surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS Australia *compiled by: Sarah Lawson and Andrew Bowie*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

PART 1 - Activities from January 2015 to December 2015

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.

Marine nitrogen fixation is co-limited by the supply of iron and phosphorus in large areas of the global ocean. Up to 75 % of marine nitrogen fixation may be limited by iron supply due to the relatively high iron requirements of planktonic diazotrophs. The deposition of soluble aerosol iron can initiate nitrogen fixation and trigger toxic algal blooms in nitrate-poor tropical waters. There is a large variability in estimates of soluble iron, related to the mixing of aerosol iron sources. Most studies assume that mineral dust represents the primary source of soluble iron in the atmosphere. However, seasonal biomass burning in tropical regions is a potential source of aerosol iron that could explain the large variability in soluble iron.
To investigate aerosol iron sources to the adjacent tropical waters of Australia, the fractional solubility of aerosol iron was determined during the Savannah Fires in the Early Dry Season (SAFIRED) campaign at Gunn Point, Northern Territory, Australia during the dry season in 2014. The source of PM10 aerosol iron was a mixture of mineral dust, fresh biomass burning aerosol, sea spray and anthropogenic pollution. The mean soluble and total aerosol iron concentrations were 30 and 500 ng m-3 respectively. Fractional Fe solubility was relativity high for the majority of the campaign and averaged 8 % but dropped to 3 % during the largest and most proximal fire event. Fractional Fe solubility and proxies for biomass burning (elemental carbon, levoglucosan, oxalate and carbon monoxide) were unrelated throughout the campaign. An explanation to explain the lack of correlation between fractional Fe solubility and elemental carbon at the biomass burring source is due to the physical properties of elemental carbon, i.e., fresh elemental carbon aerosols are initially hydrophobic, however they can disperse in water after aging in the atmosphere. Combustion aerosols are thought to have a high factional Fe solubility, which can increase during atmospheric transport from the source. Although, elemental carbon may not be a direct source of soluble iron, it can act indirectly as a surface for aerosols iron to bind during atmospheric transport and subsequently be released to the ocean upon deposition. In addition, biomass burning derived aerosols can indirectly impact the fractional solubility of mineral dust. Fractional Fe solubility was

highest during dust events at Gunn Point, and could have been enhanced by the mixing of biomass burning derived species. Iron in dust may be more soluble in the tropics compared to higher latitudes due to the presence higher concentrations of biomass burring derived reactive organic species in the atmosphere, such as oxalate, and their potential to enhance the fractional Fe solubility of mineral dust. As the aerosol loading is dominated by biomass burning emissions over the tropical waters in the dry season, additions of biomass burning derived soluble iron could have harmful consequences for initiating nitrogen fixating toxic algal blooms. Future research is required to quantify elemental carbon sources of soluble iron over tropical waters.

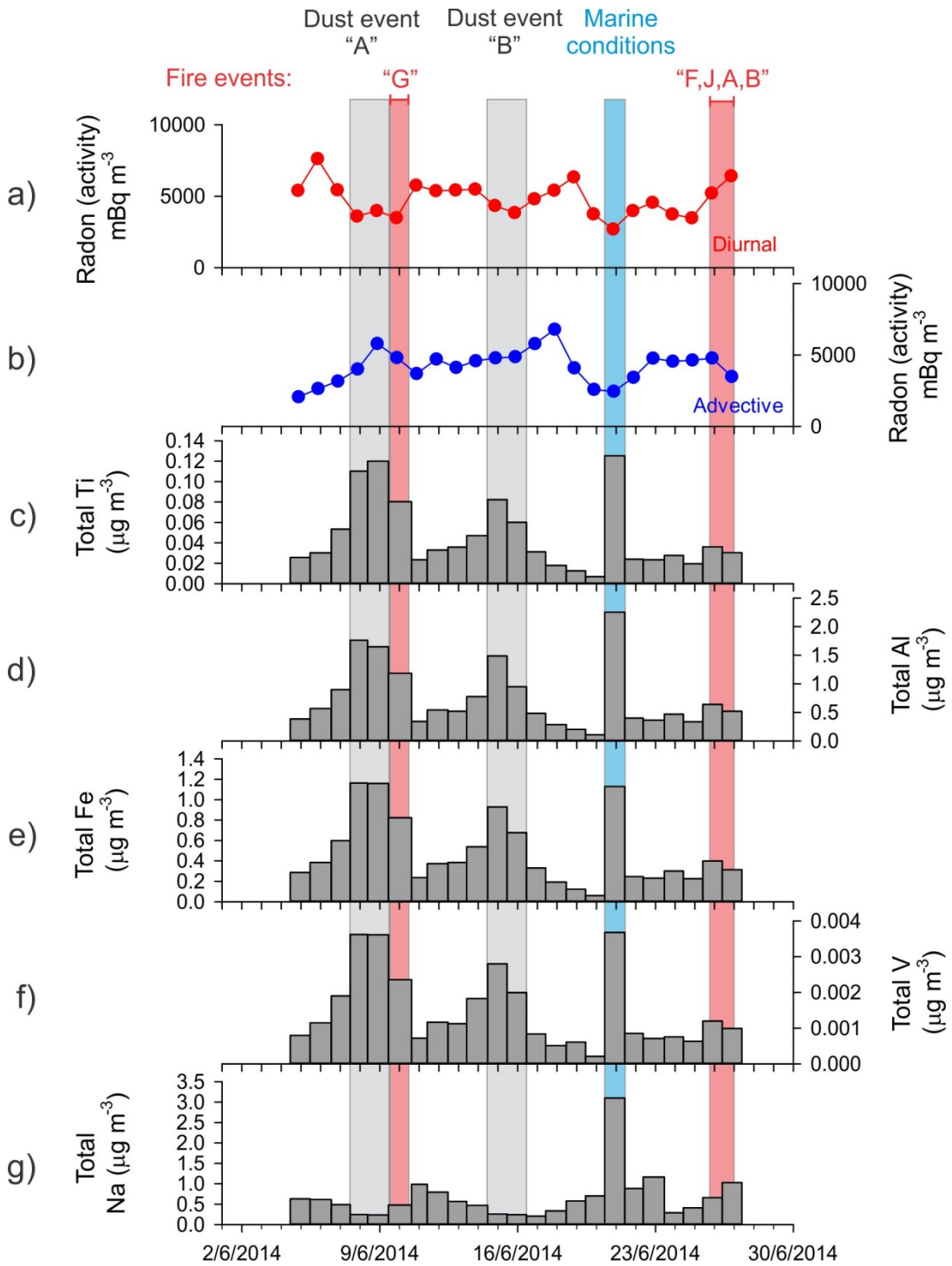

Figure: Time series of a) diurnal radon, b) advective radon, and total PM10 trace element concentrations c) Ti, d) Al, e) Fe, and f) Na during the (SAFIRED) campaign at Gunn Point, Northern Territory, Australia.

Citation: V.H.L. Winton et al. Dry season aerosol iron solubility in tropical northern Australia. In preparation.

2. Activities/main accomplishments in 2015 (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 first Cold Water trial and the Maiden Scientific Voyage of Australia's new Research Vessel the RV Investigator were made in January and March 2015 respectively in the Southern Ocean. The RV Investigator travelled to the ice edge of Antarctica (65ºS) on the Cold Water Trial. A wide variety of atmospheric measurements were made on both voyages, including organic trace gases, greenhouse gases, aerosol chemical composition, aerosol size distribution, and aerosol microphysical and optical properties. Preliminary results of aerosol chemical composition were presented at SOLAS OSC.

Atmospheric monitoring and sampling campaigns have been included in both of the first two voyages of RV Investigator in 2016 (see Part 2, section 1 below).

RV Investigator blog:
https://blog.csiro.au/investigator

An aerosol trace metal sampling program was established on the 'leading tower at the Gravity Discovery Centre in Gingin (Western Australia') in March 2015. This complements existing monitoring at Cape Grim (Tasmania) (since 2013), and plans for new stations to be established on Lord Howe Island and Mt Wellington (southern Tasmania) in 2016.

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

Cravigan, L. T., Ristovski, Z., Modini, R. L., Keywood, M. D., and Gras, J. L. (2015) : Observation of sea salt fraction in sub-100 nm diameter particles at Cape Grim, Journal of Geophysical Research: Atmospheres, 2014JD022601, 10.1002/2014JD022601, 2015.

Lawson, S. J., Keywood, M. D., Galbally, I. E., Gras, J. L., Cainey, J. M., Cope, M. E., Krummel, P. B., Fraser, P. J., Steele, L. P., Bentley, S. T., Meyer, C. P., Ristovski, Z., and Goldstein, A. H. (2015) Biomass burning emissions of trace gases and particles in marine air at Cape Grim, Tasmania, Atmos. Chem. Phys., 15, 13393-13411, 10.5194/acp-15-13393-2015, 2015a.

Humphries, R. S., Klekociuk, A. R., Schofield, R., Keywood, M., Ward, J., and Wilson, S. R.: Unexpectedly high ultrafine aerosol concentrations above East Antarctic sea ice, Atmos. Chem. Phys., 16, 2185-2206, doi:10.5194/acp-16-2185-2016, 2016.

Humphries, R. S., Schofield, R., Keywood, M. D., Ward, J., Pierce, J. R., Gionfriddo, C. M., Tate, M. T., Krabbenhoft, D. P., Galbally, I. E., Molloy, S. B., Klekociuk, A. R., Johnston, P. V., Kreher, K., Thomas, A. J., Robinson, A. D., Harris, N. R. P., Johnson, R., and Wilson, S. R.: Boundary layer new particle formation over East Antarctic sea ice – possible Hg-driven nucleation?, Atmos. Chem. Phys., 15, 13339-13364, doi:10.5194/acp-15-13339-2015, 2015

Winton, V. H. L., R. Edwards, B. Delmonte, A. Ellis, P. S. Andersson, A. Bowie, N. A. N. Bertler, P. Neff, and A. Tuohy (2016), Multiple sources of soluble atmospheric iron to Antarctic waters, Global Biogeochem. Cycles, 30, doi:10.1002/2015GB005265.

V.H.L. Winton, A.R. Bowie, R. Edwards, M. Keywood, A.T. Townsend, P. van der Merwe, A. Bollhöfer, 2015. Fractional iron solubility of atmospheric iron inputs to the Southern Ocean. Marine Chemistry 177 (2015) 20–32, doi:10.1016/j.marchem.2015.06.006

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.

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.)

1.CAPRICORN (Clouds, Aerosols, Precipitation and atmospherIc Composition Over the southeRN ocean) on voyage IN2016_V02 of RV Investigator in March-April 2016 as part of International SOCRATES (Southern Ocean Clouds Radiation Aerosol Transport Experimental Study). Follow up CAPRICORN voyages scheduled for July – Sep 2017 and Jan –Mar 2018.

2. Cloud radar and lidar observations being made at Macquarie Island in 2016 also as part of SOCRATES

3. The Great Barrier Reef as a significant source of climatically relevant aerosol particles, August 2016. Includes researchers from Queensland University of Technology, CSIRO Oceans and Atmosphere, Southern Cross University, University of Melbourne, University of Eastern Finland, Swiss Federal Institute of Technology, Lausanne, National Institute of Water and Atmospheric Research, New Zealand, University of Helsinki, Finland, NIES Japan.

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

The Cape Grim Baseline Air Pollution Station will celebrate its 40th year Anniversary in April 2016. The WMO GAW Reactive Gases Scientific Advisory Group will hold its annual Scientific Advisory Group meeting in Tasmania in November 2016.

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')

Voyages on RV Investigator as listed above under 1) funded by the Marine National Facility

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.

In February 2016 the inaugural Australian Meteorological and Oceanographic Society expert group on Atmospheric and Oceanic Composition was formed. This Expert Group will focus on the sub-discipline of Atmospheric and Oceanic Composition, defined as both natural and anthropogenically influenced composition from the stratosphere to the deep ocean. Strong linkages exist between the scientific focus of this expert group and the SOLAS strategic focus.
Sarah Lawson (an Australian SOLAS representative) is a member of the new Expert group.

Comments

In February 2016 the Federally funded Commonwealth Scientific and Industrial Research Organisation (CSIRO) announced that it would be halving the number of positions working in the areas of climate science modelling and monitoring in the Oceans and Atmosphere Business Unit. This loss of positions is in line with a new CSIRO strategy to reduce public good research and focus on increased commercialisation of science. Despite international protest, including two articles in the New York Times and signing of a petition of protest by 3000 scientists from 60 countries, the cuts are going ahead with impacted people scheduled to be informed in early April 2016. CSIRO has a major and central role in atmospheric and oceanic research in Australia; these cuts will have a major impact on the ability of Australia to both monitor and predict future changes in climate. Cape Grim Baseline Station and atmospheric measurements on the RV Investigator will be severely impacted by these cuts.

http://www.nytimes.com/2016/03/04/opinion/australia-turns-its-back-on-climate-science.html?_r=0

http://www.nytimes.com/2016/02/28/world/australia/cape-grim-climate-change-research.html

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS Belgium *compiled by: Nathalie Gypens*

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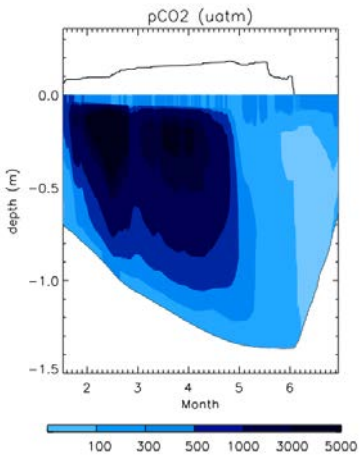
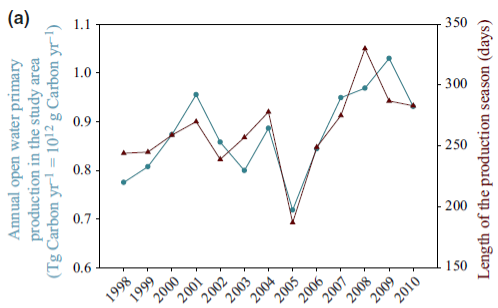
PART 1 - Activities from January 2015 to December 2015

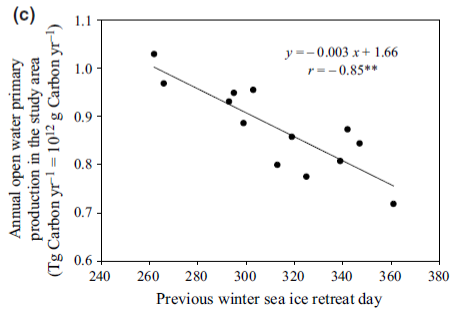
1. Scientific highlight

Moreau et al. 2015. Drivers of inorganic carbon dynamics in first-year sea ice: A model study. Journal of Geophysical Research: Oceans, 120(1):471-495



We analyzed CO_2 dynamics within sea ice using a one-dimensional halo-thermodynamic sea ice model including gas physics and carbon biogeochemistry. The results show that the DIC budget is mainly driven by physical processes, whereas brine-air CO_2 fluxes, ikaite formation, and net primary production, are secondary factors. In terms of ice-atmosphere CO_2 exchanges, sea ice is a net CO_2 source and sink in winter and summer, respectively.





Moreau et al. 2015. Climate change enhances primary production in the western Antarctic Peninsula. Global Change Biology 21(6):2191-205

We observed the effects of climate change on primary production in the waters west of the Antarctic Peninsula over the last three decades. Since 1978, sea ice retreat has been occurring earlier in the season (in March in 1978 and in late October during the 2000s) while the ozone hole is present in early spring since the early 1990s, increasing the intensity of UVB radiation. The annual open water primary production (retrieved from satellite observations) increased from 1997 to 2010 (from 0.73 to 1.03 Tg C yr^{-1}) concomitantly with the increase in the production season length. The coincidence between the earlier sea ice retreat and the presence of the ozone hole increased photoinhibition during austral spring (from 0.014 to 0.025 Tg C yr^{-1}). This increase in photoinhibition was minor compared to the overall increase in production, however. Climate change hence had an overall positive impact on primary production in the WAP waters.

2. Activities/main accomplishments in 2015 (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 and projects

During 12-26 May 2015, an oceanographic campaign was jointly conducted by VUB and ULB on board the R/V Belgica. It aims at assessing the different biogeochemical processes controlling the nitrogen cycle in oligotrophic N.E. Atlantic waters. During this BG2015/14 cruise we concentrated most of the work on the Iberian Margin to verify the regional extent and intensity of diazotrophy there. Incubation experiments enriched with ^{13}C and ^{15}N using natural phytoplankton assemblages were conducted on board to measure the primary production, nitrification and N_2 fixation in the euphotic layer. Special efforts were devoted to study the influence of dissolved Fe on N_2 fixation. The 2014 results show that N_2 fixation rates in oligotrophic waters have been tremendously stimulated through the addition of dissolved Fe compared to the control, demonstrating the limitation of N_2 fixation by Fe.

In addition, laboratory perturbation experiments were conducted to assess the impact of iron speciation and availability on the phytoplankton and the diazotroph communities. The individual and combined effects of pCO_2 (ocean acidification), temperature (seawater warming) and dust deposition were investigated. The results show that dust particles could provide a readily utilizable source of Fe and other macronutrients (dissolved phosphate and silicate) for phytoplankton growth. Elevated pCO_2 concentrations may have adverse impact on the diatom growth; warming may cause diatom poleward shifts in biogeographic distribution.

Optimist 2015 sea ice survey in Storefjord in March 2015. 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. Vivier from LOCEAN - UPMC. We measured greenhouse gases (CO_2, CH_4, N_2O) concentration and related physical and biogeochemical parameters in sea ice.

N-ICE 2015 survey. The Norwegian Young sea ICE cruise (N-ICE2015) was a drifiting ice station that took place from January to June 2015 north west of Svalbard. N-ICE 2015 was investigating ocean, sea ice and atmosphere processes. We measured N_2O in the water column and sea ice and are collaborating with the groups involved in CH_4 and CO_2 measurements. N-ICE 2015 was funded by the Norwegian Polar Institute (among others) and led by H. Steen and M. Granskog. http://www.npolar.no/en/projects/n-ice2015.html

Conferences

There is strong Belgian community involved in sea ice chemistry that was involved in the session "Towards Joint SOLAS- Clic Activities on Sea -Ice Biogeochemistry" at the SOLAS 2015 open conference, 07-11 Septembre 2015, Kiel, Germany

47th International Liège Colloquium “Marine Environmental Monitoring, Modelling and Prediction”, 4th - 8th May 2015, Liège, Belgium

Session on “Biogeochemistry of coastal seas and continental shelves and impacts of anthropogenic pressures on coastal ecosystem functioning and services”, European Geosciences Union, General Assembly, Vienna, Austria, 12-17 April 2015

Participation to the Goldschmidt 2015 conference: Li X., D. Fonseca, H. Ingber, N. Roevros, F. Dehairs and L. Chou (2015) Iron biogeochemistry under a changing climate: impact on the phytoplankton growth and the diazotrophic nitrogen fixation. Goldschmidt 2015 conference, 16-21 August 2015, Prague, Czech Republic. Oral presentation.

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

Borges A.V. and W. Champenois (2015) Seasonal and spatial variability of dimethylsulfoniopropionate (DMSP) in the Mediterranean seagrass Posidonia oceanica, Aquatic Botany, 125, 72-79

De Jong JTM, Stammerjohn SE, Ackley SF, Tison J-L, Mattielli N, Schoemann V (2015) Sources and fluxes of dissolved iron in the Bellingshausen Sea (West Antarctica): The importance of sea ice, icebergs and the continental margin, Marine Chemistry, 177, 518–535.

Hagens H., C. P. Slomp, F. J. R. Meysman, D. Seitaj, J. Harlay, A. V. Borges, J. J. Middelburg (2015) Biogeochemical processes and buffering capacity concurrently affect acidification in a seasonally hypoxic coastal marine basin, Biogeosciences, 12(5):1561-1583

Moreau S., H. Kaartokallio, M. Vancoppenolle, J. Zhou, M. Kotovitch, G. Dieckmann, D. N. Thomas, J.-L. Tison, B. Delille. (2015) Assessing the O_2 budget under sea ice: An experimental and modelling approach. *Elementa,* 3, 000080, doi: 10.12952/journal.elementa.000080

Moreau S., Vancoppenolle M., Delille B., Tison J.-L., Zhou J., Kotovitch M., Thomas D., Geilfus N.-X. and Goosse H. (2015). Drivers of inorganic carbon dynamics in first-year sea ice: A model study. Journal of Geophysical Research: Oceans, 120 (1) : 471-495

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.)

Field campaigns and projects

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We 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. We will take part of the NB Palmer where will deal with sea ice biogeochemistry. This cruise is schedule in April-June 2017

Laboratory experiments

Laboratory incubation experiments using *Trichodesmium* are planned to study the influence of pCO_2 and temperature on the nitrogen fixation of this filamentous cyanobacterium. Nutrient and dust addition bioassays are also planned to investigate the effect of phosphate and dissolved Fe on N_2 fixation. Special attention will be given to studying the effects of mineral dust deposition which is believed to promote N_2 fixation through increasing Fe availability.

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

Conferences

Colloquium "Submesoscale Processes: Mechanisms, Implications and new Frontiers" 48th International Liège Colloquium on ocean dynamics, University of Liège, 23rd - 27th May 2016

Session on “Biogeochemistry of coastal seas and continental shelves, with a special focus on Sedimentary Carbon in the Coastal Ocean”, European Geosciences Union, General Assembly, Vienna, Austria, 17-22 April 2016

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. Oral or poster presentation to be decided by the convenor.

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’)

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 HS^2 that are key parameters to global change and incorporate them into Earth System Models.

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.
Belgium is strongly involved in the BEPSII (Biogeochemical exchange processes at Sea Ice Interfaces) community and activities. 2016 will be a transitional year for the BEPSII community, since the first phase and its financial support from SCOR will come to an end. As a results, in 2015 BEPSII community reviewed its progress and proposed new objectives. In addition BEPSII turned towards CLIC and SOLAS to fund its activities (mainly meetings)

Comments

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Report for the year 2015 and future activities

SOLAS Brazil ***compiled by:Leticia C. da Cunha (Brazlian SOLAS Representative, Universidade do Estado do Rio de Janeiro), Frédéric K. Bonou (Universidade Federal de Pernambuco), Paulo Nobre (Istituto Nacional de Pesquisas Espaciais)***

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PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

1 – FORSA Cruise (Following Ocean Rings in the South Atlantic Ocean)

Commission FORSA – Following Ocean Rings in the South Atlantic was the name of the maiden cruise of RV Vital de Oliveira (H-39, Brazilian Navy, in partnership with Brazilian Ministry of Science, Technology and Innovation). The ship left Cape Town, South Africa, and sailed to Brazil, in June-July 2015. The multidisciplinary scientific crew had 18 scientists from five Brazilian institutions, and Prof. Moacyr Araujo (UFPE) was the Chief-Scientist.

The ship followed the known Agulhas Rings Corridor in the South Atlantic Ocean (Figure 1), and performed underway measurements using a Moving Vessel Profiler (CTD, LOPC, fluorimeter) each 60 nm, a GO “ferry-box” system for surface ocean and atmospheric pCO_2 measurements, eddy-covariance fluxes of heat momentum and CO_2 (micro meteorological tower installed at the ship's bow), XBTs and radiometers. Six chosen meso-scale structures, known as Agulhas Rings were sampled (oceanographic stations, including plankton sampling), and the results are now being processed at the respective laboratories.

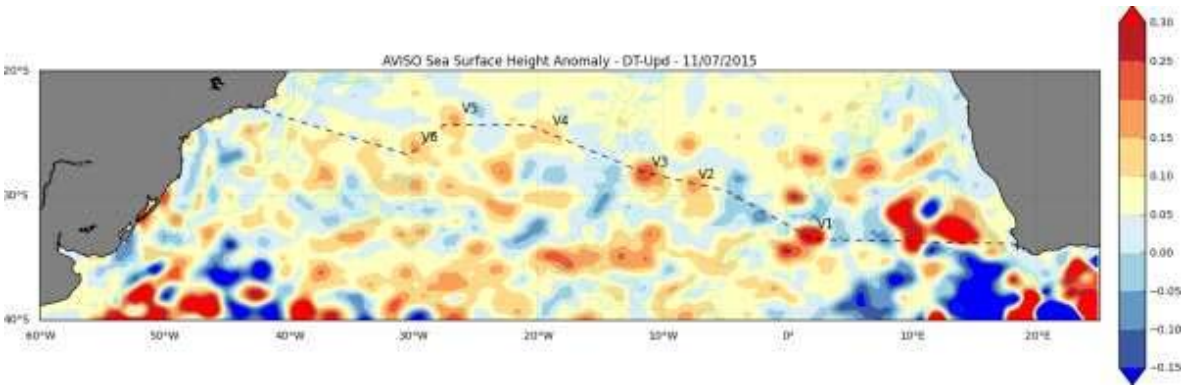


Figure 1 – RV Vital de Oliveira track during Commission FORSA (2015). The Rings are marked with V1 to V6 over sea surface height anomaly (in cm) from AVISO.

The FORSA Cruise was also the subject of an article at the "In Depth" Section in Science Magazine in August 2015:

Escobar, H.: Brazil looks to project scientific power on the Atlantic, Science (80-.)., ***349(6248), 573, 2015.***

2. Activities/main accomplishments in 2015 (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.)

*** Establishment of the Latin-American Ocean Acidification Network (LAOCA Network)**

On 14th and 15th December 2015, a group of 24 scientists from seven Latin-American countries, including Argentina, Brazil, Colombia, Ecuador, Peru, Mexico, and Chile meet at the city of Concepcion, Chile, for to establish the Latin-American Ocean Acidification Network (LAOCA Network). This regional workshop was co-funded by the International Atomic Energy Agency (IAEA) through the Ocean Acidification International Coordination Centre (OA-ICC), the Intergovernmental Oceanographic Commission (IOC-UNESCO), the Center for the Study of Multiple-Drivers on Marine Socio-Ecological Systems (MUSELS), and the Millennium Institute of Oceanography (IMO) from Chile. During two days the group of scientists discuss the strengths and weaknesses of each country in relation to ocean acidification' research, and also defining the mission and goals of LAOCA Network: (i) to synthesize the information about ocean acidification in L. America, (ii) implement long-term observations of carbonate chemistry in Latin-America, (iii) training of LAOCA members in the different action lines (e.g. observation, experimentation, and modeling), (iv) ensure good practices in order to enhance data quality, (v) to establish a regional node for the articulation and communication between local, regional, and global research programs, (vi) to determine and evaluate local and regional scenarios of Ocean Acidification for different types of marine ecosystems, (vii) to enhance scientists and student tudent exchange among institutions and LAOCA member countries, (viii) to design an outreach strategy for communicate the problematic of ocean acidification to society, (ix) to promote the development of cooperation projects between member countries of LAOCA, and (x) to promote the inclusion of Ocean Acidification on the political agenda of member countries.

Finally, scientists defined the LAOCA Executive Council, which will be co-chaired by Leticia C. da Cunha, (Universidade do Estado do Rio de Janeiro – UERJ, Brazil; Co-leader of the Brazilian Ocean Acidification Network), Nelson A. Lagos (Centro de Investigación e Innovación para el Cambio Climático (CiiCC), Universidad Santo Tomás, Chile; Member of the OA–ICC advisory board and SOLAS-IMBER WG in Ocean Acidification, SIOA) and Cristian A. Vargas (Universidad de Concepción, Chile; Member of the Executive Scientific Council at GOA-ON (Global Ocean Acidification Observing Network) and IOCCP (International Ocean Carbon Coordination Program). In addition, this executive council includes representatives from each country participating: Rodrigo Kerr (FURG, Brasil), Patricio Manríquez (CEAZA, Chile), Patricia Castillo-Briceño (ESPOL, Ecuador), Alberto Acosta (UTADEO, Colombia), Michelle Graco (IMARPE, Perú), Alejandro Bianchi (SHN, Argentina) and José Martín Hernández-Ayón (UABC, México). http://www.eula.cl/musels/latinoamerica-ya-tiene-su-red-de-acidificacion-del-ocaano-laoca-2015/

Figure 2 – Participants of the LAOCA Workshop, help in December 2015 in Concepción, Chile.

*** CMIP5 Model intercomparison:**

Brazilian Earth System Model (BESM) v. 2.3 has taken part into CMIP5 global climate change scenarios. The National Institute for Space Research (INPE) hosts the BESM group (Prof. P. Nobre and colleagues). BESM, at its newest version, will also participate to the coming CMIP6 round of coupled model intercomparisons.

*** Joint BrOA (Brazilian Research on Ocean Acidification) and SOLAS (Surface Ocean Lower Atmosphere Study) Workshop**

The joint workshop combined invited and selected talks, along with breakout group discussions corresponding to the main BrOA network and SOLAS topics. We realized that most of the original founders of BrOA were present and brought results of initiatives, experiments and collaborations. Also, that these groups have acquired or built, independently or in collaboration with each other, new equipments and facilities that are distributed in a wide range of the territory. We agreed on the need to push a common activity such as writing a position paper describing what we know, the groups involved in OA research, the infrastructure available, and the needs we identified to move forward on scientific aspects. It was an unanimous idea that we need a common ground on standardization of methods and data management. Besides, the need of using new technologies on sensors and platforms was also agreed. As the creation of a Latin American OA network was on discussion, we realized that many of our needs seemed to be common on the regional context. Thus, it was suggested that training workshops could be done, such as SOLAS Summer School, focusing on standardization of procedures and new technologies for CO_2 system measurements and that Latin American researchers could be a target public.

Workshop Highlights

* Two years after its implementation/start, BrOA network has now well established collaborations among its participants;
* BrOA laboratories have enhanced their analytical and experimental capacity;
* BrOA community will submit a statement paper to the special issue of ICES Journal of Marine Science where all current activities are compiled, and BROA's future goals and needs are presented;
* Workshop conveners will suggest SOLAS International Project Office to have its next Summer School focusing on CO2-system measurements, including new technologies for autonomous sensors;
* During the workshop, the participants identified the need to enhance communication about Ocean Acidification with policy makers, stakeholders, and general public;
* First concrete action to implement LAOCA Network – Latin American Ocean Acidification

Network.

Figure 3 - Participants of the Joint BrOA – SOLAS Workshop in Santos, Brazil (March 2015).

*** India / Brazil / South Africa (IBSA) Workshop on Earth System Modelling**, São Paulo, June 2015, Organised by P. Nobre (INPE).

CRUISES :

1 - PIRATA Brazil cruise over the western Tropical Atlantic between 19S-34W, 15N-38W; hydrography, pCO2, and atmospheric profiling done, on board RV Vital de Oliveira (Brazilian Navy), Oct. 2015..

2 – INCT Criosfera/GOAL/ACEX Cruise along the SW Atlantic Ocean, from Rio Grande to the Brazil/Malvinas Confluence ; hydrography, eddy-covariance measurements (micro-meteorology tower), meteorology, radiometer, on board Polar RV Almte. Maximiano (Brazilian Navy), Oct. 2015.

3 – NAUTILUS/INTERBIOTA cruise on the Antarctic Peninsula (Bransfield and Gerlache Straits) : hydrography and sample collection for chemical analysis (organic carbon, nutrients, total alkalinity, TCO2, pigments), on board Polar RV Almte. Maximiano (Brazilian Navy), February 2015.

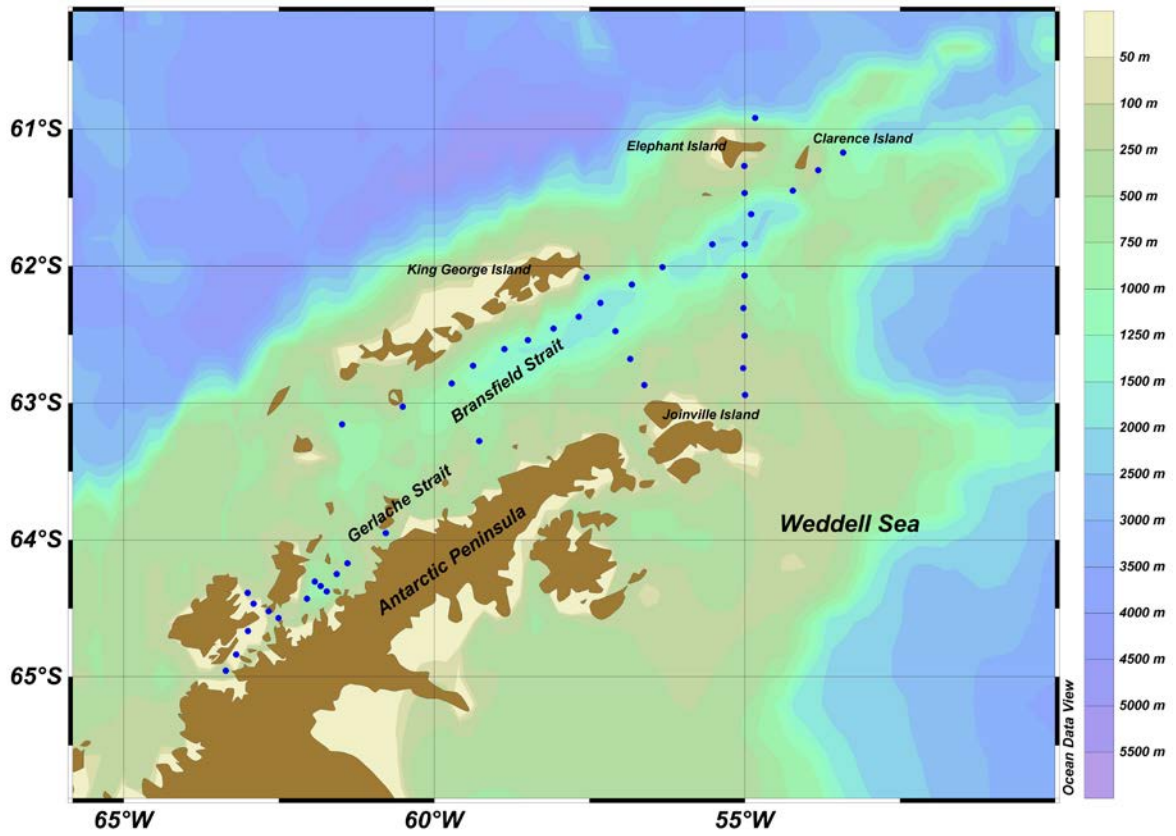


Figure 4 – NAUTILUS/INTERBIOTA 2015 Cruise - Occupied hydrographic stations at Bransfield and Gerlache Strait.

POSTER/ORAL PRESENTATIONS IN SOLAS RELEVANT EVENTS:

1. da Cunha, Leticia C., COELHO, C. A. W., SANTOS, P. P. W., KEIM, R. A., SOUZA, H. A. S., ARAUJO, M. P., Farias, C. O., HAMACHER, C. A snapshot of the marine CO2-system in three coastal ecosystems in SE Brazil In: 3rd PICES International Symposium: Effects of Climate Change on the World's Oceans, 2015, Santos. Book of Abstracts. PICES, 2015. v.1. p.177 - 177

2. da Cunha, Leticia C., SOUZA, H. A. S., ARAUJO, M. P., FARIAS, C. O., HAMACHER, C. Acidification through eutrophication- an example from an urban coastal ecosystem in SE Brazil In: SOLAS Open Science Conference 2015, Kiel.Abstracts, 2015. p.39 - 39

3. KERR, R., DA CUNHA, L. C., KIKUCHI, R. On the progress of the Brazilian Ocean Acidification Research Group: Two years of activities In: 3rd PICES International Symposium: Effects of Climate Change on the World's Oceans, 2015, Santos. Book of Abstracts. PICES, 2015. v.1. p.178 - 178

4. da Cunha, Leticia C., KERR, R., Araújo, M., NOBRE, P., SOUZA, R. B., PEZZI, L. The SW Atlantic Ocean: filling the observation gaps on ocean-atmosphere interactions In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

5. Santini, M. F., Souza, R. B. In situ measurements of the ocean--atmosphere interaction and land--atmosphere fluxes at Deception Island In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

6. Souza, R. B., Pezzi, L. P. A decade--long observational effort for s tudying ocean--atmosphere interaction processes in the Southwestern Atlantic Ocean. In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

7. Souza, R. B., Pezzi, L. P Mesoscale eddies of the Southwestern Atlantic Ocean and their impact on the atmosphere at the synoptic scale. In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

8. Pezzi, L. P, Souza, R. B., Acevedo, O., Miller, S. Atlantic Carbon and Fluxes Experiment (ACEx):
Results from the first cruise and perspectives. In: SOLAS Open Science Conference 2015, Kiel. SOLAS Open Science Conference Poster Abstracts. , 2015.

9. Soares, H. C., Nobre, P., Capistrano, V. B. The use of the TOPAZ as the marine biogeochemical component of the Brazilian Earth System Model (BESM). In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

10. Capistrano, V. B., Nilo, S., Reyes, P., Nobre, P. The new surface layer scheme of the Brazilian Earth System Model. In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

11. Nobre, P., Giarolla, E., Siqueira, L. Bottino, M., Malagutti, M., Capistrano, V. Equatorial Atlantic Ocean dynamics in a coupled ocean-atmosphere model simulation. In: WRCP/EMBRACE Workshop on CMIP5 Model Analysis and scientific plans for CMIP6, Dubrovnik, Croatia, 2015.

12. V. Capistrano, P. Reyes, S. Figueroa, E. Giarolla, C. Fonseca, M. Malagutti, M. Bapista, P. Nobre. Climate sensivity of the Brazilian Earth System Model, version 2.5. In: WRCP/EMBRACE Workshop on CMIP5 Model Analysis and scientific plans for CMIP6, Dubrovnik, Croatia, 2015.

13. Bonou, F. et al. “Variability of total alkalinity and total inorganic carbon in the western tropical Atlantic Ocean”. 3rd PICES International Symposium: Effects of Climate Change on the World’s Oceans, 2015, Santos. - Book of Abstracts. PICES, 2015

14. Bonou, F. et al “Western Tropical pCO2 maps derived from refression models”, Colloquium in Physical Oceanography and Applications: TACCOVAR : Tropical Atlantic Climate and Coastal Variability - October 5-1, 2015, Cotonou, Benin

15. EIDT, R. T. ; ORSELLI, I. B. M. ; Kerr, Rodrigo . Hydrography and CO2 partial pressure in the Gerlache Strait, Antarctica, during austral summer 2015. In: VIII Congreso Latinoamericano de Ciencia Antártica, 2015, Montevideo. Proceedings, 2015.

TRAINING:

*** Brazilian Earth System Model (BESM) Summer School**
July,27 until August, 7/2015 – Advanced Lectures Series on Coupled Ocean-Atmosphere Data Assimilation, with students from South Africa, India, and Brazil. INPE (National Institute for Space Research), Cachoeira Paulista, Brazil. http://spsgcm.ccst.inpe.br/index.html

*** 2015 LFA Summer Course :**
16 – 27 March 2015 – Course on atmospheric aerosols and clouds with introduction to process oriented modeling. Universidade de São Paulo & Universitet Stockholms. USP (Universidade de São Paulo), São Paulo, Brazil. http://lfa.if.usp.br/index.php/Events/2015SummerCourse

* - L. C. da Cunha is grateful to the SOLAS Open Science Conference and the OA-ICC at IAEA for the travel grant obtained to participate to the Conference in Kiel, Sep. 2015.

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

1 - Kerr, R., da Cunha, L. C., Kikuchi, R. K. P., Horta, P. A., et al. : The Western South Atlantic Ocean in a High-CO2 World: Current Measurement Capabilities and Perspectives, Environ. Manage., 57(3), 740–752, doi:10.1007/s00267-015-0630-x, 2016.

2 - Cotovicz Jr., L. C., Knoppers, B. A., Brandini, N., Costa Santos, S. J. and Abril, G.: A strong CO2 sink enhanced by eutrophication in a tropical coastal embayment (Guanabara Bay, Rio de Janeiro, Brazil), Biogeosciences, 12(20), 6125–6146, doi:10.5194/bg-12-6125-2015, 2015

3 - Giarolla, E., Siqueira, L. S. P., Bottino, M. J., Malagutti, M., *Capistrano*, V. B. and Nobre, P.:

Equatorial Atlantic Ocean dynamics in a coupled ocean–atmosphere model simulation, Ocean Dyn., 65(6), 831–843, doi:10.1007/s10236-015-0836-8, 2015

4 - Bonou, F. K., Noriega, C., Lefèvre, N. and Araujo, M.: Distribution of CO2 parameters in the Western Tropical Atlantic Ocean, Dynamics of the Atmosphere and the Oceans, 73, 47–60, doi:10.1016/j.dynatmoce.2015.12.001, 2016.

5 - Noriega, C., Araujo, M., Lefèvre, N., Montes, M. F., Gaspar, F. and Veleda, D.: Spatial and temporal variability of CO2 fluxes in tropical estuarine systems near areas of high population density in Brazil, Reg. Environ. Chang., 15(4), 619–630, doi:10.1007/s10113-014-0671-3, 2015.

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.)

- Bonou et al.(2016), A comparative study of Total Alkalinity and Total Dissolved Inorganic Carbon in the western and eastern boundaries.(To be submitted), Universidade Federal de Pernambuco (UFPE) → ***Future SOLAS Theme 1***

- Inclusion of the effects of river discharges, with tracers transport, into the Brazilian Earth System (BESM) climate simulations; inclusion of the full cycle of carbon (Land-Atmos-Ocean) into BESM version 2.5, Instituto Nacional de Pesquisas Espaciais (INPE), PI: Prof. Paulo Nobre → ***Future SOLAS Theme 1***

- 2017 PIRATA cruise in the Tropical Atlantic. PIRATA cruises are normally led by the team at the Dept. of Oceanography at UFPE. The date and the research vessel are yet to be confirmed. → ***Future SOLAS Themes 1, 2 and ; 5***

- Publication of the results of the first Brazilian intercalibration exercise on Total Alkalinity measurements in the SW Atlantic Ocean (MSc. Candidate Cíntia Coelho – Universidade do Estado do Rio de Janeiro – UERJ, supervisor Leticia C. da Cunha, with the participation of the Universidade Federal do Rio Grande – FURG, supervised by Rodrigo Kerr) → ***Future SOLAS Theme 3****;*

- 2016 EstARte-SUL Cruise: Biogeochemistry, Acidification and Anthropogenic Carbon at the SW Atlantic shelf break, on board RV Cruzeiro do Sul (Brazilian Navy). Date to be confirmed yet. PI: Prof. Rodrigo Kerr (FURG) → ***Future SOLAS Themes 1, 2, and 3***

- 2016 NAUTILUS/INTERBIOTA cruise to the Southern Ocean happened in Feb 2016: NAUTILUS project focuses on the processes that lead to the formation of Antarctic Bottom Water around the Antarctic Peninsula. Additionally, we are interested in the amounts of carbon and nutrients involved in the water mass transport in the region. INTERBIOTA is closely linked to NAUTILUS as it is an ecological approach of the marine food web in the region, from microbes to large marine mammals. PIs:Prof. Mauricio Mata (NAUTILUS, FURG) and Prof. Eduardo Secchi (INTERBIOTA, FURG) → ***FUTURE SOLAS Themes 1, 2, and 3***

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

Please note this is a non-exhaustive list!

- ***4th International Symposium on the Ocean in a High-CO_2 World AND Global Ocean Acidification Observing Network (GOA-ON) Science Workshop****, in May 2016 in Hobart Australia → we foresee the participation of Br-SOLAS collaborators to the two events.*
- ***VII Brazilian Oceanography Congress (CBO2016')*** *– The congress will happen in November 2016 and counts with a special BrOA session and a joint BrOA/GEOTRACES Brazil short course for undergraduate students on using the available SOCAT 3.0 and GEOTRACES databases in Ocean Data View. Conference Web Page: http://www.cbo2016.org/*

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')

Please note this is a non-exhaustive list of ongoing projects!

- **EstARte-SUL Cruise: Biogeochemistry, Acidification and Anthropogenic Carbon at the SW Atlantic shelf break:** funding through FAPERGS and CNPq, PI: Prof. Rodrigo Kerr (FURG), ***Future SOLAS Themes 1, 2 and 3***
- **INCT Criosfera and INCT AmbTrop:** Both are large consortia for Marine Sciences in Brazil, funded by CNPq. At present under negotiation for an extension of their duration. Links: http://www.ufrgs.br/inctcriosfera/ (Criosfera) and http://www.inctambtropic.org/ (Tropical Environments – AmbTrop), ***Future SOLAS Themes 1, 2,3, and 5***
- **PIRATA: Prediction and Research moored Array in the Tropical Atlantic**. PIRATA is a three-country project aiming at understanding tropical variability in the Atlantic Ocean (Brazil, France and USA). Br-PIRATA is funded through Ministry for Science, Technology and Innovation (MCTI) since 1997. http://pirata.ccst.inpe.br/ ***Future SOLAS Themes 1, 2, and 3***
- **SIMCOSTA: Coastal Monitoring System using autonomous buoys**. SIMCOSTA is funded through CNPq, Ministries for "Science, Technology and Innovation" and "Environment" and Rede Clima. Data available here: http://www.simcosta.furg.br . PI: Prof. Carlos Garcia (FURG). ***Future SOLAS Themes 1, 2, and Coastal Ecosystems***
- **Bilateral cooperation project UERJ – GEOMAR** (Kiel, Germany): focusing on establishing best practices for measuring CO2 system parameters over Brazilian shelf waters. The project foresees establishing in the future underway autonomous pCO2 measurements through VOS (voluntary observation ships). PIs: Prof. Leticia C. da Cunha (UERJ) and Dr. Tobias Steinhoff (GEOMAR), funding FAPERJ/DFG Call E_39/2014, Brazilian side yet to receive the money. ***Future SOLAS Themes 1 and Coastal Ecosystems***
- ***LTER/PELD Estuário da Lagoa dos Patos:*** a component of this LTER programme is now including monitoring CO2 system parameters in the Patos Lagoon Estuary in South Brazil. PI: Prof. Clarisse Odebrecht (FURG). http://www.peld.furg.br/ ***Future SOLAS Themes 1 and Coastal Ecosystems***
- **CAPES Ciências do Mar II – Guanabara Bay at Rio de Janeiro.** The project aims at understanding the exchanges between the inner shelf and the Guanabara Bay, one of the most populated coastal areas in Brazil. It has a strong component on biogeochemical fluxes (including phytoplankton ecology, nutrients and carbon), led by Prof. Gleyci Moser (UERJ). Funding by CAPES (Brazilian Federal Agency). ***Future SOLAS Theme "Coastal Ecosystems"***
- **Coastal Ecosystems in Rio de Janeiro.** Research grant from Rio de Janeiro State

Funding Agency FAPERJ to enable the regional development of marine CO2-system observations in coastal areas. PI: Prof. Leticia C. da Cunha. ***Future SOLAS Theme "Coastal Ecosystems"***

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)

Please note this is a non-exhaustive list!

1) Fernando de Noronha Experimental Observatory - FNEO: A proposal will be submitted to Brazilian Agency CNPq in order to start a scientific cooperation (Brazil-Cape Verde-Germany-France, led by *UFPE*) that aims to install a meteo-ocenographic observatory at the Fernando de Noronha Archipelago (tropical western Atlantic). The idea is to have in the western tropical Atlantic boundary a similar structure and sampling protocol used in the Cape Verde Oceanic Observatory.

2) Inclusion of the effects of river discharges, with tracers transport, into the Brazilian Earth System (BESM) climate simulations; inclusion of the ***full carbon cycle (Land-Atmos-Ocean)*** into BESM at INPE.

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

Please note this is a non-exhaustive list!

1) CMIP6 is including the Brazilian Earth System Model (BESM) in its climate runs. PI: Prof. Paulo Nobre at INPE;

2) Brazilian Ocean Acidification Network (BrOA) is now actively linked to the **Latin American Ocean Acidification Network (LAOCA)**

3) Brazil is a partner in the **AtlantOS Consortium – H2020 – EU.** AtlantOS envisages improving and innovating the ocean observations in the Atlantic Ocean to to obtain an international, more sustainable, more efficient, more integrated, and fit-for-purpose system. The country is represented by the Ministry of Science, technology and Innovation (MCTI) https://www.atlantos-h2020.eu/about/

4) **MyScience-Cruise – an on-board training on the research vessel METEOR in 2016.** Two Brazilian students, Lívia Sancho (Universidade Federal do Rio de Janeiro – UFRJ) and Laís Lopes (FURG) participated to this training cruise. Support for "MyScience-Cruise" was provided by the Kiel Cluster of Excellence "The Future Ocean", "Partnership for Observation of the Global Oceans" (POGO), the EU H2020 project AtlantOS and École Normale Supérieure, Paris. http://www.oceanblogs.org/mysciencecruise/sample-page/

Comments

Although there are quite a few important research projects relevant to SOLAS science in Brazil at present, there is a big question mark concerning the scientific achievements for this year (2016) and at least for the coming 2-3 years, as a result of the severe economic crisis in the country.

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS CANADA ***compiled by: Maurice Levasseur***

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlights

1. Ammonia in the summertime Arctic marine boundary layer: sources, sinks and implications

Continuous hourly measurements of gas-phase ammonia ($NH_{3(g)}$) were taken from 13 July to 7 August 2014 on a research cruise throughout Baffin Bay and the eastern Canadian Arctic Archipelago. Concentrations ranged from 30 to 650 ng m^{-3} (40–870 pptv) with the highest values recorded in Lancaster Sound. Simultaneous measurements of total ammonium ([NH_x]), pH and temperature in the ocean and in melt ponds were used to compute the compensation point (χ), which is the ambient $NH_{3(g)}$ concentration at which surface–air fluxes change direction. Ambient $NH_{3(g)}$ was usually several orders of magnitude larger than both χ_{ocean} and χ_{MP} indicating these surface pools are net sinks of NH_3. The GEOS-Chem chemical transport model was employed to examine the impact of $NH_{3(g)}$ emissions from seabird guano on boundary-layer composition and nss-SO_4^{2-} neutralization. A GEOS-Chem simulation without seabird emissions underestimated boundary layer $NH_{3(g)}$ by several orders of magnitude and yielded highly acidic aerosol. A simulation that included seabird NH_3 emissions was in better agreement with observations for both $NH_{3(g)}$ concentrations and nss-SO_4^{2-} neutralization. This is strong evidence that seabird colonies are significant sources of NH_3 in the summertime Arctic, and are ubiquitous enough to impact atmospheric composition across the entire Baffin Bay region.

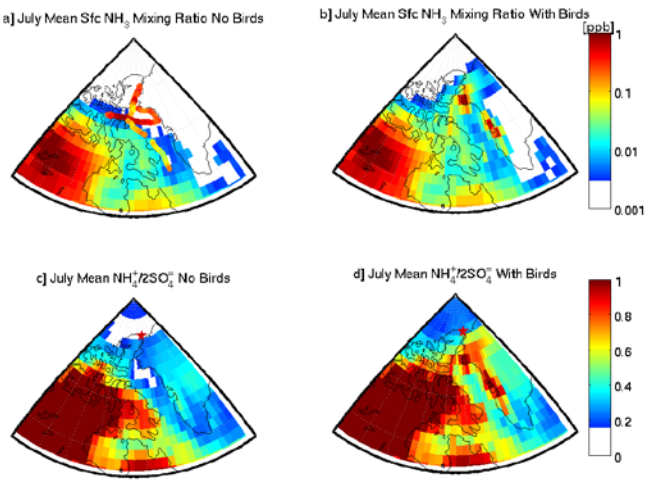


Figure 1. GEOS-Chem simulation of NH_3 mixing ratio (ppb) of the July monthly mean surface layer for (a) no seabird emissions and (b) with seabird emissions. Circles in (a) represent the ship track coloured by NH_3 measurements. Panels (c) and (d) show GEOS-Chem simulations for the

ammonium to non-sea salt sulphate ratio during the same period for (c) no seabird emissions and (d) with seabird emissions. The star indicates the average ratio observed at Alert during July.

Wentworth, G. R. J. G. Murphy, B. Croft, R. V. Martin, J. R. Pierce, J.-S. Côté, I. Courchesne, J.-É. Tremblay, J. Gagnon, J. L. Thomas, S. Sharma, D. Toom-Sauntry, A. Chivulescu, M. Levasseur, and J. P. D. Abbatt, "Ammonia in the summertime Arctic marine boundary layer: sources, sinks and implications", Atmos. Chem. Phys., 16, 1937-1953, 2016. doi:10.5194/acp-16-1937-2016 http://www.atmos-chem-phys.net/16/1937/2016/

2. Dimethyl Sulfide oxidation contributes to summertime Arctic SO_2 and fine aerosol sulfate

DMS and its oxidation products SO_2, as well as size segregated aerosol sulfate were measured aboard the Canadian Coast Guard ship the Amundsen in the Arctic during July 2014. DMS contributions to SO_2 and fine aerosol sulfate (<0.49 microns: >70%) were considerable. Gas to particle conversion was determined to be the most likely source of a majority of the fine aerosol sulfate during most sampling periods. Evidence for this was a strong correspondence between the isotope composition of SO_2 and fine aerosol sulfate (Figure). Potential aerosol growth was also inferred for particular sampling periods. Similarity between ^{34}S values for aerosols in the fine and accumulation mode and SO_2 suggests either the SO_2 and aerosols were transported together from their source region, or that aerosol growth took place. These results emphasize the importance of marine organisms to the formation, and possibly growth, of fine particles in the marine boundary layer above the Arctic Ocean in summer.

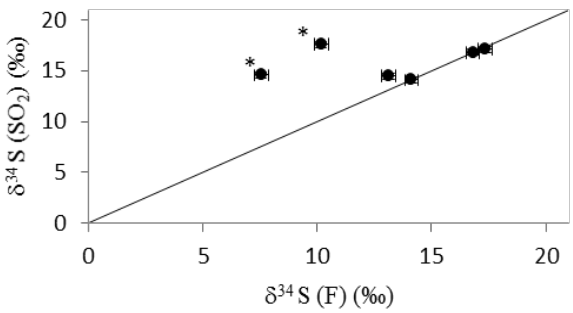


Figure 1: δ^{34}S values for $F_{<0.49\ \mu m}$ and SO_2 relative to a 1:1 line. Four of six samples show good correspondence between ^{34}S values for SO_2 and sulfate. These four sample sets have ^{34}S values that are quite near the expected value for biogenic sulfur (+18 permil). Two samples with lower δ^{34}S values for sulfate than SO_2 suggest a greater proportion of anthropogenic sulfate was present (asterisks) at times.

Ghahremaninezhadgharelar, R, Norman, A.L., Abbatt, J., Levasseur, M., Biogenic, anthropogenic and sea salt size-segregated aerosols in the Arctic summer. Atmos. Chem. Phys. Discuss., acp-2015-1010, 2016.

3. Effects of dust additions on phytoplankton growth and DMS production in high CO_2 northeast Pacific HNLC waters

Ocean acidification (OA) is likely to have an effect on the fertilizing potential of desert dust in high-nutrient, low-chlorophyll oceanic regions, either by modifying Fe speciation and bioavailability, or by altering phytoplankton Fe requirements and acquisition. To address this issue, short incubations (4 days) of northeast subarctic Pacific waters enriched with either $FeSO_4$ or dust, and set at pH 8.0 (in situ) and 7.8 were conducted in August 2010. We assessed the impact of a decrease in pH on dissolved Fe concentration, phytoplankton biomass, taxonomy and productivity, and the production of dimethylsulfide (DMS) and its algal precursor dimethylsulfoniopropionate (DMSP). Chlorophyll *a* (chl *a*) remained unchanged in the controls and doubled in both the $FeSO_4$-enriched and dust-enriched incubations, confirming the Fe-limited status of the plankton assemblage during the experiment. In the acidified treatments, a significant reduction (by 16-38%) of the final concentration of chl *a* was measured compared to their non-acidified counterparts, and a 15% reduction in particulate organic carbon (POC) concentration was measured in the dust-enriched acidified treatment compared to the dust-enriched non-acidified treatment. $FeSO_4$ and dust additions had a fertilizing effect mainly on diatoms and cyanobacteria. Lowering the pH affected mostly the haptophytes, but pelagophyte concentrations were also reduced in some acidified treatments. Acidification did not significantly alter DMSP and DMS concentrations. These results show that dust deposition events in a low-pH iron-limited Northeast subarctic Pacific are likely to

stimulate phytoplankton growth to a lesser extent than in today's ocean during the few days following fertilization and point to a low initial sensitivity of the DMSP and DMS dynamics to OA.

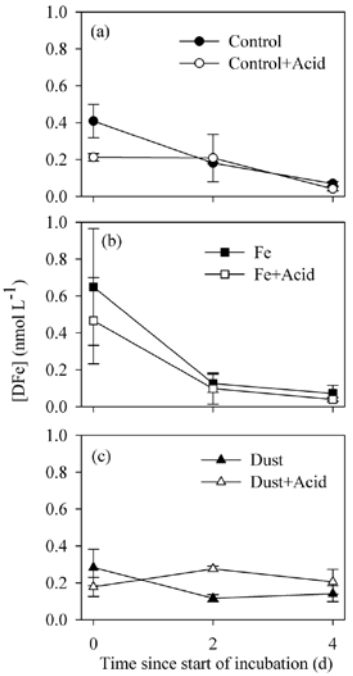


Figure 1: AVERAGE CONCENTRATION OF DFE IN EACH TREATMENT DURING THE INCUBATIONS MEASURED AT T0, T2 AND T4. (A) CONTROL AND CONTROL+ACID. (B) FE AND FE+ACID. (C) DUST AND DUST+ACID. ERROR BARS INDICATE STANDARD DEVIATIONS. N = 3 EXCEPT FOR ACID, T0, T2, DUST+ACID, T0, AND CONTROL (ALL TIMES) WHERE N = 2.

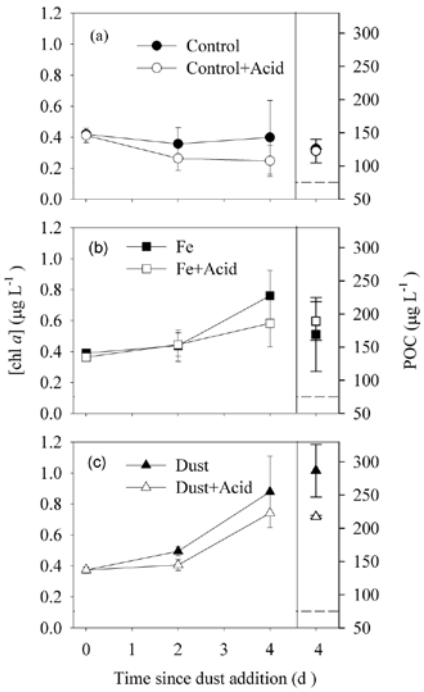


FIGURE 2: AVERAGE CONCENTRATION OF CHL A (LEFT AXIS) DURING THE INCUBATIONS AND POC AT T4 (RIGHT AXIS) IN EACH TREATMENT. (A) CONTROL AND CONTROL+ACID. (B) FE AND FE+ACID. (C) DUST AND DUST+ACID. ERROR BARS INDICATE STANDARD DEVIATIONS. DASHED LINE INDICATES POC CONCENTRATION AT T0. CHL A: N = 3 EXCEPT FOR ACID, T0, DUST+ACID, T4, FE+ACID, T0 AND CONTROL (ALL TIMES) WHERE N=2 BECAUSE OF MISSING/UNRELIABLE DATA OR CONTAMINATION (CONTROL 1). POC: N=3 EXCEPT CONTROL WHERE N=2.

Mélançon J, Levasseur M, Lizotte M, Scarratt M, Tremblay J-É, Tortell P, Yang G-P, Shi G-Y, Gao H-W, Semeniuk DM, Robert M, Arychuk M, Johnson K, Sutherland N, Davelaar M, Nemcek N, Peña A, Richardson W (2016). Effects of dust additions on phytoplankton growth and DMS production in high CO_2 northeast Pacific HNLC waters. Biogeosciences 13.

2. Activities/main accomplishments in 2015 (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. Cambridge Bay ocean CO_2 observatory
A new CO_2 monitoring program was established at Cambridge Bay, Nunavut, Canada. The observatory includes a cabled bottom (8 m) node with in-situ sensors for pH and pCO_2 200 m from the Cambridge Bay dock, and a CO_2 flux tower on a small island about 35 km across the bay.

2. ArcticNet 2015 annual cruise
The annual ArcticNet cruise completed a survey of autumn pCO2 fluxes through the eastern Canadian Archipelago, across the Northwater Polynya, and down the western side of Baffin Bay. In addition, onboard incubation experiments were conducted in July on the combined effect pH and light on phytoplankton bloom dynamics and DMS production during the spring arctic bloom. The aim of this project was to compare the sensitivity of marginal ice bloom and under ice bloom to the predicted decrease in pH for Arctic waters (NETCARE/SOLAS student Rachel Hussherr).

3. GreenEdge ice camp (Qikiqtarjuaq, Baffin Island, May-July 2015)
Participation of Levasseur's group to the program GreenEdge (Leader: Marcel Babin, Université Laval,Takuvik) allowed to further assess the importance of melt ponds as a source of DMS for the Arctic atmosphere (work of the NETCARE/SOLAS PhD Student Margaux Gourdal).

4. NETCARE-POLAR6 aircraft campaign (March-April 2015)
This was a joint flight between Canadian NETCARE and AWI researchers. 86 flight hours were completed on 10 sciences and 12 ferry flights. The campaign started in Longyearbyen, Svalbard, and moved to Alert, Eureka and Inuvik. A new development related to these flight was the first deployment of a Far-Infrared Radiometer (FIRR). FIRR development and deployment was funded by the Canadian Space Agency under a project led by Co-I Blanchet, UQAM. A focus of NETCARE is to better understand the role of ice crystals to affect the radiation budget, which occurs largely in the far-infrared. A critical link with anthropogenic aerosol has been identified through ice nucleation processes.

5. Snow sampling at Alert (2014-2015)
Close to 50 snow samples were collected at Alert during the fall-winter-spring season of 2014-2015. These samples are being analyzed for their BC, OC, metal, and ionic content, as a joint project between NETCARE co-investigators and Environment Canada collaborators. These measurements will provide information on aerosol fluxes to the snowpack in the high Canadian Arctic, and will be used for detailed source-receptor analysis and comparison to chemical transport model predictions. This is the first data set of this type yet collected, where the snow is not from the ground but from a snow table instead.

6. Ice nucleation particles
Activities to measure the number and character of INPs in remote environments started at Ucluelet in 2013, and have progressed with measurements from the Amundsen (2014), POLAR6 (summer 2014, spring 2015), Whistler (2015) and Alert (2014 and 2015). This work has shown that: a) a large fraction of the INPs are in the supermicron mode for all sites investigated presumably from mineral dust or biological particles and b) at Ucluelet (a remote coast site) a large fraction of the ambient ice nuclei were most likely biological particles from terrestrial sources. These results will be useful when modelling ice cloud formation and the indirect effect of aerosols on climate.

7. Modelling of Arctic sulphur cycle (Nadia Steiner)
Progress has been made with the development of a 1-D ocean-ecosystem model with sulphur cycling in the Arctic. The model now includes sea-ice and a sea-ice ecosystem with ice algal contributions to DMS from sympagic and pelagic systems.

8. Further models development (Knut Von Salzen)

Overall, focus in this activity has been upon assessments of processes included in the models and comparisons to existing data. Activities within the past year with the GEOS-Chem model include interpretation of 1) the Amundsen measurements to understand sources of DMS and NH3, 2) aerosol optical depth from AEROCAN observations to understand processes affecting their variation, 3) Whistler black carbon measurements to understand controlling processes, and 4) measurements at Alert to understand black carbon sources and processes controlling aerosol number.

We have completed a fine, coarse and total aerosol optical depth (AOD) climatology for the polar winter at Eureka and Ny Alesund (2 years) and an analogue 4-year climatology for the polar summer at five Arctic stations. As mentioned, these climatologies have been compared with GEOS-Chem simulations and are being worked up in two draft papers.

Impacts of emissions of BC on Arctic temperatures in CanAM4.2 were investigated based on simulations with 4 models, in collaboration with the Expert Group on Black Carbon and Ozone, Arctic Monitoring and Assessment Programme (AMAP); results were documented in an AMAP assessment report and in a paper in Nature Climate Change (Sand et al.). For the first time, the study provided evidence that present-day emissions of BC from domestic sources and vegetation fires in Asia cause significant warming of the Arctic.

In addition, simulated concentrations of BC in snow in CanAM4.2 and associated radiative forcings were compared to observations and results from other models (Namazi et al.), complementing earlier comparisons with observations at surface sites and aircraft data (Eckhardt et al.).

3. Top 5 publications in 2015 (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.

SOLAS TOP FIVE

Wentworth, G. R. J. G. Murphy, B. Croft, R. V. Martin, J. R. Pierce, J.-S. Côté, I. Courchesne, J.-É. Tremblay, J. Gagnon, J. L. Thomas, S. Sharma, D. Toom-Sauntry, A. Chivulescu, M. Levasseur, and J. P. D. Abbatt, “Ammonia in the summertime Arctic marine boundary layer: sources, sinks and implications”, Atmos. Chem. Phys., 16, 1937-1953, 2016. doi:10.5194/acp-16-1937-2016
http://www.atmos-chem-phys.net/16/1937/2016/

Mélançon J, Levasseur M, Lizotte M, Scarratt M, Tremblay J-É, Tortell P, Yang G-P, Shi G-Y, Gao H-W, Semeniuk DM, Robert M, Arychuk M, Johnson K, Sutherland N, Davelaar M, Nemcek N, Peña A, Richardson W (2016). Effects of dust additions on phytoplankton growth and DMS production in high CO_2 northeast Pacific HNLC waters. Biogeosciences 13.

Wilson TW, Ladino LA, Alpert PA, Breckels MN, Brooks IM, Browse J, Burrows SM, Carslaw KS, Huffman JA, Judd C, Kilthau WP, Mason RH, McFiggans G, Miller LA, Najera JJ, Polishchuk E, Rae S, Schiller CL, Si M , Vergara Temprado J, Whale TF, Wong JPS, Wurl O, Yakobi-Hancock JD, Abbatt JPD, Aller JY, Bertram AK, Knopf DA, Murray BJ, 2015. A marine biogenic source of atmospheric ice nucleating particles. *Nature* **525**: 234-8.

Brown KA, Miller LA, Mundy CJ, Papakyriakou T, Francois R, Gosselin M, Carnat G, Swystun K, Tortell JP, 2015. Inorganic carbon system dynamics in landfast arctic sea ice during the early-melt period. *J. Geophys. Res. Oceans* **120**, doi: 10.1002/2014JC010620.

Croft B, Martin RV, Leaitch WR, Tunved P, Breider TJ, D'Andrea SD, Pierce JR, 2015, Processes controlling the seasonal cycle of Arctic aerosol number and size distributions, *Atmos. Chem. Phys. Discuss.*, 15, 29079-29124.

OTHER SOLAS TOP FIVE...

Mason RH, Si M, Li J, Chou C, Dickie R, Toom-Sauntry D, Pöhlker C, Yakobi-Hancock JD, Ladino LA, Jones K, Leaitch WR, Schiller CL, Abbatt JPD, Huffman JA, Bertram AK. 2015. Ice nucleating particles at a coastal marine boundary layer site: correlations with aerosol type and meteorological conditions. Atmospheric Chemistry and Physics Discussions, 15, 16273-16323, doi:10.5194/acpd-15-16273-2015.

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

Miller LA, Fripiat F, Else BGT, Bowman JS, Brown KA, Collins RE, Ewert M, Fransson A, Gosselin M, Lannuzel, Meiners KM, Michel C, Nishioka J, Nomura D, Papadimitriou S, Russell LM, Sørensen LL, Thomas DN, Tison J-L, van Leeuwe MA, Vancoppenolle M, Wolff EW, Zhou J, 2015. Methods for biogeochemical studies of sea ice: The state of the art, caveats, and recommendations. *Elem*. *Sci. Anth.* **3**: 000038, doi: 10.12952/journal.elementa.000038.

Mason RH, Si M, Chou C, Irish VE, Dickie R, Elizondo P, Wong R, Brintnell M, Elsasser M, Lassar WM, Pierce KM, Leaitch WR, MacDonald AM, Platt A, Toom-Sauntry D, Sarda-Estève R, Schiller CL, Suski KJ, Hill TCJ, Abbatt JPD, Huffman JA, DeMott PJ, Bertram AK. 2015. Size resolved measurements of ice nucleating particles at six locations in North America and one in Europe, *Atmospheric Chemistry and Physics Discussions*, 15, 20521-20559, doi:10.5194/acpd-15-20521-2015.

Namazi M, von Salzen K, Cole JNS, 2015, Simulation of black carbon in snow and its climate impact in the Canadian Global Climate Model, *Atmos. Chem. Phys.*, 15, 10887-10904.

Pierce JR, Croft B, Kodros JK, D'Andrea SD, Martin RV, 2015, The importance of interstitial particle scavenging by cloud droplets in shaping the remote aerosol size distribution and global aerosol-climate effects, *Atmos. Chem. Phys*., 15, 6147-6158, doi:10.5194/acp-15-6147-2015, 2015.

Galí M, Devred E, Levasseur M, Royer S-J, Babin M. 2015. A remote sensing algorithm for planktonic dimethylsulfoniopropionate (DMSP) and an analysis of global patterns. *Remote Sensing of Environment* 171, 171-184.

Darroch LJ, Lavoie M, Levasseur M, Laurion I, Sunda WG, Michaud S, Scarratt M, Gosselin M, Caron G. 2015. Effect of short-term light stress on dimethylsulfoniopropionate (DMSP), dimethylsulfide and DMSP lyase potential activity in *Emiliania huxleyi* (CCMP 1742). *Aquatic Microbial Ecology* 74, 173-185.

Lavoie M, Levasseur M, Sunda WG. 2015. A steady-state physiological model for intracellular dimethylsulfoxide in marine phytoplankton. *Environmental Chemistry*, http://dx.doi.org/10.1071/EN14221.

Lavoie M, Levasseur M, Babin M. 2015. Testing the potential role of dimethylsulfoniopropionate in marine phytoplankton: A modeling study. *J. of Plankton Res*. 1-13.

Galindo V, Levasseur M, Scarratt M, Mundy CJ, Gosselin M, Kiene RP, Gourdal M, Lizotte M. 2015. Under-ice microbial dimethylsulfornio-propionate metabolism during the melt period in the Canadian Arctic Archipelago. *Mar. Ecol. Prog. Ser.* 524. 39-53.

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.)

1. NETCARE 2016 MISSION (SEVERAL NETCARE PIs)

Planning is now intensively underway for the second and last Amundsen campaign on the CCGS Amundsen (July 14 – Aug 25, 2016). As described in detail in the original proposal, novel activities to be pursued on the ship involve the deployment of a remotely-controlled microlayer sampler and the use of a MART-like tank for in situ generation of primary marine aerosol. We will couple aerosol characterization instruments to the tank (e.g. to measure CCN, INPs, particle distributions), sometimes amending ocean water with microlayer samples. Water DMS concentrations will also be measured at high spatial/temporal resolution with a new MIMs (Lizotte and Levasseur).

2. NETCARE MODELING (SEVERAL NETCARE PIs)

Modeling activities with the Environment Canada chemical transport model, GEM-MACH, have included implementation of different ice nucleation schemes and comparison to cirrus cloud observations during the ISDAC field campaign. This work is being extended to evaluation of the relationship between INPs and modeled aerosol concentration and composition during the NETCARE Amundsen and POLAR 6 campaigns.

A final project assesses how sensitive future global, and regional, climate projections are to a model's representation of aerosol radiative forcing (ARF). We are building multiple (five) equally plausible versions of a single GCM (NCAR CESM1), each with different strengths of sulfate and black carbon ARF, and will compare future projections of global and regional climate from these five versions. We have recently completed historical simulations and testing of the five versions, and are beginning the future simulations now (runs should be complete by end of 2015, with analysis and write-up to come in 2016).

3. NETCARE NH3 WORK (Jennifer Murphy)

The NH3 work to date is particularly interesting because the measurements from the Amundsen can only be matched by the GEOS-CHEM chemical transport model if sea bird emissions are included. This is the first indication that marine wildlife can have a major effect on the polar atmosphere, with impacts on particle formation and composition. We anticipate this will be one of NETCARE's major achievements, and so we plan extending these novel measurements in 2016 by prolonging the planned Alert campaign into two phases, one in the spring to study INPs (see above), and a second in the summer to study new particle formation and its relationship to key gaseous precursors, such as NH3, H2SO4 and OVOCs. Planning for both phases of the Alert measurements is underway with major participation by Environment Canada, involving collaboration with Sharma, Leaitch, Liggio, Wentzell, Platt and Toom-Sauntry. Scientists from both the Climate and Air Quality Divisions are involved.

4. Expansion of observatories in the Canadian Archipelago (Lisa Miller)

An additional 3 moorings are planned, to include CO_2 system measurements in the Canadian Arctic waters.

5. R/V Endeavour cruise (Rachel Chang)

R Chang will participate to a R/V Endeavour cruise on Sep 25 – Oct 25, 2016, as part of a project funded by the NSF (Chemical Oceanography; PI: D. Kieber, SUNY Albany. The objective of the project is to understand the role of primary marine organic aerosol on the ocean carbon cycle.

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

1. NETCARE ANNUAL WORKSHOP

The NETCARE annual workshop will take place on November 14-16 at University of Toronto, Ontario, Canada. Based on previous years, about 60 participants are expected.

2. Joint Quebec-Qingdao workshop on the Impact of ocean acidification on marine resources and biogeochemical cycles in estuaries

The workshop will take place in Qingdao in October or November 2016 (date to be determined). It will gather participants to the Quebec and China joint program on the impact of ocean acidification in coastal waters led by M Levasseur and G-P Yang.

3. NETCARE special issue

Results from NETCARE researches will be published in a special issue entitled "NETCARE (Network on Aerosols and Climate: Addressing Key Uncertainties in Remote Canadian Environments) (ACP/AMT/BG inter-journal SI)" as part of the journals ACP, AMT and BG. The guest editors are L. Bopp, K. Carslaw, D.J. Cziczo, and L. M. Russell.

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')

1. NETCARE 2012-2018 (Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environments)

NETCARE is a network led by Jon Abbatt of the University of Toronto. It includes researchers from ten Canadian universities (Toronto, UBC, UQAM, Waterloo, UQAR, Laval, Dalhousie, Calgary, Sherbrooke, Victoria) and five partner institutions (Environment Canada, Fisheries and Oceans Canada, Alfred Wegener Institute, Max Planck Institute, Johannes Gutenberg University). NETCARE is one of seven Canadian networks funded by the Climate Change and Atmospheric Research (CCAR) program at NSERC.
SOLAS theme: Greenhouse gases, ocean biogeochemical control on atmospheric chemistry, integrated systems.

2. ArcticNet – Project: Marine Biogeochemistry and Surface Exchange of Climate Active Gases in a Changing Arctic System, 2015-18
PIs: T. Papakyriakou, B. Else, and 6 others. $154,000/year.
SOLAS theme: Greenhouse gases, ocean biogeochemical control on atmospheric chemistry, integrated systems.

3. BaySys 2015-2018
Contributions of climate change and hydro-electric regulation to the variability and change of freshwater-marine coupling in the Hudson Bay System. With D. Barber and many others (pan-Canadian research network). NSERC Collaborative Research and Development Grant. $4,540,000.
SOLAS theme: Greenhouse gases, integrated systems, SOLAS and society.

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)

Polar Knowledge Canada and the Canadian High Arctic Research station are really gearing up, with increasing support for marine and terrestrial monitoring activities throughout the Canadian Arctic. A call for marine proposals is anticipated soon (likely this year?), and numerous plans are being developed for large, integrated projects in which SOLAS issues of marine controls on atmosphere chemistry, greenhouse gas dynamics, and sea ice biogeochemistry are prominent.

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

Wrap-up of BEPSII SCOR working group 140, on sea-ice biogeochemistry. A number of publications in a special feature in *Elementa: Science of the Anthropocene* (https://home.elementascience.org/special-features/biogeochemical-exchange-processes-at-sea-ice-interfaces-bepsii/). Development of next phase, in the form of a joint SOLAS-CliC activity to build on the tools developed in the SCOR working group to begin addressing big-picture questions of the role of sea ice in the global system and climate change feedbacks. There is major Canadian leadership in the ongoing development of BEPSII.

Comments

The possibility to implement a national (international) program on the impact of volcanic ash on ocean biogeochemistry has been discussed. Interested parties for now are at Dalhousie University and Laval University. Too early to publicise, but good to know...More to come.

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS: Chile compiled by: Laura Farías

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

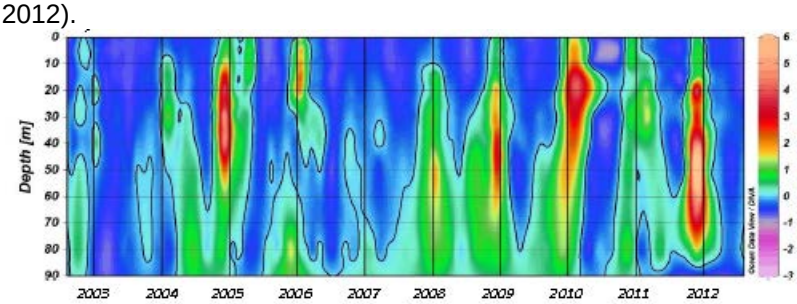
IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups)!*

PART 1 - Activities from January 2015 to December 2015

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.

Seasonal and inter-annual variability of biogeochemical variables, including nitrous oxide (N2O) an important climate active gas, were analyzed during monthly observations between 2002 and 2012 at the Center for Oceanographic Research in the South Pacific (COPAS) Ocean Time-Series station in the coastal upwelling area off central Chile (36° 30.8'; 73° 15'). Oxygen, N2O, nutrients and chlorophyll-a showed clear seasonal variability associated with upwelling favorable winds (spring-summer), and also inter-annual variability, which in the case of N2O was clearly observed during N2O hotspot occurrence with saturation levels of up to 4849%. The hotspots consistently occurred during the upwelling-favorable period in years 2004, 2006, 2008, 2010 and 2011, below to the mixed layer (15-50 m depth) in waters with hypoxia and specific NO2- accumulation. They displayed a three times greater excess of N2O (ΔN2O) than the average monthly anomalies (2002-2012).



Estimated relationships of ΔN2O vs. apparent oxygen utilization (AOU) and ΔN2O vs. NO3- suggest that aerobic ammonium oxidation (AAO) and partial denitrification are the processes responsible for high N2O accumulation in subsurface water. Chlorophyll-a levels correlated fairly well with the presence of the N_2O hotspots, suggesting that microbial activities fuelled by high availability of organic matters lead to high N2O production. This in turn results in a huge efflux into the atmosphere of up to 260 µmol m-2 d-1. N2O hotspots are transient events or hot moments,

which may occur more frequently than they are observed. If so, this upwelling area is producing and emitting greater than expected amounts of N2O and resulting in an important source of N2O that should be considered in the global atmospheric N2O balance. Taken from Farías L, Besoain V, and García-Loyola S. (2015). *Presence of nitrous oxide hotspots in the coastal upwelling area off central Chile: An analysis of temporal variability based on ten years of a biogeochemical time series*. Environmental Research Letter 10 (2015) 044017 doi:10.1088/1748-9326/10/4/044017

2. Activities/main accomplishments in 2015 (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.)

Temporal variability in biogeochemical variables (including nitrous oxide and methane) have been evaluated from time series (TS) stations off Concepcion ~36°S (COPAS TS;) and one new with two years of monitoring off Valparaiso ~32°S). We participated in the CIMAR 21 expedition to the eastern South Pacific (Valparaiso to Eastern Island, October 2015). We took our recently implemented system (own technological development) for continuous measurement of nitrous oxide and methane in surface oceanic waters to estimate the air-sea fluxes in the region. We also collected samples for studying the very fine vertical distribution (each meter) of the variables in the water column in order to determine the origin of gases in the South Pacific gyre. We also participate in LOWPHOX cruise in order to investigate the impact of ocean acidification on nitrifying activity, preliminary results suggest that OA does not seem affect nitrification but N2O yielding rates (Frame et al., in progress).

Chile through Laura Farías participates in the Scientific Committee on Ocean Research (SCOR) Working Group: Dissolved N_2O and CH_4 measurements: Working towards a global network of ocean time series measurements of N_2O and CH_4. This group aims to improve and consolidate measurements of the greenhouse gases nitrous oxide (N_2O) and methane (CH4) dissolved in seawater. an intercalibration exercise is being conducted amongst WG members targeting discrete N_2O and CH_4 measurements. Recommendations and protocols for calibration, quantification, and data reporting will be published following this exercise.

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

1.-Cornejo M, Murillo AA, Farias L. (2015) An unaccounted for N2O sink in the surface water of the eastern subtropical South Pacific: Physical versus biological mechanisms. Progress in Oceanography. Vol.137(A):12-23. doi:10.1016/j.pocean.2014.12.016

2.-Farías L, Besoain V, and García-Loyola S. (2015). *Presence of nitrous oxide hotspots in the coastal upwelling area off central Chile: An analysis of temporal variability based on ten years of a biogeochemical time series*. Environmental Research Letter 10 (2015) 044017 doi:10.1088/1748-9326/10/4/044017

3.-Farias L, Flores L, Besoain V and Fernandez C. (2015). *Dissolved greenhouse gases (nitrous oxide and methane) associated with the natural iron- fertilized Kerguelen region (KEOPS 2 cruise) in the Southern Ocean*. Biogeosciences, doi:10.5194/bgd-11-12531-2014

4.-Lambert, F., A. Tagliabue, G. Shaffer, F. Lamy, G. Winckler, L. Farias, L. Gallardo, and R. De Pol-Holz (2015), Dust fluxes and iron fertilization in Holocene and Last Glacial Maximum climates, Geophysical Research Letters, 42(14), 6014-6023, doi:10.1002/2015gl064250.

5.- Vuille, M., Franquist, E.,Garreaud, R., Lavado, W., Cáceres, B.Impact of the global warming hiatus on Andean temperature Journal of Geophysical Research: Atmosphere doi: 10.1002/2015JD023126

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.)

Next years, our research will be focused on the behavior of water vapor in Northern Chile is representative of a much larger region that includes the subtropical anticyclone. The region of the subtropical anticlyclone in the Eastern Pacific is the locus of some of the critical feedbacks in the climate system, in particular, low cloud feedbacks and water vapor feedback. The dynamics of water vapor is tied to the general warming of the planet, as on the zeroth-order, the distribution of water vapor in the subtropical free troposphere is controlled by the temperature of last saturation of air parcels which can have a high and mid-latitude origin. Changes in the water vapor distribution in regions of low water vapor are relatively more important than changes in regions of high water vapor due to the saturation of the radiative response in the infrared. This region is the locus of significant radiative cooling to space that occurs from the top of the stratocumulus cloud base or from the surface of the ocean. This cooling is instrumental in regulating the radiative response of the planet to climate change. This highlights the interest in understanding what controls the water vapor amount in this region and what are the mechanisms that control possible trends of water vapor in similar regions of the planet.

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')

Most of researchers related with SOLAS issues are making in the new Center for Climate and Resilience Research (CR)2, (www.cr2.cl) a world-class research center focusing on Earth System Science, which in a interdisciplinary manner and in close relation to stakeholders, improves our understanding of the Earth System and is functional to the enhancement of societal resilience in Chile. The proposed research tackles highly relevant questions in biogeochemistry, climate dynamics, ecosystem services, social science, and modeling and observing systems. This research is oriented towards addressing with an integrated approach pressing issues for Chile: scarcity and variability of water resources in Central and Northern Chile, growing urbanization in Central and Southern Chile, and fast land use changes in Central and Southern Chile. Natural scientists convened at (CR)2 will address interactions in the regional climate system in a quantitative manner, by means of paleorecords, in situ and remote measurements, and model simulations. Social scientists at (CR)2 will use comparative studies and multi-criteria evaluations to examine attainable adaptation, mitigation, and practices to confront the expected climate changes. This center is founded by CONICYT

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 2015 and future activities

SOLAS China *compiled by:_Minhan Dai and Huiwang Gao*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

PART 1 - Activities from January 2015 to December 2015
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.
The concentration, size distribution, and formation of dimethylaminium (DMA+) and trimethylaminium (TMA+) ions in atmospheric particles were studied during a cruise campaign over the Yellow Sea and the Bohai Sea of China in May 2012. The concentrations of DMA+ and TMA+ in PM_{11} were 4.4 ± 3.7 and 7.2 ± 7.1 nmol m^{-3}, respectively. The two ions had a good correlation (R^2=0.86), and both had a moderately good correlation with chlorophyll a fluorescence (R^2=0.66-0.67). The observed concentrations were from 1-3 orders of magnitude higher than the concentrations reported in other marine atmospheres. The high concentrations of DMA^+ and TMA^+ observed in the marine atmosphere were probably associated with local biogenic activity instead of the long-range transport of these species from adjacent continents. The calculated mole ratios of (DMA^+ + TMA^+) to NH_4^+ in different-sized particles over the seas indicated that (DMA^+ + TMA^+) most likely played an important role in neutralizing acidic species in particles less than 0.43 µm but not in particles of other sizes. Size distributions of DMA+ and TMA+ in the marine and coastal atmospheres were analysed and the results showed a multiple contributors to the observed concentrations of the two ions over the seas.

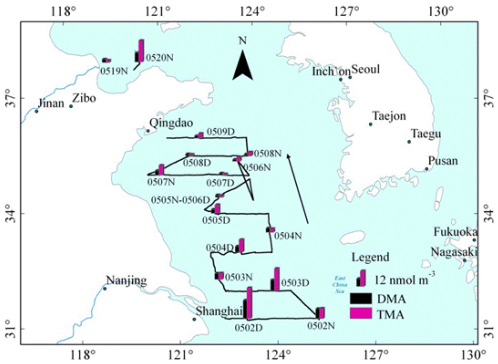


Fig. 1 Distribution of DMA+ and TMA+ in PM11 measured over the Yellow Sea and Bohai Sea in May of 2012.

2. Activities/main accomplishments in 2015 (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

- A cruise campaign was conducted in March-April 2015 from the marginal seas of China to the Northwest Pacific Ocean to study N cycling in relation to atmospheric deposition.
- Two surface ocean buoys monitoring both pCO_2 and pH have been operating since 2012, deployed at the seasonal hypoxia zone off in the East China off the Changjiang estuary (buoy 1) and on the mid-shelf of the East China Sea (buoy 2).
- A cruise was conducted on the northern South China Sea shelf in July-August 2015 to study the carbon and nutrient dynamics in the Pearl River plume.
-

2.2 SOLAS-Endorsed Project: CHOICE-C renewed

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.

2.3 Infrastructure

A new research vessel with the capacity of SOLAS and trace metal researches under construction.

A 78-m long new research vessel of Xiamen University started its construction in March 2015 and is expected to be in commissioning late 2016.

2.4 Workshop organized

The Second Xiamen Symposium on Marine Environmental Sciences (2nd XMAS), January 7-9, 2015, Xiamen, China

CHOICE-C II kick-off Meeting, September 18-20, 2015, Xiamen, China.

2.5 International interactions and collaborations

- Minhan Dai, Diagnosing CO_2 fluxes in Ocean-dominated margins (OceMar): coupling the physical dynamics and biogeochemistry, The 2nd Open Science Symposium on Western Pacific Ocean Circulation and Climate (OSS 2015), October 25-29, 2015, Busan, South Korea (Plenary talk)
- Minhan Dai, Diagnosing the CO_2 fluxes in the land-ocean interface: coupling the

physical dynamics and biogeochemistry, ECSA 55-Unbounded boundaries and shifting baselines: Estuaries and coastal seas in a rapidly changing world, September 6-9, London, UK (Keynote speech)

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

- The OA-ICC Training Course on Best Practices in Ocean Acidification Research took place in Xiamen, October 19-23, 2015. The course was organized by the Ocean Acidification International Coordination Centre (OA-ICC) of the International Atomic Energy Agency (IAEA), coordinated by Drs. Lisa Robbins (US Geological Survey) and Minhan Dai, and was hosted by the State Key Laboratory of Marine Environmental Science (Xiamen University).
- The 4th Xiamen University Ocean Sciences Open House was held on November 15, 2015, Zhou-Long-Quan Building, Xiang'An Campus, Xiamen University, China

3. Top 5 publications in 2015 (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.

1) Hu, Q.J., Yu, P.R., Zhu, Y.J., Li, K., Gao, H.W., Yao, X.H. 2015. Concentration, Size Distribution, and Formation of Trimethylaminium and Dimethylaminium Ions in Atmospheric Particles over Marginal Seas of China. *Journal of the Atmospheric Sciences*, 72(9), 3487-3498, DOI: 10.1175/JAS-D-14-0393.1.
2) Bai, Y., Cai, W.-J., He, X.Q., Zhai, W.D., Pan, D.L., Dai, M.H., Yu, P.S. 2015. A mechanistic semi–analytical method for remotely sensing sea surface pCO_2 in river–dominated coastal oceans: A case study from the East China Sea. *Journal of Geophysical Research: Oceans*, 120, 2331-2349.
3) Guo, X.H., Zhai, W.D., Dai, M.H., Zhang, C., Bai, Y., Xu, Y., Li, Q., Wang, G.Z. 2015. Air-sea CO_2 fluxes in the East China Sea based on multiple-year underway observations. *Biogeosciences*, 12, 5495-5514.
4) Yang, G-P, Zhang, S, Zhang, H., Yang, J., Liu, C-Y. 2015. Distribution of biogenic sulfur in the Bohai Sea and northern Yellow Sea and its contribution to atmospheric sulphate aerosol in the late fall. *Marine Chemistry,* 169, 23-32.
5) Cai, P.H., Zhao, D.C., Wang, L., Huang, B.Q., Dai, M.H. 2015. Role of particle stock and phytoplankton community structure in regulating particulate organic carbon export in a large marginal sea. *Journal of Geophysical Research-Oceans*, 20, 2063-2095.

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.)

A campaign will performed in summer 2016 to study atmospheric chemistry and physics related to super green tide in the Yellow Sea.

A cruise will be conducted in the Luzon Strait and the northern South China Sea (SCS) basin to study the influence of the north Pacific deep water inflow on the carbon dynamics of the upper ocean of the SCS.

A cruise will be conducted in the South China Sea basin in Winter 2016 to make comparative study of the carbon cycle in the RioMar and OceMar.

China Ocean Observation Initiative is being launched in 2016-2017.

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

(1) AOGS Annual Assembly, Beijing, July 31-August 5, 2016.
(2) International SOLAS SSC meeting, Qingdao, China, October 23-26, 2016.
(3) Future SOLAS Symposium, Qingdao, China, October 26-28, 2016.
(4) CHOICE-C II mid-term review meeting, Guangzhou (Nansha), China May 28-30, 2016.
(5) Ocean Acidification research in China: an international workshop, Shanghai, China, April 28-29, 2016.
(6) The third Xiamen Symposium on Marine Environmental Sciences (3rd XMAS) will be held in Xiamen, January 9-11, 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 the activity topics relate – including the themes on 'SOLAS science and society' and 'Geoengineering')

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.

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)

China-SOLAS is seeking sponsorship of Chinese National Committee for Future Earth (CNC-FE), which was established in March 2014.

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

The State Key Laboratory of Marine Environmental Science (Xiamen University) was invited to participate in the IAEA interregional project "Supporting a Global Ocean Acidification Observing Network towards Increased Involvement of Developing States".

Comments

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS Denmark *compiled by: Lise Lotte Sørensen*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

Estimate of the CO_2 uptake of the coastal Grennlandic ocean

It is critical to accurately estimate CO_2 uptake by the Greenlandic coastal area because the marine region is sensitive to climate change and it takes up relative more CO_2 than other marine areas. Thus we aim to obtain a reliable assessment of the CO_2 uptake by the Greenlandic coastal area and air – water CO_2 fluxes were estimated for the coastal area of Greenland based on measurements at two Greenlandic estuaries at two different latitudes; Godthåbs fjord in Nuuk, and Young Sound, Daneborg.
Both estuaries appear as CO_2 sinks and therefore the total coastal area is estimated to be a sink. The estimated uptake is depending on ice cover, temperature, and wind velocities. The coastal marine surface of Greenland is 0.08% of the total global ocean surface and 1.1% of the coastal area. However the estimated uptake of CO_2 is around 0.5% of the global ocean uptake and 6.1% of the global coastal uptake. The uptake is estimated from the parameterization of Clarck et al. (1995) and Ho et al., 2006 which showed similar results. The uptake is shown in Table 1.
The estimated uptake is based on a very limited dataset and it is clear from new measurements that more knowledge of the spatial and temporal distribution of air sea CO_2 fluxes around Greenland is needed.

	Clarck et al. (1995)	*Reduced sea ice (30%)*	*Changed wind climate*
Exchange velocity *g-C m^{-2} hr^{-1}*	1 - 7 x 10^{-3}		
Total uptake *Tg C y^{-1}*	11.65	16.65	11.28

Table 1: CO_2 uptake by the coastal marine area of Greenland estimated using three different scenarios (present climate, reduced sea ice, reduced sea ice but including increased water temperature and changed wind climate) (http://dx.doi.org/10.6027/TN2015-538).

2. Activities/main accomplishments in 2015 (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.)

Coastal measurements of CO2 and CH4 fluxes at Station Nord (LAT: 81°36'09. LONG:16°40'12)

A mobile flux tower was installed on the sea ice at Station Nord in mid- April with two Licor instruments (one enclosed sampler 7200 and one open path sampler 7500A) and two sonics to measure fluxes of CO2 and heat over the snow covered sea ice in spring and summer 2015 (a gap in July due to difficulties in access to the station with batteries). In May a CH4 instrument was added to the instrument package to also measure CH4 fluxes. In end of May the tower was moved from the ice to the shore and measurements over the open water surface was continued.
The instruments have been measuring most of the summer until December 2015, where the tower was taken down and instruments calibrated. We have just started the data analyzes, where the first task is to compare data from the two different CO2 sampler.
The project is collaboration between Aarhus University, Denmark and University of Manitoba, Canada.

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

Sievers J., Sørensen, L. L., Papakyriakou, T., Sejr, M., Søgaard, D. H., Barber, D. and Rysgaard, S., 2015, Winter observations of CO2 exchange between sea ice and the atmosphere in a coastal fjord environment. *The Cryosphere*, 9, 1701-1713, DOI:10.5194/tc-9-1701-2015.

Lansø, A. S., Bendtsen, J., Christensen, J. H., Sørensen, L. L., Chen, H., Meijer H. A. J. and Geels, C., 2015. Sensitivity of the air-sea CO2 exchange in the Baltic and Danish waters to atmospheric short term variability. *Biogeosciences*. 12, 2753-2772, DOI: 10.5194/bg-12-2753-2015.

Sievers, J., Papakyriakou, T., Larsen, S. E., Jammet, M. M., Rysgaard, S., Sejr, M. K. and Sørensen, L. L., 2015, Estimating surface fluxes using eddy covariance and numerical ogive optimization. *Atmospheric Chemistry and Physics* 15, 2081–2103, DOI:10.5194/acp-15-2081-2015.

Miller L. A., Fripiat, F., Else, B. G. T, Bowman, J. S., Brown, K. A., Collins, R. E., Ewert, M., Fransson, A., Gosselin, M., Lannuzel, D., Meiners, K., Michel, C., Nishioka, J., Nomura, D., Papadimitriou, S., Russell, L. M., Sørensen, L. L., Thomas, D. N., Tison, J.-L., van Leeuwe, M. A., Vancoppenolle, M., Wolff, E. W., Zhou, J., 2015,. Methods for Biogeochemical studies of sea ice: The state of the art, caveats, and recommendations. *Elementa: Science of the Anthropocene*, 3:000038, DOI:10.12952/journal.elementa.000038.

Meire L., Søgaard, D.H., Mortensen, J., Meysman, F. J. R, Soetaert, K., Arendt, K. E., Juul-Pedersen, T., Blicher, M. E. and Rysgaard, S., 2015, Glacial meltwater and primary production are drivers of strong CO2 uptake in fjord and coastal waters adjacent to the Greenland Ice Sheet, *Biogeosciences*, 12, 2347-2363, DOI:10.5194/bg-12-2347-2015

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.)

This spring Aarhus University is planning on field work in Nuuk fjord where we will measure adjacent fluxes of CO2 and sea spray.

Furthermore a multidisciplinary study of Greenland ice sheet-ocean interactions in Greenland fjords will be conducted. Based on oceanographic surveys along ~5 transects from the shelf towards main outlet glaciers in NW Greenland we will: 1) Identify near shore water mass characteristics and bathymetry to assess potential marine heat sources and circulation processes important for glacial melt. 2) Identify impacts of glacial melt water on vertical mixing, light and nutrient conditions and subsequent rates of phytoplankton production. 3) Determine surface pCO2 values and carbonate system dynamics including pH and aragonite saturation states to confirm if glacial fjords are sites of high uptake of atmospheric CO2. 4) Determine the importance of glacial derived carbon for pelagic and benthic carbon cycling

A coastal Danish ICOS atmospheric station measuring CO2 and CH4 will be established At Station Nord in 2016 and 2017.

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

We are planning a SOLAS-DK national workshop

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')

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

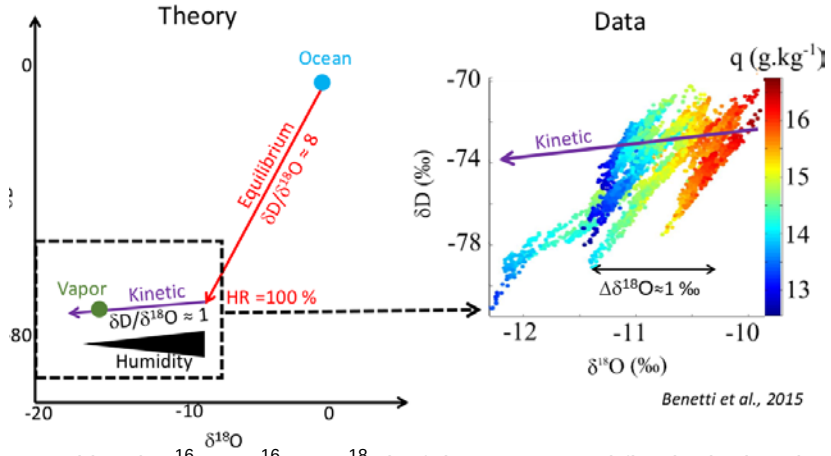
Report for the year 2015 and future activities

SOLAS France, *compiled by R. Losno*

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

What have we learned on air-sea vapor exchange from water isotopologue measurements during cruises in the tropical and subtropical Atlantic. **SPURS, PIRATA, Rara Avis** projects, Marion Benetti LOCEAN (mabelod@locean-ipsl.upmc.fr)



The isotopic composition ($H_2{}^{16}O$,$HD^{16}O$, $H_2{}^{18}O$) of the evaporated flux is depleted compared to the surface sea water by equilibrium or kinetic effects. Kinetic effects are not well understood yet. This work aimed to search on how do local atmospheric parameters such as humidity and wind speed control the kinetic fractionation during evaporation. The investigations are made and result obtained using samples and data collected during the STRASSE oceanographic campaign in summer 2011. The figure show a strong influence of the evaporation on the water vapor at 17 m. A new campaign was held in 2015 on a scientific sailor boat in the sub tropical North Atlantic Ocean (RARA AVIS 2015) to measure the seasonal variability of δ_e.

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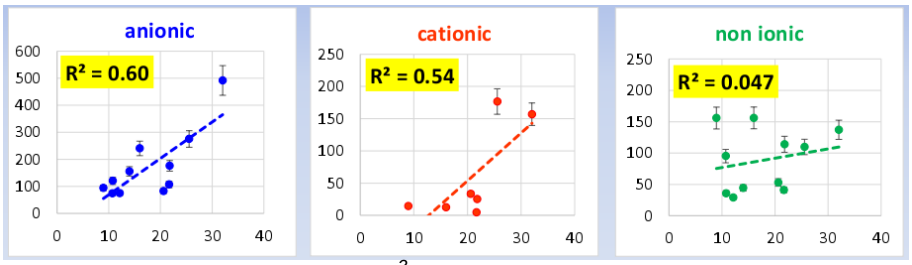
2. Activities/main accomplishments in 2015 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, etc.)

The year 2015 was marked by the SOLAS international conference and the participation of twelve French SOLAS active scientists. This conference was preceded by the SOLAS-France meeting held in Paris on June 29th. 32 attendants presented all the on going SOLAS topic with a snapshot of the active SOLAS work done in France during the year 2015. SOLAS-France congratulates the new position of Véronique Garçon as the SOLAS leader and wish her a total success.

Ongoing developments in the Meso-NH model for the generation of primary marine salts. Marine Clayes, CNRM (marine.claeys@meteo.fr)
An improve model published by Ovadnevaite et al. in 2014 was implemented in MESO-NH atmospheric model. These improvements take into account the effects of SST, sea state and also include smallest particles. The parametrization is made using field measurements.

Surface tension and anionic, cationic, and non-ionic surfactant concentration in aerosols from contrasting regions: filling the gaps in the ecosystems-aerosol-cloud relationship.

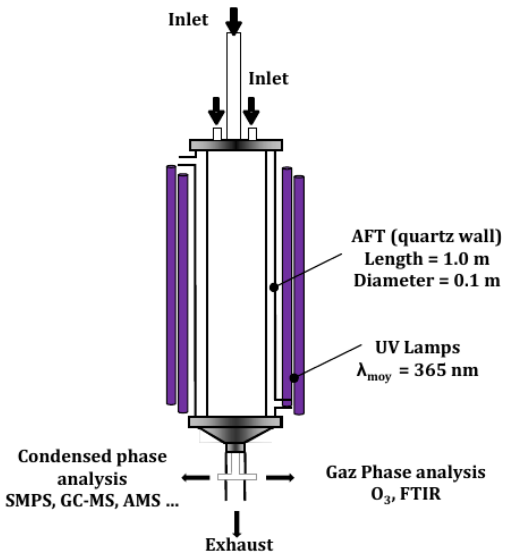
Barbara Nozière, IRCELYON (barbara.noziere@ircelyon.univ-lyon1.fr) and col. (Violaine Gérard, Christine Baduel, Amanda Frossard and Ron. C. Cohen).



Surfactant concentration (Y axis, pmol/m^3) versus chlorophyll concentration (X axis, mg/m^3)

Surfactants present in atmospheric aerosols are expected to enhance the activation into cloud droplets by acting on one of the two key parameters of the Köhler equation: the surface tension, σ. But because the magnitude of this effect and its regional and temporal variability are still highly uncertain, various approaches have been developed to evidence it directly in the atmosphere. We made analysis of surfactants present in PM2.5 aerosol fractions collected at the coastal site of Askö, Sweden (58◦ 49.5' N, 17◦ 39' E) from July to October 2010. The total surfactant fraction was extracted from the samples using an improved double extraction technique. Surface tension measurements performed with the pendant drop technique indicated the presence of very strong surfactants (σ ~35 mN/m) in these aerosols. In addition, these extractions were combined with colorimetric methods to determine the anionic, cationic and non-ionic surfactant concentrations, and provided for the first time interference-free surfactant concentrations in atmospheric aerosols (figure). At this site, the total surfactant concentration in the PM2.5 samples varied between 7 to 150 mM and was dominated by anionic and non-ionic ones. The absolute surface tension curves obtained for total surfactant fraction displayed Critical Micelle Concentrations (CMC) in the range 50 - 400 uM, strongly suggesting a biological origin for the surfactants. (in *Geophysical Research Abstracts*, Vol. 17, EGU2015-851, 2015, EGU General Assembly 2015).

Lab measurements of oxidation of fatty acid in marine organic aerosol. Ahmad El Masri PC2A, Lille (elmasri.ahmad@gmail.com), N. visez and Denis Petitprez (denis.petitprez@univ-lille1.fr).

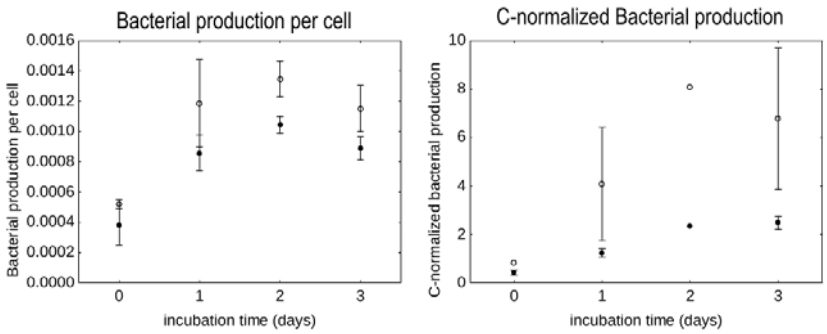


Organic aerosols are produced with sea salt aerosol in film and drop jets. A laboratory experiment was set up to measure the reactivity or organic marine aerosol with Cl and O_3. A focus was made on fatty acids, reaction products and kinetics of oxidation reactions. Organic aerosol is generated in the laboratory using distillation and condensation under a nitrogen flow. The produced aerosol is introduced in the heterogeneous kinetic reactor (figure) where ozone is added. Ozone and the chemical composition of the remaining aerosol are analyzed.

Secondary aerosol emissions from open sea waters via halogenated species: evidences from mesocosm experiment Karine Sellegri LaMP/OPGC (k.sellegri@opgc.univ-bpclermont.fr)

and col. (A. Culot, C. Rose, J. pey, S. Mas, B. D'anna, R. Sempere B. Charriere and N. Marchand). New particle formation through the gas-to-particle conversion is an important and complex process that generate aerosols which can, in turn, affect the climate on a global scale by influencing cloud radiative processes (Slingo, 1990). This phenomenon has been widely studied in many environments, including marine coastal areas where the largest nucleation rates have been reported so far in the literature, when macro-algae are exposed to ambient air at low tide during daytime. However, extremely scarce information is available for open-ocean conditions which represent 71 % of the earth surface. Nucleation is suspected to occur over open ocean areas (O'Dowd (2010)), but there were, to our knowledge, no direct measurement of new cluster particle significant formation. Iodine has been identified as a precursor to formation of new particles in coastal environment (O'Dowd 2002), and is also released by microalgae species (Thorenz et al. 2014), but in-situ measurement failed to identify iodine as a precursor to new particle formation events in the open-ocean atmosphere. Here, we evidence that new cluster particles (1-6 nm of diameter) are abundantly produced from open-sea-representative seawater, free of coastal macro-algae, from mesocosm experiments.

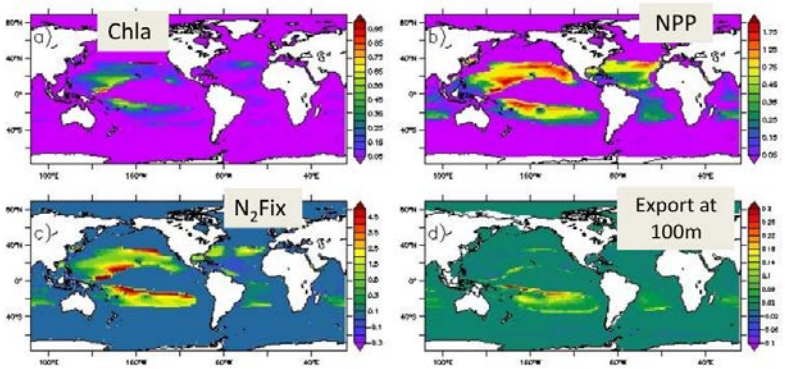
Experimental evidence of dust-induced changes in DOM bioavailability in the surface ocean.
DONUT project, Elvira Pulido MIO (elvira.pulido@univ-amu.fr)
DOC is the second largest oceanic C pool (662 ± 32 Pg C) and is a crucial advective/mixing pathway of carbon export, particularly in the oligotrophic ocean. DOC export through vertical mixing results from the decoupling between production and removal processes during the stratification period due to nutrient limitation of bacterial activity. Nutrient limitation of bacterial activity can be transiently relieved through the pulsed inputs of new nutrients derived from Saharan dust The DONUT project aimed at revisiting the 'bacterial' link between dust deposition and C cycle. Its main objective was to assess the hypothesis that the bacterial and microbial loop responses to dust deposition might shape the DOM pool and modify its residence time with implications on DOM bioavailability. DONUT strategy was based on an original 2-step experiment: The first step of the experiment consisted on long-term incubations (21 days) in which a bacterial natural assemblage was submitted to dust enrichments. The second step of the experiment consisted on using the transformed DOM from DONUT-1 to re-initiate short-term incubations (3 days) in order to check for modifications on the DOM bioavailability caused by dust amendment. Bacterial abundance and production was lower in the treatment previously submitted to dust enrichment (Figure) suggesting a decrease in DOM bioavailability induced by dust addition. This is promising result which points to a new link between dust and carbon cycle through the modification of the residence time of the surface DOM pool.



Bacterial production per cell and per unit of available DOC was significantly lower under dust-enriched conditions (solid circles).

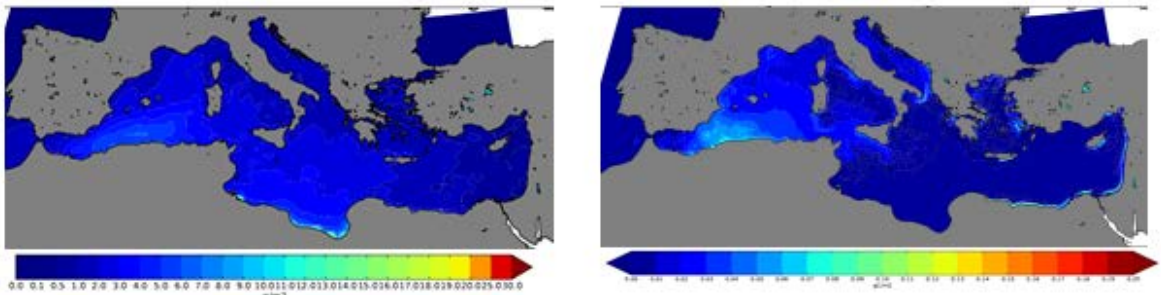
Atmospheric impact on ocean biogeochemistry: from experiments to modelling Cécile Guieu LOV (guieu@obs-vlfr.fr).
The objectives are to assess the importance of atmospheric deposition of elements (µ-)nutrient for oligotrophic areas in the ocean, including N, P and Fe. We aim to compare the results from experimental studies and modeling at a global scale. Deposition fluxes are highly variable from place to place and large portions of ocean surface is poorly documented with field data necessitating model calculations. We used the concept of "atmospheric turnover time (ATT)" which is the time required for atmospheric deposition alone to reach the actual sea surface concentration. The lowest ATT values are found in the LNLC regions and are different between N, P and dissolved iron. Consequently, atmospheric deposition may change the N:P:DFe ratio in the ecosystem. In the global warming conditions, an extension of LNLC regions and a reduction of oceanic nutrients inputs is foreseen, enhancing the role of atmospheric deposition. Computation of oceanic response to a pulsed dust input is also spatially variable (figure showing maximum relative change after a

dust pulse input).



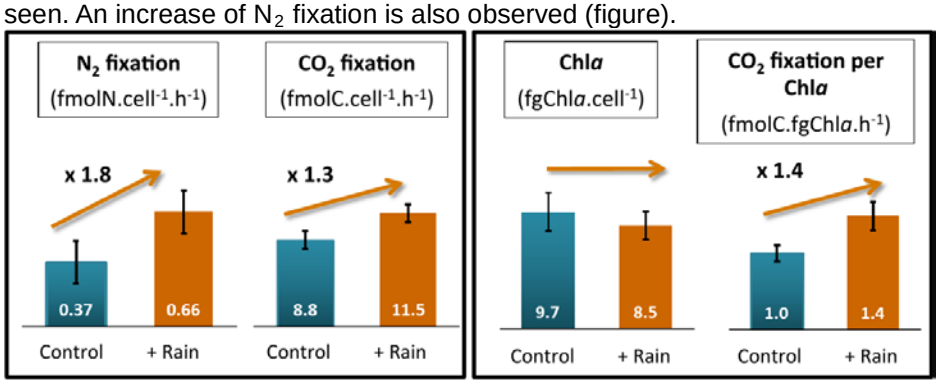
A large spatial variability is due to variable LNLC physico chemical conditions. This fast response is limited to one to two weeks inducing a limited long term effect .

Impact and dust deposit modeling in the Mediterranean. Jean-Claude Dutay (jean-claude.dutay@lsce.ipsl.fr), François Dulac LSCE (francois.dulac@cea.fr) and Camille Richon (camille.richon@lsce.ipsl.fr).
A high resolution (1/12 deg) coupled dynamical-biogeochemical model of the Mediterranean (NEMOMED12-PISCES) was implemented with new high resolution dust deposition forcings (ALADIN-Climat, Nabat et al.) and low resolution nitrogen deposition (INCA, Hauglustaine et al.). Atmospheric deposition is the major source of nutrient (especially P through dust deposition) for some remote parts of the Mediterranean (e.g. the Ionian Basin in Spring and Summer). Our results suggest that the effects of atmospheric deposition are greater during intense deposition events occurring in the stratified period. The fertilizing effects of aerosols are visible in the areas of deposition and are quickly transmitted along the biological chain.



Average dust deposition in June (left) and corresponding surface enhancement of Chla concentration (right) (Camille Richon, on-going PhD, CEA-LSCE)

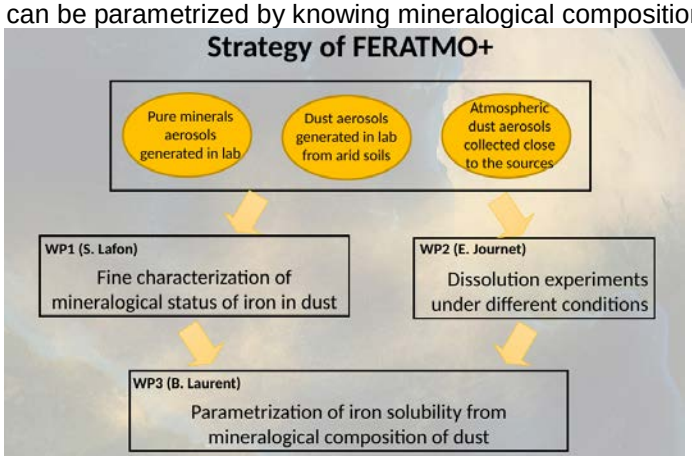
Impact of atmospheric iron from Saharan dust on *Crocosphaera watsonii* Violaine Jacq LOCEAN (violaine.jacq@locean-ipsl.upmc.fr) and col. (C Ridame, S L'helguen, K Desboeufs).
Diazotrophic cyano bacteria have an ecological advantage in N-Limited areas. The impact of atmospheric iron deposition on N_2 fixation is still poorly known. experiments were done with Fe limited *C. Watsonii WH8501* cultures. Artificial Saharan rain were added and a bioavailable iron release is seen. An increase of N_2 fixation is also observed (figure).



Increase in synthesis of enzymes involved in N_2 fixation and photosynthesis. Increase in CO_2 fixation rate per Chla inducing a more efficient photosynthesis. Saharan dust juice have an higher impact on N_2 fixation than on CO_2 fixation.

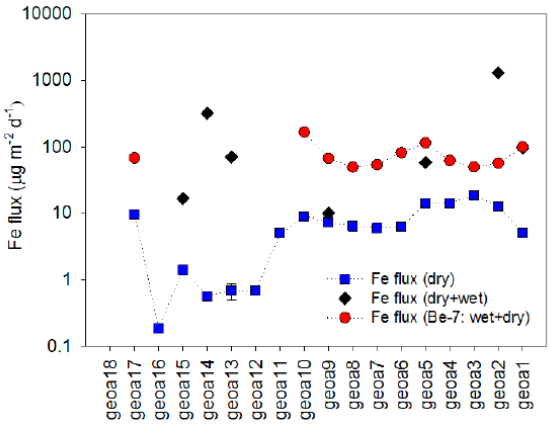
Role of the atmospheric contribution to the degradation process and stoichiometry of dissolved organic matter in the Mediterranean Sea. Kahina Djaoudi MIO (kahina.djaoudi@mio.osupytheas.fr) and col. (Elvira Pulido-Villena and France Van Wambeke).
It has become increasingly apparent that atmospheric transport plays an important role in the supply of macro and micro-nutrients to the surface ocean. This atmospheric input is especially important in oligotrophic regions where the vertical supply from the subsurface is low particularly during the stratification period. Compared to its inorganic counterpart, the organic fraction of atmospheric deposition and its impact on surface ocean biogeochemistry has been poorly explored. In the ocean, carbon export to depth (and therefore, its long term storage with presumed consequences on climate) occurs both through particle sedimentation and through the transfer of dissolved organic matter (DOM) via diffusion or convection. DOM export from the surface ocean represents up to 50% of total organic carbon flux to the deep ocean in oligotrophic regions such as the Mediterranean Sea. The efficiency of this C export pathway depends, among others, on the elemental C: N: P ratios of surface DOM which might be affected by the relative contribution of microbial processes and allochtonous sources such as atmospheric Inputs.

Dust mineralogical composition to study Iron nutrient solubility. FERATMO+ *project,* Emilie Journet LISA (emilie.journet@lisa.u-pec.fr) and col. (S. Lafon, M. Bandak, S. Nowak, S. Chevaillier, P. Ausset, B. Laurent).
Objective of FERATMO: The global objective is to describe iron dissolution processes from a mineralogical point of view in order to improve modeling of dissolved iron inputs to surface ocean: (i)How iron status and content in dust varies according to the dust mineralogy/source and particle size? (ii) What is the solubility of the different iron-bearing mineral found in dust? How solubility is sensible to the size particle? to the dissolution condition (pH, organic complexation, light...)? (iii) Are there iron status differences of freshly emitted dust play significantly on iron solubility? (iv) How solubility of iron dust can be parametrized by knowing mineralogical composition of dust?



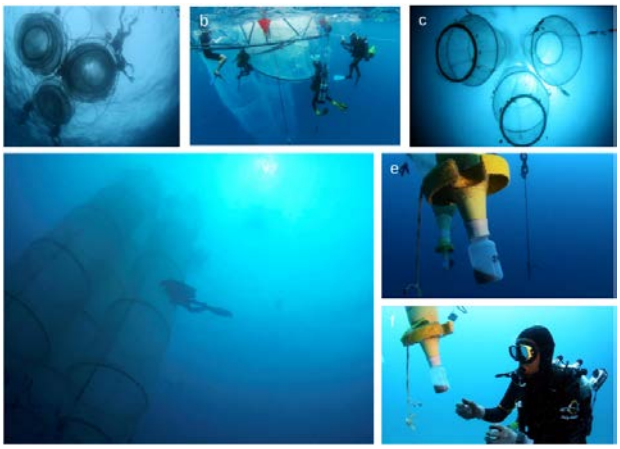
The final objective of this project is modeling the flux of dissolved iron from the mineral soil maps

Trace element composition, solubility and flux estimates of aerosols from contrasting regions of the North Atlantic Ocean. **GEOTRACES GA01** and offshore Senegal, Rachel Shelley LEMAR (rachel.shelley-@-univ-brest.fr) and col. (Geraldine Sarthou, Eric Machu, Habib Senghor, Muntsa Roca Marti, Pere Masque, Georges Tymen, Christophe Messager, Thomas Gorgues, Hamet Diadhiou, Patrice Brehmer).



Atmospheric deposition of aerosols is an important source of trace elements (TE) to the surface ocean. Aerosols contain both essential bioactive elements, e.g. Fe, Cu, Co, Zn, and pollution-derived elements which have no known biological role, e.g. Pb. In particular, the aerosol Fe flux is a key component of biogeochemical and ecosystem models. At present, TE flux estimates are poorly constrained. The largest contribution to this uncertainty results from the use of a fixed deposition velocity. In this study, we take a novel approach to estimate TE fluxes. Beryllium-7 (^{7}Be) is a cosmogenically-formed radioisotope ($T_{1/2}$=53 days). By multiplying the water column inventory of ^{7}Be activity with the TE/7Be ratio in the bulk aerosol we are able to significantly reduce the uncertainty of the flux estimates. As only a certain fraction of the aerosol TE are soluble (the most readily bioavailable fraction), it is of paramount importance to determine this fraction. To this end, samples were collected from two contrasting regions of the North Atlantic Ocean. Data is presented from the French-GEOTRACES cruise (GA01) which sampled a low aerosol regime (e.g. total aerosol Fe = 0.19-18.7 ng Fe m^{-3} air filtered), and from the AWA series of cruises (ECOAO, Upsen-2, AWA) off the coast of Senegal, under the Saharan plume with tropical influence (Fe = 52.4-3471ng Fe m^{-}3 air filtered). Aerosol-Fe solubility was lowest for the AWA samples (<0.5% soluble in DI water). However, what the combined effects of changing meteorological conditions, increasing industrialisation and land-use changes will have on aerosol solubility is largely unknown.

VAHINE project first publications in Biogeosciencs journal: VAriability of vertical and tropHIc transfer of diazotroph derived N in the south wEst Pacific. Sophie Bonnet (MIO, sophie.bonnet@univ-amu.fr).



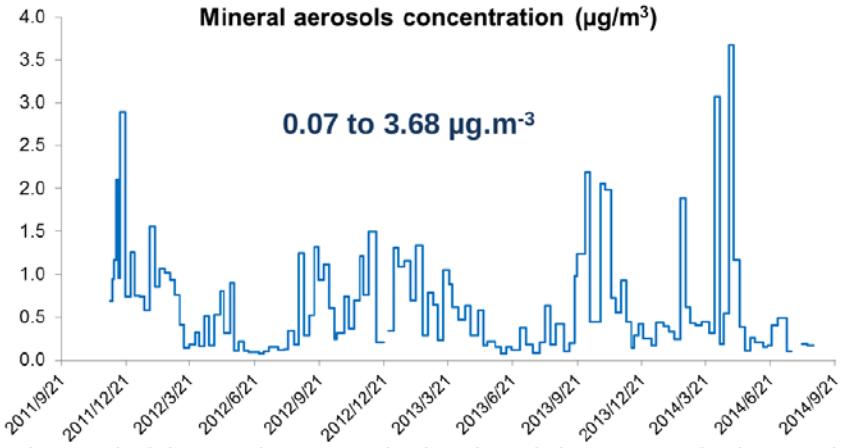
At the global scale, N_2 fixations provides the major external source of reactive nitrogen to the surface ocean, before atmospheric and riverine inputs, and sustains ~50 % of new primary production in oligotrophic environments. The main goal of the VAHINE project was to study the fate of nitrogen newly fixed by diazotrophs (or diazotroph-derived nitrogen) in oceanic food webs, how it impact heterotrophic bacteria, phytoplankton and zooplankton dynamics, stocks and fluxes of biogenic elements and particle export. Three large-volume (~50 m^{3}) mesocosms were deployed in a tropical oligotrophic ecosystem (the New Caledonia lagoon, south-eastern Pacific) and intentionally fertilized with ~0.8 µM of dissolved inorganic phosphorus (DIP) to stimulate diazotrophy and follow subsequent ecosystem and fluxes changes. VAHINE was a multidisciplinary project involving close collaborations between biogeochemists, molecular ecologist, chemists, marine opticians and modelers.

Starting the Polar Pod project (Severine Alvain, LOG, severine.alvain@cnrs.fr). **POLAR.POD** is a project lead by Dr. Jean Louis Etienne and his team that is developing a new oceanographic platform for sub-antarctic regions. The Southern ocean is a region of strong ocean-atmosphere interactions. Being a key region controlling heat and CO_2 flux between the ocean and the atmosphere, the Southern Ocean plays a major role in the regulation of global climate. POLAR.POD will be a tool dedicated to basic and applied research in the Southern Ocean with a capacity to host a wide variety of atmospheric and oceanic captors and samplers on a long term lasting. Its scientific program is described using four topics: 1) Air-Sea Exchange in the Southern Ocean, 2) Long-term monitoring of the Southern Ocean from remote sensing, 3) The biodiversity of the Southern Ocean and 4) Anthropic Impact.

***Seasonal cycles of air-sea CO_2 fluxes in the Southern Ocean: what do we learn from observations around Kerguelen*?** is a project conducted by Claire Lo Monaco (LOCEAN, claire.lomonaco@locean-ipsl.upmc.fr) and col. (N. Metzl, F. d'Ovidio, J. Llort, C. Ridame, R. Gomez, C. Mignon, V. Racapé , S. Blain et B. Quéguiner).

Iron, light and silicic acid availability are the main factors limiting the biological CO_2 uptake in the Southern Ocean (south of 50°S), leading to a small uptake of atmospheric CO_2 in this region (~0.1 PgC/yr). Iron fertilization experiments have demonstrated the potential for increased CO_2 uptake for short periods (a few weeks), but little is known about the seasonal evolution of biogeochemical cycles in iron-fertilized ecosystems. In the frame of the KEOPS2 and OISO projects, observations were collected in October-November 2011 over and downstream of the Kerguelen Plateau, allowing to investigate for the first time the mechanisms that control the oceanic CO_2 uptake at the onset of the blooming period. As soon as vertical mixing is reduced, we observed the rapid establishment of strong CO_2 sinks in waters fertilized with iron (up to -20 mmolC/m²/d). We then used all data available since 1991 to draw the seasonal evolution of air-sea CO_2 fluxes in different regions of Kerguelen's phytoplankton bloom. The impact of iron fertilization on the ocean CO_2 uptake is revealed by comparing estimates in the bloom (1-1.5 molC/m²/yr) and in the iron-poor waters (about 0.4 molC/m²/yr). Extrapolating these results to the large High-Nutrient Low-Chlorophyll area in the Southern Ocean (~50°S-60°S) suggests that iron fertilization may increase the uptake of atmospheric CO_2 by less than 0.1 PgC/yr, i.e., less than 1% of the current anthropogenic CO_2 emissions.

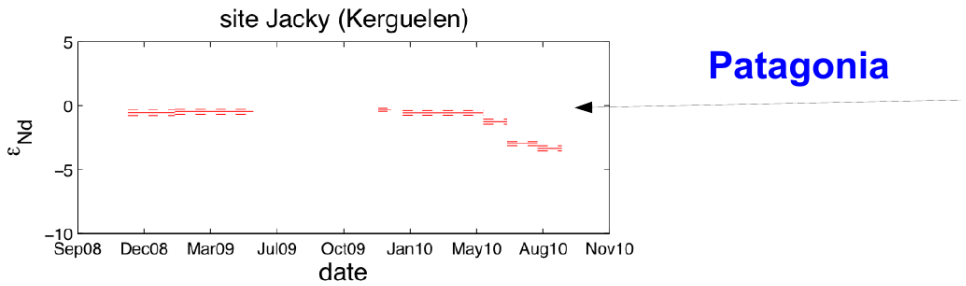
Airborne Aerosol time series at Rio Gallegos (Patagonia). **DFP** project, Zihan Qu LISA/IPGP (zihan.qu@lisa.u-pec.fr).



Patagonia (South America) is a major atmospheric mineral dust source in the South Hemisphere. The input of Patagonian dust plays a critical role in the biogeochemistry of Southern Ocean. From November 2011 to August 2014, aerosol samples were continuously collected on a weekly basis in Río Gallegos (69.32°W, 51.60°S), by the south Patagonia east coast. This three-year measurement is the first long term time series of mineral dust concentrations obtained in the sub-Antarctic region. Backward trajectories by HYSPLIT model showed that up to 90% of air mass arrived at Río Gallegos originated from the west side (between NNW and SSW) of sampling site. Amounts of Al, Si and Fe were determined by XRF analysis. The compositions of the three elements remained stable during the three years samplings. Weekly dust concentrations measured in South Patagonia varied from 0.07 to 3.68 µg.m-3 and reveals a strong seasonal variation pattern. Average winter dust concentrations could decrease down to five times lower than in other seasons. Higher wind speeds unexpectedly did not result in higher dust concentrations. However, variations of the

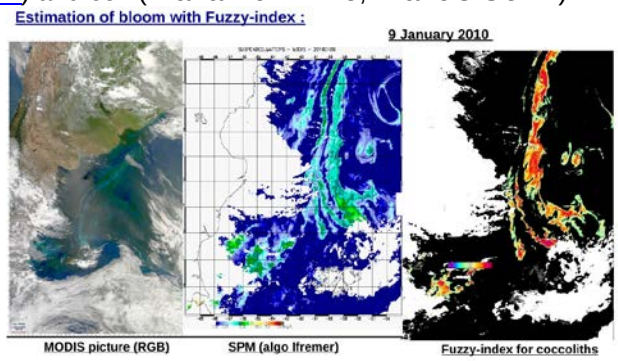
temperature and the air relative humidity correlated significantly with the dust concentration variation. This suggests that surface soil moisture changes are the primary regulating factor of dust concentration variation in Patagonia. Land frozen effect was potentially another factor resulting low level of dust concentration in winter. The temperature and relative humidity dependence of seasonal dust concentration variation implicate a feedback of dust emission in response to short term climate variations. Our results permit also the improvement of atmospheric dust modelling in the South Hemisphere.

From Patagonia to Kerguelen, dust transport. **FLATOCOA** and **DFP** project, Rémi Losno IPGP (losno@ipgp.fr) and col. (A Heimburger, A Cogez, F Monna and J Gaillardet)



Elemental and isotopic composition was measured at Kerguelen Island. Neodynium isotopic ratio patern bring a strong evidence of Patagonian origin of the deposited mineral material during spring, summer and winter time. A shift is observed during winter time that is probably caused by Southern African inputs.

Monitoring coccolithophores at a global scale from satellite data. Laurie Perrot, IFREMER (Laurie.Perrot@ifremer.fr) and col. (Diana Ruiz-Pino, Francis Gohin).



Calcareous phytoplankton group (coccolithophores) has an ubiquist repartition and is the main calcifying organism in the open ocean. At a global scale coccolithopore blooms are studied in regard of $CaCO_3$ production and three potential feedback on climate change: albedo modification by the way of dimethylsulfide (DMS) production and atmospheric CO_2 source by calcification and a CO_2 pump by photosynthesis. Contradictory assumptions were pointed out about the evolution of coccolithophore blooms during the anthropogenic era. At one hand, calcification and coccolithophores blooms extension could be decreasing as a consequence of acidification (pH decrease). At the contrary an extension and an increase of blooms and propagation to high latitudes have been pointed out by recently studies. The remote-sensing approach based on Ocean Colour data give us a large temporal and spatial view allowing us to understand the phenology of these calcareous phytoplankton blooms. Determination of the trend of blooms, from satellite data, in a long term view (inter-annual variability), needs the discrimination of the coccolithophore signal from other active materials, such as mineral particles (Suspended Particulate Matter SPM) mainly in coastal waters. To detect coccolithophores from satellite reflectance and overcome the induced noise in the signal calcareous phytoplankton SPM signal we developed a method based on fuzzy mathematical scheme principles. It uses as input the 6 wave lengths of colour satellite reflectance signal of the SeaWifs and MODIS satellite and extracted from the SPM signal the associated signal of coccolithophores. The calibration of the algorithm is made from Suspended Particulate Matter (SPM) concentration derived from SeaWiFS (1998-2002) and MODIS (2003-2014) reflectance obtained in a region of strong bloom of coccolithophores: North-East Atlantic ocean. The algorithm is calibrated with in-situ taxonomic data obtained during the years 98 and 99.The SPM concentration derived from the semi-analytical algorithm appear to be well correlated to the coccolithophores mass derived from the NASA calcite algorithm. Although a regular pattern in the phenology of the North east Atlantic blooms is observed, starting south in April and moving

northwards until July, there is a high temporal (seasonal and inter-annual) variability in the blooms extension. To be used at global scale and for the long trend studies the method has to be validate in other oceanic region where in-situ observation of coccolithophores has been obtained. This method applied to the reflectance of chlorophyll pixels could provide a daily and quantitative variability of other groups of phytoplankton as a function of their spectral reflectance.

Oxygen Minimum Zone (OMZ) dynamics in the context of the ocean deoxygenation: the case off Peru. The **AMOP** (Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific) project, Aurélien Paulmier LEGOS, Toulouse (aurelien.paulmier@gmail.com) and col. (M Bretagnon, B Dewitte, V Garcon, C Maes, F Campos, A Franco-Garcia, K Mosquera, O Vergara, C Barus, L Coppola, E Carrasco, O Depretz-De-Gesincourt, G Eldin, E Garcia-Robledo, J Grelet, S Illig, I Montes, N Leblond, A Oschlies, J Quispe, J Sudre).
Oxygen Minimum Zones (OMZs), defined as suboxic (O_2 <20 µmol/L) subsurface layer and mainly associated with Eastern Boundary Upwelling Systems (EBUS), would contract and expand during cold and warming periods, respectively. In the current context of the ocean deoxygenation, OMZs are known to play a key-role on the evolution of climate (greenhouse gases) and on the ecosystems and fisheries (nitrogen loss, respiratory barrier, sulfidic events) at both local and global scales. The objective of AMOP project ("Activties of research dedicated to the Minimum of Oxygen in the eastern Pacific")is to carry out a complete O_2 budget off Peru considering physical (advection/diffusion) and biological (O_2 consumption/production) contributions. The central hypothesis is that the physical and biogeochemical O_2 contribution to the OMZ maintaining and variability depends on the different OMZ layers, in particular the oxycline which would be the engine of an intense but intermittent biogeochemical and ecosystem activity. The project is focused in one of the most intense and shallow OMZs associated with the most productive upwelling system (10 % of the world fisheries), the Peruvian OMZ. The trans-disciplinary approach is based on: a cruise (January-February 2014; in the Peruvian OMZ) focused on 8 fixed stations (~54 h) on 3 transects at 7°S, 12°S and 14°S with the RV Atalante associated with an effort of experimental development (instrumentation, sensors: Argo-floats experiments; drifting lines; a trimaran dedicated to ocean-atmosphere exchanges, OCARINA; nanomolar O_2 measurements); a monitoring (2013-2014) mooring at 12°S at 30 nm from the coast; a complementary high resolution regional coupled modeling platform integrating the different spatio-temporal scales. This French-Peruvian-German project involving 5 other countries (~90 participants) is viewed as one of the main pilot projects of the SOLAS Mid Term Strategy Initiative on OMZ-EBUS. Preliminary results, in particular from recent high frequency (15-30 min) mooring data complemented with models simulations show a intra-annual variability of the OMZ dynamics associated with the productivity and environmental forcing (i.e. tide, wind-forced upwelling, meso-scale activity and equatorial Kelvin wave). For the first time, three main regimes of variability have been reported (sub-daily: < 1 day; sub-monthly: 1-30 days; sub-seasonal: 30-90 days), which should be taken into account for the validation of regional models and the interpretation of the evolution of marine resources along the coast of Peru. Cruise and fixed and drifting sediment traps core parameters (including O2 and nutrients, organic matter, and respiratory rates from incubations) will be analysed in order to estimates the physical and biogeochemical contributions to the OMZ dynamics. In particular, the influence of the phytoplankton on the OMZ and of the OMZ on the organic matter quantity and quality will be explored.

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

Benetti M, Aloisi G, Reverdin G, Risi C and Sèze G (2015), Importance of boundary layer mixing for the isotopic composition of surface vapor over the subtropical North Atlantic Ocean. *Journal of Geophysical Research: Atmospheres*, 120(6), 2190-2209.

Bettencourt J, López C, Hernández-García E, Montes I, Sudre J, Dewitte B, Paulmier A and Garçon V (2015), Boundaries of the Peruvian Oxygen Minimum Zone shaped by coherent mesoscale dynamics, *Nature Geoscience*, 8, 937-940, doi:10.1038/ngeo2570

Bonnet S, Rodier M, Turk-Kubo K, Germineaud C, Menkes C, Ganachaud A, Cravatte S, Raimbault P, Campbell E, Quéroué F, Sarthou G, Desnues A, Maes C and Eldin G (2015), Contrasted geographical distribution of N2 fixation rates and nifH phylotypes in the Coral and Solomon Seas (southwestern Pacific) during austral winter conditions, *Global Biogeochemical Cycles*,

10.1002/2015GB005117.

Brown CW, Boutin J, and Merlivat L (2015), New insights of pCO2 variability in the tropical eastern Pacific Ocean using SMOS SSS, Biogeosciences, 12, 7315–7329.

Merlivat L, Boutin J, Antoine D (2015) Roles of biological and physical processes in driving seasonal air-sea CO2 flux in the Southern Ocean: New insights from CARIOCA pCO2, J. Mar. Syst.147,9-20, http://dx.doi.org/10.1016/j.jmarsys.2014.04.015

Merlivat L., Boutin J, and d'Ovidio F (2015), Carbon, oxygen and biological productivity in the Southern Ocean in and out the Kerguelen plume: CARIOCA drifter results, Biogeosciences, 12(11), 3513-3524.

Nozière B, Kalberer M, Claeys M, Allan J, D'Anna B, Decesari S, Finessi E, Glasius M, Grgic I, Hamilton J, Hoffmann T, Iinuma Y, Jaoui M, Kahnt A, Kampf C J, Kiss G, Kourtchev I, Maenhaut W, Saarikoski S, Schnelle-Kreis J, Stephanou E G, Surratt J D, Szidat S, Szmigielski R, Wisthaler A (2015), The Molecular Identification of Organic Compounds in the Atmosphere: State of the Art and Challenges, *Chemical Reviews , special issue "Chemistry in Climate"*, 115, 3919.

Schwier AN, Rose C, Asmi E, Ebling AM, Landing WM, Marro S, Pedrotti ML, Sallon A, Luculano F, Agusti S, Tsiola A, Pitta P, Louis J, Guieu C, Gazeau F and Sellegri K (2015), Primary marine aerosol emissions from the Mediterranean Sea during pre-bloom and oligotrophic conditions: correlations to seawater chlorophyll-a from a mesocosm study, *Atmospheric Chemistry and Physic*, 15, 7961-7976, doi:10.5194/acp-15-7961-2015.

S. Sobanska, J. Barbillat, M. Moreau, N. Nuns, I. De Waele, D. Petitprez,Y. Tobona and C. Brémard (2015) Influence of stearic acid coating of the NaCl surface on the reactivity with NO2 under humidity, Phys. Chem. Chem. Phys., 17, 10963-10977.

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.)

End of VAHINE project and special issue in Biogeosciences (diazotrophy)

PLAR.POD launching and experiments on Southern Ocean

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

SOLAS-France meeting will become an annual meeting held in June or July

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')

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)

- Southern Ocean as a key point for climate control, including air-sea exchange and biogeochemistry, including POLAR.POD as a new tool.

- Atmospheric deposition to the oceans
  - Volcanic ashes supplying nutrients to the surface ocean
  - More investigations on ^{7}Be results for atmospheric deposition measurements
  - Improving our knowledge on atmospheric deposition of macro and micro nutrients into the ocean surface.
  - Working on the mutual influence of dust particles and plankton excretions in the organic carbon export.
  - Using mineral soil maps to model atmospheric dissolved iron flux at a global scale

- Focussing model and experimental integration at the Mediterranean basin scale.

- Work on marine atmospheric organic carbon chemistry and oceanic DOM including relationship with dust deposition, experimental developments for surfactants determination.

- Satellite remote sensing determination of phytoplanktonic species.

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

Close collaborations from SOLAS participants with former IMBER and IGAC community, implication in the global policy of Future Earth organization

Comments

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS <u>your country</u> *compiled by:*_____

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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PART 1 - Activities from January 2015 to December 2015

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.

Example to be deleted:

Glyoxal and methyl glyoxal over the Southern Hemisphere oceans

Dicarbonyls glyoxal and methylglyoxal have been measured in clean marine air over the temperate Southern Hemisphere oceans, both during the SOLAS-endorsed Surface Ocean Aerosol Production (SOAP) Voyage in the South West Pacific, and at Cape Grim Baseline Station [1]. Both are present in non-negligible mixing ratios, even in pristine marine air, suggesting the likely widespread contribution of these gases to secondary organic aerosol production over the oceans. This is the first study to measure a range of dicarbonyl precursors (VOCs), including isoprene and monoterpenes over the ocean in parallel with the dicarbonyls, allowing the expected yield of dicarbonyls to be determined. At most only 29% of the observed glyoxal and methylglyoxal can be explained from the measured precursors; this supports suggestions from other studies that there must be another major source contributing to formation of the glyoxal, and we show for the first time that another source must also be contributing to methylglyoxal formation.

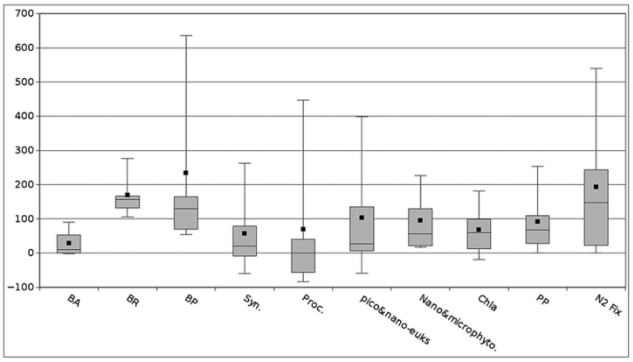

Figure: Seasonal glyoxal VCDs retrieved from GOME-2 and calculated from surface based observations at Cape Grim and Chatham Rise.

In situ glyoxal observations were converted to vertical column densities (VCDs) and show that GOME-2 satellite VCDS are significantly higher than those calculated from in situ observations. This discrepancy may be due to the incorrect assumption that all glyoxal observed by satellite is within the boundary layer, or may be due to challenges retrieving low VCDs of glyoxal over the

oceans due to interferences by liquid water absorption, or use of an inappropriate normalisation reference value in the retrieval algorithm. This study provides much needed data to verify the presence of these short lived gases over the remote ocean and provide further evidence of an as yet unidentified source of both glyoxal and also methylglyoxal over the remote oceans.

Lawson, S.J., Selleck, P.W., Galbally, I.E., Keywood, M.D., Harvey, M.J., Lerot, C., Helmig, D. and Ristovski, Z., Seasonal in situ observations of glyoxal and methylglyoxal over the temperate oceans of the Southern Hemisphere Atmos. Chem. Phys. Discuss., 14, 21659–21708, 2014

2. Activities/main accomplishments in 2015 (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.)

3. Top 5 publications in 2015 (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.

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.)

SCOR WG#143: N2O/CH4 inter-comparison cruise, Baltic Sea, Oct. 2016 (PI: G. Rehder, IOW)

R/V Sonne cruise to the Arabian Sea, early 2018, PI: Birgit Gaye, U Hamburg

R/V Sonne cruise (GEOTRACES) to the Southern Indian Ocean, 2017/2018, PI: Eric Achterberg, GEOMAR

R/V Meteor cruise (SFB754) to the Peru upwelling, June/July 2017; PIs: H. Bange, C. Löscher, GEOMAR

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

Boknis Eck Time-Series Station: 60th Anniversary, Workshop, Kiel, Spring 2017, PI: HBange, GEOMAR)

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')

- **SFB754 'Climate-biogeochemical interactions in tropical oceans', Phase III, www.sfb754.de -> SOLAS Integrated Topic Upwelling**
- **AlantOS, Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems, www.atlantos-h2020.eu -> SOLAS Theme 1**
- **ICOS-D, German Integrated Carbon Observation System, http://www.icos-infrastruktur.de/index.php?id=7868 -> SOLAS Theme 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)

- **Integrated German Indian Ocean Study, proposal in preparation for BMBF or DFG, submission 2016/17.**

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**
- **and many more**

International Organisations

- **IPCC**
- **and many more**

Comments

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS INDIA *compiled by:_VVSS Sarma_____*

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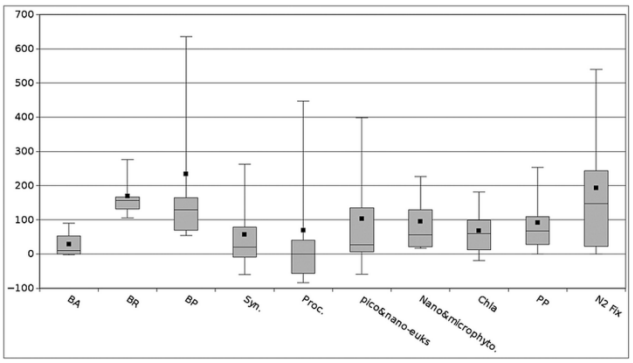

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In situ glyoxal observations were converted to vertical column densities (VCDs) and show that GOME-2 satellite VCDS are significantly higher than those calculated from in situ observations. This discrepancy may be due to the incorrect assumption that all glyoxal observed by satellite is within the boundary layer, or may be due to challenges retrieving low VCDs of glyoxal over the

oceans due to interferences by liquid water absorption, or use of an inappropriate normalisation reference value in the retrieval algorithm. This study provides much needed data to verify the presence of these short lived gases over the remote ocean and provide further evidence of an as yet unidentified source of both glyoxal and also methylglyoxal over the remote oceans.

Lawson, S.J., Selleck, P.W., Galbally, I.E., Keywood, M.D., Harvey, M.J., Lerot, C., Helmig, D. and Ristovski, Z., Seasonal in situ observations of glyoxal and methylglyoxal over the temperate oceans of the Southern Hemisphere Atmos. Chem. Phys. Discuss., 14, 21659–21708, 2014

2. Activities/main accomplishments in 2015 (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 cruises have been undertaken in the northern Indian Ocean by ORV Sindhu Sankalp and ORV Sagar Kanya to collect atmospheric aerosol and upper water column sampling.

3. Top 5 publications in 2015 (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.

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.)

1. Mesocosm experiments have been planned along the east coast of India in the Bay of Bengal to examine the influence of atmospheric dust driven nutrients on the coastal ecosystem
2. Ecosystem response in the temperature and salinity frontal zone is proposed to examine in the northern Indian Ocean during winter/spring when significant number of short-lived fronts are formed
3. Simultaneous collection of atmospheric dust and surface water column is proposed to measure to examine the influence of atmospheric dust (mainly sulfates and nitrates) on surface ocean acidification.

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

NA

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')

GEOTRACES project is planned to complete by March 2017. We discussed with Ministry to extend this for additional five years (2017-2022). Some discussions are underway and brainstorming discussions are planned to conduct in June 2016. In which SOLAS related work is also included.

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 project on "Land-Ocean-Atmosphere interactions and biogeochemical and ecosystem responses" was proposed to Council of Scientific and Industrial Research (CSIR) for possible funding and decision is yet to receive.

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

GEOTRACES, SIBER programs.

Comments

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS Ireland *compiled by: Brian Ward*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

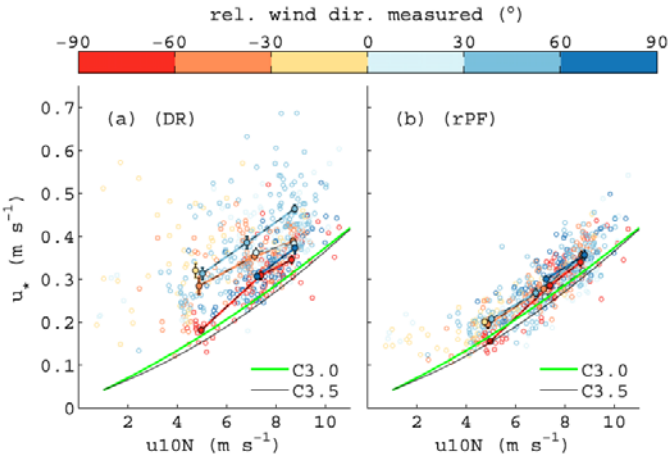
PART 1 - Activities from January 2015 to December 2015

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.

Example to be deleted:
Direct flux measurements from mobile platforms at sea

Ship-based measurements of wind speed and direct fluxes are affected by airflow distortion that can lead to a tilt of the wind vector as well as acceleration or deceleration of the wind speed. Direct flux measurements are additionally affected by the fluctuating velocity of the platform. The classic approach is to first correct the wind speed for angular and translational platform velocities and



Direct measurements of **u*** as a function of **u**10N and the measured relative wind direction: (a) results obtained using the standard motion correction and rotation into the stream and (b) results using the new improved method.

thereafter rotate the wind vector into the mean flow. This study finds that for ships under way, this leads to an overestimation of the vector tilt and biased flux estimates. This may explain the

common observation that flux estimates from ships in transit have lower quality than measurements taken on station. Here an alternative approach is presented, where the flow-distortion-induced tilt of the wind vector is estimated from the 3D wind speed measurements and applied to the apparent wind vector. The tilt correction is carried out after correction for the fluctuating part of the platform velocity but before removing the ship's mean translational velocity. This new method significantly improved the agreement of direct momentum flux measurements made from a ship under way with the parameterization of the COARE3.5 bulk model. The sensitivity of the eddy covariance measurements of momentum and scalar fluxes to the choice of the tilt-motion correction method is analyzed, and this study proposes that a reanalysis of previous direct flux measurements with the new method discussed here can improve researchers' understanding of air–sea interaction.

Landwehr, S., N. O'Sullivan, and B. Ward, 2015. Direct flux measurements from mobile platforms at sea: Motion and air flow distortion corrections revisited. J. Atmos. Oceanic Technol. , 32 :1163–1178. doi:10.1175/JTECH-D-14-00137.1

2. Activities/main accomplishments in 2015 (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.)

- BW: Oilbay Experiment: Study of the impact on oil on surface waves and turbulence in August 2015 in Galway Bay.

- BW: Svalbard: Study of wave dampening due to the presence of ice (March 2015)

- BW: Participation in the 4th WCRP Data Advisory Council in Reading UK (July 2015)

- BW: Participation in the Southern Ocean Air-Sea Fluxes workshop in Frascati (September 2015)

- TMG: Post-doctoral Project: Biogeochemical cycling of carbon and nutrients in Irish marine and estuarine waters (NUIG funded by the Marine Institute and EPA). Sampling and analysis from project complete and dataset of seasonal and temporal inorganic carbon and nutrients produced for three inshore sites.

- TMG: Research survey completed in February 2015 where a range of biogeochemical parameters (dissolved inorganic carbon, total alkalinity, inorganic nutrients, oxygen, salinity) were sampled in Irish coastal waters (Dublin north about to Galway).

- TMG: Continued international collaboration with National Oceanographic Centre, Southampton on the UK Shelf Sea Biogeochemistry Project.

3. Top 5 publications in 2015 (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.

O'Dowd, C,Ceburnis, D,Ovadnevaite, J,Bialek, J,Stengel, DB,Zacharias, M,Nitschke, U,Connan, S,Rinaldi, M,Fuzzi, S,Decesari, S,Facchini, MC,Marullo, S,Santoleri, R,Dell'Anno, A,Corinaldesi, C,Tangherlini, M,Danovaro, R, Connecting marine productivity to sea-spray via microscale biological proceses: Phytoplankton Dance or Death Disco? *Nature Scientific Reports*, DOI 10.1038/srep14883, (2015).

Walesby, K., J. Vialard, P. Minnett, A. Callaghan, and B. Ward, 2015. Observations indicative of rain-induced double diffusion in the ocean surface boundary layer. Geophys. Res. Lett. , 42 . doi:10.1002/2015GL063506

Wain, D. J., J. Lilly, A. H. Callaghan, I. Yashayaev, and B.Ward, 2015. A breaking internal wave in

the surface ocean boundary layer. J. Geophys. Res. , 120 . doi:10/6p8

McGrath, T., McGovern, E., Cave, R. and Kivimäe, C. 2015. The Inorganic Carbon Chemistry in Coastal and Shelf Waters Around Ireland. *Estuaries and Coasts*, 1-13, DOI: 10.1007/s12237-015-9950-6.

U. Nitschke*, S. Dixneuf, M. Schmid, A.A. Ruth, D.B. Stengel, "Contribution of living and degrading kelp to coastal iodine fluxes", Mar. Biol. 162 (2015) 1727-1738.

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.)

- BW: participation in the Retrospect experiment in a Norwegian fjord to study air-sea fluxes and their dependency on waves and turbulence (April 2016)

- BW: Experiment in Svalbard to study the impact of ice on the wave field

- TMG: Post-doctoral Project: Biogeochemical cycling of carbon and nutrients in Irish marine and estuarine waters (NUIG funded by the Marine Institute and EPA). This project will continue until August 2016. Results from the project are being prepared for publication.

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

- BW: Whitecap conference to be held at NUIG in 2016/2017

- BW: ESA/SOLAS workshop on remote sensing (June 2016)

- BW: Keynote address at the ESA/SOLAS project Oceanflux (September 2016)

- TMG: TEDx presentation at TEDx Fulbright Dublin event, February 2016. https://www.youtube.com/watch?v=8m1X26Auw6Q

- TMG: Quasimeme Workshop on Ocean Acidification, Southampton, February 2016. Poster: Trends of ocean acidification in the NE Atlantic.

- TMG: Marine Chemistry Working Group, March 2016. Oral presentation: The inorganic carbon chemistry in in Irish coastal, shelf and offshore waters.

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')

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)

- BW: Possible proposal to ESA for Southern Ocean flux study 2017

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

- BW: WCRP Data Advisory Council
- BW: WDAC Surface Fluxes Task team
- BW: Steering Committee on Souther Ocean Air-Sea Fluxes

Comments

Contributors:
Brian Ward (BW)
Triona Mcgrath (TMG)
Colin O'Dowd (COD)
Andy Ruth (AR)

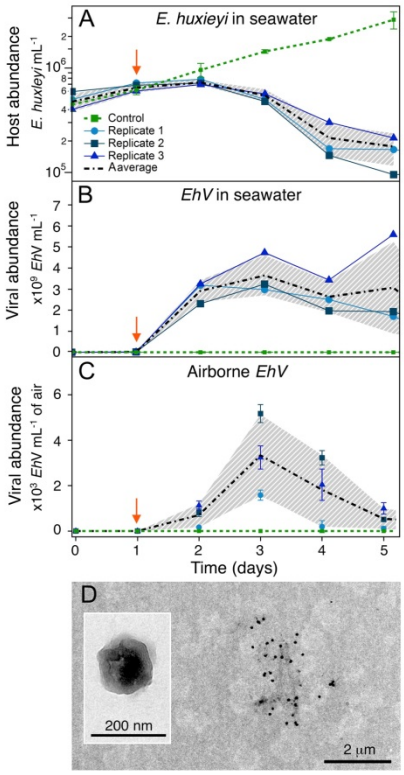
surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS Israel ***compiled by: Yoav Lehahn***

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight



Infection of bloom-forming phytoplankton by aerosolized marine viruses

Marine viruses constitute a major ecological and evolutionary driving force in the marine ecosystems, however their dispersal mechanisms remain underexplored. Here we follow the dynamics of Emiliania huxleyi viruses (EhV) that infect the ubiquitous, bloom-forming phytoplankton E. huxleyi, and show that EhV are emitted to the atmosphere as primary marine aerosols. Using a laboratory-based setup, we showed that the dynamic of EhV aerial emission is strongly coupled to the host- virus dynamic in the culture media. In addition, we recovered EhV DNA from atmospheric samples collected over an E. huxleyi bloom in the North Atlantic, providing evidence for aerosolization of marine viruses in their natural environment. Decay rate analysis in the lab revealed that aerosolized viruses can remain infective under meteorological conditions prevailing during E. huxleyi blooms in the ocean, allowing potential dispersal and infectivity over hundreds of kilometers. Based on the combined lab and in situ findings, we propose that atmospheric transport of EhV is an effective transmission vector for spreading viral infection over large areas in the ocean. This transmission vector may also have an important ecological impact on the the large scale host-virus "arms race" during bloom succession and consequently the turn-over of carbon in the ocean. For further information see Sharoni et al., 2015.

Figure: *E. huxleyi host abundance (A) and EhV abundance (B) in the culture media, and EhV abundance in the collected aerosols (C). The red arrows represent the time of viral addition to the culture media. The average of three replicates (blue lines) is presented by the dashed black line. The shadowed area represents the standard deviation of the three replicates' average. The green line is the control experiment using a non-infected E. huxleyi culture. (D) Aggregates of EhV collected from aerosols emitted from the infected culture.*

2. Activities/main accomplishments in 2015 (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[1], etc.)

Important advancement in SOLAS research in Israel is the implementation of new facilities for systematic sampling the oceanin mixed layer, by IOLR Israel Oceanographic and Limnology Research (IOLR) researcher. Using a “Harvey (1965)” like drum sampler, the scientists are able to collect high volumes (0.2-2L) of the top layer from >50m length water transects. High volumes are crucial for marine organic material concentration and chemical analysis such as GC/MS and LC/MS.

A major part of SOLAS-Israel research focuse on the Mediterranean, and especially on it eastern basin. Researchers from IOLR have shown a diverse microbial community associated with dust and other aerosol particles in the region, which differed significantly according to their geographical air mass origin. Using microcosm bioassay experiments, in which aerosols were added to sterile (0.2 µm filtered and autoclaved) SE Mediterranean Sea (SEMS) water, the researchers show that dust/aerosol deposition can be a potential source of a wide array of microorganisms, which may impact microbial composition and food web dynamics in oligotrophic marine systems such as the SEMS. On a different direction, using continuous satellite-derived sea surface temperature and elevation collected over the last 21 years, researchers from the Hebrew Unversity of Jerusalem have shown that the hypothesis that the Eastern Mediterranean upper layer heat content in fall impact winter precipitation over Israel.

On April 2015 we had a first meeting of scientists associated with SOLAS-Israel, with the goals of establishing a scientific network and identifying possibilities for financing SOLAS-related project. The meeting was a satellite event of the annual conference of the Israeli Association of Aquatic Sciences.

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

1. Rahav, E., G. Ovadia, A. Paytan, and B. Herut (2016), Contribution of airborne microbes to bacterial production and N2 fixation in seawater upon aerosol deposition. Geophys. Res. Lett. 43: 1–9. doi:10.1002/2015GL066898.
2. Sharoni, S., M. Trainic, D. Schatz, Y. Lehahn, J. M. Flores, S. Ben Dor, Y. Rudich, I. Koren and A. Vardi (2015), Infection of bloom-forming phytoplankton by aerosolized marine viruses, Proc. Natl. Acad. Sci. USA 112, 6643-6647.
3. Belkin, N., Rahav, E., Elifantz, H., Kress, N., and Berman-Frank, I. (2015), Enhanced salinities, as a proxy of seawater desalination discharges, impact coastal microbial communities of the eastern Mediterranean Sea. *Environmental Microbiology*, DOI: 10.1111/1462-2920.12979.
4. Gross, A., T. Goren, C. Pio, J. Cardoso, O. Tirosh, M.C. Todd, D. Rosenfeld, T. Weiner, D. Custódio, and A. Angert (2015), Variability in sources and concentrations of Saharan dust phosphorus over the Atlantic ocean*, Environmental Science & Technology Letters 2* (2), 31-3.
5. Gufan A, Lehahn Y, Fredj E, Price C, Kurchin R & Koren I. (2016) Segmentation and Tracking of Marine Cellular Clouds observed by Geostationary Satellites, *International Journal of Remote Sensing, 37:5,* 1055-1068*.*

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.)

SOLAS-Israel is facing a new era in terms of the capacity to curry out field campaigns and to collect oceanic data in the Mediterranean. This improvement in capabilities is associated with the implementation of three gliders, and with the launching of a new advanced research vessel. The gliders project involve researchers from several instuiutes, including Israel Oceanographic and Limnology Research (IOLR), Weizmann Institute of Science, The Hebrew University and Bar Ilan

University. Both the gliders and the new research vessel will be operated by the IOLR staff.

In addition, researchers from IOLR and Weizmann institute develop advanced capabilities in simulating, measuring and analyzing fluxes of biological matter across the ocean-atmosphere interface, which opens the way to exciting SOLAS research projects.

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

In the coming year we plan to continue with the emerging tradition of having an annul SOLAS-Israel meeting. Similar to our previous gathering, the meeting, which is aimed at interdisciplinary exchange of ideas and knowledge on SOLAS-related issues, will be a satellite event of the annual IAAS meeting.

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')

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)

Scientists from the Weizmann Institute of Science have started a collaboration with the Tara-ocean project, and will participate in the coming campaign at the Pacific Ocean. The Weizmann group will implement aerosol sampling systems, with the goal of studying properties of marine boundary layer aerosols and relating them to changes in oceanic and atmospheric conditions.

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS ITALY *compiled by:_ Chiara Santinelli_____*

Please note that this report has two parts!

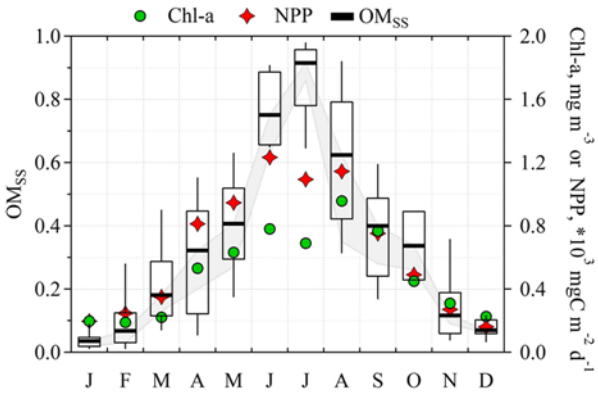
Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

Connecting marine productivity to sea-spray via nanoscale biological processes: Phytoplankton Dance or Death Disco?

Bursting bubbles at the ocean-surface produce airborne salt-water spray-droplets, in turn, forming climate-cooling marine haze and cloud layers. The reflectance and ultimate cooling effect of these layers is determined by the spray's water-uptake properties that are modified through entrainment of ocean-surface organic matter (OM) into the airborne droplets. In the newly published paper (O'Dowd et al., 2015), we presented new results illustrating a clear dependence of OM mass-fraction enrichment in sea spray (OM_{SS}) on both phytoplankton-biomass, determined from Chlorophyll-*a* (Chl-*a*), and Net Primary Productivity (NPP). The correlation coefficient for OM_{SS} as a function of Chl-*a* increased form 0.67 on a daily timescale to 0.85 on a monthly timescale. An even stronger correlation was found as a function of NPP, increasing to 0.93 on a monthly timescale. We suggest the observed dependence is through the demise of the bloom, driven by nanoscale biological processes (such as viral infections), releasing large quantities of transferable OM, comprising cell debris, exudates and other colloidal materials. This OM, through aggregation processes, leads to enrichment in sea-spray, thus demonstrating an important coupling between biologically-driven plankton bloom termination, marine productivity and sea-spray modification with potentially significant climate impacts. The Figure shows the seasonal variability of OM_{SS} at Mace Head and its relation with Chl-*a* and NPP.

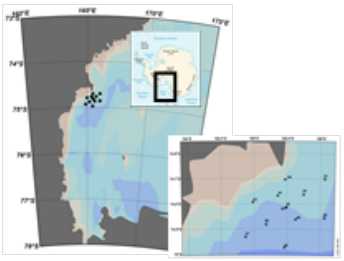


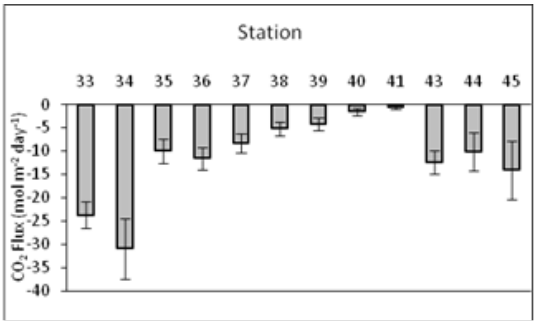
OMss, NPP and Chl-a annual cycle. Bold lines represent median concentrations, boxes- 25–75% percentile and whiskers demonstrate 10–90% percentile. Grey area represents a reduction in primary OM_{SS} due to possible secondary OM contribution to total organics. The secondary OM contribution was derived from data presented in Ceburnis et al. (2014) and ranges from 22% to 74% depending on the month.

O'Dowd, C.D., D. Ceburnis, J. Ovadnevaite, J. Bialek, D. B. Stengel, M. Zacharias, U. Nitschke, S.Connan, M. Rinaldi, S. Fuzzi, S. Decesari, M. C. Facchini, S. Marullo, R. Santoleri, A. Dell'Anno, C. Corinaldesi, M. Tangherlini and R. Danovaro, Connecting marine productivity to sea-spray via nanoscale biological proceses: Phytoplankton Dance or Death Disco? Scientific Reports, Volume 5, 14 October 2015, Article number 14883.

Physical and biological forcing of mesoscale variability in the carbonate system of the Ross Sea (Antarctica)

Data analysis of the surface water carbonate system properties, collected in the 2014 PNRA cruise in the Ross Sea, document substantial spatial heterogeneity and complexity of the system and the magnitude of the CO_2 flux at a horizontal length scale of about 10 km, emphasizing the importance of mesoscale events to regional biogeochemistry of the Southern Ocean. The investigated coastal region overall acted as a sink of CO_2, with respect to the measured atmospheric CO_2 with fluxes ranging from −0.5 ± 0.4 to −31.0 ± 6.4 mmol m^{-2} d^{-1}. The CO_2 flux was controlled primarily by phytoplankton activity rather than physical forcing, which, on the other hand, created the favorable conditions for the phytoplankton growth. This is confirmed by the fact that the greatest air–sea CO_2 disequilibrium (ΔpCO_2) occurred at those stations where O_2 supersaturation (112–113%) and high pH values (8.42) were recorded. Nevertheless, as wind speed is the main driver of the air–sea flux, together with the ΔpCO_2, the lowest fluxes were calculated for those stations characterized by the weaker hourly averaged winds.





Calculated CO_2 flux (mol m^{-2} day^{-1}) in the coastal area of the Ross Sea (Antarctica) investigated by the RoME Project during the austral summer 2014

Rivaro, P., Ianni, C., Langone, L., Ori, C., Aulicino, G., Cotroneo, Y., Saggiomo, M., Mangoni, O., Physical and biological forcing of mesoscale variability in the carbonate system of the Ross Sea (Antarctica) during summer 2014. Journal of marine system, http://dx.doi.org/10.1016/j.jmarsys.2015.11.002, 2015.

2. Activities/main accomplishments in 2015 (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. **EVENTS**

- **IMBER** (Integrated Marine Biogeochemistry and Ecosystem research) **IMBIZO IV** workshop on Marine and human systems: Addressing multiple scales and multiple stressors was held from October 26th to 30th 2015, at OGS, Trieste, Italy

2. **CRUISES**

- **COSIMO** 2015, R/V URANIA (CNR), April 10th to 29th 2014, CNR-ISAC, Roma (Chief scientist, Dr. F. Falcini). Main goals of the cruise: (1) Characterization of bio-optical properties of the Adriatic Sea; (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.
- **MARINE STRATEGY** 2015, R/V MINERVA2 (CNR) November 4th to 22nd 2015, DTA-CNR. Main goals of the cruise: (1) fill up knowledge gaps on biological parameters in Mediterranean areas; (2) Monitoring plankton in offshore environments (MSFD, Activity 1.7); (3) monitoring the physical and chemical variables and nutrients (MSDF: activity 1.3). Assessment Areas: South Adriatic and Ionian Seas.
- **ARCA** 2015, R/V TEISTEN, June 16th to 29th 2015, CNR-IAMC, Messina (Chief scientist, Dr. M. Azzaro). Main goals of the cruise: (1) Study of microbial and chemical parameters in

the surface microlayer of the Kongsfjorden (Svalbard); (2) automatization of the sampling process in extreme conditions (e.g. in proximity of a glacier) with a specifically developed automatic water multisampler.

- **CEFA/PNRA** 2015, pack ice hole and rubber dinghy, October 2015-January 2016, CNR-IAMC, Messina. Main goals of the field campaign: (1) monitoring the evolution of microbial communities living in the coastal surface layer of Terra Nova Bay (Antarctica); (2) assessing the biogeochemical signatures in a changing environment.
- **ESAW-1**, Evolution and spreading of Southern Adriatic Waters, Eurofleet2, R/V BIOS DVA (Croatia), December 10th-15th 2015, OGS Trieste (Chief Scientist: V. Kovacevic). Main goals of the cruise: (1) to study the hydrographic and biogeochemical properties (with a special focus to carbon) along two shore to shore sections (Gargano – Split and Bari Dubrovnik) and in the Mid Adriatic depression, in winter.
- **AdritLTER1** 2015, R/V Dallaporta, march 8th to 15th 2015, CNR-ISMAR (Chief scientist: M. Bastianini). Main goals of the cruise: (1) determination of spatial variability of carbonate system properties, other chemical parameters (DO, DIN, DIP,SiO2), and phytoplankton in a shelf region, highly sensitive to ocean acidification (2) maintenance of instruments and sensors on buoys.
- **PEGASO**, RV Hesperides (Spain). CNR-ISAC, together with C-CAPS NUIG (Centre for Climate and Air Pollution Studies, Natinal University of Ireland Galway, Ireland) and ICM-CSIC (Institut de Ciències del Mar, Barcelona, Spain), participated to a scientific cruise in the Southern Ocean. The main aim of the cruise was to understand how marine biota affects the chemical composition and climate-relevant properties of marine aerosol, with particular attention to sea spray. During the cruise (January-February 2015), a series of bubble bursting experiments were performed following the approach of Facchini et al (2008) and O'Dowd et al. (2015), setting the measurements over high biologically active seawaters. In detail, measurements were located in the region between South Georgia Island and the Antarctic Peninsula, over four distinct phytoplankton blooms identified from satellite data (see details of the cruise in Figure 1).

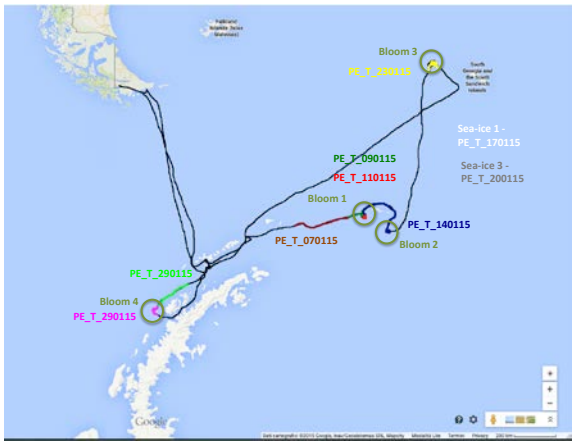


Figure 1. PEGASO cruise route. Colored segments indicate the regions where sea spray production and characterization experiments were performed. The four blooms identified from in-situ and satellite measurements are indicated by the green circles.

3. ON-GOING ACTIVITIES AND MAIN RESULTS

Marine aerosol characterization campaign at Mace Head

Facchini M.C, Rinaldi M., Paglione M., S. Sandrini, F. Belosi, G. Santachiara, A. Donateo, D. Contini (CNR-ISAC)

CNR-ISAC participated in the joint BACCHUS – Air-Sea Lab marine aerosol characterization campaign, held at Mace Head (Ireland) during August 2015. The aim of the campaign was to characterize the aerosol-cloud interaction in the North Atlantic Marine Boundary Layer (MBL).

The advanced in situ and remote sensing aerosol-cloud characterization instrumentation, running continuously at Mace Head research station, was integrated by observations carried on by CNR-ISAC, focusing particularly on marine cloud condensation nuclei (CCN) and ice nucleating particles (INP) emission and formation processes.

INP measurements

Offline deposition and condensation freezing INP analysis have been performed by Langer dynamic developing chamber (Santachiara et al., 2010), for the determination of their atmospheric concentration in the PM1 and PM10 size ranges. These measurements allow the investigation of INP particles in the marine boundary layer and of the role of biogenic organic matter associated to sea spray particles in determining the INP properties of primary particles produced from the ocean surface, testing the recent hypothesis by Wilson et al. (2015). Figure 1 presents an overview of the INP concentration determined at -22°C, as a function of the size range and of the water saturation ratio (Sw).

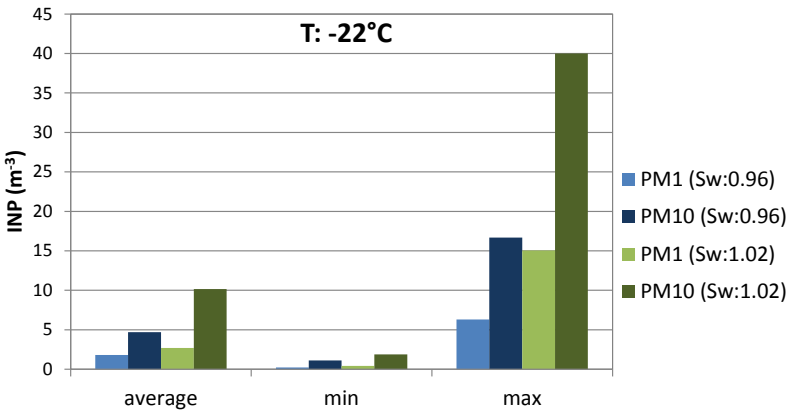


Figure 1. Overview of the INP concentrations observed at Mace Head during the August 2015 campaign.

Aerosol flux measurements by Eddy Covariance

Aerosol flux measurements by eddy covariance, combining high time resolution aerosol mass spectrometer (HR-ToF-AMS), condensation particle counter (CPC) and optical particle counter (OPC) measurements performed during the campaign in collaboration with C-CAPS NUIG and NERC (Edinburgh, UK) provide new information on the emission of marine aerosols particles potentially acting like CCN and INP in the (MBL).

Measurements were carried out using a micrometeorological flux system based on the Eddy Covariance (EC) method. The system was placed on the tallest Mace Head tower at 22 m height (Figure 2).

Figure 2. a) Micrometeorological Tower on the measurement observatory of Mace Head. b) Sonic anemometer and CPC inlet coupled in eddy covariance configuration.

Development of new technology devices for extreme polar environments: first "in situ" application of an automatic sampler in the Svalbard Islands

Zappalà G., Bruzzone G., Caruso G., Azzaro M. (CNR-IAMC; CNR-ISSIA)

Increased attention has recently been addressed to Arctic ecosystems due to the well-known impact of global warming on the northern polar region. Advanced technologies for marine monitoring are needed to monitor environmental changes, especially those related to ice melting. In the framework of the CNR ARCA project aimed at studying the hydrological cycle and its consequences on the climate in the boreal hemisphere, a first prototype of automatic equipment was specifically designed to perform discrete sampling of surface waters in the area close to the Kronebreen glacier, in the Svalbard Islands. This contribution reports the results of the first in situ application of this device to the study of heterotrophic bacterial distribution and functional metabolism. High enzymatic activity and abundance of culturable heterotrophic bacteria were observed close to the Kronebreen glacier. The extracellular enzymatic profiles of the bacterial isolates showed that lipids, proteins and organic phosphates play a major role in bacterial metabolism in this area of the Arctic Ocean.

Figure 1: The automatic vehicle (left) towing the multisampler (right)

Total atmospheric deposition of dissolved organic carbon (DOC) at the Lampedusa Island: preliminary results

Santinelli C. (CNR-IBF), Galletti Y. (CNR-IBF), Di Sarra G. (ENEA), 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 and December 2nd. 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 Creta Island (0.14 mmol C m^{-2} day^{-1}). The EEMs of CDOM, in total deposition, showed 3 peaks (Fig. 2). (1) Peak A (λ_{ex} = 250 nm and λ_{em} = 400-500 nm), that has been observed in many studies on marine DOM, in particular in coastal regions and is attributed to terrestrial humic-like substances. (2) Peak M (λ_{ex} = 310-320 nm and λ_{em} = 400-450 nm) showed lower levels of fluorescence intensity than peak A, and it was observed in all the samples. It was reported in previous studies and it could be due to the occurrence of marine as well as terrestrial humic-like substances. (3) Peak T (λ_{ex} = 280 nm and λ_{em} = 340 nm) is attributed to protein-like substances and it was not observed in all the samples.

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

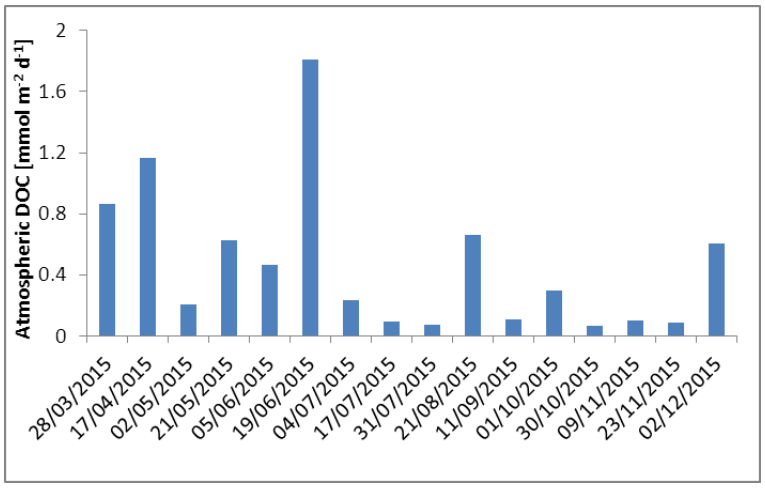


Figure 1. The DOC fluxes during the study period.

3. Top 5 publications in 2015 (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.

1. Canepa E., Pensieri S., Bozzano R., Faimali M., Traverso P., Cavaleri L. (2015) The ODAS Italia 1 buoy: more than forty years of activity in the Ligurian Sea. Progress in Oceanography. Volume 135, June 2015, Pages 48–63. http://dx.doi.org/10.1016/j.pocean.2015.04.005
2. O'Dowd, C.D., D. Ceburnis, J. Ovadnevaite, J. Bialek, D. B. Stengel, M. Zacharias, U. Nitschke, S.Connan, M. Rinaldi, S. Fuzzi, S. Decesari, M. C. Facchini, S. Marullo, R. Santoleri, A. Dell'Anno, C. Corinaldesi, M. Tangherlini and R. Danovaro (2015), Connecting marine productivity to sea-spray via nanoscale biological proceses: Phytoplankton Dance or Death Disco? *Scientific Reports*, 5, 14883, doi: 10.1038/srep14883.
3. Rivaro P., Ianni, C., Langone, L., Ori, C., Aulicino, G., Cotroneo, Y., Saggiomo, M., Mangoni, O.(2015). Physical and biological forcing of mesoscale variability in the carbonate system of the Ross Sea (Antarctica) during summer 2014. Journal of marine system,

http://dx.doi.org/10.1016/j.jmarsys.2015.11.002, 2015
4. Zaccone R., G. Caruso, Azzaro M., M. Leonardi, G. Maimone, L.S., Monticelli, A. Cuttitta, B. Patti, R. La Ferla (2015). Seasonal changes on microbial metabolism and biomass in the euphotic layer of Sicilian Channel. Mar Environ Res, 112B: 20-32 special issue Mares. DOI: 10.1016/j.marenvres.2015.07.007
5. Celussi M., Gallina A.A., Ras J., Giani M., Del Negro P. 2015. Effect of sunlight on prokaryotic organic Carbon uptake and dynamics of photoheterotrophy relevant pigments in the Adriatic Sea, Aquatic Microbial Ecology, 74: 235–249. doi: 10.3354/ame01738.
6. Cossarini G. , Querin S., Solidoro C. 2015.The continental shelf carbon pump in the northern Adriatic Sea (Mediterranean Sea): Influence of wintertime variability. Ecological Modelling 314: 118–134.

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.)

- **April 2016**. **AIR-SEA LAB Project campaign**. P.I.: Maria Cristina FACCHINI. Main focus: characterization of the air quality & climate interactions in the Mediterranean Basin. The Air-Sea Lab partners C-CAPS NUIG and CNRS LaMP (France) will participate in the campaign. Measurements will be carried at 6 coastal sites representative of different pollution conditions in the Mediterranean (Fig. 1):

    a. **Capogranitola**. Marine background site in the Strait of Sicily, potentially influenced by ship traffic.

    b. **Civitavechia Porto** (mobile lab). Civitavecchia hosts an intensive traffic of ferries linking Sardinia to the mainland, plus a continuous traffic of cruise ships stopping there to allow for tourist visits to Rome. Furthermore, the port is rapidly expanding to the north to host maritime commercial traffic of goods. 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.

    c. **Civitavecchia LACOST**. Micrometeorology, Radiative and energy balance, wind profiles, vertical velocity profile, atmospheric thermal structure, mixing layer height.

    d. **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).

    e. **Lamezia Terme**. Coastal site in the Southern Tyrrenian Sea, potentially influenced from East North-East direction by urban surrounding small villages anthropic activity and from South-West from Etna volcanoes emission and Saharian Dust.

    f. **Lampedusa**. Marine background site. Lampedusa station will be available through the external collaboration with ENEA and University of Florence.

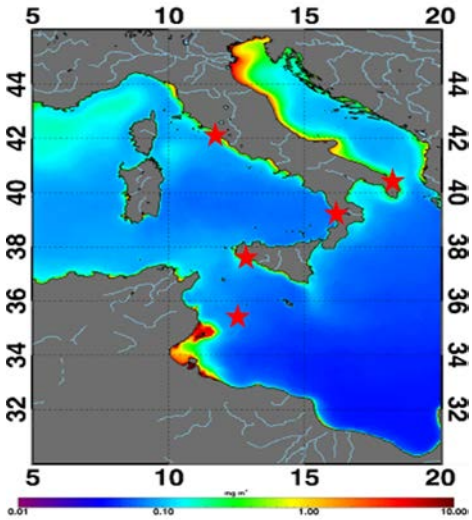


Figure 1. Sampling stations (red stars) during the Air-Sea Lab campaign in the Mediterranean Basin (April 2016). Colors refer to Chlorophyll concentration climatology over the Mediterranean Sea (1998-2009; Case I – Case II chlorophyll product derived by MedOC4 to SeaWiFS remote sensing reflectances)

- **June 2016 PELAGIC MESOSCOSM EXPERIMENT in the Gulf of Naples.** P.I.: Christophe Brunet (SZN). The SZN in collaboration with many research institutes and Universities from Italy and Europe is organizing a Pelagic Mesocosm experiment in the Gulf of Naples in June 2016. The experiment will consist in the deployment of 6 mesocosms (≈ 100 m^3 each, 3 m diameter and 15 m depth) in order to follow the ecosystem dynamics (almost end-to-end: from viruses to macrozooplankton) in response to macronutrient addition, with or without presence of microplastics. The six bags will be enriched by nutrients (nitrates, phosphate and silicates), and in three of them microplastics will be added. The aims of the experiment are:

  (i) to induce a coastal bloom in order to investigate the ecosystem processes relied to this event, such as succession, primary and secondary production, vertical fluxes, viral infection, grazing, biodiversity, changes in the chemistry of the water column and the biogeochemical cycles.

  (ii) to study the impact of the microplastics in a coastal area, such as the vertical fluxes, the interactions with the biotope and the trophic food web, interactions with the marine chemistry (metals, dissolved organic matter).

The experiment will last 15 days. Many researchers will contribute to the whole data set retrieved from this first Italian Pelagic Mesocosm experiment. Many parameters will be analysed and complementary technical approaches will be used. For all biological compartments (virus, bacteria, phytoplankton, microzooplancton and macrozooplankton), the biodiversity will be studied through conventional taxonomic measurements together with molecular approaches, and the biochemistry, physiology and production will be also investigated. Physical (salinity, temperature) and chemical parameter will be measure in order to investigate organic matter (dissolved and particulated, polysaccharides, absorption and fluorescence of its chromophoric fraction) and metals dynamics. The outside control station will be used for assessing all the changes occurring in the water column following the fertilization with or without the enrichment in microplastics.

Figure 2: Above surface view of three pelagic mesocosms (used in the French DUNE project, Picture by C. Brunet, 2010), and the map of the inner part of the Gulf of Naples showing the position (red dot) of the mesocosms deployment in June 2016.

- **2017 Spring**. **AFRÒS CRUISE** in the Thyrrenian Sea. Solas-Italy community and international partner. Main goals: Characterization of the main processes of sea spray formation; Biogeochemical and microbial characterization of surface water in relation to sea spray formation. To investigate carbon fluxes at the surface ocean-atmosphere interaction.

- **March 2015 - Ongoing** Total atmospheric deposition sampling at the Lampedusa Island, in collaboration with MIO, Marseille, France.

- **September 2016** Mineralization experiments to assess the impact of atmospheric deposition of inorganic nutrients and organic matter on marine biogeochemical cycle. In collaboration with MIO, Marseille, France. Project ADORE.

- **January-February 2016** - **RoME Project activities** in the framework of the oceanographic cruise of Italian National Program of Research in Antarctica (XXXI Expedition). Main goals: (1) determination of spatial variability of carbonate system properties, other chemical parameters (DO, nutrients, iron), and phytoplankton in a shelf region of the Ross Sea impacted by mesoscale structures; (2) calculation of air–sea CO2 fluxes, (3) maintenance of instruments and sensors on long-term moorings.

- **Summer 2016 MARINE STRATEGY** 2016 Cruise. Main objectives: monitoring plankton in offshore areas (MSFD, Activity 1.7), monitoring physical-chemical variables and nutrients (MSDF: activity 1.3).

- **Summer 2016 or 2017 ARCA** project in the Kongsfjorden (Svalbard). Main objectives: monitoring superficial microlayer and bottom boundary layer.

- **ESAW-2**, Evolution and spreading of Southern Adriatic Waters, **Eurofleet2**, R/V BIOS DVA (Croatia), April 4th-12th 2016, OGS Trieste (Chief Scientist: V. Kovacevic). Main goals of the cruise: (1) to study the hydrographic and biogeochemical properties (with a special focus to carbon) along two shore to shore sections (Gargano – Split and Bari Dubrovnik) and in the Mid Adriatic depression, in the post-convection phase.

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

XXXIV SCAR (Scientific Committee on Antarctic Research) Meeting 2016 and **Open Science Conference** 23 to 26 August 2016. The theme of the conference will be "*Antarctica in the Global Earth System: From the Poles to the Tropics*" Kuala Lumpur, Malaysia, http://scar2016.com/

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')

- **ADORE (2016).** 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.
- **AIR-SEALAB (2014-2016)**. Aerosol-cloud interaction in marine areas. CNR funded Bilateral Project.
- **BACCHUS (2013-2016).** Impact of Biogenic versus Anthropogenic emissions on Clouds and Climate: towards a Holistic UnderStanding. Funded by EU FP7. www.bacchus-env.eu/
- **CEFA/PNRA 2015 (2015-2016)** Coastal Ecosystem Functioning in a changing Antarctic ocean
- **EMODNet European Marine Observation and Data network (2013-2016).** EMODNET aims to assemble fragmented and inaccessible marine data into interoperable, continuous and publicly available data streams for complete maritime basins. EMODNET is a long term marine data initiative from the European Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE) underpinning its Marine Knowledge 2020 strategy. **EMODNET Chemistry.** Coordinator OGS-NODC. www.emodnet-chemistry.eu.
- **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/
- **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/
- **PERSEUS (2012-2016)**. Policy-oriented marine Environmental Research in the Southern European Seas. EU FP7. www.perseus-net.eu
- **Rewarding ARCA (2014-2016)**. ARtico: cambiamento Climatico Attuale ed eventi estremi del passato, Supported by DTA-CNR.
- **RITMARE (2012-2017).** Italian Flagship Project, supported by the Italian Ministry of Research and University. www.ritmare.it.

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 is under development 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).
- Carbonate system measurements will be integrated at E2M3A site, South Adriatic Sea
- The S1 system, now configured as an elastic beacon, will be implemented during 2017 with a 'yo-yo' device.
- An integrated air-sea observatory is already working in the North Adriatic Sea (PALOMA station: 35.5°N, 13.6°E) for 6 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.
- To continue the pCO_2 continuous measurements (in seawater and in atmosphere) in the Adriatic Sea.
- Cruise with dedicated experiments

<u>Atmospheric deposition and ocean biogeochemistry</u>

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

<u>Marine ecosystems, aerosol and clouds: interactions and feedbacks</u>

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

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
- Joint CNR-ISAC/NUIG/CSIC cruise in the Southern Ocean. An integrated activity on aerosol-cloud interaction in marine environments (Mediterranean and North Atlantic) is starting at CNR-ISAC under the framework of AIR-SEA Lab project in collaboration with

university of Galway.

- Sea-spray measurements from the CNR-ISMAR Acqua Alta platform in the Northern Adriatic Sea in collaboration with University of Toulon (France) *We are searching for financial support, e.g., we are going to apply to the JERICO NEXT TNA call*

Remote sensing of biogeochemical processes

Goals:

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

Activities

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

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

Comments

The Italian community is very active on SOLAS themes and in January 2015 a first meeting was organised in order to discussion about the best way to strengthen and increase the visibility of the SOLAS-Italy community.

Today SOLAS-Italy counts about 40 participants from more than 13 Institutions. Our key words are: interdisciplinarity, collaboration, cooperation and sharing of both infrastructures and resources. The first goal of this community is to be able to “speak the same language” between atmospheric and marine scientists going behind the sea-air frontier. We realized that there is a problem of communication, the same process is often defined differently from atmospheric and marine perspective.

In May 19th the SOLAS-Italy web site was launched **http://www.isac.cnr.it/solas/home**.
We are excited to take on this new frontier-breaking challenge that will increase our knowledge and will give us the unique opportunity to better understand oceanographic and atmospheric processes in a global perspective, we would like to thank SOLAS for giving us this great opportunity.

We are looking for projects to support our activities as well as for international collaborations.

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS Japan *compiled by: Hiroshi Tanimoto*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

Enhancement of dimethylsulfide production by anoxic stress

Dimethylsulfide (DMS) is produced by phytoplankton in the ocean and plays an important role in biogeochemical cycles and climate system of the Earth. Previous field studies reported a possible relationship between DMS enhancement and anoxic condition, although the governing processes are still to be identified. Here we show the first direct evidence for the enhancement of DMS production by natural planktonic assemblages caused by anoxic stress. Under the anoxic condition, DMS production was considerably enhanced and DMS bacterial consumption was inhibited, resulting in an eightfold higher rate of gross DMS production than that under the oxic condition. Our results demonstrated that anoxic stress is one of important "environmental factors" in the marine DMS dynamics, suggesting the possible global importance due to ubiquity of anoxic conditions in the coastal oceans. This process would become more important in the future due to expansion of coastal hypoxic and anoxic zones by global warming.

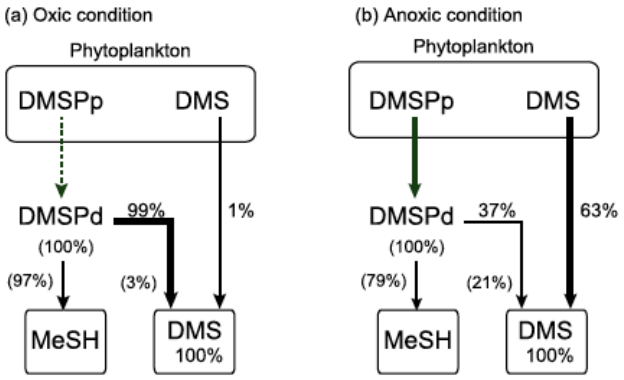


Figure: Diagrams of the paths and fates of DMS production and DMSP degradation under (a) oxic and (b) anoxic conditions in the bay water.

Omori, Y., H. Tanimoto, S. Inomata, S. Wada, K. Thume, G. Pohnert, Enhancement of dimethylsulfide production by anoxic stress in natural seawater, Geophys. Res. Lett., 42, 4047−4053, doi:10.1002/2015GL063546, 2015.

2. Activities/main accomplishments in 2015 (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.)

Events:

- Nov. 2015: SOLAS-Japan synthesis presentation as part of the IGBP-Japan 25th anniversary special symposium, “Biogeochemical cycles between surface ocean and lower atmosphere and its impacts on climate” (by Y. Nojiri)

Field campaign:

- March 2015: “Influence of Okhotsk sea-ice melt-water on productivity and biogeochemical processes”, R/V Hakuho-Maru cruise made in the coastal Oyashio and Oyashio region of the western North Pacific Ocean (KH-15-1 led by J. Nishioka) - measurements of volatile organic compounds (VOCs) in air and seawater, chemical components in submicron aerosols, and CCN were made in order to assess the effect of the phytoplankton blooms on trace gases and submicron organic aerosols and the resulting climatic and environmental impacts
- July 2015: “Evaluation of sampling methods for DMS in seawater” at Akkeshi Bay (by S. Kameyama)
- August-October 2015: Arctic Ocean cruise by R/V Mirai (MR-15-03) as part of the ArCS project
- November 2015: Atmospheric gas and aerosol observation during R/V Hakuho-maru cruise (KH-15-4 led by H. Saito) which sailed Kuroshio region in the western North Pacific

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)

Data analysis:

- SOLAS-relevant activities in the NEOPS (New Ocean Paradigm on its Biogeochemistry, Ecosystem and Sustainable Use) project - observations of sea-to-air flux of DMS and other VOCs, and of physical and chemical properties of marine aerosols at the north-south transect in the western Pacific (by Y. Miyazaki, M. Mochida, Y. Iwamoto, Y. Omori, H. Tanimoto, M. Uematsu)

International collaborations:

- Contribution to the review paper entitled “Methods for Biogeochemical Studies of Sea Ice: The State of the Art, Caveats, and Recommendation” by Miller et al. (with D. Nomura as a co-author), Elementa, 3, 000038, doi:10.12952/journal.elementa.000038, 2015.

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

Omori, Y., H. Tanimoto, S. Inomata, S. Wada, K. Thume, G. Pohnert, 2015, Enhancement of dimethylsulfide production by anoxic stress in natural seawater, Geophys. Res. Lett., 42, 4047−4053, doi:10.1002/2015GL063546.

Tohjima, Y., Y. Terao, H. Mukai, T. Machida, Y. Nojiri, and S. Makyutov, 2015, ENSO-related variability in latitudinal distribution of annual mean atmospheric potential oxygen (APO) in the equatorial Western Pacific, Tellus B, 67, 25869, http://dx.doi.org/10.3402/tellusb.v67.25869.

Cui, Y., S. Suzuki, Y. Omori, S.-K. Wong, M. Ijichi, R. Kaneko, S. Kameyama, H. Tanimoto, and K. Hamasaki, 2015, Abundance and distribution of dimethylsulfoniopropionate degradation genes and the corresponding bacterial community structure at dimethyl sulfide hotspots in the tropical and subtropical Pacific Ocean, Appl. Environ. Microbiol., 81(12), 4184−4194, doi: 10.1128/AEM.03873-14.

Ooki, A., D. Nomura, S. Nishino, T. Kikuchi, Y. Yokouchi, 2015, A global-scale map of isoprene and volatile organic iodine in surface seawater of the Arctic, Northwest Pacific, Indian, and Southern oceans, J. Geophys. Res.-Oceans, 120, doi:10.1002/2014JC010519.

Taketani, F., T. Miyakawa, H. Takashima, Y. Komazaki, X. Pan, Y. Kanaya, and J. Inoue, 2016, Shipborne observations of atmospheric black carbon aerosol particles over the Arctic Ocean, Bering Sea, and North Pacific Ocean during September 2014, J. Geophys. Res.-Atmos., 121, doi:10.1002/2015JD023648.

Products: Uematsu, M., S. Takeda, Y. Nojiri, and H. Tanimoto, 2015, Biogeochemical cycles between surface ocean and lower atmosphere and its impacts on climate (in Japanese), “Global Environment”, 20(2), 195-202.

Weblinks: Monitoring of atmosphere-ocean carbon dioxide exchange by Ship-of-Opportunity (SOOP) website (http://soop.jp)

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.)

Field studies:

- 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
- Summer 2016: Australian cruise around the coastal Great Barrier Reef with Japanese contribution on seawater measurements of VOCs (contributors: H. Tanimoto, Y. Omori)
- Feb-Dec 2016, Hokkaido Bay study for dynamics of nutrient and VOCs in seawater (led by A. Ooki).
- Feb-Mar 2016, Okhotsk Sea study for sea ice observation (led by D. Nomura)
- Summer 2018, Arctic Ocean observations (as part of ArCS, NABOS-II projects)
- Research cruises in the Pacific Ocean by R/V Hakuho-Maru and Shinsei-Maru

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

Workshop:

- SOLAS-Japan National Committee annual meeting (led by Y. Yamanaka)
- March 2016: Joint NIES-KOPRI workshop on the Arctic observations (by H. Tanimoto)

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 projects:

- NIES VOS program funded by the Ministry of Environment of Japan,
  - 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.
  - Integrative observational study of oxygen and isotopes of carbon dioxide in the atmosphere to investigate the climate responses of the global carbon cycle (PI: Y. Tohjima), FY2014-2018.
- JAXA GCOM RA6
  - 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
- MEXT/JSPS Grait-in-Aid for Scientific Research funded to several SOLAS-relevant projects, including "Determination on the triple oxygen isotopes of tropospheric ozone" (PI: U. Tsunogai, FY2014-2016), "Global observations of VOCs dissolved in the surface ocean using novel time-of-flight mass spectrometry" (PI: H. Tanimoto, FY2015-2018)

International projects:

- NABOSS-II (http://research.iarc.uaf.edu/NABOS2/) (contributor: D. Nomura)
- SCOR (http://www.scor-int.org/SCOR_WGs_WG140.htm) (contributor: D. Nomura)

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)

- “New earth and planetary science using a flying boat” (led by U. Tsunogai) to be submitted to the Science Council of Japan, asking for an endorsement.
- 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 2015 and future activities

SOLAS Mexico *compiled by: J. Martin Hernandez Ayon*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

Winds have intensified in the California upwelling system

Analyses suggests that winds have intensified in the California upwelling system. In 1990, Andrew Bakun proposed that increasing greenhouse gas concentrations would force intensification of upwelling-favorable winds in eastern boundary current systems that contribute substantial services to society. The authors performed a meta-analysis of the literature on upwelling-favorable wind intensification. The analyses suggests that winds have intensified not only in the California, but also in Benguela, and Humboldt upwelling systems and weakened in the Iberian system over time

Stronger intensification signals are observed at higher latitudes, consistent with the warming pattern associated with climate change.

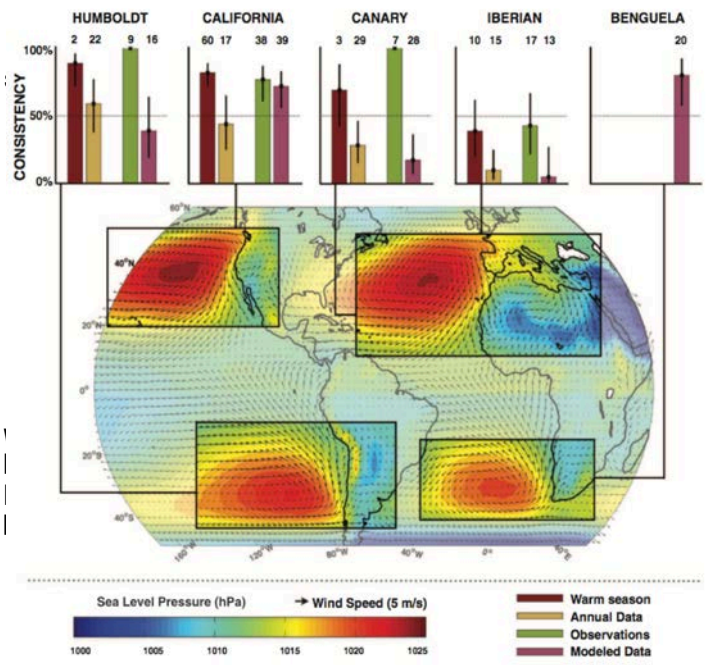


Figure*:* EBCSs of the world showing warm-season spatial climatologies of sea-level pressure and surface wind speed from the NCEP/NCAR (National Centers for Environmental Protection/National Center for Atmospheric Research) model-data reanalysis product. These are estimates from logistic regression of consistency with the wind

intensification hypothesis; bars show the estimated probability (T 95% confidence intervals). Numbers above the bars denote the number of trends contributing to each point estimate and confidence interval. The dashed horizontal line denotes the null hypothesis of equal probability of increasing or decreasing winds.

Sydeman, W. J., et al. "Climate change and wind intensification in coastal upwelling ecosystems." *Science* 345.6192 (2014): 77-

2. Activities/main accomplishments in 2015 (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.)

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

Meza-Padilla R., Appendini C., Pedrozo-Acuña A. 2015. *Hurricane/induced waves and storm surge modeling for the Mexican coast*. Ocean Dynamics, 65: 1199-1211. DOI: 10.1007/s10236-015-0861-7

Delgadillo-Hinojosa F., Camacho-Ibar V., Huerta-Díaz M.A., Torres-Delgado V., Pérez-Brunius P., Lares L., Marinone S.G., Segovia J.A., Peña-Manjarrez J.L., García-Mendoza E. and Castro R. 2015. *Seasonal behavior of dissolved cadmium and CD/PO_4 ratio in Todos Santos Bay: A retention site of upwelled waters in the Baja California peninsula, Mexico*. Marine Chemistry. 160: 37-48. DOI:10.1016/j.marchem.2014.10.010

Espinosa M.L., Martínez A., Peralta O. and Castro T. 2015. *Spatial variability of dimethylsulfide (DMS) and dimethylsulfoniopropionate (DMSP) in the southern Gulf of Mexico.* Environmental Chemistry. DOI.org/10.1071/EN14266

Chapa-Balcorta C., Hernández-Ayón J.M., Durazo R., Beiber E., Alin S.R. and López-Pérez A. 2015. *Influence of post-Tehuano oceanographic processes in the dynamics of the CO2 system in the Gulf of Tehuantepec, Mexico*. Journal of Geophysical Research: Oceans. 120:7752-7770. DOI:10.1002/2015JC011249.

Muñoz-Anderson M.A., Lara-Lara J.R., Álvarez-Borrego S., Bazán-Guzman C., de la Cruz-Orozco M. 2015. *Water-air carbon fluxes in the coastal upwelling zone off northern Baja California.* Ciencias Marinas. 41(2): doi.org/10.7773/cm.v41i2.2484

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.)

A new Mexican oceanographic observation network of physical, geochemical and ecological processes in the Gulf of Mexico started in March of 2015. The project was approved by the CONACYT (Consejo nacional de Ciencia y Tecnología)-SENER (Secretaria de Energía)-Hidrocarbons Fund to a consortium led by CICESE (Centro de Investigación Científica y De Educación Superior de Ensenada and participating institutions CINVESTAV -IPN (Centro de Investigación y de estudios Avanzados del Instituto Politécnico nacional) Mérida, CIDESI (centro de ingeniería y Desarrollo Industrial), UABC (Universidad Autónoma de Baja California), several research Institutes from UNAM (Universidad Nacional Autónoma de México, ICMyL (Instituto de Ciencias del Mar y Limnologia), CCA (Coordinación de Cooperación Académica) , IBT (Instituto de Biotecnologia), INECC (Instituto nacional de Ecología y Cambio Climático)-SEMARNAT (Secretaria del Medio Ambiente y Recursos naturales) and Baja Innova, SAPI de CV (Sociedades Anónimas Promotoras de Inversión). In addition international institution we also involved as, Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, UC Santa Barbara, RSMUS-UoF (Rosentiel School of Marine and Atmospheric Science), Texas A&M (USA), LOCEAN (Laboratoire d'Etudes en Géophysique et Océanographie Spatiale), UPMC (University Pierre and Marie Curie)-Paris and LEGOS (Laboratoire d'Etudes en Géophysique et Océanographie Spatiale), from France and GEOMAR from Germany. This interdisciplinary project proposes for five years the creation of a comprehensive system of oceanographic observations and numerical models to generate scenarios of potential impacts of large oil spills. The project objectives are to strengthen the scientific, technological infrastructure and human capacity of the Mexican oceanographic community to address the challenges associated with the exploitation of hydrocarbons in the Gulf of Mexico, using an interdisciplinary approach and implementing cutting edge technologies.

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

1) The second Ocean Acidification workshop for Latin-American student is planned for September 2016 LAOCA).
2) The Mexican Carbon International Symposium is organized for May 2016. This is a yearly symposium.

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')

A new Mexican oceanographic observation network of physical, geochemical and ecological processes in the Gulf of Mexico started in March of 2015. The project was approved by the CONACYT (Consejo nacional de Ciencia y Tecnología)-SENER (Secretaria de Energía)-Hidrocarbons Fund to a consortium include SOLAS activities topics as: AIRE SEA INTERFACE AND FLUXES, 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)

Remain the plans to study de Oxygen Minimun Zone (OMZ) in the North Pacific area in from of Mexico between Mexican Institution and LEGOS from France. The eastern Pacific has the most extensive OMZ ranging offshore over most of the Pacific coast of North and South America, and particularly off Peru and central Mexico where this OMZ system is well developed. Mexican institutions are applying to CONACYT from Mexico and are waiting for opportunities between both countries (France-Mexico).

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

Mexican researchers participate in the SOLAS mid-term strategy on the OMZs (http://www.solas-int.org/aboutsolas/organisationaandstructure/midtermstrategy/omzmeeting.html), in Lima thanks to French (LEGOS, IRD) and international funding. This workshop allowed starting an international coordination of an intense fieldwork in the Eastern Pacific OMZ (oceanographical cruises, research flight, experiments, observations network implementation for the long-term) from 2012-2013. In France, an OMZ oceanographical cruise in the L'Atalante for January 2013 was set in the Eastern Pacific OMZ off Peru were several international institutions had participation including Mexican researches from CICESE and from the University of Baja California Mexico. A first workshop is planned for October 2016.

Comments

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS New Zealand **compiled by:** *Cliff Law*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

Is the sea surface microlayer a source of DMS?
Dimethylsulfide (DMS) flux to the atmosphere is generally determined using water sampled at or below 2 m depth, thereby excluding any concentration anomalies at the air-sea interface. Two independent techniques were used to assess the potential influence of near-surface DMS enrichment on marine emissions and the factors determining surface enrichment. Measurements were made in productive frontal waters over the Chatham Rise, east of New Zealand. DMS gradients in subsurface seawater (SSW, 0.01-6m) were negligible, whereas enrichment in the sea-surface microlayer (SSM) was variable with a mean enrichment factor (EF]) of 1.7. Physical and biological factors influenced SSM [DMS], with high EFs (> 1.3) only observed in a dinoflagellate-dominated bloom, and associated with low-medium wind speeds and near-surface temperature gradients. On occasion high EFs preceded periods when the ocean-air DMS flux, measured by eddy covariance, exceeded the expected flux calculated using COARE parameterised gas transfer velocities and measured SSW [DMS]. The results of these two independent approaches suggest that air-sea emissions may be influenced by near-surface DMS production under certain conditions, and highlights the need for further study to constrain the magnitude and mechanisms of DMS production in the sea surface microlayer.

Walker CF, Harvey MJ, Smith MJ, Bell TG, Saltzman ES, Marriner AS, McGregor JA and Law CS. 2016. Assessing the potential for DMS enrichment at the sea-surface and its influence on air-sea flux Atmospheric Chemistry Physics, submitted

2. Activities/main accomplishments in 2015 (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 NZ- Ocean Acidification Observing Network (NZOA-ON)

NZOA-ON is a network of coastal sites around the country – a mix of pristine and urban sites, and sites which are of particular interest to regional councils, the aquaculture and fishing industries, and sites of scientific interest. Water samples for analysis of carbonate system parameters are collected fortnightly, with SeaFET pH sensors deployed for periods of 4-5 months. There are currently 11 sites distributed around New Zealand, with sample collection by partners and stakeholders including regional councils and the shellfish aquaculture industry, using existing infrastructure where possible to take advantage of auxiliary data and historic records. Data will be used to determine local conditions and to provide a baseline against which to measure future change. Data is freely available on an open-access website, and the network is linked into the Global Ocean Acidification Observing Network (GOA-ON)

https://www.niwa.co.nz/coasts-and-oceans/research-projects/new-zealand-ocean-acidification-observing-network-nzoa-on

Coastal Acidification: Rates Impacts and Management (CARIM)

CARIM is a four-year national project that will provide new knowledge on the acidification of coastal waters to enhance protection and management of New Zealand coastal ecosystems. CARIM is led by NIWA, with three other partners and will involve interaction with Maori partners and national stakeholders, including the shellfish fishery sector, ministries, NGOs, regional councils, and scientists in the US and Australia. CARIM will establish the magnitude and variability of pH and the carbonate system at three sentinel sites, and build upon the NZ-OAON (see above). Monitoring information will underpin development of models to identify the main drivers of acidification, which will subsequently inform land and coastal management. The impacts of coastal acidification on primary production, food quality and habitat availability will be assessed, and there will be a particular focus on the sensitivity of different life stages of three iconic species, NZ Abalone, Greenshell Mussel and Snapper. Information on the rate of acidification, and the sensitivity of ecosystems and species, will be used in models to forecast populations for these species. In addition, novel research will investigate the potential for adaptation within different families of NZ Abalone and Greenshell Mussel. The CARIM project also has a major outreach component that includes a programme for schools and local communities at the sentinel sites.

http://www.carim.nz/

Ocean Acidification in the Pacific Islands

New Zealand scientists have been actively developing awareness and action on ocean acidification in the South-West Pacific. Following the ocean acidification workshop at the SIDS (Small Island Developing States in 2014). A *New Zealand Partnership on Ocean Acidification in the Pacific Islands*, led by SPREP (South Pacific Regional Environmental Protectorate) was initiated, with an initial workshop in October 2015 that identified existing and potential impacts and vulnerabilities, and potential priority sites and activities, and assessed options for policy and regional coordination.

https://www.sprep.org/climate-change/sprep-and-new-zealand-collaborate-to-address-ocean-acidification

Law CS, OA in the Pacific: NZ Perspectives. NZ Pacific Islands Regional Ocean Acidification Workshop, 7/10/2015, Stamford Plaza, Auckland, New Zealand

Currie, KI, Setting up a coastal ocean acidification observing network in New Zealand. NZ Pacific Islands Regional Ocean Acidification Workshop, 7/10/2015, Stamford Plaza, Auckland, New Zealand.

Characterising high CO2 vent regions
A multi-disciplinary study by a team of national, & international (Australia, Belgium and the UK) scientists was carried out around White Island, an active volcano north of New Zealand. Led by the University of Otago Ocean Acidification Research Theme, the "White Island Blitz" aimed to assess the potential of shallow water high CO2 vents around the island as analogues for a future ocean.
http://www.otago.ac.nz/oceanacidification/index.html

Surface Ocean Aerosol Processes (SOAP)
SOAP is a SOLAS Endorsed multi-national collaboration incorporating marine biogeochemistry, air-sea exchange and atmospheric chemistry that seeks to establish the marine biogenic contribution to aerosols over the Southern Ocean. SOAP is lead by New Zealand (NIWA), with partners from the USA (UCI, U Chapman, SUNY), Germany (IFM-G), Eire (NUIG), U.K. (U. Cambridge), Canada (U. Laval), Australia (CSIRO and QUT), and Finland (UEF). A pilot study in 2011 (PreSOAP) was followed by the SOAP voyage in the subtropical Front south-east of New Zealand in February-March 2012. Analysis of preliminary results took place at a data workshop in Wellington in March 2013. To date 3 papers have been published in a joint Special Issue of *Atmospheric Chemistry Physics Discussions* and *Ocean Sciences* (see below); a further five papers are in the process of submission and preparation.
http://www.atmos-chem-phys.net/special_issue333.html

Sources and characterisation of marine aerosols
A workshop convened for environmental air quality regulators and practitioners in central and local government aimed to raise awareness of the aerosol science that underpins understanding of urban aerosol composition, chemistry and transport. From the SOLAS perspective, marine aerosols were one focus, being important to the background aerosol climatology of New Zealand, and a major contributor of mass in many coastal towns and cities.
Coulson, G., Longley, I., Harvey, M., Somerville, E. An Introduction to Aerosol Science: CASANZ Branch distributed video conference convened at NIWA 12/6/2015. Presentations available at: https://www.niwa.co.nz/our-science/atmosphere/research-projects/all2/healthy-urban-atmospheres/air-quality/workshops

Southern Ocean Aerosol and Cloud
The Deep South National Science Challenge http://www.deepsouthchallenge.co.nz/ research plan was finalised during the year with a 10 year plan, and a focus on understanding climate processes in the Southern Ocean and Antarctica to improve climate prediction. An initial project focus aims to improve representation of clouds and aerosols in the NZ Earth System Model. As a lead into this new programme, a voyage to the Ross Sea in February 2015 successfully deployed a CL-51 ceilometer making measurements of the altitude, depth, and MBL height in a region where only, satellite measurements exist that can lack detail on the lower level clouds.

McDonald, A., Plank, G., Harvey, M., Ridden-Harper, R., Schuddeboom, A., Ichoja, A. (2015) Ship-based ceilometer measurements of Clouds over the Southern Ocean. 26th IUGG General Assembly, Prague Conference Centre, Czech Republic, 27th June 2015.

Shallow methane seeps
Following the discovery of an area of shallow methane flares on the shelf to the east of New Zealand in an active tectonic subduction zone, a second research voyage to the region

established the extent and characteristics of the flare field. Acoustic mapping identified 766 individual flares with elevated methane saturation in surface waters and a direct contribution to the atmospheric methane pool. Further research will examine the fate of the methane released in this region.
http://www.radionz.co.nz/national/programmes/ourchangingworld/audio/201753099/exploring-seabed-methane-seeps

Coastal mixing
Some estuarine coastal regions are a strong source of CO_2, but the pathway to the atmosphere is controlled by transport and vertical turbulent mixing processes. A study in the Marlborough Sounds, New Zealand, characterized the dynamical controls within an estuarine channel. Exchange was modulated by turbulent mixing through its effect on density stratification and scaling parameters were used to assess the effect across a tidal cycle. Benthically generated turbulence generally dominated over internal shear turbulence and surface wind-driven turbulence.

Stevens CL; Smith MJ. 2016. Turbulent mixing in a stratified estuarine tidal channel: Hikapu Reach, Pelorus Sound, New Zealand. 2016. NZ Journal Marine & Freshwater Research, accepted

SOLAS & Geoengineering
NZ SOLAS scientists have played a leading role in the in situ iron addition studies, which have been drawn into the broader debate on geoengineering. Indeed, the role of SOLAS in geoengineering is considered in the SOLAS Science and Implementation Plan (SOLAS Steering Committee and Breverie, 2015). As there are an increasing number of potential geoengineering purposes being proposed in the ocean-atmosphere domain, a discussion session at the SOLAS OSC in Kiel considered what role SOLAS scientists should play in their assessment and deployment. See report:-
http://www.solas-int.org/files/solas-int/content/downloads/Activities/SOLAS%20events/OSC2015/Geong_Discuss%20Session%20Report_
OSC%202015.pdf

The 8th NZ National Ocean Acidification Workshop (University of Otago, Dunedin)
http://nzoac.nz/workshops/

SOLAS 2015-2025 Science Plan and Organisation (2015) - NZ contribution to planning and production of SOLAS V2 proposal

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

Burrell, TJ, Maas EW, Hulston DA and Law CS 2015. Bacterial abundance, processes and diversity responses to acidification at a coastal CO2 vent. *FEMS Microbiology Letters* 2015; doi: 10.1093/femsle/fnv154

Sander, SG, Tian, F, Ibisanmi EB, Currie KI, Hunter, KA, and Frew, RD 2015. Spatial and seasonal variations of iron speciation in surface waters of the Subantarctic front and the Otago Continental Shelf. *Marine Chemistry* 173:114-124.

MacLeod, CD, Doyle, HL, Currie, KI. 2015. Technical Note: Maximising accuracy and minimising cost of a potentiometrically regulated ocean acidification simulation system. *Biogeosciences* 12(3):713-721.

Stevens CL; Smith MJ. 2016. Turbulent mixing in a stratified estuarine tidal channel: Hikapu Reach, Pelorus Sound, New Zealand. 2016. *NZ Journal Marine & Freshwater Research*, accepted

Baltar, F.G., Stuck, E., Morales, S., Currie, K., 2015. Bacterioplankton carbon cycling along the subtropical frontal zone off New Zealand. *Progress in Oceanography* 135, 168-175, doi: 10.1016/j.pocean.2015.05.019

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.)

NZOA-ON (see above) – ongoing coastal ocean acidification monitoring campaign with fortnightly sampling and moored sensors at 11 sites throughout New Zealand. Collaborators include the NIWA, University of Otago, aquaculture and fishing industries, Dept, of Conservation, and regional councils.

CARIM (see above) - ongoing ocean acidification monitoring at 3 focal sites in the New Zealand coastal region with moored pH sensors and bottle sampling. Collaborators include NIWA, University of Otago, University of Auckland, Cawthron Institute, local stakeholders

Deep South Aerosol-Cloud interaction observations – plans are evolving and funding being sought for a voyage in 2017/18 summer to further in situ study of boundary layer aerosol – cloud interaction over the Southern Ocean. This activity will attempt to coordinate with The Southern Ocean Clouds, Radiation, Aerosol Transport Experimental Study or SOCRATES, an international and multi-agency initiative that is under development. Collaborators include CSIRO, Australia

Shallow Shelf methane seeps (see above) - further sampling plans are under discussion with US collaborators, with a potential research voyage in 2016/17

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

The CARIM project (see above) has an active outreach component with information on coastal acidification made available to the public and stakeholders via a variety of media and platforms including a participatory programme for schools and local communities. In addition pH data is publicly available at the NZOA-ON website.

Web: http://www.carim.nz/ - just a landing page visible at present but I'll be releasing more pages as I complete them in the short term
Facebook: www.facebook.com/CoastalAcidificationNZ
Facebook Group for Ocean Guardians: https://www.facebook.com/groups/242608429405803/
Twitter: @CARIM_NZ https://twitter.com/CARIM_NZ
Instagram: carimnz https://www.instagram.com/carimnz/

The 9th NZ National Ocean Acidification Workshop, will take place in July 2016 in Wellington. The workshop attracts ~70 scientists, stakeholders and policy makers.

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’)
CARIM (see above) – Theme 1 Greenhouse gases and the Oceans The Deep South National Science Challenge http://www.deepsouthchallenge.co.nz/ - Theme 4 Interconnections between aerosols, clouds and ecosystems NZOA-ON (see above) - Theme 1 Greenhouse gases and the Oceans NZ Core funding – Ocean-Climate Interactions – Themes 1,3 & 4, SOLAS Science & society, SOLAS Science & geoengineering
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)
Funding is being sought to further develop SOAP research in Southern Ocean aerosols within the New Zealand National Science Challenge *Deep South* and the SOCRATES programme, and into the influence of marine biogenic sources of aerosols via the New Zealand Royal Society Marsden Fund.
5. Engagements with other international projects, organisations, programmes etc.
CSIRO Access ESM and Southern Ocean Aerosol-Cloud Research The Deep South National Science Challenge: http://www.deepsouthchallenge.co.nz/ GOA-ON IOCCP Scientific Steering Group, and SOCAT Global QC Group, NZ committee member member, K. Currie SCOR Working Group “Dissolved N2O and CH4 measurements: Working towards a global network of ocean time series measurements of N2O and CH4”, NZ member C. Law

Comments

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS Norway *compiled by: Siv K. Lauvset*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

A new study by Lauvset et al. (2015) has shown that the average global ocean pH trend has been -0.0018 units per year between 1991 and 2011. Unfortunately, there are not enough data in the 1980s for a trend estimate in the period 1981-2011, but the Pacific Ocean trend in the 30-year period (-0.0020 per year) is roughly consistent with the global 20-year trend. This signifies that there has not been any significant change and/or acceleration in ocean acidification the past few years.

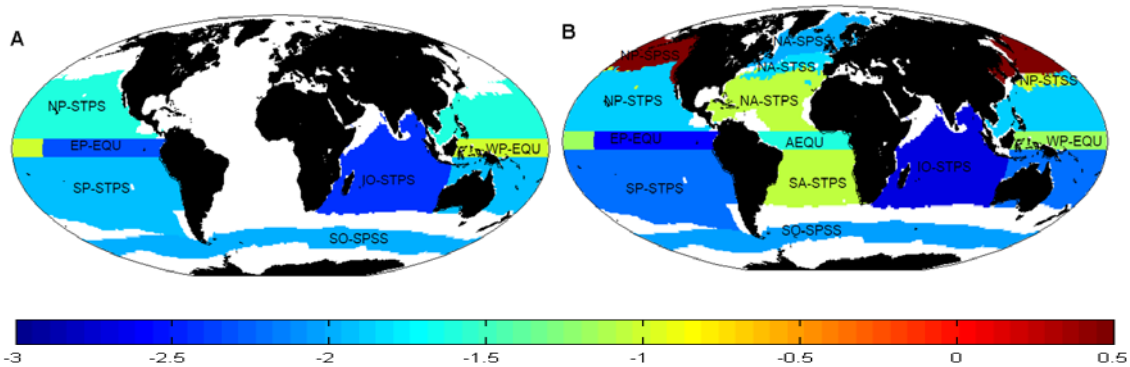


Fig. 1. Global map showing the (A) 1981-2011 and (B) 1991-2011 pH trend in different biomes. The color bar signifies changes in 10^{-3} pH units.

Because of the large-scale ocean circulation and how this transports carbon in the ocean, it was expected that ocean pH changes would present spatially very variable. However, the results in Lauvset et al. (2015) show that ocean pH changes have been very spatially homogeneous (Fig. 1), but that there are large uncertainties due to the high levels of noise in the data and the relatively short time frame in which we have observations. A

comparison with pH changes in the Norwegian Earth system model NorESM showed that we need to improve the data coverage both in time and in space in order to further understand the underlying mechanisms that drive the pH changes and their spatial variability. It is likely that changes in the ocean buffer capacity is a main reason for spatial variability in the pH changes, but it is yet not fully understood how and how much the buffer capacity has changed. Overall the observed pH changes found by Lauvset et al. (2015) are consistent with the ocean being in thermal equilibrium with the atmosphere. Such that the increasing CO_2 in the atmosphere drives increased CO_2 concentrations in the ocean which again drives the pH change.

Lauvset, S. K., Gruber, N., Landschützer, P., Olsen, A., and Tjiputra, J.: Trends and drivers in global surface ocean pH over the past 3 decades, Biogeosciences, 12, 1285-1298, 2015.

2. Activities/main accomplishments in 2015 (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.)

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

Frigstad, H., Henson, S. A., Hartman, S. E., Omar, A. M., Jeansson, E.,Cole, H., Pebody, C., and Lampitt, R. S.(2015): Links between surface productivity and deep ocean particle flux at the Porcupine Abyssal Plain sustained observatory, *Biogeosciences*, 12, 5885-5897, doi:10.5194/bg-12-5885-2015, 2015

Goris, N.,Tjiputra, J.,Schwinger, J.,Heinze, C.(2015). Responses of carbon uptake and oceanic *p*CO2 to climate change in the North Atlantic: A model study with the Bergen Earth System Model, *Global Biogeochem. Cycles*, 29,doi:10.1002/2015GB005109

Jeansson, E., Bellerby, R. G. J., Skjelvan, I., Frigstad, H., Ólafsdóttir, S. R., and Olafsson, J., 2015, Fluxes of carbon and nutrients to the Iceland Sea surface layer and inferred primary productivity and stoichiometry, *Biogeosciences*, 12, 875-885, doi:10.5194/bg-12-875-2015.

Lauvset, S. K., Gruber, N., Landschützer, P., Olsen, A., and Tjiputra, J.: Trends and drivers in global surface ocean pH over the past 3 decades, Biogeosciences, 12, 1285-1298, 2015.

Le Quéré, C, R Moriarty, R M Andrew, J G Canadell, S Sitch, J I Korsbakken, P Friedlingstein, G P Peters , R J Andres, T A Boden , R A Houghton , J I House, R F Keeling, P Tans, A Arneth, D C E Bakker, L Barbero, L Bopp , J Chang, F Chevallier, L P Chini, P Ciais, M Fader, R A Feely, T Gkritzalis, I Harris, J Hauck, T Ilyina, A K Jain , E Kato, V Kitidis, K Klein Goldewijk, C Koven , P Landschützer, S K Lauvset, N Lefèvre, A Lenton , I D Lima, N Metzl , F Millero, D R Munro, A Murata, J E M S Nabel, S Nakaoka, Y Nojiri, K O'Brien, A Olsen, T Ono, F F Pérez, B Pfeil, D Pierrot, B Poulter, G Rehder, C Rödenbeck, S Saito, U Schuster, J Schwinger, R Séférian, T Steinhoff, B D Stocker, A J Sutton, T Takahashi, B Tilbrook, I T van der Laan-Luijkx, G R van der Werf, S van Heuven , D Vandemark, N Viovy, A Wiltshire, S Zaehle , and N Zeng , 2015, Global Carbon Budget 2015. Earth Syst. Sci. Data, 7, 349–396. www.earth-syst-sci-data.net/7/349/2015/ doi:10.5194/essd-7-349-2015.

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.)

1. Carbon-VOS lines Nuka Arctica and G.O.Sars will be continued and Carbon-VOS line Trans Carrier will be re-started as part of ICOS RI, all lines measuring fCO2 in surface water in the Nordic Seas, North Sea, and north Atlantic (Uni Research Climate/University of Bergen).
2. Biogeochemistry measurements in surface and deep water four times a year south of Bergen at the west coast of Norway (Uni Research Climate/University of Bergen).

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')

FixO3 – Fixed-point open ocean observatories, EU project 2013-2017 (SOLAS Focus 2).
Ocean Acidification program – Norwegian project 2013-2016 (SOLAS Focus 2)
EXPECT – Exploring the Potential and Side Effects of Climate Engineering ('Geoengineering theme')

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)

EU proposal - Cooperation between Norway and Red Sea University of Sudan, analyses and data management of biogeochemical time series, capacity building (Uni Research Climate, University of Bergen, Red Sea University), submission March 2016.

Atmospheric inverse modelling is a key tool for reconstructing anthropogenic carbon emissions. The accuracy of air-sea and land-air fluxes depends on the atmospheric data base, but also the quality of air-sea fluxes. Norway (Bergen) plans to contribute with biogeochemical re-analyses to provide interannualy varying air-sea fluxes globally with different approaches: (a) A neural network regression approach. (b) A bottom-up combined state-parameter estimation using an Earth system model. In both cases, multi-tracer data sets of biogeochemical observations together with modelling frameworks will be employed. The re-analyses would help to create an independent greenhouse gas emission verification system.

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

Comments

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS PERU *compiled by:MICHELLE GRACO*

Part 1: *reporting of activities in the period of January 2015 – December 2015*

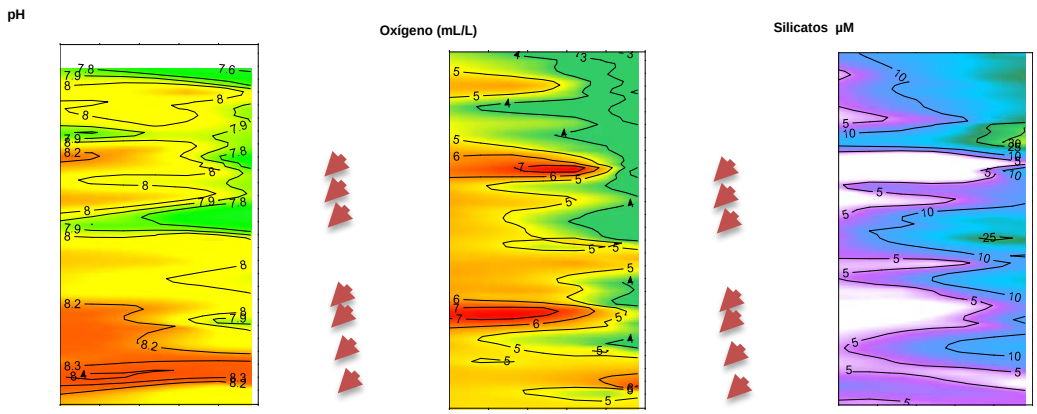
Part 2: *reporting on planned activities for 2016 to 2018/19.*

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

1- Coastal Upwelling off Perú

Since 2013 the Instituto del Mar del Perú IMARPE develop 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. The goal of this project is to investigate the physical, chemical processes, the atmosphere-oceanic exchange and the planktonic and benthic communities associated to the Peruvian coastal upwelling, with emphasis on the onshore-offshore gradient off Central Peru and its variability at different time scales. The study will involve different approaches, cruises and modelling, and also modern and historical data. Several international research collaborations are concurrent with this project. In particular in the SOLAS frame we develop research on the OMZ, and the acidification topics. One of the results of this research are associated with the evidence of El Niño impact in the upwelling during the last 2014 and 2015. The deep change in the water masses affect directly the pH, the oxygen and nutrients with a strong impact in the productivity and economically resources.



Boletín PPR- IMARPE. Graco et al., 2016 (see publication)

2- Aerobic Microbial Respiration in Oceanic Minimum Zones

In the frame of the SFB 754 from GEOMAR Alemania and the collaboration in Peru with IMARPE in the last years there are several research initiatives associated with the Oxygen Minimum Zone studies in particular the biogeochemistry of carbon and nitrogen. One of the products of this research was related with the Aerobic respiration under this oxygen deficient areas. The results indicate that results suggest that microaerobic respiration is a major mode of organic matter

remineralization and source of ammonium (~45-100%) in the upper oxygen minimum zones, and reconcile hitherto observed mismatches between ammonium producing and consuming processes therein (see publication).

3- Acidification and the Peruvian Upwelling system

Since 2013, IMARPE has the contract 18007 with the IAEA to develop studies focus in the acidification and the impact in biological communities. Under this project we develop a review of the carbonate system state of the art off Perú and conduct several investigations and master thesis with calcifiant organisms. Thesis 1) The carbonate system off Peru, 2) Cocolitoforids off Perú: ecology and calcification, 3)foraminifers under low pH and 4) Bivalves under different CO_2 conditions. This thesis will finish on 2016. They are under collaboration with the CALHIS Project, LOCEAN-CEREGE France.

4- Modelling approaches for the upwelling oceanographic and ocean-atmosphere coupling

IMARPE and the Instituto Geofísico del Perú IGP 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 2015 to the El Niño conditions that modified the water column chemical and physical conditions.

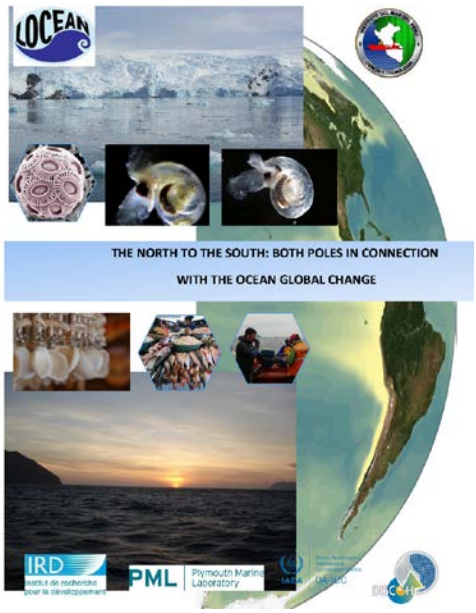
2. Activities/main accomplishments in 2015 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, etc.)

1- Workshops " KOSMOS PERU 2017 "AN OMZ MESOCOSM EXPERIMENT"

During 2014/2015 in Kiel, Germany at the GEOMAR institute and in Lima 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) with the participation of more than 60 scientist, mainly from Germany and Perú, IMARPE and Peruvian universities UPCH, UCSUR. The project is in the logistic phase and we have the permission for marine research off the San Lorenzo Island as a natural observatory and laboratory. The experiment will be launch in 2017. (information mgraco@imarpe.gob.pe)

2- SIDE EVENT COP 21

"The north to the south: both poles in connection with the ocean global change" ***side event (***9 July 2015, Paris) was organized by the University Paris VI UPMC, LOCEAN (France) and the Instituto del Mar del Perú (Perú) with the Plymouth Laboratory UK and University of Washington, Seattle USA. The side event combine research form the north to the south about the ocean and climate change and the importance in a global problem to have actions around the world in order to multiply the initiatives and impulse every stakeholders. This side event is connected with several side events presented during the COP 20 in Lima, Peru December 2014.



3- LAOCA Latinoamericana NETWORK of Acidification

Last December 2015 was establish at Concepción Chile the Latin American Ocean Acidification network (LAOCA) with the participation of Perú University Pedro Ruiz Gallo, Lambayeque, IMARPE Callao, Chile, Colombia, Argentina, Brazil, Mexico, Ecuador. The goal of LAOCA is combine efforts between Latin countries to develop a regional research on acidification directly connected with the GO-ON and international reference in this relevant and significant topic for the Uperlling areas.

5-**Low Oxygen Network GO2NE**

Last December IOC- UNESCO initiated the network of scientist focused on oxygen in open and coastal ocean. IGP and IMARPE participate in this first meeting to develop terms of reference and a plan for the multidisciplinary IOC UNESCO network.

4-Participation in several international conferences / OSC Open Science Conference 2015, Kiel Germany/ IMBER Italy/ AGO Fall meeting San Francisco USA

Several students and professionals form Perú, IGP, UPCH, IMARPE 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.

**Kalvelage T., Gaute Lavik, Marlene M. Jensen, Niels Peter Revsbech,Carolin Löscher, Harald Schunck, Dhwani K. Desai, Helena Hauss, Rainer Kiko,Moritz Holtappels, Julie LaRoche, Ruth A. Schmitz, Michelle I. Graco, Marcel M.M. Kuypers. 2015 Aerobic Microbial Respiration In Oceanic Oxygen Minimum Zones. PLOS ONE DOI 101371.*

** Dale, A. W., Sommer, S., Lomnitz, U., Montes, I., Treude, T., Liebetrau, V., Gier, J., Hensen, C., Dengler, M., Stolpovsky, K., Bryant, L. D., and Wallmann, K., 2015: Organic carbon production, mineralisation and preservation on the Peruvian margin, Biogeosciences, 12, 1537-1559, doi:10.5194/bg-12-1537-2015, 2015.*

** Bettencourt, J.H., C. López, E. Hernández-Garcia, I. Montes, J. Sudre, B. Dewitte, A. Paulmier, and V. Garçon, 2015: Boundaries of the Peruvian Oxygen Minimum Zone shaped by coherent mesoscale dynamics, Nature Geoscience, doi:10.1038/ngeo2570.*

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.

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

-Symposium-Australia Fourth International Symposium on the Ocean in a High-CO2 World Participation of IMARPE in the symposium with a grant IAEA/ Monaco May 2016.

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.

Comments

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS POLAND *compiled by: TYMON ZIELINSKI*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

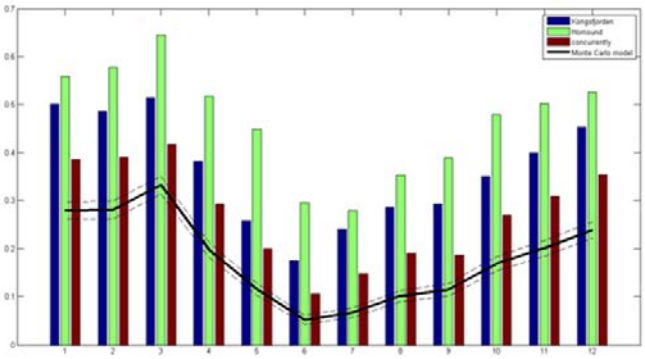
The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

The authors analyzed data series (1992-2013) of wind measurements from meteorological stations in Ny-Ålesund and Hornsund in Svalbard and compared them to surface layer winds from the NCEP/NCAR reanalysis. They showed large discrepancies between the local wind directions and directions of wind compatible with analyses of the pressure fields. They argue that one of the most important factors controlling wind directions in the Svalbard fjords is the temperature difference between the neighboring glaciers and surface sea temperatures of open waters warmed by the West Spitsbergen current. This creates atmospheric circulation patterns similar to night breeze in temperate climates.



Probability of breeze occurrence in Kongsfjorden (blue), Hornsund (green) and for both fjords simultaneously (red). The black lines (solid and dashed) represent probability of simultaneous breeze occurrence and its standard deviation, calculated from a Monte Carlo model.

Work submitted to a scientific journal as: Influence of breeze circulation on local wind climatology in Svalbard fjords: Kongsfjorden and Hornsund; Małgorzata Cisek, Dorota Gutowska, Przemysław Makuch, Marion Maturilli, Tomasz Petelski, Jacek Piskozub.

2. Activities/main accomplishments in 2015 (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. Organization of a discussion session on the Baltic Sea as a special case of a shelf sea during the SOLAS 2015 Conference.
2. Membership in the Board of Directors of the Centre for Polar Studies.
3. Organization of a national symposium called the Sopot Forum for Young Scientists.
4. Co-ordination of the public consultations within the Sea for Society project.
5. Lessons on sea and marine impact on climate changes for students of all ages within the EDUSCIENCE project.
6. Organization and running of a number of meetings with various steakholders within the 7 FP project Sea for Society.
7. Leaders in the POLAND-AOD network.
8. Polish coordination in the NASA Maritime Aerosol Network.
9. Membership in the Scientific Council of the Climate Forum – Science on Climate.
10. Coordination of the Sopot Association for the Advanced Sciences activities.
11. Organization of a number of public events, promoting science.
12. PIs in the iAREA Polish-Norwegian project.

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

1. Aerosol remote sensing in polar regions, Earth Science Reviews, 140, 108-157, C. Tomasi, A. Kokhanovsky, A. Lupi, Ch. Ritter, A. Smirnov, N. T. O'Neill, R. Stone, B. N. Holben, S. Nyeki, Ch. Wehrli, A. Stohl, M. Mazzola, Ch. Lanconelli, V. Vitale, K. Stebel, V. Aaltonen, G. de Leeuw, E.Rodriguez, A. B. Herber, V. Radionov, T. Zielinski, T. Petelski, S. Sakerin, D. Kabanov, Y. Xue, L. Mei, L. Istomina, R. Wagener, B. McArthur, P. Sobolewski, R. Kivi, Y. Courcoux, P. Larouche, S. Broccardo, S. Piketh, 2015.
2. Impact of climate changes on marine environments; Springer Series: GeoPlanet: Earth and Planetary Sciences; ISBN 978-3-319-14282-1; T. Zielinski, M. Weslawski, K. Kulinski, 2015.
3. Impact of breaking waves on sea salt production and local change of aerosol optical properties; Springer Series: GeoPlanet: Earth and Planetary Sciences; ISBN 978-3-319-14282-1, pp. 7-23; A. Strzalkowska, T. Zielinski, P. Makuch, P. Pakszys, T. Petelski, 2015.
4. 4. Annual changes of aerosol optical depth and Ångström exponent over Spitsbergen; Springer Series: GeoPlanet: Earth and Planetary Sciences; ISBN 978-3-319-14282-1, pp. 23-37; P. Pakszys, T. Zielinski, K. Markowicz, T. Petelski, P. Makuch, J. Lisok, M. Chilinski, A. Rozwadowska, Ch. Ritter, R. Neuber, R. Udisti, M. Mazzola, 2015.

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.)

1. Ny-Alesund Flagship programs, spring 2016 international campaign.
2. NASA AERONET, ongoing activities.
3. POLAND-AOD, ongoing activities.

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

1. Organization and chairing of an international aerosol workshop, which was a contribution to the Ny-Aalesund Atmosphere Flagship Programme (28-29 January 2016).
2. Co-organization of a winter aerosol school (6-13 March 2016).
3. Organization of school competition (theatre plays) entitled: I live by the sea. Sea stories (19 May 2016. Activity within the framework of the European Marine Days).
4. Organization of an international conference for young scientists entitled: Where the World is Heading (20 May 2016).
5. Continuation of work within the POLAND-AOD network.
6. Polish coordination in the NASA Maritime Aerosol Network (agreement until 2019).

7. Membership in the Scientific Council of the Climate Forum – Science on Climate.
8. Coordination of the Sopot Association for the Advanced Sciences activities.

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')

None at the moment. A number of projects to be submitted during 2016.

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 2016. We will seeks funding on both 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 2015 and future activities

SOLAS Spain *compiled by: Alfonso Saiz-Lopez*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

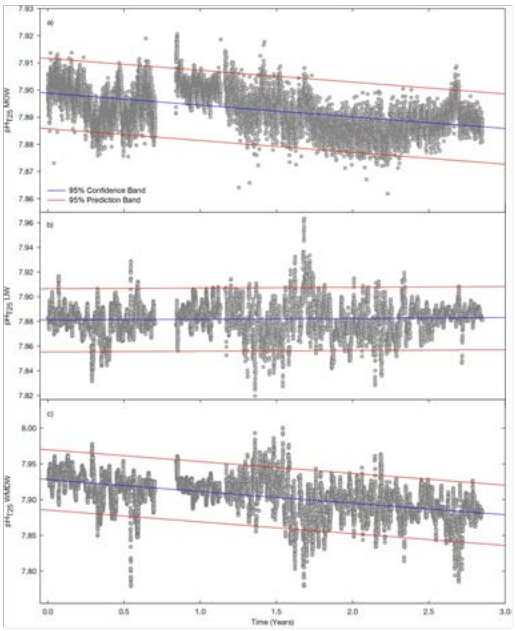
IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups)!*

PART 1 - Activities from January 2015 to December 2015

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.

Assessing ocean acidification in the Mediterranean Sea



The trend of pH decrease with time in the Mediterranean Sea was assessed through high frequency observational data collected at the Strait of Gibraltar. Continuous pH measurements taken at the time series GIFT during 3 years documented a remarkable decreasing annual rate of −0.0044 ± 0.00006 pH units in the Mediterranean, which can be interpreted as an indicator of ocean acidification in the basin. Modelling pH data of the Mediterranean outflow water (MOW) allowed to discriminate between the pH values of its two main constituent water masses, the Levantine Intermediate Water (LIW) and the Western Mediterranean Deep Water (WMDW). Both water masses also exhibited a decline in pH with time, particularly the WMDW, which could be related to their different biogeochemical nature and processes occurring during transit time from respective formation sites to the Strait of Gibraltar.

Figure: Linear fitting of pH with time of the MOW and its forming water masses during the monitoring period: (a) MOW, (b) LIW and (c) WMDW. Blue and red lines represent the 95% confidence and prediction bands, respectively.

Flecha, S., Pérez, F.F., García-Lafuente, J., Sammartino, S., Rios, A.F., Huertas, I.E. Trends of pH decrease in the Mediterranean Sea through high frequency observational data: indication of ocean acidification in the basin. *Scientific Reports-Nature,* 5, 16770, doi: 10.1038/srep16770. 2015

2. Activities/main accomplishments in 2015 (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:

Carbon cycle and greenhouse fluxes over the Gulf of Cadiz (CTM2014-59244-C3-1-R). Period: 01/01/2015 - 31/12/2017. Contact: Jesús Forja, University of Cadiz, <jesus.forja@uca.es>

INGOS (Integrated non CO2 greenhouse gas observing system), funded by the 7th Frame Program of the European Commission, 2011-2015. Spanish partners: CSIC and Fundación Centro de Estudios Ambientales del Mediterráneo. Contact: I. E. Huertas, ICMAN-CSIC <emma.huertas@icman.csic.es>

Field Campaigns:

Four oceanographic campaigns at the Strait of Gibraltar on board the RVs SOCIB (June and December) and Ramon Margaleff (June and November) were carried out to sample the ocean time series GIFT and to maintain the mooring line containing moored pCO_2 and pH sensors that are being used to monitor the temporal variability of CO_2 and ocean acidification in the Mediterranean Sea. PI and contact: E. Huertas, ICMAN-CSIC

International collaborations

The ICMAN-IIM (CSIC) group participated in the annual meeting of the SCOR (Scientific Committee for Oceanographic Research) Working Group 143 *Dissolved N_2O and CH_4 Measurements: Working Towards a Global Network of Ocean Time Series Measurements of N_2O and CH_4* held in Kiel (Germany) in September. Report from the first inter-calibration exercise amongst 10 WG members has been sent out.

Events

The ICM-CSIC, ICMAN-IIM (CSIC), IQFR-CSIC groups attended the 2015 SOLAS Open Science Conference in Kiel.

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

Flecha S, Pérez FF, García-Lafuente J, Sammartino S, Rios AF, Huertas IE. 2015. Trends of pH decrease in the Mediterranean Sea through high frequency observational data: indication of ocean acidification in the basin. *Scientific Reports-Nature*, 5, 16770, doi: 10.1038/srep16770.

Burgos, M., A. Sierra, T. Ortega, J.M. Forja, 2015, Anthropogenic effects on greenhouse gas (CH4 and N2O) emissions in the Guadalete River Estuary (SW Spain), *Science of the Total Environment*, 503, 179-189.

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.

de la Fuente, M., Skinner, L., Calvo, E., Pelejero, C. and Cacho, I., 2015, Evidence for increased reservoir ages and poorly ventilated deep waters in the glacial eastern equatorial Pacific. *Nature Communications*, doi:10.1038/ncomms8420.

Navarro, M., E. L. Atlas, A. Saiz-Lopez, X. Rodriguez-Lloveras, D. E. Kinnison, J-F. Lamarque, S. Tilmes, M. Filus, N. R. P. Harris, E. Meneguz, M. J. Ashfold, A. J. Manning, C. A. Cuevas, S. M. Schauffler, and V. Donets, 2015, Airborne measurements of organic bromine compounds in the Pacific tropical tropopause layer**,** *PNAS*, doi:10.1073/pnas.1511463112.

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.)

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).

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

School

The ICMAN-CSIC team will be in charge of organizing the workshop *Climate change and coastal wetlands: role on the atmospheric exchange of GHGs and impact on the ecosystem services* sponsored by the Universidad Internacional Menéndez Pelayo, which will be held in Seville in July 2016.

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')

Projects

Effect of the permeabilization of Doñana marshland on the biogeochemical structure of the wetlands, funded by the Spanish Ministry of Food, Agriculture and Environment. 2015-2018. PI and contact: E. Huertas, ICMAN-CSIC <emma.huertas@icman.csic.es>, related to SOLAS activities 1.5, 2.1, 2.2 and 3.3.

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 2015 and future activities

SOLAS Taiwan *compiled by: Gwo-Ching Gong*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

PART 1 - Activities from January 2015 to December 2015

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.

Dissolved organic nitrogen in wet deposition of the southern East China Sea:

In 2015, air pollution problem has become a big issue in the Northeast Asia, because of the accelerated economic development, high levels of urbanization, restructuring of the agricultural industry, thriving industrial industry, and increased use of fossil fuels. From January 2012 until June 2013, 78 rainwater samples were collected over an 18-month period and were analyzed to examine the total dissolved nitrogen (TDN), dissolved inorganic nitrogen (DIN), dissolved organic nitrogen (DON) and major ions in the rainwater. The concentrations of dissolved nitrogen species observed in the research area between November 2012 and April 2013 were relatively high, whereas those observed between May 2013 and October 2012were relatively low. The patterns of changes over time were similar to those of non-sea-salt (nss) ions. The amounts of DIN and DON accounted for 63± 5% and 37 ± 5% of the TDN, respectively, and the percentage of the DIN was higher during the spring and winter. The concentrations of low molecular weight – DON (LMW-DON) and high molecular weight – DON (HMW-DON), which accounted for 84 ± 3% and 16 ± 3% of the DON, respectively, were both high in the winter and low in the summer. The percentage of LMW-DON increased in the summer, possibly because of the numerous oceanic air masses and typhoons. Regarding the wet deposition fluxes (Table 1), the DIN (197±10.27 $mmolm^{-2}$ yr^{-1}) and DON (129±6.82 $mmolm^{-2}$ yr^{-1}) accounted for approximately 64% and 36% of the TDN, respectively, and the LMW-DON (108 ± 5.97 $mmolm^{-2}$ yr^{-1}) and HMW-DON (19 ± 1.02 $mmolm^{-2}$ yr^{-1}) accounted for 85% and 15% of the DON, respectively. The wet deposition flux of the nitrogen species observed in the

research area was 332 ± 16.0 mmolm^{-2} yr^{-1}, and the total flux (dry and wet deposition) was approximately 393.4 ± 25.2 mmolm^{-2} yr^{-1} (5508 ± 353 mg N m^{-2} yr^{-1}).

References:

Chen, Y.X., Chen, H.Y., Wang, W., Yeh, J.X., Chou, W.C., Gong, G.C., Tsai, F.J., Huang, S.J., Lin, C.T. (2015), Dissolved organic nitrogen in wet deposition in a coastal city (Keelung) of the southern East China Sea: Origin, molecular composition and flux, Atmospheric Environment, 112, 20-31.

Table 1. Annual fluxes of various nitrogen species in dry and wet deposition (mmol m^{-2} yr^{-1})

	TN	ON	LMW-ON	HMW-ON	IN
Dissolved	327±9.89	127±6.06	108±5.97	19±1.02	200±7.81
Water-soluble*	61.4±19.5	22.2 ± 8.8	11.2±3	11±4.6	39.2 ±17.4

2. Activities/main accomplishments in 2015 (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 joint research project of three-year (2013-2015) between Taiwan and Russia has been conducting to compare the carbonate system and pertinent chemical hydrography between the East China Sea and the Sea of Japan.

3. Top 5 publications in 2015 (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.

1. Chen, Y.X., Chen, H.Y., Wang, W., Yeh, J.X., Chou, W.C., Gong, G.C., Tsai, F.J., Huang, S.J., Lin, C.T. (2015), Dissolved organic nitrogen in wet deposition in a coastal city (Keelung) of the southern East China Sea: Origin, molecular composition and flux, Atmospheric Environment, 112, 20-31.
2. Chou, W.C., Gong, G.C., Hsieh, P.S., Chang, M.H., Chen, H.Y., Yang, C.Y., Syu, R.W. (2015), Potential impacts of effluent from accelerated weathering of limestone on seawater carbon chemistry: A case study for the Hoping power plant in northeastern Taiwan, Marine Chemistry, 168, 27-36.
3. Tsai, A.Y., Gong, G.C., Hu, S.L., Chao, C.F. (2015), The effect of grazing and viral lysis on the diel variations of Synechococcus spp. abundance in the East China Sea, Estuarine Coastal and Shelf Science, 163, 108-115.
4. Tsai, A.Y., Gong, G.C., Shiau, W. (2015), Viral lysis and nanoflagellate grazing on prokaryotes: effects of short-term warming in a coastal subtropical marine system, Hydrobiologia, 751, 43-54.
5. Chung, C.C., Gong, G.C., Huang, C.Y., Lin, J.Y., Lin, Y.C. (2015), Changes in the Synechococcus Assemblage Composition at the Surface of the East China Sea Due to Flooding of the Changjiang River, Microbial Ecology, 70, 677-688.
6. Yeh, Y.C., Peres-Neto, P.R., Huang, S.W., Lai, Y.C., Tu, C.Y., Shiah, F.K., Gong, G.C., Hsieh, C.H. (2015), Determinism of bacterial metacommunity dynamics in the southern East China Sea varies depending on hydrography, Ecography, 38, 198-212.
7. Liu, K.K., Yan, W.J., Lee, H.J., Chao, S.Y., Gong, G.C., Yeh, T.Y. (2015), Impacts of increasing dissolved inorganic nitrogen discharged from Changjiang on primary

production and seafloor oxygen demand in the East China Sea from 1970 to 2002, Journal of Marine Systems, 141, 200-217.

8. Chen, C.C., Hsu, S.C., Jan, S., Gong, G.C. (2015), Episodic events imposed on the seasonal nutrient dynamics of an upwelling system off northeastern Taiwan, Journal of Marine Systems, 141, 128-135.
9. Lui, H.K., Chen, C.T.A., Lee, J., Wang, S.L., Gong, G.C., Bai, Y., He, X.Q. (2015), Acidifying intermediate water accelerates the acidification of seawater on shelves: An example of the East China Sea, Continental Shelf Research, 111, 223-233.
10. Shih, Y.Y., Hung, C.C., Gong, G.C., Chung, W.C., Wang, Y.H., Lee, I.H., Chen, K.S., Ho, C.Y. (2015), Enhanced particulate organic carbon export at eddy edges in the oligotrophic Western North Pacific Ocean, PLOS One, 7, DOI: 10.1371/journal.pone.0131538.

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.)

Promote second phase (2015.8-2018.7) of integrated project of "***Effects of Global Change on Ocean Biogeochemistry and Ecosystems in the Seas surrounding Taiwan in the Northwest Pacific (ECOBEST-II)".***

There are three major research categories which are:

1. Marine and Atmospheric Physics,
2. Riverine and Atmospheric Nutrients,
3. Ocean Acidification.

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

1. 2016 Taiwan Geosciences Assembly (TGA), 16 to 20 May, 2016, Taipei, Taiwan.
2. AOGS 13th Annual Meeting, "Effects Of Global Change On Marine Biogeochemistry And Ecosystem In Marginal Seas: A Session Tribute To Prof. K. K. Liu." (Section OS6), 31 Jul to 5 Aug, 2016, Beijing, China.

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')

Please kindly see Part 2 Section 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)

Please kindly see Part 1 Section 2.

5. Engagements with other international projects, organisations, programmes etc.
N/A.

Comments

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS UK *compiled by:* *Tom Bell*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

PART 1 - Activities from January 2015 to December 2015

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.

Exciting work, largely supported by a NERC research grant, has been looking at the sources of marine biogenic ice nucleating particles (INPs) that could be triggering ice formation in clouds in remote regions. Wilson et al. (Nature 525, 234–238, 2015) provide evidence that marine particles may be important for ice formation in clouds in areas with low dust content such as the Southern Ocean. Experiments with surface ocean samples demonstrated that microlayer organic material that can be ejected into the atmosphere are highly effective at causing water droplets to freeze. Exudates from diatoms (like those found in the microlayer samples) were also shown to enhance ice particle formation. The authors used a model to extrapolate their data to the global picture. The results could have implications for our understanding of future climate change.

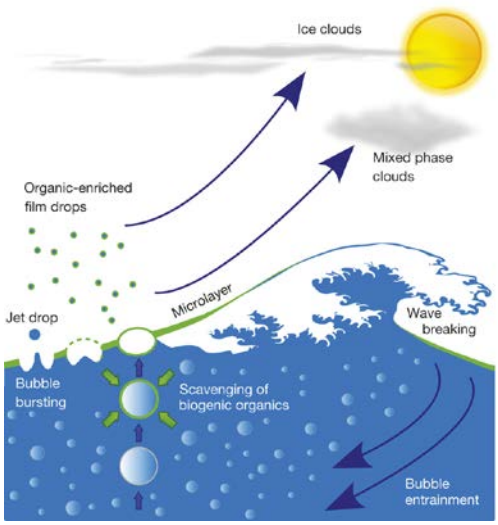


Figure 1 | Sea-spray aerosol particles enriched in organic material are generated when bubbles burst at the air–sea interface. Surface active organic material of biological origin is scavenged at the interfaces of bubbles as they rise through the water column. This process enriches the air–sea interface with surface active organic material forming the SML (green layers). The organic material is ejected on bubble bursting with resulting submicrometre film drops being enriched with organic material compared with larger jet drops. We show that the biogenic organic material in the SML is probably an important source of atmospheric INPs that could influence cloud properties.

The work involved substantial collaboration (4 countries, 15 institutes). The paper was covered by the BBC. Further fieldwork has also been conducted at the Mace Head atmospheric research station as part of a new ERC consolidator grant (MarineIce).

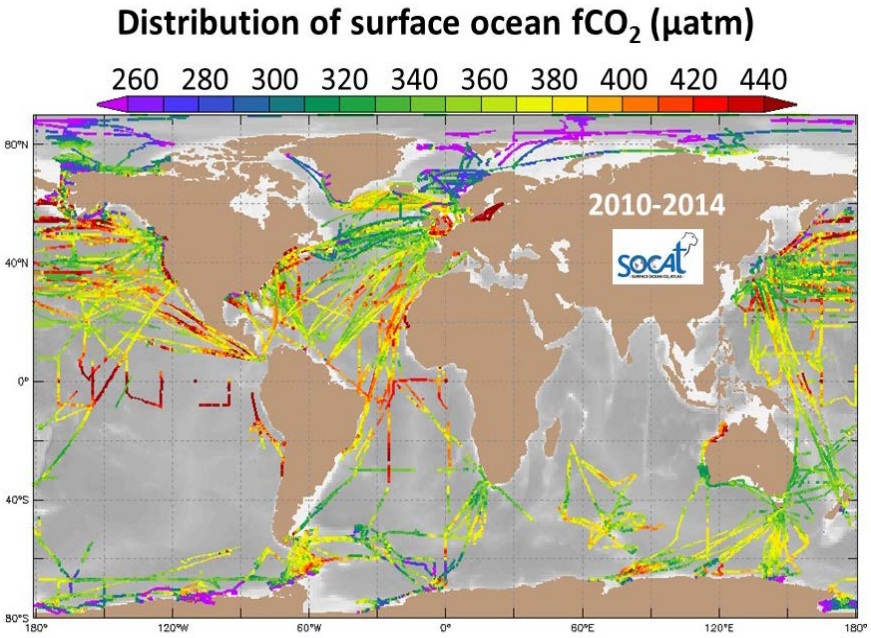
2. Activities/main accomplishments in 2015 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, etc.)

Accomplishments

1. Release of SOCAT version 3 and launch of the SOCAT automation system

The international, seagoing marine carbon community released version 3 of the Surface Ocean CO_2 Atlas (SOCAT, www.socat.info) on 7 September 2015 (SOCAT and SOCOM, 2015; Bakker et al., in prep.). Version 3 has 14.5 million quality controlled, surface ocean CO_2 values collected between 1957 and 2014. The observations span the global oceans and coastal seas. The data distribution in SOCAT is uneven with most measurements made in recent decades and in the northern hemisphere.

The SOCAT automation system is now operational (SOCAT and SOCOM, 2015) and will allow annual updates to SOCAT. SOCAT is being used for estimating the ocean carbon sink from year to year. Scientists participating in the Surface Ocean pCO_2 Mapping Project (SOCOM) have concluded that the global ocean carbon sink varies considerably from year to year and that global ocean carbon models underestimate this year-to-year variation in the ocean carbon sink (Rödenbeck et al., 2015). SOCAT represents a milestone in research coordination, data access, biogeochemical and climate research and in informing policy. Long-term funding for sustained, high-quality ocean carbon observations and their synthesis is essential for detection of changes in carbon uptake by the our planet's oceans.



- Olsen, A., Metzl, N., Bakker, D. C. E., and O'Brien, K. (2015) SOCAT quality control cookbook - For SOCAT Version 3, available at: http://socat.info/upload/2015_SOCAT_QC_Cookbook_v3.pdf (last access: 11 December 2015).
- SOCAT and SOCOM, 2015. SOCAT (Surface Ocean CO_2 Atlas) and SOCOM (Surface Ocean pCO_2 Mapping Intercomparison) Event, SOLAS (Surface Ocean Lower Atmosphere Study) Open Science Conference, University of Kiel, Kiel, Germany, 7 September 2015, available at http://www.socat.info/upload/2015_SOCAT_and_SOCOM_Event_Report.pdf.

2. *Penlee Point Atmospheric Observatory*. First full year of data at a new atmospheric observatory situated on the south west coast of the UK (http://www.westernchannelobservatory.org.uk/penlee/). Led by PIs at Plymouth Marine Laboratory (Tom Bell and Mingxi Yang) and at Plymouth University (Simon Ussher), continuous measurements are made of meteorology, sulfur dioxide, ozone, carbon dioxide, methane, carbon monoxide aerosol composition and vertical fluxes of momentum, heat, CO_2 and CH_4. Two publications are just out (Yang et al, 2016a,b). The site has hosted a field campaign from University of Leicester and is now part of the NERC ACSIS (North Atlantic Climate System: Integrated Study) programme and Global Methane consortium (see Newly-funded projects: Part 2, Section 3).

Activities/Leadership

- UK leadership of the SCOR Sea Surface Microlayer Working Group – Co-Chair: M. Cunliffe (http://www.scor-int.org/Working_Groups/wg141.htm)
- UK leadership of ESA OceanFlux projects (http://www.oceanflux-ghg.org) – Lead PI: J. Shutler
- International Space Science Institute (ISSI) Working Group on Atmosphere-ocean gas exchange (2015-2017) - Lead PI: J. Shutler (http://www.issibern.ch/workinggroups/atmosgasexchange)
- Leadership on Ocean Acidification – UK consortium work has produced a special issue looking at impacts on the surface pelagic ocean (http://www.biogeosciences.net/special_issue160.html)

Newly-funded Projects – see Part 2, Section 3

Ongoing Projects

- 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
- Radiatively Active Gases from the North Atlantic Region and Climate Change (RAGNARoCC) – Lead PI: A. Watson (www.greenhouse-gases.org.uk/ragnarocc)
- Turbulent Exchange: Aerosols, Bubbles And Gases (UK contribution to HiWinGS) – Lead PI: I. Brooks
- Co-ordinated Airborne Studies in the Tropics (CAST) – Lead PI: N. Harris (http://www-cast.ch.cam.ac.uk/)
- Atlantic BiogeoChemical fluxes (ABC) – PI: E. McDonagh (http://www.rapid.ac.uk/abc/)
- UK-GEOTRACES consortium – PI: G. Henderson. Final open science meeting was at the Royal Society in London in December. https://royalsociety.org/events/2015/12/ocean-chemistry/
- 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.

- Dissolution of trace metals into seawater (Marie Curie) – Lead PI: Simon Ussher
- Oceanic Reactive Carbon: Chemistry-Climate impacts – Lead PI: Steve Arnold

Outreach

- Bakker, D. C. E., Currie, K., Landschützer, P., Olsen, A., Rödenbeck, C. (2015) The Ocean carbon sink from SOCAT and SOCOM. 7 September 2015 guest blog on the SOCAT and SOCOM Event on 7 September 2015 at the SOLAS Open Science Conference in Kiel, Germany, at ICOS RI (Integrated Ocean Carbon Observation System Research Infrastructure) website: https://www.icos-ri.eu/ (last access: 22 January 2016).
- Moriarty, R.., Bakker D. C. E., Andrew R. M., Peters G. P., Le Quéré, C., the Global Carbon Budget Team, SOCAT contributors (2015) Global Carbon Budget: Ocean carbon sink. Outreach leaflet by the Global Carbon Project, the Surface Ocean CO_2 Atlas and CarboChange. 6 pp.
- Moller, S.J. Carpenter, L.J. and Purvis, R.M. Development of an atmospheric chemistry exhibit for festivals, events and conferences. RSC Outreach Grant - Science in the Skies

3. Top 5 publications in 2015 (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 2015 publications (n = 39) 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.

- Achtert, P., I. M. Brooks, B. J. Brooks, J. Prytherch, P. O. G. Persson, and M. Tjernström. 2015: Measurement of wind profiles over the Arctic Ocean from ship-borne Doppler lidar. Atmos. Meas. Tech. 8, 4993-5007, doi: 10.5194/amt-8-4993-2015
- Andrews, S. J., Hackenberg, S. C. and Carpenter, L. J. (2015) Technical Note: A fully automated purge and trap GC-MS system for quantification of volatile organic compound (VOC) fluxes between the ocean and atmosphere, Ocean Science 11(2), pages 313-321
- Allan, J. D., Williams, P. I., Najera, J., Whitehead, J. D., Flynn, M. J., Taylor, J. W., Liu, D., Darbyshire, E., Carpenter, L. J., Chance, R., Andrews, S. J., Hackenberg, S. C., and McFiggans, G. (2015) Iodine observed in new particle formation events in the Arctic atmosphere during ACCACIA, Atmos. Chem. Phys., 15, 5599-5609, doi:10.5194/acp-15-5599-2015.
- Arnold SR; Emmons LK; Monks SA; Law KS; Ridley DA; Turquety S; Tilmes S; Thomas JL; Bouarar I; Flemming J; Huijnen V; Mao J; Duncan BN; Steenrod S; Yoshida Y; Langner J; Long Y (2015) Biomass burning influence on high-latitude tropospheric ozone and reactive nitrogen in summer 2008: A multi-model analysis based on POLMIP simulations, Atmospheric Chemistry and Physics, 15, pp.6047-6068. doi: 10.5194/acp-15-6047-2015
- Bell, T. G., De Bruyn, W., Marandino, C. A., Miller, S. D., Law, C. S., Smith, M. J., and Saltzman, E. S. (2015) Dimethylsulfide gas transfer coefficients from algal blooms in the Southern Ocean, Atmos. Chem. Phys., 15, 1783-1794, doi:10.5194/acp-15-1783-2015.
- Breider, T. J., Chipperfield, M. P., Mann, G. W., Woodhouse, M. T. and Carslaw, K. S. (2015) Suppression of CCN formation by bromine chemistry in the remote marine atmosphere. Atmosph. Sci. Lett., 16: 141–147. doi: 10.1002/asl2.539
- Brévière, E. H. G., Bakker, D. C. E., Bange, H. W., Bates, T. S., Bell, T. G., Boyd, P. W., Duce, R. A., Garçon, V., Johnson, M. T., Law, C. S., Marandino, C. A., Olsen, A., Quack, B., Quinn, P. K., Sabine, C. L., Saltzman, E. (2015) Surface ocean - lower atmosphere study: Scientific synthesis and contribution to Earth System science. Anthropocene. In press. doi.org/10.1016/j.ancene.2015.11.001.

Available online 11 November 2015.

- Carpenter, L. J. and Nightingale, P.D. (2015) Chemistry and Release of Gases from the Surface Ocean, Chemical Reviews 115(10), pages 4015-4034.
- Carpenter, L. J., Andrews, S. J., Lidster, R. T., Saiz-Lopez, A., Fernandez-Sanchez, M., Bloss, W. J., Ouyang, B. & Jones, R. L. (2015) A nocturnal atmospheric loss of CH_2I_2 in the remote marine boundary layer. Journal of Atmospheric Chemistry, DOI 10.1007/s10874-015-9320-6.
- Chance, R., Jickells, T.D., Baker, A.R. (2015) Atmospheric trace metal concentrations, solubility and deposition fluxes in remote marine air over the south-east Atlantic, Marine Chemistry 177, Part 1, pages 45-56, http://dx.doi.org/10.1016/j.marchem.2015.06.028
- Emmons LK; Arnold SR; Monks SA; Huijnen V; Tilmes S; Law KS; Thomas JL; Raut JC; Bouarar I; Turquety S; Long Y; Duncan B; Steenrod S; Strode S; Flemming J; Mao J; Langner J; Thompson AM; Tarasick D; Apel EC; Blake DR; Cohen RC; Dibb J; Diskin GS; Fried A; Hall SR; Huey LG; Weinheimer AJ; Wisthaler A; Mikoviny T; Nowak J; Peischl J; Roberts JM; Ryerson T; Warneke C; Helmig D (2015) The POLARCAT Model Intercomparison Project (POLMIP): Overview and evaluation with observations, Atmospheric Chemistry and Physics, 15, pp.6721-6744. doi: 10.5194/acp-15-6721-2015
- Fuzzi, S., Baltensperger, U., Carslaw, K., Decesari, S., Denier van der Gon, H., Facchini, M. C., Fowler, D., Koren, I., Langford, B., Lohmann, U., Nemitz, E., Pandis, S., Riipinen, I., Rudich, Y., Schaap, M., Slowik, J. G., Spracklen, D. V., Vignati, E., Wild, M., Williams, M., and Gilardoni, S. (2015 Particulate matter, air quality and climate: lessons learned and future needs, Atmos. Chem. Phys., 15, 8217-8299, doi:10.5194/acp-15-8217-2015.
- Goddijn-Murphy, L., D. K. Woolf, A. H. Callaghan, P. D. Nightingale, and J. D. Shutler (2016), A reconciliation of empirical and mechanistic models of the air-sea gas transfer velocity, J. Geophys. Res. Oceans, 121, 818–835, doi:10.1002/2015JC011096.
- Goddijn-Murphy, L. M., Woolf, D. K., Land, P. E., Shutler, J. D., and Donlon, C. (2015) The OceanFlux Greenhouse Gases methodology for deriving a sea surface climatology of CO_2 fugacity in support of air–sea gas flux studies, Ocean Sci., 11, 519-541, doi:10.5194/os-11-519-2015.
- Heinze, C., Meyer, S., Goris, N., Anderson, L., Steinfeldt, R., Chang, N., Le Quéré , C., Bakker, D. C. E. (2015) The ocean carbon sink – impacts, vulnerabilities and challenges. Earth System Dynamics 6:327-358. doi:10.5194/esd-6-327-2015.
- Jones, E.M., Bakker, D. C. E., Venables, H. J., Hardman-Mountford, N. (2015) Seasonal cycle of CO_2 from the sea ice edge to island blooms in the Scotia Sea, Southern Ocean, Marine Chemistry 177: 490-500. doi:10.1016/j.marchem.2015.06.031.
- Land, P.E., J.D. Shutler, H.S. Findlay, F. Girard-Ardhuin, R. Sabia, N. Reul, J.-F. Piolle, B. Chapron, Y. Quilfen, J.E. Salisbury, and others (2015). Salinity from space unlocks satellite-based assessment of ocean acidification. Environmental Science & Technology 49:1,987–1,994, http://dx.doi.org/10.1021/es504849s.
- Landschützer, P., Gruber, N., Haumann, F. A., Rödenbeck, C., Bakker, D. C. E., Heuven, S. van, Hoppema, M., Metzl, N., Sweeney, C., Takahashi, T., Tilbrook, B., Wanninkhof, R. (2015) The reinvigoration of the Southern Ocean carbon sink. Science 349 (6253): 1221-1224. doi:10.1126/science.aab2620.
- Leedham Elvidge, E. C., Phang, S.-M., Sturges, W. T., and Malin, G. (2015) The effect of desiccation on the emission of volatile bromocarbons from two common temperate macroalgae, Biogeosciences, 12, 387-398, doi:10.5194/bg-12-387-2015,.
- Legge, O. J., Bakker, D. C. E., Johnson, M. T., Meredith, M. P, Venables, H. J., Brown, P. J., Lee, G. A. (2015) The seasonal cycle of ocean-atmosphere CO_2 Flux in Ryder Bay, West Antarctic Peninsula. Geophysical Research Letters 42(8): 2934-2942. doi:10.1002/2015GL063796.
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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 release of SOCAT version 4 is planned for June 2016.
- A special issue on Ocean Acidification will be published in DSR-II in 2016, entitled: Impacts of surface ocean acidification in polar seas and globally: a field-based approach
- Ian Brooks' group (Leeds) expects to participate in a research cruise on the Swedish Icebreaker Oden during August-September 2016. Measurements will focus on turbulent exchange over sea ice, and the impact of ice fraction and ice properties (thickness, ridging, melt ponds, etc) on the transfer coefficients. Our measurements (joint with Stockholm University) piggy back on a sea-bed mapping project, and are a first step in longer term plans to develop a semi-permanent instrumentation suite on Oden with which to make longer-term measurements of atmospheric processes and properties in the Arctic, including surface exchange.

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

2nd International Workshop on Air-Sea Gas Fluxes : Progress and Future Prospects (6-9 September 2016, Brest, France)

This follows on from the first successful workshop that was held in 2013. This is a highly interdisciplinary workshop aimed at bringing the multiple communities (e.g. in situ, remote sensing and modelling) studying air-sea exchange and gas fluxes together to present and discuss recent advances, and common aims, goals and challenges.

Abstract submission is now open, with a submission deadline of 15 May 2016. Registration and submission link: http://www.oceanflux-ghg.org/Workshop/Registration

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')

Newly-funded Projects (no specific order)

- Biogeochemical cycling of N-osmolytes in the surface ocean (NERC) – Lead PI: Y. Chen. http://gtr.rcuk.ac.uk/projects?ref=NE/M002233/1
- Microbial degradation of dimethylsulfoxide in the marine environment (NERC) – Lead PI: H. Schaefer. http://gtr.rcuk.ac.uk/projects?ref=NE/L006448/1
- Iodide in the ocean: Distribution and impact on iodine flux and ozone loss (NERC) – Lead PI: L. J. Carpenter. http://gtr.rcuk.ac.uk/projects?ref=NE/N009983/1
- The Global Methane Budget (NERC Highlight Topic) – Lead PI: E. Nisbet
- Are sooty ships enhancing the primary productivity in the ocean? (Royal Soc.) – Lead PIs: Zongbo Shi, Huiwang Gao
- 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

NERC has commissioned five highly ambitious research programmes, worth £34m and spanning the next 5 years (http://www.nerc.ac.uk/press/releases/2016/11-multi/). Of these, four are very much within the SOLAS research domain:

1. The **ACSIS (North Atlantic Climate System: Integrated Study) programme** will improve the UK's capability to detect, explain and predict changes in the North Atlantic Climate System. Led by the National Centre for Atmospheric Science, in partnership with National Oceanography Centre (NOC), Plymouth Marine Laboratory (PML), British Antarctic Survey (BAS) and National Centre for Earth Observation (NCEO).
2. The **LOCATE (Land Ocean Carbon Transfer) programme** will establish how much carbon from soils is getting into our rivers and estuaries, determine what happens to it, and so answer questions about the long-term fate of the organic carbon held in the soil over the next 50 to 100 years. This is important, because scientists have estimated that soil is a major source of carbon that, if unlocked, could enter the atmosphere and contribute to climate change. Led by NOC, in partnership with CEH, PML and BGS.
3. The **ORCHESTRA (Ocean Regulation of Climate through Heat and Carbon Sequestration and Transports) programme** will use a combination of data collection, analyses and computer simulations to radically improve our ability to measure, understand and predict the circulation of the Southern Ocean and its role in the global climate. Led by BAS, in partnership with NOC, BGS, PML, the Centre for Polar Observation & Modelling (CPOM) and the Sea Mammal Research Unit.
4. The **UKESM (UK Earth System Modelling Project) programme** will develop the first UK Earth system model (ESM), based on a core Global Climate Model, HadGEM3 developed at the Met Office. The new ESM model will maintain the world-leading status of UK Earth system modelling and science, while also providing robust and detailed scientific support to the UK government through the 6th Intergovernmental Panel on Climate Change Assessment Report (AR6). Led by the National Centre for Atmospheric Science, in partnership with NOC, CEH, NCEO, BAS and BGS.

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. NERC is in the process of selecting from submitted proposals as part of a five year, £8.4 million research programme on 'The Changing Arctic Ocean: Implications for marine biology & biogeochemistry'.

2. The Strategic Programme Advisory Group (SPAG) helps NERC by recommending prioritised strategic research opportunities to Science Board. The priorities are generated from a broad and open input of ideas from the UK community.

   SPAG assembles certain ideas into either Highlight Topics or Strategic Programme Areas. A particularly SOLAS-relevant scoping group has been setup for one of the possible Strategic Programme Areas for 2016: 'Southern Ocean's role in the Earth System'

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

The Leeds ice nucleation group is working in conjunction with the EU funded BACCHUS project (http://www.bacchus-env.eu) on marine sources of ice nucleating particles. They jointly conducted a field campaign at Mace Head in summer 2015 and are working on the global modelling of ice nucleating particle concentrations including those from marine sources.

Comments

surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS USA *compiled by: Rachel Stanley*

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

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)!*

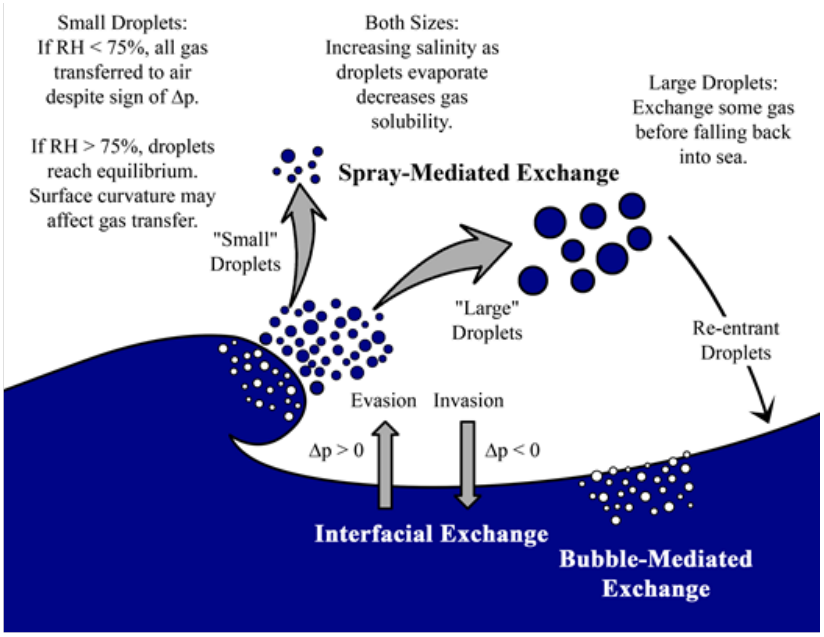
PART 1 - Activities from January 2015 to December 2015

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.

The Role of Sea Spray Droplets in Facilitating Air-Sea Gas Transfer

For over 30 years, air-sea interaction specialists have been evaluating and parameterizing the role of whitecap bubbles in air-sea gas exchange. However, the mirror-image process of how sea spray droplets can facilitate air-sea gas exchange is not known. E Andreas (Northwest Research Associates), P Vlahos (University of Connecticut) , and E Monahan (University of Connecticut) have been using sea-spray modelling approaches to quantify the role of sea-spray on air-sea gas transfer. First, they evaluated the three time scales that govern the exchange: τ_{air} (the rate of transfer between the atmospheric gas reservoir and the surface of the droplet); τ_{int} (the exchange rate across the air-droplet interface); and τ_{aq} (the gas mixing rate within the aqueous solution droplet), and showed that these timescales are all shorter than the microphysical time scales that quantify a spray droplet's physical evolution. Therefore, the gas in a spray droplet can be assumed to be in instantaneous equilibrium with the atmospheric reservoir. As a second step, they considered the upper limit of gas exchange assuming 100% saturation of model gases and 100% evaporation of all droplets. Results showed that sea spray could be a significant source of gas transfer into the atmosphere, even without 100% evaporation. Thus, sea-spray can be very important for the air-sea transfer of gases, particularly for those of higher relative solubility and for marine derived biogenic gases. This work was funded by the US National Science Foundation.



The figure depicts three routes for gas transfer: interfacial exchange, bubble-mediated exchange, and spray-mediated exchange. Modelling studies of spray-mediated exchange show it can be a significant source of gas transfer and that the exchange depends in large part on the size of the droplets, the percent evaporation of the droplet, and the solubility of the gas.

2. Activities/main accomplishments in 2015 (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 large number of SOLAS-related research projects were conducted in the USA in 2015. A summary of all the topics would be too long to include. Thus below is simply a selection of 10 exciting projects, field campaigns, and other significant contributions, listed in alphabetical order.

Arctic Ocean Primary Production Model-Data Comparison: A model-data comparison spearheaded by P Matrai (Bigelow), in collaboration with Y Lee (Bigelow), M Friederich (VIMS) and V Saba (NOAA) has been comparing in situ net primary production data from 1959 to 2011 in the Arctic Ocean to predictions by a suite of numerical models of varying complexity from ocean color to earth system models. Initial results suggest that the models in general perform better in ice-free regions, in summer than in the spring, and in the recent decade compared to the older data. The models underestimate values of primary production and overestimate nitrate concentration and euphotic zone depth.

Atmospheric Chemical Species in the Arctic: The rich dataset of air chemistry over Arctic sea ice continues to grow with the additional deployment of four O-Buoys in 2015. The autonomous buoys collect observations of BrO, O_3, and CO_2, as well as meteorological parameters (http://www.o-buoy.org). The project is a collaboration of PIs from 5 USA institutions and all data is freely available on the web at https://www.aoncadis.org

Field Portable Noble Gas Mass Spectrometer: A field portable mass Gas Equilibration Mass Spectrometer (GEMS) for measuring noble gases in air or seawater has been developed by C Manning (WHOI) and R Stanley (Wellesley College). The instrument can be used to collect continuous measurements of Ne, Ar, Kr and Xe ratios with an e-folding response time of 1.5 to 8 minutes, enabling large amounts of noble gas data to be collected with relative ease. Details on the

instrument are available in an article published in Analytical Chemistry (doi:10.1021/acs.analchem.5b03102).

Gas Transfer at Water Surfaces Symposium: The Seventh International Symposium on Gas Transfer at Water Surfaces took place from May 18 to 21, 2015 in Seattle, Washington. The symposium, organized by W Asher and A Jessup (both from the Applied Physics Lab, UW), covered a wide range of air-sea gas transfer topics including discussions of field observations, laboratory and numerical studies of gas water fluxes of mass, heat and particulates. It also included discussions of ocean acidification, biological effects, and high latitude processes. Proceedings of the conference will soon be published and will be accessible freely online.

GEOTRACES Arctic Cruise: The US GEOTRACES program conducted an Arctic Expedition from Aug 9 to Oct. 11, 2015. Scientists on board the US Coast Guard Cutter Healy occupied 66 GEOTRACES and Repeat Hydrography stations, collecting aerosols, water and particles. Additionally, scientists sampled under-ice seawater, snow, ice and meltponds.

Harmful Algal Blooms stimulated by Atmospheric Deposition: Remote sensing analysis of blooms in the East China Sea conducted by K Mackey (UC Irvine), M Kavanaugh (WHOI) and colleagues show that harmful algal blooms composed of dinoflagellates were associated with increased aerosol optical thickness and decreased sea surface temperature. By combining the remote sensing data with bottle incubation studies, the scientists hypothesize that atmospheric deposition is fueling harmful algal blooms, probably because the aerosols increase the surface ocean ratio of nitrogen to phosphorous and cause intensified phosphorus limitation.

Nitrous Oxide Field Measurements: Measurements of nitrous oxide (N_2O) were integrated into the monthly sampling program at the San Pedro Ocean Time-series, located along the west coast of the U.S. By combining N_2O measurements with nitrification rates, A Santoro (U of Maryland), D Capone (USC) and colleagues are determining whether atmospheric N_2O fluxes are dominated by local production or advection from the eastern tropical North Pacific oxygen deficient zone.

Oxygen Minimum Zone Denitrification: Profiling floats from the Applied Physics Laboratory (UW) were equipped with gas tension devices (GTDs) by E D'Asaro, C McNeil, and A Reed to study denitrification rates and processes in OMZ's. The floats were tested in a cruise off Mexico and provided estimates of excess N_2 similar to those determined by M Altabet and A. Bourbonnais (U of Massachusetts Dartmouth) using N_2/Ar from mass spectrometry.

SUSTAIN wind-wave tank: University of Miami's new wind-wave tank capable of reproducing category 5 hurricanes opened in 2015 under the directorship of B Haus. The acrylic tank is 23 m x 6 m x 2 m, can be filled with fresh or saltwater, and is equipped with a single 1460 HP fan that can generate winds up to 64 m s^{-1} (which, when scaled by boundary layer profile, is equivalent to wind speed of 100 m s-1). The tank can be used to investigate a wide range of atmospheric-ocean boundary processes at high wind speeds.

Tudor Hill Marine Atmospheric Observatory in Bermuda was rebuilt and reopened in December, 2015. The location of the tower on the island of Bermuda provides opportunity to sample marine air masses without having to use a ship or mooring. Weekly bulk aerosol and rainwater sampling have recommenced. Sampling is routinely made to monitor organic pollutants, ozone, CO_2 and other greenhouse gases, and air column properties. Opportunities are open for collaboration to measure or collect other parameters. http://www.bios.edu/research/projects/tudor-hill-marine-atmospheric-observatory/

3. Top 5 publications in 2015 (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.

Many excellent SOLAS relevant papers were published by US authors in 2015. 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 2015.

Evans, W, J T Mathis, J N Cross, N R Bates, K E Frey, B G T Else, T N Papkyriakou, M D DeGrandpre, F Islam, W-J Cai, B Chen, M Yamamoto-Kawai, E Carmack, W J Williams, T Takahashi. 2015, Sea-air CO_2 Exchange in western Arctic Coastal Ocean. *Global Biogeochemical cycles.* 29: 1190-1209, DOI: 10.1002/2015GB005153

Munro D R, N S Lovenduski, B B Stevens, T Newberger, K R Arrigo, T Takahashi, P D Quay, J Sprintall, N M Freeman, and C Sweeney. 2015. Estimates of net community production in the Southern Ocean determined from time series observations (2002-2011) of nutrients, dissolved inorganic carbon, and surface ocean pCO_2 in Drake Passage. *Deep Sea Research Part II: Topical studies in Oceanography*. 114: 49-63. DOI: 10.1016/j.dsr2.2014.12.014

Rivero-Calle, S., A Gnandadesikan, C E Del Castillo, W M Balch, and S D Guikema. 2015. Multidecadal increase in North Atlantic coccolithophores and the potential role of rising CO_2. *Science.* 350: 1533-1537. DOI: 10.1126/science.aaa8026

Schwendeman M and J Thomson: Observations of whitecap coverage and the relation to wind stress, wave slope, and turbulent dissipation. 2015. *Journal of Geophysical Research: Oceans*, 120: 8346-8363. DOI: 10.1002/2015JC011196

Varaljay, V A, J Robidart, C M Preston, S M Gifford, B P Durham, A S Burns, J P Ryan, R Marin, III, R P Kiene, J P Zehr, C A Scholin, M A Moran, 2015. Single-taxon field measurements of bacterial gene regulation controlling DMSP fate. *ISME JOURNAL* 9, 1677-1686. DOI: 10.1038/ismej.2015.23

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.)

NAAMES: NASA has commenced a five year investigation entitled North Atlantic Aerosols and Marine Ecosystem Study (NAAMES) which is aimed to study the connection between atmospheric aerosols and key oceanic processes controlling marine ecosystems, with an emphasis on implications for climates. Fieldwork associated with the project started in 2015 and will continue through 2018, consisting of four targeted ship and aircraft measurement campaigns. The field campaigns will be combined with continuous satellite and in situ ocean sensor records and with modelling studies.

EXPORTS: NASA is planning a large field campaign entitled Export Processes in the Ocean from RemoTe Sensing (EXPORTS). The focus of the campaign is to develop a predictive understanding

of the export and fate of global ocean net primary production (http://dx.doi.org/10.3389/fmars.2016.00022). While the details of the field experiments are still being discussed by the Science Definition Team, it is likely that the main field activities will start in the North Atlantic Ocean in 2018 followed by field activities in the North Pacific in 2020. Projects related to mining previous data and modelling studies are already commencing.

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 (I08S, I09N) in 2016 and (I05, I06S) in 2018 and 2019, in the Pacific ocean (P18, P06) in 2016 and 2017, and in the Atlantic Ocean (A13.5) in 2019.

Ongoing US Time-series: Regular cruises (typically monthly but each time-series differs) will occur in 2016 in the Pacific Ocean near Hawaii as part of the Hawaii Ocean Time-series (HOT), in the Sargasso Sea as part of the Bermuda Atlantic Time-series Study (BATS), in the Cariaco Basin as part of the CARIACO Ocean Time-series, and in coastal California waters as part of of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) time series.

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

Arctic Science Summit Week, March 12-18, 2016. Fairbanks, AK. Annual gathering of international scientists and policymakers who advance Arctic research.

Cornell Satellite Remote Sensing Program, June 3-17, 2016, 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.

Ocean Global Change Biology Gordon Conference. July 17-22, 2016. Watervillle Valley, NH. Conference focuses on understanding the consequences of global ocean change on marine organisms.

Organic Geochemistry Gordon Conference. July 24-29, 2016. Holderness NH. Theme is applying new technologies to address current and future societal challenges.

Ocean Carbon Biogeochemistry Workshop: July 25-28, 2016. Woods Hole, MA. Annual workshop that highlights research and includes substantial time for community discussion of new directions.

Joint 21st Satellite Meteorology, Oceanography and Climatology Conference and 20th conference on Air-Sea Interaction. Aug 15-19, 2016 in Madison, WI. A special session on sea surface processes, including waves, spray, bubbles and aerosols in honour of Ed Andreas will be one of 25 separate and joint sessions between the two conferences.

American Association for Aerosol Research Annual Conference. Oct 17-21, 2016. Portland, OR.

Annual Meteorological Society Annual Meeting. Jan 22-26, 2017. Seattle.

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')
There are too many US projects to report. Please see the planned studies section for some large-scale projects relevant to SOLAS.
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)
Nothing to report.
5. Engagements with other international projects, organisations, programmes etc.
Nothing to report.

Comments