surface ocean solas lower atmosphere study

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Chamber measurements of air-ice CO_2 exchange at a field experiment near Kapisilit, Greenland, carried out by researchers from the Alfred Wenger Institute. (Photo credit: Bjarne Jensen, Aarhus University)

Mid-Term Strategy Science

Previously publicised in SOLASnews Issue 11, the SOLAS 'Mid-Term Strategy' is in progress and this newsletter comprises updates and scientific articles relating to five of the Mid-Term Strategy themes: 'Sea ice biogeochemistry and interactions with the atmosphere'; 'Ocean-derived aerosols: production, evolution and impact'; 'Atmospheric control of nutrient cycling and production in the surface ocean'; 'Ship plumes: impacts on atmospheric chemistry, climate and nutrient supply to the oceans' and 'Air-sea gas fluxes at Eastern boundary upwelling and Oxygen Minimum Zone (OMZ) systems'.

We also introduce our new SOLAS chair, Eric Saltzman (University of California Irvine), who is taking over from Doug Wallace (previously of IFM-GEOMAR and more recently Dalhousie University).

We would like to take this opportunity to thank Doug Wallace for his time as SOLAS Chair and wish him the very best as he relocates to Canada.

Also in this issue, we present our newest SOLAS nation, Mexico, and its national representative, José Martín Hernández-Ayon; we also offer a belated, public welcome to Stefan Kontradowitz, the newest member of the SOLAS team based at the International Project Office in Kiel, Germany; give updates on the penultimate activities of COST Action 735 "Tools for assessing global air-sea fluxes of climate and air pollution relevant gases" in follow-up to its finale event; a plea for SOLAS-relevant data from our SOLAS Data Integrator of our regular features: partner projects, national reports and conference calendar.

in this issue...

Mid-Term Strategy

At the 2008 SOLAS Scientific Steering Committee meeting in Cape Town, the committee identified some key, pressing scientific issues and areas where international coordination is required to make progress and could be provided by the support of an international programme such as SOLAS.

The following strategic themes have been developed:

- Sea-ice biogeochemistry and interactions with the atmosphere.
  Co-ordinator: Jacqueline Stefels (j.stefels@rug.nl)
- Ocean-derived aerosols: production, evolution and impacts.
  Co-ordinator: David Kieber (djkieber@mailbox.syr.edu)
- Atmospheric control of nutrient cycling and production in the surface ocean.
  Co-ordinator: Cecile Guieu (guieu@obs-vlfr.fr)
- Ship plumes: impacts on atmospheric chemistry, climate and nutrient supply to the oceans.
  Co-ordinator: Roland von Glasow (r.von-glasow@uea.ac.uk)
- Air-sea gas fluxes at Eastern boundary upwelling and Oxygen Minimum Zone (OMZ) systems.
  Co-ordinator: Véronique Garçon (veronique.garcon@legos.obs-mip.fr)
- SOLAS observatory and MOIN: The Minimalist OceanSITES Interdisciplinary Network.
  Co-ordinator: Doug Wallace (dwallace@ifm-geomar.de)

Since this meeting, the themes have developed at different rates with some in 'full-swing' having held meetings and collaborations underway; others having cultivated collaborations with future workshops and studies planned.

The support intended by SOLAS, to develop these key themes, is to provide a platform for hosting and promoting events and workshops; facilitate collaborations and networks amongst multidisciplinary communities; develop devoted studies; and, ultimately, gain a broad vision of and strengthen the activities and projects already pursuing research within each theme.

Within this issue of SOLASnews, we endeavour to share how five of the themes have progressed and introduce you to timely and relevant research being undertaken by members of the SOLAS community.

Atmospheric control of nutrient cycling and production in the surface ocean

Co-ordinator Cécile Guieu
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Background

Atmospheric deposition is an important pathway for nutrient and particle delivery to the surface ocean which may increase significantly in response to climate change. Atmospheric nutrient supply modifies nutrient inventories and influences phytoplankton nutrient stoichiometry, with feedbacks to atmospheric CO_2 via air-sea exchange and the ocean carbon sink. Yet, despite significant experimental, field and modelling work over the past decade, the links between atmospheric deposition, nutrient availability, ocean productivity, carbon cycling and feedback to climate are still poorly understood. In consequence, the role of atmospheric inputs remains underrepresented in marine biogeochemical models. The aim of this MTS theme is to identify new research directions and develop coordinated approaches to monitoring and testing surface ocean biota sensitivity to atmospheric deposition.

Proposed Developments

- To plan and systemise the maintenance and extension of time-series, in both hemispheres, of aerosol composition.
- To link proposals and synthesise experimental and analytical approaches to allow for future comparison in varying regions.

Progress

- A COST Action 735 workshop on "Atmospheric versus land based controls of nutrient cycling and production in the surface ocean: from fieldwork to modelling", 8-9 December 2010, in Istanbul (Full report can be found in SOLASnews Issue 12). A review article 'Impacts of atmospheric deposition on oligotrophic marine systems' is currently being written.
- Following the IGPB Fast Track Initiative 'Upper Ocean Nutrient limitation: processes, patterns and potential for change' workshop (3-5 November 2010, Southampton, UK coord. Mark Moore and Matt Mills), a review article is in preparation.
- At the ASLO conference in Puerto-Rico, 13-18 February 2011, a 'SOLAS' session was devoted to the theme (see Special Report).
- During the GEOTRACES Mediterranean Planning Workshop, 6-8 October 2010, Nice, France, the SOLAS-GEOTRACES cooperation in the Mediterranean Sea was enhanced where links exist in particular within atmospheric deposition studies.
- A related French SOLAS-IGAC meeting, 'Chemistry, transport and biogeochemistry feedback: frontiers in chemistry, physics and biology', took place from 29-30 June 2010 in Paris, France.
- A session on 'Atmospheric deposition impacts on biogeochemical cycling in the surface ocean: natural and anthropogenic disturbance' has been proposed to the 'Planet under Pressure' conference in London, 26-29 March 2012.
- The theme will also be largely covered in a planned publication 'Ocean-Atmosphere Interactions of Gases and Particles' which will mark the end of COST Action 735 next year.

Ship plumes: impacts on atmospheric chemistry, climate and nutrient supply to the oceans

Co-ordinator Roland von Glasow
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Background

Emissions of gases (mainly NO_X and SO_2) and particles from ocean-going ships have major impacts on photochemistry in the marine boundary layer and cloud properties; are potentially important for the deposition of nutrients to the ocean. Throughout large regions of the ocean, ship emissions dominate the natural sulphur emissions, largely of DMS, and therefore have to be considered in estimates of climate forcing by sulphate aerosols which are also directly released from ships. Ship emissions are important sources of nitrogen and the input of nitrogen into marine ecosystems might affect marine productivity. Furthermore the fluxes of carbonaceous aerosol particles as well as hydrocarbons are also significant. The effects on atmospheric photochemistry include the production of ozone in regions that are usually sinks for ozone and the pollution-induced release of reactive chlorine from sea salt, which has a lifetime of several days (due to multiphase cycling), so that it is significantly longer than the lifetime of the ship plume itself. Ship traffic has increased significantly in the last decade (but declined in the last years due to the economic crisis) and is projected to keep increasing.

Progress

As an outcome from the sessions held at the SOLAS Open Science Conference 2009 and EGU General Assembly 2011, four key questions have been defined and deemed of most importance to current studies.

1) How can sub-grid-scale ship plumes be parameterised in numerical models?

2) What are the regional and global quantitative impacts of ship emissions on atmospheric photochemistry?

3) What are the regional and global impacts of ship emissions on climate forcing?

4) Does nitrogen or heavy metal deposition due to ship emissions impact ocean biogeochemistry?

The articles by Chul Song and Geert Vinken found in this issue of SOLASnews follow from papers presented at these aforementioned sessions.

Ocean-derived aerosols: production, evolution and impacts

Co-ordinator David Kieber
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Background

The oceans are the largest global source of aerosol by mass to the atmosphere.

Produced by breaking waves and bursting bubbles, freshly produced marine aerosol is mass dominated by supermicrometer particles composed primarily of sea salt and number dominated by submicrometer aerosol composed of a mixture of sea salt and organic matter. Ocean-derived aerosols affect the atmospheric chemistry in both remote-, marine- and continentally-impacted marine regions. In addition, they determine aerosol optical depth in remote marine regions and are thought to play an important role in controlling cloud formation and properties, thereby affecting the Earth's radiation balance. There are many remaining questions concerning the production, evolution, and atmospheric impact of ocean-derived aerosols including:

- What is the chemical composition of ocean-derived aerosols?
- How do upper-ocean biogeochemical processes affect the flux and physical and chemical properties of marine aerosols?
- What are the sources of water soluble and insoluble organic matter present in nascent and aged marine aerosols and how do they vary seasonally in biologically productive and nonproductive regions of the ocean?
- What is the magnitude of size-resolved fluxes of ocean-derived aerosol and how do they vary spatially (e.g. coastal vs. open ocean) and temporally (e.g. seasonally)?
- What is the impact of ocean-derived aerosols on the chemistry of the troposphere in coastal regions where marine and continental air mixes and over the open ocean in regions minimally influenced by continental air?
- What is the effect of ocean-derived aerosols on aerosol direct and indirect forcing?
- What is the significance of submicrometer ocean-derived aerosols relative to continental emissions transported out over the oceans and emissions from marine vessels?

Proposed Developments

- Use of both controlled laboratory and ship-based experiments to determine the effects of physical and biological parameters on the production and properties of sea spray aerosol.
- Comparison of measured size-resolved sea spray aerosol production rates and parameterisations developed through various methods to develop accurate sea-spray source functions that take into account both inorganic and organic components and physical and biological controls.
- Characterise the composition of both nascent and aged ocean-derived aerosols.
- Assess the cloud-nucleating ability of ocean-derived aerosols.

Progress

- A workshop designed at assessing the composition of ocean-derived aerosols relative to the organic composition of surface seawater is in the planning stages.
- A plenary session and a discussion session on ocean-derived aerosols are planned for the SOLAS OSC in May 2012 with the goal of assessing what is known about ocean-derived aerosols; what the knowledge gaps are; and, how to move forward?

Air-sea gas fluxes at Eastern boundary upwelling and Oxygen Minimum Zone (OMZ) systems

Co-ordinator Véronique Garçon
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Background

Oxygen Minimum Zones (OMZs), known as suboxic layers, play a crucial role in climate evolution (greenhouse gas production) and in marine ecosystems (respiratory barrier, nitrogen loss through denitrification and anammox). However, feedback effects of OMZs are complex and remain to be quantified. The project will focus in the OMZ of the East Pacific, namely in the East Tropical South Pacific.

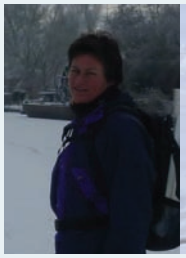
- Are emissions of the most important long-lived radiatively active gases N_2O, CO_2 and CH_4 coupled or decoupled during upwelling events, and which is the net greenhouse effect of the OMZs?
- Do OMZs have a significant role on the atmospheric cycle for the tropospheric and stratospheric ozone (O_3) through halogen compounds and N_2O, respectively?
- Is it possible to determine and assess the full influence of OMZs on climatic change considering their impact on greenhouse gases, cloud formation (DMS consumption) and control of O_3 and O_2?
- What is the role, in the greenhouse gases production, of the shift between an O_2-respiration (aerobic remineralization) towards a NO_3-, NO_2-, N_2O- and SO_4-"respiration", even to methanogenesis and to anaerobic mechanisms using other electrons acceptors (e.g. IO_3, Mn, Fe)?

Proposed Developments

- To develop into an articulated international project, connected with other mid-term SOLAS strategies, IGBP core-projects (IMBER and PAGES) and the SCOR project GEOTRACES.
- To acquire short- and long-term data (cruises, laboratory experiments, network, moorings, gliders, ARGO floats, ASIP, aircrafts) associated with the use of historical and new databases (e.g. MEMENTO for N_2O and CH_4, and maybe later for H_2S), remote sensing and analysis.
- To develop parameterizations, coupled biogeochemical/physical/atmospheric modelling, new numerical tools and large scale validation based on intercomparisons (mainly between the Atlantic and Pacific).

Progress

- An international meeting took place on 8-10 November 2010 at IMARPE in Lima, Peru. A short report on this initiative can be found in SOLASnews Issue 12. The outcome of this meeting will be a coordinated international effort at sea and science flights in 2014-2015. Prior to this, the community will try to optimize all planned experiments from 2012-2015 in encouraging joint venture between GEOTRACES, PAGES and SOLAS related cruises. In addition the SOLAS network has now two new members: SOLAS Peru with Dr Michelle Graco as national representative and SOLAS Mexico with Dr José Martín Hernández-Ayon as national representative.
- A session was held at the ASLO Puerto Rico Aquatic Sciences Meeting during the week of 13-18 February 2011 on "Biogeochemical, Ecological and Physical Dynamics of Eastern Boundary Upwelling Systems" with Carol Robinson and Véronique Garçon as chairmen.
- Following up the last SOLAS OSC Conference in Barcelona and the COST Action 735 meeting in Toulouse in March 2010, an ESA call entitled Support to Science Element OceanFlux (ESRIN/AO/1-6668/11/I-AM) on SOLAS Science was launched early this year. Among the 3 themes selected by ESA, Theme 3 was on upwelling. A proposal on this theme was submitted early April 2011 with the following PIs and co-PIs: Christoph Garbe, Véronique Garçon, André Butz, Boris Dewitte, Aurélien Paulmier, Joël Sudre, Isabelle Dadou and Hussein Yahia.
- A EUR-OCEANS Flagship on Ocean deoxygenation in Eastern Boundary Upwelling Systems has been awarded to IFM-GEOMAR, Kiel, Germany, LEGOS CNRS and IRD, Toulouse; and LOCEAN, Paris, France; with IMARPE, IGP, Lima, Peru as co-partners. A two-year post-doctorate, between Toulouse, Lima and Kiel, has been recruited and will start on 1 September 2011.
- A EUR-OCEANS conference on "Ocean deoxygenation and Implications for marine biogeochemical cycles and ecosystems" will take place in Toulouse, 24 – 26 October 2011 with support from CNRS/INSU, IRD, Académie des Sciences, Observatoire Midi Pyrénées, LEGOS, IMBER and SOLAS. Please consult: http://www.eur-oceans.net/conf-oxygen.



Sea-ice biogeochemistry and interactions with the atmosphere

Co-ordinator Jacqueline Stefels
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Background

Near-future climate change is predicted to have its strongest impact in polar regions due to direct changes in the surface area of polar oceans and ice sheets and to subsequent feedback processes. Observed reductions in sea-ice cover appear to be occurring faster than predicted by current model forecasts. Currently, global models include the seasonal wax and wane of sea ice, but restrict associated properties to only a few physical features. Emerging views indicate, however, that sea ice itself plays an important role in the biogeochemical cycling and exchange of climate relevant compounds. Relevant examples of such processes are:

- The impact of biology on climate-relevant gases such as CO_2, DMS, N_2O, halocarbons, etc.
- The impact of biology on ice structure: porosity, energy absorption
- Strong precipitation and dissolution processes of CO_2 in brines
- Optical properties of sea ice and associated photochemical processes
- The release of macro and trace nutrients (N, P, Fe) for surrounding waters during ice melt

Apart from the need for a better understanding of the biogeochemical cycles in sea ice for future climate models, this is also important for unravelling palaeoclimatology. Sea-ice extent is an important indicator for past climate. Proxies in Antarctic ice cores, such as methane sulphonic acid and ikaite crystals, are used to reconstruct regional sea-ice extent. Combining knowledge on sea-ice related processes involved in the formation of both compounds with data analyses from firn, will improve our understanding of palaeoclimate.

Proposed Developments

- To link with and build upon on several ongoing studies and initiatives such as the CFL (Circumpolar Flaw Lead System Study), SIPEX (Sea Ice Physics and Ecosystem Experiment), SIMBA (Sea Ice Mass Balance in Antarctica), PolarCat, ArcticNe and several relevant iLEAPS-recognised projects
- To follow-up on the EU project DAMOCLES (Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies).

Progress

In 2010/11, the SOLAS-related sea-ice biogeochemistry community has grown to over 50 interested scientists from 15 countries. Ties with the OASIS community have been strengthened and a first exploratory workshop was held in Amsterdam, April 2011, under the auspices of the European COST Action 735. The workshop was attended by a significant cross-section of the sea-ice biogeochemical community (see COST Action 735 meeting report).
The specific outcomes of the workshop were:

- A proposal for a SCOR working group on 'Biogeochemical Exchange Processes at the Sea-Ice Interfaces (BEPSII)' (contact Jacqueline Stefels: j.stefels@rug.nl)
- A commitment to compile a review on the current state-of-the-art of methodologies for sea-ice biogeochemical studies. Input from the global community will be solicited for the paper (contact Lisa Miller: lisa.miller@dfo-mpo.gc.ca).
- A commitment to write a white paper in collaboration with the OASIS community.
- An effort will be made to find additional funding for network support.

For those interested: A special issue of Deep-Sea Research on sea-ice studies in the Antarctic during IPY has been published: Worby et al., (eds.) Antarctic Sea Ice Zone research during the International Polar Year 2007-2009.Deep-Sea Research II 58:9-10.

If you are interested in taking part and/or contribute to one of the themes, please contact the co-ordinator or the SOLAS IPO.
For more information, visit http://www.solas-int.org/mts

SOLAS Belgium

It has been a busy year for Belgian SOLAS scientists, especially in co-operation with the COST Action 735. The first COST Action 735 workshop to mention was held in Liége covering 'Experimental, typological and modelling approaches to evaluate at global and regional scales horizontal and vertical fluxes from land to the open ocean through rivers, estuaries and the coastal ocean'. Belgium's Christine Lancelot also attended the 'Atmospheric versus land-based controls of nutrient cycling and production in the surface ocean: from fieldwork to modelling' meeting which was held in Istanbul, Turkey. For a full reports of both meetings please visit http://www.cost-735.org/.

Belgium's recent scientific highlights include:

Air-sea CO_2 fluxes in the global coastal ocean

By evaluating the exchange of CO_2 between the atmosphere and the global coastal ocean, using a spatially-explicit global typology of inner estuaries and continental shelves, it was found that the computed emission of CO_2 to the atmosphere from estuaries is ~26-55% lower than previous estimates while the sink of atmospheric CO_2 over continental shelf seas is at the low end of the range of previous estimates (-0.22 to -1.00 PgC.yr^{-1}).

Laruelle, G.G., et al. (2010) Evaluation of sinks and sources of CO_2 in the global coastal ocean using a spatially-explicit typology of estuaries and continental shelves. Geophys. Res. Lett. 37: L15607.

Air-ice-sea DMS fluxes

High resolution profiles of ice DMS and DMSP concentrations were measured during a time series of decaying summer level first-year sea ice throughout December 2004 during the Ice Station Polarstern drift experiment (Western Weddell Sea, Antarctica). Very high DMSP and DMS concentrations were observed (up to 2627 nM & 1430 nM respectively) at the bottom of the ice sheet. On this basis, it was estimated that decaying summer level first-year sea ice alone could significantly contribute to the regional sulphur budget of the Weddell Sea with an average loss rate of 5.7 µmol DMS(P) m^{-2}d^{-1} toward the atmosphere and the ocean.

Tison, J.-L., et al. (2010). High-resolution dimethyl sulfide and dimethylsulfoniopropionate time series profiles in decaying summer first-year sea ice at Ice Station Polarstern, western Weddell Sea, Antarctica. J. Geophys. Res. 115: G04044.

National Representative:
Christiane Lancelot (lancelot@ulb.ac.be)

Chul H. Song is currently Associate Professor at Gwangju Institute of Science and Technology (GIST) in Korea. He is interested in ship-plume photochemistry and an integration of the chemical transport model (CTM) simulations with remote-sensing data.

Hyun S. Kim is a Ph.D. Candidate at Gwangju Institute of Science and Technology (GIST), working on the ship-plume photochemical/dynamic modelling.

Impacts of ship emissions on atmospheric chemistry in the marine boundary layer (MBL): ITCT 2K2 ship-plume case

C. H. Song and H. S. Kim, School of Environmental Science & Engineering, Gwangju Institute of Science and Technology (GIST), Gwangju, Korea Contact: chsong@gist.ac.kr

Recently, ship emissions have attracted increasing attention because ship-emitted particles, NO_X and SO_2 can significantly perturb atmospheric photochemical cycles and the global radiation budget in the marine boundary layer (MBL), and may also have a major impact on the biogeochemistry of the surface ocean (Capaldo et al., 1999; Lawrence and Crutzen 1999; Duce et al., 2008).

In order to accurately investigate the impacts of ship emissions on the atmospheric photochemistry in the MBL, a photochemical/dynamic ship-plume model was developed. This model considered both the non-linear O_3-NO_y-HO_X ship-plume photochemistry and turbulent dispersion in a state-of-the-science manner. The model performance was then evaluated with the data observed during the ITCT 2K2 (Intercontinental Transport and Chemical Transformation 2002) ship-plume experiment (Kim et al., 2009). Figure 1 presents the cross-sectional distributions of O_3, OH, HNO_3 and H_2SO_4 of the ITCT 2K2 ship-plume, where the levels of four species were observed to be greatly enhanced inside the ship plume. In particular, the OH mixing ratio increased to ~1.6x10^7 molecules cm^{-3}. This OH level was ~2.6 times higher than the background OH level of ~6.1x10^6 molecules cm^{-3}. These high levels of ship-plume OH subsequently produce high levels of HNO_3 and H_2SO_4, mainly via NO_2+OH+M (M: a third body) and SO_2+OH reaction channels (inside the ship plume, the levels of NO_2 and SO_2 were also high due to the massive ship emissions). The HNO_3 (or nitrate) produced inside the ship plume will then be dry/wet deposited onto the ocean surface, possibly providing an important nitrogen-source for marine biogeochemical activities. The level of H_2SO_4 was also approximately 2.7 times higher than that in the background air (Figure 1), creating favourable conditions for nucleation, and sometimes resulting in MBL stratocumulus clouds along the ship corridors, often called "ship track".

These ship-plume situations can also be examined using lifetime analyses. As shown in Table 1, the lifetimes of ship-plume NO_X, SO_2, and CH_4 were shortened by factors of ~0.42, ~0.54 and ~0.55, respectively, compared to those in the background air, mainly due to the elevated level of OH inside the ship plume.

Table 1. Equivalent and averaged instantaneous lifetimes (τ^e_i and $\overline{\tau_{CH_4}}$) and averaged OPE ($\overline{OPE}$) estimated for the ITCT 2K2 ship-plume

	$\tau^e_{NO_X}$ (hrs)	$\tau^e_{SO_2}$ (hrs)	$\overline{\tau_{CH_4}}$ (yrs)	$\overline{OPE}$
Inside ship-plume	2.6-2.9	10.3-14.3	0.4-0.8	6.4-19.4
Background MBL	6.5	23.0	1.1	44.7

Note: The lifetimes and OPEs of ship-plumes vary due to the stability conditions of the MBL and the NO_X emission rates.

Because of such a shortened lifetime of NO_x, the ozone production efficiency (OPE) inside the ship plume also became ~0.29 times smaller than that in the background air. CH_4 is an important source of atmospheric formaldehyde (HCHO). The shortened CH_4 lifetime indicated that CH_4 very actively produced HCHO inside the ship plume (Song et al., 2010). The enhanced level of HCHO has sometimes been detected via satellite observations along the ship corridors (Marbach et al., 2009). Collectively, this study suggests that ship emissions can greatly perturb atmospheric oxidation cycles, affect climate change by forming stratocumulus clouds within the MBL, and may supply important amounts of nutrients to the ocean.

References

Capaldo, K., et al. (1999). Effects of ship emissions on sulphur cycling and radiative climate forcing over the ocean. Nature 400: 743–746.

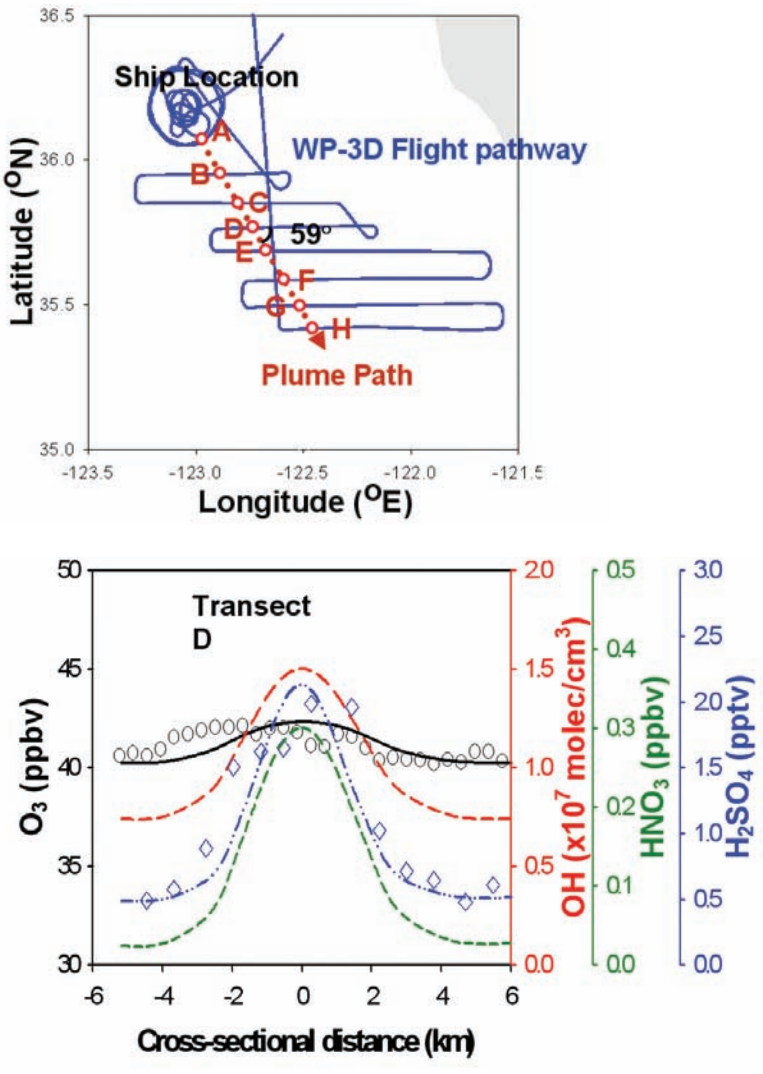
Duce, R. A., et al. (2008). Impacts of atmospheric anthropogenic nitrogen on the open ocean. Science 320: 893-897.

Kim, H. S., et al. (2009). Investigation of ship-plume chemistry using a newly-developed photochemical/dynamic ship-plume model. Atmos. Chem. Phys. 9: 7531–7550.

Lawrence, M. G. and Crutzen, P. J. (1999). Influence of NO_x emissions from ships on tropospheric photochemistry and climate. Nature 402: 197-170.

Marbach, T., et al. (2009). Satellite measurements of formaldehyde linked to shipping emissions. Atmos. Chem. Phys. 9: 8223–8234.

Song, C. H., et al. (2010). Source identification and budget analysis on elevated levels of formaldehyde within the ship plumes. Atmos. Chem. Phys. 10: 11969-11985.



Λ Figure 1 : Cross-sectional distributions of O_3 (black), OH (red), HNO_3 (green) and H_2SO_4 (blue) for the ITCT 2K2 ship plume. Black circles and blue diamonds represent the O_3 and H_2SO_4 mixing ratios observed during the ITCT 2K2 ship-plume experiment. The upper panel shows eight ship-plume transects (A–H) made by the NOAA WP-3D flight during the ITCT 2K2 campaign, which was conducted ~100 km off the California coast (after, Kim et al., 2009).

SOLAS Brazil

With SOLAS Brazil's future objectives being to incorporate new projects and promote the development of the air-sea interaction in Brazil by involving new research groups, the development of FluTuA and Study of the atmospheric boundary layer in the region of Brasil-Malvinas Confluence are playing a great part in achieving this:

FluTuA: Turbulent fluxes over the tropical Atlantic
Coordinator: Jacyra Soares (jacyra@usp.br)

The local ocean-atmosphere interaction has been investigated through the direct observation of air-sea variables. The major goals of this are to characterise, observationally, the interaction between the atmosphere and the ocean in micro-, meso- and macro-scales in order to develop, calibrate and verify the parameterization formulae used to indirectly estimate flux from conventional meteorological variables. The observations carried out have been analyzed and results indicated that the surface energy balance at night and the diurnal evolution of the intensity of turbulence and turbulent fluxes at the surface in the Archipelago area are dependent on the ocean state and trade winds' intensity.

Study of the atmospheric boundary layer in the region of Brasil-Malvinas Confluence
Coordinator: Marcelo Dourado (dourado@ufpr.br)

A subproject entitled "Coupled Modelling the Ocean and Atmospheric Boundary Layer in upwelling region" was developed during 2010. In the Cabo Frio region (23ºS, 42ºW), upwelling has great influence on the primary productivity and local climate. The coupling between the ABL and OBL has to be understood as a problem of fluid dynamics, where the main difference is the fluid's density. A coupled one-dimensional numerical model has been developed to simulate the diurnal evolution of the vertical structure of both the oceanic and atmospheric boundary layers. This model is based on the 2.5 closure of Mellor and Yamada which has then been applied to a set of differential equations describing the behaviour of temperature, salinity (water vapour), two horizontal components of current (wind speed) and their respective variances and covariances in the ocean and atmosphere.

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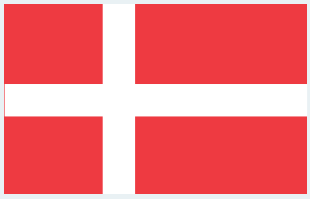

SOLAS Denmark

Denmark can proudly boast several exciting developments within their SOLAS nation and is able to announce a new project, 'ECOCLIM'. The project goal is to estimate CO_2 exchange between the atmosphere and the biosphere in Denmark and will to a large extent, focus on air-sea CO_2 exchange in coastal regions. Partners include Copenhagen University, DTU and Roskilde University and will be coordinated from the Department of Environmental Science at Aarhus University.

The aforementioned ECOCLIM project and the project 'Air-sea-ice exchange of CO_2 in the Arctic coastal area' funded by the Nordic Council of Ministers, will be some of the activities of the new Nordic Centre of Excellence named DEFROST http://www.ncoe-defrost.org/. DEFROST includes a working package focussing on air-sea-ice exchange of CO_2, coordinated by Lise Lotte Sørensen and Søren Rysgaard. Measurement stations for air-sea exchange of CO_2 will be established in the Nuuk fjord this year and at Young Sound in 2012. These stations will be managed from the Greenland Climate Research Centre where several Danish SOLAS members recently participated in a field experiment in Kapisigdlit (see front cover image) to study air-ice-sea carbon exchange. This experiment was part supported by the project, 'Air-sea-ice exchange of CO_2 in the Arctic coastal area', and the project 'Marine Carbon Cycle' coordinated by Ronnie Glud, University of Southern Denmark.

Further to this SOLAS Denmark's scientific highlight is the development of new analysis methods for CO_2 air-sea flux. Different flux estimation techniques to evaluate air-sea exchange have been developed and suggested for use on moving platforms. Techniques using power spectra and cospectra are applied to estimate fluxes of momentum, sensible heat, latent heat and CO_2 (Sørensen and Larsen, 2010, Boundary Layer Meteorology, 136 (1): 59-81). The CO_2 fluxes can be calculated from the dissipation technique utilising the inertial sub-range of the power spectra and from estimation of the cospectral amplitude.

National Representative:
Lise Lotte Sørensen (lls@dmu.dk)

Geert Vinken is a PhD student at the Department of Applied Physics at Eindhoven University of Technology in The Netherlands. Currently, he is focusing on better understanding how global ship NOx emissions affect marine atmospheric composition, as part of the project 'Attributing the sources of tropospheric ozone from space'.

From ship smokestack to global air pollution: bridging the scales to better constrain ship NO_X emissions from space

G. Vinken[1] and F. Boersma[1,2]

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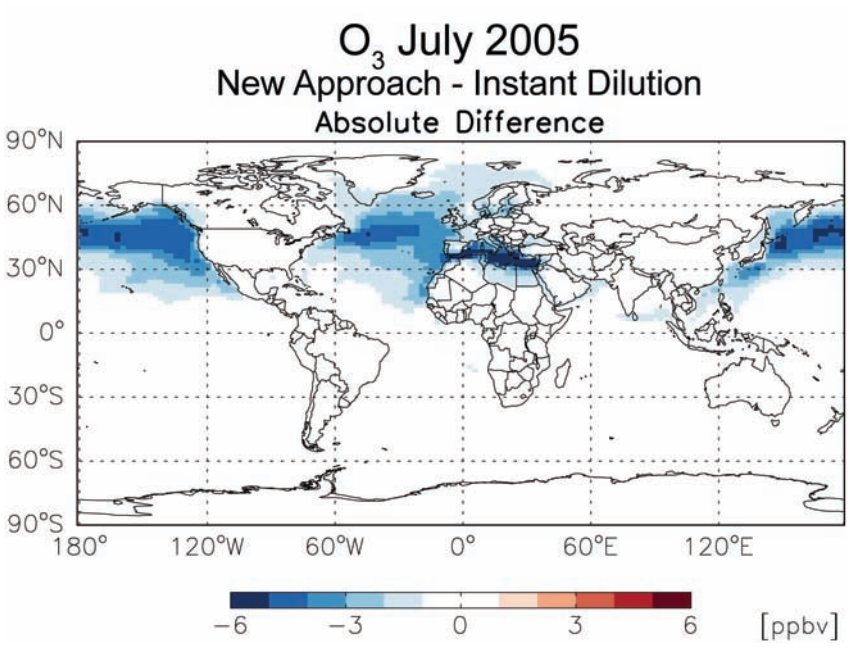
Seagoing ships combust massive amounts of marine heavy fuel, which leads to significant emissions of nitrogen oxides (NO_x = NO + NO_2), important precursors for ozone (O_3) and particulate matter in the lower marine atmosphere. Ship NO_x emissions are high, but also highly uncertain: recent estimates suggest that they represent between 15 to 30% of global NO_x emissions (e.g. Eyring et al., 2010). Because most of the ship emissions occur within 400 km of land (Corbett et al., 1999), it is important to understand how global shipping affects atmospheric composition and how it affects air quality in densely populated coastal regions. These enhanced NO_2 concentrations along shipping lanes from Europe, via the Middle East, to eastern Asia can be observed from space (Figure 1) illustrating the significance and global character of ship pollution.

The impact of ship emissions on atmospheric composition is usually assessed with so-called chemistry transport models in combination with emission inventories. These models instantly dilute emissions of highly localised sources such as ship smokestacks over the entire volume of a model grid cell (typically 200 km by 200 km). This is a reasonable approach for chemically inert species, or for situations with many individual sources present within a grid cell. However, for strongly localised emissions in clean background conditions, it fails. Previous work (Kasibhatla et al., 2000; Davis et al., 2001) has shown that using the instant dilution approach for ship emissions leads to strong overestimations of NO_x and O_3 concentrations over the oceans, because the non-linear chemistry occurring in the initial stages of plume dispersion is neglected.



Λ Figure 1 : Absolute difference plots between monthly mean global O_3 concentrations simulated with GEOS-Chem for July 2005 for the instant diluting model and the new plume-in-grid model simulations, for the lowest model layer (0-0.12 km).

In a recently submitted paper (Vinken et al., submitted), we now present a new approach to better account for ship emissions and the subsequent non-linear chemistry in global models. We use a plume-in-grid method that is based on a Gaussian plume model in combination with a detailed chemical scheme, to explicitly simulate the chemical evolution during dispersion of the plume. The Gaussian plume model simulates the chemical transformations of NO_x in the first five hours after emission. Then, the reduced NO_x emissions, plus the secondary pollutants ozone and HNO_3, produced along the way, are released into the parent (grid) model.

By running the plume model for a wide range of relevant environmental parameters, and storing the reduced NO_x emissions in a look-up table, we have generated a computationally efficient tool to account for the non-linear effect of ship emissions in a global model. We applied our method on the global GEOS-Chem model, but other chemistry transport models could also easily use our look-up table to start accounting for non-linear chemistry in ship plumes.

The results we obtain with our plume-in-grid approach highlight that the commonly used instant dilution approach overestimates observed NO_x concentrations by up to a factor of five, whereas our new approach results in NO_x concentrations that match best with observations. Instant dilution of ship emissions also tends to overestimate O_3 concentrations; in a trade route above the North Atlantic, O_3 is too high by 10-25% (3-5 ppbv).

Now that we accurately simulate NO_x concentrations in a global CTM, we are in a better position to address the uncertainty in bottom-up ship emission inventories. We intend to do so by using global, long-term NO_2 observations from space by instruments like the Ozone Monitoring Instrument (OMI, Figure 2). Combining our improved representation of ship NO_x pollution in a global model with state-of-science satellite observations, will provide valuable top-down constraints on ship NO_x emissions.

Geert Vinken recently won a poster award for the work presented at 'Ship Plumes: Impacts on atmospheric chemistry, climate and nutrient supply to the oceans' held at EGU General Assembly 2011. His poster can be viewed at http://www.solas-int.org/news/newsletter/files/Poster_EGU.pdf

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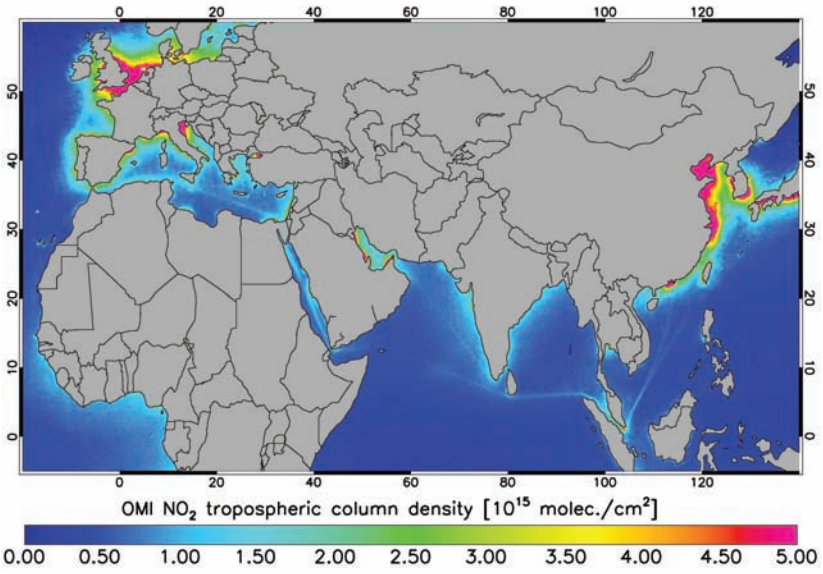
Acknowledgements

This work is supported by the Netherlands Organisation for Scientific Research (NWO) through Vidi grant 864.09.001.



Λ Figure 2 : OMI tropospheric NO_2 columns averaged over 2005-2007 on 0.1° by 0.1° grid cells, clearly showing 8 ship tracks from western Europe to eastern Asia. Land masses have been greyed-out.

SOLAS India

After hosting the successful '5th International Symposium on Biological and Environmental Chemistry of DMS(P) and Related Compounds' in Goa last October (Full report can be found in SOLASnews Issue12). India's SOLAS scientists have kept up the pace by highlighting the exciting application of stable oxygen isotopes for estimation of transfer velocity of trace gases.

The rate of sea-to-air flux is directly controlled by transfer velocity (k). The k has been parameterized to obtain averages but using several assumptions. Air-sea transfer velocity can be estimated by measuring the two processes controlling the variations in the ^{17}O anomaly in the mixed layer i.e. gross primary production (GPP) and air-sea exchange of O_2. In the absence of GPP, the changes in ^{17}O anomaly are solely controlled by exchange of O_2 at the air-water interface. In order to quantify transfer velocity of oxygen, the night-time variations in ^{17}O were measured (when no GPP occurs) in the subarctic North Pacific and Sagami Bay during different periods.

The results clearly established that the natural ^{17}O anomaly method can effectively be used to derive gas transfer velocities at air-water interfaces. The major advantage of this method is that (1) it can be applied to any aquatic environments, such as lakes, coastal regions and the open ocean, and (2) it does not involve any artificial or radioactive tracers such as SF_6, ^3He, and ^{14}C. The present method is more robust and allows an easy estimation of k at any region. The oxygen isotopes are being measured on a routine basis under ongoing or planned international projects including SOLAS, IMBER and GEOTRACES. These measurements will contribute to gaining a comprehensive global picture of the transfer of greenhouse gases across air-water interface thereby reducing uncertainties in the oceanic sinks/sources of trace gases. This study has made such an overview more attainable.

Sarma, V.V.S.S., et al. (2010). Estimating of gas transfer velocity using triple isotopes of dissolved oxygen. J. Oceanogr. 66: 505-512.

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Dileep Kumar (dileep@nio.org)

Elena Fuentes-Lopez has been Research Associate at the Centre for Atmospheric Sciences of the University of Manchester since 2006. Her research is focused on understanding the influence of biogenic organic matter on the production and hygroscopic behaviour of marine aerosols and on characterising the volatility properties of organic aerosols.

Insights into the production, composition and hygroscopic behaviour of primary marine aerosols enriched with biogenic organics

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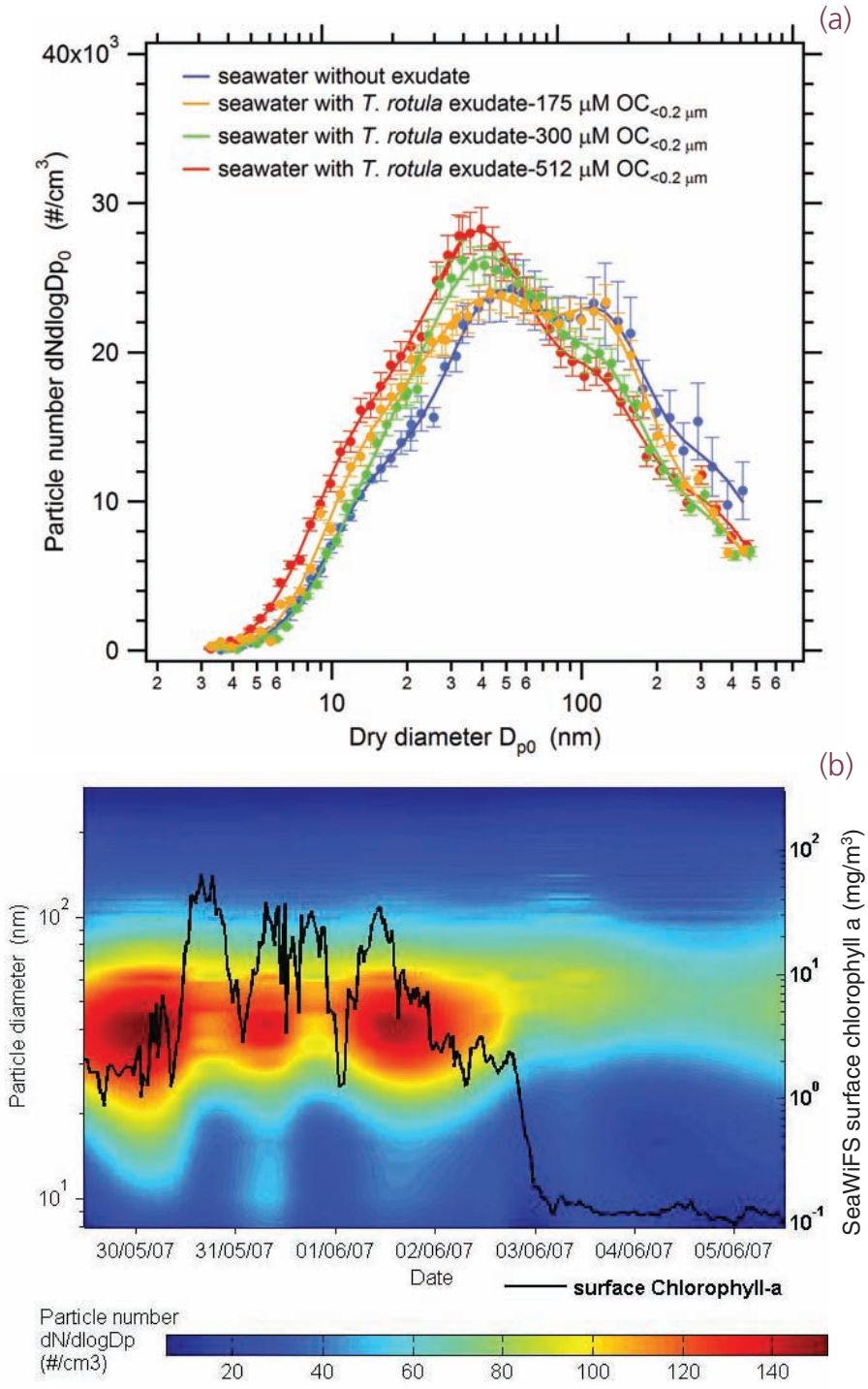
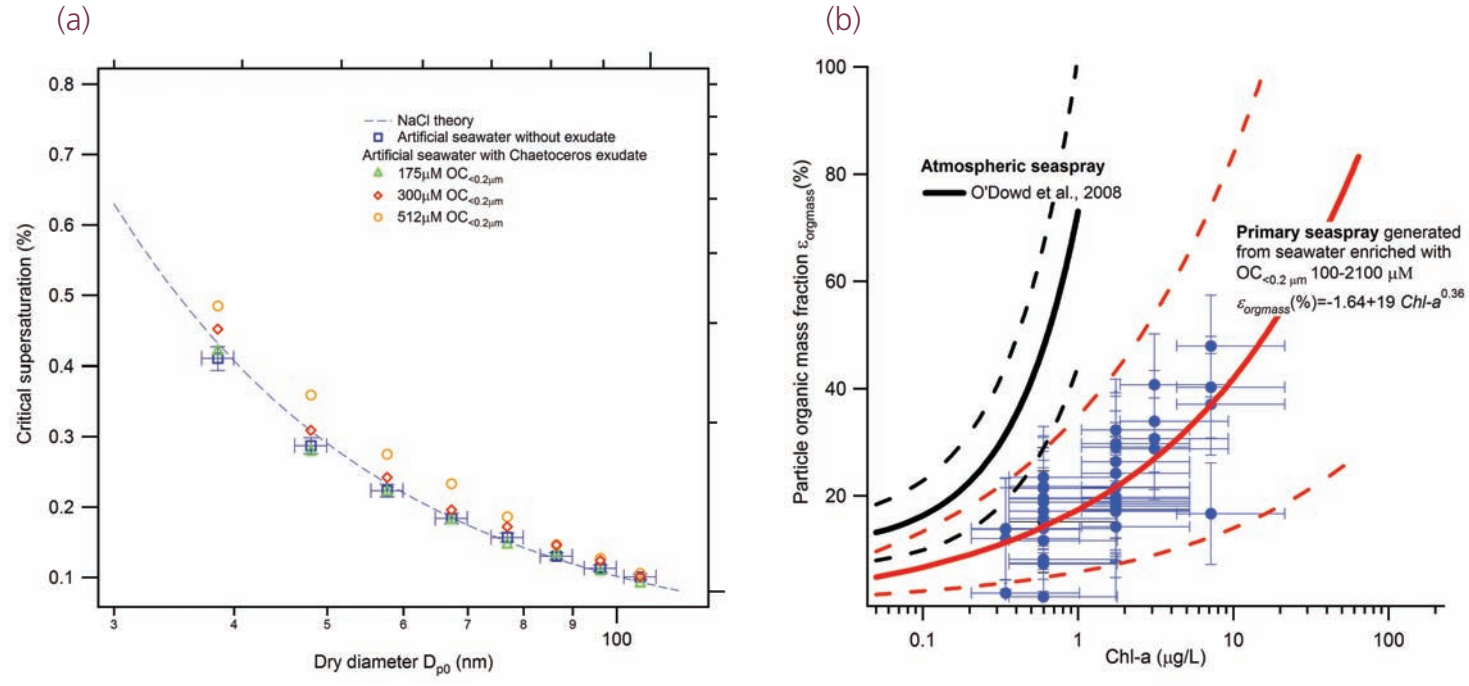
[2]Scottish Association for Marine Science, Oban, UK Contact: elena.fuentes-lopez@manchester.ac.uk

Recent work has shown that the marine aerosol submicron size range, which dominates the particle number in the marine atmosphere, comprises a large amount of organic material (O'Dowd et al., 2004). The ocean surface is rich in biogenic organics resulting from the metabolic activity of marine phytoplankton. Such material is incorporated into the marine aerosols composition by the action of wind-driven whitecaps breaking on the ocean surface and may be responsible for changing air-sea exchange rates of gaseous material and also altering the production, hygroscopicity behaviour and cloud condensation nuclei (CCN) activity of marine aerosols.

Our recent research aimed to elucidate the extent to which nanogel and dissolved organic matter (OC) <0.2 m produced by phytoplankton is able to affect the production and the hygroscopic behaviour of the submicron primary marine aerosol (Fuentes et al., 2010b; 2011). Seawater samples were collected along a transect off the West African coast during the UK SOLAS RHaMBLe (Reactive Halogens in the Marine Boundary Layer) cruise in order to identify the main algal species in regions of high biological activity. Cultures of microalgal strains, representative of oceanic species, were grown in order to produce natural bioexudate. The produced material was used to prepare organic-enriched seawater proxies for the laboratory production of marine particles using a plunging-waterjet aerosol generator (Fuentes et al., 2010a). An increase in the production of particles <100 nm was observed with increasing seawater exudate content (Figure 1a) for OC concentrations > 175 µM, implying that an effect of the organic matter on particle production would be substantial only in high biological activity areas. These findings were in agreement with analogous bubble-bursting experiments conducted with unfiltered seawater collected during the RHaMBLe cruise (Figure 1b).



Λ Figure 1 : (a) Effect of seawater OC concentration on the primary marine aerosol production. (b) Particle production experiments with oceanic seawater and chlorophyll-a concentration during RHaMBLe.



Λ Figure 2 : (a) Comparison of organic mass fractions in the primary and atmospheric marine aerosol. (b) Effect of seawater exudate concentration on the CCN activity of the primary marine aerosol.

Our results suggest that the observed increase in the atmospheric aerosol modal sizes from winter to summer, in North Atlantic waters (O'Dowd et al., 2008), is not directly due to an impact of the higher biological production occurring during warm periods. A novel sub-micrometric, size-resolved source flux function, defined as a function of the seawater exudate concentration, was derived from the production measurements and estimations of the fractional whitecap coverage.

The aerosol generated from seawater enriched with marine exudate presented an organic volume fraction between 8-37% (Figure 2a), which is lower than that found in atmospheric measurements in high biological activity areas, thus pointing at the presence of organics of secondary origin in the atmospheric particles. The hygroscopic growth and CCN activity of the organic-enriched particles were 9-17% and 5-24% lower, respectively, than those of the aerosol produced from seawater devoid of exudate (Figure 2b). This implies that the potential enhancement in the CCN number resulting from the higher particle generation in productive areas would be counteracted by the reduction in the CCN activity of the organic-enriched aerosol.

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Acknowledgements

This work was supported by the UK Natural Environment Research Council [NE/D005175/1 & NE/G000247/1].

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CALL FOR PAPERS Deadline for abstracts: 19 August 2011

Yuzo Miyazaki is Assistant Professor of Atmospheric Chemistry at Hokkaido University, Sapporo, Japan. His research investigates the sources and mechanisms of organic aerosol formation from natural origins (both marine and terrestrial), with a focus on water-soluble organics and secondary organic aerosols (SOA).

Aerosol organic nitrogen and organic carbon from marine biological sources over the Western North Pacific

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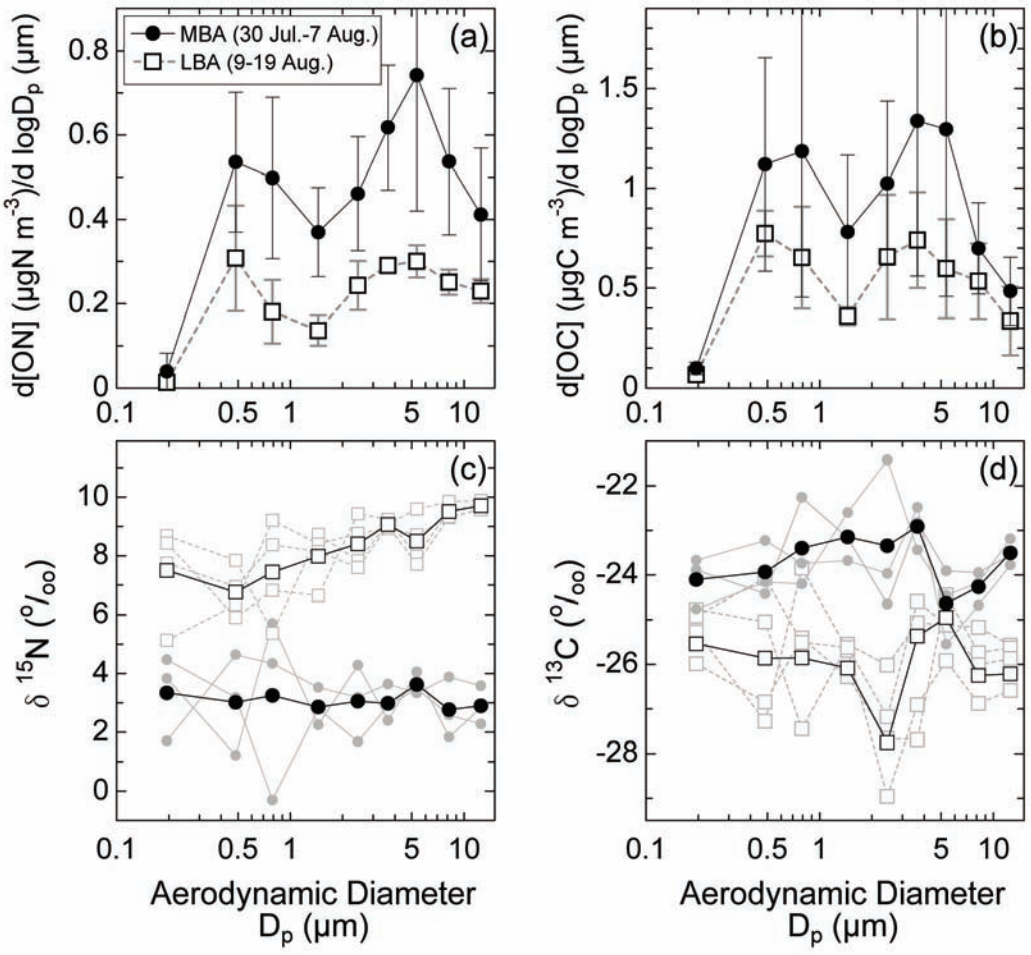
Organic nitrogen (ON) and organic carbon (OC) in marine aerosols are subjected to chemical transformations and form climate-relevant products. Despite the importance of aerosol ON in marine biogeochemical cycles and its critical role in the atmosphere, little is known about its origin or chemical composition associated with marine biological activity (Duce et al., 2008).

Recently, we found evidence of marine biological sources of aerosol ON and OC over the western North Pacific (Miyazaki et al., 2010a; 2010b; 2011). Our research results are based on aerosol measurements onboard the *R/V Hakuho–Maru*, which were conducted over the western North Pacific from July to September 2008 (KH08–2). Size-resolved aerosol measurements showed that both the ON and OC had bimodal size distributions (Figure 1). In our study, methanesulphonic acid (MSA) and azelaic acid were used as biogenic tracers to evaluate the contribution of marine biological activity to the observed aerosols. We found that average ON and OC concentrations were two times greater (ON/OC~0.50) in aerosols collected over the oceanic regions of higher biological productivity than in those from the regions with lower productivity. Our results provide evidence that organic aerosols in this region are enriched in ON, which is linked to oceanic biological activity and subsequent emissions to the atmosphere.

We further investigated the spatial distributions of ON aerosols and quantified the bulk concentrations of water-insoluble organic nitrogen (WION) for the first time. WION was found to be the most abundant nitrogen aerosol, accounting for 55±16% of the total (Figure 2). The abundance of WION was particularly high in subarctic and subtropical regions, for which a significant influence of marine biological activity on aerosols was observed. Stable carbon isotope analysis ($\delta^{13}C$) indicated that marine-derived carbon accounted for ~88±12% of the total aerosol carbon. Our results indicated a



Λ Figure 1 : Size distributions of (a) ON and (b) OC together with (c) $\delta^{15}N$ and (d) $\delta^{13}C$ in biologically more (MBA) and less (LBA) influenced aerosols.

preferential transfer of mostly water-insoluble nitrogen-containing organic compounds from the sea surface to the atmosphere via sea spray. WION appeared to be associated with microorganisms, plankton debris, a large number of semi-transparent gel-like particles and proteins (Kuznetsova et al., 2005). The substantial amount of WION provides insights into the chemical composition of water-insoluble OC (WIOC). Further studies are required for the chemical characterizations of WION in aerosols from marine biological sources and the mechanisms of primary and secondary formation of WION.

For OC, the concentrations of OC and oxalic acid were approximately two to three times larger in marine, biologically-influenced aerosols. Substantial fractions of oxalic acid were present in the sub-micrometer size range. Water-soluble OC (WSOC) accounted for 15–21% of the total mass in the sub-micrometer range of biologically influenced aerosols, which were comparable to those of WIOC. A detailed analysis suggested that secondary production of oxalic acid occurs via the oxidation of organic precursors in oceanic regions with higher biological productivity. More investigation is required to better understand the high abundance of WSOC produced from marine biological sources using various approaches, including global modelling.

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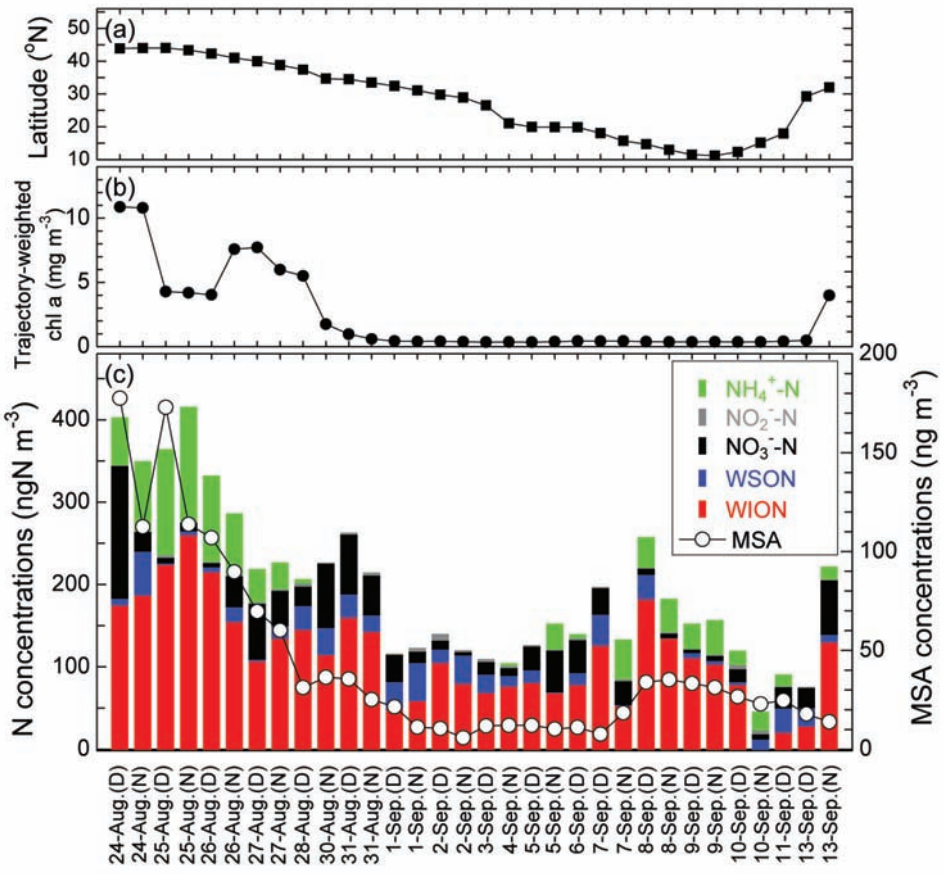
Acknowledgements

This work was performed in collaboration with Profs. Kimitaka Kawamura and Mitsuo Uematsu. The research was supported by grants-in-aid for scientific research from the MEXT, Japan.



Λ Figure 2 : Time series of (a) the latitudinal location of the ship, (b) concentrations of trajectory-weighted chlorophyll-a and (c) fractions of nitrogen species with MSA concentrations obtained during daytime ("D") and nighttime ("N").

SOLAS Mexico

IMECOCAL (Investigaciones Mexicanas de la Corriente de California) is the Mexican research project becoming most relevant to SOLAS. This is an inter-institutional program supported by the Mexican government initiated off Baja California (25–31°N). The surveys were scheduled to coincide as closely as possible to the California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruise periods in central and southern California, and to follow a subset of the original CalCOFI grid in Mexican waters. In October 2011, IMECOCAL will complete its fourteenth year of quarterly cruises dedicated to the monitoring and the analysis of the state of the pelagic ecosystem in the southern region of the California Current as a major research field. However, since 2007, IMECOCAL has also evolved into two more research fields: carbon cycle in marginal seas and the impact of the ocean acidification on marine ecosystems. Projects reflective of these progresses include a multiple PI project sponsored also by the Mexican government. Imecocal is administered through CICESE (Centro de Investigación Científica y de Educación Superior de Ensenada) with active participation of scientists from UABC (Universidad Autónoma de Baja California), CICIMAR (Centro Interdisciplinario de Ciencias Marinas), CIBNOR (Centro de Investigaciones Biológicas del Noroeste) and UNAM (Universidad Nacional Autónoma de México).

Thus far, a regular program of oceanographic observations in the Mexican sector now exists to provide the coverage needed to match the scale of observation to the scale of variability in the California Current System.

Time series stations are also critical for understanding the processes controlling ocean carbon and biogeochemical cycles but also relevant for SOLAS. Presently, Mexico has three marginal sites in the Mexican Pacific: One in Ensenada Baja California, the second in Bahia Magdalena Baja California Sur and a third off Colima. The first one has a strong influence from the California Current (CC); the second has a transitional spot between CC and subtropical waters; and, the last one is under the influence from the OMZ. As well as IMECOCAL, these time series are supported by the Mexican government but administered by CICESE in the first two cases and the University of Colima in the last one, with the active collaborations from UABC and CICIMAR.

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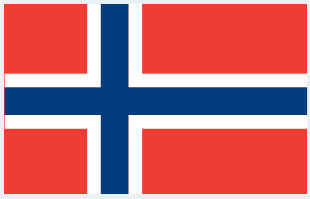

SOLAS Norway

SOLAS Norway's main announcement is that of their newest project, 'CARBOCHANGE' (Changes in carbon uptake and emissions by oceans in a changing climate) which began in January 2011 and is led by Christoph Heinze. The project proposal was submitted by The University of Bergen and the Bjerknes Centre for Climate Research and accepted by the European Commission as a large-scale integrating collaborative project under the 7th framework programme. The consortium includes 28 partners from Europe, Africa, and North America. The International Project Office will be located at the University of Bergen, Geophysical Institute and Bjerknes Centre for Climate Research. Other new projects, partnered by The University of Bergen and Uni Bjerknes, of interest to the SOLAS community are the EU projects GreenSeas, EuroBasin and Monarch, and the PolarBuoy project.

With further involvement with SOLAS partner projects, several Norwegian SOLAS scientists, led by Richard Bellerby at Uni Bjerknes, University of Bergen, participated in an Arctic mesocosm experiment in Ny Ålesund (79°N) May-July 2010, funded by the MERCLIM and EPOCA projects. This was the northernmost, biggest and longest ocean acidification experiment ever conducted, being specifically designed to advance our understanding of the biological, ecological, biogeochemical, and societal implications of ocean acidification. Norway's main contribution was to study the carbonate system developments and follow net community production evolution http://www.epoca-project.eu/index.php/what-do-wedo/science/arctic-2010.html

And if that was not enough, SOLAS Norway also made it into the press...

A recent article reports that the modern isotopic ratio of carbon in the ocean, which is used when interpreting marine sediment cores, is strongly influenced by anthropogenic CO_2. The authors show that correcting for this effect (known as the Suess effect) enhances the interpretation of past ocean climate which is archived in the microfossils deposited in the sediment of the deep ocean through time.

National Representative:
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Olsen, A. & U. Ninnemann (2010). Large $\delta^{13}C$ gradients in the pre-industrial North Atlantic revealed. Science 29: 330(6004): 658-659.

Michael Long studied Environmental Sciences at the University of Virginia and began as Post-Doctoral Fellow at Harvard University in June 2011 following a position at Oak Ridge National Laboratory in Oak Ridge, Tennessee, USA.

Climatic implications of reactions involving halogen and sulphur species in marine air

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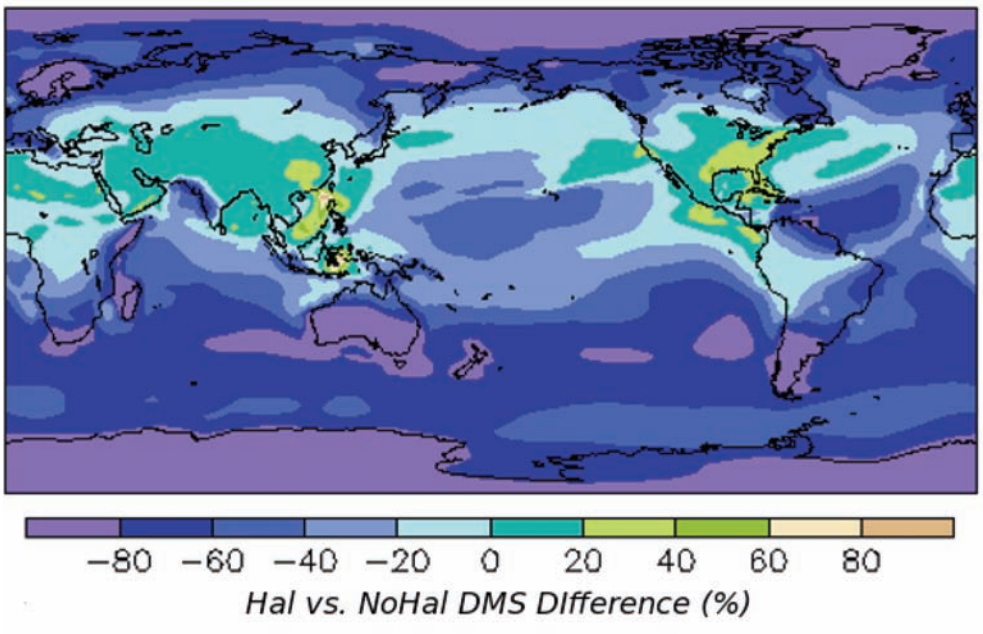
Wave breaking at the air-sea interface is the largest source of aerosol mass in Earth's atmosphere. Marine aerosols exert important yet poorly-constrained influences on Earth's climate via scattering solar radiation and modulating cloud albedo (Andreae and Rosenfeld 2008). They also undergo multiphase transformations involving halogen radicals that impact other climate-relevant species including ozone (Keene et al., 2009), sulphur (von Glasow and Crutzen 2004) and hydrocarbons (Lawler et al., 2009). However, reactive tropospheric halogens are largely overlooked in models of chemistry-climate interactions.

We coupled MECCA (Module Efficiently Calculating the Chemistry of the Atmosphere; Sander et al., 2005) with the National Center for Atmospheric Research (NCAR) Community Atmosphere Model (CAM v.3.6.33) to investigate the influence of marine-derived halogens on atmospheric composition and climate. CAM includes a 3-mode, aerosol-microphysical module permitting online, size-resolved phase-transfer and aqueous reactions (including pH characterisation) necessary to accurately resolve the chemistry (Ghan et al., 2008). Two 20-year simulations were run: (1) Transformations involving reactive halogens were evaluated explicitly (denoted "*Hal*"); and (2) halogens were assumed chemically inert (denoted "*NoHal*"). Otherwise, simulations were identical.

Halogen chemistry significantly impacted the processing and climatic influences of S species through two interrelated pathways. Relative to *NoHal*, the average atmospheric lifetime of dimethylsulphide (DMS) was reduced 21% by halogen reactions in the planetary boundary layer (PBL). Shorter DMS lifetime in the *Hal* simulation also limited its atmospheric transport.



Λ Figure 1 : Global distribution of percent differences in average annual PBL DMS mixing ratios in Hal versus NoHal simulations (((Hal – NoHal) / NoHal) x 100).

Figure 1 depicts the percent difference between simulations in annual average PBL DMS mixing ratios. Spatially, the average mixing ratio of DMS in the *Hal* PBL was 42% lower than *NoHal*. DMS + BrO accounted for 61% of total sink in the PBL and 75% in the southern hemisphere marine boundary layer (SH-MBL). DMS + Cl accounted for 10% and 7% for the PBL and SH-MBL, respectively. DMS oxidation by OH and NO_3, typically considered in global models, were relatively less important. In *Hal*, OH accounted for 11% and 9%, and NO_3 accounted for 17% and 8%, for the PBL and SH-MBL, respectively.

In *Hal*, S(IV) oxidation by HOCl and HOBr in deliquesced PBL aerosol (59% and 20%, respectively, of the total particulate S(IV) sink) accelerated S(IV) oxidation in aerosols by 51% versus *NoHal* and shifted SO_2 phase partitioning toward the aqueous phase. The average SH-MBL SO_2 lifetime and mixing ratio in *Hal* were 67% and 53% less, respectively, versus *NoHal* and the size distribution of non-sea-salt SO_4^{2-} shifted towards larger, shorter-lived particles. Because aerosol production from pathways involving H_2SO_4 vapour decreased, number concentrations of particles less than 500-nm diameter were lower by factors of 2 to 4 in the SH-MBL. Consequently, average global aerosol optical depth was lower by 7.5% and up to a 21% maximum in *Hal* versus *NoHal*. Offline sea-surface temperatures for these simulations precluded reliable evaluation of climatic feedbacks.

The above indicates that climate models must evaluate halogen-S reactions to reliably predict influences of S emissions – in particular DMS – on aerosol-climate interactions. Because key halogen activation and cycling pathways are strongly pH dependent, increasing atmospheric acidification via expanding southern-hemisphere industrialization could influence Earth's climate system.

In addition, since marine aerosol production varies exponentially with wind velocity and, where atmospheric acidity is sufficient to titrate sea-salt alkalinity most associated bromine is activated (e.g., Keene et al., 2009), climate-related impacts on wind speed would have disproportionately large influences on halogen-S interactions and resulting climatic impacts.

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Acknowledgements

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http://www.eo4oceanatmosphere.info/

SOLAS Turkey

Turkey's SOLAS-related activities and their involvement in one of SOLAS's Mid-Term Strategy themes gained great promotion when they hosted the 'Atmospheric versus land based controls of nutrient cycling and production in the surface ocean: from fieldwork to modelling' COST Action 735 workshop held in Istanbul in December last year (SOLASnews Issue 12). The full report from the meeting can be found at http://www.cost-735.org/.

SOLAS Turkey also reported on the following key finding of interest to the SOLAS community:

Atmospheric nutrient inputs to the northern Levantine Basin (NLB) from long-term observation: sources and comparison with riverine inputs

The cluster analysis of the daily air-mass back trajectories (taken from long-term aerosol, rainwater and riverine data) showed that phosphate and silicate concentrations in the aerosol and rain samples were higher when airflow originated from the North Africa and the Middle East, when the NLB was heavily influenced by large dust plumes from the Sahara and the Middle East deserts. Flux calculations revealed that atmospheric nitrate flux was dominated by dry deposition (~80%) whilst silicate and ammonium fluxes were mainly due to wet deposition (~60%); both of which were comparable to phosphate, dissloved inorganic nitrogen (DIN) and phosphate inputs to the NLB were shown to be dominated by the atmospheric pathway (~90% and ~60%) and the Si pool almost exclusively originated from riverine runoff (~ 90%). Considering molar N/P ratios from the atmosphere (236) and riverine (22) sources it is clear that the NLB of the Eastern Mediterranean Sea receives excessive amounts of DIN; more than the amounts required by autotrophic organisms and this unbalanced P and N inputs may provoke even more phosphorus deficiency. Surprisingly, observed molar Si/N ratio suggested that Si limitation relative to N might cause a switch from diatom dominated communities to non-siliceous populations particularly at coastal areas where in NLB.

National Representative:
Barış Salihoğlu (baris@ims.metu.edu.tr)

Koçak, M., et al. (2010). Atmospheric nutrient inputs to the northern Levantine basin from a long-term observation: sources and comparison with riverine inputs. Biogeosciences 7: 4037-4050.

Emilio Marañón obtained his PhD in Biological Oceanography from University of Oviedo (Spain) in 1995 and then worked for three years at the Southampton Oceanography Centre (UK). Since 1999, he is Senior Lecturer at University of Vigo (Spain). He studies the ecology and biogeochemical role of phytoplankton, with particular interest in primary production, N_2 fixation and calcification.

Patterns in the response of microbial plankton to Saharan dust inputs

Emilio Marañón, Facultad de Ciencias del Mar, Universidad de Vigo, Vigo, Spain Contact: em@uvigo.es

Aeolian transport of dust from arid land regions to the open ocean represents a potentially important flux of nutrients and other bioactive substrates that can affect the composition and metabolic activity of surface plankton communities. Perhaps the most studied effect, and the one that is better represented in current biogeochemical models, is the ocean fertilisation that results from the stimulation of phytoplankton productivity by dust-borne nutrients such as nitrate, phosphate and iron (e.g., Jickells et al., 2005). However, bacterial metabolism can also be nutrient-limited in very oligotrophic areas, and therefore dust inputs can also stimulate heterotrophic processes such as bacterial production and respiration (e.g., Marañón et al., 2010; Pulido-Villena et al., 2008).

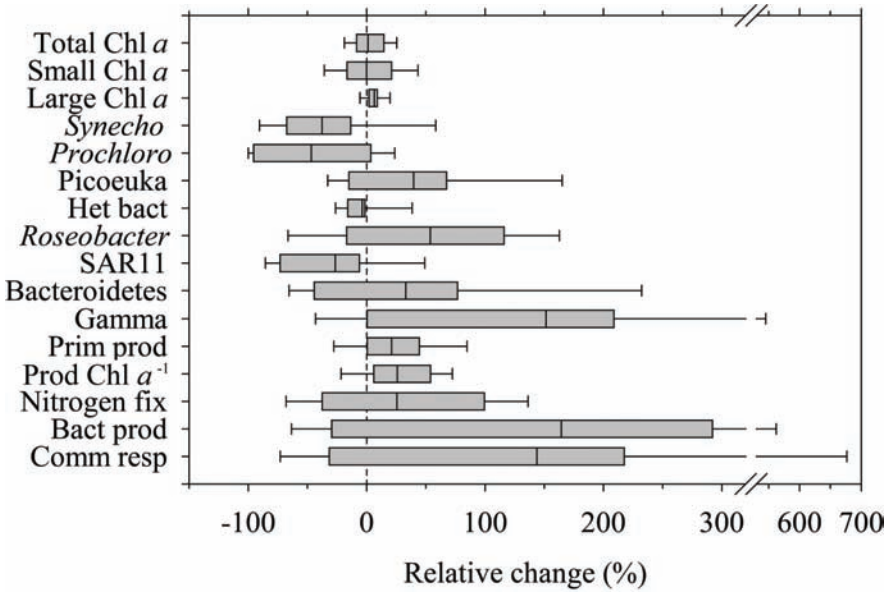
Given the divergent biogeochemical implications, from the point of view of atmospheric CO_2 drawdown, of a phytoplankton- versus bacteria-dominated response, it is critical to consider both the autotrophic and heterotrophic components when studying the effects of dust inputs on the microbial plankton community. In addition, the biota of different locations may respond differently to a given input. Therefore, it is important to determine these responses in different locations over wide spatial scales, in order to find general patterns in the effects of dust on microbial plankton.

Within the framework of the TRYNITROP (Trichodesmium and N_2 fixation in the tropical Atlantic) project, we conducted eight dust addition bioassays between 30°N-30°S in the central Atlantic Ocean during two cruises in November 2007 and April 2008. Our intention was to study the responses of different microbial plankton communities, sampled at the surface in eight locations over a >6,000 km transect, to the same Saharan dust input (2 mg L^{-1}). The studied locations, while always corresponding to oligotrophic settings, covered a wide range of conditions in terms of hydrography and expected nutrient availability.

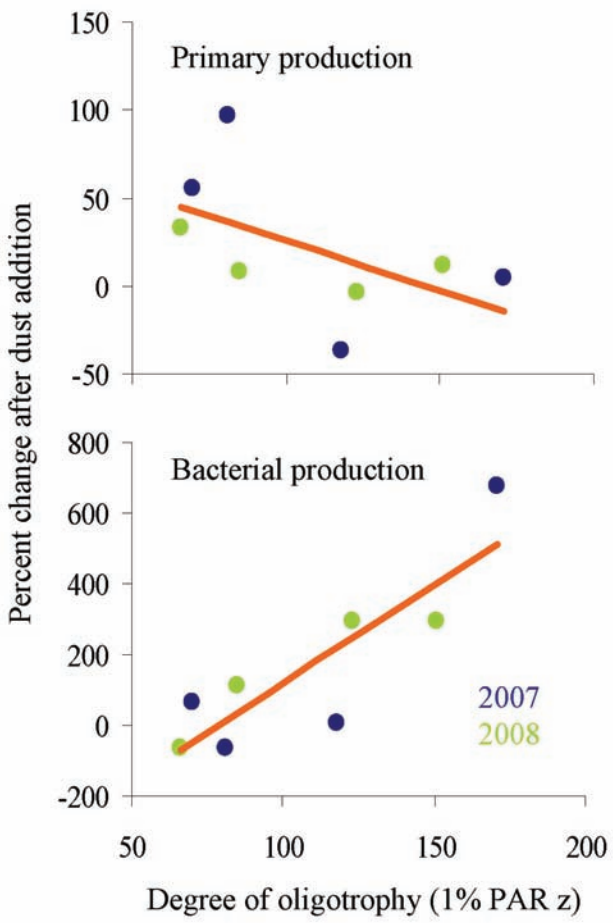
Although the specific responses observed in each location varied, the fact that we conducted a relatively high number of experiments allowed us to extract several consistent patterns (Figure 1).
We found that total standing stocks of both phytoplankton and bacteria tended to respond less than metabolic rates, which suggests that enhanced losses, presumably due to grazing, counterbalance the potential of the populations to increase in size after nutrients are delivered, to some extent. However, in spite of the relatively modest changes observed in bulk abundance and biomass, dust addition did cause changes in community structure as the response of different groups of microbes was different.

The abundance of *Synechococcus* and *Prochlorococcus* tended to decrease markedly after the dust addition, while the opposite was true for the picoeukaryotes. This pattern may reflect a higher ability of picoeukaryotes to respond to enhanced nutrient concentrations, together with a possible toxic effect of dust on the cyanobacteria. In the case of heterotrophic bacteria, the gammaproteobacteria, which are typically associated with enhanced resource supply conditions, showed mostly positive responses to dust. In contrast, the SAR11 group, which is adapted to ultraoligotrophic conditions, tended to decrease in abundance in response to the dust addition.

Most previous studies on the biological effects of dust have concentrated on the stimulation of phytoplankton activity (Herut et al., 2005). In our study, however, autotroph-dominated metabolic rates such as primary production and N_2 fixation were less responsive than heterotroph-dominated rates such as bacterial production and community respiration, which showed the largest increases in response to dust addition (Figure 2).



Λ Figure 1 : Relative change (%) of different variables in response to dust addition in all experiments combined. Relative change was calculated as 100 × (D – C) / C, where D and C are the mean value of the variable in the dust and the control treatments, respectively. Boxes and bars enclose the 25th-75th and 5th-95th percentiles, respectively, and the vertical line is the mean.



Λ Figure 2 : Relationship between the ecosystem's degree of oligotrophy and the relative change in (a) primary production and (b) bacterial production in response to dust addition (where PAR is the photosynthetically active radition).

The mean, dust-induced increase in primary production was ca. 25%, while that of bacterial production was around 150%. These results suggest that in ultraoligotrophic environments, where both phytoplankton and heterotrophic bacteria are nutrient-limited, the latter may be more efficient at using the very low amounts of nutrients released from the dust.

When we plotted the relative dust-induced change in primary production and bacterial production as a function of the degree of oligotrophy, represented by the euphotic layer depth, we found that the predominant type of metabolic response depended on the ecosystem's degree of oligotrophy. The increase in bacterial production became larger with increasing oligotrophy, whereas primary production became less responsive to dust as the ecosystem's degree of oligotrophy increased. Our results thus suggest that the biological effects of dust deposition are more complex than a simple, universal fertilisation effect, which may be modulated by competitive interactions between phytoplankton and bacteria, but depend also on the ecosystem's degree of oligotrophy.

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Acknowledgements

This work was made possible by the efforts of many researchers who contributed to the TRYNITROP project. Our research is funded by the Spanish Ministerio de Ciencia e Innovación.

Earth System Science Partnership

ESSP

The Earth System Sciences Partnership (ESSP) participated in the workshop that was held in conjunction with 34th Meeting of the Subsidiary Body for Scientific and Technological Advice (SBSTA34), held June 2011 in Bonn, Germany. The workshop featured research activities of the Earth System Science Partnership (ESSP), represented by its Global Carbon Project (GCP), Global Environmental Change and Human Health Project (GECHH) and Climate Change, Agriculture and Food Security programme (CCAFS). Further the presenters covered the scientific findings of the Inter-American Institute for Global Change Research (IAI), the European Research Framework Programme (FP7), the Intergovernmental Panel on Climate Change (IPCC), the Asia-Pacific Network for Global Change Research (APN) and several other scientific organizations. Examples of topics covered are detailed below:

Bruce Campbell discussed the impacts of climate change on farming systems and food production. Adaptation in agriculture is required as production is hindered due to increasing climate change, resulting in an increase in food prices causing an increase in malnutrition for children.

Andy Haines presented results from studies on the effects of GHG reduction strategies on public health and concluded that, although prior assessment of the impacts of mitigation strategies is needed, these strategies can result in major benefits for public health (e.g. decreases in premature deaths), and that these co-benefits can offset the costs of such strategies.

Corinne le Quéré, addressed the response of the carbon sinks to recent climate change, and current and expected emissions in the short term from fossil fuel burning and land use. She indicated that the size of the natural sinks has grown but at a slower pace than emissions have grown, although year-to-year variability is large. This implied a decline in the efficiency of the sinks in removing atmospheric CO_2 over time, a trend expected to continue in the future. Models suggest that CO_2 sinks could be responding to climate change and variability.

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Lauren Zamora recently obtained her Ph.D. in Marine and Atmospheric Chemistry from the University of Miami. She now is Post-Doctoral Researcher in biogeochemical modelling at IFM-GEOMAR in Kiel, Germany.

Phosphorus stress induced by atmospheric deposition to the surface waters of the subtropical North Atlantic

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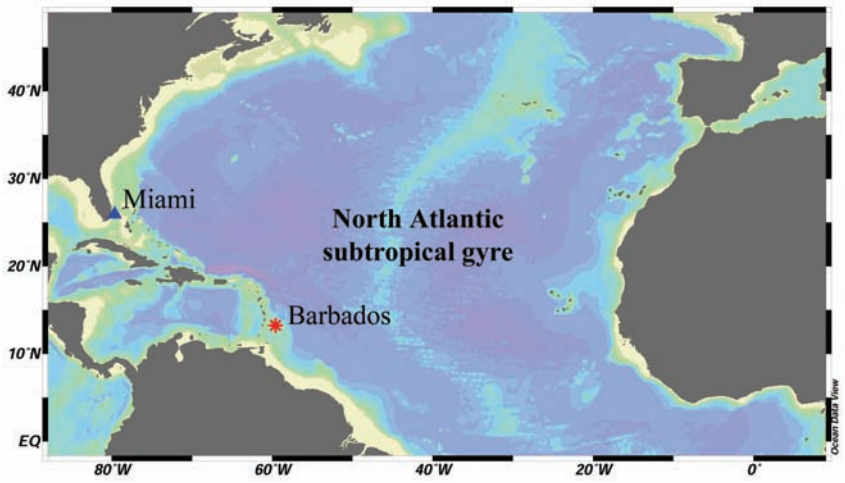
Over the past 150 years, nitrogen (N) deposition to the ocean has doubled (Duce et al., 2008). Atmospheric phosphorus (P) deposition, in contrast, has remained relatively steady (Mahowald et al., 2008). Recent modelling studies indicate that because the deposition fluxes of these two common limiting nutrients are diverging, P depletion in surface waters will increase (e.g., Zamora et al., 2010).

The highly oligotrophic North Atlantic subtropical gyre (NASG) is particularly susceptible to changes in atmospheric nutrient flux. Due to its proximity to strong continental sources, the NASG receives higher anthropogenic N deposition flux than other ocean basins. Phosphate levels in surface waters are already very low, reaching subnanomolar levels (Wu et al., 2000). Therefore, diazotrophs in the subtropical North Atlantic are thought to be limited or co-limited by P (e.g., Mills et al., 2004). Recent studies indicate that the greater phytoplankton community is P stressed as well (based on multiple physiological responses of local organisms to low phosphate concentrations).

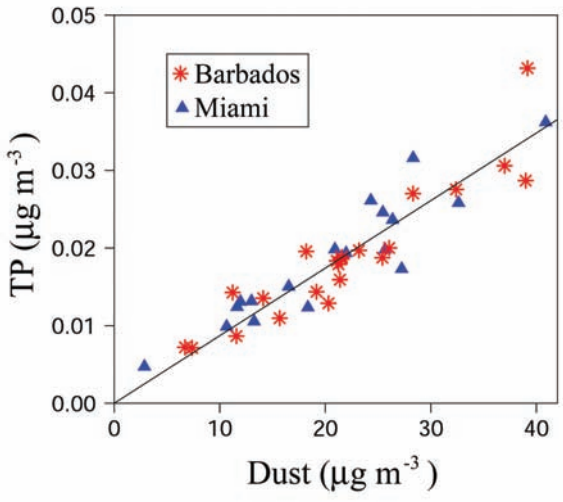
To better understand the magnitude of atmospheric N and P deposition on the NASG, we undertook a variety of field and modelling experiments. First, we estimated the flux of atmospheric P and N to the NASG. Due to the paucity of data, models commonly estimate total phosphorus (TP) deposition to the ocean based on dust deposition. We validated this technique by measuring dust and TP aerosol concentrations in Barbados and Miami (Figure 1 & 2), confirming a very strong correlation between the two.

Using the dust-TP relationship in combination with a 20-year aerosol dust and inorganic N record at Barbados and Miami, we calculated historic deposition rates of excess inorganic N (the amount of atmospheric N deposited in excess of Redfield molar ratio expectations of P; i.e., 16N:1P). For two years, we also measured the contribution of water soluble organic N (WSON) in aerosols and precipitation, finding that WSON adds an additional 6-14% of total soluble N deposition in Miami and Barbados (Zamora et al., submitted). Water soluble organic P was very low in comparison.

The flux of excess N to the sea surface represents the potential for P depletion in surface waters. Conservatively assuming that TP is fully bioavailable and that WSON will contribute 10% of soluble nitrogen in atmospheric deposition, we estimate that most (72-94%) nutrient deposition to the western subtropical NA is in excess of Redfield ratios, contributing 12-14 and 61-62 mmol.N.m^{-2}yr^{-1} in Barbados and Miami, respectively. If these sites are representative of the larger region, atmospheric N deposition rates would be comparable with regional N fluxes from lateral Ekman transport, diapycnal mixing, and N2 fixation, which provide 30-60, 15-50, and 45-149 mmol.m^{-2}yr^{-1}, respectively (e.g., Williams and Follows, 1998; Oschlies, 2002; Hansell et al., 2007).



Λ Figure 1 :Sampling locations.



Λ Figure 2 : The relationship between total phosphorus and dust in Barbados (red stars) and Miami (blue triangles) on dusty days.

Model studies indicate that the degree of P stress in surface waters due to atmospheric deposition depends not only on the deposition's magnitude but also its fate in the ocean. Phytoplankton may moderate atmospherically-derived P stress in surface waters via preferential remineralization or export of atmospheric nutrients from surface waters in non-Redfield ratios (Zamora et al., 2010). Also, particle export locations and rates determine whether surface currents remove atmospheric nutrients from the NASG system, or whether remineralized atmospheric nutrients are instead later returned to surface waters by upwelling, thereby establishing a positive feedback of atmospherically-derived high N:P ratios in the surface waters. Thus, while model and field studies both indicate that atmospheric deposition is causing P depletion in the NASG, the magnitude of depletion (and associated P stress) is, as yet, unknown.

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Conference Calendar

Month	Dates	Conference	Location
August	22-26	8th Baltic Sea Science Congress	St. Petersburg, Russia
	30 - 01 Sep	Open Science Meeting for an International Quiet Ocean Experiment	Paris, France
September	12-16	solas The Ocean Carbon Cycle at a time of change: Synthesis and vulnerabilities	Paris, France
	26-30	World Conference on Marine Biodiversity	Aberdeen, UK
	27-30	20th International Symposium on Environmental Biogeochemistry	Istanbul, Turkey
	27-29	Acidification in Aquatic Environments Workshop	Tromsø, Norway
October	06-07	1st International Workshop on the Long-Range Transport and Impacts of African Dust on the Americas	San Juan, Puerto Rico
	24-26	GEO Carbon Conference 'Carbon in a changing world'	Rome, Italy
	24-26	solas EUR-OCEANS Conference - Ocean deoxygenation and implications for marine biogeochemical cycles and ecosystems	Toulouse, France
	24-28	WCRP Open Science Conference - 'Climate Research in Service to Society'	Denver, USA
	24-29	7th WIOMSA Scientific Symposium 'Coping with Global Change'	Mombasa, Kenya
November	14-17	3rd GEOTRACES Data-Model Synergy Workshop	Barcelona, Spain
	29	COST Action 735 Finale Event	Frascati, Italy
	29 - 02 Dec	solas ESA-SOLAS-EGU Conference on Earth Observation for Ocean-Atmosphere Interactions Science	Frascati, Italy
December	05-09	AGU Fall Meeting 2011	San Francisco, USA

For more information on forthcoming meetings and events please, visit http://www.solas-int.org/news/conferencemeetings/conference.html

Roberta Hamme is a Chemical Oceanographer who makes high precision dissolved and atmospheric gas measurements. Her goal is to use these observations to constrain ocean processes from productivity rates to water mass formation to nutrient cycling. She is currently Assistant Professor at University of Victoria.

Peter Webley is a Remote Sensing Scientist with an interest in volcanic ash clouds and operational monitoring. He works with satellite remote sensing data and ash dispersion models in understanding their connection to real-time hazard mitigation. Peter is Assistant Research Professor at the Geophysical Institute, University of Alaska Fairbanks.

Iron fertilisation by volcanic ash drives unprecedented plankton bloom

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In August 2008, ash from the explosive eruption of Kasatochi Volcano in the Aleutian Islands not only snarled air travel in the region, it also fuelled a phytoplankton bloom of an unprecedented scale in the North Pacific. Productivity and export in the subarctic North Pacific, 20% of the world's oceans, is limited by low iron concentrations despite plentiful nutrients like nitrate. Experiments in these high nutrient / low chlorophyll (HNLC) regions have demonstrated that iron addition increases productivity. Natural iron fertilisation of these regions by dust may occur and has been proposed to play a role in reducing atmospheric carbon dioxide during ice ages, though this is controversial. The August 2008 event in the North Pacific is the first directly-observed, natural, iron fertilisation by volcanic ash (Hamme et al., 2010; Langmann et al., 2010), a relatively new mechanism proposed for iron supply to the ocean.

In August 2008, SeaWiFS and MODIS ocean colour satellites documented the largest phytoplankton bloom in the subarctic NE Pacific in 12 years of records.

The spatial extent of the bloom matched the airborne dispersal, and likely deposition, of volcanic ash from the 7-8 August 2008 eruption of Kasatochi volcano in the Aleutian Islands, Alaska, USA (Figure 1). The eruption injected ash into a forming storm system which swept across the subarctic NE Pacific, resulting in an unusually widespread ashfall that provided iron to the ocean surface upon contact.

Observations from a mooring and profiling ocean sea-glider in the area show decreasing pCO_2, increasing pH, and increasing fluorescence beginning 2-4 days after ashfall; which could only have been caused by plankton growth. The timing of these changes is similar to that of purposeful iron enrichment experiments. Measurements from two oceanographic cruises in the region during late August 2008 confirm high chlorophyll, high productivity rates, and increased dominance of diatoms in the phytoplankton assemblage, all evidence of iron fertilisation. Other satellite and in situ measurements disprove competing hypotheses for the event such as transport of coastal waters by ocean eddies; deposition of dust from Asia; deep mixing bringing iron up from below; or, a delay in the spring bloom.

Purposeful fertilisation of HNLC areas with iron to reduce atmospheric CO_2 levels has been explored for climate mitigation. The 25µatm decrease in pCO_2 observed at the mooring implies a carbon drawdown of 0.3-0.7 mol-C m^{-2} for this event. Extrapolating to the area of the bloom results in a potential ~0.01 Pg C drawdown, relatively modest compared with the roughly 2 Pg C of anthropogenic CO_2 taken up by the ocean each year. This event acts as a natural illustration of the scale of iron fertilisation required to accomplish purposeful CO_2 sequestration in the ocean.

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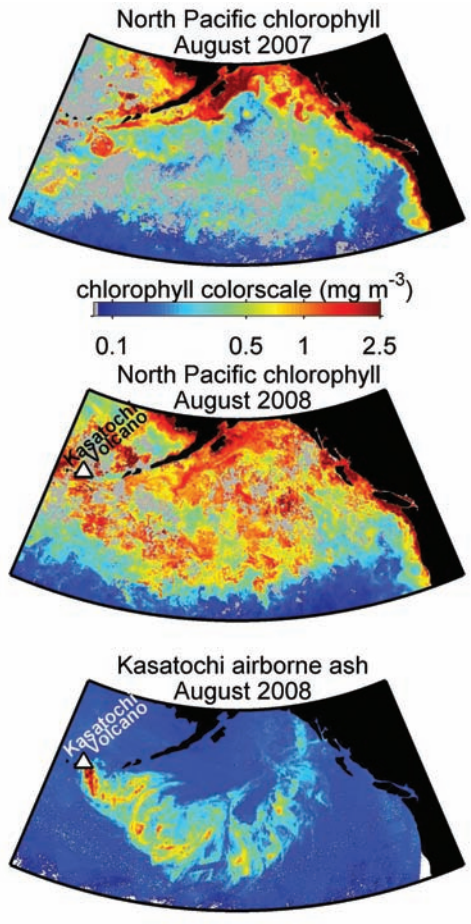

Λ Figure 1 : Top two panels show MODIS monthly-averaged surface chlorophyll in August 2007 and 2008 in the subarctic NE Pacific. Bottom panel shows composite of most intense satellite detections of airborne ash from the August 2008 Kasatochi eruption.

Martin Vancoppenolle is Research Associate at the Earth and Life Institute, Belgium, and is using models to try to understand the role of sea ice in the global biogeochemical cycles and climate. With a background in physics, he has expertise in physical and biological modelling of sea ice at small- and large-scales. Martin finds his observations are a perpetual source of inspiration.

Simulation of brine-microalgae interactions in sea ice

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Global models of ocean biogeochemistry still consider sea ice as biologically inert and impermeable to gas exchange. However, sea-ice supports life and active gas transport, with potential impacts on the marine ecosystems and the global cycles of carbon, sulphur and iron (Thomas and Dieckmann 2011).

Microbial life in sea ice is only possible because sea ice is filled with liquid inclusions of brine. Temperature determines the size and salinity of brines. Ice permeability drastically increases for brine volume fractions above 5% (>-5°C) providing a stable substrate where ice algae can thrive. The convective overturning of brine regularly supplies nutrients from the ocean to the ice.

In order to understand the implications of brine inclusions on sea-ice micro-algal developments, an explicit representation of the brine-biogeochemistry coupling has been included in the one-dimensional (1D) sea-ice model LIM-1D (Louvain-la-Neuve Ice Model; http://www.climate.be/lim/). LIM-1D also includes a representation of ice thermodynamics, brine dynamics and simple biogeochemical processes. Model simulations (Vancoppenolle et al., 2010) suggest a central role for brine dynamics on micro-algal developments in sea ice.

First, brine dynamics influence the vertical distribution of ice algae (Figure 1). Typically, so-called basal communities develop near the ice base, where brines join the ocean. In some instances, when snowfall is large enough, the snow-ice interface is depressed below sea level. Seawater, brine and nutrients may reach the snow-ice interface through brine uplift from below or drainage from the edge of ice floes. This surface flooding leads to the development of surface communities. Basal and surface algal communities can only be simulated if nutrients are supplied at the correct depth in the ice.

Brine dynamics also determine the seasonality of ice algae. Polar night precludes algal growth in winter. Significant growth periods occur when both light and nutrients are sufficient. Nutrient supply requires brine convection, which occurs all year long except in summer. During summer, nutrients may even be expelled due to surface melt water percolation. Rapid summer exhaustion of nutrients prevents further biomass increase. Hence, a sea- ice model will simulate maxima of primary production in fall and spring if the simulated brine dynamics capture the correct seasonality.

Model results also suggest that the maximum biomass reached in summer relies on the maximum winter nutrient stock in sea ice, which itself depends on brine convection. Finally, sensitivity tests suggest that the mode of ice algae transport within brine (passive or active) induces important biomass differences.

In summary, our results indicate that previous 1D sea-ice models – where brine dynamics were not properly represented – missed a key component for simulating micro-algae dynamics in sea ice. Brine dynamics play a role that is similar to vertical mixing and convection in the open ocean; influencing the spatial distribution, the seasonality and the magnitude of primary production in sea ice.

Changes in marine biogeochemistry and ecosystems projected for the 21st century in the polar oceans are larger and occur earlier than in other regions of the world ocean. However, Earth system models carry the largest uncertainties in the polar oceans. For instance, they do not agree on the sign of the Arctic Ocean primary production change by 2100 (Steinacher et al., 2010). Including a realistic biogeochemical sea-ice component in Earth System models should help to reduce the uncertainties in projected polar marine biogeochemistry and ecosystems.

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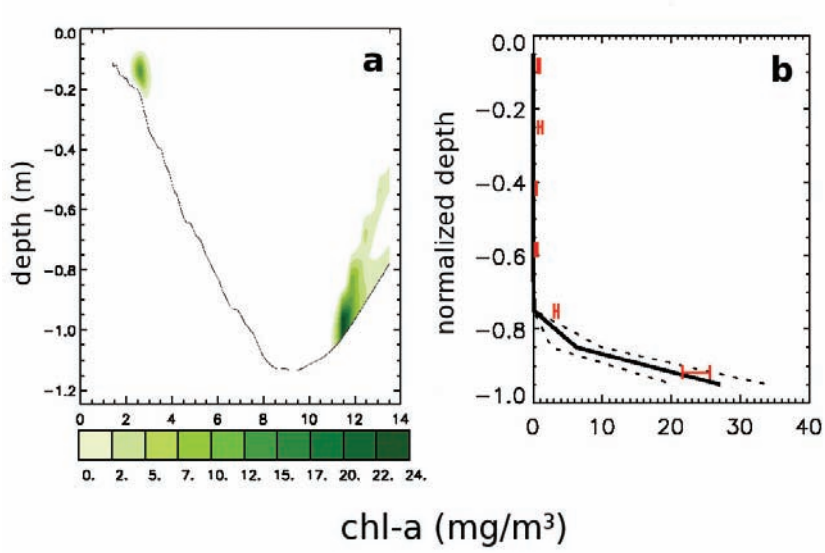
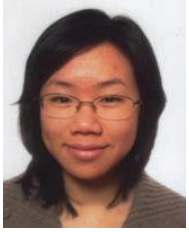
Acknowledgements

Ivan Grozny is gratefully acknowledged for continuous support and Jiayun Zhou for comments on this manuscript.



< Figure 1 : (a) An example of the vertical development of chlorophyll-a in sea ice simulated over a year in the Weddell Sea with LIM-1D. (b) Comparison of the simulated chlorophyll-a profile (December, solid line) with observations (red bars).



Jiayun Zhou is a PhD student on an FNRS fellowship in Glaciology (ULB) and Oceanography (ULg). Her work is to identify and to quantify the main physicochemical and biological processes that affect sea ice gas content. The purpose is to assess whether sea ice acts as a source or a sink of greenhouse gases.

Gas concentrations in Barrow landfast sea ice: the winter/spring contrasts

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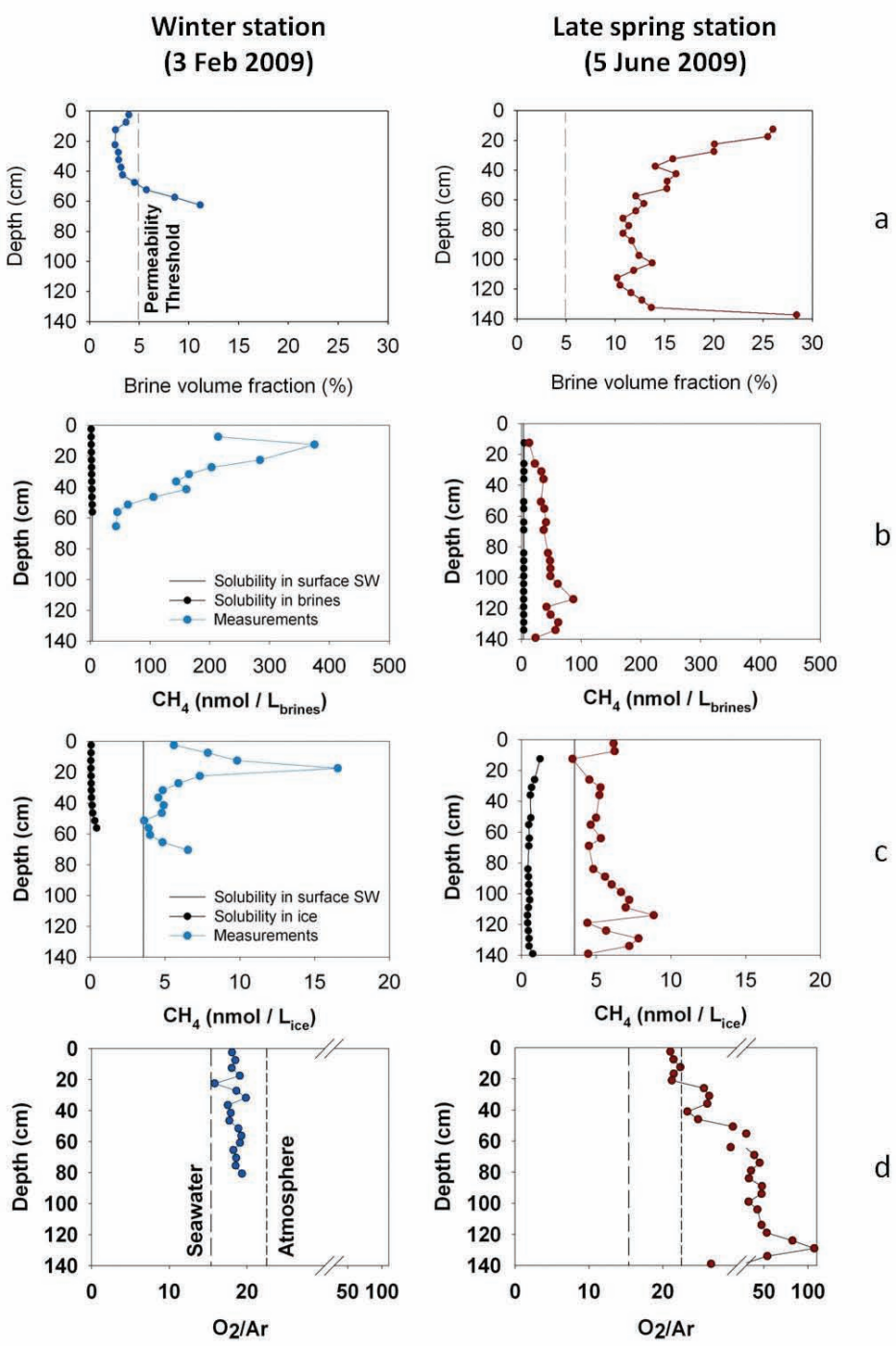
Recent work has suggested that sea ice may affect gas exchanges between the atmosphere and the ocean. Indeed, gas (CO_2, DMS) fluxes across the air-sea ice interface have been reported in both Antarctica and the Arctic (Zemmelink et al., 2008; Miller et al., 2011).

Since current climate models assume that sea ice is impermeable, the simulated fluxes should be reconsidered. To assess the contribution of sea ice to the atmospheric gas budget, annual surveys are required, because processes that affect gas content clearly vary with time. The contrasts are particularly obvious for the wintertime versus springtime brine volume fraction, CH_4 concentrations and O_2/Ar ratios, as shown in Figure 1. The data is from a year-round survey of Barrow land-fast sea-ice in 2009.

Sea-ice permeability depends on brine volume fraction. When the latter exceeds 5%, columnar sea-ice should be permeable (Golden et al., 1998). In winter, sea ice is only permeable at its base, while in late spring, sea ice is permeable over its full depth (Figure 1a), suggesting potential exchanges between the atmosphere and the underlying seawater.

Our measurements of CH_4 concentrations in sea ice (up to 60ppmV-not shown) largely exceed the atmospheric value (1.8ppmV). Shakhova et al. (2010) report higher concentration (11400ppmV) probably due to a stronger sedimentary source and the ebullition transport. In the winter, the CH_4 concentrations in brines are higher than enabled by maximum solubility in brines (Figure 1b), meaning that a large part of the measured CH_4 is in the bubble phase. In late spring, as sea ice becomes warmer, the CH_4 concentrations get closer to the solubility value. This is due to both the increase in brine volume fraction (and the induced brine dilution) and to the release of CH_4 bubbles from the upper part of sea ice (Figure 1b,c). This example shows how sea-ice physics (in this case, permeability and brine dilution) affects gas concentrations in sea ice, and thus gas exchanges with the atmosphere.



Λ Figure 1 : Selected results from landfast first year sea ice analyses at Barrow (Alaska) from January to June 2009: (a) Brine volume fraction, (b) CH_4 (nmol/L_{brines}), (c) CH_4 (nmol/L_{ice}), (d) O_2/Ar. Gas concentration are given for both dissolved and bubble phase.

Nonetheless, sea ice is not only a simple valve that limits gas exchanges between the atmosphere and the underlying seawater. Indeed, sympagic organisms may actively modify the exchanged gas composition. As in seawater, the O_2/Ar ratio is an indicator of the net community production (the net production of sympagic organisms). Using the solubility of O_2 and that of Ar and assuming maximal efficiency for gas diffusion at the ice base, we have determined a range of O_2/Ar values in brines, in abiotic conditions. This range represents the background signal, which is purely due to physical processes. Values that are below or above this theoretical background can be attributed to biological activity. In the winter, O_2/Ar remains between the limits of the theoretical background values. In late spring however, as the chlorophyll-a concentration increases (not shown), O_2/Ar increases, and greatly exceeds the upper threshold of the theoretical background values. This highlights a biological production of O_2, which implies a consumption of CO_2. Hence, if permeable, sea ice could act as a biological pump of CO_2. This process will add on other purely physicochemical mechanisms reducing the pCO_2 in the Spring sea-ice (Delille et al., 2007).

To conclude, the processes in sea ice that modulate gas exchanges between the atmosphere and the underlying seawater vary across seasons. Wintertime sampling is characterised by CH_4 accumulation and low photosynthetic activity. In contrast, springtime sampling is characterised by a partial release of the accumulated CH_4 and a biological consumption of CO_2. Since current surveys are mainly carried out in spring, further autumn and winter analyses in sea ice should refine our estimates of CO_2 and CH_4 sources and sinks at the global level.

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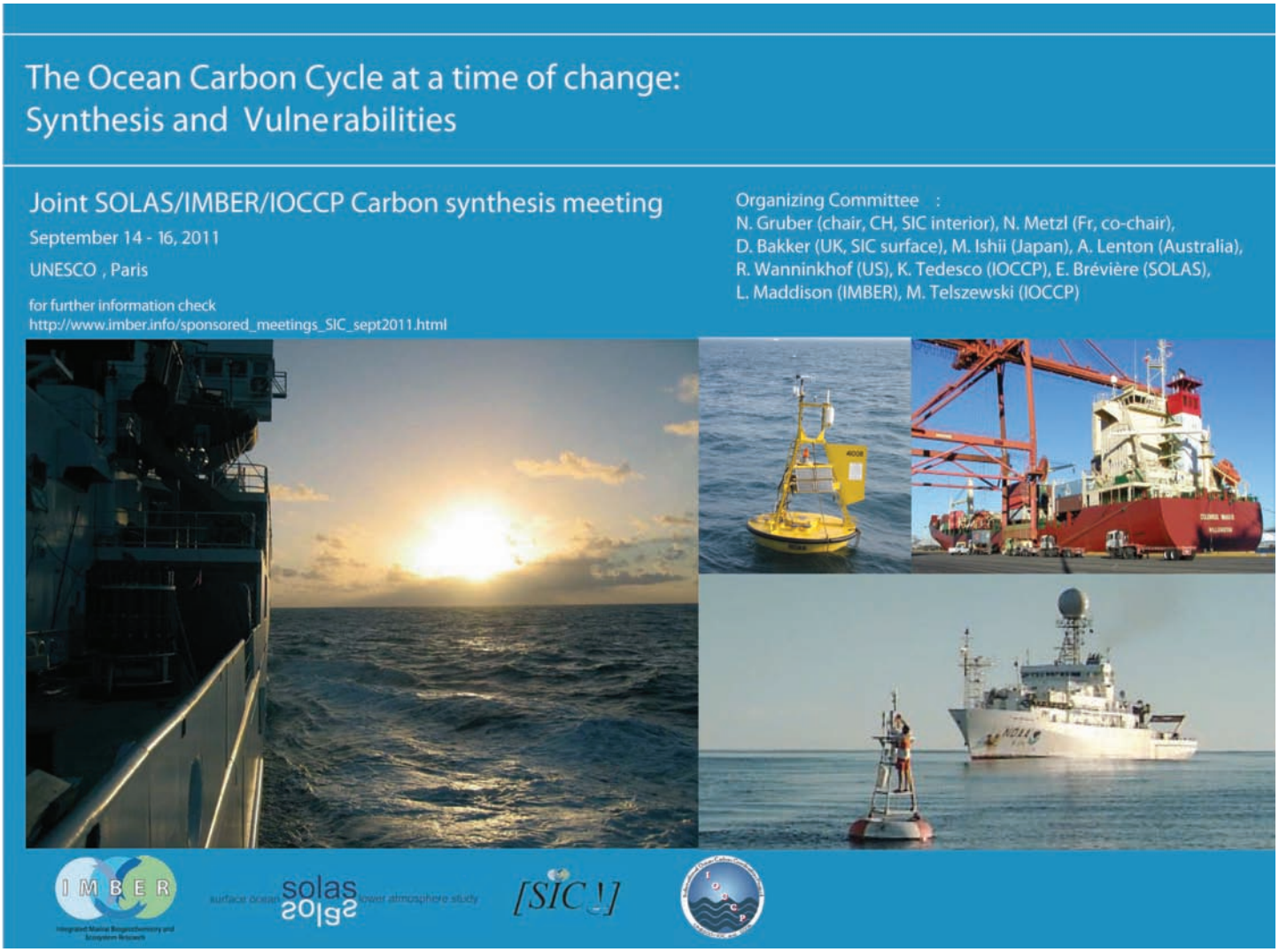

GREENCYCLES II

GREENCYCLESII is a four year FP7 Marie Curie ITN network funded by the Research Executive Agency (REA). The network has 14 partners (http://www.greencycles.org/partners/). The science objective of GREENCYCLESII is to substantially improve current understanding of the impacts of climate-biogeochemistry feedbacks on the evolution of the Earth system over the next two centuries.

The research is classed into data and model benchmarking, marine processes, terrestrial processes, high latitude feedbacks, and coupled modelling. The closely related training objective is to produce highly interdisciplinary, multi-skilled young scientists needed to address the environmental challenges of the 21st century.

GREENCYCLESII started on 1 January 2010, and since then, there have been two annual network meetings. Following this year's meeting, Instituto Superior de Agronomia has organised a visit to an experimental field-site investigating the effect of precipitation variability on the understory of cork oak woodlands. A major event and milestone for the network was the Summer School, "Feedbacks in the Earth System: the state-of-the-art", organised by Potsdam Institute for Climate Impact Research, at Peyresq Foyer d'Humanisme, France, in May 2011. 26 network fellows and five external researchers attended lectures and practicals and learnt about climate science from world leaders in the field (http://www.pik-potsdam.de/infodesk/education/summer-schools/greencyclesii/programme/index_html). The overall progress of the network is very good.

Recruitment, one of the most important milestones is almost complete: 27 fellows out of 28 have been recruited. The fellows have started their science and training projects and have attended and presented at national and international meetings and workshops. The first progress report and other formal documents requested by the funder have been completed on time and are up to date. The network has its own website (http://www.greencycles.org) which has been improved and it is constantly updated.

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Programme Co-ordinator
(Andrew.Friend@geog.cam.ac.uk)

Katerina Goubanova got her PhD in Environmental Sciences from Université Pierre et Marie Curie (Paris, France). She is currently Post-Doctoral Research Fellow at LEGOS, Toulouse, France. Her main scientific interests concern the regional impact of climate change and air-sea interaction in Eastern boundary upwelling regions of the Southern Hemisphere.

Atmospheric forcing in Eastern boundary upwelling systems: downscaling strategies for climate change impact studies

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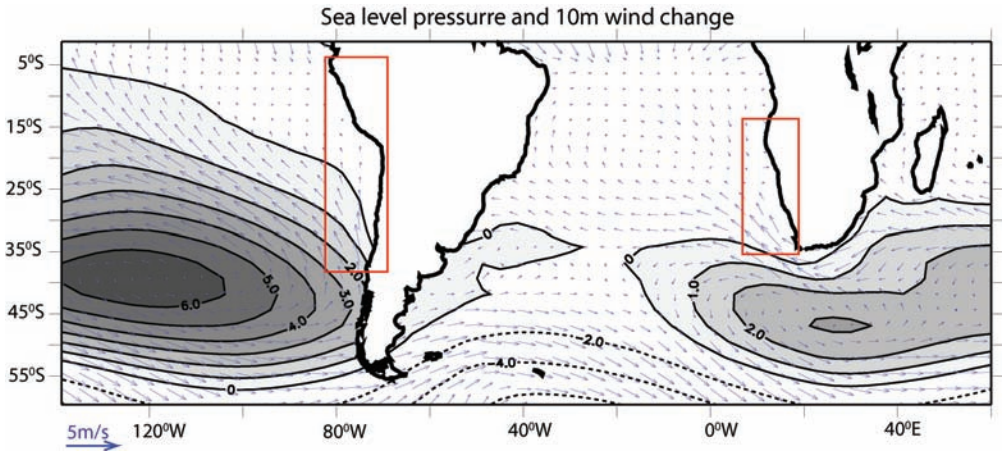
Eastern boundary upwelling systems (EBUS) are regions of active physical, biogeochemical and biological processes. Wind-driven coastal upwelling brings cold, nutrient-rich waters to the surface promoting high primary productivity and, therefore, a rich marine ecosystem. Other prominent features of the EBUS are the presence of extended Oxygen Minimum Zones, their contribution to the greenhouse gas production and their important role in the biogeochemical cycles of nitrogen, carbon and phosphorus.

In order to evaluate future evolution of the EBUS and its impact on global climate, it is essential to assess the evolution of surface winds since, on one hand, winds drive the coastal upwelling and, on the other, wind constitutes a main physical parameter controlling the air-sea gas exchange. Although the global coupled models (GCMs) provide meaningful information on the potential impact of climate change on the large-scale atmospheric circulation, they cannot be used directly to infer the impact on the wind regime along the coast because their resolution is too coarse. Downscaling the GCMs projections is necessary in order to provide a more quantitative estimate of the EBUS response to climate change.

We propose a statistical method that allows deriving regional information on upwelling-favourable wind from large-scale atmospheric surface circulation (Goubanova et al. 2010). Although statistical downscaling does not represent complete regional physics it offers a cost-effective alternative to the use of high resolution regional climate models that are generally heavy to implement and require extensive computation resources.

A statistical model based on multiple linear regressions was built between large-scale predictors (surface winds and sea level pressure) from i) the National Centers for Environmental Predictions (NCEP) reanalysis and ii) high-resolution surface winds from the QuikSCAT satellite; for both EBUS of the Southern Hemisphere, the Humboldt Current system (off Peru/Chile) and the Benguela system (Angola/Namibia). A potential impact of climate change on the alongshore wind, associated to anthropogenic greenhouse gas emission increase, was assessed using two contrasting scenarios simulated by the IPSL-CM4 coupled model (Marti et al., 2009): one corresponding to pre-industrial climate (PI) and the other one corresponding to CO_2 quadrupling ($4xCO_2$).



Λ Figure 1 : Differences in sea level pressure (contour, hPa) and 10m wind (arrows) in the SE Pacific and SE Atlantic between the $4xCO_2$ and PI climates for July-December simulated by the IPSL-CM4 model. Red rectangles show the Humboldt and Benguela upwelling regions.

A 30-year period was arbitrarily chosen for each CO_2-stabilized experiment: 1970–1999 for PI and 2120–2149 for 4xCO_2. Figure 1 shows the response of the large-scale surface circulation to CO_2 quadrupling over the South-Eastern (SE) Pacific and SE Atlantic for the July-December season when upwelling-favourable winds in Humboldt and Benguela EBUS are the strongest. Note that the spatial patterns of the surface circulation response to warmer climate in the IPSL-CM4 model are similar to those obtained from an ensemble of GCMs (Goubanova et al. 2010).

Applying the statistical models to the IPSL-CM4 predictor variables over the SE Pacific and SE Atlantic allowed assessing how the change in the large-scale circulation presented in Figure 1 translates on a regional scale in the Humboldt and Benguela EBUS, respectively. Figure 2a shows that regional upwelling-favourable winds in the Humboldt system significantly increase off the coast of Chile with the maximum change (more than 15%) at about 30°S. Along the coast of Peru, winds slightly decrease exhibiting statistically significant weakening in January-February (not shown). Over the Benguela upwelling system (Figure 2b), winds decrease significantly (up to 15%) all along the coast except in its extreme southern part where a slight intensification is observed consistently with the increasing meridional pressure gradient south of South Africa.

Although the proposed statistical method takes into account only the regional wind change associated with modification of the large-scale atmospheric circulation and does not consider smaller-scale land-sea-air interaction processes that impact alongshore wind, it provides a first approximation of EBUS regional response to climate change. Our results clearly show that the response to climate change can be different among the EBUS. These results should be confronted with appropriate dynamical downscaling experiments which will include complete regional physics and, thus, will offer more accurate estimations of future change in atmospheric forcing for the Humboldt and Benguela upwelling systems.
This work is currently under progress in the frame of the CORDEX project (http://www.meteo.unican.es/en/projects/CORDEX).

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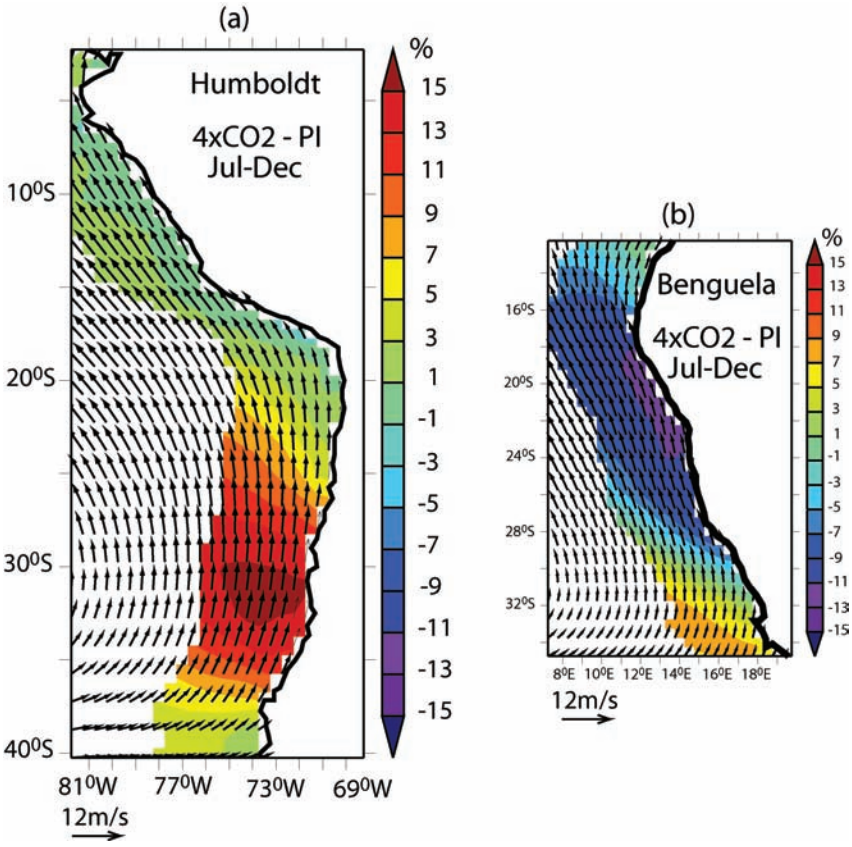

Λ Figure 2 : Relative change in mean surface wind speed (colour code in percent) from July to December for the 4xCO_2 climate relative to the PI climate derived from statistical downscaling applied to the IPSL-CM4 model outputs over (a) Humboldt and (b) Benguela EBUS. Arrows show mean wind for the PI climate.

ICSU

ICSU (International Council for Science) have recently launched their new, interactive website as part of their effort to be more strategic in communicating with members and the wider scientific community. The 'Insight' newsletter has been revamped and is integrated into the website, enabling subscribers to keep up to date with ICSU's global and regional activities, latest publications and events from ICSU's members. Recent SOLAS-relevant news as featured in Insight newsletter:

Global environmental change programmes appoint new Scientific Chairs

New Scientific Committee Chairs have been appointed to two of ICSU's global environmental change programmes - the International Human Dimensions Programme on Global Environmental Change (IHDP) and the International Geosphere-Biosphere Programme (IGBP).

Polar research boosts understanding of our climate & global environment

The largest coordinated research project ever undertaken into the Arctic and Antarctic regions yielded a treasure trove of information which will shape our understanding of the polar regions, global oceans, climate and climate change for decades ahead, according to a summary of the research released this month, http://www.icsu.org/news-centre/news/.

Visioning: Towards a new initiative for global sustainability research

The Earth System Visioning process concluded in February with participants at the third and final meeting agreeing on key elements for a new initiative that will address the Grand Challenges for Earth System Science - delivering knowledge to enable societies to meet their sustainable development goals in the next decade. For more information, please see http://www.icsu-visioning.org/.

30th General Assembly of ICSU

The website for the 30th General Assembly of ICSU is now open (http://www.icsu.org/general-assembly). The website provides delegates with information about the programme as well as practical information.

To subscribe to Insight, visit http://www.icsu.org/about-icsu/about-us/join_form.

Leah Goldfarb,
Science Officer
(Leah.Goldfarb@icsu.org)

CARBOCHANGE

CARBOCHANGE - Changes in carbon uptake and emissions by oceans in a changing climate - is a large-scale, integrating, collaborative research project of seven million euros funded by the EU's 7th Framework Programme in the period 2011-2015 (start 1 March 2011). The goal of CARBOCHANGE is to quantify the oceanic uptake of human-produced carbon dioxide from the atmosphere. It is coordinated by the Geophysical Institute at the University of Bergen and the Bjerknes Centre for Climate Research, Norway. CARBOCHANGE gathers a consortium of 28 research institutions from Europe, North America (USA and Canada) and Africa (Morocco and South Africa) with outstanding scientific expertise in the field of carbon cycle research.

Carbon dioxide from fossil fuel burning and land use changes is the main contributor to a human-induced climate change. Currently, the ocean takes up about 25% of the world-wide, annually produced, carbon dioxide but this rate is subject to continuous change.

CARBOCHANGE investigates how large this uptake rate has been in the past; how it is changing at present; and, how it will evolve in the future. Carbon dioxide in the surface ocean has to pass through the bottleneck of oceanic mixing on its way to the deep ocean. Climate change and biogeochemical processes further modify the oceanic absorption of carbon dioxide.

CARBOCHANGE employs cutting edge measurement and modelling techniques to watch the ongoing carbon dioxide uptake by the oceans; to understand the underlying processes; and, to predict changes in uptake to come.

The project places special emphasis on a systematic combination of ocean carbon observations and ocean models through advanced model performance assessments and data assimilation methods. CARBOCHANGE will provide science-based guardrails for political decisions on mitigation actions in order to control and alleviate the impact of carbon dioxide emissions and climate change.

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Friederike Hoffmann,
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Martín Hernández-Ayon is a Chemical Oceanographer from the University of Baja California (Mexico). His research is focused on the inorganic carbon system, ocean acidification and biogeochemistry in coastal regions as Baja California, Sea of Cortez, subtropical region where the Oxygen Minimum Zone is located and recently Gulf of Mexico.

CO_2 system studies in Mexican coastal waters: Baja California and the connections with subtropical water

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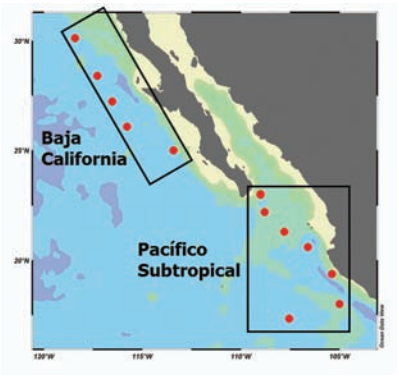
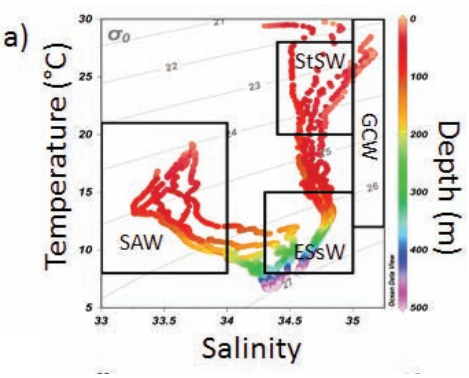
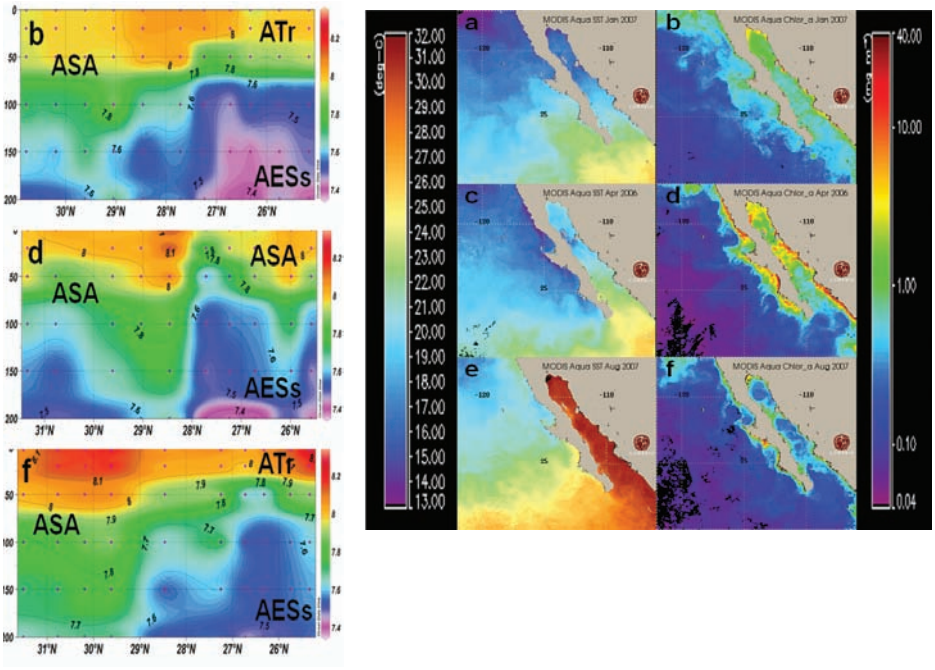
The region off the Baja California (BC) coast is the southern limit of the California Current System (CCS), composed by an alongshore, near-surface, equator-ward flow carrying cold, fresh, modified subarctic water (SAW), and a subsurface pole-ward current flowing along the edge of the continental slope. The area is characterised by coastal upwelling due to northerly winds most of the year (Durazo, 2009), and is considered a transition region where the relatively cold and fresh equator-ward flow of the California Current (CC), meets with the saltier, warmer equatorial and subtropical waters (Durazo and Baumgartner, 2002) with low oxygen concentration (Figure 1). The figures highlight the differences in depth (a) and oxygen (b) for water masses in two regions: the left showing data from BC and the subtropical area on the right. Figure 1 indicates how shallow the Subsurface Equatorial Water (SsEW) in the subtropical region is (<100m) where the Oxygen Minimum Zone (OMZ) is located. The boundary between these water masses exhibits latitudinal shifting at seasonal and larger scales. At the seasonal scale, subarctic waters dominate during the peak of the upwelling season in spring and summer, while tropical and subtropical influences are commonly observed during summer and fall (Durazo, 2009).

In particular, the geochemistry is poorly sampled in the coastal ocean off Baja California and this is critical to understand the transitional region between the tropics and mid-latitudes along the eastern boundary of the North Pacific, but also in combination with climate change. pH for example, has gained interest in the process described as "ocean acidification", which is attributed to increased absorption of anthropogenic CO_2 in surface waters. On this topic, it was found that during upwelling events in BC, carbonate subsaturated water is transported onto the continental shelf (Feely et al. 2008). Figure 2 shows $pH_{(25oC)}$ measurements in BC region, together with surface temperature and chlorophylls.





Λ Figure 1 : T–S diagrams illustrating the differences between Baja California and the Subtropical area for both depth (a) and oxygen (b). Water masses: TSW: Tropical surface water; StSW: Subtropical surface water; SAW: Subartic water; TrW: Transitional water; SsEW: Equatorial subsurface water.



Λ Figure 2 : Seasonal pH sections North-South (see red line Fig. a) Between 27 and 28ºN correspond to Punta Eugenia B.C. Figures (a), (c) and (e) represent sea surface temperature and (b), (d) and (f) (left) chlorophyll for January, April and July respectively (Colunga-Juarez et al., 2010).

Representative seasonal conditions in the upper 200m were selected to show different scenarios: in winter, pH values were close to the equilibrium value (~8.05) at the surface due to water-atmosphere exchange and low biological productivity; in spring, pH showed greater variability derived from high biological productivity due to upwelling; and in summer, maximum pH values were recorded and attributed to the consumption of inorganic carbon accumulated by the end of the upwelling season. Below 50m depth, pH was controlled by advection processes. In winter and summer, lower pH values were recorded south of Punta Eugenia owing to the incursion of SsEW with pH < 7.5; whereas in spring, pH values were ~0.2 units higher than in winter and summer because of the presence of SAW with pH > 7.7 (Colunga-Juarez et al, 2010). The spatial variation of pH off the coast of Baja California is thus determined mainly by temporal variations in the proportion of both water masses but it is needed to be monitored together with oxygen to understand the transitional region between mid-latitudes and the tropics, where the OMZ is located.

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Acknowledgements

Warm thanks to Kathy Barbeau and her group for their time and efforts during her oceanographic campaign in 2008. But also thanks to the *R/V Francisco de Ulloa* crew, scientists and students. IMECOCAL has been funded by CONACyT through scientific initiatives 25339, SEMARNAT-CONACYT 23804, SEP-CONACYT CB 2008-99252 and 15va Conv.-UABC.

The Ocean in a High-CO_2 World
Ocean Acidification
An international science symposium series

24-27 September 2012, Monterey, California, USA

The symposium will bring together the global community of scientists studying ocean acidification to discuss the impacts of ocean acidification on marine organisms, ecosystems, and biogeochemical cycles. It will also cover socio-economic consequences of ocean acidification, including policy and management implications.

http://www.highco2-iii.org/

SOLAS-related plenary presentation and parallel session topics include:

- Changes in ocean carbonate chemistry since the Industrial Revolution
- Rates of change of ocean acidification: Insights from the palaeorecord
- Interactions of ocean acidification with physical climate change
- Biogeochemical consequences of ocean acidification and feedbacks to the Earth
- Detection and attribution of ocean acidification changes
- Effects of ocean acidification on nutrient and metal speciation
- New developments in measuring and observing ocean acidification and its effects
- Regional impacts of ocean acidification
- Effects of ocean acidification on calcifying organisms
- New concerns in ocean acidification research

Registration and abstract submission opens: 15 September 2011

SOLAS special reports

22nd Pacific Science Congress 'Megacities in the Coastal Zone (MCCZ)'

14-18 June 2011, Kuala Lumpur Convention Centre, Kuala Lumpur, Malaysia

Mitsuo Uematsu (uematsu@aori.u-tokyo.ac.jp)
Ocean Research Institute, The University of Tokyo, Japan.

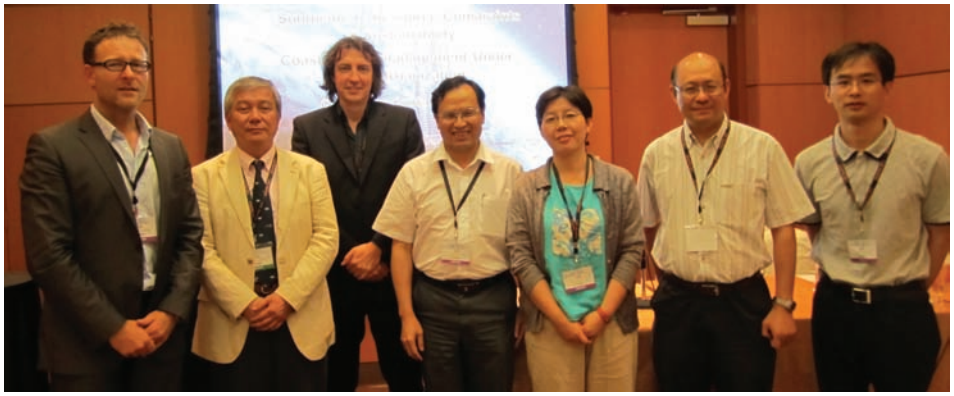
More than 10% of the world's population live in megacities (cities containing more than 10 million people), and this proportion is expected to increase in coming decades. Even though a very large number of megacities are located at the coast, there has not been a systematic consideration of the additional pressures and effects that this juxtaposition of land and ocean has. An SOLAS/IGAC/LOICZ fast track initiative workshop sponsored by IGBP/SCOR held in Norwich in April 2010 and focused on the physical and biogeochemical interactions between the atmosphere, the land and the ocean in and around coastal megacities.

We had an opportunity to present our outcomes at the session "Coastal Zone Management under Rapid Urbanization" (co-chairs: P. Shi, J. Weichselgartner, Ailikun and C. Tang) at the 22nd Pacific Science Congress organised by the Pacific Science Association, an NGO which has advanced science, technology and sustainable development in the region since 1920.

Approximately 800 people from 45 countries participated in the Congress.

Twelve talks were presented during the two-day session from the various topics including changes in quality of water and air; coastal ecosystem under rapid urbanisation; and, climate change in Asia and other regions, mainly from the LOICZ community. More than half of the talks were introducing issues from coastal zone development and its management in China. The session was going quite well with vivid discussions on the floor. Most of the time the audience contained over 20 people and peaked to over 30.

The LOICZ community heads establishing a way to approach the matter of growing MCCZs, incorporating coastal, social and ecological systems, whilst, the SOLAS community focuses from a natural science point-of-view. We have to reduce this pronounced discrepancy between LOICZ and SOLAS/IGAC. Scientists will be required to provide their points-of-view to aid future decision-making in coastal management. This is a critical issue for the future sustainability of urban development, not only in Asia but, world-wide.



Λ Photo : Attendees of the Megacities in the Coastal Zone (MCCZ) session.

2011 ASLO Aquatic Sciences meeting 'Limnology and oceanography in a changing world' 13-18 February 2011, San Juan, Puerto Rico

Cécile Guieu (guieu@obs-vlfr.fr), Laboratoire d'Océanographie de Villefranche, Villefranche-Sur-Mer, France.
Douglas Wallace (dwallace@ifm-geomar.de)
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IFM-GEOMAR, Kiel, Germany.

The ASLO 2011 Aquatic Sciences meeting took place in Puerto-Rico in February this year. The session S49, entitled 'Atmospheric Control of Nutrient Cycling and Production in the Surface Ocean' was convened by Cécile Guieu, Doug Wallace, and Cliff Law and was chaired by Cécile Guieu and Julie La Roche. This session was directly related to the Mid-Term Strategy initiative with the same name; and its objective was to discuss new results on key aspects such as the bioavailability of atmospheric inorganic and organic nutrients; impact on marine community structure; future variation of atmospheric nutrient deposition; and, its impact on carbon and nitrogen fixation at different time scales. The session consisted of 13 oral presentations and was indeed an occasion to learn from recent research from field work to modelling approaches. An invited talk was given by Prof. E. Marañón (see articles pages 16 & 17) who presented an overview of recent findings concerning general patterns in the way biomass, community structure and metabolic activity of microbial plankton change as a result of atmospheric nutrient deposition. The other talks addressed presented recent results concerning (1) atmospheric deposition of trace elements and nutrients; their partitioning between wet and dry deposition; and, the contribution of anthropogenic inputs, including data from time series in very contrasting areas (i.e. Barbados, Kerguelen Islands); (2) new methodologies to measure Fe organic speciation in rainwater and to produce a dust analog for artificial seeding experiments; (3) in situ measurements of the distribution and relative abundance of specific microplankton organisms including diazotrophs and their control by environmental factors such as atmospheric deposition; (4) atmospheric impacts on both trace elements chemistry and biological activity of artificial seeding within large mesocosms; (5) modelling of the impacts of variability of atmospheric dust deposition on biogeochemical cycles, ecosystem structure and primary production.

4th Annual SOPRAN Meeting 2011

22-23 March 2011, Institut für Umweltphysik, University of Heidelberg, Germany

Hermann Bange (hbange@ifm-geomar.de) IFM-GEOMAR, Kiel, Germany.

SOPRAN is a German national contribution to SOLAS and is funded by the Federal Ministry for Research and Education (BMBF). More than 70 scientists from all over the country attended the meeting which focussed on results from the first year of the second phase of SOPRAN (which is funded for the period February 2010 to January 2013). The first day of the meeting saw overview talks Bernd Jähne (Univ. Heidelberg) and Birgit Quack (IFM-GEOMAR) on "Current state and open issues in our understanding of the air-sea gas transfer mechanisms" and "Halocarbon emissions from tropical oceans and their transport into the stratosphere", respectively. The overview presentations were followed by the "Young Scientists Highlight Presentations" by Luisa Galgani (AWI, Bremerhaven), Michael Krupski (Univ. Hamburg), Qiang Shi (IFM-GEOMAR, Kiel), Jens Tschritter (Univ. Heidelberg), Evridiki Mesarchaki (MPI Chemie, Mainz), Christine Kräuter (Univ. Heidelberg) and Ingo Weinberg (Univ. Heidelberg). The presentations by the young scientists covered the broad thematic spectrum of SOPRAN including composition of the surface microlayer, atmospheric distribution, emissions and oceanic formation of halogenated compounds as well as recent measurements of the gas exchange coefficient of moderately soluble compounds in the Heidelberg Aeolotron. During the afternoon poster session, the 27 posters sparked many lively discussions which continued over dinner in the Aeolotron wind/wave facility. The 2nd day included overview talks by the platform PIs and discussion groups concerning seasurface microlayer, Cape Verde as well as FINO2/Aeolotron activities and halogenated compounds.

SOPRAN Phase II is structured around shared use of research "platforms", most of which were established under Phase I. The platforms are: (1) mesocosms, particularly the floating mesocosms developed at IFM-GEOMAR; (2) the tropical Eastern North Atlantic region, including the Cape Verde Observatory and the upwelling off Mauritania; (3) the FINO2 platform in the Baltic Sea which has been instrumented for gas exchange studies, as well as the Aeolotron facility in Heidelberg; (4) a R/V Merian cruise to the equatorial Atlantic Ocean in 2011; and (5) a modelling "platform".

The collection of meeting abstracts and the meeting agenda can be downloaded from www.sopran.pangaea.de -> Meetings/Events. The 5th Annual SOPRAN Meeting will be hosted by IFM-GEOMAR, Kiel, in March 2012. More details about SOPRAN can be found under www.sopran.pangaea.de. If you wish to join the SOPRAN mailing list contact Hermann Bange (hbange@ifm-geomar.de).

Λ Figure 1 : Snapshot taken during the evening event at the Heidelberg Aeolotron wind/wave facility.

EGU General Assembly 2011 - Sensitivity of marine ecosystems and biogeochemical cycles to global change

03-08 April 2011, Vienna, Austria

Bariş Salihoğlu (baris@ims.medu.edu.tr), Institute of Marine Science, Middle East Technical University, Turkey.
Christoph Garbe (christoph.garbe@uni-heidelberg.de), University of Heidelberg, Germany.
Emilie Brévière (ebreviere@ifm-geomar.de), IFM-GEOMAR, Kiel, Germany.

The Surface Ocean - Lower Atmosphere Study (SOLAS) and Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) projects organised a joint special session at the European Geosciences Union General Assembly 2011. This joint session comprised many aspects of marine biogeochemistry and ecosystem dynamics and their links to lower atmosphere and climate change effects. The session comprised of 18 oral and 22 poster contributions.

Keynote speakers were Jean-Pierre Gattuso, Laboratoire d'Océanographie, CNRS-UPMC, Villefranche-Sur-Mer, France, and John Plane, School of Chemistry, University of Leeds, UK. Jean-Pierre gave a brief introduction of ocean acidification and focussed on the levels of evidence, agreement and confidence of the consequences of ocean acidification on 15 key issues. He pointed out that the effects on the past, present and future carbonate chemistry are known with a high degree of certainty. Most biological and ecological effects are much less certain although there is little doubt that calcification, primary production, nitrogen fixation and biodiversity will be altered but with an unknown magnitude. The key systems facing the greatest impact of ocean acidification were identified to be polar seas, deep-sea and coral reefs.

John discussed the impact of halogens in the marine boundary layer focussing on iodine and bromine. The subsequent atmospheric chemistry of these halogens changes the oxidising capacity of the marine boundary layer by destroying ozone and changing the hydroxyl radical concentration. Furthermore it reacts efficiently with dimethylsulphide and mercury (in the polar regions) and leads to the formation of ultra-fine particles which may contribute to cloud condensation nuclei (CCN) and hence affect climate. John reported on observations of I, IO, OIO, I_2 and BrO in several contrasting marine environments and presented wide-ranging laboratory studies.

Throughout the special session, different aspects of marine biogeochemistry, biology and ecology as well as physical processes were lively discussed. The effects of physical forcing and phytoplankton community structure on carbon transport were addressed as were the impacts of a wide range of processes on and by global climate change. Also, technical and conceptual aspects of current measurement techniques were discussed and an outlook was given towards a universal relationship between wind speed and gas exchange.

Programme details from the session can be found at **http://meetingorganizer.copernicus.org/EGU2011/session/6716**

First public release of the Surface Ocean CO_2 Atlas planned for September 2011

The Surface Ocean CO_2 Atlas (SOCAT) is a global compilation of underway surface water fCO_2 (fugacity of CO_2) data with 6.3 million measurements from 1767 cruises run between 1968 and 2008 by more than 10 countries. SOCAT brings together, in a common format, all publicly available surface water data from the global oceans, including the Arctic, and the coastal seas. All data are evaluated for data quality using methods that are transparent and fully documented (http://www.socat.info/). The details of the data analysis and preparation will be described in technical articles that will be submitted shortly (Pfeil et al., in preparation; Sabine et al., in preparation). The first public release of SOCAT (version 1.4) will be on 14 September 2011.

Two SOCAT products will be made publicly available:
1) A global surface ocean fCO_2 data set with second level quality control; 2) A global gridded product of monthly surface water fCO_2 means, with no temporal or spatial interpolation (i.e. bin averages). A Live Access Server (http://ferret.pmel.noaa.gov/LAS) will allow exploration and downloading of the data and gridded products from the web.

SOCAT will be released as part of a workshop, 'The Ocean Carbon Cycle at a Time of Change: Synthesis and Vulnerabilities' (14-16 September 2011, Unesco, Paris), where the researchers that helped produce the CO_2 Atlas will present some of the initial science coming from the product. There is also a special session at the Ocean Sciences meeting on 20-24 February 2012 devoted to SOCAT science titled: 'The Changing Ocean Carbon Cycle: Data Synthesis, Analyses and modeling'.

Research using SOCAT will highlight the response of surface water fCO_2 and the oceanic CO_2 sink to increasing levels of atmospheric CO_2 in a changing climate. The SOCAT data set will be an important building block for future global carbon research.

Future updates to SOCAT are envisaged, but only if sustained funding can be secured to augment the initial funding now available. Colleagues are strongly encouraged to use the Atlas and to submit their quality controlled surface water fCO_2 data for inclusion in future SOCAT releases. We simple ask that you acknowledge the SOCAT project and let us know if you publish a manuscript based on the Atlas. We also welcome your ideas on future SOCAT.

Enjoy SOCAT,
Dorothee Bakker, Benjamin Pfeil, Are Olsen, Chris Sabine, Nicolas Metzl, Steve Hankin, Heather Koyuk, Jeremy Malczyk, Alex Kozyr, Maciej Telszewski and all SOCAT contributors.

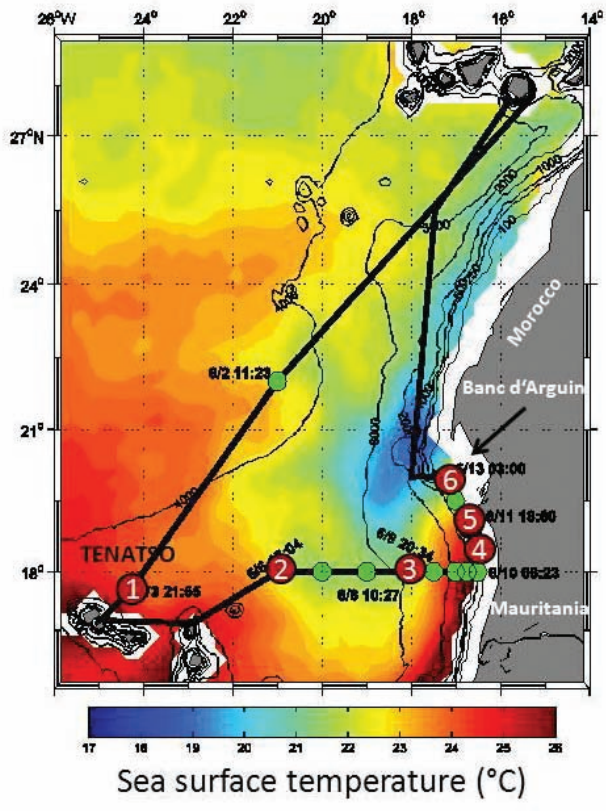
Diurnal and regional variability of halogen emissions off Mauritania: The DRIVE ship campaign in June 2010

H.W. Bange and B. Quack

Forschungsbereich Marine Biogeochemie, IFM-GEOMAR, Leibniz-Institut für Meereswissenschaften, Düsternbrooker Weg 20, 24015 Kiel, Germany
Contact: hbange@ifm-geomar.de

Volatile halogenated organic compounds (halocarbons) are ubiquitous trace constituents of the oceans and the atmosphere. They contribute significantly to the biogeochemical cycling of bromine and iodine in the environment. Once released to the atmosphere, halocarbons are involved in various chemical reactions in the troposphere and in the stratosphere. Ocean surface waters have been identified to release a wide range of brominated and iodinated halocarbons to the troposphere. A variety of natural production and consumption pathways of oceanic halocarbons, including biological and photochemical pathways, have been identified. In general, enhanced concentrations of dissolved halocarbons such as bromoform ($CHBr_3$) are found in coastal areas including coastal upwelling areas. However, $CHBr_3$ emissions from the upwelling off Mauritania can only partly explain the observed high atmospheric concentrations which indicates that a major source of atmospheric $CHBr_3$ in this region has not been identified yet.

To this end the DRIVE (Diurnal and Reglonal Variability of Halogen Emissions) campaign to the upwelling off Mauritania (NW Africa) was funded by the BMBF as part of the German SOLAS project SOPRAN (Surface Ocean PRocesses in the ANthropocene; www.sopran.pangaea.de): The second leg of the 399th cruise of *R/V Poseidon* (P399/2) took place from 31 May to 17 June 2010. Ten scientists from IFM-GEOMAR (Kiel), IfAM (U Kiel), IfBM (U Hamburg) and IUP (U Heidelberg) representing various SOPRAN subprojects took part in the cruise which was the sixth of a series of German SOLAS cruises to the tropical North Atlantic Ocean.

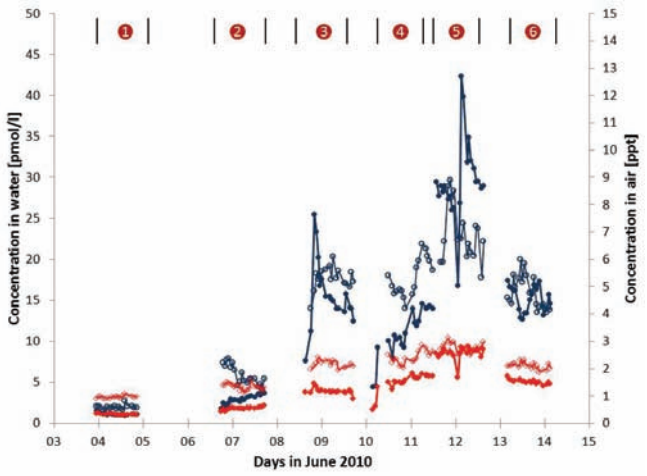


Λ Figure 1 : Cruise track of P399/2. 24h stations are indicated by numbers.

The major objective of P399/2 was to investigate the regional and diurnal atmospheric and oceanic variations of halogenated compounds in the eastern tropical North Atlantic Ocean with special focus on the Mauritanian upwelling. The main working packages of P399/2 included measurements of

- Atmospheric BrO and IO
- Atmospheric halocarbons (in cooperation with E. Atlas, RSMAS, Miami)
- Isotope signature of atmospheric halocarbons
- Other atmospheric trace gases such as ozone, methane etc. (in cooperation with M. Heimann, MPI Biogeochemie, Jena; J. Williams, MPI Chemie, Mainz; G. Friedrichs, U Kiel)
- Aerosol composition (in cooperation with A. Baker; UEA, Norwich)
- Vertical structure of the atmosphere
- Dissolved halocarbons, nitrous oxide and carbon dioxide
- CTD, dissolved nutrients, O_2, and chlorophyll
- Microstructure of the upper water column

Besides an extensive underway measurement program of dissolved (halocarbons, N_2O, CO_2) and atmospheric (BrO, halocarbons, other trace gases, aerosol) compounds, six 24h stations were performed and 23 regular CTD stations with depth profiles of the entire water column were occupied (Figure 1). The data set from P399/2 will be available as of July 2011, and data requests should be submitted to the authors.



Λ Figure 2 : Bromoform ($CHBr_3$, blue lines) and dibromomethane (CH_2Br_2, red lines) atmospheric mixing ratios (open symbols) and ocean surface concentrations (filled symbols). (Helmke Hepach, unpublished data). The numbers correspond to the station numbering in Figure 1.

The cruise P399/2 took place during the decline of the coastal upwelling (upwelling off Mauritania is most pronounced during Feb/Mar). Therefore, upwelling was observed only north of 19°N. The upwelling could easily be identified by a drop in the sea surface temperature from 26°C to 18°C. As expected, dissolved nutrients, chlorophyll-a as well as dissolved CO_2 and N_2O concentrations were enhanced in the upwelled waters. The daily aerosol filter sampling indicated only weak deposition of Saharan dust during the cruise (at station 5).

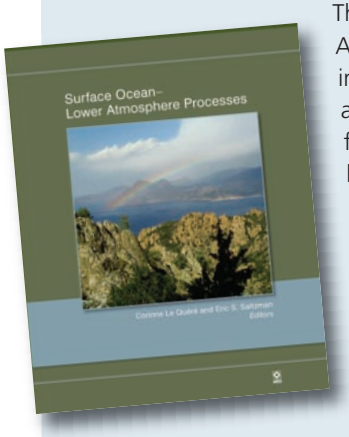
During the 24h stations, when the ship was positioned against the wind at one fixed position, high resolved measurements of the atmospheric and dissolved halocarbons bromoform ($CHBr_3$) and dibromomethane (CH_2Br_2) were performed (Figure 2). Dissolved surface concentrations and saturation anomalies were in the range from 1 to 43 pmol L^{-1} and <0 to 225%, respectively, indicating that the Mauritanian upwelling is generally a net source of both compounds for the atmosphere during P399/2. Dissolved $CHBr_3$ and CH_2Br_2 concentrations as well as atmospheric mixing ratios of both compounds showed a clear increasing trend towards the coast which is in line with previous observations of near shore sources. The maxima of dissolved and atmospheric $CHBr_3$ and CH_2Br_2 (station 5) were not found at the station with the most intensive upwelling (station 6).

Diurnal variabilities were observed for the atmospheric and dissolved concentrations, however, there seems to be no obvious correlation between both parameters. Computations of the sea-to-air fluxes of $CHBr_3$ indicated that they are not sufficient to explain neither the observed, elevated atmospheric mixing ratios, nor their rapid increases during the day, and require additional sources, most likely from shallow coastal waters of the Banc d'Arguin area. The $CH_2Br_2/CHBr_3$ ratio in the atmosphere was constant whereas in the surface ocean it was increasing towards the open ocean indicating an enhanced loss of $CHBr_3$ from the surface layer compared to CH_2Br_2.

Acknowledgements

We are indebted to the P399/2 team (incl. the shipboard party and the land based colleagues) for their excellent collaboration without whom P399/2 would not have been successful. We thank the authorities of Mauritania and Cape Verde for permissions to work in their territorial waters and acknowledge the excellent support by the officers and crew of *R/V Poseidon*. This work was funded by SOPRAN (FKZ 03F0611A).

Surface Ocean - Lower Atmosphere Processes Textbook



The focus of Surface Ocean-Lower Atmosphere Processes is biogeochemical interactions between the surface ocean and the lower atmosphere. Lectures from the 2007 Summer School have been developed into a textbook 'Surface Ocean - Lower Atmosphere Processes' (SOLAP). The textbook is designed to provide graduate students, postdoctoral fellows and researchers from a wide range of academic backgrounds with a basis for understanding the nature of ocean-atmosphere interactions and the current research issues in this area. The book is published by AGU and edited by Corinne Le Quéré and Eric Saltzman.

To find out more about this textbook and the SOLAS summer school visit www.solas-int.org/summerschool/textbook.htm

To order your copy visit www.agu.org/pubs/books

Reference:

Corinne Le Quéré and Eric S. Saltzman,
Surface Ocean- Lower Atmosphere Processes, 2009, Geophysical Monograph Series, Volume 187, 350 pp., hardbound,
ISBN 978-0-87590-477-1, AGU Code GM1874771

In Focus

Meet the SOLAS' newest member of staff, Stefan Kontradowitz; our newest national representative of Mexico, a new SOLAS nation, J. Martín Hernández-Ayon; and our new SOLAS chair, Eric Saltzman.

SOLAS welcomes a new Chair

After 3.5 years as SOLAS Chair, Doug Wallace has stepped down, mid July 2011, to become SOLAS's Ex-officio and has made way for our new Chair, Eric Saltzman. Doug Wallace, a marine chemist, has recently relocated to Dalhousie University, from IFM-GEOMAR, where he will take up the Canada Excellence Research Chair (CERC) in Ocean Science and Technology. As the original co-ordinator of SOPRAN (Surface Ocean Processes in the Anthropocene), he has played a large part in strengthening the SOLAS community in Germany and, as Chair, internationally. We, here at SOLAS, wish him the best of luck in his new position and new home in Canada. With every goodbye, there is often a hello, so we extend a warm welcome to Eric Saltzman from the University of California, Irvine. Very much experienced within the field of SOLAS, Eric has been a Scientific Steering Committee member since 2007. He is also the co-chair of US SOLAS and a regular lecturer at the SOLAS Summer Schools. He has also chaired on a number of committees and advisory panels and we are proud to have him on board as our new chair and we look forward to the next few years of SOLAS in his company.

Doug Wallace

Eric Saltzman

Eric Saltzman is an atmospheric chemist whose research involves the biogeochemical cycling of trace gases and their relationship to climate change. His research involves air/sea gas exchange, halogen photochemistry, and analysis of polar ice cores. Dr. Saltzman has published more than 100 scientific articles. He received a BS in Geology from the University of Rochester and MS and PhD degrees in Oceanography from the University of Miami. He is co-chair of US SOLAS, and recently become Chair of International SOLAS. He has served as NSF Program Manager for Atmospheric Chemistry; chaired two university departments; and, is also a Fellow of AGU. He is currently a Professor in the Department of Earth System Science at the University of California, Irvine.

Contact: esaltzma@uci.edu

Our newest Project Officer

Stefan Kontradowitz

Stefan Kontradowitz was born and raised near Kiel, Germany. After graduating from the University of Kiel in 2009 with a Degree in Physical Geography, he shortly worked for a space science journal before taking a job as a Research Assistant at the IFM-GEOMAR. Since February 2011, he has become a Project Officer for SOLAS working in the International Project Office at IFM-GEOMAR. He is mainly concentrating on planning and organising the next SOLAS Open Science Conference in 2012 as well as supporting the day-to-day work of the IPO.

Contact: skontradowitz@ifm-geomar.de

Mexico - a new SOLAS nation

J. Martín Hernández-Ayon

J. Martín Hernández-Ayon is a full-time Researcher at the Instituto de Investigaciones Oceanologicas (OII) of the University of Baja California (UABC). He is member of Mexico's National System of Researchers (NSI) and he is also a committee member of the Mexican Carbon Program. He received his Ph.D. in Coastal Oceanography from the UABC School of Marine Sciences in 2000 and after his degree he did a post-doctoral studies at the Scripps Institute of Oceanography, University of California, San Diego, USA. His research centres around the role of coastal- ocean ecosystems in the global carbon cycle, including ocean acidification (OA) in coastal ecosystems, interactions between OA and other natural or anthropogenic stressors as hypoxia, climate change, and air-sea CO_2 exchange in coastal oceans.

Contact: jmartin@uabc.edu.mx

SOLAS Project Integrator's appeal for data

"The SOLAS aerosol/rain database has finally been launched, and this was possible because of generous contributions made by scientists from the SOLAS community. This database consists of aerosol (trace metals, nitrate, phosphate, MSA, nss-SO_4 etc) and rain (e.g. major ions, trace metals) data collected exclusively from 'ship cruises'. The files containing aerosol and rain data are currently hosted by BODC (British Oceanographic Data Centre), and are available (in tabular form due to the limited number of files) for open access from **http://www.bodc.ac.uk/solas_integration /implementation_products/group1/aerosol_rain/.**

My intention is to improve on the quantity of these datasets by collating as much aerosol/rain data, exclusively from 'ship cruises', as possible and making them available to the scientific community. Therefore, it is my sincere request that all scientists kindly contribute their aerosol/rain data towards this database and help foster SOLAS scientific objectives. If you have any questions/recommendations about the SOLAS aerosol/rain database or if wish to contribute your data, then please do not hesitate to contact me."

Shital Roheker
SOLAS Project Integrator
(Contact: s.rohekar@uea.ac.uk)

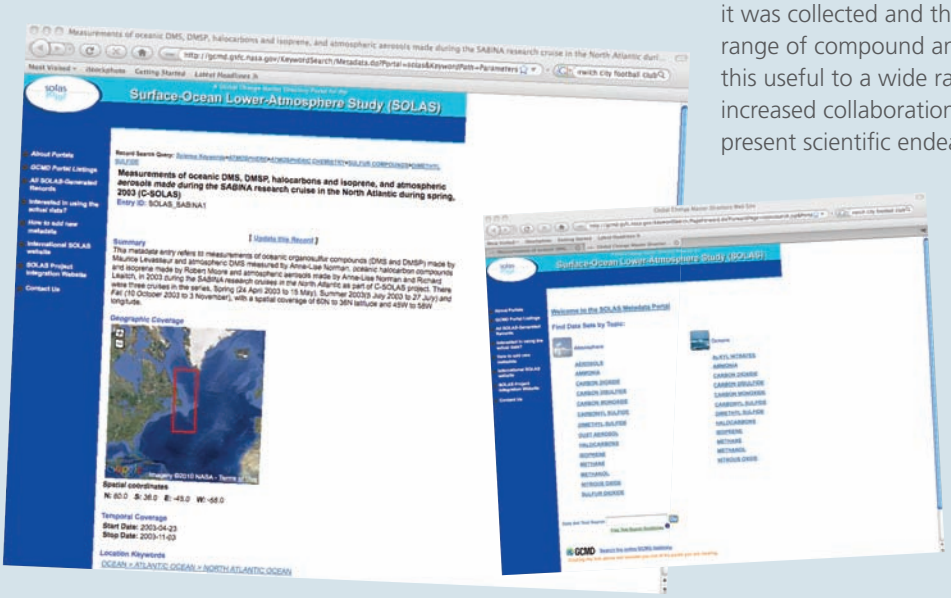
SOLAS Metadata Portal – A resource available to the community

Ever wondered what data has been collected by other members of the SOLAS community?

Ever known that data exists from a region but can't remember who collected it and when?

Then try the SOLAS Metadata portal! http://tinyurl.com/46xnf9

The SOLAS Metadata Portal is an ongoing effort, initiated through SOLAS Integration (with the help of the SOLAS IPO), to identify what SOLAS data exists and where it is archived.

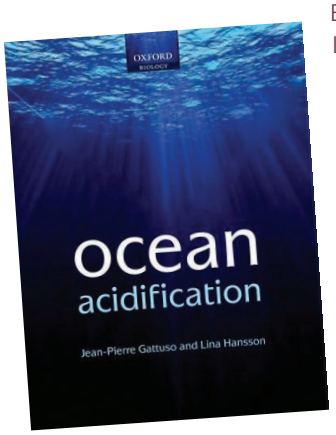


Metadata is, simply speaking, information about data. In the context of the SOLAS Portal, Metadata refers to information (or links to other sources of information) about a dataset (often collected throughout a research cruise or aircraft campaign). Much of the recent worldwide SOLAS Metadata has been assembled and archived into an inventory run by NASA (the Global Change Master Directory, GCMD).

This resource is freely-available to the entire community and enables the user to identify relevant datasets that include information about the actual data's location, when it was collected and the name of the data-provider. A wide range of compound and particle types are covered, making this useful to a wide range of SOLAS research, enabling increased collaboration and adding value to past and present scientific endeavour.

In its current state, the SOLAS Metadata Portal is an invaluable resource, in particular for communities that wish to generate a compilation of all relevant historical measurements at a global scale. However, if you have information that could be included, it's a very quick job to contribute. Please contact Shital Rohekar (s.rohekar@uea.ac.uk) or use the template form which can be found at http://tinyurl.com/328zjr5.

'Ocean Acidification' textbook



Edited by Jean-Pierre Gattuso and Lina Hansson

344 pages 75 illustrations
246×189 mm

Publication date: September 2011

EPOCA
European Project on OCean Acidification

About this book

Synthesizes the findings of recent national and international research efforts, including those of EPOCA (European Project on Ocean Acidification), set in a broader global context.

Reviews our current knowledge of the chemical, biological, biogeochemical, and societal implications of ocean acidification, with a particular emphasis on its impact on marine organisms and ecosystems.

Assesses the uncertainties, risks, and thresholds related to ocean acidification at molecular, cellular, organismal, local, and global scales.

http://ukcatalogue.oup.com/product/9780199591091.do#

Second International Symposium – 'Effects of Climate Change on the World's Oceans'

Yeosu, Korea 15 – 19 May 2012

This symposium aims to bring together experts from different disciplines to exchange observations, results, models and ideas at a global scale and to discuss the opportunities to mitigate and protect the marine environment and its living resources.

http://www.pices.int/meetings/international_symposia/2012/Yeosu/scope.aspx

SOLAS-related theme sessions and workshops include:

- Climate variability versus anthropogenic impacts; analysing their separate and combined effects on long-term physical, biogeochemical and ecological patterns
- Systematic, sustained and integrated global ocean observations
- From genes to ecosystems: Genetic and physiological responses to climate change
- Trend and impacts of de-oxygenation in oceanic and coastal ecosystems
- Marine tipping points in the earth system
- Changes in the marine carbon cycle
- Ocean observation: Strategic framework
- Climate change projections for marine ecosystems: Best practice, limitations and interpretation

Registration and abstract submission open.
Deadline for workshop proposals: 15 September 2011

PICES

UNESCO

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

Reducing the impact of emissions from aviation and shipping

City Chambers, Edinburgh 09 September 2011

This one-day event will bring together representatives of the aviation and shipping industries and climate change researchers to exchange views on how to reduce the impact from shipping and aviation and the implications for climate change.

www.conference.tri-napier.org

SOLAS-related plenary presentations include:

- Reducing shipping emission through 'Optimum Ship Routing' and 'Virtual Arrival' practices
- Emissions to air from shipping and future abatement techniques
- Exploring the feasibility of climate-optimised flight routing

Registration open now

RMetS
Royal Meteorological Society

Transport Research Institute

The 7th COST Action 735 Management Committee (MC) meeting was held in Istanbul, Turkey, in December 2010. The meeting reviewed the four workshops and two STSMs held since the last MC meeting and finalised plans for the conclusion of the Action.

The action will utilise available COST funding to produce a publication based on the work carried out during the course of the Action. The publication will serve as a synthesis of what the Action has achieved, drawing where relevant on the outcomes of the meetings and STSMs the Action has supported and also contributing to the legacy of SOLAS to which the Action's goals are closely aligned. On the recommendation of the Action's Management Committee members, five outline chapters were proposed with two-three lead authors identified for each chapter. A meeting of lead authors was held in early May 2011 to elucidate the scope and format of the publication further and more than 60 researchers were identified as key contributors to this publication.

In November, the Action will hold two meetings at the ESA-ESRIN premises in Frascati, Italy. On Monday, 28 November 2011, a one day meeting of contributing authors will allow researchers to work collaboratively on the final Action publication.

On Tuesday, 29 November 2011, the Action holds its final event: a half day symposium, which will include speakers covering COST Action 735 science themes, recognising the achievements of the Action and looking to the future of research in these areas.

These meetings are to be held directly preceding the 'Earth Observation for Ocean-Atmosphere Interactions Science' meeting, 29 November – 2 December 2011, Frascati, Italy. This meeting is sponsored by ESA, SOLAS and EGU, further details can be found at http://www.eo4oceanatmosphere.info/.

For further details on the COST Action 735 final event please see http://www.cost-735.org/meetings/finalevent.html

Short Term Scientific Missions (STSMs)

COST Action 735 also provides opportunities for young scientists to collaborate with senior researchers on STSMs. These STSMs are based around the COST Action 735 working group foci and aim to promote an international community of young scientists working within the scope of the COST foci. The STSMs also offer a chance for young scientists to develop data sets, experimental methods and gas flux product development.

Characterisation of CO_2 fluxes in estuarine systems: Schedlt River estuary case study

Susana Flecha Saura (susana.flecha@icman.csic.es), Instituto de Ciencias Marinas de Andalucia (CSIC), Cadiz, Spain
STSM Host: Alberto Borges, Chemical Oceanography Unit, University of Liege, Belgium Dates: 01 October - 21 December 2010

"My research is focused on the processes involved in the carbon cycle in the Atlantic-Andalusian shelf. This study includes the analysis of the influence of the Guadalquivir River on the functioning of the carbon cycle in the shelf, determining concomitantly its potential role as a regulating node. Thus, the quantification of air-sea CO_2 exchange and associated biogeochemical processes are strongly necessary.

During the period of the STSM, several tasks were carried out in order to improve the understanding of the entire process related to the CO_2 and CH_4/N_2O sampling and measurement, including the subsequent CO_2 fluxes calculations.

Field sampling was performed monthly, with participation in two cruises in the Scheldt estuary; where the principal purpose was to monitor CO_2, TA, CH_4/N_2O and and transparent exopolymer particles (TEPs). The samples collected for CH_4/N_2O analysis in the Scheldt estuary were prepared to be determined in the laboratory by gas chromatography with a SRI 8610C Gas Chromatograph (GC).

Working in the laboratory gave me a valuable opportunity to gain a deep understanding of the automation of the GC and to identify the components, functions and troubleshooting aspects of the instrument. Once all the problems of the GC were solved, different analytical routines were developed:

- Different tests to obtain a clear and reproducible signal in the chromatogram, done with standard gases and brine samples
- New improvements to avoid noise from other gases that appear in samples as oxygen, and to avoid the sulphide pollution
- Weekly maintenance of the GC: desiccant change and ferule adjusts
- Manual integration of sample peaks as required
- Calibration with standard gases

Next, when the instrument was ready to use, the measurements of the Scheldt estuary samples were measured. The technique used was the head space technique with a modification carried out to avoid the overpressure during the injection of the head space from the glass flask with the syringe. Finally, the CO_2 fluxes were calculated.

Having been trained in CO_2 fluxes calculations in estuaries, I am enabled to apply this knowledge to data from the Guadalquivir estuary. Plans for future collaborations are also in place."

Development of a greenhouse gas ocean-atmosphere flux sensor with Micro-Electrical-Mechanical Systems (MEMS) based photoacoustic technology

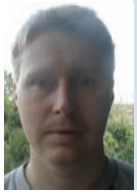
Sebastian Landwehr (s.landwehr1@nuigalway.ie), National Univeristy of Ireland, Galway, Ireland

STSM Host: Juho Uotila, Gasera Ltd, Turku, Finland Dates: 01 November – 24 December 10

"This STSM was a visit to Gasera Ltd. in Turku, Finland, a company which develops the gas detector used in my PhD project. The purpose of my stay at Gasera was to be given intensive training on the new instrument and to learn about the measurement technique. The goal was to enable me to perform measurements as well as to maintain the instrument and to conduct small repairs or changes in the setup, independently. The subject of my PhD thesis is the application of a very sensitive and fast-responding, photo-acoustic gas detector for ship-based, eddy covariance measurements of the CO_2 flux at the ocean-atmosphere boundary. Currently, the accuracy of the available CO_2 detectors limits the eddy covariance measurements of CO_2 over the ocean to regions with high concentration gradients, thus; only a small part of the ocean can be covered. Hence, a further improvement of the current sensitivity of the CO_2 detectors is crucial for a better understanding of the ocean as a sink for CO_2.

During my stay, I was involved in performance tests of the components, solving the resulting problems and assembling the instrument setup. The duration of the stay was set so that the instrument development was finished but the assembly of the first prototype was on-going. This allowed me to contribute my own ideas and suggestions in order to optimize the setup for the flux measurements on sea. Further, I gained good training in repairing and maintaining the instrument.

The tests showed that the interferometer calibration method, which is usually used for Gasera instruments, causes a periodic structure on the signal 1-3% of the signal amplitude, which limits the measurement accuracy. In January and February, I returned to Turku to help with the assembly of the prototype and solve the problems that were found during the first stay. The instrument was then delivered to NUI-Galway. At NUI, I plan to implement the gas detector together with a sonic anemometer into an eddy covariance system for CO_2 and H_2O flux measurement.
The new system will first be applied in June/July for measurements on the *R/V Knorr* from Woods Hole. The results are expected to be publishable."



The role of organics in SOAP (Southern Ocean Aerosol Production)

Dr Petri Vaatovaara (Petri.Vaattovaara@uku.fi), University of Eastern Finland, Kuopio, Finland

STSM Host: Michael Harvey, National Institute of Water & Atmosphere research (NIWA), Wellington, New Zealand
Dates: 25 January – 20 February 2011

"Recent observations show the presence of a remarkable marine-originated, secondary organic fraction in ultrafine particles which has been identified down to nucleation mode size particles (d<15nm) over Irish coastal waters of the Atlantic Ocean; the Arctic Ocean close to ice edges; and the Australian sub-tropical Pacific Ocean waters. In spite of the importance of a secondary fraction to the properties of radiatively active sizes in marine environments, marine-produced particle composition is very unknown in various other marine biologically-active locations around the world.

This study about the composition of nucleation (d<15nm) and the lower end of Aitken (20nm<d<60nm) modes particles was focused on particle production in the Chatham Rise region, in the southern Pacific Ocean over the Sub-Tropical Convergence (STC) to the east of New Zealand, (New Zealand) during the SOAP pilot project voyage (austral summer period; 1-12 February 2011): A region which experiences intensive, austral-summer phytoplankton blooms.

The ultrafine particle composition was studied using the Ultra Fine Organic – Tandem Differential Mobility Analyser (TDMA; my instrument) and the Volatility Humidity Tandem Differential Humidity Analyser (Queensland University of Technology). Auxiliary data was collected and marine biological activity was checked with MODIS satellite data and supported by in situ chlorophyll and dissolved DMS measurements.

The TDMA measurements showed that in the biologically-active marine area, observed nucleation and Aitken mode sized particles include a clearly detectable organic fraction. Due to intensive solar radiation, secondary organic fraction was highly probable in those ultrafine particles. Furthermore, the comparison between in situ bubble burst chamber and atmospheric particles composition measurements strongly support secondary origin of the atmospherically observed ultrafine particles. The comparison of the secondary organic fraction observations on Atlantic, Arctic, and Pacific Oceans reveals that, even though the secondary organic fraction clearly exists in ultrafine particle phase in the different biologically active marine regions, the exact properties of the fraction can be dependent on local marine area conditions.

As a result of this STSM visit and co-operation, I have sent an abstract (Topic: Secondary organic aerosol on southern Pacific Ocean) to the European Aerosol Conference 2011 and results will be published in an international scientific journal. With the good instrument set-up, measurement and living facilities, successful co-operation and interesting results obtained during this voyage, research co-operation with voyage participants has been planned to continue with more detailed study of in situ marine, atmospheric, ultrafine particle's production, composition and properties research. A further research possibility through participation in the planned, Austral Summer 2012 SOAP voyage is being explored."

Reaction cycling of particulate iodine in the marine boundary layer - A chamber study

Ru-Jin Huang (rujin@uni-mainz.de), Centre for Climate and Air Pollution Studies, National University of Ireland, Galway, Ireland
STSM Host: Thorsten Hoffmann, Institute of Inorganic Chemistry and Analytical Chemistry, Johannes Gutenberg University of Mainz, Germany
Dates: 29 January – 06 May 2011

"The impact of iodine chemistry in the lower troposphere is presently a subject of considerable interest. Numerous studies have concentrated on the potential of gaseous reactive iodine to affect the oxidising capacity of the marine boundary layer (MBL). However, recent studies indicate that iodine oxides, the photochemical products of gaseous reactive iodine, are the most likely species involved in nucleation and growth of new particles in the MBL. However, the evolution of iodine in the marine aerosols is still poorly understood. The aim of this STSM is to take relevant chamber experiments between iodine species and organic compounds to reduce the existing uncertainties.

After setting up a reaction chamber system, iodine-containing particles were generated and introduced into the reaction chamber (10 L/70 L) where the reaction of iodine with organic compounds in particle phase (surface) occurred. The resulting particles as well as gaseous compounds were collected. Total iodine was measured by inductively coupled plasma mass spectrometry (ICPMS). The organic marker compounds were measured by a liquid chromatography/mass spectrometry (LC/MS) method. Gaseous compounds were measured by gas chromatography/mass spectrometry (GC/MS) and thermodesorption GC/MS. The size and chemical compositions of the resulting particles were also measured by time-of-flight aerosol mass spectrometry (ToF AMS).

The experiments showed that inorganic iodine was effectively converted into organic iodine in the particle phase (surface) via reaction with organic compounds. The resulting organic iodine compounds can be those with high or low molecule weight. The high-molecule-weight organic iodine compounds (i.e. low volatility) will accumulate in the particle phase, which explains the observation of elevated fraction percentage of organic iodine in the marine aerosols. It is found that certain low-molecule-weight organic iodine compounds (i.e. high volatility) were released into the gas phase, the main contribution could be from reaction on the particle surface.

After the STSM, I participated in an international field campaign "MaCloud" carried out at the Mace Head Atmospheric Research Station (Ireland). Fine and coarse aerosol particles were collected during this one month of measurements. It is expected that the measurements of iodine species in these aerosol samples will provide substantial support to the chamber experiments performed during this STSM visit.

Further collaboration with Prof. Thorsten Hoffmann's atmospheric chemistry group is scheduled and the results of this STSM will, together with results from field measurements, be published in a scientific journal."

Implementation of novel methods of particle flux measurements

Jakub Kowalczyk (jakub.kowalczyk@put.poznan.pl), Institute of Oceanology, Polish Academy of Sciences, Poland
STSM Host: Lise Lotte Sørensen, Risø DTU, Risø National Laboratory, Roskilde, Denmark Dates: 28 March – 15 April 2011

"The main goal of the STSM was to become trained in the implementation of novel methods for measurement of the vertical particle fluxes from moving platforms, especially from research vessels, and data processing the results. The visit was to enable implementation of the dissipation technique and the new co-spectrum peak method used by Dr. Sørensen's group. It was also a preparatory step for a joint Arctic cruise on *R/V Oceania*, the IOPAS ship for the summer of 2012.

This experimental effort, involving multiple measurement techniques, could help improving both source function and deposition velocity parametrisation.

- The first week was dedicated to the introduction to the host institute's measurement equipment and experimental stations as well as to new methods of measurement.
- The database with the 2010 date, collected in the Svalbard region using the *R/V Oceania*, was checked that it was complete for further analysis.
- Meetings with Dr. Sørensen, a specialist in marine fluxes measurements, were held to discuss the issue of marine fluxes and advantages and disadvantages of different techniques and how to incorporate them for use on our data.
- A new database was made considering the research vessel distortion and weather and sea conditions.
- 21 most suitable days were picked, from the data, and the inertial dissipation method was implemented using Matlab. The first results were presented and discussed and minor changes were applied. This allowed us to show on which days and time there was deposition or convection of aerosols - an important aspect when considering the role of marine aerosols in polar regions and climate change.
- The next few days were spent applying the co-spectrum peak method to our former database and confronting it with the eddy correlation and deposition method. Good correlations were obtained. Results were then presented at the last working group seminar and some conclusions were made.
- Both institutes are interested in future collaboration concerning measurements of marine aerosol fluxes from moving platforms and agreed to organise a workshop in Sopot, Poland in October 2011 to look at flux measurements from both Greenland, the Hornsund station and R/V Oceania data processing.

The data and results which were obtained during my STSM program will be used for future paper/article publication."

Sub-WG2&3 meeting - What is the sea surface microlayer? Towards a unified physical, chemical and biological definition of the air ocean interface.

Meeting convened by Michael Cunliffe (micnli@mba.ac.uk), 25-26 January 2011, Plymouth, UK

As the science of the air-sea interface develops by becoming more interdisciplinary, a workable overarching definition of the sea surface microlayer is required, along with the establishment of a network of scientists involved in microlayer research.

The meeting aimed to deliver a detailed scientific description of the sea surface microlayer based on current understanding and recent developments in the field. The programme extended from 'the sea surface microlayer is within the top 1mm of the ocean' to a systematic physical, chemical and biological definition based upon empirical evidence.

The meeting started with a detailed synopsis of the physiocochemical properties of the sea surface microlayer including defining principal biochemical components and reviewing their role in specific properties of microlayers. For example, lipids are present in relatively low concentrations yet they have a significant impact on microlayer surface active properties, and can be used as biomarkers to determine the source of microlayer material.

Discussions progressed to focus on the sources of surface microlayer components. It is still clear that most surface microlayer material is biogenic, but it is unclear to what extent microlayer material comes from subsurface water or is formed within the interface layer. A substantial amount of discussion was focused on the emerging significant role of transparent exopolymer particles (TEPs) in surface microlayers.

It was concluded that both microbiological and physiocochemical properties together must be considered with respect to the sea surface microlayer. The implications of the physicochemical and microbiological properties of sea surface microlayers were then discussed in relation to air-sea flux of climate and pollution relevant gases. A substantial amount of evidence was present from research supported by the UK Natural Environment Research Council through its Surface Ocean Lower Atmosphere Study (SOLAS) directed programme.

It was clear that significant advances have been made in our understanding of the sea surface microlayer and the air-sea interface. The logical way to progress is to embrace a multidisciplinary approach.

A group of European researchers has now been established with a common interest in the air-sea interface and sea surface microlayer. The group is currently pursuing funding to support further meetings which will specifically allow the design and formation of a wider European network of sea surface microlayer scientists to enable the submittal of Europe-wide research proposals.

A publication discussing the key findings from the meeting is currently in preparation. It is anticipated to be submitted for peer review early this summer.

Sub-WG 1&3 meeting - Sea-ice biogeochemistry and interactions with the atmosphere

Meeting convened by Jacqueline Stefels (j.stefels@rug.nl), 12-14 April 2011, Amsterdam, Netherlands

The aim of the working group was to bring together sea-ice specialists from multiple disciplines and modellers of sea-ice systems at the different scales, in order to:

- share existing knowledge on the role of sea ice in influencing climate-relevant elemental fluxes
- discuss and formulate the relevant biogeochemical processes and specify gaps in our knowledge
- stimulate integrated model development

A brief summary of the major scientific findings as they were presented:

1. Sea ice can be a major source of climate-active and biogenic gases, like DMSO, bromoforms and dibromomethanes. The bromides in turn affect ozone chemistry. In addition, sea ice is a major source of sea-salt aerosols but not yet clear if it is a source or a sink for CO_2.
2. Most processes in sea ice are governed by physicochemical processes. Many of these processes are still poorly understood, due to a lack of data and inadequate methodology. In addition, surface processes and exchange of biochemical components with atmosphere are not well described.
3. Sea ice is a heterogeneous medium, including solid ice, brines, gases, and solid salt precipitates, and it exhibits substantial variability on all spatial and temporal scales. While standard analytical methods exist for the parameters of interest, the phase combinations and difficult sampling conditions that characterise sea-ice studies limit the application of existing methods.
4. The lack of data constrains model development. Sea-ice models are still poorly developed on temporal and spatial scales. Small scale models cannot properly distinguish between the different ice phases. The larger (global) sea-ice models only consider sea ice as a "cap" on the ocean surface and entirely lack a biochemical compartment.
5. Given the potential impact of climate change on sea ice (biogeochemistry) and subsequent effects on the global climate system, upgrading of modelling and methodology is urgently needed.

Two parallel working groups were then organised discussing (i) strategies for continuation of the sea-ice working group and set the outline for a grant proposal for a SCOR-working group and (ii) sea-ice methodology.

Considered a first step towards combining expertise and effort in this complex area by establishing a genuine sea-ice community, the meeting was very successful and had the following outcomes:

- Bi-annual meetings will be organised, most likely as a satellite meeting at larger scientific meetings i.e. AGU, EGU, ASLO and IGS-sea ice.
- Website to be constructed to facilitate data exchange, to act as a discussion platform and to share general information.
- White paper in preparation for EOS; describing the state-of-the-art to improve awareness on the importance of sea ice; in order to promote additional research efforts into this vast, yet poorly explored territory.
- Review paper in preparation describing the current state-of-the-art on sea-ice methodology.
- Proposal has been submitted for a SCOR-working group, 'BEPSI: Biogeochemical Exchange Processes at the Sea-Ice Interfaces'.
- COST-action proposal to be drafted later this year.

Present your science at the SOLAS Open Science Conference 2012

7 – 10 May 2012, Washington State, USA

We are proud to announce the plenary session themes for next year's SOLAS Open Science Conference:

- Sea-ice biogeochemistry and interactions with the atmosphere*
- Ocean-derived aerosols: production, evolution and impacts*
- Atmospheric control of nutrient cycling and production in the surface ocean (incl. dry/wet deposition and ship plumes)*
- Air-sea gas fluxes at Eastern boundary upwelling and Oxygen Minimum Zone (OMZ) systems*
- SOLAS and the future ocean
- Long-lived greenhouse gases: sea-air exchange and impact (incl. ocean acidification)*
- Physics of air-sea exchange*
- Emerging Issues

Invited speakers have been identified and will be contacted shortly. However like never before, we are opening the floor to the whole SOLAS community to present your science orally at a plenary session. We have eight talk slots of 20 minutes available within five of the aforementioned themes (* themes with available slot).

How do I apply to give a talk?

Registration has opened and you are invited to submit a poster abstract. As part of the submittal procedure, you are given the opportunity to express your interest in giving a talk instead of presenting a poster.

Further announcements will be made via the SOLAS e-bulletin and website news pages. If you wish to subscribe to the SOLAS e-bulletin and newsletter, please visit http://www.solas-int.org/news/newsletter/subscribe.html

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7th – 10th May 2012
Washington State, USA

- Local organiser: Trish Quinn (NOAA/PMEL, USA)
- Conference organiser: SOLAS International Project Office (IFM-GEOMAR, Germany)

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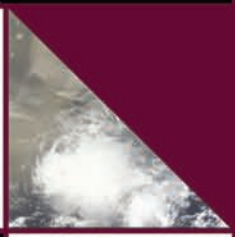
Participate in this international conference to learn about new research, present your recent findings, share your knowledge, and develop future research directions and collaborations.

The conference will highlight global research advances contributing to the SOLAS Mid-Term Strategy themes from the sea ice biogeochemistry of the polar regions to air-sea gas fluxes in the tropics.



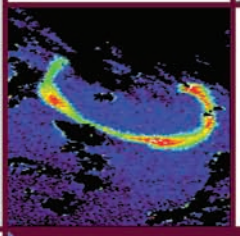


Photo credits: Emilie Brévière, Terry Joyce, William Miller

The venue is less than 150km from Seattle set on the sunny slopes of the Cascade mountains.