influence plankton production , species composition, and aerosol emission. https://naames.larc.nasa.gov/science.html

EXPORTS: The NASA EXPORTS program is expected to commence its first fieldwork activities with a cruise in the North Pacific in 2018. The cruise will likely use 2 ships and a fleet of autonomous platforms (gliders, floats, etc) to collect data in support of EXPORT's goal of understanding and predicting the fate of marine net primary production. https://cce.nasa.gov/ocean_biology_biogeochemistry/exports/index.html

CLIVAR Repeat Hydrography Cruises: US CLIVAR will be conducting Repeat Hydrography Cruises that aim to quantify changes and storage of CO_2, heat and freshwater in the ocean. The cruises reoccupy WOCE lines and scientists onboard measure many variables from the atmosphere, the surface ocean and the deep ocean. Upcoming planned cruises consist of cruises in the Indian Ocean (I05, I06S, IO7N) in 2018 and 2019, in the Pacific ocean (P06) in 2017, and in the Atlantic Ocean (A13.5) in 2019.

GEOTRACES: US-Geotraces is planning a Pacific Meridonal Transect cruise in summer 2018 from Tahiti to Alaska. The cruise will include sampling in the high nutrient low chlorophyll equatorial upwelling regions in the equatorial Pacific and subarctic as well as the oligotrophic subtropical gyres.

Ongoing US Time-series: Regular cruises (typically monthly but each time-series differs) will occur in 2017 and 2018 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.

Two New Long-Term Ecological Research Sites: The US National Science Foundation (NSF) has funded two new marine long-term ecological research sites whose research activities will commence in 2017. The new LTER on the Northeastern US Shelf, an area known for productive fisheries, is focused on understanding the mechanisms that link physical ocean environment to plankton food webs and ultimately to fish stocks. The new LTER on the Northern Gulf of Alaska Coast will allow researchers to make observations across a large geographic region, leading to a better understanding of a thriving ecosystem of fish, crab, birds, and marine mammals. Both programs will have numerous research cruises.

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

Biogeochemical Processes at Sea Ice Interfaces (BEPSII), April 3-5, 2017, Scripps Institute of Oceanography, La Jolla, San Diego. Annual meeting.

3rd Blue Planet Symposium:, May 31-June 2: 2017, College Park, MD. This meeting will serve as a forum for discussion of societal information needs resulting from the important role the oceans play in Earth's life-support system and the challenge of minimizing the impacts of human activities on the oceans while utilizing the resources of the oceans to meet our needs.

Ocean Carbon Biogeochemistry Workshop: June 26-29, 2017, Woods Hole, MA, MA. Annual workshop that highlights research and includes substantial time for community discussion of new directions.

Cornell Satellite Remote Sensing Program, June 5-16, 2017, Ithaca, NY. Intensive 2 week summer course to teach scientists how to access and use remote sensing data. Course is intended for scientists with essentially no experience in remote sensing

Gordon Research Conference on Coastal Ocean Dynamics, June 11-16, Biddeford, MA. Theme: Multi-Scale Coastal Ocean Dynamics and Exchange Processes

Regional Sea Level Changes and Coastal Impacts, July 10-14, 2017, Columbia University, New York. International conference on sea level research to address existing challenges in describing and predicting regional sea level changes.

Ocean Optics Class: July 10-Aug 4, University of Maine, Walpole Maine. Summer course with goal of preparing a new generation of oceanographers trained in the use of optics to study the oceans.

Gordon Research Conference on Chemical Oceanography: July 23-28, 2017. New London, NH. Theme: Synthesizing Multifaceted Data in Chemical Oceanography.

Gordon Research Conference on Atmospheric Chemistry: July 30-Aug 4, 2017. Newry, ME. Theme: Addressing the Complexity of Our Atmosphere Through Integration Across Scales

Indian Ocean Science Workshop: Sept 11-13, 2017, La Jolla, CA. Focus on biological, chemical, physical, and geological oceanography, as well as climate dynamics and atmospheric science to generate integrated observing and process experiment strategies to science questions in the Indian Ocean basin

Ocean Carbon Hot Spots Workshop: Sept 25-26, 2017, Monterey Bay Aqauirium Research Institute. The goal of the workshop is to develop an interdisciplinary research community that will facilitate a better understanding of carbon uptake and storage in western boundary current regions with an emphasis on the Kuroshio Extension

American Association for Aerosol Research Annual Conference: Oct. 16-20, 2017, Raleigh, NC

Coastal Estuarine Research Federation (CERF): Nov 5-9, 2017, Providence RI. Theme: Coastal Science at the Inflection Point: Celebrating Successes & Learning from Challenge

Fall American Geophysical Union (AGU) meeting: Dec 11-15, New Orleans, LA.

American Meterological Society Annual Meeting: Jan 7-11, 2018, Austin TX.

Ocean Sciences Meeting: Feb 11-16, Portland OR

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)
Too many to report though some major ones are listed in the upcoming studies section of this report (section 2.1).
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)
Too many to report.
5. Engagements with other international projects, organisations, programmes etc.
Too many to report.

Comments