Addendum to the SOLAS Report to SCOR:

Reporting period of the following reports: Jan 2012- Dec 2013

Version of 10 July 2013 by Dr Emilie Brévière

- National SOLAS networks 2012 annual reports

- 2012/13 SOLAS endorsed project submission form

- SOLAS endorsed projects 2012 annual reports

- SOLAS Task Team 2012 annual report

- ESA OceanFlux projects 2012 annual report

National SOLAS networks 2012 annual reports

SOLAS Australia

compiled by Sarah Lawson/Andrew Bowie

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight. Please focus on results that would not have happened without SOLAS.*

Trace metals in Southern Ocean waters south of Tasmania during the 'SAZ-Sense' project

Trace metal micronutrients regulate primary production in oceanic surface waters, particularly those characterised as 'high nutrient, low chlorophyll', such as the Subantarctic Zone (SAZ). The SAZ-Sense Study looked into a scenario for the SAZ to the south of Australia under global climate change, and it also had a goal to map trace metal micronutrients in surface waters of this understudied region (Bowie et al. 2011). Distinct regional environments were responsible for differences in the mode and strength of Fe supply mechanisms, with higher iron stocks and fluxes observed in surface northern subantarctic waters, where atmospheric iron fluxes were greater. Subsurface waters southeast of Tasmania were also enriched with particulate Fe, Mn and Al, indicative of a strong advective source from shelf sediments. Subantarctic phytoplankton blooms are thus driven by both seasonal iron supply from southward advection of subtropical waters and by wind-blown dust deposition, resulting in a strong decoupling of iron and nutrient cycles (Bowie et al. 2009; Lannuzel et al. 2011). Other micronutrients Cd, Co, Cu, Ni and Zn displayed variable behaviours (Butler et al. 2012), but did not correlate with Fe (see Figure). Dissolved concentrations of Cd, Cu and Ni correlated closely with the dissolved reactive P over meridional SAZ section, even in the highly dynamic eddy field along the Subtropical Front (STF). Dissolved Zn also had a broadly nutrient-like profile, but it was much more weakly correlated with dissolved reactive Si. It was decoupled from macronutrients around the STF. Dissolved labile Co behaved as a nutrient in the surface 200 m of the SAZ, but deeper it had a characteristic subsurface peak, which was plausibly explained by lateral supply from polar surface waters to lower-latitude ocean depths via Antarctic Intermediate Waters. These new data for Cd, Co, Cu, Ni and Zn improve scant coverage for them in the Australian sector of the Southern Ocean, and provide a basis for linking their distribution to regional primary productivity and variations in phytoplankton community structure (Hassler et al. 2012)

Bowie A. R., Lannuzel D., Remenyi T.A., Wagener T., Lam P.J., Boyd P.W., Guieu C., Townsend A.T., Trull T.W., 2009. Biogeochemical iron budgets of the Southern Ocean south of Australia: Decoupling of iron and nutrient cycles in the subantarctic zone by the summertime supply. Global Biogeochemical Cycles 23, GB4034, doi: 10.1029/2009GB003500

Bowie A.R., Griffiths F.B, Dehairs F., Trull T.W., 2011. Oceanography of the subantarctic and Polar Frontal Zones south of Australia during summer: Setting for the SAZ-Sense study. Deep-Sea Research II, 58(21-22), 2059-2070, doi: 10.1016/j.dsr2.2011.05.033

Butler E.C.V., O'Sullivan J.E., Watson R.J., Bowie A.R., Remenyi T., Lannuzel D., 2012. Trace metals Cd, Co, Cu, Ni, and Zn in waters of the Subantarctic and Polar Frontal Zones south of Tasmania during the 'SAZ-Sense' project. Marine Chemistry, in press (accepted 26 October 2012), doi: 10.1016/j.marchem.2012.10.005

Hassler, C.S., Sinoir, M., Clementson, L.A. and Butler, E.C.V. (2012) Exploring the link between micro-nutrients and phytoplankton in the Southern Ocean during the 2007 austral summer. Frontiers in Microbiological

Chemistry, 3:202. doi: 10.3389/fmicb.2012.00202

Lannuzel D., Remenyi T., Lam P., Townsend A., Ibisanmi E., Butler E., Wagener T., Schoemann V., Bowie A.R., 2011. Distributions of dissolved and particulate iron in the sub-Antarctic and polar frontal Southern Ocean (Australian sector). Deep-Sea Research II, 58(21-22), 2094-2112, doi: 10.1016/j.dsr2.2011.05.027

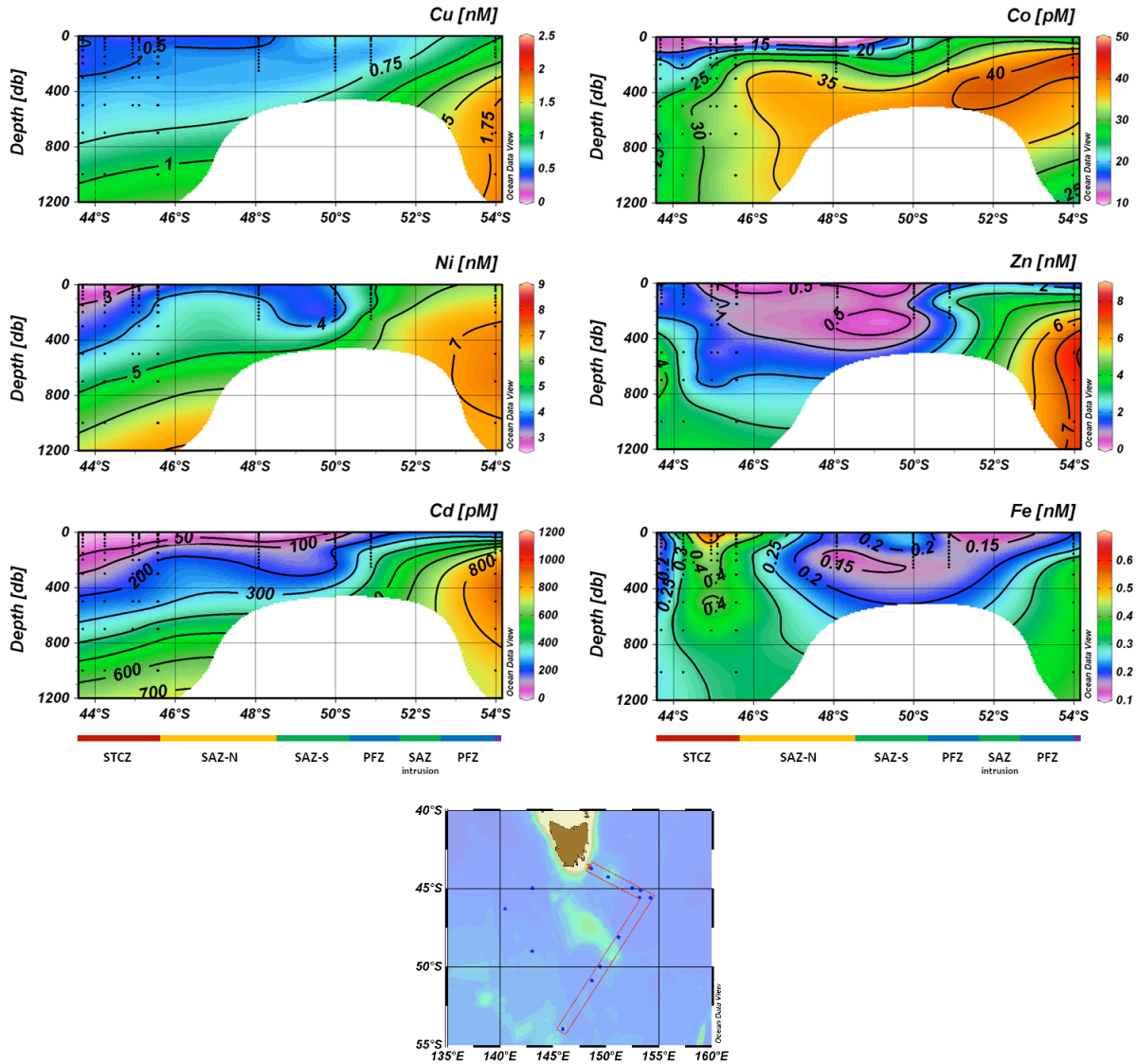

Figure: Eastern Section of SAZ-Sense study (combining SE and NE transects) of dissolved Cu, Ni, Cd, Co, Zn and Fe concentrations. The coloured bars beneath the panels left and right indicate the oceanographic zones from low to high latitude. The meandering of the SAF-S is represented by the presence of SAZ waters south of polar waters in the sections, and is labelled 'SAZ intrusion'.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Cruises

1. SOAP Voyage

The SOAP voyage in February-March 2012 examined biotic influences on aerosol production in a productive frontal system in the south-west Pacific Ocean. Sampling took place along the Sub-Tropical Front east of New Zealand, primarily in three phytoplankton blooms with different characteristics. The voyage was lead by NIWA (NZ).
Work-package 1 examined the relationships between the distribution of DMS and pCO_2, and phytoplankton biomass & species composition, and related spatial variation in aerosol number distribution and composition properties of the surface microlayer. Work-package 2 measured DMS & CO_2 flux to and from the atmosphere, and examined relationships between gas transfer velocity and physical drivers, such as near-surface turbulence, sea-state and whitecap coverage. Work-package 3 addressed the relative importance of primary and secondary organic sources to aerosol production.
Several Australian scientists were involved Work-package 3, including Luke Cravigan, Marc Mallet, Zoran Ristovski (Queensland University of Technology) and Sarah Lawson, Melita Keywood and Jason Ward (CSIRO Marine and Atmospheric Research).

We are currently in the initial data analysis phase, with a data workshop planned for 2013. SOAP is a SOLAS endorsed project, and a NZ SOLAS contribution to the SOLAS Mid-Term Strategy Ocean-derived aerosols: production, evolution and impacts. The SOAP team consisted of:
Law, C.S., Harvey, M., Smith, M., K. Currie, F. Elliot, S. George, P. Johnston , J.McGregor, A. Marriner, G. Olivares, G. Olsen, K. Safi, N. Talbot, C. Walker (NIWA, NZ); T. Bell, C. McCormick, E. Saltzman (UCI, USA), W. deBruyn (U Chapman, USA), S. Landwehr (NUIG, Ireland), C. Marandino (IFM-Geomar, Germany), M. Lizotte. M. Levasseur (Uni. Laval, Canada); S. Miller, (SUNY, USA), L. Cravigan, M. Mallet, Z. Ristokski (QUT, Australia); P. Vaattovaara, (U Eastern Finland), S. Lawson, J. Ward (CSIRO, Australia), N. Harris, A. Robinson (U Cambridge, U.K.).

http://solas-int.org/science/researchendorsements/resendprojects/endorsedprojects.html#soap

Lawson, S.J., Keywood, M.D, Galbally, I.E., Harvey, M., Law, C., Selleck, P.W., Cheng, M. and Ristovski, Z (2012) Characterising VOCs in the Marine Boundary Layer During the SOAP Voyage, Chatham Rise, 44ºS. SOLAS Open Science Conference, Cle Elum, Washington State 7-10 May 2012.

2. SIPEX II Voyage

Measurements of a number of atmospheric components were undertaken over 1 year-old sea ice off East Antarctica as part of the Sea Ice Physics EXperiment (SIPEX II) during September and October this year (2012). SIPEX II is an integrated and multi-disciplinary study of physical, biogeochemical and ecological sea ice processes on small to regional scales which aims to enhance our understanding of sea ice in Antarctic climate and ecosystem processes. More than 50 scientists from eight countries departed Hobart (Australia) on September 14 aboard the Australian research and supply vessel Aurora Australis. Research was conducted at about 100-120° East, the region off Law Dome and to the east of Australia's Casey Station (see Figure). While the scientists did not set foot on terra firma, 8 multi-day research stations were set up on suitable sea ice floes.

A number of atmospheric measurements were made, including mercury (total in-situ), ozone (in-situ and column), halocarbons (in-situ using GC-ECD), particle number (in-situ) and aerosol and trace gas (e.g. BrO, IO) concentration profiles (using UV-Vis Multi-AXis Differential Optical Absorption Spectrometry (MAX-DOAS)). The aims of the campaign are to develop our understanding of a number of atmospheric and environmental phenomena including the reactive chemistry and biological impact of mercury; the chemistry of new particle formation; and the physics and presence of column aerosol and its local climate implications.

SIPEX-2 was also a GEOTRACES Process Study. Antarctic sea ice is known to store key micronutrients, such as iron as well as a suite of less studied trace metals in winter, which are rapidly released in spring. This stimulates ice edge phytoplankton blooms which drive the biological removal of climatically-important gases like carbon dioxide. By linking the distribution of iron and other trace elements to the cycles of carbon, nitrogen and silicon in the sea ice zone in spring, this project will identify their biogeochemical roles in the seasonal ice zone and how this may change with predicted climate-driven perturbations. Samples were be collected for laboratory trace elemental analysis in both sea ice cores and in the underlying water column using specialised sampling techniques.
Updates on the SIPEX-2 expedition can be found at: http://seaice.acecrc.org.au/sipex2012 and a cruise blog can be found at: http://www.antarctica.gov.au/about-antarctica/history/australias-involvement-in-antarctica/modern-expeditions/diaries-and-stories/spotlight-on-the-sea-ice

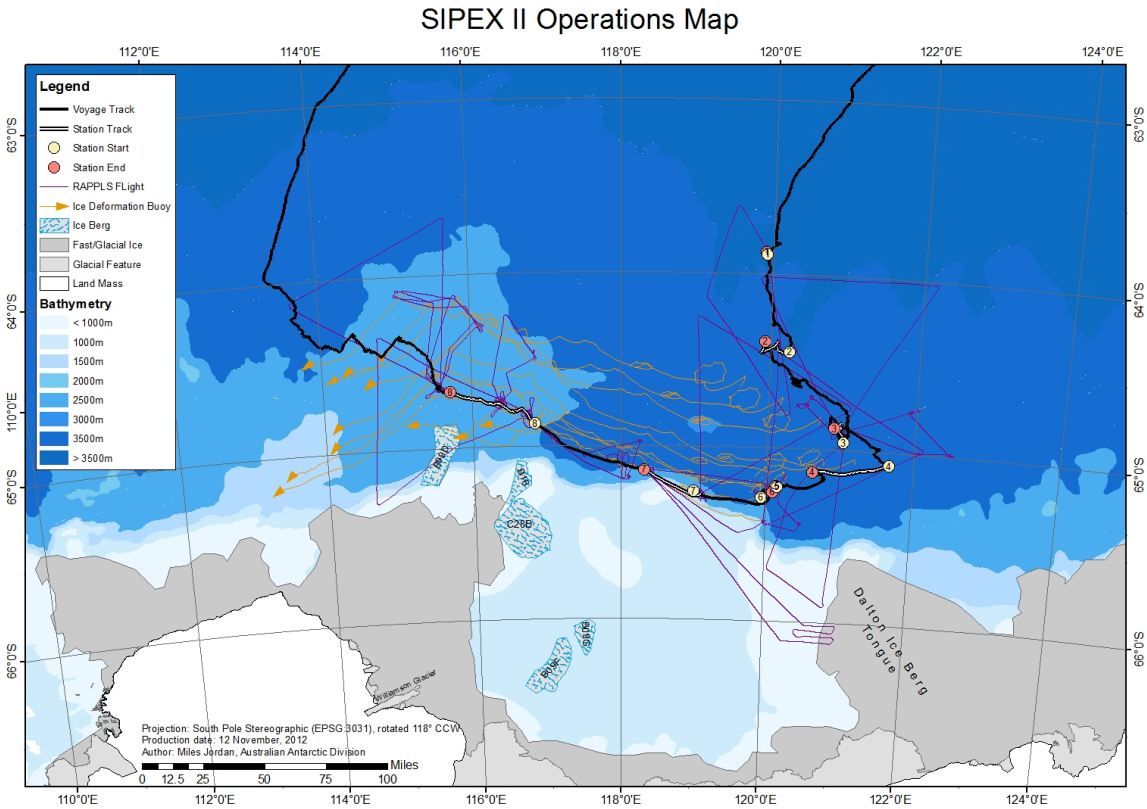

Figure: Study map and cruise track of the SIPEX-II expedition in East Antarctica.

3. Greenhouse gas measurements in the Southern Pacific Ocean

During three ship cruises in the Southern Pacific (April till June 2012) measurements of the key greenhouse gases CH4, CO2, N2O, O3 as well as CO and 13C(CO2) were performed in the marine boundary layer by a continuous in-situ FTIR system and an UV-absorption

ozone monitor aboard the Australian research vessel "RV Southern Surveyor". During the first transect from Hobart (42.5° S, 147.2° E) to Brisbane (27.3° S, 153.1° E) in April 2012 air influenced by terrestrial sources from Australia, such as pollution plumes originating from biomass burning or large metropolitan areas, were sampled. Southern Hemisphere marine air over the Pacific Ocean were characterised during the second and third transect from Brisbane to Fiji (17.6° S, 177.5° E) and Fiji to Hobart in May and June 2012.
Air masses with different composition were sampled and back trajectory studies indicate the origin of air influenced by the Australian continent as well as marine air. This unique data set will help to constrain current models of the lower atmosphere and hence improve our understanding of the processes contributing to the growth and variability of greenhouse gases in the atmosphere.

Workshops/meetings

1. Workshop on the Clouds, Precipitation and Meteorology over the Southern Ocean was held at Monash University on the 27th November 2012
2. Australian New Zealand Aerosol Workshop and Atmospheric Composition Observations and Modelling Conference incorporating the Cape Grim Annual Science Meeting 2012 were held at Murramarang Beachfront Nature Resort from 26-30 November 2012
3. Joint Australian Marine Sciences Association - New Zealand Marine Science Society conference, 'Marine Extremes - And Everything In Between' was held in Hobart from 1-5 July 2012

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

"Tropospheric Ozone and the Montreal Protocol" Ian Galbally, invited presentation at the workshop on 'Unanswered Questions in Ozone Research' 2 – 4 April 2012, School of Earth Science, University of Melbourne

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Butler E.C.V., O'Sullivan J.E., Watson R.J., Bowie A.R., Remenyi T., Lannuzel D., 2012. Trace metals Cd, Co, Cu, Ni, and Zn in waters of the Subantarctic and Polar Frontal Zones south of Tasmania during the 'SAZ-Sense' project. Marine Chemistry, in press (accepted 26 October 2012), doi: 10.1016/j.marchem.2012.10.005

Hassler, C.S., Sinoir, M., Clementson, L.A. and Butler, E.C.V. (2012) Exploring the link between micro-nutrients and phytoplankton in the Southern Ocean during the 2007 austral summer. Frontiers in Microbiological Chemistry, 3:202. doi: 10.3389/fmicb.2012.00202

Kirstine, W. and Galbally, I.E.: (2012) The global atmospheric budget of ethanol revisited, *Atmospheric Chemistry and Physics*, 12, 545-555, doi:10.5194/acp-12-545-2012, www.atmos-chem-phys.net/12/545/2012/

Kirstine, W. and Galbally, I.E.: (2012) Ethanol in the environment - a critical review of its roles as a natural product, a biofuel and a potential environmental pollutant, *Critical Reviews in Environmental Science and Technology*, **42** (16): 1735-1779. DOI: 10.1080/10643389.2011.569874

Oltmans, S.J., A. S. Lefohn, D. Shadwick , J. M. Harris, H.E. Scheel, I. Galbally, D. A. Tarasick, B. J. Johnson, E.-G. Brunke, H. Claude, G. Zeng, S. Nichol, F. Schmidlin, J. Davies, E. Cuevas, A. Redondas, H. Naoe, T. Nakano, T. Kawasato (2013) Recent Tropospheric Ozone Changes – A Pattern Dominated by Slow or No Growth, *Atmospheric Environment*, **67**, 331-351. http://dx.doi.org/10.1016/j.atmosenv.2012.10.057

Meiners, K. M., Vancoppenolle, M., Thanassekos, S., Dieckmann, G. S., Thomas, D. N., Tison, J.-L., Arrigo, K. R., Garrison, D. L., McMinn, A., Lannuzel, D., van der Merwe, P., Swadling, K. M., Smith, W. O., Jr. Melnikov, I., Raymond, B. (2012), Chlorophyll a in Antarctic sea ice from historical ice core data, Geophys. Res. Lett., 39, L21602, doi:10.1029/2012GL053478

Sinoir M., Butler E.C.V., Bowie A.R., Mongin M., Nesterenko P.N., Hassler C.S., 2012. Zinc marine biogeochemistry in seawater: a review. Marine and Freshwater Research, 2012, 63, 644–657. http://dx.doi.org/10.1071/MF11286

Vancoppenolle M, Meiners, K.M, Michel C, Delille B, Tison J.-L., van der Merwe P, Lannuzel D., Moreau S., Madec G., Brabant F., Carnat G . (2012) Role of sea ice in global biogeochemical cycles: Emerging views and challenges, Quaternary Science Reviews, accepted with minor revision

Wake B.D., Hassler C.S., Bowie A.R., Haddad P.R., Butler E.C.V., 2012. Phytoplankton selenium requirements: the case for species isolated from temperate and polar regions of the Southern Hemisphere. Journal of Phycology 48(3), 585-594, doi:10.1111/j.1529-8817.2012.01153.x

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

"Developments in background VOC monitoring at CSIRO Marine and Atmospheric Research" Ian Galbally, Sarah Lawson, Erin Dunne, Min Cheng, Paul Selleck and Suzie Molloy. Presented by Ian Galbally by Skype to The 4th GAW Expert Workshop on Volatile Organic Compounds, 11-12 September 2012, York, UK

Galbally, Ian E. and Martin G. Schultz (2012) Guidelines for Continuous Measurement of Ozone in the Troposphere, GAW Report World Meteorological Organisation, Geneva Switzerland, 82pp. (submitted)

6. Goals, priorities and plans for future activities/events

New Research Vessel under construction

Construction of Australia's new ocean-going research vessel, the RV *Investigator* is currently underway, and on its completion in 2013/14 will provide opportunities for international collaboration in marine and atmospheric research.

The RV *Investigator* will have a two dedicated laboratories for atmospheric research, including an aerosol laboratory located at the bow of the ship and an air chemistry laboratory on the foredeck. Atmospheric research on board the RV Investigator will take the form of "routine" climate tracking observations and mission driven campaign experiments. The ship will also have new dedicated equipment to sample for trace elements in ocean waters, including a clean laboratory clean container and trace-metal rosette.

The call for applications for use of RV Investigator in 2015/16 will be next year.

http://www.csiro.au/Outcomes/Oceans/Future-Research-Vessel.aspx

http://www.marine.csiro.au/nationalfacility/application/researchvoyagesInvestigator.htm\

Keywood, M.D and Lawson, S.J. (2012) Opportunities aboard Australia's new research vessel, the RV Investigator. SOLAS Open Science Conference, Cle Elum, Washington State 7-10 May 2012 and IGAC Open Science Conference, Beijing 2012

7. Other comments

SOLAS Belgium

compiled by Christiane Lancelot

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Climate active gases and their controls in ice-associated systems

A Year-Round survey of Antarctic landfast sea ice biogeochemistry (YROSIAE / BIGSOUTH - ULB, ULg, UCL - BELSPO - FNRS funding) has been investigated from November 2011 to December 2012 in McMurdo Sound (Ross Sea, Antarctica), in collaboration with Antarctica new Zealand, IRL and the University of Dunedin. The survey included measurements of physico-chemical (T°, salinity, texture, $d^{18}O$) and biogeochemical (nutrients-including isotopic signature-, trace metals, micro-algae, bacteria, carbonate system, CO_2, CH_4, DMS/O/P, O_2, Ar, N_2) compounds in first-year sea ice near Evans Cove. These measurements were performed in ice, brine, water and the atmosphere as relevant. Besides regular (12) full day sampling stations, the sea ice cover was equipped with an ice mass balance buoy (French collaboration), sediment traps (AWI and NIOZ collaboration), radiometers, eddy-correlation tower (CO_2, DMS) and automatic chambers (CO_2). These data will serve the understanding and modelling of sea ice biogeochemical processes and their impact on fluxes of climate-significant compounds across the sea-ice-atmosphere interface.

DMSP laboratory-controlled studies

A set of laboratory experiments were carried out by ULB (Lancelot, Gypens) and ULg (Borges) to determine DMSP cell quota in North Sea dominant phytoplankton species in view of refining the DMS model of ULB (MIRO-DMS).

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

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Artioli Y., J.C. Blackford, M. Butenschön, J.T. Holt, S.L. Wakelin, H. Thomas, A.V. Borges & I. Allen (2012) The carbonate system in the North Sea: sensitivity and model validation, Journal of Marine Systems, 102-104, 1-13

Engel A, Harlay J, Piontek J & L Chou (2012) Contribution of combined carbohydrates to dissolved and particulate organic carbon after the spring bloom in the northern Bay of Biscay (North-Eastern Atlantic Ocean), Continental Shelf Research 45, 42-53

Geilfus N.-X., G. Carnat, T. Papakyriakou, J.-L. Tison, B. Else, H. Thomas, E. Shadwick and B. Delille (2012) pCO_2 dynamics and related air-ice CO2 fluxes in the Arctic coastal zone (Amundsen Gulf, Beaufort Sea), Journal of Geophysical Research - Ocean, 117, C00G10, doi:10.1029/2011JC007118

Stefels, J., Carnat, G., Dacey, J.W.H., Goossens, T., Elzenga, J.T.M. and Tison, J.-L. (2012). The analysis of dimethylsulfide and dimethylsulfonopropionate in sea ice: Dry-crushing and melting using stable isotopes additions Marine Chemistry, 128, 34-43.

Boereboom, T., Depoorter, M., Coppens, S. and Tison, J.-L. (2012) Gas properties of winter lake ice in Northern Sweden: implication for carbon gas release. Biogeosciences, 9, 827-838

Geilfus, N.-X., Delille, B., Verbeke, V. and Tison, J.-L. (2012) Towards a method for high vertical resolution measurements of the partial pressure of CO2 within bulk sea ice J. of Glaciol., 58, 208, 287-300

de Jong, J., Schoemann, V., Lannuzel, D., Croot, P., de Baar, H. and Tison, J.-L. (2012) Natural iron fertilization of the Atlantic sector of the Southern Ocean by continental shelf sources of the Antarctic Peninsula J. of Geophys. Res., 117, G1, G01029

Meiners, K..M., Vancoppenolle, M., Thanassekos, S., Dieckmann, G.S., Thomas, D.N., Tison, J.-L., Arrigo, K.R., Garrison, D.L., McMinn, A., Lannuzel, D., Van Der Merwe, P., Swadling, K.M., Smith Jr, W.O., Melnikov, I. and Raymond, B. (2012) Chla in Antarctic sea ice from historic records GRL, 39, 21, L21602

Van Oostende N, Harlay J, Vanelslander B, Chou L, Vyverman W & K. Sabbe (2012) Phytoplankton community dynamics during late spring coccolithophore blooms at the continental margin of the Celtic Sea (North East Atlantic, 2006–2008), Progress in Oceanography 114, 1-16

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Field collaborations in polar seas: Antarctica new Zealand, IRL (T. Haskell) and the University of Dunedin (P. Langhorne), AWI (G. Dieckmann), NIOZ (V. Schoemann), LOCEAN (F. Viviers)

Contribution of A. Borges to IPCC WG1 fifth Assessment draft Report, chapter 6

6. Goals, priorities and plans for future activities/events

6.1 Experiments and modelling

Sea ice biogeochemical modelling (including gas exchange between ocean and sea-ice and between sea-ice and the atmosphere

Further experiments on DMSP cell quotas and DMS modelling

6.2 Meeting organisation

The 45th Liège Colloquium from 13 to 17 May 2013 will deal with “The variability of primary production in the ocean: from the synoptic to the global scale” (http://modb.oce.ulg.ac.be/colloquium/).

Session on “Coastal Biogeochemistry” at 2013 EGU meeting will be chaired by Helmuth Thomas and Alberto V. Borges

Session on " Coastal ecosystem under anthropogenic pressure: impact on ecosystem structure and services" at 2013 EGU meeting will be chaired by Nathalie Gypens, Marilaure Grégoire, Jorn Bruggeman and Sheldon Nelson

6.3 Conference abstracts

Salt L, H. Thomas, F. Prowe, A. Borges & H. de Baar, Variability of North Sea pH and CO2 pumping in response to North Atlantic Oscillation forcing, EGU General Assembly 2013, Vienna, Austria, 07 – 12 April 2013

Borges AV, F Meysman & J Harlay, CO2, CH4 and N2O dynamics and fluxes in the brackish Lake Grevelingen (The Netherlands), EGU General Assembly 2013, Vienna, Austria, 07 – 12 April 2013

Gypens N, AV Borges, S Paulet, J-Y Parent & C Lancelot, The dimethylsulphide propionate (DMSP) content in microalgae and its influence on DMS emission: Experimental and modelling study in the Southern North Sea, EGU General Assembly 2013, Vienna, Austria, 07 – 12 April 2013

Hagens M, C Slomp, F Meysman, A Borges & J Middelburg, The influence of biogeochemical processes on the pH dynamics in the seasonally hypoxic saline Lake Grevelingen, The Netherlands, EGU General Assembly 2013, Vienna, Austria, 07 – 12 April 2013

7. Other comments

SOLAS Chile *compiled by Laura Farias*

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1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight. Please focus on results that would not have happened without SOLAS.*

Undoubtedly, studies relative on the global nitrogen cycles have been controversial. In the ocean, the magnitude of N loss via denitrification is not clearly resolved. Therefore, there is urgent need to resolve currently open questions on how to look at the global balance between N gains and losses in the ocean and earth system. Using relationships that depend on threshold levels of O_2 (< 8 µM) and nitrite (>0.75 µM), we reproduced the apparent N_2O production (ΔN_2O) with high reliability (r2=0.63 p=0.01). Our results will improve the prediction of N_2O behavior, an important greenhouse gas, under future OMZ expansion scenarios. Our findings deal with the ability of microbes to consume N_2O during denitrification, putting in evidence that oceanic N_2O may be higher than previously thought. The work "Following the N2O consumption at the Oxygen Minimum Zone in the eastern South Pacific" by Marcela Cornejo and Laura Farías (Biogeosciences 9, 3205-3212. Doi10.5194/bg-9-3205-2012) displays Meridonal distribution of N2O in a wide region of the ocean (from 0 to 30°S) in the eastern South Pacific Ocean. This stusdy also present data from a region that has been poorly studied.

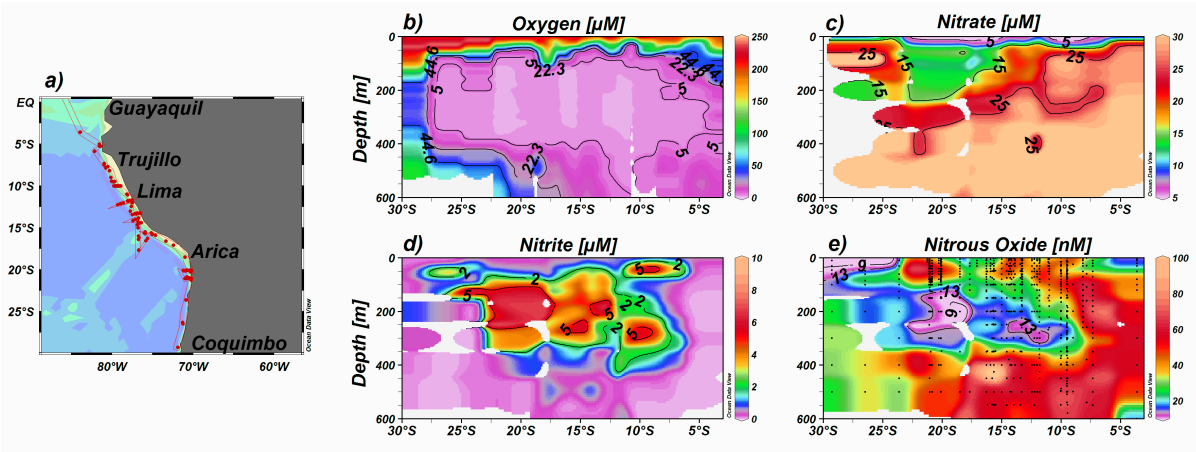


Figure 1. Meridional vertical distributions of: b) Oxygen [µM]; c) nitrate [µM]; Nitrite [µM]; and Nitrous oxide [nM]. Data was collected during several cruises mainly in eastern South pacific Region including tropical and subtropical regions.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

1.- An Inter-calibration exercise of levels of methane and nitrous oxide in seawater is being made among three laboratories Philippe Tortel (University of British Columbia, Canada), Laura Farías (Lab. Procesos Oceanográficos y Clima PROFC, Universidad de Concepcion, Chile) and Sam Wilson (Center for Microbial Oceanography, University of Hawaii; Hawaitt USA). To do that, a set of samples was taken at two depths (I.e., surface and intermediate waters) in June 2012. These samples are being analyzed in the mentioned laboratories.

2.- The recently granted Center for Climate and Resilience Research by the Chilean Commission for Science and Technology (CONICYT, http://www.conicyt.cl/fondap/) aims at becoming a world-class research center focusing on Earth System Science, which in an interdisciplinary manner and in close relation to stakeholders, improves our understanding of the Earth System and is functional to the enhancement of societal resilience in Chile. We convene the majority of researchers dealing Climate issues in Chile, and in a partnership involving Universidad de Chile (http://www.uchile.cl/), Universidad de Concepción (http://www.udec.cl) y Universidad Austral de Chile (http://www.uach.cl/). The proposed research will tackle highly relevant questions in biogeochemistry (particularly processes cycling greenhouse gases in surface waters), climate dynamics, ecosystem services, social science, and modeling and observing systems. This research is oriented towards addressing with an integrated approach.

3.- Laboratory PROFC is planning to acquire new research infrastructures (N_2O, H_2O analyzers and their isotopic composition, PICARRO INC) in order to provide access to a wider of researches and postgraduate student, that are interested in applying new technologies to marine biogeochemistry.

4.- In July 2002, the Center for Oceanographic Research in the South Eastern Pacific (COPAS) launched a time series study off central-south Chile (36º S). This study reflects an integrated, ongoing activity of the COPAS Center through which all the individual research programs converge into a unique platform to tackle integrated scientific questions. At present time, we have 10 year of measurements of N_2O and CH_4. This register represents one of more complete time series study that includes greenhouse gases.

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

With the recently creation of the Center for Climate and Resilience Research, an increase of outreach, capacity building will be reflected in new post doc positions (with international calling) and new scholarships for students.

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Cornejo, M. & L. Farias. (2012). Following the N2O consumption at the Oxygen Minimum Zone in the eastern South Pacific. Biogeosciences 9, 3205-3212. Doi10.5194/bg-9-3205-2012

Dalsgaard, T,B. Thamdrup, L. Farías & N. P. Revsbech (2012). Anammox and denitrification in the oxygen minimum zone of the Eastern Tropical South Pacific. Limnol & Oceanogr. 57, 1331-1346. Doi 10.431/lo2012.57.51331

Fernandez, C., L. Farías (2012). Assimilation and regeneration of inorganic nitrogen in a coastal upwelling system: ammonium and nitrate utilization. Marine Ecology Progress Series. doi: 10.3354/meps09683

Molina, V., C.E. Morales, L. Farías, M. Cornejo, M. Graco, Y. Eissler & LA. Cuevas (2112). Potential contribution of planktonic components to nitrogen regeneration in the coastal area off central-southern Chile during non-upwelling conditions. Progress in Oceanography 92-95:43-49.

Cornejo, M. and L. Farías (2012). Meridional variability of the vertical structure and air–sea fluxes of N2O off

central Chile (30–40°S) Progress in Oceanography, 92-95: 33-42.

http://www.dgf.uchile.cl/CR2

http://www.profc.udec.cl/

http://www.copas.cl/

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

With the support of the Gordon and Betty Moore Foundation (GBMF, Palo Alto, California), a study has been carry out to study oxygen minimum zone (OMZ) along the coast of Oregon-USA and Concepción-Chile.

This study has a main goal to understand the spatial and temporal variability of the OMZ along both the Oregon and Concepcion regions, and their associated mechanisms, by integrating Physical, Biogeochemical, Microbial, and Paleo-oceanography. The outcome is to identify similarities and distinctions between the microbial assemblages inhabiting both regions, characterize physical and biogeochemical seasonal patterns in the development and maintenance of hypoxic zones over both shelves, and determine the long term changes in the seasonal fluctuation of oxygen concentration over the shelves with the use of paleo proxies. More detailed information can be found in: http://mi-loco.coas.oregonstate.edu/

6. Goals, priorities and plans for future activities/events

A proposal to form a Scientific Committee on Oceanic Research (SCOR) Working Group on 'Dissolved N2O and CH4 measurements: Working towards a global network of ocean time series measurements of N2O and CH4'. As outlined in the document, this proposal aims to consolidate and ultimately improve the measurements of N2O and CH4 in seawater. This proposal is being led Dr. Hermann Bange at GEOMAR, Kiel and Dr. Sam Wilson at C-MORE, University of Hawaii. This proposal will be submitted in May 2013.

7. Other comments

SOLAS Canada

compiled by Maurice Levasseur

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight. Please focus on results that would not have happened without SOLAS.*

Lizotte M, Levasseur M, Michaud S, Scarratt MG, Merzouk A, Gosselin M, Pommier J, Rivkin RB, Kiene RP (2012). Biological cycling of dimethylsulfoniopropionate (DMSP) and dimethylsulfide (DMS) in the Northwest Atlantic - Macroscale patterns and dynamics. Biogeochemistry. doi: 10.1007/s10533-011-9698-4.

The influence of the seasonal development of microplankton communities on the cycling of dimethylsulfide (DMS) and its precursor dimethylsulfoniopropionate (DMSP) was investigated along a South-North gradient (36-59°N) in the Northwest Atlantic Ocean. The South-North progression of the diatom bloom, a prominent feature in the Northwest Atlantic, did not influence the production of DMS whereas conditions in the North Atlantic Drift lead to a persistent bloom of DMSP-rich flagellate-dominated phytoplankton community and high net DMS production rates. Macroscale patterns of the observed variables were further explored using principal component analysis (PCA). The first axis of the PCA showed a strong association between the spatio-temporal distribution of DMSP and the abundance of prymnesiophytes and phytoflagellates, as well as with the microbial-mediated $DMSP_d$ consumption and yields and rates of the conversion of DMSP into DMS. The second axis reveals a strong association between concentrations of DMS and SML depth and photosynthetically active radiation, a result supporting the prominent role of solar radiation as a driver of DMS dynamics.

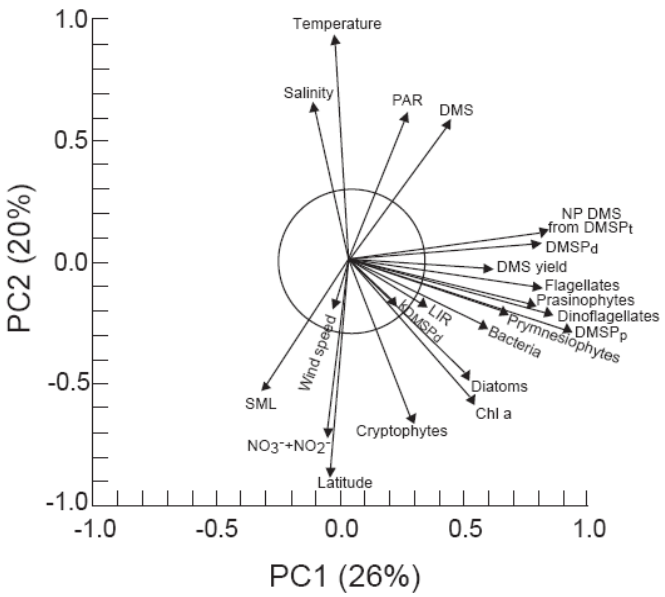


Fig. 1. Principal component analysis (PCA) of 22 variables measured along a meridional transect in the NW Atlantic Ocean in spring, summer and fall 2003. The data matrix includes DMSP microbial cycling variables ($DMSP_p$, $DMSP_d$, DMS, $DMSP_d$ loss rate constant (k_{DMSPd}), DMS yield from $DMSP_d$, and net production (NP) of DMS from $DMSP_t$), biological variables (bacterial abundance and leucine incorporation rates (LIR), abundance of phytoplankton groups and chl *a* concentration) and environmental variables (wind speed, incident photosynthetically active radiation (PAR), surface mixed layer (SML) depth, water temperature, salinity, NO_3^- + NO_2^- concentration and latitude). The circle of equilibrium descriptor contribution is drawn.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

i) **BaySys2012**: As part of a continuing project investigating mixing processes in Arctic coastal surface waters, we are investigating air-sea CO_2 exchange dynamics as high-pCO_2 river plumes mix with low-pCO_2 sea-ice melt-influenced marine waters in Hudson Bay. In a follow up to an intensive expedition in 2010, we returned to the study site at the mouth of the Nelson River, to measure the inorganic carbon system parameters in the surface waters at high vertical resolution.

ii) ARCTIC-ICE program: We conducted the third ice camp of this program in May-June 2012 in the Resolute Passage. Highlights of this sampling year were the very high DMS concentrations (up to 770 nmol l^{-1}) measured at the bottom of the ice and the extremely short (min) turnover time of the dissolved DMSP reservoir measured in the ice, suggesting the presence of very active microbial activity in the brines.

iii) SABINA (Study of Air-Sea Biogeochemical Interactions in the North-western Atlantic) Workshop. A workshop was held in Quebec City in order to summarize the data collected during the three cruises conducted in the North-western Atlantic during the Canadian SOLAS program. The workshop was sponsored by Canadian Foundation for Climate and Atmospheric Sciences. Several papers are in preparation.

iv) Surface Ocean Aerosol Production (SOAP) project. Canadian SOLAS scientist M. Lizotte (U. Laval) from Levasseur's lab (and collaboration with R Kiene, U. of South Alabama) participated to the NIWA SOAP project in New Zealand waters (lead scientist: C. Law). Our role was to quantify DMSP microbial cycling in the different water masses and bloom types, with a special look at the surface microlayer.

v) Impact of ocean acidification on the microbial production of DMS – Microcosms experiments were conducted in July 2012 to test the effect of pH on DMS production by natural estuarine communities. Results from this first experiment indicate that the local diatom community is resistant to pH changes.

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

Ph.D. student, Kristina Brown, University of British Columbia. Proposed thesis title: A multi-tracer study of the role of sea ice on carbon cycling in the Arctic Ocean.

Ph.D. student, Virginie Galindo, Université Laval. thesis title : Fate of dimethylsulfoniopropionate (DMSP) at the ice-water interface during the spring melt period in the canadian Arctic Archipelago

Ph.D. student: Josiane Mélançon, Université Laval, thesis title: Impact of dust on DMS production in the North-east Pacific.

M.Sc. student: Robin Bénard, Université Laval, thesis title: Impact of acidification on a natural planktonic community and DMS production in the St. Lawrence estuary

M.Sc. student : Margaux Gourdal, Université Laval, thesis title : Distribution and fate of two climate active gas, dimethylsulfide and nitrous oxide, in sea ice and water column during the spring melt in the Canadian Arctic Archipelago.

4. Top 10 publications in 2012 (Reports, <u>ACCEPTED</u> articles, models, datasets, products, website etc)

Else B.G.T., R.J. Galley, T.N. Papakyriakou, L.A. Miller, A. Mucci, D. Barber, 2012. Sea Surface pCO_2 cycles and CO_2 fluxes at landfast sea ice edges in Amundsen Gulf, Canada. J. Geophys. Res. **117**, C09010, doi:10.1029/2012JC007901.

Else B.G.T., T.N. Papakyriakou, R.J. Galley, A. Mucci, M. Gosselin, L.A. Miller, E.H. Shadwick, H. Thomas, 2012. Annual Cycles of pCO_{2sw} in the southeastern Beaufort Sea: New understandings of air-sea CO_2 exchange in Arctic polynyas. J. Geophys. Res **117**, C00G13, doi:10.1029/2011JC007346.

Barber D.G., M.G. Asplin, T.N. Papakyriakou, L.A. Miller, B.G.T. Else, J. Iacozza, C.J. Mundy, M. Gosselin, N.C. Asselin, S. Ferguson, J.V. Lukovich, G.A. Stern, A. Gaden, M. Pućko, N.-X. Geilfus, and F. Wang, 2012. Consequences of change and variability in sea ice on marine ecosystem and biogeochemical processes during the 2007–2008 Canadian International Polar

Year program. Clim. Change, doi:10.1007/s10584-012-0482-9.
Feely R.A., C.L. Sabine, R. H. Byrne, F. J. Millero, A. G. Dickson, R. Wanninkhof, A. Murata, L.A. Miller, and D. Greeley, 2012. Decadal changes in the aragonite and calcite saturation state of the Pacific Ocean. Global. Biogeochem. Cycles **26**, GB3001, doi:10.1029/2011GB004157.
Papakyriakou, T., G. Carnat, M. Chierici, B. Delille, B. Else, A. Fransson, N.-X. Geilfus, B. Lansard, L.A. Miller, A. Mucci, E. Shadwick, H. Thomas, and J.-L. Tison, 2012. In: On the Edge (D. Barber, T. Tjaden, D. Leitch, L. Barber, and W. Chan, Eds.), Chapter 3.6, pp. 109-22, University of Manitoba Press, Winnipeg. Team 6: Gas fluxes. (not peer reviewed)
Lizotte M., M. Levasseur, S. Michaud, M.G. Scarratt, A. Merzouk, M. Gosselin, J. Pommier, R.B. Rivkin, R.P. Kiene (2012). Biological cycling of dimethylsulfoniopropionate (DMSP) and dimethylsulfide (DMS) in the Northwest Atlantic - Macroscale patterns and dynamics. Biogeochemistry. doi: 10.1007/s10533-011-9698-4.
Elliott S., C. Deal, G. Humphries, E. Hunke, N. Jeffery, M. Jin, M. Levasseur, J. Stefels (2012) Pan-Arctic Simulation of Coupled Nutrient-Sulfur Cycling due to Sea Ice Biology: Preliminary Results. J. Geophys. Res. doi.org/10.1029/2011JG001649.
Sjostedt S.J., W.R. Leaitch, M. Levasseur, M.G. Scarratt, S. Michaud, J. Motard-Coté J, J.P.D. Abbatt (2012) Evidence for the uptake of acetone and methanol by the Arctic Ocean during late summer DMS events. J. Geophys. Res. **117**, D12303, doi:10.1029/2011JD017086, 2012.
Randall K., M.G. Scarratt, M. Levasseur, S. Michaud, H. Xie, M. Gosselin (2012) Arctic sea ice: source or sink for nitrous oxide? J. Geophys. Res. **117**, C00G15, doi:10.1029/2011JC007340, 2012.
Steiner N., M. Robert, M. Arychuk, L. Asher, M. Levasseur, A. Merzouk, A. Pená, W. Richardson, P. Tortell (2012). Evaluating DMS measurements and model results in the Northeast subarctic Pacific from 1996–2010. Biogeochemistry. DOI 10.1007/s10533-011-9669-9.
Sharma S., E. Chan, M. Ishizawa, D. Toom-Sauntry, T. Agnew, S.L. Gong, S.M. Li, W.R. Leaitch, A.-L. Norman, P.K. Quinn, T.S. Bates, M. Levasseur, L.A. Barrie, W. Maenhaut (2012). Influence of Transport and Ocean Ice Extent on Biogenic Aerosol Sulfur in the Arctic. J. Geophys. Res. **117**, D12209, doi:10.1029/2011JD017074, 2012.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

i) Canadian SOLAS scientists J. Christian and L. Miller contributed both data and expertise to the PACIFICA North Pacific inorganic carbon data product.

ii) The on-going Arctic Monitoring and Assessment Program on Arctic Ocean Acidification continues to have a strong Canadian input, and the Canadian ocean acidification research community, as a whole, held a workshop in September to conduct the national review of the draft assessment.

iii) Canadian SOLAS scientist M. Lizotte participated to the NIWA project SOAP in New Zealand waters in March 2012. Her contribution was to quantify DMSP microbial cycling.

6. Goals, priorities and plans for future activities/events

i) **NETCARE - NET**work on **C**limate and **A**erosols: Addressing Key Uncertainties in **R**emote Canadian **E**nvironments. The proposal NETCARE was submitted to NSERC in September 2012. Final decisions are expected for February 2013. If successful, this 5-year network will allow for an in depth evaluation of the sources, dynamics and climate impacts of aerosols in the Canadian Arctic (Lead scientist: J. Abbatt, U. of Toronto). NETCARE's overall objectives are to address key uncertainties in predictions of aerosol effects on climate by using a variety of observational and modeling approaches, as well as to use that increased knowledge to improve the accuracy of Canadian climate and Earth system model predictions of aerosol radiative forcing.

7. Other comments

SOLAS China (Beijing)

compiled by Minhan Dai and Huiwang Gao

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight. Please focus on results that would not have happened without SOLAS.*

(1) On the Variations of Sea Surface pCO_2 in the Northern South China Sea - A Remote Sensing Based Neural Network Approach

Jo, YH; Dai, MH; Zhai, WD; Yan, XH; Shang, SL. ***Journal of Geophysical Research***, 117, C08022, doi:10.1029/2011JC007745.

Using a neural networking (NN) approach, we developed an algorithm primarily based upon sea surface temperature (SST) and chlorophyll (Chla) to estimate the partial pressure of carbon dioxide (pCO_2) at the sea surface in the northern South China Sea (NSCS). Randomly selected in situ data collected from May 2001, February and July 2004 cruises were used to develop and test the predictive capabilities of the NN based algorithm with four inputs (SST, Chla, longitudes and latitudes). The comparison revealed a high correlation coefficient of 0.98 with a root mean square error (RMSE) of 6.9 μatm. We subsequently applied our NN algorithm to satellite SST and Chla measurements, with associated longitudes and latitudes, to obtain surface water pCO_2. The resulting monthlymean pCO_2 map derived from the satellite measurements agreed reasonably well with the in situ observations showing a generally homogeneous distribution in the offshore regions. The pCO_2 exerts a very dynamic feature in nearshore regions, especially in the coastal upwelling and estuarine plume regions. We identified three low pCO_2 zones (<330 μatm), two of which are influenced by coastal upwelling: off Hainan island in the western part of the NSCS; and off Guangdong province in the eastern part of the NSCS. The path of the Pearl River plume on the shelf was another zone with low *p*CO2. For the monthly mean *p*CO2 variations estimated based on the MODIS-SST and -Chla values, an RMSE of ~6 μatm may be attributable to the measurement errors associated with MODIS measurements. As a first order estimation, we used the same sampling periods of remote sensing and in situ measurements, and were able to estimate pCO_2 with an accuracy of 12.05 μatm for onshore regions and 13.0 μatm for offshore regions, but with combined uncertainties associated with the NN Testing algorithm and MODIS SST and Chla measurements.

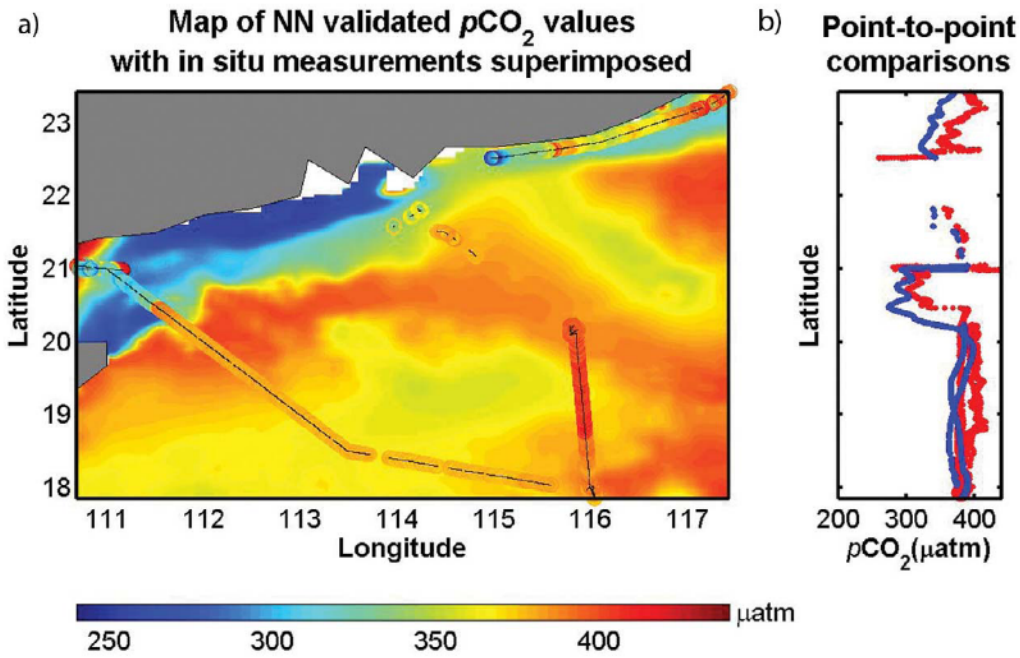


Figure 1. (a) Map of the NN validated pCO_2 values for the July 2004 cruise with the locations of the field measurements superimposed. (b) A comparison of the in situ (red dots) and NN (blue dots) pCO_2 measurements along the same latitudes.

(2) New evidences for acid enhanced formation of secondary organic aerosols in marine atmosphere

Feng et al. Source and formation of secondary particulate matter in $PM_{2.5}$ in Asian continental outflow. ***Journal of Geophysical Research***, 117, D03302, doi:10.1029/2011JD016400, 2012.

Acid enhanced formation of secondary organic aerosols (SOA) in the atmosphere is still in doubt because of uncertainties on determination of aerosol acidity. Marine atmosphere is poor in NH_3 and provides a unique acid environment to examine the importance of the mechanism. A year-long measurement has been made for the target at a sea island downwind of urban airshed in the North China. The result shows that i) when $[H^+] > 0$, a moderately good linear correlation of the estimated aerosol acidity $[H^+]$ with the water-soluble organic carbon (WSOC) was observed with $R^2 = 0.70$ and an increase of $[H^+]$ by 100 neq m^{-3} would increase 1.2 mg m^{-3} WSOC in $PM_{2.5}$; ii) when $[H^+] > 0$, an increase of $[H^+]$ by 100 neq m^{-3} would increase 1.4 mg m^{-3} of SOA in $PM_{2.5}$ [Fig]. However, high concentrations of WSOC and SOA were also observed when $[H^+] < 0$. The comparison of SOA (or WSOC) between $[H^+] > 0$ and $[H^+] < 0$ may not be valid to examine the importance of acid enhanced formation of SOA, although the approach has been widely employed in the literature.

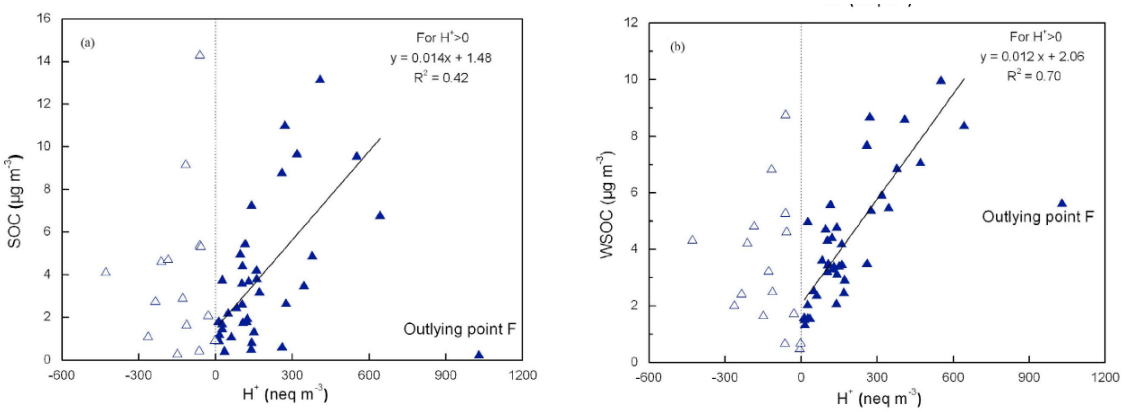


Figure 2. Correlations (a) between secondary OC and aerosol acidity and (b) between WSOC and aerosol acidity.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

2.1 Cruise and field experiment

A 24-day long and multidisciplinary CHOICE-C summer cruise was conducted onboard R/V Dongfanghong II on July 29-August 21, 2012, covering the northern South China Sea. The cruise map is shown in Figure 3.

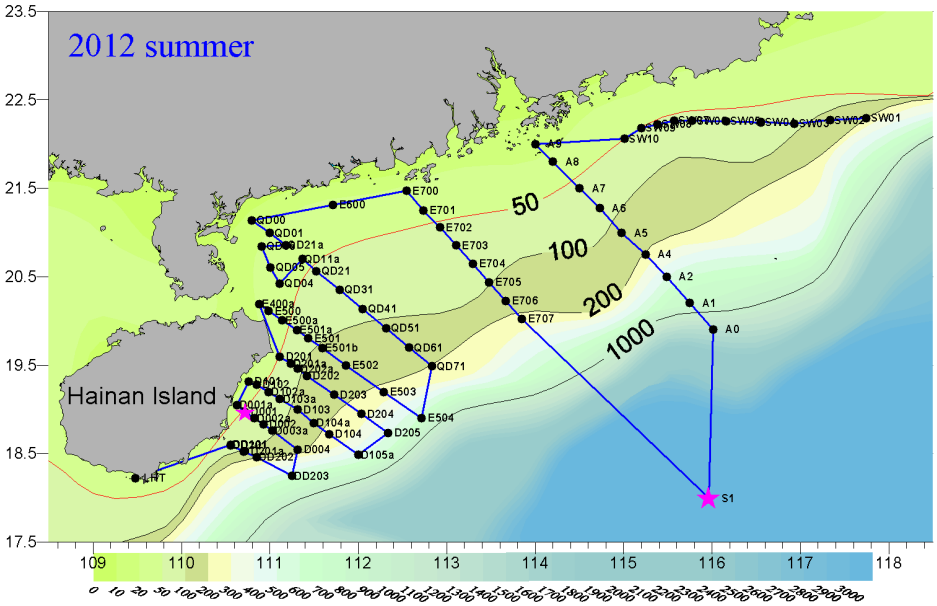


Figure 3. Map of the South China Sea showing the sampling stations in the CHOICE-C 2012 summer cruise.

2.2 Workshop convened or organized

1) 2012 CHOICE-C annual meeting, November 30-December 2, 2012, Guangzhou, China.

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

The Ocean and Me---2012 Xiamen University Ocean Sciences Open House, November 4, 2012, Ocean Building, Xiamen University, China

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

(1) Gao, K.S., J.T. Xu, G. Gao, Y.H. Li, D.A. Hutchins, B.Q. Huang, L. Wang, Y. Zheng, P. Jin, X.N. Cai, D.-P. Hader, W. Li, K. Xu, N.N. Liu, and U. Riebesell, 2012. Rising CO_2 and increased light exposure synergistically reduce marine primary productivity. ***Nature Climate Change***, 2: 519-523.

(2) Cao, Z.M., M. Frank, M.H. Dai, P. Grasse, and C. Ehlert, 2012. Silicon isotope constraints on sources and utilization of silicic acid in the northern South China Sea. ***Geochimica et Cosmochimica Acta***, 97: 88-104.

(3) Jo, Y.-H., M.H. Dai, W.D. Zhai, X.-H. Yan, and S.L. Shang, 2012. On the Variations of Sea Surface pCO_2 in the Northern South China Sea - A Remote Sensing Based Neural Network Approach. ***Journal of Geophysical Research***, 117, C08022, doi:10.1029/2011JC007745.

(4) Han, A.Q., M.H. Dai, S.J. Kao, J.P. Gan, Q. Li, L.F. Wang, W.D. Zhai, and L. Wang, 2012. Nutrient dynamics and biological consumption in a large continental shelf system under the influence of both a river plume and coastal upwelling. ***Limnology and Oceanography***, 57(2): 486-502.

(5) Yang, D.Z., B.S. Yin, Z.L. Liu, T. Bai, J.F. Qi, and H.Y. Chen, 2012. Numerical study on the pattern and origins of Kuroshio branches in the bottom water of southern East China Sea in summer. ***Journal of Geophysical Research***, 117, C02014, doi:10.1029/2011JC007528.

(6) Shi, J.H., Gao, H.W., Zhang, J., Tan, S.C., Ren, J.L., Liu, C.G., Liu, Y., Yao, X., 2012. Examination of causative link between a spring bloom and dry/wet deposition of Asian dust in the Yellow Sea, China, ***Journal of Geophysical Research***, 117, D17304, doi:10.1029/2012JD017983.

(7) Yang Gui-Peng, Zhuang Guang Chao, Honghai Zhang, Yuan Dong, Jian Yang, 2012. Biogeochemistry of dimethylsulfide and dimet hylsulfoniopropionate in the Yellow Sea and the East China Sea during spring: spatio-temporal variability and controlling. ***Marine Chemistry*** 138-139: 21-31.

(8) Zhen He, Gui-Peng Yang, Xiao-Lan Lu, 2012. Distributions and sea-to-air fluxes of volatile halocarbons in the East China Sea in early winter. ***Chemosphere*** 90: 747-757.

(9) Yao and Zhang, Chemical processes in sea-salt chloride depletion observed at a Canadian rural coastal site, ***Atmospheric Environment***, 46, 189-194, 2012.

(10) Liu, B., C. Guan, L. Xie and D. Zhao (2012): An investigation of the effects of wave state and sea spray on an idealized typoon using an air-sea coupled modeling system. ***Adv. Atmos. Sci.***, 29, 391-406.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

1) Minhan Dai, Coastal Ocean Carbon Cycling – Current Understanding and Challenges, 2012 ASLO (the Association for the Sciences of Limnology and Oceanography) Aquatic Sciences Meeting, 8-13 July 2012, Lake Biwa, Otsu, Shiga, Japan. (Plenary Talk)

2) Kunshan Gao, Rising carbon dioxide and increasing light exposure act synergistically to reduce marine primary productivity ,Third International Symposium on the Ocean in a High-CO2 World, (September,24-27 2012, Monterey, USA)

6. Goals, priorities and plans for future activities/events

SOLAS-Endorsed Project CHOICE-C is going to end in 2013, and we will seek opportunities to get renewed. At the same time, SOLAS-China community is going to propose a multiple-PIs project on nitrogen dynamics at the ocean-atmosphere interface through China National Basic Research Program sponsored by Ministry of Science and Technology.

7. Other comments

SOLAS Denmark

compiled by Lise-Lotte Sørensen/Mikael Sejr

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

High air-sea CO_2 uptake rates in near shore and shelf areas of Southern Greenland

In a recent study by Rysgaard et al., 2012 observations of low pCO_2 conditions in near shore and offshore areas of southern Greenland showed a clear under saturation of the sea surface relative to the atmosphere (Fig.). The strong pCO_2 under saturation in the surface waters from the different fjord systems along the Greenland coast line may be responsible for the low pCO_2 values observed on the shelf and most likely representative for the region.

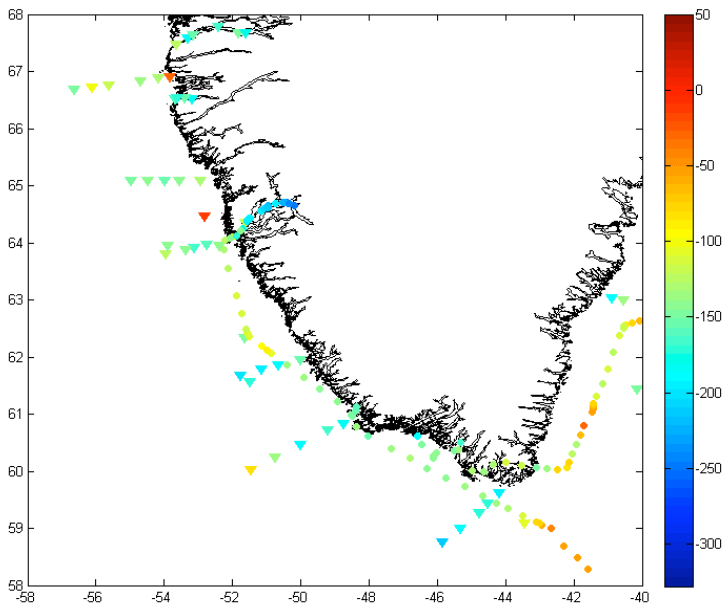


Figure: Difference in pCO_2 between atmosphere and sea surface ($\Delta pCO2$) in nearshore and offshore waters around southern Greenland. The data are both equilibrator online data (circles) from a cruise in summer 2008 and a cruise in fall 2006 and data from various discrete sampling (triangles).

Through compilations of data, Takahashi et al. (2009) computed the ΔpCO_2 level in surface waters and found that ΔpCO_2 levels in surface water areas north of 50 N in average vary by 40 μatm during a season. If this also applies to our study area, surface water pCO_2 would be under saturated at all seasons and the area will thus be a strong sink for atmospheric CO_2 on an annual basis. Our calculations show that the Godthåbfjord takes up 7.5 tons C month^{-1} km^{-1} and must be considered a very strong sink compared to the uptake of the high-latitude North Atlantic, with a mean of 2.5 tons C month^{-1} km^{-2} (Takahashi et al., 2009). If our calculated uptake is typical for similar fjord systems in Greenland, then the coastal areas of Greenland constitute a much larger sink than anticipated.

References:

1. Rysgaard, S., Mortensen, J., Juul-Pedersen, T., Sørensen, L.L., Lennert, K., Søgaard, D.H., Arendt, K.E., Blicher, M.E., Sejr, M.K. and Bendtsen, J., 2012, High air-sea CO_2 uptake rates in nearshore and shelf areas of Southern Greenland: Temporal and spatial variability. Marine Chemistry, 128-129, 26-23, doi:10.1016/j.marchem.2011.11.002

2. Takahashi, T., et al., 2009, Climatological mean and decadal change in surface ocean pCO2 and net sea-air CO_2 flux over the global oceans. Deep Sea Res. II 56, 554-577.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

An experiment to study the air-sea exchange of CO_2 over Arctic waters during ice formation and melting took place in Young Sound near Zackenberg, Greenland in March 2012. The data from this experiment is still being processed.

A thorough study of the CO_2 air-sea exchange processes in coastal regions and fjord areas in Denmark has been carried out during spring and summer 2012. The data are being processed.

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

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Rysgaard, S., Mortensen, J., Juul-Pedersen, T., Sørensen, L.L., Lennert, K., Søgaard, D.H., Arendt, K.E., Blicher, M.E., Sejr, M.K. and Bendtsen, J., 2012, High air-sea CO_2 uptake rates in nearshore and shelf areas of Southern Greenland: Temporal and spatial variability. Marine Chemistry, 128-129, 26-23, doi:10.1016/j.marchem.2011.11.002

Norman, M., A. Rutgersson, L.L. Sørensen, E. Sahlée, 2012, Estimating fluxes of CO_2 from high frequency measurements using different techniques. Boundary Layer Meteorology, 144:379-400, DOI 10.1007/s10546-012-9730-9.

Fenger, M., Sørensen, L.L., Kristensen, K., Jensen, B., Nguyen, Q.T., Nøjgaard, J.K., Massling, A., Skov, H. and Glasius, M., 2013, Sources of anions in aerosols in northeast Greenland during late winter. Accepted for Atmospheric Chemistry and Physics

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Many of the activities in the Arctic are part of the Nordic Centres of Excellence, DEFROST and CRAICC and thus has collaboration with researchers from Helsinki University, Lund University, Finnish Meteorological Institute and Stockholm University. Furthermore there is a strong link to Uppsala university through PhD students.

A new Arctic Science Partnership (ASP, www.asp-net.org) between Arctic Research Centre, Aarhus University, Denmark; Greenland Climate Research Centre, Greenland Institute of Natural Resources and Centre for Earth Observation Science (CEOS), University of Manitoba , Canada has been established. A focus area of this partnership is to study the processes controlling air-sea exchange of constituents in Arctic waters.

6. Goals, priorities and plans for future activities/events

Several field experiments in the Nuuk area in southern Greenland focusing on air-sea exchange of carbon species (VOC, CO_2 etc.) will take place in 2013. The focus will be on carbon component influencing the climate as greenhouse gases or as cloud condensation nucleus. The Processes controlling the concentrations in the surface waters as well as processes controlling the air-sea exchange will be studied.

Planning of field experiments in 2014 at the north east coast of Greenland is under development. In these studies there will be focus on climate relevant constituents as well as on mercury.

7. Other comments

SOLAS France

compiled by Rémi Losno, C. Guieu and V. Garçon

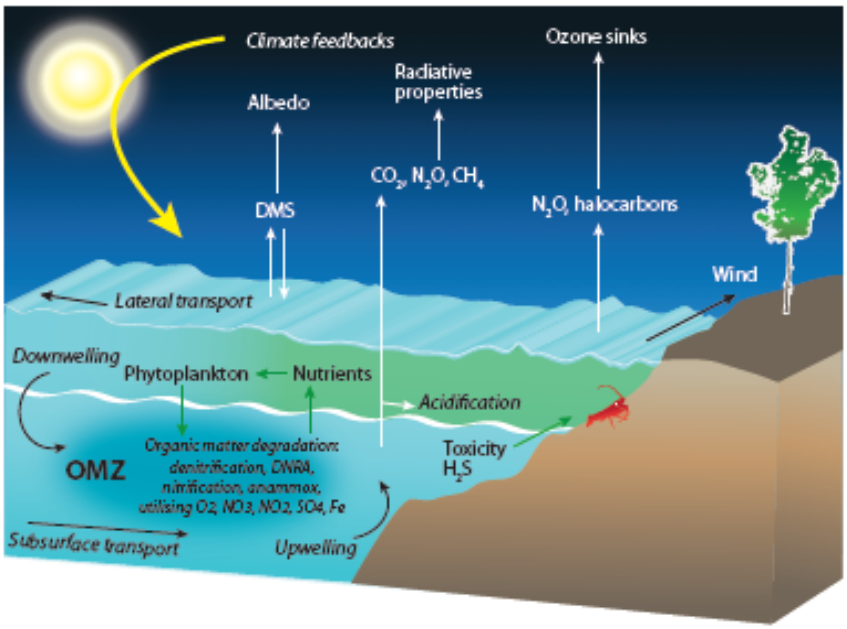
Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Evolving Research Directions in Surface Ocean-Lower Atmosphere Science *(SOLAS)*

Oxygen Minimum Zones (OMZs)

Eastern Boundary Upwelling Systems and their associated OMZs are crucial sites for greenhouse gas, trace gas, aerosol and nutrient cycling. These regions influence climate, cloud properties and marine productivity, yet feedbacks are complex and poorly quantified. French SOLAS with the AMOP project aims to determine the overall climate impact of these regions, by considering CO_2 and trace gas production and emission, with a focus on the East Tropical South Pacific off Peru, using multiple sampling platforms to develop new data bases, remote sensing, parameterizations, regional coupled atmospherical-physical and biogeochemical models.



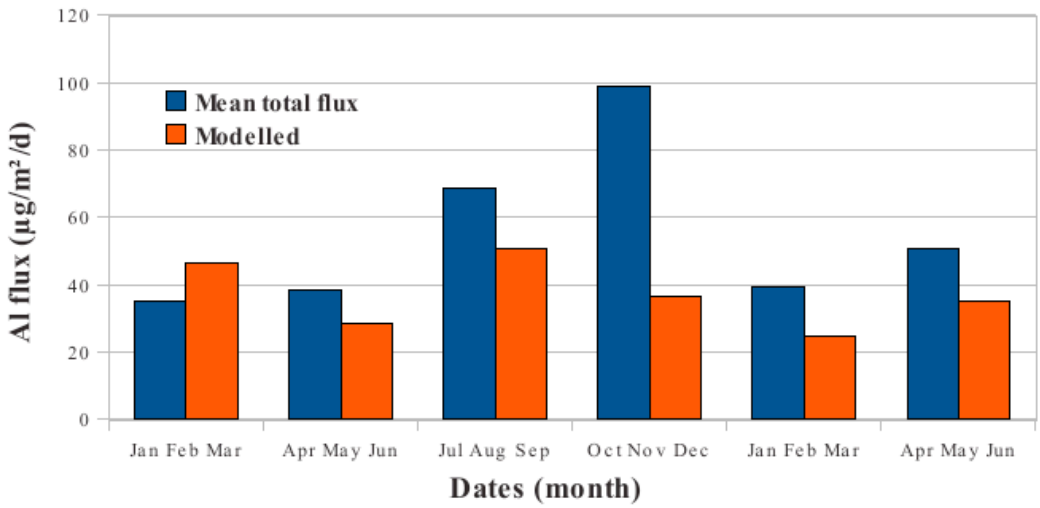
Conceptual diagram illustrating the main issues, processes and species relating to EBUS and OMZs. Processes are indicated in italics.

[1]Law, C.S., Brévière, E., de Leeuw, G., Guieu, C., Garçon ,V.C., Kieber, D.J., Kontradowitz, S., Paulmier, A., Quinn, P.K., Saltzman,E., Stefels, J., and Roland von Glasow, 2012,

Evolving Research Directions in Surface Ocean-Lower Atmosphere Science (SOLAS), ***Environmental Chemistry****, in press.*

Micronutriments atmospheric deposition flux into Southern Oceans

Total atmospheric deposition and crustal aerosol concentrations are monitored on Kerguelen Islands (49°18′S; 70°07′E) in the Southern Ocean during a short campaign in early 2005 and then continuously for about 2 years (2009–2010). Results are published now and show that atmospheric dust and trace metals concentrations are very low in the area but that direct measured deposition fluxes are much higher than expected from atmospheric concentrations and consistent with global models. The averaged total dust deposition flux as derived from Al deposition measurements is 659 µg m^{-2} d^{-1}. . Observations and model results suggest that dust is transported above the marine atmospheric boundary layer to Kerguelen Islands, and thus that surface concentrations are not representative of the total dust column. Indeed, using surface aerosol concentrations leads to very large computed wet scavenging ratios, and to the conclusion that it is not appropriate to derive deposition fluxes from surface concentrations at remote ocean sites. These results are parts of SOLAS endorsed project FLATOCOA.



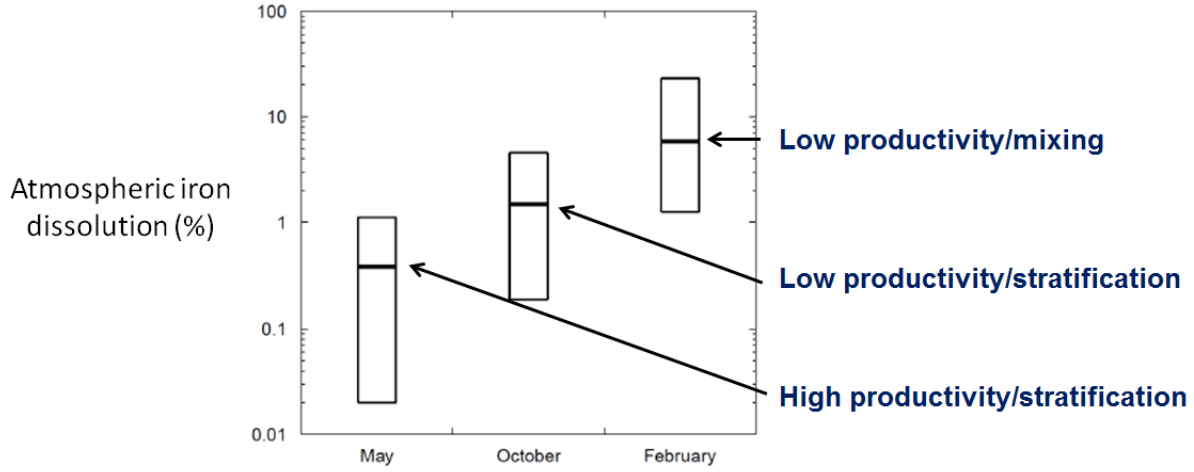
Three-month sampling time weighted average (full) of total deposition fluxes of Al for the years 2009–2010 and corresponding modelled outputs (hatched), from Heimburger et al.[2].

[2]A. Heimburger, R. Losno, S. Triquet, F. Dulac and N. Mahowald, Direct measurements of atmospheric iron, cobalt and aluminium-derived dust deposition at Kerguelen Islands, Global Biogeochemical Cycles, ***26-4****, GB4016, doi:10.1029/2012GB004301.*

Organic complexation versus scavenging: What really happens to new atmospheric iron in the ocean's surface?

By the mean of abiotic experiments conducted in clean “minicosm”, we have been studying the influence of the composition and the concentration of the dissolved organic matter (DOM) on the fate of atmospheric new nutrients (N, P and Fe). We have shown that atmospheric iron dissolution is depending on age and amount of dissolved organic matter in

seawater. Post-depositional processes controlled by DOM, are thus very important to take into consideration to predict biota response to atmospheric deposition of nutrients. This work was presented during the last SOLAS OSC meeting in Cle Elum in May 2012 (M. Bressac winner of the student poster award). A paper is currently under review [Bressac and Guieu, submitted to GBC].



Atmospheric Iron dissolution: one order of magnitude difference depending on in situ biogeochemical conditions; the same experimental conditions were used for the 3 'clean minicosm' experiments conducted in abiotic conditions (same dust, same deposition flux) at 3 contrasted seasons (0.2 µm seawater sampled in the Bay of Villefranche/mer). (Bressac M., 2012, PhD and Bressac & Guieu, submitted GBC).

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

SOLAS OSC: The 2012 SOLAS OSC at Cle Elum (USA, WA) included 10 french contributions and a well represented attendance.
An invited talk was given by Sophie Bonnet (IRD, MIO): "Dinitrogen fixation above Oxygen Minimum Zones". One special session (Impact of dust and ash on ocean productivity) was co-convened by R. Hamme, R. Losno, I. Lin and Diego Gaiero. In addition to "SOLAS-France", 8 scientific posters were presented:

- Remote atmosphere sampling and storage for mercury and very low level trace metals (S. Triquet)
- Physical and biogeochemical processes maintaining the Oxygen Minimum Zone of the Benguela Upwelling System using an eddy resoving model (V. Garçon).
- AMOP: activities of research dedicated to the minimum of oxygen in the eastern Pacific (A. Paulmier)
- Dust emission from Patagonia (R. Losno).
- Impact of Saharan dust deposition on dissolved-colloidal-particulate nutrient distribution in seawater (M. Bressac, winner of the student poster award).
- A plan for a SOLAS campaign across the Mediterranean Sea in 2015 (C. Guieu).
- Atmospheric deposition of trace elements over the Southern Indian Ocean (A. Heimburger).
- A new mineralogical database for atmospheric dust to estimate soluble iron fluxes to surface ocean (E. Journet).

Full textes are available in SOLAS-France web pages (http://www.lisa.u-pec.fr/SOLAS/OSS_attendance.html)

SOLAS News: 5 scientific contributions, 1 special report and 3 endorsed project reports were given for publication in issue 14 (summer 2012). Pages are for 'on screen' version:

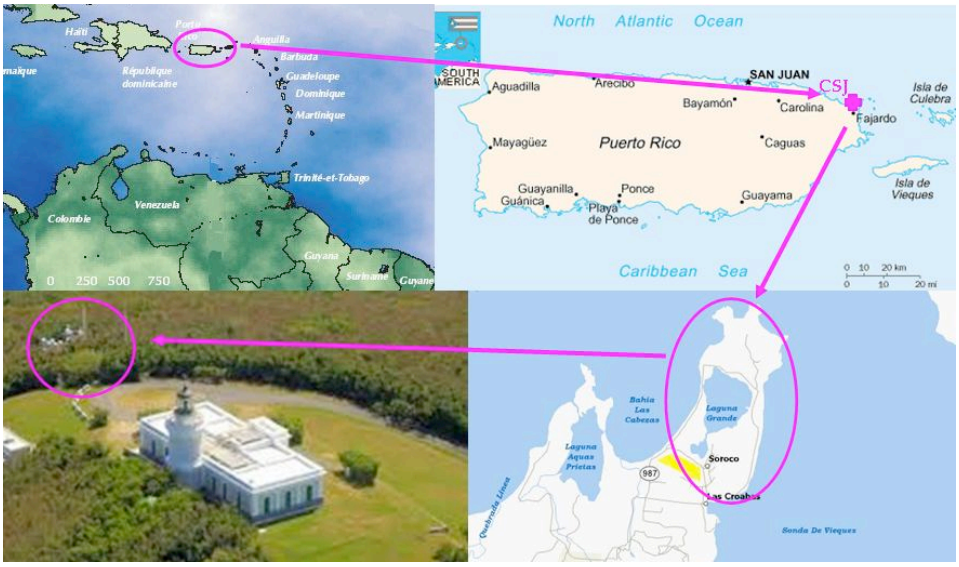
- S. Bonnet, NanoSIMS reveals efficient transfer of fixed N2 from Trichodesmium to large size phytoplankton, 5-8, scientific contribution.
- Bressac M., Dust deposition: the fate of atmospheric new nutrients, interactions with organic matter and the impact on carbon export. 12-14, scientific contribution.
- E. Journet, Iron solubility and dust mineralogy, 22-24, scientific contribution.
- A. Paulmier, V. Garçon, M. Graco, C. Maes, D. Gutierrez, B. Dewitte and K. Takahashi, AMOP: Activity of research dedicated to the Minimum of Oxygen in the Eastern Pacific, 25-27, scientific contribution.
- Heimburger A., R. Losno and N.M. Mahowald, Field measured atmospheric deposition fluxes over the Southern Ocean, 35-38, scientific contribution.

- EUR-OCEANS Conference 'Ocean deoxygenation and implications for the marine biogeochemical cycles and ecosystems' 24-26 October 2011, Toulouse, France. Dewitte, B., Garçon, V. and Paulmier, A., 87-88, special report.

- FLATACOA: Atmospheric dust in South Hemisphere, R. Losno and A. Heimburger, 113-114, endorsed project.
- MERMEx (Marine Ecosystems Response in the Mediterranean Experiment), X. Durrieu de Madron, C. Guieu and R. Sempéré, 115-117, endorsed project.
- MedSea project, Gazeau F., 120-122, endorsed project.

SOLAS Mid-Term Strategy Initiative *"Air-sea gas fluxes at Eastern boundary upwelling and Oxygen Minimum Zone (OMZ) systems":* Workshop on "Towards an integrative regional coupling in the Eastern Boundary Upwelling Systems (EBUS), Instituto Geofisico del Peru, Lima, 26- 27 November 2012 , as a Contribution to the SOLAS Mid-Term Strategy Initiative "Air-sea gas fluxes at Eastern Boundary upwelling and Oxygen Minimum Zone systems (http://solas-int.org/mts/research-strategy-5.html) (V. Garçon, Veronique.Garcon@legos.obs-mip.fr). Publications in SOLAS NewsLetters n° 14: A. Paulmier et al., AMOP and EUR-OCEANS.

Dust Attack *(Dust Aging and transport from Africa to the Carribean), Contact: Paola Formenti (paola.formenti@lisa.u-pec.fr), LISA, Paris*: This project, funded by Partner University Fund, aims to improve our knowledge on the evolution of mineral dust properties during atmospheric transport, notably the modification of their fractional solubility in nutrients, as Fe. The strategy is to compare measurements close to African source regions and after few-days of transport in the atmosphere. In this purpose, a field campaign was conducted in Puerto Rico at the Cape San Juan, a noaa/wmo sampling station, in June/July 2012. Measurements of mineral dust composition, size distribution, individual particle shape, morphology and soluble fraction were carried out. Measurements on dust properties were also did in the wet deposited fraction. Five dust events were collected during the field campaign. The collected dust was shown to be issued from major sources in Sahara, but presents very close features. The next step is the comparison of these results with database of physico-chemical properties of mineral dust in the proximity of source regions of African dust impacting the Carribean which has been collected during the AMMA experiment.



The Cape San Juan Sampling site

Dust From Patagonia (contact remi.losno@lisa.u-pec.fr)
The South America and particularly the Argentinean Patagonia is suspected to be a major source of dust for southern hemisphere oceans. A field campaign is involved at Rio Gallegos, Bariloche and Comodoro Rivadavia in order to sample continuously aerosols close to theirs sources and to observe temporal variations of their vertical profile before export of dust to the South Atlantic Ocean and beyond.

MERMeX *(Marine Ecosystems Response in the Mediterranean Experiment)-WP4. (contact: Karine Desboeufs - karine.desboeufs@lisa.u-pec.fr, Marc Mallet - Marc.Mallet@aero.obs-mip.fr, Elvira Pulido-Villena* elvira.pulido@univ-amu.fr*):* The main MERMEx activities relevant to SOLAS are the assessment of gas fluxes (CO2) and acidification and the impacts on ecosystems and biogeochemical cycles, the study of aerosol fluxes at the air-sea interface [coupled with the component ChArMEx of MISTRALS (Chemistry-Aerosol Mediterranean Experiment)] considers both the formation of marine aerosol and the atmospheric deposition of nutrients and the influence of solar radiations on biogeochemical cycles includes the potential effect of aerosol and tropospheric ozone attenuation on marine ecosystems. A full report of the MERMeX-SOLAS activities can be find in the SOLAS endorsed projects reports.

MedSea *Mesocosms experiment (contact Frederic Gazeau –* gazeau@obs-vlfr.fr*)*: MedSeA (EU FP7, started in February 2011, Mediterranean Sea Acidification in a changing climate. A first joint experiment using large pelagic mesocosms took place in Corsica (summer 2012) to assess the effects of ocean acidification on planktonic communities in oligotrophic areas (see article in this issue). Another experiment will take place in the Bay of Villefranche in Feb- March 2013. (see report in SOLAS NEWS issue 14, summer 2012).

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

SOLAS Open Science Conference , 7-10 May, 2012: Parallel discussion session on Earth Observations for SOLAS science, Cle Elum, USA

Integrative regional coupling in the Eastern Boundary Upwelling Systems (EBUS)

Lecture day on “Towards an integrative regional coupling in the Eastern Boundary Upwelling Systems(EBUS), Instituto Geofisico del Peru, Lima, 28 November 2012, 8 lectures for peruvian Master and graduate students, as a Contribution to the SOLAS Mid-Term Strategy Initiative “Air-sea gas fluxes at Eastern Boundary upwelling and Oxygen Minimum Zone systems (http://solas-int.org/mts/research-strategy-5.html) (V. Garçon)

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Bressac M., C. Guieu, D. Doxaran, F. Bourrin, G. Obolensky and JM Grisoni (2012), A mesocosm experiment coupled with optical measurements to observe the fate and sinking of atmospheric particles in clear oligotrophic waters, *Geo-Marine Letters* 32: 153-164

Chami, M., Mallet M., Gentili, B., Quantitative analysis of the influence of dust sea surface forcing on the primary production of the subtropical Atlantic Ocean using a ten-year time series of satellite observations, *JGR-Oceans*, 117, C07008 DOI: 10.1029/2012JC008112, 2012

Coupel, P., H. Y. Jin, Joo M., Horner R., Bouvet H.A., Sicre M-A., Gascard J-C., Chen J-F., V. Garçon, and Ruiz-Pino, D. (2012), Phytoplankton distribution in unusually low sea ice cover over the Pacific Arctic , *Biogeosciences,* 9, 4835-4850.

de Leeuw, G., C. Guieu, A. Arneth, N. Bellouin, L. Bopp , P. Boyd, H. Denier van der Gon, K. Desboeufs, F. Dulac, C. Facchini, B. Gantt, B. Langmann, N. Mahowald, E. Maranon, C. O'Dowd, N. Olgun, E. Pulido-Villena, M. Rinaldi, E. Stephanou, T. Wagener (2013). Ocean-Atmosphere interactions of particles. In: P. Liss and M. Johnson (Editors), *"Ocean-Atmosphere Interactions of Gases and Particles" Publisher: Springer*, Heidelberg, in press.

Garbe, C.S., A. Butz, I. Dadou, B. Dewitte, V. Garçon, S. Illig, A. Paulmier, J. Sudre and H. Yahia (2012), Climatically-Active Gases In The Eastern Boundary Upwelling And Oxygen Minimum Zone (OMZ) Systems, *IEEE International Geoscience and Remote Sensing*, in press.

Garçon, V. C., Bell, T. G., Wallace, D., Arnold S. R., Baker A., Bakker, D. C. E., Bange, H. W., Bates, N. R., Bopp, L., Boutin, J., Boyd, P. W., Bracher, A., Burrows, J. P., Carpenter, L. J., Fennel, K., Font, J., Friedrich, T., Garbe, C. S., Gruber, N., Jaeglé, L., Lana, A., Lee, J. D., de Leeuw, G., Liss, P. S., Miller, L. A., Olgun, N., Olsen, A., Pfeil, B., Quack, B., Read, K. A., Reul, N., Rödenbeck, C., Rohekar, S. S., Saiz-Lopez, A., Saltzman, E. S., Schneising, O., Schuster, U., Séférian, R., Steinhoff, T., Yves Le Traon, P., Wittke, F. (2013) Perspectives and Integration in SOLAS science. In: Liss, P. S. and Johnson, M. T. (Editors), *"Ocean-Atmosphere Interactions of Gases and Particles" Publisher: Springer*, Heidelberg, in press.

Heimburger, A., M. Tharaud, F. Monna, R. Losno, K. Desboeufs and E. Bon Nguyen, (2012) SLRS-5 elemental concentrations of thirty-three uncertified elements deduced from SLRS-5/SLRS-4 ratios, *Geostandards and Geoanalytical Research*, doi: 10.1111/j.1751-908X.2012.00185.

Heimburger, A., R. Losno, S. Triquet, F. Dulac and N. Mahowald, Direct measurements of atmospheric iron, cobalt and aluminium-derived dust deposition at Kerguelen Islands, *Global Biogeochemical Cycles*, **26-4**, GB4016, doi:10.1029/2012GB004301.

Kalvelage, T., Lavik, G., Lam, P., Contreras, S., Arteaga, L., Löscher, C., Oschlies, A., Paulmier, A., Stramma, L., and M.M.M. Kuypers, 2013, Organic matter export regulates nitrogen cycling in the South Pacific oxygen minimum zone, *Nature Geoscience* (Accepted)

Law, C.S., Brévière, E., de Leeuw, G., Guieu, C., Garçon ,V.C., Kieber, D.J., Kontradowitz, S., Paulmier, A., Quinn, P.K., Saltzman,E., Stefels, J., and Roland von Glasow, 2012, Evolving Research Directions in Surface Ocean-Lower Atmosphere (SOLAS) Science, *Environmental Chemistry*, in press.

Sudre, J., Maes,C. ,and Garçon,V., 2012, On the global estimates of geostrophic and Ekman surface currents, *Limnology and Oceanography: Fluids and Environments*, in press.

Wallhead,P., Garçon,V., and Martin, A., 2012, Efficient upscaling of ocean biogoechemistry, *Ocean Modelling*, http://dx.doi.org/10.1016/j.ocemod.2012.12.002, in press.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Close international collaborations within AMOP : Peru, Germany, France, Ireland, Spain, China, Denmark and Mexico.

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.

Research program "Dust from Patagonia" is conducted with argentinean laboratory CEILAP (Buenos AIres, E. Quel) part of CNRS UMI 3351 IFAECI (Buenos AIres). This research team is involved in atmospheric optics and LIDAR developments. A LIDAR array covering Patagonia is about to be set up for a dust vertical profile survey over this area. French laboratory LISA is in charge of the determination of aerosol chemical properties determination.

6. Goals, priorities and plans for future activities/events

Plan for future activities

DONUT *'Dependance of dissolved organic matter cycling on atmospheric inputs of nutrients' (Elvira Pulido-Villena)* The main goal of DONUT is to assess how and to which extent the response of heterotrophic prokaryotes to atmospheric inputs of nutrients shape the DOM pool and modify its bioavailability. There are recent evidences of the preferential uptake of dust-derived nutrients by heterotrophic prokaryotes resulting in heterotrophic processes being more stimulated by dust pulses compared to autotrophic processes. How can we go further on our understanding of the consequences of these results on C cycling? The stimulation of bacterial respiration by dust pulses during the stratification period would decrease the amount of carbon susceptible to be exported to depth through winter mixing. Nevertheless, the efficiency of the Microbial Carbon Pump depends not only on the amount of carbon in the dissolved pool but also on the characteristics of the DOM which may modify its residence time in the water column. How and to what extent dust pulses can, through the stimulation of Hprok activity, shape the surface DOM pool remains totally unexplored and constitute one bottleneck to our advances to understand the role of atmospheric deposition on marine C cycle. The DONUT strategy is based on the experimental assessment of the transformation of DOM during bacterial degradation under simulated dust inputs.

AMOP *for "Research Activities dedicated to the Oxygen Minimum in the East Pacific*"(Aurélien Paulmier aurelien.paulmier@gmail.com): Deployment of multidisciplinary mooring planned for January 5, 2013 from R/V Meteor off Callao (12°S, 77°40'W) for a 3 years period, and servicing every 3 months. Oceanographic cruise planned for 2013, early 2014 in the OMZ off Peru.

CHIPIE*: Comportement des éléments d'intérêt biogéocHImiques et du carbone Particulaire aux Interfaces atmosphère-océan et continent-océan dans un contexte d'évolution des conditions Environnementales (Cécile Guieu,* guieu@obs-vlfr.fr*).* The objective of this project is to study the impact of climate and environment change (temperature, acidification) on the behavior of biogeochemical elements and particulate carbon at the atmosphere-ocean interface. The experimental approach ('clean minicosm in abiotic conditions') initiated at the end of the DUNE project (see Bressac, 2012) will be completed by temperature and turbulence controls and an integrated sampling system will be developed. Such

developments are currently done in order to perform three experiments in 2013. A PhD started in fall 2012 (J. Louis, LOV) and 3 experiments are scheduled in 2013. (funding University Paris VI).

PEAcEtIME *"ProcEss studies at the Air-sEa Interface: a Mediterranean Experiment" (Cécile Guieu, Karine Desboeufs)*. A working group is currently working on a proposal for a field cruise planned in 2015 (this will be a joint experiment between MERMEX and ChArMEx). This project was presented at the 2012 OSC to call for international collaboration on that "SOLAS cruise" in the Mediterranean; it will be submitted for funding at the autumn 2013.

7. Other comments

SOLAS Germany

compiled by Hermann Bange (GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, Germany)

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

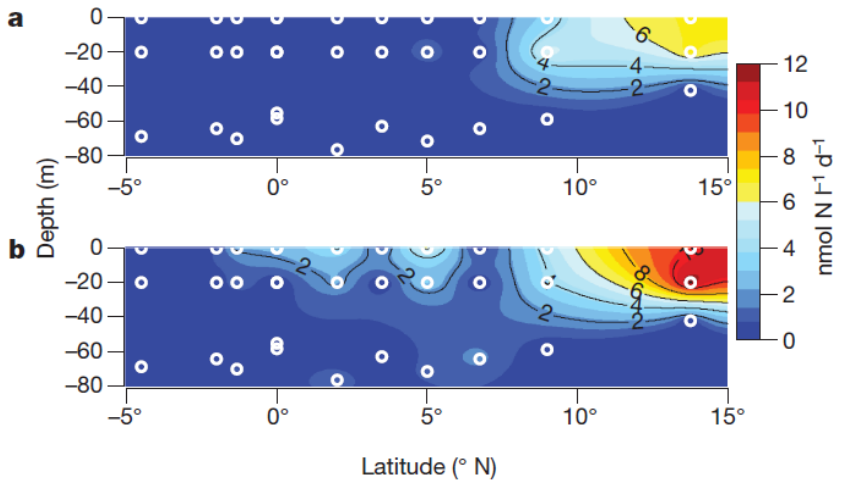
1. Scientific highlights

Doubling of marine dinitrogen-fixation rates based on direct measurements

Tobias Großkopf1, Wiebke Mohr1†, Tina Baustian1, Harald Schunck1, Diana Gill1, Marcel M. M. Kuypers2, Gaute Lavik2, Ruth A. Schmitz3, Douglas W. R.Wallace4 & Julie LaRoche1†

1 Helmholtz Centre for Ocean Research Kiel (GEOMAR), Düsternbrooker Weg 20, 24105 Kiel, Germany.
2 Max Planck Institute for Marine Microbiology, Celsiusstraße 1, 28359 Bremen, Germany.
3 Institute for General Microbiology, Christian-Albrechts University Kiel, Am Botanischen Garten 1–9, 24118 Kiel, Germany.
4 Oceanography Department, Dalhousie University, 1355 Oxford Street, PO Box 15000, Halifax, Nova Scotia, B3H 4R2, Canada.
† Present addresses: Harvard University, Department of Earth and Planetary Sciences, 20 Oxford Street, Cambridge, Massachusetts 02138, USA (W.M.); Department of Biology, Dalhousie University, 1355 Oxford Street, PO Box 1500, Halifax, Nova Scotia B3H 4R2, Canada (J.L.R.).

Biological dinitrogen fixation provides the largest input of nitrogen to the oceans, therefore exerting important control on the ocean's nitrogen inventory and primary productivity. Nitrogen-isotope data from ocean sediments suggest that the marine-nitrogen inventory has been balanced for the past 3,000 years. Producing a balanced marine-nitrogen budget based on direct measurements has proved difficult, however, with nitrogen loss exceeding the gain from dinitrogen fixation by approximately 200 Tg N yr -1. Here we present data from the Atlantic Ocean and show that the most widely used method of measuring oceanic N2-fixation rates underestimates the contribution of N2-fixing microorganisms (diazotrophs) relative to a newly developed method. Using molecular techniques to quantify the abundance of specific clades of diazotrophs in parallel with rates of 15N2 incorporation into particulate organic matter, we suggest that the difference between N2-fixation rates measured with the established method and those measured with the new method can be related to the composition of the diazotrophic community. Our data show that in areas dominated by Trichodesmium, the established method underestimatesN2-fixation rates by an average of 62%. We also find that the newly developed method yields N2-fixation rates more than six times higher than those from the established method when unicellular, symbiotic cyanobacteria and c-proteobacteria dominate the diazotrophic community. On the basis of average areal rates measured over the Atlantic Ocean, we calculated basin-wide N2-fixation rates of 14 +/- 1 Tg N yr-1 and 24 +/- 1 Tg N yr-1 for the established and new methods, respectively. If our findings can be extrapolated to other ocean basins, this suggests that the global marine N2-fixation rate derived from direct measurements may increase from 103 +/- 8Tg N yr-1 to 177 +/- 8 Tg N yr-1, and that the contribution of N2 fixers other than Trichodesmium is much more significant than was previously thought.



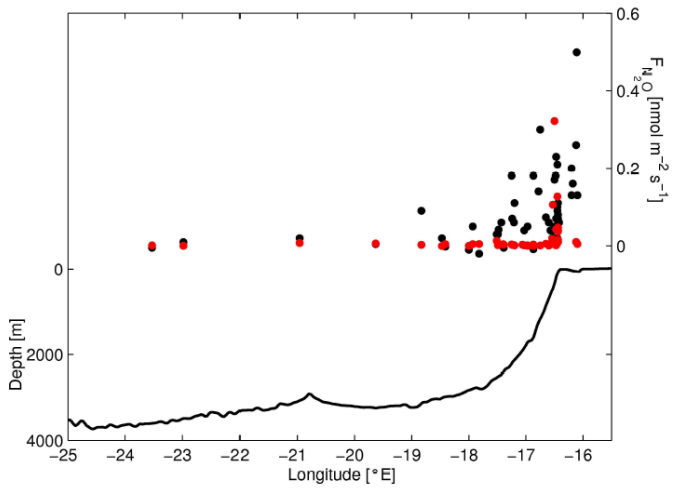
Mixed-layer inventory of N_2-fixation rates in the tropical and equatorial Atlantic Ocean. a, N_2-fixation rates measured with the bubble-addition method. b, N_2-fixation rates measured with the dissolution method.

Sea-to-air and diapycnal nitrous oxide fluxes in the eastern tropical North Atlantic Ocean

A. Kock[1], J. Schafstall[2], M. Dengler[2], P. Brandt[2], and H. W. Bange[1]

[1]Forschungsbereich Marine Biogeochemie, Helmholtz-Zentrum für Ozeanforschung Kiel (GEOMAR), Germany
[2]Forschungsbereich Ozeanzirkulation und Klimadynamik, Helmholtz-Zentrum für Ozeanforschung Kiel (GEOMAR), Germany

Sea-to-air and diapycnal fluxes of nitrous oxide (N_2O) into the mixed layer were determined during three cruises to the upwelling region off Mauritania. Sea-to-air fluxes as well as diapycnal fluxes were elevated close to the shelf break, but elevated sea-to-air fluxes reached further offshore as a result of the offshore transport of upwelled water masses. To calculate a mixed layer budget for N_2O we compared the regionally averaged sea-to-air and diapycnal fluxes and estimated the potential contribution of other processes, such as vertical advection and biological N_2O production in the mixed layer. Using common parameterizations for the gas transfer velocity, the comparison of the average sea-toair and diapycnal N_2O fluxes indicated that the mean sea-to-air flux is about three to four times larger than the diapycnal flux. Neither vertical and horizontal advection nor biological production were found sufficient to close the mixed layer budget. Instead, the sea-to-air flux, calculated using a parameterization that takes into account the attenuating effect of surfactants on gas exchange, is in the same range as the diapycnal flux. From our observations we conclude that common parameterizations for the gas transfer velocity likely overestimate the air-sea gas exchange within highly productive upwelling zones.



Diapycnal N2O (red dots, right axis) and sea-to-air fluxes (black dots, right axis) projected to 18_ N and bottom depth along 18_ N (solid line, left axis). Fluxes from stations to the north and south of 18_ N were projected onto 18_ N according to their distance from the 400m isobath.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

* Internatl. SOLAS/SOPRAN Workshop on N2 Fixation, GEOMAR, Kiel, 6-8 February 2012

* SOPRAN Annual Meeting 2012, GEOMAR, Kiel, 20/21 March 2012

* SOPRAN Mesocosm experiment at the research station Tvärminne (Finland), June-July 2012 (PI Ulf Riebesell, GEOMAR).

* SOPRAN cruise M91 with R/V Meteor to the upwelling off Peru, 01 – 26 December 2012 (PI Hermann Bange, GEOMAR, Kiel)

* Internatl. SOLAS/SOPRAN Workshop on 'Marine gels and their impact on atmospheric aerosol and cloud', GEOMAR, Kiel, 11-13 December 2012

* SOLAS/IGAC funded expert workshop 'HitT – Climate impact of seasalt-derived Cl atoms', GEOMAR, Kiel, 17-19 Dec 2012.

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

* Several newspaper articles, TV features, etc. about SOPRAN activities have been produced.

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Baustian, T., M. Graco, H. W. Bange, G. Flores, J. Ledesma, M. Sarmiento, V. Leon, C. Robles, and O. Moron (2012), Nitrous oxide time series measurements off Peru - A collaboration between SFB754 and IMARPE, Annual Report 2011 GEOMAR *Rep.#2*, 14 pp, GEOMAR, Kiel.

Bittig, H. C., B. Fiedler, T. Steinhoff, and A. Körtzinger (2012), A novel electrochemical calibration setup for oxygen sensors and its use for the stability assessment of Aanderaa optodes, *Limnol. Oceanogr. Methods*, *10*, 921-933.

Croot, P. L., and M. I. Heller (2012), The importance of kinetics and redox in the biogeochemical cycling of iron in the surface ocean, *Frontiers in Microbiology*, *3:219*.

Freing, A., D. W. R. Wallace, and H. W. Bange (2012), Global oceanic production of nitrous oxide, *Philosophical Transaction of the Royal Society B*, *367*, 1245-1255.

Großkopf, T., W. Mohr, T. Baustian, H. Schunck, D. Gill, M. M. M. Kuypers, G. Lavik, R. A. Schmitz, D. W. R. Wallace, and J. LaRoche (2012), Closing the gap – doubling global rates of marine pelagic N2 fixation, *Nature*, *488*, 361-364.

Kock, A., J. Schafstall, P. Brandt, M. Dengler, and H. W. Bange (2012), Sea-to-air and diapycnal nitrous oxide fluxes in the eastern tropical North Atlantic Ocean, *Biogeosciences*, *9*, 957-964.

Löscher, C. R., A. Kock, M. Könneke, J. LaRoche, H. W. Bange, and R. A. Schmitz (2012), Production of oceanic nitrous oxide by ammonia-oxidizing archaea, *Biogeosciences*, *9*, 2419-2429.

Mouriño-Carballido, B., M. Pahlow, and A. Oschlies (2012), High sensitivity of ultra-oligotrophic marine ecosystems to the atmosphere nitrogen deposition, *Geophysical Research Letters*, *39*, L05601, doi:10.1029/2011GL050606.

Ryabenko, E., A. Kock, H. W. Bange, M. A. Altabet, and D. W. R. Wallace (2012), Contrasting biogeochemistry of nitrogen in the Atlantic and Pacific oxygen minimum zones, *Biogeosciences*, *9*, 203-215.

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Zamora, L. M., A. Oschlies, H. W. Bange, K. B. Huebert, J. D. Craig, A. Kock, and C. R. Löscher (2012), Nitrous oxide dynamics in low oxygen regions of the Pacific: Insights from the MEMENTO database, *Biogeosciences*, *9*, 5007–5022.

Zindler, C., I. Peeken, C. A. Marandino, and H. W. Bange (2012), Environmental control on the variability of DMS and DMSP in the Mauritanian upwelling region, *Biogeosciences*, *9*, 1041-1051.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Plenty

6. Goals, priorities and plans for future activities/events
* SOPRAN (Surface Ocean Processes in the Anthropocene, www.sopran.pangaea.de) will start its third (synthesis) phase by 01 Feb 2013 * Planning and construction of the Ocean Science Center in Mindelo, Cape Verde Island * SOPRAN III Mesocosm Experiment off Gran Canaria (Spring 2014) * International SOLAS Open Science Conference in Kiel, 14-18 Sept 2015
7. Other comments

SOLAS India

compiled by Dileep Kumar

Reporting Period is January 2012 – December 2012

1. Scientific highlights

A. High DMS production along the western Indian continental shelf

The western Indian continental shelf experiences seasonal sub-oxic to anoxic conditions during the fag end of the southwest monsoon and is a hot spot for the production of climatically important gases. Being one of the highly productive zones in the World's Oceans this region produces above average concentrations of dimethylsulphide (DMS). During a 3-day time series observation at a station (of the Candolim time series, CaTS) off the coast of Goa very high concentrations of DMS (442 nM) were observed in bottom waters associated with the seasonal anoxia (12 µM of H_2S). Interestingly total dimethylsulphoniopropionate and dimethylsulphoxide could not account for the observed DMS. Further studies are being done to probe the role of sediments in the production of the observed high DMS concentration.

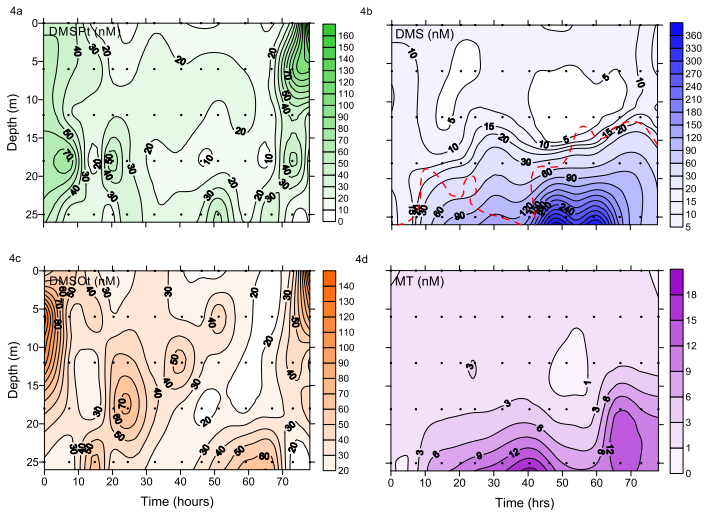


Figure A1: Contour plots showing vertical distribution of total dimethylsulphoniopropionate ($DMSP_t$), dimethylsulphide (DMS), dimethylsulphoxide ($DMSO_t$) and methanethiol (MT). The superimposed red dotted line in figure b is the 4 µM contour of dissolved oxygen which is considered the upper limit of suboxia.

A1. Shenoy, D.M., Sujith, K.B., Gauns, M.U., Patil, S., Sarkar, A., Naik, H., Narvekar, P.V. and Naqvi, S.W.A. 2012. Production of dimethylsulphide during the seasonal anoxia off Goa. Biogeochemistry, 110 (1-3), 47-55.

B. Carbon dioxide emissions from Indian monsoonal estuaries

Studies in 27 Indian estuaries of variable discharges (~28 to 3500 $m^3 s^{-1}$) revealed a variation of pCO_2 between ~300 and 15210 µatm in those located along the east coast of India and between 1840 and 18492 µatm along the west coast of India (Fig. 1). Close to or >10,000 µatm of pCO_2 were noticed in 6 estuaries, four of them (Haldia, Mahanadi, Godavari, Ponniyaar estuaries) in the east. The mean pCO_2 values of estuaries showed positive relation with rates of discharge (r^2=0.71;

p<0.001), except in Tapti which is a highly polluted estuary, suggesting that the magnitude of discharge has significant impact on the CO_2 abundances. Higher particulate organic carbon (POC) concentrations (339±60 μM) were found in estuaries receiving >1000 m^3 s^{-1} of discharge than (152±40 μM) lower discharge (<300 m^3 s^{-1}) estuaries suggesting that increased inputs of POC led to enhanced bacterial degradation. The CO_2 efflux from the Indian estuaries ranged between -0.0002 and 0.362 molC m^{-2} d^{-1} during wet period. Higher fluxes were noticed from the Baitarini, Godavari, Penniyaar, Tapti, Netravathi and Mandovi estuaries while low fluxes were (<0.02 molC m^{-2} d^{-1}) found in other estuaries. Such high fluxes in these estuaries were driven by the combination of high pCO_2 and winds. The mean flux from the Indian estuaries was 0.027 molC m^{-2} d^{-1} during wet period. The pCO_2 levels were <1000 μatm during the dry period. Low pCO_2 levels were due to the occurrence of phytoplankton blooms, which were supported by increased flushing time (long residence time of water column) and decreased suspended matter (increase in light penetration depth). India houses 14 major, 44 medium and 162 minor estuaries and the total surface area of Indian estuaries amounts to 27000 km^2 calculated from the mouth of the estuary to the region where tidal oscillations are almost negligible. The emission of CO_2 from the Indian estuaries thus amounts to 1.60 TgC during wet period and to ~0.32 TgC during dry period. The annual flux from the Indian estuaries to the atmosphere totals to 1.92 TgC y^{-1}.

The mean flux of CO_2 from the Indian estuaries (0.027 molC m^{-2} d^{-1}) is an order of magnitude less than that found in the European estuaries (mean flux of 0.17 molC m^{-2} d^{-1}). Our results suggest that Indian estuaries contribute negligible percentage to the anthropogenic CO_2 emission than hitherto hypothesized, and that the same may be applicable in general to the tropical belt.

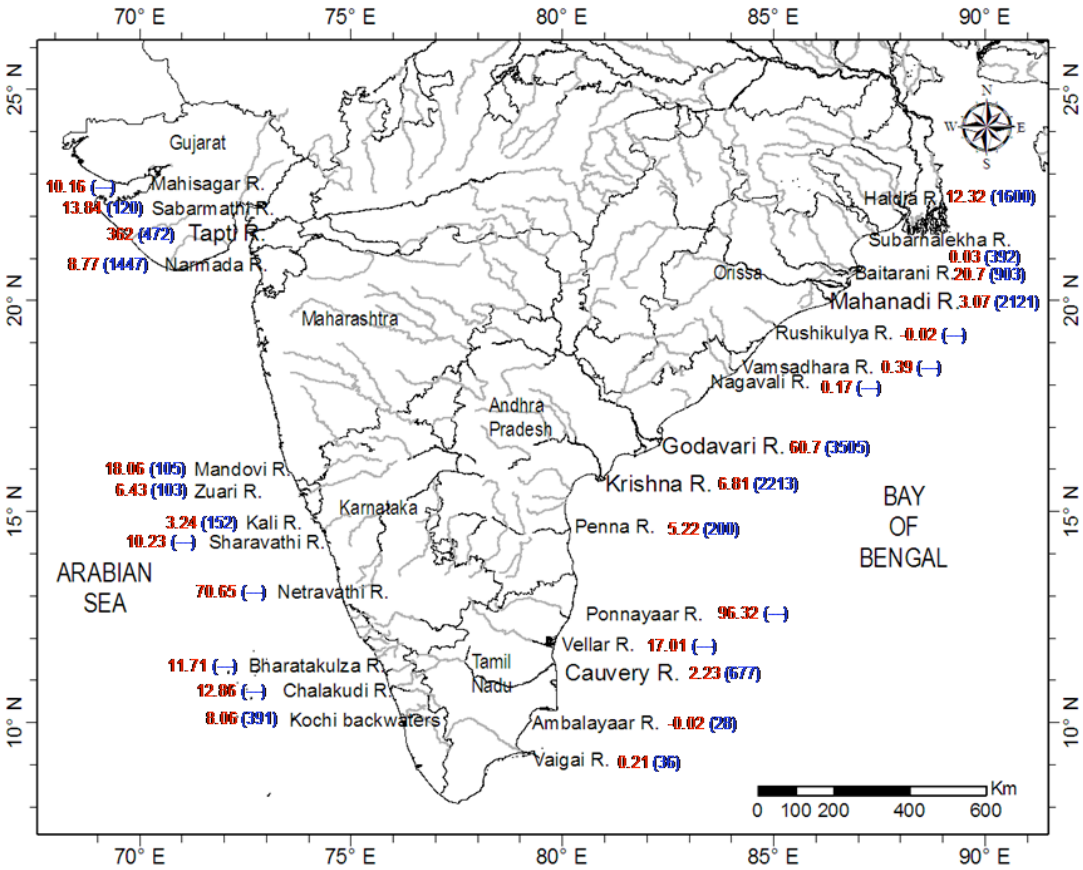


Figure B1: Map shows rivers studied and major rivers listed in larger font size. The main course of river is shown as dark line and for tributaries in grey color. The numbers in red and blue colours indicate CO_2 flux (mmol C m^{-2} d^{-1}) and annual mean river discharges (m^3 s^{-1}).

B1. V. V. S. S. Sarma, R. Viswanadham, G. D. Rao, V. R. Prasad, B. S. K. Kumar, S. A. Naidu, N. A. Kumar, D. B. Rao, T. Sridevi, M. S. Krishna, N. P. C. Reddy, Y. Sadhuram and T. V. R. Murty (2012) Carbon dioxide emissions from Indian monsoonal estuaries. Geophys. Res. Lett., VOL. 39, L03602, doi:10.1029/2011GL050709.

C. Air-sea deposition of P_{Inorg} and anthropogenic trace metals to the Bay of Bengal

In the present day-scenario of growing anthropogenic loading of atmosphere, aerial deposition of nutrients to surface ocean can have significant impact on the biogeochemistry of surface waters. On the other hand, atmospheric deposition of anthropogenic trace metals may adversely influence marine primary production in waters located downwind of pollution centres. Our systematic study (Srinivas and Sarin, 2012a) on the spatio-temporal variability of inorganic phosphorous (P_{Inorg} = PO_4^{3-}) in the marine atmospheric boundary layer (MABL) of the Bay of Bengal, conducted during March-April 2006 and January 2009, suggests its dominant

occurrence (0.3 – 2.8 nmol m^{-3}) in coarse mode ($D_a \geq 2.5\mu m$) compared to (0.1 – 0.8 nmol m^{-3}) in $PM_{2.5}$ (particles of size < 2.5 µm). The data provided evidence for the chemical processing of mineral dust by acidic species that led to the mobilization of P_{Inorg} during the long-range atmospheric transport. Significantly high P_{Inorg}/nss-Ca^{2+} ratios over the Bay of Bengal suggest dominant contribution from anthropogenic sources (fertilizers and biomass burning emissions). In addition, high enrichment factors of Pb and Cd (EF_{Pb}: ~ 225; EF_{Cd}: ~1165) further substantiate the dominance of anthropogenic sources. In contrast, P_{Inorg} concentration over the Arabian Sea is about 4 to 5 times lower and is primarily associated with the mineral dust from Desert regions. The dry-deposition flux of P_{Inorg} to the Bay of Bengal varies by one order of magnitude (0.5 - 5.0 µmol P m^{-2} d^{-1}; Av: 0.02 Tg P yr^{-1}). Based on P/Al ratio in mineral dust and measured P_{Inorg} and Al concentrations, we have estimated relative contribution of P_{Dust} and P_{Anth} over the Bay of Bengal and Arabian Sea (Fig. 1).

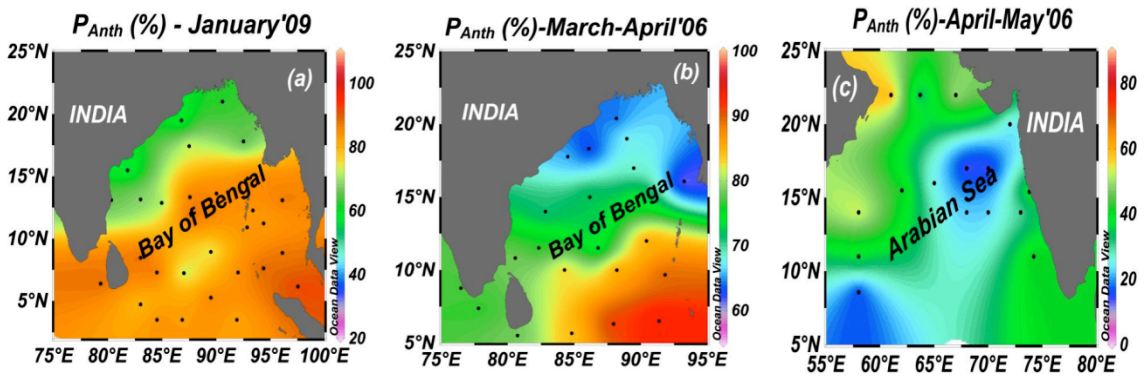


Figure C1 Spatio-temporal distribution of fractional contribution of anthropogenic water-soluble phosphorous to the P_{Inorg} over the Bay of Bengal and Arabian Sea during the continental outflow.

A notable seasonal shift in the wind regimes and source region of mineral dust, during the continental outflow (Jan-April), is evident based on Ca/Al and Fe/Al ratios in aerosols. It is suggested that alluvial soils from the Indo-Gangetic Plain is a dominant source of mineral dust to the Bay of Bengal; whereas long-range transport from desert regions (Arabian and Thar Deserts) could contribute significantly during the Spring-intermonsoon (March-May). The deposition of mineral dust (0.3 - 6 g m^{-2} yr^{-1}) to the Bay of Bengal is consistent with model results reported in the literature (Srinivas and Sarin, 2012b).

C1. Srinivas, B & Sarin, M, 2012a, 'Atmospheric pathways of phosphorous to the Bay of Bengal: contribution from anthropogenic sources and mineral dust', Tellus B, vol. 64, 17174, DOI: 10.3402/tellusb.v64i0.17174.

C2. Srinivas, B & Sarin, M, 2012b, 'Atmospheric dry deposition of mineral dust and anthropogenic trace metals to the Bay of Bengal', Journal of Marine Systems, vol. 68, *article in press*, DOI: 10.1016/j.jmarsys.2012.11.004.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Under the aegis of Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER) and funding support from the Ministry of Earth Sciences (MoES), the CSIR-NIO has initiated Time series observation stations at CaTS (Candolim Time Series) site since 2010 in coastal waters of off-Goa (central west coast of India) and more recently one station each in the open waters of the Arabian Sea (ASTS, 17°N 68°E) and the Bay of Bengal (BoBTS, 18°N, 89°E). The observations cover a wide range of biogeochemical parameters including radiatively important gases. Both ASTS and BoBTS are also augmented with sediment trap moorings. During 2012, three cruises have been conducted to these time series stations. In addition, coastal time series site is monitored regularly on a monthly basis except during the summer monsoon months (June to August) when the sea gets rough.

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

One of the objectives of SIBER-India programme is to impart comprehensive hands-on training to SIBER- students coming from various institutes and universities of India on tools and techniques in biogeochemical studies. A training course was organized on 'Biogeochemistry in the framework of Earth System Science' at the National Institute of Oceanography- Goa, from 1st to 10th February 2012. In 20 lectures spread over 10 days the training course covered modern methods and technologies in marine data collection, processing, methodology and principles for creation of databases.

4. Top 10 publications in 2012 (Reports, <u>ACCEPTED</u> articles, models, datasets, products, website etc)

1. *Shenoy, D.M., Sujith, K.B., Gauns, M.U., Patil, S., Sarkar, A., Naik, H., Narvekar, P.V. and Naqvi, S.W.A. 2012. Production of dimethylsulphide during the seasonal anoxia off Goa. Biogeochemistry, 110 (1-3), 47-55.*

2. *Hatton, A.C., Shenoy, D.M., Hart, M.C., Mogg, A. and Green, D.H. Metabolism of DMSP, DMS and DMSO by the cultivable bacterial community associated with the DMSP-producing dinoflagellate Scrippsiella trochoidea. Biogeochemistry 110 (1-3), 131 – 146.*

3. *Kurian, S., Roy, R., Repeta, D.J., Gauns, M., Shenoy, D.M., Suresh, T.; Sarkar, A., Narvenkar, G., Johnson, C.G., Naqvi, S.W.A. Seasonal occurrence of anoxygenic photosynthesis in Tillari and Selaulim reservoirs, Western India. 2012 Biogeosciences, 9, 2485 – 2495.*

4. *V. V. S. S. Sarma, R. Viswanadham, G. D. Rao, V. R. Prasad, B. S. K. Kumar, S. A. Naidu, N. A. Kumar, D. B. Rao, T. Sridevi, M. S. Krishna, N. P. C. Reddy, Y. Sadhuram and T. V. R. Murty (2012) Carbon dioxide emissions from Indian monsoonal estuaries. Geophys. Res. Lett., VOL. 39, L03602, doi:10.1029/2011GL050709.*

5. *Srinivas, B & Sarin, M, 2012a, 'Atmospheric pathways of phosphorous to the Bay of Bengal: contribution from anthropogenic sources and mineral dust', Tellus*

B, vol. 64, 17174, DOI: 10.3402/tellusb.v64i0.17174.

6. *Srinivas, B & Sarin, M, 2012b, 'Atmospheric dry deposition of mineral dust and anthropogenic trace metals to the Bay of Bengal', Journal of Marine Systems, vol. 68, article in press, DOI: 10.1016/j.jmarsys.2012.11.004.*

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Dr. SWA Naqvi was awarded Marie-Curie Actions - International Incoming Fellowships funded by the European Commission for the project titled 'Aquatic N in India- Fate of anthropogenic nitrogen in aquatic systems of India". Under this project, he had collaborated with Prof. Marcel Kuypers, Max-Plank Institute for Marine Microbiology, Bremen, Germany during 2008-2011. The overarching goal of this study was to understand the fate of the huge quantity of anthropogenic N introduced to various terrestrial aquatic systems in India. The focus of the interdisciplinary research was on anaerobic processes of denitrification and anammox including a quantitative assessment of their relative importance through rate measurements and understanding the mechanisms of transformations through isotopic analyses. Presently, freshwater reservoirs of India are being studied under the return phase of Marie-Curie Fellowship (2012-13).

6. Goals, priorities and plans for future activities/events

Acidification, eutrophication and deoxygenation of water are the major threats faced today by aquatic ecosystems both on land and in the sea. Under India's 12th five year plan the CSIR has funded a five year network project "Indian Aquatic Ecosystems: Impact of Deoxygenation, Eutrophication and Acidification (INDIAS IDEA)" with National Institute of Oceanography as the nodal agency.

7. Other comments

Dr. VVSS Sarma was accorded Hidaka outstanding publication award by Japan Oceanographic Society (JOS) for the year 2012, for his publication [V. V. S. S. Sarma, Osamu Abe, Makio Honda and Toshiro Saino (2010) Estimating of Gas Transfer Velocity Using Triple Isotopes of Dissolved Oxygen. *Journal of Oceanography*, Vol. 66, pp. 505 to 512]. The award consists medal, certificate and prize money (1,00,000 JPY). The award was presented during the JOS General Assembly at Tsukuba on 28th May 2012. The award was named after Professor Koji Hidaka, the first director of Ocean Research Institute/University of Tokyo, and the founder of Japan Marine Science Foundation.

SOLAS Ireland

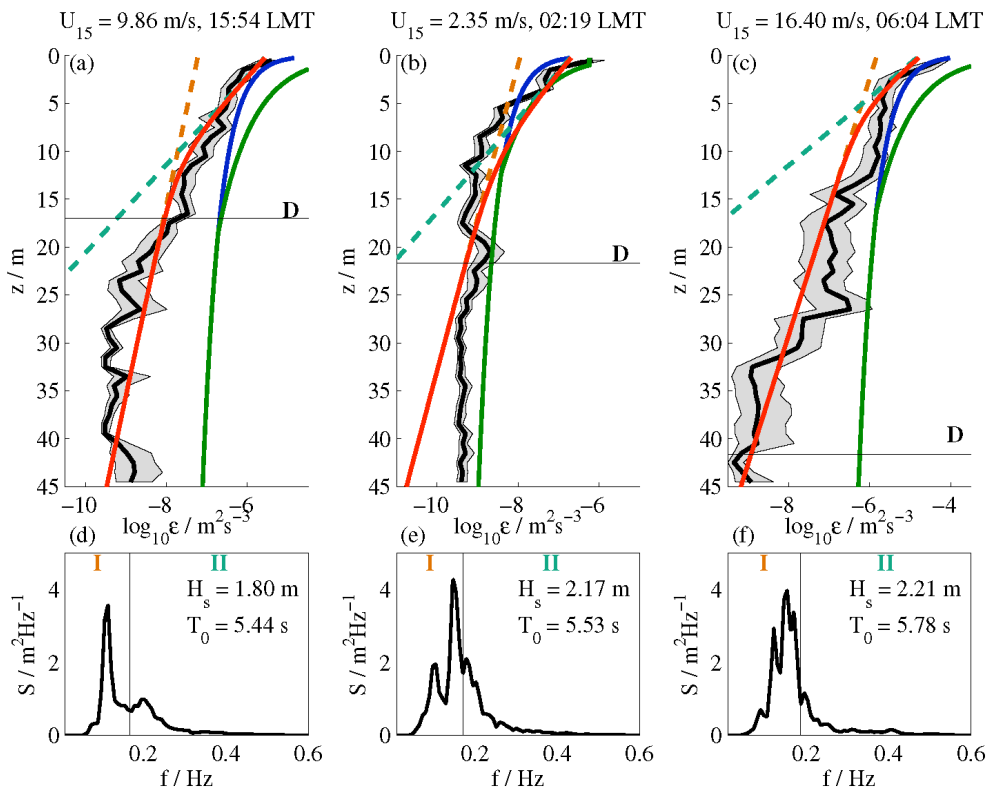
compiled by Brian Ward

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

1. Wave-turbulence scaling in the ocean mixed layer Sutherland, G., Christensen, K. H., and Ward, B.: Ocean Sci. Discuss., 9, 3761-3793, doi:10.5194/osd-9-3761-2012, 2012

Turbulence in the upper ocean contributes to air-sea gas exchange through erosion of the mass boundary layer immediately adjacent to the air-sea interface. During the Knorr11 gas exchange cruise, microstructure measurements were collected using the Air-Sea Interaction Profiler (ASIP) autonomous freely rising profiler under a variety of different atmospheric forcing and sea states in the open ocean. Here, profiles of turbulent kinetic energy dissipation rate, ε, are compared with various proposed scalings. In the oceanic boundary layer, the depth dependence of ε was found to be consistent with that expected for a purely shear-driven wall layer. This is in contrast with many recent studies which suggest higher rates of turbulent kinetic energy dissipation in the near surface of the ocean. Verification of these models will allow us to parameterise the gas exchange coefficient with estimates of dissipation.



Profiles of turbulent kinetic energy dissipation **(a–c)** for a particular wave spectra **(d–f)** . Five successive profiles of ε taken over one hour are averaged vertically into 1m bins with the solid black line showing the mean and the grey shaded region the 95% confidence intervals determined using a bootstrap method. The

depth dependence of ε is compared with Eq. (5) (blue line), scaling of Terray et al. (1996) (green line), and the wave scaling of Huang and Qiao (2010) (red line) using portions of the wave spectra along with Eq. (6) (dashed lines with colours matching the corresponding spectral region marked by I, and II in **(d–f)**). The red line denotes the sum of the three wave scaling turbulence profiles. The values of Hs and T0 for each wave spectra are computed for the entire spectra. The mixed layer depth is the black horizontal line denoted by D.

2. Observed variation in the decay time of oceanic whitecap foam, Callaghan, A. H., G. B. Deane, M. D. Stokes, and B. Ward (2012), J. Geophys. Res., 117, C09015, doi:10.1029/2012JC008147

Whitecap foam decay times for 552 individual breaking waves determined from digital images of the sea surface are reported. The images had sub-centimeter pixel resolution and were acquired at frame rates between 3 and 6 frames per second at the Martha's Vineyard Coastal Observatory over a 10-day period in 2008, subdivided into 4 observation periods. Whitecap foam decay times for individual events varied between 0.2 s to 10.4 s across the entire data set. A systematic positive correlation between whitecap foam decay time and maximum whitecap foam patch area was found for each observation period. For a given whitecap size within each observation period, the decay times varied between a factor of 2 and 5, with the largest variation occurring during unsteady environmental forcing conditions. Within observation periods, bin-averaged decay times varied by up to a factor of 4 across the range of foam patch areas. Between observation periods, the effective whitecap foam decay time, which we define as the area-weighted mean decay time, varied by a factor of 3.4 between 1.4 s and 4.8 s. We found a weak correlation between decay times and individual event-averaged breaking wave speeds. The variation in the active breaking area across all 4 observation periods was small, indicating relatively uniform surface whitecap area generating potential. We speculate that the variation in the foam decay times may be due to (i) the effect of surfactants on bubble and foam stability, and (ii) differences between bubble plume characteristics caused by a variation in breaking wave type.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

- Brian Ward participated in the Salinity Processes in the Upper Ocean Regional Study (SPURS) workshop held in Seattle in January 2012. One of the objectives of the SPURS project is to study the air-sea fluxes of freswater.
- The Airsea group (NUIG) participated in the Surface Ocean Aerosol Production (SOAP) study with SOLAS colleagues from NIWA in New Zealand with a travel grant from Science Foundation Ireland. Direct measurements of air-sea CO2 fluxes were made in collaboration with SUNY, Albany.
- Brian Ward (NUIG) chaired a session at Ocean Sciences ("Upper Ocean Turbulence and Its Impact on Air-Sea Fluxes") in Salt Lake City in February 2012.
- The 1st annual meeting of the FP7 Carbochange project was hosted by Brian Ward at NUIG in March 2012. In attendance was about 80 scientists from the Carbochange consortium.
- Two students from the Airsea group (NUIG) presented posters at the SOLAS Open Science Conference in May 2012.
- In August 2012 the AirSea group at NUIG (Brian Ward) participated in the Sub Tropical Atlantic Surface Salinity Experiment (STRASSE) cruise in a collaboration with the LOCEAN Laboratory in Paris. The objectives of this experiment was to study the processes controlling the North Atlantic Salinity Maximum. We deployed the ASIP profiler and a complete underway carbon system (pCO2, DIC, pH, and alkalinity).
- In November 2012, Peter Croot (NUIG) participated in the M90 research expedition in the Eastern Tropical South Pacific (ETSP), which focused on the oxygen minimum zone along 85 50 W. The focus of this work was on the distribution and speciation of redox sensitive trace elements in this region, particularly with regard to dust inputs (e.g. Ti, Mn and Fe) and to oxygen control of redox cycles (e.g. Iodine and H2O2). Data for picoplankton (i.e. Bacteria, *Prochlorococcus* and *Synechococcus*) abundance were also obtained at each station using a desktop flow cytometer (Accuri C6). Coloured dissolved organic matter (CDOM) absorbance and 3D fluorescence was also measured throughout the transect using a Horiba Aqualog. This work was performed in cooperation with German, French and

Peruvian colleagues and is a contribution to SOLAS work on Eastern Boundary Upwelling Systems (EBUS).

- In November 2012 Brian Ward hosted a workshop in Florence Italy (during sabbatical there) for the Oilwave Project in collaboration with Norwegian Meteorological Institute. The objectives of this project are to study the interaction of turbulence and waves towards the improvement in oil drift modelling.
- The Airsea group at NUIG participated in the workshop "Towards an integrative regional coupling in the EBUS" in IGP, Lima, Peru, on November 26-27, 2012

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

- In September 2012, the Airsea group participated in the Sea2Sky public outreach event in Galway as part of the Marie Curie Researcher Nights event across Europe.
- Sebastian Landwehr (PhD student at NUIG) spent 5 months on a short-term travel fellowship (STTF) to SUNY Albany with funds from Science Foundation Ireland (SFI) to enhance expertise in eddy correlation flux measurements.
- Phip Bresnahan (PhD student Scripps Institute of Oceanography) spent 4 months at NUIG on a STTF with funds from SFI. The objectives were to test our new micro-rosette instrument for ocean carbon measurements.

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Sutherland, G., Christensen, K. H., and Ward, B.: Wave-turbulence scaling in the ocean mixed layer, Ocean Sci. Discuss., 9, 3761-3793, doi:10.5194/osd-9-3761-2012, 2012

Scanlon, B., Wick, G. A., and Ward, B.: Near-surface diurnal warming simulations: validation with high resolution profile measurements, Ocean Sci. Discuss., 9, 3851-3878, doi:10.5194/osd-9-3851-2012, 2012.

A. H. Callaghan, G. B. Deane, M. D. Stokes, and B. Ward (2012), Observed variation in the decay time of oceanic whitecap foam, J. Geophys. Res., 117, C09015, doi:10.1029/2012JC008147.

R. J. Langlois, M. M. Mills, C. Ridame, P. Croot, and J. LaRoche. "Impact of Saharan dust additions on nifH abundances in field and laboratory experiments." *Marine Ecology Progress Series*, **470**, 1-14 (2012).

P. Williamson, D.W.R. Wallace, C. S. Law, P.W. Boyd, Y. Collos, P. Croot, K. Denman, U. Riebesell, S. Takeda and C. Vivian. "Ocean fertilization for geoengineering: A review of effectiveness, environmental impacts and emerging governance". *Process Safety and Environmental Protection*, **90**, 475-488 (2012).

A. Dammshäuser and P.L. Croot. "Contrasting distribution of soluble and colloidal aluminium and titanium in surface waters of the Tropical Atlantic". *Geochimica et Cosmochimica Acta*, **96**, 304-318 (2012).

V. Smetacek, C. Klaas, V. H. Strass, P. Assmy, M. Montresor, B. Cisewski, N. Savoye, A. Webb, J. M. Arrieta, U. Bathmann, R. Bellerby, G. M. Berg, P. Croot, F. d'Ovidio, S. Gonzalez, J. Henjes, G. J. Hernd, L. J. Hoffmann, H. Leach, M. Losch, M. M. Mills, C. Neill, I. Peeken, R. Röttgers, O. Sachs, E. Sauter, M. M. Schmidt, J. Schwarz, A. Terbrüggen, & D. Wolf-Gladrow "Carbon export from a Southern Ocean iron-fertilized phytoplankton bloom" *Nature*, **487**, 313-319 (2012).

M. Cheize, G. Sarthou, P.L. Croot, E. Bucciarelli, A-C. Baudoux and A.R. Baker. "Determination of the iron organic speciation in rainwater using cathodic stripping voltammetry" *Analytica Chimica Acta*, **736**, 45-54, doi:10.016/j.aca.2012.05.011 (2012).

P.L. Croot and M.I. Heller. "The importance of kinetics and redox in the biogeochemical cycling of iron in the surface ocean ". *Frontiers in Microbiological Chemistry*, **3**, (2012). doi: 10.3389/fmicb.2012.00219.

C. Schlosser, C. L. De La Rocha, P. Streu and P. L. Croot “Solubility of iron in the Southern Ocean”. *Limnology and Oceanography*, **57(3)**, 684-697 (2012). doi: 10.4319/lo.2012.57.3.0684.

J.D. de Jong, V. Schoemann , D. Lannuzel , P. Croot , H. de Baar and J-L Tison. “Natural iron fertilization of the Atlantic Southern Ocean by continental shelf sources” *Journal of Geophysical Research – Biogeosciences*, **117**, G01029, doi:10.1029/2011JG001679 (2012).

A.Smirnov, A.M.Sayer, B.N.Holben, N.C.Hsu, S.M. Sakerin, A.Macke, N.B.Nelson, Y.Courcoux, T.J.Smyth, P.Croot, P.K.Quinn, J.Sciare, S.K.Gulev, S.Piketh, R.Losno, S.Kinne, V.F.Radionov. “ Effect of wind speed on aerosol optical depth over remote oceans, based on data from the Maritime Aerosol Network” *Atmos. Meas. Tech*., **5**, 377-388, doi:10.5194/amt-5-377-2012 (2012).

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

- Brian Ward (NUIG) was invited to serve as member of the WCRP Data Advisory Council (WDAC) and to attend the 1st WDAC session in Beijing, China in July 2012. This appointment is for three years.

6. Goals, priorities and plans for future activities/events

- Participate in a second SPURS air-sea freshwater flux experiment in the Subtropical North Atlantic in 2013 (Ward)
- Deploy our new photoacoustic gas analyser for air-sea eddy covariance flux measurements (Ward)
- Deploy our new micro-rosette for autonomous DIC measurements in the ocean (Ward)

7. Other comments

In February this year, Dr Peter Croot took up the position of Established Professor of Earth and Ocean Sciences at the National University of Ireland in Galway. Dr Croot previously worked on SOLAS related projects in the UK (Plymouth Marine Laboratory) and in Germany (GEOMAR, Kiel). He is looking forward to being an active member of SOLAS Ireland

SOLAS Italy

compiled by Chiara Santinelli

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight. Please focus on results that would not have happened without SOLAS.*

Evidence for heavy fuel oil combustion aerosols from chemical analyses at the island of Lampedusa: a possible large role of ships emissions in the Mediterranean

Measurements of aerosol chemical composition made on the island of Lampedusa, south of the Sicily channel, during years 2004–2008, are used to identify the influence of heavy fuel oil (HFO) combustion emissions on aerosol particles in the Central Mediterranean.
Aerosol samples influenced by HFO are characterized by elevated Ni and V soluble fraction, high V and Ni to Si ratios, and values of V_{sol} > 6 ng m^{-3}. Evidence of HFO combustion influence is found in 17% of the daily samples.
Back trajectories analysis on the selected events show that air masses prevalently come from the Sicily channel region, where an intense ship traffic occurs. This behavior suggests that single fixed sources like refineries are not the main responsible for the elevated V and Ni events, which are probably mainly due to ships emissions.
V_{sol}, Ni_{sol}, and non-sea salt SO_4^{2-} ($nssSO_4^{2-}$) show a marked seasonal behavior, with an evident summer maximum. Such a pattern can be explained by an increased photochemical activity in summer and/or stronger marine boundary layer stability in summer.
HFO combustion emissions account, as a summer average, at least for 1.2 µg m^{-3}, representing about 30% of the total $nssSO_4^{2-}$,3.9% of PM10, 8% of PM2.5, and 11% of PM1.

Reference: Becagli, S., Sferlazzo, D. M., Pace, G., di Sarra, A., Bommarito, C., Calzolai, G., Ghedini, C., Lucarelli, F., Meloni, D., Monteleone, F., Severi, M., Traversi, R., and Udisti, R.: Evidence for heavy fuel oil combustion aerosols from chemical analyses at the island of Lampedusa: a possible large role of ships emissions in the Mediterranean, Atmos. Chem. Phys., 12, 3479-3492, doi:10.5194/acp-12-3479-2012, 2012.

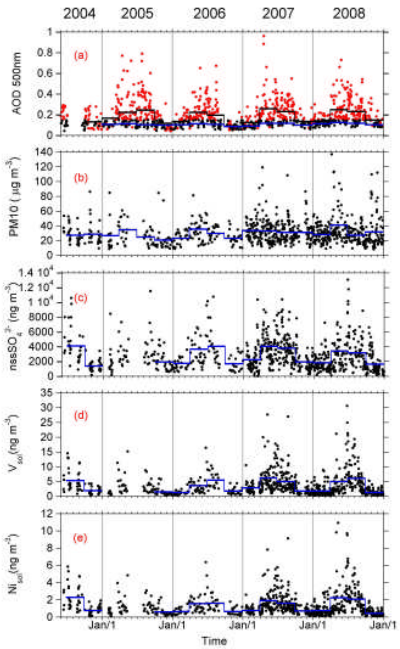


Figure: Temporal evolution of aerosol optical depth (AOD), PM10, $nssSO_4^{2-}$ V_{sol} and Ni_{sol}, at Lampedusa island. Blue lines in plot **(b,c,d,e)** represent the three months mean. Red dots in the plot a are related to Saharan dust events. Black dots represent the remaining days. In this plot the dark line represent the AOD three month average, the blue one the three month mean excluding the Saharan dust event (i.e. calculated over the black dot).

Ocean acidification in the Northern Adriatic Sea and distributions of carbonate system properties in relation to the main drivers.

New data, showing the seasonal variability of carbonate system in the waters of the Gulf of Trieste (Northern Adriatic Sea), a coastal region sensitive to ocean acidification and climate change, have been collected in order to highlight the effects of biological processes, meteorological forcing and river loads on the dynamics of pHT, CO_2 partial pressure (pCO_2), dissolved inorganic carbon (DIC), carbonate ion concentration ($CO_3^{=}$), aragonite saturation state (ΩAr) and total alkalinity (AT). The research, which appeared in Estuarine, Coastal and Shelf Science and was presented in several international meetings, provides new insight by means of time series analysis (2008 – still in course).

Reference: Cantoni C., Luchetta A., Celio M., Cozzi S., Raicich F. and Catalano G. (2012). Carbonate system variability in the Gulf of Trieste (North Adriatic Sea). Estuarine, Coastal and Shelf Science 115, 51-62.

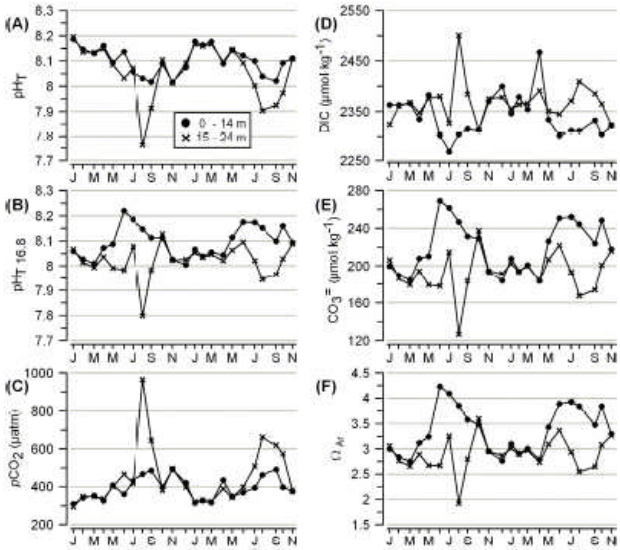


Fig 1 Average values of pH_T (A), pH_T at 16.8 °C, pCO_2 (C), DIC (D), $CO_3^{=}$ (E) and Ω_{Ar} (F) in the both the upper (0-14 m) and deep (15-24 m) layer of North Adriatic, through 2008 and 2009 years.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

1. **Research projects:**
   - **ACCENT Plus** Atmospheric composition change the european network, Coordinator: CNR-ISAC
   - **EPOCA (2008-2012)** European Project on OCean Acidification, EU FP7
   - **JERICO (2011-2015)** Towards a Joint European Research Infrastructure network for Coastal Observatories
   - **PEGASOS (2011-2015)**: Pan-European Gas-AeroSol-climate interaction Study
   - **RITMARE (2012-2017),** Italian Flagship Project
   - **PERSEUS (2012-2016)** Policy-oriented marine Environmental Research in the Southern European Seas. Seventh Framework Programme.
   - **MyOcean-2 (2012-2014):** Prototype Operational Continuity for GMES Ocean Monitoring and Forecasting Service. Seventh Framework Programme. CNR-ISAC is leading the Ocean Colour Thematic Assembling Centre that is providing ocean colour satellite products for the global ocean and for the European Seas
   - **SSD-Pesca (2011-2014)** Decision support system for the sustainable management of fishery in the South of Italy, Italian Project aimed at supporting the development of productive activities in the South

2. **Cruises**
   - WMED-BIOOPT 2012, R/V URANIA, 22/03/2012-10/04/2012, CNR-ISAC, Roma (Chief scientist, Dr. F. Bignami). Participants: CNR-IBF, ENEA, Frascati, JRC Ispra; SZN. Main goals of the cruise: (1) Characterization of Tyrrhenian and Sardinian Sea bio-optical properties during the spring phytoplankton bloom phase; (2) Extension of the Mediterranean Sea in situ bio-optical dataset to the

above areas for the support of marine biological parameter estimates using satellite data; (3) Validation of regional algorithms for the estimates of marine chlorophyll and primary production from satellite data; (4) Development of new regional algorithms for the estimates of chlorophyll, primary production, chromophoric dissolved organic matter (CDOM) and phytoplankton species from satellite data

- Gargano platform (Gulf of Manfredonia) 2012, CNR-ISMAR (Chief scientists Dr. Marini and D'Adamo). Continuous measurements of CDOM and chlorophyll by means optical sensors and calibration of parameters with spectrophotometers and fluorometers. Partecipants: CNR-ISMAR, CNR-IAMC, CNR-ISAC, Roma)
- GoT 2012, R/V F.V.G. dell'ARPA FVG; participants CNR-ISMAR, ARPA FVG. Main goals: characterization of carbonate system properties and other physical and biogeochemical parameters in the Gulf of Trieste (North Adriatic).

3. Workshop and conferences

- "Marine gels and their impact on atmospheric aerosol and cloud", participation in the SOLAS/IGAC Workshop, 11-13 December, 2012, Kiel, Germany. (*Cristina Facchini, CNR-ISAC*)
- "Chlorophyll-a and other ocean color products as predictive tools of the organic mass fraction in submicron sea spray", oral presentation at AAAR 31th annual meeting, 8-12 October, 2012, Minneapolis, Minnesota. (*Matteo Rinaldi, CNR-ISAC*)
- "Evaluation of different ocean color products as predictive tools of the organic mass fraction in submicron sea spray", poster presentation at IGAC 2012 science conference, 17-21 September, Beijing, China. (*Matteo Rinaldi, CNR-ISAC*)
- Sparnocchia S., Luchetta A., Cantoni C. International Workshop to Develop an Ocean Acidification Observing Network of Ship Surveys, Moorings, Floats and Gliders, University of Washington, June 26-28, 2012 (*Stefania Sparnocchia, CNR-ISMAR)*
- "How do oceanic biotic components influence the production mechanism of organic aerosol in Marine Boundary Layer (MBL)?", oral presentation at Goldshmidt conference 2012, 24-29 June, 2012, Montreal, Canada. (*Cristina Facchini, CNR-ISAC*)
- "Production mechanism, number concentration, size distribution, chemical composition, and optical properties of sea spray aerosols", participation in the Workshop, 4-6 June, 2012, Raleigh, North Carolina. From this workshop a manuscript has been originated, actually under review by Atmospheric Science Letters. (*Matteo Rinaldi, CNR-ISAC*)
- "Submicron Marine Organic Aerosols: primary vs. secondary", invited oral presentation at SOLAS Open Conference, Seattle, 7-10 May, 2012. (*Cristina Facchini, CNR-ISAC*)
- Cantoni C., Luchetta A., Celio M., Cozzi S., Sparnocchia S.. Thermal versus biological control of air-sea CO_2 fluxes and pHT variability in a coastal region of the Northern Adriatic shelf from time series analysis. EPOCA Final Meeting, Saint Jean Cap Ferrat (France), 2-5 April 2012. (*Carolina Cantoni, CNR-ISMAR)*
- Luchetta A., Cantoni C., Kovacevic V., 2012. pH and carbonate system spatial variability from the North to the South (North Adriatic to Ionian seas) in the central Mediterranean Sea. EPOCA Final Meeting, Saint Jean Cap Ferrat (France), 2-5 April 2012. (*Anna Lucchetta, CNR-ISMAR)*
- "Marine organic aerosol and oceanic biological activity", oral presentation at Planet under pressure, 26-29 March 2012, London, UK. (*Cristina Facchini, CNR-ISAC*)

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

Outreach activity
Lessons about Oceanography, Marine Carbon cycle and Climate Change in primary schools (8-10 years old children)

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

1. Becagli S., Sferlazzo D. M., Pace G., di Sarra A., Bommarito C., Calzolai G., Ghedini C., Lucarelli F., Meloni D., Monteleone F., Severi M., Traversi R., Udisti R. (2012). Evidence for heavy fuel oil combustion aerosols from chemical analyses at the island of Lampedusa: a possible large role of ships emissions in the Mediterranean. Atmospheric Chemistry and Physics 12, 3479-3492, doi:10.5194/acp-12-3479-2012, 2012.
2. Cantoni C., Luchetta A., Celio M., Cozzi S., Raicich F. and Catalano G. (2012). Carbonate system variability in the Gulf of Trieste (North Adriatic Sea). Estuarine, Coastal and Shelf Science 115, 51-62.
3. Kishcha, P., Starobinets, B., Bozzano, R., Pensieri, S., Canepa, E., Nickovic, S., di Sarra, A., Udisti, R., Becagli, S., Alpert, P. (2012). Sea-salt aerosol forecasts compared with wave height and sea-salt measurements in the open sea. In: Steyn, Douw G., Trini Castelli, Silvia (Eds.), Air Pollution Modeling and its Application XXI, Chapter 51, p. 299-303 Springer, Dordrecht; ISBN 978-94-007-1358, doi 10.1007/978-94-007-1359-8_51.
4. Balzarini A., Pirovano G., Riva G.M., Toppetti A., Bozzano R., Pensieri S., Canepa E. Schiano, E. (2012). WRF evaluation exercise using open sea in situ measurements. International Journal of Environment and Pollution 50, Nos. 1/2/3/4, pp.151-163, doi: 10.1504/IJEP.2012.051189.
5. Volpe G., Buongiorno Nardelli B., Cipollini P., Santoleri R., Robinson I.S.. (2012). Phytoplankton response to physical processes: EOF analysis of satellite observations. Remote Sensing of Environment 117, 223-235.
6. Lazzari P., Solidoro C., Ibello V., Salon S., Teruzzi A., Beranger K., Colella S., Crise A. (2012). Seasonal and inter-annual variability of plankton chlorophyll and primary production in the Mediterranean Sea: a modeling approach. Biogeosciences 9 (1), 217-233, doi: 10.5194/bg-9-217-2012.
7. Santinelli C., Sempéré R., Van Wambeke F., Charriere B., Seritti A. (2012). Organic carbon dynamics in the Mediterranean Sea: An integrated study. Global Biogeochemical Cycles 26, doi:10.1029/2011GB004151, in press.
8. Santinelli C., Ibello V., Lavezza R., Civitarese G., Seritti A. (2012). New insights into C, N and P stoichiometry in the Mediterranean Sea: the Adriatic Sea case. Continental Shelf Research 44, 83–93, doi:10.1016/j.csr.2012.02.015.
9. Azzaro M., La Ferla R., Maimone G., Monticelli L.S., Zaccone R., Civitarese G. (2012). Prokaryotic dynamics and heterotrophic metabolism in a deep-convection site of Eastern Mediterranea Sea (the Southern Adriatic Pit). Continental Shelf Research 44, 106-118, doi:10.1016/j.crs.2011.07.011.
10. Campanelli A., Cabrini M., Grilli F., Fornasaro D., Betti M., Penna P., Kljajić Z., Marini M. (2012). Physical, biochemical and biological comparison between two opposite areas of the southern Adriatic Sea. Open Journal Marine Science, doi:10.4236/ojms. In press

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

R. Santoleri (CNR-ISAC) is participating to the Global Ocean Observing System Steering Committee (GOOS SC), established by UNESCO/IOC XXVI-8. The GOOS Steering Committee has been nominated by IOC in January 2012 and has mandate to carry out activities to:

- identify the essential ocean variables to observe, and develop and update the scientific, technical and implementation plans and targets for GOOS,
- monitor and promote the development of GOOS based on these agreed plans,
- assess the performance of GOOS in providing users with fit-for-purpose data and information,
- encourage research and operational programmes to enhance and improve GOOS, and
- advise on developing the capacity of all Member States to participate in and benefit from GOOS.

Contribution to the Community White Paper "A global sea surface carbon observing system: inorganic and organic carbon dynamics in coastal oceans" by Borges et al., presented at Oceanobs 09, Published in the Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society. Available at http://www.oceanobs09.net *(Anna Lucchetta, CNR-ISMAR)*

6. Goals, priorities and plans for future activities/events

- Study of carbonate system and aragonite calcite saturation states in the North Adriatic Sea and in the central Mediterranean (Adriatic and Ionian seas) in relation with CO_2 fluxes.
- Impacts of acidified North Adriatic dense water masses on marine calcifying organisms.
- Validation of regional algorithms for the estimates of marine chlorophyll and primary production from satellite data.
- Development of new regional algorithms for the estimates of chlorophyll, primary production, chromophoric dissolved organic matter (CDOM) and phytoplankton species from satellite data.
- Study of CDOM photodegradation processes and their role in CO_2 fluxes to the atmosphere.
- Study of the atmospheric input of DOM and CDOM in key areas of the Mediterranean Sea.
- Performing optical measurements (absorption and fluorescence) of CDOM at different season with different stages of phytoplankton to characterize the different CDOM sources in offshore and nearshore waters of the southern Adriatic sea and lagoon systems.
- Acquisition of a time series of optical data in continuum by oceanographic platforms already installed in the Adriatic Sea.
- "Spatial variability of marine aerosol radiative forcing over the Mediterranean and Black Sea - impact on weather, climate and pollution within a climate change perspective", ***consortium for next call of EU Horizon 2020***.
- Organization of the section: ***Atmospheric aerosol in air quality and climate: the science and solutions*** by Cristina Facchini, Gordon McFiggans at Goldsmicth 2013.

7. Other comments

SOLAS Japan

compiled by Mitsuo Uematsu

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Atmospheric inorganic nitrogen in marine aerosol and precipitation and its deposition to the North and South Pacific Oceans

Aerosol and rain samples were collected between 48°N and 55°S during the KH-08-2 and MR08-06 cruises conducted over the North and South Pacific Ocean in 2008 and 2009, to estimate dry and wet deposition fluxes of atmospheric inorganic nitrogen. Inorganic N in aerosols was composed of ~68% NH_4^+ and ~32% NO_3^-, with ~81% and ~45% of each species being present on fine mode aerosol, respectively. Concentrations of NH_4^+ and NO_3^- in rainwater ranged from 1.7–55 μmol L^{-1} and 0.16–18 μmol L^{-1}, respectively, accounting for ~87% by NH_4^+ and ~13% by NO_3^- of total inorganic N. A significant correlation between NH_4^+ and methanesulfonic acid (MSA) was found in rainwater samples collected over the South Pacific, whereas no significant correlations were found between NH_4^+ and MSA in rainwater collected over the subarctic and subtropical western North Pacific, suggesting that emissions of ammonia (NH_3) by marine biological activity from the ocean could become a significant source of NH_4^+ over the South Pacific. While NO_3^- was the dominant inorganic N species in dry deposition, inorganic N supplied to surface waters by wet deposition was predominantly by NH_4^+ (42–99% of the wet deposition fluxes for total inorganic N). We estimated mean total (dry+wet) deposition fluxes of atmospheric total inorganic N in the Pacific Ocean to be 32–64 μmol m^{-2} d^{-1}, with 66–99% of this by wet deposition, indicating that wet deposition plays a more important role in the supply of atmospheric inorganic N than dry deposition.

Jung, J., Furutani, H. and Uematsu, M. (2011) Atmospheric inorganic nitrogen in marine aerosol and precipitation and its deposition to the North and South Pacific Oceans. Journal of Atmospheric Chemistry, 68, 157–181, I 10.1007/s10874-012-9218-5. (Received: 13 September 2011 / Accepted: 7 February 2012)

Dispersion of radio-caesium from Fukushima in the western North Pacific

In March 2011, an accident at the Fukushima Daiichi nuclear power plant (FNPP-AC) was caused by the Tohoku earthquake and tsunami. Here we show the distribution of ^{134}Cs and ^{137}Cs in the western North Pacific one month after the FNPP-AC. In surface seawater, ^{137}Cs concentrations were from several times to two orders of magnitude higher than before the FNPP-AC. ^{134}Cs was also detected, and in many seawater samples the $^{134}Cs/^{137}Cs$ ratio was about 1. These findings indicate that radionuclides from the FNPP dispersed quickly in the western North Pacific. ^{134}Cs and ^{137}Cs concentrations in suspended solids and zooplankton at stations K2 and S1 were also one to two orders higher than before the accident. Numerical simulation results show that the higher caesium observed in the western North Pacific one month after the FNPP-AC was transported not only by diffusion and advection of seawater but also via the atmosphere as an aerosol.

Honda, M. C., Aono, T., Aoyama, M., Hamajima, Y., Kawakami, H., Kitamura, M., Masumoto, Y., Miyazawa, Y., Takigawa, M., Saino, T. (2012) Dispersion of artificial caesium-134 and -137 in the western North Pacific one month after the Fukushima accident. Geochem. J. (Express), 46, e1-e9.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

the EqPOS (Equatorial Pacific Ocean and Stratospheric/Tropospheric Atmospheric Study) research cruise was conducted as a part of SOLAS Japan activity to understand biogeochemical ocean-atmosphere interaction and exchange processes between stratosphere and troposphere. Coordinated atmospheric, oceanic, and marine biological observations including sampling/characterization of thin air-sea interfacial layer (sea surface microlayer: SML) and stratospheric air sampling using balloon-borne cryogenic air samplers were carried out on-board R/V Hakuho Maru starting from 29 January to 7 March 2012 for 39 days.

Many SOLAS-Japan members have been working on the radioactive material investigation released from the Fukushima Nuclear Power Plants in marine atmosphere and ocean by research vessels and on land. It is important to identify the inputs both from atmosphere and direct discharge of contaminated water to the ocean. SOLAS members are expert for this field.

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

Public Colloquium "Fukushima and the Ocean" was held at the University of Tokyo on November 14, 2012 with over 200 people.
http://www.whoi.edu/tokyoevent/

4. Top 10 publications in 2012 (Reports, <u>ACCEPTED</u> articles, models, datasets, products, website etc)

Aoyama, M., Tsumune, D., Uematsu, M., Kondo, F. and Hamajima, Y. (2012) Temporal variation of 134Cs and 137Cs activities in surface water at stations along coastal line near the Fukushima Dai-ichi Neclear Power Plant accident site, Japan. Geochem. J., 46, 321-325.

Asahara Y., F. Takeuchi, K. Nagashima, N. Harada, K. Yamamoto, K. Oguri, and O. Tadai (2012) Provenance of terrigenous detritus of the surface sediments in the Bering and Chukchi Seas as derived from Sr and Nd isotopes: implications for recent climate change in the Arctic regions. Deep-Sea Res. II, 61–64, 155–171.

Gamo, T., U. Tsunogai, A. Hirota, N. Nakayama, D.-J. Kang, and K.-R. Kim (2012) First measurements of methane and its carbon isotope ratio in the Japan Sea (East Sea). Mar. Chem., 128-129, 92-99.

Harada N., M. Sato, K. Oguri, K. Hagino, Y. Okazaki, K. Katsuki, Y. Tsuji, K.-H. Shin, O. Tadai, S. Saitoh, H. Narita, S. Konno, R. W. Jordan, Y. Shiraiwa, J. Grebmeier (2012) Recent environmental changes enhance coccolithophorid blooms in the Bering Sea. Global Biogeochem. Cycles, 26, GB2036, doi:10.1029/2011GB004177.

Honda, M. C., Aono, T., Aoyama, M., Hamajima, Y., Kawakami, H., Kitamura, M., Masumoto, Y., Miyazawa, Y., Takigawa, M., Saino, T. (2012) Dispersion of artificial caesium-134 and -137 in the western North Pacific one month after the Fukushima accident. Geochem. J., 46, e1-e9.

Moffet, R. C., Furutani, H., Rödel, T. C., Henn, T. R., Sprau, P. O., Laskin, A., Uematsu, M., Gilles, M. K. (2012) Iron speciation and mixing in single aerosol particles from the Asian continental outflow. J. Geophys. Res., 117, D07204, doi.org/10.1029/2011JD016746.

Nakamura, H., A. Nishina, and S. Minobe (2012) Response of storm tracks to bimodal Kuroshio path states south of Japan, Journal of Climate, 25, 7772-7779.

Takagaki, N., S. Komori, N. Suzuki, K. Iwano, T. Kuramoto, S. Shimada, R. Kurose, and K. Takahashi (2012) Strong correlation between the drag coefficient and the shape of the wind sea spectrum over a broad range of wind speeds, Geophys. Res. Lett., 39, L23604, doi:10.1029/2012GL053988.

Takashima, H., Irie, H., Kanaya, Y., and Syamsudin, F. (2012) NO2 observations over the western Pacific and Indian Ocean by MAX-DOAS on Kaiyo, a Japanese research vessel, Atmos. Meas. Tech., 5, 2351-2360, doi:10.5194/amt-5-2351-2012.

Torres R. S. Pantoja, N. Harada, H. E. Gonzalez, G. Daneri, M. Frangopulos, J. A. Rutllant, C. M. Duarte, S. Rúiz-Halpern, E. Mayol, M. Fukasawa (2011) Air-sea CO2 fluxes along the coast of Chile: From CO2 outgassing in central northern upwelling waters to CO2 uptake in southern Patagonian fjords. J. Geophys. Res., 116, doi:10.1029/2010JC006344.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Fukushima Ocean Impacts Symposium -Exploring the impacts of the Fukushima Dai-ichi Nuclear Power Plants on the Ocean- was organized at the University of Tokyo on November 12-13, 2012

http://www.whoi.edu/website/fukushima-symposium/science-symposium

Our successful collaboration of the EqPOS (Equatorial Pacific Ocean and Stratospheric/Tropospheric Atmosphere Study) cruise and the TOREDO (Tropical Ocean tRoposphere Exchange of Reactive halogen species and Oxygenated VOC) campaign in early February 2012.

A EqPOS member joined the TORERO Data Workshop at Boulder, CO, USA on 23-25 July 2012.

A session “Tropospheric Chemistry and Tropical Oceans” was organized on the 2012 AGU Fall Meeting in San Francisco, CA, USA with R. Volkamer and M. Uematsu

6. Goals, priorities and plans for future activities/events

After 5 year W-PASS project, the NEOPS (New Ocean Paradigm on Its Biogeochemistry, Ecosystem and Sustainable Use) project (PI: Ken Furuya, U of Tokyo) has been funded for the IMBER community involving the SOLAS Japan members for 5 years in the summer of 2012.

7. Other comments

Annual Report for the year 2012:

SOLAS Korea

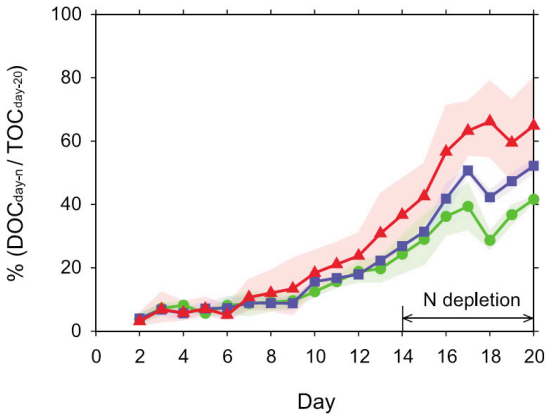
compiled by Kitack Lee

1. Scientific highlights

Shift in biogenic carbon flow from particulate to dissolved forms under high carbon dioxide and warm conditions

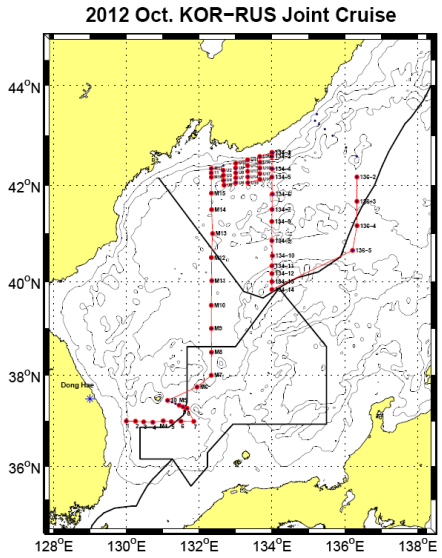
Photosynthesis by phytoplankton in sunlit surface waters transforms inorganic carbon and nutrients into organic matter, a portion of which is subsequently transported vertically through the water column by the process known as the biological carbon pump (BCP). The BCP sustains the steep vertical gradient in total dissolved carbon thereby contributing to net C sequestration. Any changes in the vertical transportation of the organic matter as a result of future climate variations will directly affect surface ocean carbon dioxide (CO_2) concentrations, and subsequently influence oceanic uptake of atmospheric CO_2 and climate. Here we present results of experiments designed to investigate the potential effects of ocean acidification and warming on the BCP. These perturbation experiments were carried out in enclosures (3,000 L volumes) in a controlled mesocosm facility that mimicked future pCO_2 (~900 ppmv) and temperature (3°C higher than ambient) conditions. The elevated CO_2 and temperature treatments disproportionately enhanced the ratio of dissolved organic carbon (DOC) production to particulate organic carbon (POC) production, whereas the total organic carbon (TOC) production remained relatively constant under all conditions tested. A greater partitioning of organic carbon into the DOC pool indicated a shift in the organic carbon flow from the particulate to dissolved forms, which may affect the major pathways involved in organic carbon export and sequestration under future ocean conditions. [1].

1.Kim, J.M., Lee, K., Shin, S., Yang, E.J., Engel, A., Karl, D. M., Kim, H.-C. (2011), Shifts in biogenic carbon flow from particulate to dissolved forms under high carbon dioxide and warm ocean conditions, Geophysical Research Letters, 38, doi:10.1029/2011GL047346



(Left) Mesocosm enclosures used in the present study. (right) DOC production in controlled, high CO_2, and high CO_2/high temperature enclosures

2. Main accomplishments (research projects, cruises, special events, workshops, outreach, capacity building, remote sensing used etc)



The East/Japan Sea in the western temperate North Pacific is ventilated from the surface to the bottom over decades. This short overturning circulation indicates that the anthropogenic CO_2 content of the East/Japan Sea is intimately tied to changing surface conditions over similarly short periods. As a consequence of the changing nature of the East/Japan Sea, this basin is an excellent site for investigating temporal trends in oceanic uptake of anthropogenic CO_2 in response to regional or global climatic change. As part of the East Asian Seas Time-series-1 project (funded by the Ministry of Land, Transport and Maritime Affair of Korea), the 2012 data were collected on the Russia *R/V Akademik Oparin* from 13–29 October 2012 (Figure). A team of 31 scientists from six institutes (POI, SNU, POSTECH, PNU, CNU) was participated in this cruise. At 43 hydrographic stations salinity, temperature, oxygen and nutrient concentrations were measured, and concentrations of total dissolved inorganic carbon and total alkalinity were determined at 25 of these stations. Total inorganic carbon and total alkalinity were measured using coulometric titration and potentiometric acid titration in a VINDTA system.

3. Top 10 publications in 2012 (Reports, articles, models, datasets, products, website etc)

1. H.J. Jeong, Y.-D. Yoo, N.S. Kang, A.S. Lim, K.A. Seong, S.Y. Lee, M.J. Lee, H.S. Kim, W. Yih, K. Lee, 2012, Heterotrophic feeding as a newly identified survival strategy of the dinoflagellate *Symbiodinium*, Proceedings of the National Academy of Science of USA, 109(31), 12604-12609, DOI: 10.1073/pnas.1204302109 (2012/07). [IF 9.681]

2., H. Lee, K.-T. Park, K. Lee, H.J. Jeong, Y.-D. Yoo, 2012, Prey-dependent retention of dimethylsulfoniopropionate(DMSP) by mixotrophic dinoflagellates, Environmental Microbiology, 14, 605-616, DOI:10.1111/j.1462-2920.2011.02600.x (2012/03). [IF 5.843]

3. V. Vandieken, M. Pester, N. Finke, J.H. Hyun, M.W. Friedrich, A .Loy, B. Thamdrup, 2012, Three manganese oxide-rich marine sediments harbor similar communities of acetate-oxidizing manganese-reducing bacteria, ISME Journal, 6, 2078-2090, DOI: 10.1038/ismej.2012.41 (2012/03). [IF 7.375]

4. D.C. Shaha, Y.-K. Cho, M.-T. Kwak, S.R. Kundu, K.T. Jung, 2012, Spatial variation of the longitudinal dispersion coefficient in an estuary, Hydrology and Earth System Sciences, 15, 3679-3688, DOI: 10.5194/hess-15-3679-2011 (2011/12). [IF 3.148]

5. S.W. Nam, W. Shin, DW. Coats, J.W Park, W. Yih, 2012, Ultrastructure of oral apparatus of Mesodinium rubrum from Korea, Journal of Eukaryotic Microbiology, 59, 625-636, DOI: 10.1111/j.1550-7408.2012.00643.x (2012/11). [IF 2.659]

6. J.W. Han, M. Yoon, F.D. Kupper, T.A. Kochkova, J.-S. Oh, J.-R. Rho, G.H. Kim, 2012, Accumulation of galloyl derivatives in a freshwater green alga, Spirogyra varians, in response to cold stress, Journal of Applied Phycology, 24, 1279-1286, DOI: 10.1007/s10811-011-9776-y (2012/10). [IF 2.411]

7. S.J Jeong, H.-L. Suh, C.-K. Kang, 2012, Trophic diversity in amphipods within a temperate eelgrass ecosystem as determined by gut contents and C and N isotope analysis, Marine Biology,

159, 1943-1954, DOI10.1007/s00227-012-1981-y (2012/06). [IF 2.276]

4. International interactions and collaborations

A group of scientists from Pohang University of Science and Technology in Korea will participate in a 3-week ocean acidification experiment at the Friday Harbour Laboratories in April 2013. Dr. Jim Murray at the University of Washington (Seattle, USA) will lead the experiment.

5. Goals and plans for future activities

6. Other comments

SOLAS Mexico

compiled by Jose Martin Hernandez Ayon

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight. Please focus on results that would not have happened without SOLAS.*

Eastern Pacific Tropical Cyclones and Their Impact Over Western Mexico

Tropical cyclones (TCs) are atmospheric vortices that form at low latitudes, over relatively warm oceans. They start as loosely organized cloud clusters and go through several stages to become intense circulation systems whose diameter is typically in the range of 500–1,000 km. This work summarizes characteristics of TCs that developed in the eastern Pacific Ocean during the last 40 years. Based on the United States National Hurricane Center best-track database, this work provide updated climatology on storm formation track, as well as time, frequency, and intensity at landfall. Emphasis is given TCs that made landfall in the southern part of the Baja California Peninsula (Fig.). Since the peninsula has a coastal length covering almost one-third of the country's coastline and frequently experiences TC landfalls, the area requires special attention. The most recent landfalls justify continued studies of summer regional storms. The monitoring capabilities offered by satellite and in situ observations allow more accurate assessments of structure and motion. Therefore, for real-time observations, these are valuable tools for operational forecasters who are responsible for providing advance warning to the populations in western Mexico.

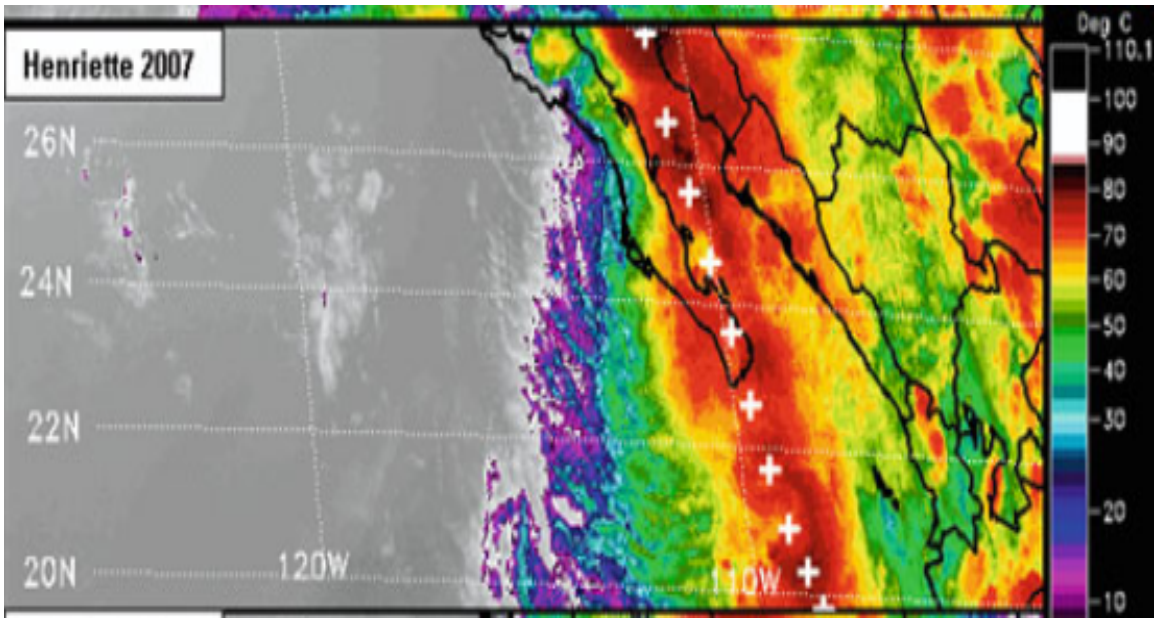


Figure. Hurricane Henriette formed from an area of disturbed weather on August 30, 2007, and became a tropical storm the next day.

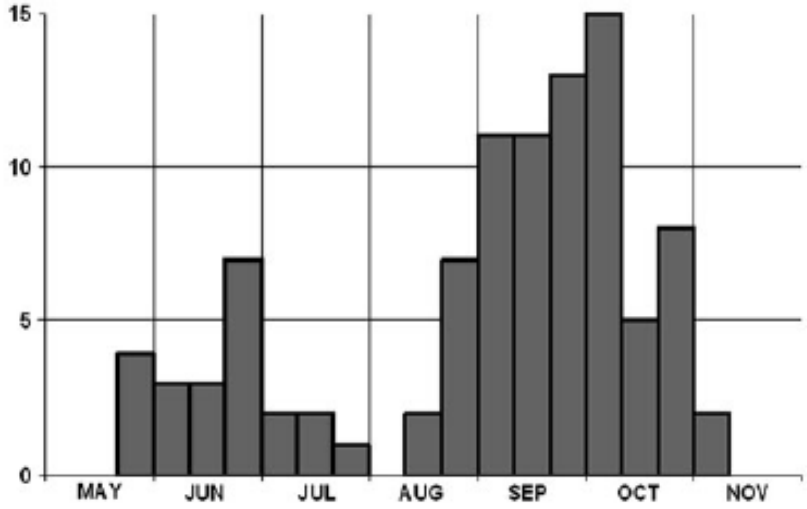


Figure: Distribution of 96 Tropical cyclones making landfall in western Mexico during summer storm seasons, with each month divided by 10- or 11-day periods. Strong winds and heavy rainfall affected communities in the southern peninsula and mainland Mexico.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

- AGU Americas Cancun meeting, 14-17 May 2013.Mexico.
- CarboNA is the international collaboration between Canada, Mexico, and the United States for carbon cycle science research throughout North America and adjacent coastal waters. For the AGU union Cancun meeting (14 - 17 May) it will be a session titled "U01: Bilateral Network Collaboration: Unifying Climate and Carbon Science Goals between Mexico and the US", the details are at: http://moa.agu.org/2013/scientific-program/sessions/u01/ .
- Fourth Symposium on Carbon in Mexico was held at Centro de posgraduados (COLPOS) at Mexico City.

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

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

The list below identifies several papers published in 2011 related with biogeochemistry studies.

Huerta-Diaz, M. A., Delgadillo-Hinojosa, F., Siqueiros-Valencia, A., Valdivieso-Ojeda, J., Reimer, J. J. and Segovia-Zavala, J. A. (2012), Millimeter-scale resolution of trace metal distributions in microbial mats from a hypersaline environment in Baja California, Mexico. Geobiology, 10: 531–547. doi: 10.1111/gbi.12008.

Linacre L, Landry MR, Cajal-Medrano R, Lara-Lara JR and others (2012) Temporal dynamics of carbon flow through the microbial plankton community in a coastal upwelling system off northern Baja California, Mexico. Mar Ecol Prog Ser 461:31-4

Guillermo Horta-Puga, José D. Carriquiry, Coral Ba/Ca molar ratios as a proxy of precipitation in the northern Yucatan Peninsula, Mexico, Applied Geochemistry, Volume 27, Issue 8, August 2012, Pages 1579-1586, ISSN 0883-2927, 10.1016/j.apgeochem.2012.05.008.

García-Nava, H., F. J. Ocampo-Torres, P. A. Hwang, and P. Osuna (2012), Reduction of wind stress due to swell at high wind conditions, *J. Geophys. Res.,* 117, C00J11, doi:10.1029/2011JC007833.

Nelson Violante-Carvalho, Ian Robinson, Christine Gommenginger, Luiz Mariano Carvalho, Francisco Ocampo-Torres, The effect of the spatially inhomogeneous wind field on the wave spectra employing an ERS-2 SAR PRI image, Continental Shelf Research, Volume 36, 15 March 2012, Pages 1-7, ISSN 0278-4343,

10.1016/j.csr.2011.12.006.

Rodrigo Vargas, Henry W. Loescher, Tulio Arredondo, Elisabeth Huber-Sannwald, Rubén Lara-Lara, Enrico A. Yépez, Opportunities for advancing carbon cycle science in Mexico: toward a continental scale understanding, Environmental Science & Policy, Volume 21, August 2012, Pages 84-93, ISSN 1462-9011, 10.1016/j.envsci.2012.04.003.

González-Rodrıguez, E., Trasviña-Castro, A., Gaxiola-Castro, G., Zamudio, L., & Cervantes-Duarte, R. (2012). Net primary productivity, upwelling and coastal currents in the Gulf of Ulloa, Baja California, México. *Ocean Sci*, *8*, 703-711.

Espinosa-Carreón, T. L., G. Gaxiola-Castro, E. Beier, P. T. Strub, and J. A. Kurczyn (2012), Effects of mesoscale processes on phytoplankton chlorophyll off Baja California, *J. Geophys. Res.,* 117, C04005, doi:10.1029/2011JC007604.

Alin, S. R., R. A. Feely, A. G. Dickson, J. M. Hernández-Ayón, L. W. Juranek, M. D. Ohman, and R. Goericke (2012), Robust empirical relationships for estimating the carbonate system in the southern California Current System and application to CalCOFI hydrographic cruise data (2005–2011), *J. Geophys. Res.,* 117, C05033, doi:10.1029/2011JC007511.

Farfán L. M., 2011. Eastearn Pacific tropical cyclones and their impact over western Mexico. In: J. Klapp, A. Cros, Ó. Velasco Fuentes, C. Stern and M. A Rodríguez Meza, eds. Experimental and Theoretical Advances in Fluid Dynamics. Berlin, Heidelberg: Springer-Verlag, pp. 135-148.DOI:10.1007/978-3-642-17958-7_9.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Global network will track acidifying oceans

Nature published an article on the International Ocean Acidification (OA) Workshop held in June 2012 at the University of Washington in Seattle. The article includes interviews of participants and a summary of major outcomes. The goal of the workshop was to develop a coordinated multidisciplinary multinational approach for observations and modelling that will be fundamental to establishing a successful research strategy for ocean acidification. More details: http://www.pmel.noaa.gov/co2/OA2012Workshop/WorkshopHome.html

6. Goals, priorities and plans for future activities/events

Mexico's research community is hoping that the new Mexican's president will put the country's scientific house in order. To do that, he will need to boost science funding and re-energize Mexico's scientific culture. The president Peña Nieto has promised to increase spending on science and technology from a paltry 0.4% of the gross domestic product to 1%, competitive with other emerging economies. Marine scientific community expects the increase will be reflected in the future scientific activities.

7. Other comments

Annual Report for the year 2011:

SOLAS New Zealand

compiled by Cliff Law

Notes:
Reporting Period is January 2011 – December 2011
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Key scientific SOLAS-relevant highlights/findings (you may include figures and references)

1. Publication of the SOLAS Air-Sea Gas Exchange Experiment (SAGE), *Deep-Sea Research II* Special Issue containing 11 papers (detailed in previous report).

2. Secondary organic aerosol in the Southern Pacific Ocean

Marine biologically active regions are known to produce a range of compounds that interact with the atmosphere directly and indirectly affecting particle production, composition, and properties in marine atmosphere. While the CLAW hypothesis (Charlson *et al*., 1987) suggests the importance of marine biological activity in ultrafine (d<100nm) particles composition and the potential importance of secondary sulphate production, this hypothesis does not take into account the secondary organic fraction in the composition of the ultrafine particles. To date, observations of the presence of a marine origin secondary organic fraction in ultrafine particles have been indicated down to nucleation mode size particles (d<15nm) in Atlantic coastal waters (Vaattovaara *et al*., 2006), ice edge waters in the Arctic (Vaattovaara *et al.*, ICNAA 2009), and sub-tropical Pacific Ocean waters (Modini *et al*., 2009). In spite of the importance of secondary particles to atmospheric radiatively active sizes, the composition of marine produced particles is still uncertain in other marine biologically active locations around the world.

This study of the composition of nucleation (d<15nm) and the lower end of Aitken (20nm<d<60nm) modes particles is focused on particle production at one such region, at the Chatham Rise (New Zealand; latitude 42°S-44°S, longitude 174°E-177°W) during the PreSOAP (Pilot Surface Ocean Particle Production) voyage during the austral summer. The region of the southern Pacific Ocean includes a sub-tropical front characterised by intensive austral summers phytoplankton blooms. The ultrafine particles composition was studied using the UFO-TDMA and the VH-TDMA methods onboard the RV Tangaroa (NIWA, Wellington, New Zealand). Auxilliary data were collected from the ship weather station and marine information observations, SMPS particle distribution measurements, total particles count CPC measurements with 5 nm and 10 nm cut-off sizes, and black carbon measurements. Marine biological activity was established using MODIS satellite data, and supported by a range of *in situ* parameters including chlorophyll and dissolved DMS. Marine air masses origin was followed with HYSPLIT trajectories.

The TDMA measurements showed nucleation and Aitken mode sized particles including a clearly detectable organic fraction. During intensive solar radiation periods secondary organic contribution is highly probable in those ultrafine particles. Furthermore, the comparison between *in situ* bubble burst chamber and atmospheric particles composition measurements strongly support a secondary origin of the atmospherically observed ultrafine particles. Comparison with the secondary organic fraction observations on Atlantic, Arctic, and Pacific oceans reveals that although the secondary organic fraction clearly exists in ultrafine particle phase, the properties of the fraction can be dependent on the marine area conditions.

P.Vaattovaara, L.Cravigan, N.Talbot, G.Olivares, C.Law, M.Harvey, Z.Ristovski and A.Laaksonen. Secondary organic aerosol on southern Pacific Ocean, EAC 2011, Manchester, UK, 4-9/9/11.

3. Ocean acidification – impact of other anthropogenic gases
   Apart from CO_2 other anthropogenic gases have the potential to alter ocean pH and CO2 chemistry, specifically SOx and NOx and NH3. We demonstrate using a simple chemical model that in coastal water regions with high atmospheric inputs of these gases, their pH reduction is almost completely canceled out by buffering reactions involving seawater HCO_3^- and CO_3^{2-} ions. However, a consequence of this buffering is a significant decrease in the uptake of anthropogenic CO2 by the atmosphere in these areas.

Keith A. Hunter, Peter S. Liss, Vanisa Surapipith, Frank Dentener, Robert Duce, Maria Kanakidou, Nilgun Kubilay, Natalie Mahowald, Greg Okin, Manmohan Sarin, Mitsuo Uematsu and Tong Zhu (2011). Impacts of anthropogenic SO_x, NO_x and NH_3 on acidification of coastal waters and shipping lanes. Geophys. Res. Lett.,38,L13602,doi:10.1029/2011GL047720

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

PreSOAP research voyage, February 2011

The Pre-SOAP voyage was carried out in February 2011 as a pilot study for the 2012 SOAP voyage. Sampling strategy around the productive Chatham Rise region east of New Zealand was informed by ocean colour images, and determined in real time by underway data collection (chl-a, pCO_2, pH, DMS, backscatter). Over 11 days three different types of phytoplankton blooms (diatom, dinoflagellate & coccolithophore–dominated), with unique biogeochemical characteristics, were sampled. Surprisingly, the coccolithophore bloom (high underway back-scatter, low pCO2 & high Chl-a) had the lowest DMS signal. A number of instruments, sensors and sampling designs were successfully trialled during PreSOAP. Of particular note were the performance of the in-line sensor suite, real-time output on the ships DAS system, the SCD-GC for measuring atmospheric DMS, the aerosol particle size suite which identified several pulses of new particle formation, the flux catamaran for measurement of CO_2 and DMS flux at distance from the ship, new microlayer sampling techniques, and the identification of ultrafine particle formation including an organic fraction in shipboard measurement and bubble burst experiments with detection by TDMA (see above highlight).

NZ Geotraces voyage, June 2011

Continuation of bimonthly Munida/Polaris time-series transect in Sub-Antarctic Water

Aerosol dust and CN sampling on the *Transfuture Five* Car Carrier, Wellington-Osaka, Japan

Participation in OSO2011 voyage, Dec 2010 / Jan 2011 University of Gothenburg (Sweden) ocean-atmosphere-ice carbon exchange

NZ 5th Annual Workshop on Ocean Acidification, NIWA Wellington; 22/8/11

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

Boyd, P.W; Law, C.S. (2011). An Ocean Climate Change Atlas for New Zealand waters. NIWA Information Series No. 79. 20p. ISSN 1174-264X

DWR Wallace, CS Law, PW Boyd, Y Collos, P Croot, K Denman, PJ Lam, U Riebesell, S Takeda, & P Williamson: 2010. Ocean Fertilization. A Scientific Summary for Policy Makers. IOC/UNESCO, Paris. (IOC/BRO/2010/2).

RSNZ Workshop on Geoengineering Feb 2011 - Lectures by P.W. Boyd, C. S. Law and M. Harvey

5th SOLAS summer school in Corsica - P.W. Boyd lecturer

IPCC WG2 Chapter 6 on Ocean Systems, P.W. Boyd Lead Author

4. Top 10 publications in 2011 (Reports, articles, models, datasets, products, website etc)

Law, C.S., Ellwood, M., Woodward, E.M.S. Marriner, A. & K. Safi. Response of surface nutrients inventories and nitrogen fixation to a tropical cyclone in the South-West Pacific. *Limnol. Oceanogr.*, 56(4), 2011, 1372–1385

Boyd, P.W., C.S. Law, and S.C. Doney. 2011. Commentary: A Climate Change atlas for the ocean. *Oceanography* 24(2):13–16, doi:10.5670/oceanog.2011.42.

Stubbins, A., C. S. Law, G. Uher, and R. C. Upstill-Goddard. 2011. Carbon Monoxide Apparent Quantum Yields and Photoproduction in the River Tyne. Biogeosciences 8, 703–713. doi:10.5194/bg-8-703-2011

Kitidis, V., Tilstone, G.H., Smyth, T.J., Torres, R. & C.S. Law. 2011. Carbon Monoxide Emission from a Mauritanian Upwelling Filament. *Mar. Chem.,* 127:123–133.

Harvey, M.J. & Law, C.S., The SOLAS Air-Sea Gas Exchange Experiment (SAGE) 2004. 2011. *Deep-Sea Res II,* 58(6)

Law, C.S., Smith, M., Stevens, C., Abraham, E.R., Hill, P., Ellwood, M. 2011. The impact of mixing and dilution on phytoplankton response to iron addition in sub-Antarctic HNLCLSi waters. *Deep-Sea Res II,* 58:786–799.

Stevens, C; Ward, B; Law, C.S.; Walkington, M. 2011. Surface layer mixing during the SAGE ocean fertilization experiment. *Deep-Sea Res II,* 58:776-785.

Currie, K.I., Macaskill, B., Reid, M.R., Law, C.S. 2011. Processes governing carbonate chemistry during the SAGE experiment. *Deep-Sea Res II,* 58:851-860

Harvey, M.J., Law, C.S., Smith, M.J., Hall, J.A., Abraham, E.R., Stevens, C., Hadfield, M., Ho, D.T., Ward, B., Archer, S.D., Cainey, J., Currie, K., Devries, D., Ellwood, M., Hill, P., Jones, G.B., Katz, D., Kuparinen, J., Macaskill, B., Main, W., Marriner, A., McGregor, J., McNeil, C., Minnett, P.J., Nodder, S., Peloquin, J., Pickmere, S., Pinkerton, M., Safi, K., Thompson, R., Walkington, M., Wright, S.W., Ziolkowski, L. 2011. The SOLAS Air-Sea Gas Exchange Experiment (SAGE) 2004. *Deep-Sea Res II,* 58:753.763.

Peloquin, J., Hall, J., Safi, K., Ellwood, M., Law, C.S., Thompson, K., Kuparinen, J., Harvey, M. and S. Pickmere. 2011. Control of the phytoplankton response during the SAGE experiment: a synthesis. *Deep-Sea Res II,* 58:824-838.

Smith, M. Ho, D.; Law, C.S., Schlosser, P., McGregor, J. 2011. Uncertainties in Gas Exchange Parameterisation during the SAGE dual-tracer experiment. *Deep-Sea Res II,* 58:869-881.

Archer, S.D.; Safi, K.; Hall, A.; Cummings, D.G.; Harvey, M. 2011. Grazing suppression of dimethylsulphoniopropionate (DMSP) accumulation in iron-fertilised, sub-Antarctic waters. *Deep-*

Sea Res II. 58:839-850.

Peloquin, J.; Hall, J.; Safi, K.; Smith Jr, W.O.; Wright, S.; van den Enden, R. 2011. The response of phytoplankton to iron enrichment in Sub-Antarctic HNLCLSi waters: Results from the SAGE experiment. *Deep-Sea Res II*, 58:808-823.

Hadfield, M.G. 2011. Expected and observed conditions during the SAGE ocean fertilization experiment. *Deep-Sea Res II,* 58:764-775.

Kuparinen, J., Hall, J., Ellwood, M., Safi, K., Peloquin, J. and D. Katz. 2011. Bacterioplankton responses to iron enrichment during the SAGE experiment. *Deep-Sea Res II,* 58:800-807.

Minnett, P.J., Smith, M. and B. Ward. 2011. Measurements of the oceanic thermal skin effect. *Deep-Sea Res II,* 58:861-868.

Catriona L. Hurd, Christopher E. Cornwall, Kim Currie, Christopher D. Hepburn, Christina M. Mcgraw, Keith A. Hunter and Philip W. Boyd (2011). Metabolically induced pH fluctuations by some coastal calcifiers exceed projected 22nd century ocean acidification: a mechanism for differential susceptibility? *Global Change Biology*, doi: 10.1111/j.1365-2486.2011.02473.x

Keith A. Hunter, Peter S. Liss, Vanisa Surapipith, Frank Dentener, Robert Duce, Maria Kanakidou, Nilgun Kubilay, Natalie Mahowald, Greg Okin, Manmohan Sarin, Mitsuo Uematsu and Tong Zhu (2011). Impacts of anthropogenic SO_x, NO_x and NH_3 on acidification of coastal waters and shipping lanes. Geophys. Res. Lett.,38,L13602,doi:10.1029/2011GL047720

Christopher E. Cornwall, Christopher D. Hepburn, Daniel Pritchard, Kim I. Currie, Christina M. McGraw, Keith A. Hunter and Catriona L. Hurd (2011). Differential responses of macroalgae with various carbon-use strategies to ocean acidification: testing the effect of CO_2 vs HCl as methods of reducing seawater pH. *Journal of Phycology* (accepted).

Gregory Okin, Alex Baker, Ina Tegen, Natalie Mahowald, Frank Dentener, Robert Duce, James N. Galloway, Keith Hunter, Maria Kanakidou, Nilgun Kubilay, Joseph Prospero, Manmohan Sarin, Vanisa Surapipith, Mitsuo Uematsu, and Tong Zhu (2011). Impacts of atmospheric nutrient deposition on marine productivity: roles of nitrogen, phosphorus, and iron. *Global Biogeochemical Cycles* (in press).

Currie, K.I., M.R. Reid and K.A. Hunter (2011). Interannual variability of carbon dioxide drawdown by subantarctic surface water near New Zealand, *Biogeochem*istry 104(1): 23-34, doi: 10.1007/s10533-009-9355-3.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

SOAP (Surface Ocean Aerosol Processes) voyage – February 2012 - QUT, CSIRO (Australia), UEF (Finland), UC Irvine, U. Chapman (USA), NUIG(Ireland), IFM-Geomar (Germany), U. Laval (Canada)

NZ Geotraces voyage – June 2011 – U. S. California, Bigelow (USA), PML (UK), ANU (Australia)

Transfuture Five aerosol sampling - NIES (Japan), UEA (UK)

OSO2011 voyage, Dec 2010 / Jan 2011 University of Gothenburg (Sweden) ocean-atmosphere-ice carbon exchange

6. Goals, priorities and plans for future activities/events

Completion of SOAP voyage, February 2012

Maintain NZ bimonthly Munida/Polaris time-series transect in Sub-Antarctic Water

Maintain Aerosol dust and CN sampling on the *Transfuture Five* Car Carrier, Wellington-Osaka, Japan

7. Other comments

SOLAS Peru

compiled by Michelle Graco

With the scientific contribution and participation of the Direction of Oceanography and Climate Change from the Marine Research Institute of Peru (IMARPE) and Dr H. Bange, T. Baustian from the Biogeochemistry Group and the SFB 754/IFM-GEOMAR.

Reporting Period is January 2012 – December 2012

1. Scientific highlights

1- "M91 PERU SOPRANO" A SOLAS CRUISE ALONG THE PERUVIAN COAST

Between December 1 and 26 professionals from the Chemical and Biological Oceanography staff from the Marine research Institute of Peru (IMARPE) participate in the METEOR cruise 91 along the Peruvian upwelling area with the goal to assess the role of this area as source or sink of climate relevant trace gases. This cruise involved different sub-projects of SOPRAN and several international partners with the principal investigator Dr. Herman Bange (GEOMAR-Kiel GERMANY) and is a contribution to the *SOLAS (Surface Ocean – Lower Atmosphere Study)* midterm strategy initiative 'Air-sea gas fluxes at eastern boundary upwelling and oxygen minimum zones systems'. The antecedents in the area show that most of the water column off Callao in different periods of the year, appears oversaturated with N_2O, indicating an intense production associated by an intense and shallow Oxygen Minimum Zone. During the SOPRANO SOLAS cruise was explored the latitudinal distribution of N_2O and others gases as the DMS and the magnitudes of the exchange fluxes. The Peruvian team participate in the phytoplankton characterization and the connection with the DMS production. In addition in the frame of the cooperation with University of Xiamén (China) and the acidification research samples from Callao were collect to analyze the alkalinity and Total CO_2 distribution. Results will be available in 2013.

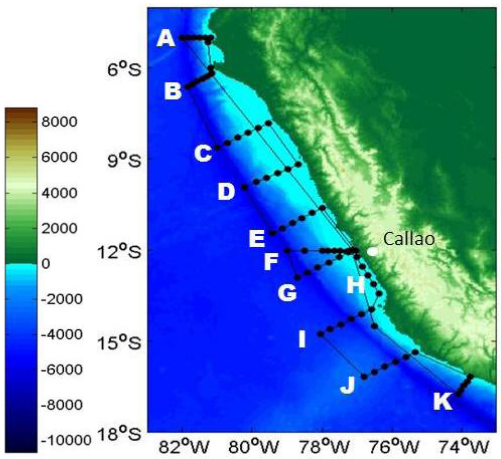


Figure 1. Cruise track SOPRAN CRUISE (topography map) on the R/V Meteor on the top. Cruise scientific group (PI: H. Bange) with the participation from IMARPE of Avy Bernales, Violeta León and Georgina Flores (IMARPE). Thanks to H. Bange pictures.

2- A PERUVIAN-FRENCH PROJECT "AMOP, SUBSURFACE MOORING OFF CENTRAL PERU

This project is in the frame of the agreement between the Marine Research Institute from Peru (IMARPE) and the Development Research Institute (IRD), the international Mix Laboratory LMI DISCOH "Dinámica del Sistema de la Corriente de Humboldt". This initiative is leading by the French scientist from LEGOS: A.Paulmier(IRD), B.Dewitte(IRD), C.Maes(/IRD) and V.Garçon(CNRS) in close collaboration with scientist from IMARPE in particular the Chemical Oceanographic Research Area (PI: Ing. O. Morón). AMOP mooring is a contribution with the Mid-Term Strategy Initiatives of the research SOLAS program (Surface Ocean-Lower Atmosphere Study) associated with the Eastern Boundary Upwelling Systems and the OMZ with the main goal to obtain high resolution measurements of dissolved oxygen in order to build up an oxygen balance in the area, to know the processes involved and the potential impact related with deoxigenation. The deployment of the subsurface mooring in front of Callao will take place on the January 5th 2013 on board of the METEOR research vessel (with the support of the GEOMAR-SFB 754 project). The AMOP mooring will be used as a multidisciplinary observational platform contributing with different aspects and research thematics of IMARPE. First data will be recover in March 2013.

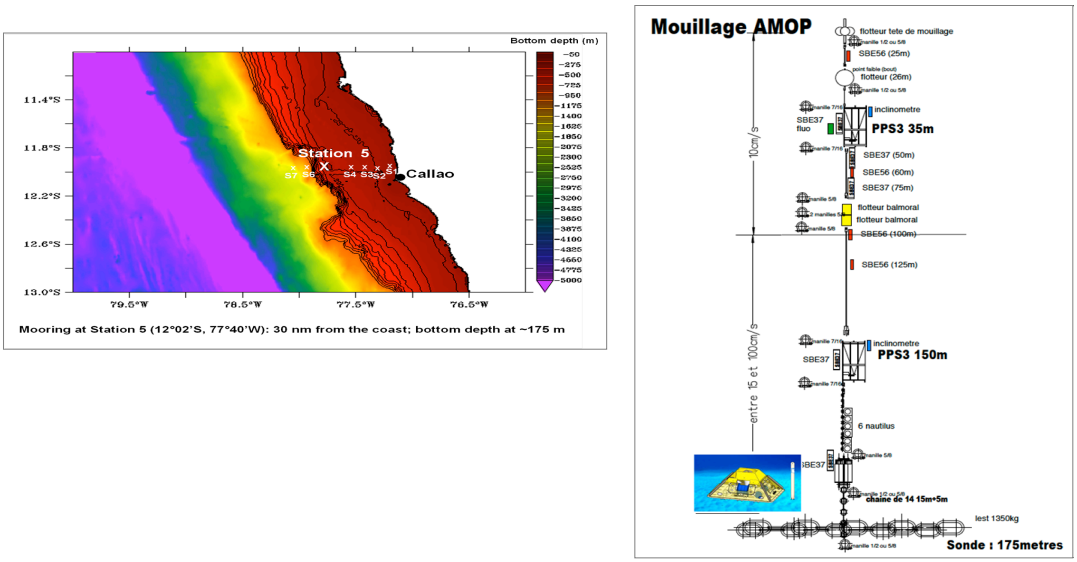


Figure. 2. Left. Mooring position at the continental shelf off Callao. Right. General scheme of the mooring including the botttom ADCP line and the line equipped with sensors.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Between 26-27 November, scientist from different disciplines and nationalities participate in the **Workshop on Towards an integrative regional coupling in the EBUS, at the Instituto de Geofísica de Perú (IGP), Lima Perú.** This workshop was in the frame of the SOLAS Mid Term Strategy Initiative "Air-sea gas fluxes at Eastern boundary upwelling and Oxygen Minimum Zone (OMZ) systems". After the workshop several scientist was involved in an open day series of conference for the student community.

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

See point 2.

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Paulmier, V. Garçon, M. Graco, C. Maes, D. Gutiérrez, B. Dewitte and K. Takahashi. AMOP: Activity of research dedicated to the Minimum of Oxygen in the Eastern Pacific. SOLAS. Newsletter Summer 2012. Issue14.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

See point 1.

6. Goals, priorities and plans for future activities/events

Short and long term goals:

-Establish time series measurements of the carbonate system (total CO2, pH and alkalinity) and N_2O off Callao (Central Perú) and at long-term establish the analysis of the carbonate system and of the N_2O analysis at IMARPE.

-To participate in national and international efforts to curry out multidisciplinary research focus in the SOLAS OMZs-EBUEs Mid-Term Strategy Iniciative topics.

-Build a national network with scientists from different disciplines and institutions from Peru in order to have a local network for communication of SOLAS activities and to coordinate studies in the frame of SOLAS Mid-Term strategy topicsassociated with the SOLAS.

7. Other comments

SOLAS Spain

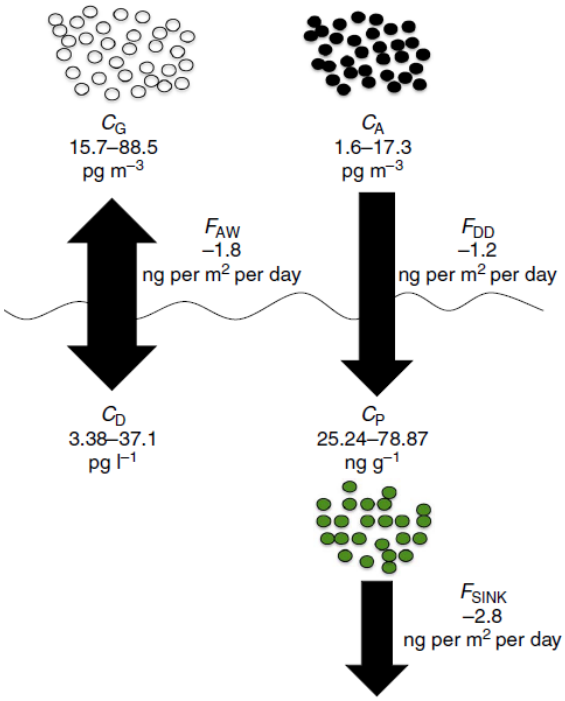
compiled by Rafel Simo

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight. Please focus on results that would not have happened without SOLAS.*

Sequestration of organic pollutant by the oceanic biological pump



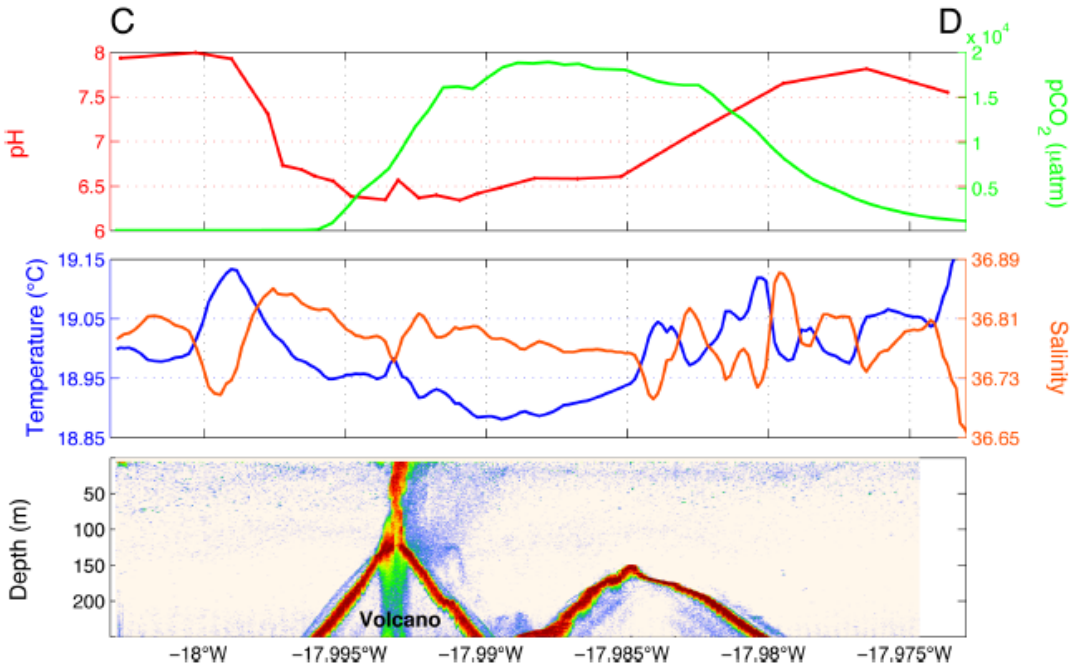
Simultaneous sampling of atmospheric samples (gas and aerosols), seawater and phytoplankton in the North Atlantic and Arctic Ocean in 2007 has allowed to show that the biological pump removes efficiently hydrophobic organic pollutants, such as polychlorinated biphenyls (PCBs), from the surface ocean, enhancing the atmospheric deposition and thus modulating the atmospheric transport of organic pollutants to the Arctic Ocean.

Reference: Galbán-Malagón et al. (2012). The oceanic biological pump modulates the atmospheric transport of persistent organic pollutants to the Arctic. *Nature Communications* 3, 862, DOI: 10.1038/ncomms1858.

Contact person: J. Dachs, IDAEA-CSIC <jordi.dachs@idaea.csic.es>

The surface ocean effects of the El Hierro submarine eruption

An intensive study has been conducted on the effects of the October 2011 shallow submarine eruption south of El Hierro (Canary Islands) on the physicochemical properties of the surrounding seawater. A total of 7 cruises reported large quantities of mantle-derived gases, solutes and heat, and the consequent extreme physical-chemical perturbations comprising thermal changes, water acidification, deoxygenation and metal-enrichment, which resulted in significant alterations of the activity and composition of local biological communities.



Surface measurements of pH, pCO2, temperature and salinity along a transect crossing the volcano 5 months after the beginning of the eruptive process. (Fraile-Nuez et al. 2012)

Reference: E. Fraile-Nuez, M. González-Dávila, J.M. Santana-Casiano, J. Arístegui, I.J. Alonso-González, S. Hernández-León, M.J. Blanco, A. Rodríguez-Santana, A. Hernández-Guerra, M.D. Gelado-Caballero, F. Eugenio, J. Marcello, D. De Armas, J.F. Domínguez-Yanez, M.F. Montero, D.R. Laetsch, P. Vélez-Belchi, A. Ramos, A.V. Ariza, I. Comas-Rodríguez, V.M. Benítez-Barrios (2012). The submarine volcano eruption at the island of El Hierro: Physical-chemical perturbation and biological response. *Scientific Reports* 2, 486, doi:10.1038/srep00486

Contact person: J.M. Santana-Casiano, Univ Las Palmas de Gran Canaria <jmsantana@dqui.ulpgc.es>

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Research Projects:

CARBOCHANGE (Changes in carbon uptake and emissions by oceans in a changing climate), funded by the 7th Frame Program of the European Commission, 2011-2014. Spanish partners: CSIC and Universidad de Las Palmas de Gran Canarias. Contacts: A.F. Rios, IIM-CSIC <aida@iim.csic.es>; M. González-Dávila, ULPGC <mgonzalez@dqui.ulpgc.es>,

INGOS (Integrated non CO_2 greenhouse gas observing system), funded by the 7th Frame Program of the European Commission, 2011-2015. Spanish partners: CSIC and Fundación Centro de Estudios Ambientales del Mediterráneo. Contact: E. Huertas, ICMAN-CSIC <emma.huertas@icman.csic.es>

ICOS (Integrated Carbon Observation System), funded by the Spanish Ministry of Sciences and

Innovation and aimed at establishing the national network of carbon observatories in terrestrial ecosystems, atmosphere and ocean, 2011-2012. Contact: : E. Huertas, ICMAN-CSIC <emma.huertas@icman.csic.es>

"Study of the biogeochemical behaviour of Fe in acidified marine environments", funded by the MICINN (Spain), Univ Las Palmas de Gran Canarias. PI and contact: J.M. Santana-Casiano <jmsantana@dqui.ulpgc.es>

ADEPT (Aerosol deposition and ocean plankton dynamics), funded by the MINECO (Spain), 2012-2014, ICM-CSIC. PI and contact: F. Peters <cesc@icm.csic.es>

Cruises:

Four oceanographic campaigns at the Strait of Gibraltar on board the RVs García del Cid (February), Sarmiento de Gamboa (June), Ramón Margalef (August) and Cornide de Saavedra (October) were conducted to sample the GIFT time series, and for maintenance and data dowload of moored pCO_2 and pH sensors that are used to monitor the temporal variability of CO_2 and ocean acidification in the outflow of Mediterranean water. PI and contact: E. Huertas, ICMAN-CSIC <emma.huertas@icman.csic.es>

The CATARINA oceanographic cruise was conducted on board the RV Sarmiento de Gamboa along the OVIDE section and across the Labrador sea, in the North Atlantic, 22 June to 12 August. Researchers from the IIM-CSIC (Vigo), ICM-CSIC (Barcelona), Universidad de Vigo, University of Bremen and Ifremer-Brest conducted measurements of the carbon system and biogeochemical tracers. Chief scientist and contact: A.F. Ríos, IIM-CSIC <aida@iim.csic.es>

BIMBACHE cruises, November 2011 to April 2012. 7 cruises led by the IEO visited the submarine volcano south of the Island of El Hierro, in the Canary Islands. The QUIMA group at the Univ Las Palmas de Gran Canarias was responsible for the measurements of the carbonate system variables, sulfur and iron reduced species. Contact: M. González-Dávila <mgonzalez@dqui.ulpgc.es>

Clivar 2012 section A1E along 59.5ºN, cruise AI38, June 2012. Led by the Shirshov Institute of Oceanology, Russia. The QUIMA group at the ULPGC was responsible for the determination of the carbonate system variables. Contact: M. González-Dávila <mgonzalez@dqui.ulpgc.es>

SUMMER-2 in the NW Mediterranean on board the RV García del Cid, 21-23 May. A lagrangian, high resolution study of diel cycles in dimethylsulfide concentrations and bio-optics was conducted. Chief scientist and contact: R. Simo, ICM-CSIC <rsimo@icm.csic.es>

Remote sensing:

Use of a real-time remote monitoring network (RTRM) to characterize the Guadalquivir estuary ecosystem, including variables involved in the carbon cycle (Navarro et al., 2012. Sensors 12: 1398-1421, doi:10.3390/s120201398)

Use of DEIMOS-1 satellite to provide high spatial resolution measurements (22m) of Guadalquivir river plume dynamics, wetland flood levels in the Doñana NP and intertidal vegetation changes (Caballero et al., 2012. Sea Technology, 53, 2: 10-13).

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

Peters, F. 2012. ADEPT: Aerosol deposition and ocean plankton dynamics. SOLAS News, Issue 14.

Flecha, S. 2012. The characterisation and quantification of carbon cycle processes in the Gulf of Cádiz and the Strait of Gibraltar. SOLAS News, Issue 14.

TV documentary (Espacio protegido) shown in Canal Sur channel the 2nd of June 2012 presenting the activities that are being conducted in observatory of the Strait of Gibraltar to monitor the effects of climate change on the Mediterranean. Release included the functioning and regulation of the carbon system in the area. Contact: E. Huertas, ICMAN-CSIC <emma.huertas@icman.csic.es>

The Malaspina Circumnavigation 2010-2011 team, led by C. Duarte (IMEDEA-CSIC), has produced a number of TV documentaries, participations in the media, and talks in research centers, primary and secondary schools, associations and NGOs, always with the aim to communicate about the role of the oceans in the functioning of the Earth System and the importance of ocean's exploration to the grand challenges of mankind. The book *España explora. Malaspina 2010. Cambio global y biodiversidad en el océano* (M.A. Puig-Samper, S. Rebok, eds.) has been published and distributed by the CSIC and the Fundación BBVA. The Project has also issued a White Book of Methods and launched an exhibition on past and current ocean's exploration. Contact: C. Duarte <carlosduarte@imedea.uib-csic.es>

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Fernández, A., Graña, R., Mouriño-Carballido, B., Bode, A., Varela, M., Domínguez-Yanes, J. F., Escánez, J., de Armas, D., Marañón, E. (2012) Community N2 fixation and Trichodesmium spp. abundance along longitudinal gradients in the eastern subtropical North Atlantic. *ICES J Mar Sci*, doi: 10.1093/icesjms/fss142.

Friedrich, T., A. Timmermann, A. Abe-Ouchi, N. R. Bates, M. O. Chikamoto, M. J. Church, J. E. Dore, D. K. Gledhill, M. González-Dávila, M. Heinemann, T. Ilyina, J. H. Jungclaus, E. McLeod, A. Mouchet and J. M. Santana-Casiano (2012). Detecting regional anthropogenic trends in ocean acidification against natural variability. *Nature Clim Change*. DOI: 10.1038/NCLIMATE1372.

Galbán-Malagón, C., N. Berrojalbiz, M.J. Ojeda, J. Dachs (2012). The oceanic biological pump modulates the atmospheric transport of persistent organic pollutants to the Arctic. *Nature Comm* 3, 862, DOI: 10.1038/ncomms1885.

Hönisch B., Ridgwell A., Schmidt D.N., Thomas E., Gibbs S.J., Sluijs A., Zeebe R., Kump L., Martindale R.C., Greene S.E., Kiessling W., Ries J., Zachos J.C., Royer D.L., Barker S., Marchitto Jr. T.M., Moyer R., Pelejero C., Ziveri P., Foster G.L. and Williams B. (2012) The geological record of ocean acidification. *Science* 335: 1058-1063.

Huertas IE, Rios AF, García-Lafuente J, Navarro G, Makaoui A, Sánchez-Román A, Rodríguez-Gálvez S, Orbi A, Ruiz J, Perez FF. (2012) Atlantic forcing of the Mediterranean oligotrophy. *Global Biogeochem Cycles* 26, GB2022. doi:10.1029/2011GB004167.

Lana, A., R. Simó, S.M. Vallina, J. Dachs (2012). Potential for a biogenic influence on cloud microphysics over the ocean: a correlation study with satellite-derived data. *Atmos Chem Phys* 12:

7977–7993.

Llabrés, M., J. Dachs, S. Agustí (2012). Transference of atmospheric hydroxyl radical to the ocean surface induces high phytoplankton cell death. *Photochem Photobiol* 88, 1473-1479.

Mouriño-Carballido, B., Pahlow, M., Oschlies, A. (2012) High sensitivity of ultra-oligotrophic marine ecosystems to atmospheric nitrogen deposition. *Geophys Res Lett* 39, L05601, doi:10.1029/2011GL050606.

Movilla J., Calvo E., Pelejero C., Coma R., Serrano E., Fernández-Vallejo P. and Ribes M. (2012) Calcification reduction and recovery in native and non-native Mediterranean corals in response to ocean acidification. *J Exp Mar Biol Ecol* 438: 144-153.

Vázquez-Rodríguez, M, Padin, XA, Ríos, AF, Pérez, FF (2012). The subsurface layer memory of water mass formation conditions in the Atlantic: A reliable reference to estimate preformed properties and air-sea CO2 disequilibria. *J Mar Sys* 92: 52–63, doi:10.1016/j.jmarsys.2011.10.008.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Links with observation and integration communities:

CARBOCHANGE (Changes in carbon uptake and emissions by oceans in a changing climate), funded by the 7th Frame Program of the European Commission, 2011-2014. Spanish partners: CSIC and Universidad de Las Palmas de Gran Canarias. Contacts: A.F. Rios, IIM-CSIC <aida@iim.csic.es>; M. González-Dávila, ULPGC <mgonzalez@dqui.ulpgc.es>,

INGOS (Integrated non CO_2 greenhouse gas observing system), funded by the 7th Frame Program of the European Commission, 2011-2015. Spanish partners: CSIC and Fundación Centro de Estudios Ambientales del Mediterráneo. Contact: E. Huertas, ICMAN-CSIC <emma.huertas@icman.csic.es>

6. Goals, priorities and plans for future activities/events

2013 brings the launch of a new 3-years project: MANIFEST (Marine Acidification: New Insights From manipulative Experiments on selected Species and paleoceanographic reconstructions over key periods of Time), led by C. Pelejero, ICM-CSIC (pelejero@icm.csic.es) and funded by the MINECO (Spain). MANIFEST delves into the study of ocean acidification from pH manipulation experiments targeting a selection of key marine organisms (jellyfish, marine sponges, coccolithophores and cold-water corals). This project also aims to provide new evidence regarding the linkage between the Southern Ocean and the tropical Pacific Ocean over glacial to interglacial times and its role in regulating atmospheric CO_2 concentration, from the comparison of deep-sea sediment core paleoreconstructions in the Eastern Equatorial Pacific and in the New Zealand Sector of the Southern Ocean.

Another 3-year project launched in 2013 is PEGASO (Plankton-derived Emission of trace Gases and Aerosols in the Southern Ocean), led by R. Simó, ICM-CSIC (rsimo@icm.csic.es) and funded by the MINECO (Spain). PEGASO aims at investigating the biological factors driving plankton-derived production and emission of aerosol forming substances, namely

some trace gases, microgels and biological particles. Towards this goal, the project will combine process-oriented experiments, a time-series study in the coastal Mediterranean, and an oceanographic cruise to the Atlantic-Antarctic sector of the Southern Ocean.

7. Other comments

The research groups from the Univ Vigo, ICMAN-CSIC and ICM-CSIC were represented in the SOLAS-Open Science Conference held in Cle Elum, WA, (USA) in May.

SOLAS Turkey

compiled by Mustafa Kocak, Baris Salihoglu

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Key scientific SOLAS-relevant highlights/findings (you may include figures and references)

Influence of mineral dust transport on the Chemical Composition and Physical Properties of the Eastern Mediterranean aerosol

M. Koçak, C. Theodosi, P. Zarmpas, M.J.M., Séguret, B. Herut, G. Kallos, N. Mihalopoulos , N. Kubilay and M. Nimmo

Atmospheric Environment, 57, 266-277, 2012

Temporal and geographical variability in the aerosol chemical and physical properties, in the Eastern Mediterranean atmosphere have been investigated through samples simultaneously collected from three coastal rural sites during two distinct dust periods; October (2007) and April (2008). From these findings the following conclusions may be made:

Crustal elements (Al, Fe, Mn and Ca as well, see Table 1) were found to be 2 to 4 times higher at ER and TS than that of HR during October 2007 because the influence of mineral dust transport particularly from the desert areas located at the Middle East (see Table 2). Nonetheless, the concentration diagrams comparing elemental composition for April 2008 reveal strong similarity. This distinct difference suggested i) the Middle East desert may play a significant role to supply of mineral dust particle but over a more restricted area covering the far Eastern Mediterranean in October and ii) whereas, mineral dust particles from Saharan desert may impact larger area covering the whole Eastern Mediterranean during April.

Possible mineral dust source areas were identified applying threshold aerosol Al concentration (Al > 1000 ng m^{-3}), Skiron dust model simulations and 3-days backward trajectories. By this means, the dust events were categorized into three groups namely, Middle East, Mixed and Saharan desert (see Table 2). ER and TS were substantially affected by dust events originated from the Middle East particularly in October whilst HR was not influenced by dust transport from the Middle East.

Although TS revealed the highest Al concentration with a value around 6300 ng m^{-3}, observed AI and AOT values were relatively lower. Al concentrations at ER were similar for both October and April, whilst OMI-AI and AOT values in April were ~2 times higher than that observed for October (see Table 1). This might be attributed to a) the weak sensitivity of the TOMS instrument to absorbing aerosols near the ground underestimating dust at heights less than 1.5 km and b) optical difference between Middle East desert dusts and Saharan desert dust.

During dust events concentrations of anthropogenic aerosol species were found to be 1.1 to 4.1 times higher than those for non-dust events (see Table 1). These species were particularly found to be enhanced when mineral dust arrived at sites after passing through populated and industrialized urban areas. Amongst the sites, the lowest enhancement of anthropogenic aerosol species was observed at HR during dust events. Indeed, the lowest $nssSO_4^{2-}/nssCa^{2+}$ ratio with a value of 0.13 was observed at HR reported in region shows minimal interaction between sulfate and mineral dust.

Table 1. Geometric mean concentrations of aerosol species, aerosol index (AI), aerosol optical thickness (AOT) and fine fraction (FF) for dust and non-dust events at Erdemli, Heraklion and Tel Shikmona October 2007 and April 2008.

Species	Erdemli (n=54)		Heraklion (n=48)		Tel Shikmona (n=40)	
	October	April	October	April	October	April

	Dust	Non-dust	Dust	Non-dust	Dust	Non-dust	Dust	Non-dust	Dust	Non-dust	Dust	Non-dust
Al	3181	599	3163	328	2241	293	3500	201	2022	547	6356	299
Fe	2222	396	1862	246	1937	320	2380	224	1751	532	3847	208
Ca	8162	2462	7024	2028	7313	2121	9298	1204	5527	2517	13997	1366
Mn	43.2	9.0	32.0	5.3	29.8	6.7	38.4	2.2	26.6	8.0	70.1	4.7
Ca/Al	2.6	4.1	2.2	6.2	3.3	7.2	2.7	6.0	2.7	4.6	2.2	4.6
Cr*	5.1	1.2	5.1	1.8	0.8	0.7	2.7	1.7	2.7	0.6	0.7	0.5
Zn*	22.8	12.4	20.4	12.1	13.8	9.9	12.3	4.8	41.1	27.9	40.6	38.3
V*	6.3	0.9	5.4	1.6	10.0	6.3	5.5	2.6	7.4	3.6	6.2	1.1
Ni*	7.1	2.1	4.1	1.8	7.1	6.2	2.8	0.9	4.9	1.9	5.7	1.0
Cu*	4.3	4.3	5.6	4.9	7.4	5.9	4.9	1.9	6.6	3.7	6.3	1.9
Cd*	0.32	0.13	0.17	0.09	0.13	0.08	0.05	0.03	0.20	0.11	0.31	0.13
Pb*	15.1	6.9	8.8	4.4	4.8	2.8	2.3	1.6	5.1	3.1	8.6	2.3
Na^+	1148	1112	2044	2500	1954	1941	1106	1729	6418	2374	3379	5089
Cl^-	1983	1854	2469	3236	2301	2373	2305	2691	12585	4569	7948	9193
Mg^{2+}	423	281	591	369	310	215	407	219	947	501	941	663
K^+	486	264	466	322	298	215	198	170	511	362	519	351
Ca^{2+}	7085	2112	6124	1761	6281	1861	8264	1018	4561	1774	7819	1037
NH_4^+	1707	1034	1761	1537	894	952	260	726	1020	804	1121	1002
NO_3^+	6427	2701	10869	4424	5614	3657	2830	2188	6604	4680	10001	3407
$nssSO_4^{2-}$	5483	2402	6991	4041	5050	2750	2268	1572	4093	2873	6911	3153
$C_2O_4^{2-}$	474	197	474	223	622	439	140	79	736	519	484	87
AI	0.86	0.73	1.55	0.82	1.23	0.80	1.35	0.74	0.89	0.69	1.35	0.81
AOT	0.41	0.17	0.64	0.24	0.49	0.20	0.61	0.21	0.24	0.22	0.48	0.22
FF	0.38	0.45	0.15	0.28	0.35	0.54	0.20	0.28	0.23	0.27	0.13	0.33

Shows anthropogenic fractions of aerosol trace metals

Table 1. Identified dust events along with possible desert source areas.

Erdemli (ER)			Tel Shikmona (TS)			Heraklion (HR)		
Date	Case	Possible Source	Date	Case	Possible Source	Date	Case	Possible Source
09-13/10/07	*1*	*ME*	*08-09/10/07*	*1*	*ME*	-	-	-
19-24/10/07	*2*	*ME+SAH*	*17-18/10/07*	*2*	*ME*	-	-	-
-	-	-	*26/10/07*	*3*	*SAH*	-	-	-
30/10/07	*3*	*SAH*	*29-31/10/07*	*4*	*SAH*	*29-31/10/07*	*1*	*SAH*
06/04/08	*4*	*SAH*	*06/04/08*	*5*	*SAH*	-	-	-
12-16/04/08	*5*	*SAH*	*13-17/04/08*	*6*	*SAH*	*08-14/04/08*	*2*	*SAH*
21-26/04/08	*6*	*SAH*	*23/04/08*	*7*	*SAH*	*18-23/04/08*	*3*	*SAH*

Bridging marine ecosystem and biogeochemistry research: Lessons and recommendations from comparative studies

B. Salihoglu[1], S. Neuer[2], S. Painting[3], R. Murtugudde[4], E. E. Hofmann[5], J. H. Steele[6], R. R. Hood[7], L. Legendre[8], M. W. Lomas[9], J. Wiggert[10], S. Ito[11], Z. Lachkar[12], G. Hunt[13], K. F. Drinkwater[14], C. L. Sabine[15]

1 Institute of Marine Sciences, Middle East Technical University, Erdemli, Turkey
2 School of Life Sciences, Arizona State University, Tempe, AZ 85287-4501, USA
3 Center for Environment, Fisheries and Aquaculture Science, Pakefield Rd., Lowestoft, Norfolk, NR33 0HT, UK
4 ESSIC, University of Maryland, College Park, College Park, Maryland, USA
5 Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA 23529, USA
6 Woods Hole Oceanographic Institution, 266 Woods Hole Rd., MS# 41, Woods Hole, MA 02543-1050, USA
7 Horn Point Laboratory, University of Maryland Center for Environmental Science, P.O. Box 775, Cambridge, MD 21613, USA
8 Laboratoire d'Oceanographie de Villefranche (LOV) B.P. 28, 06234 Villefranche-sur-Mer Cedex, FRANCE
9 Bermuda Institute of Ocean Sciences, 17 Biological Lane, St. George, GE 01, BERMUDA
10 Univ. of Southern Mississippi Dept. of Marine Sciences, 1020 Balch Blvd. Stennis Space Center, MS 39529-9904, USA
11 Fisheries Research Agency, Tohoku National Fisheries Research Institute, 3-27-5 Shinhama-cho, Shiogama, Miyagi 985-0001, Japan
12 ETH Zürich Inst.f.Biogeochemie u.Schadstoffdynamik CHN E 23.1, Universitätstrasse 16 8092 Zürich, Switzerland
13 Department of Ecology and Evolutionary Biology, University of California, 321 Steinhaus Hall, Irvine, CA 92697-2525, USA
14 Institute of Marine Research and the Bjerknes Center for Climate Research Box 1870, Nordnes, N-5817 Bergen, Norway
15 National Oceanic and Atmospheric Administration (NOAA) Pacific Marine Environmental Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115, USA.

There is growing interest in linking marine biogeochemistry with marine ecosystems research in response to the increasing need to understand and predict the effect of global change on the marine ecosystem. Such a holistic approach combines oceanographic and biogeochemical processes and information on organisms, ranging from microbes to higher-trophic-levels. Comparative studies offer a means to improve understanding of critical mechanisms that influence marine systems by showing differences in ecosystem response to changing ocean conditions. Comparing similar biomes that differ in a particular set of physical or biological characteristics can provide insight into the susceptibility of the key features of a system to perturbation. Also comparative studies based on long-term observations at fixed time-series stations enable the evaluation of long-term changes in the physical and biological environment, such as those driven by climate patterns. Moreover, the comparative approach provides a feasible alternative to costly and complex research programs designed to provide detailed end-to-end evaluations of marine systems. Planned and unplanned perturbations allow the investigation of the sensitivity of ecosystems and their biogeochemical processes to change at different time and space scales. In well-studied regions where sufficient data are available, models can provide comprehensive syntheses, mechanistic insights and even predictions. We present examples of successful comparative studies that incorporate both biogeochemical and ecosystem aspects. A framework for a basic approach for comparative studies is proposed that considers the interactions between biogeochemical cycles and ecosystems. This approach is based on constructing a minimalistic observational framework grounded within a conceptual model.

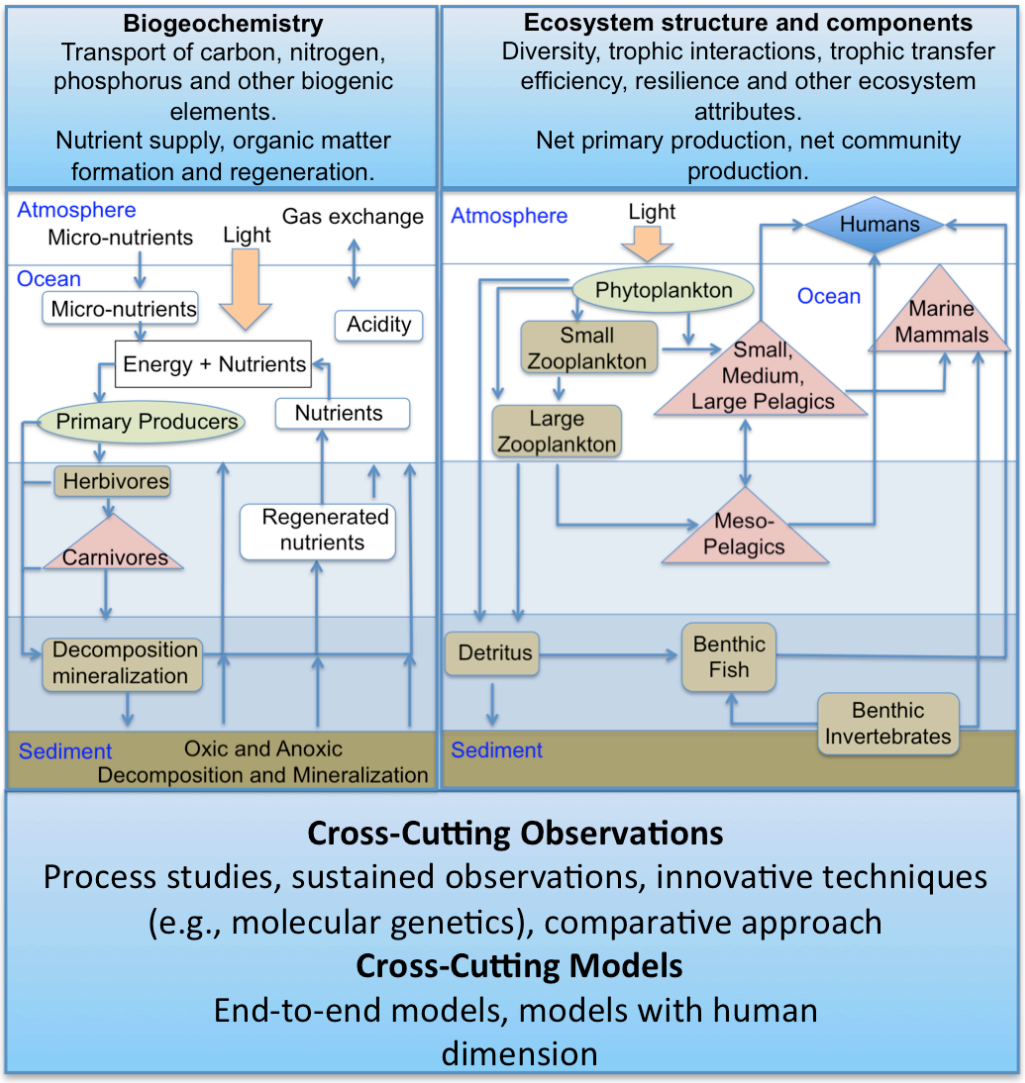


Fig. 1. Upper panels indicate the biogeochemistry and ecosystem processes that need to be integrated in comparative studies, middle panels show interactions on these processes, and the

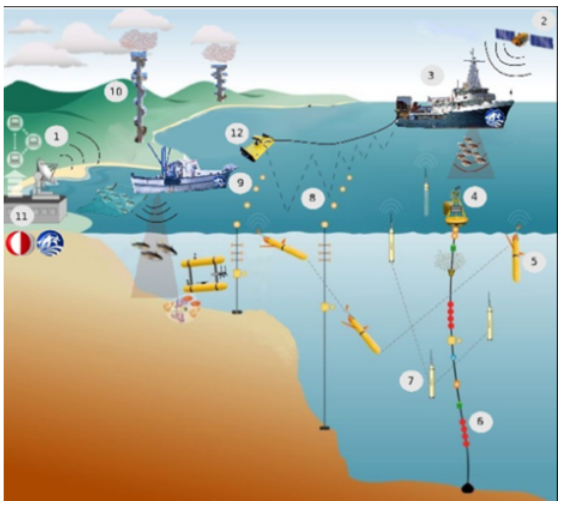
bottom panels provide an overview on cross-cutting tools for comparison.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Center for Marine Ecosystems and Climate Research (CMECLIM) is being founded with the financial support from the Government of the Turkish Republic as the national center of Turkey for climate related studies with special focus on marine ecosystems as well as atmospheric and geosphyical research under the leadership of Institute of Marine Sciences of the Middle East Technical University with the support of 17 governmental and private institutions including universities, governmental offices and private marine engineering companies. The center shall carry out experimental research in line with the objectives and research focus of the Intergovernmental Panel on Climate Change (IPCC) and aim to provide scientific and management-related products primarily for the national institutions of Turkey but also with a global perspective in order to help enhance the climate related research.

Center for Marine Ecosystems and Climate Research (CMECLIM)

Climate related studies with special focus on marine ecosystems as well as atmospheric and geophysical research



Innovative Oceanographic Equipment

RV Bilim-2

Marine Science Laboratory

McDonnell International Scholars Academy Symposium: Global Energy Future October 1 – 5, 2010, USA

The CMECLIM aims to be the leading climate-related research center not only in Turkey but also in the Middle East and Eastern Europe by carrying out experimental studies and providing data-related products for use by other institutions dealing with related research objectives and/or activities in the region. Nationwide, the CMECLIM shall act as the scientific foundation for the Turkish Government to develop measures and management policies within the nation to help the global objective of preventing climate change by anthropogenic interventions. With this in mind, CMECLIM welcomes all scientists, institutions and policy makers across the globe to help carry out climate related research and develop policies for management of anthropogenic activities for

preventing the global climate change.

Last year, IMS-METU atmospheric research group was obtained ICS-5000 and AIM (ambient ion monitor) through national infrastructure project (CMECLIM). The obtained instruments are going to be tested in February 2013.

Atmospheric aerosol filter samples (for Perseus) were collected during IMS-METU cruises from Eastern Mediterranean and Black Sea.

First focus of IMS-METU in the scope of the Black Sea experiment (BSEX) will be the influence of atmospheric nutrient deposition in southern Black Sea, DIN, DIP, DOC, DON, and DOP, as well as selected anthropogenic trace metals, will be determined for at least a 1-year period.

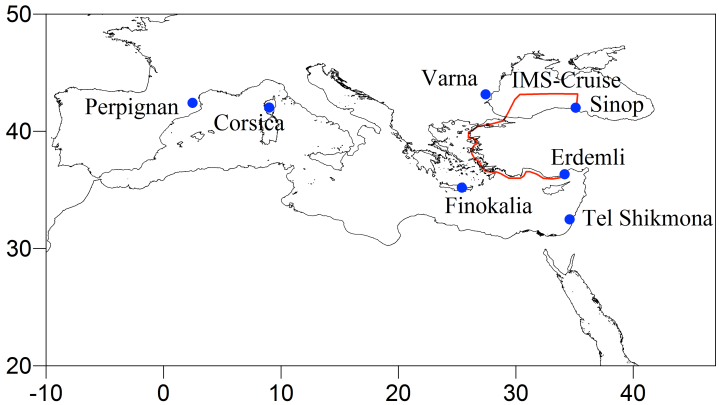


Fig. 2*:* Sampling locations around Mediterranean and Black Sea.

There is limited information about the atmospheric nutrient deposition in Black Sea Basin (Kubilay et al., 1995). In addition, the atmospheric deposition of metals has poorly investigated (Theodosi et al., 2013). According to this study the observed bulk deposition fluxes of major and trace metals are within the range of the reported values for the Mediterranean Sea. By comparing atmospheric deposition fluxes of metals with data from sediment trap collectors, the significant role of the atmosphere as an external source of major and trace metals to the southern Black Sea has been demonstrated.

Additionally, studies have shown that in phytoplankton bloom areas such as Black Sea, the atmospheric organic fraction dominates and contributes up to 63% to the submicrometre aerosol mass (O'Dowd et al., 2004), while emissions from such areas, including amines and methylamines (Facchini et al., 2008), influence importantly the local photochemistry (Yassaa et al., 2008).

To address this gap in the frame of the Perseus project it is planned a series of atmospheric deposition and atmospheric particles samplings in around Black Sea areas (Figure 2) with focus not only to inorganic forms of nutrients but also in organics and trace metals.

<u>Tentative plan on IMS-METU planned Mediterrenean and Black Sea cruise measurements:</u>

- Two cruises in 2013 (March, June tbd)
- Eutrophication O2, nutrients, pH, chl, PAR
- Biodiversity phyto fractional change
- Bacterial biomass/production

- PP
- Phyto-species level
- Zooplankton-higher taxons/group level/jellyfish (IU)
- Fish acoustics/zooplankton, jelly? (biomass, species level)
- Food web PP vs fish biomass
- Contaminants , contaminants in fish (heavy metal)
- Box corer/corer sample
- Eggs/Larvae + Noctiluca
- Atm deposition
- TOC, TN
- Gelatinous
- Eggs and larvae

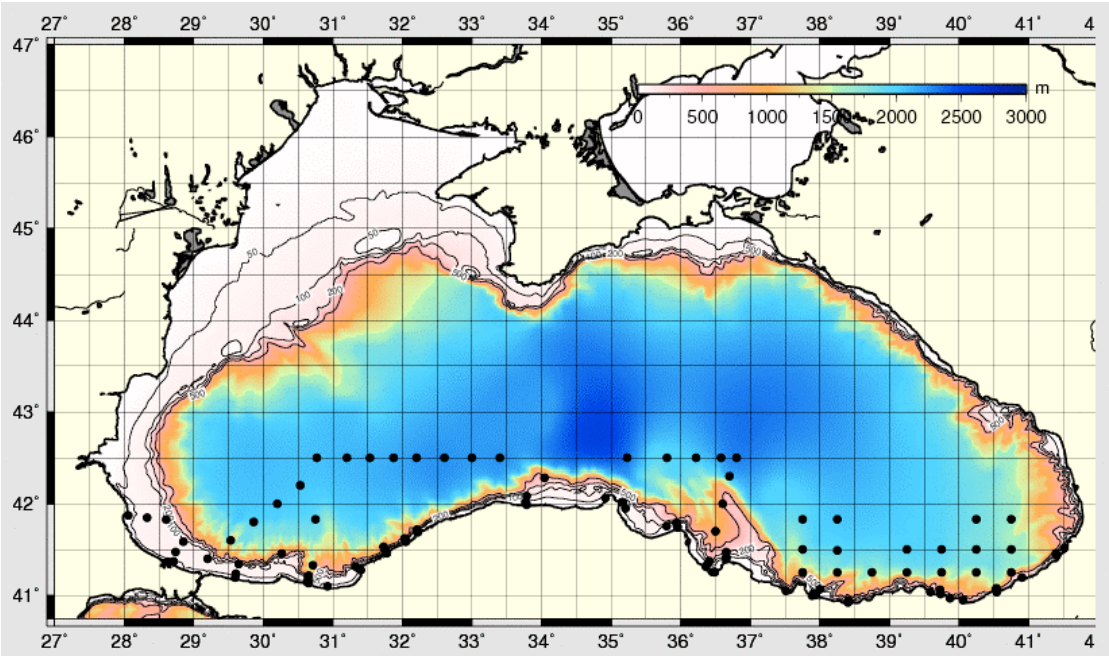


Fig. 3 Tentative cruise track Black Sea experiment by METU

Other Selected Projects – FP7

PERSEUS - Policy-orientated marine Environmental Research for the Southern European Seas

COCONET - Towards COast to COast NETworks of marine protected areas (from the shore to the high and deep sea), coupled with sea-based wind energy potential

MEECE - Marine Ecosystem Evolution in a Changing environment

EURO-BASIN - Basin-scale Analysis, Synthesis & Integration

SEADATANET - Pan-European Infrastructure For Ocean & Marine Data Management

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

CLIMECO3 "A View Towards Integrated Earth System Models. Human-nature Interactions in the Marine World" Summer School is organized in July 2012 in Ankara.

The programme focused on the interface between marine ecosystem biogeochemistry, physical drivers, food webs and socio-economic systems; with lectures on modelling all of these system processes, as well as model coupling and Earth System models. To help understanding there were bdaily "hands-on" sessions with example models.

4. Top 10 publications in 2012 (Reports, articles, models, datasets, products, website etc)

Im, U., Markakis, K., Kocak, M., Gerasopoulos, E., Daskalakis, N., Mihalopoulos, N., Poupkou, A., Kindap, T., Unal, A., Kanakidou, M., (2012) Summertime aerosol chemical composition in the Eastern Mediterranean and its sensitivity to temperature. Atmospheric Environment, 50, 164-173 DOI: 10.1016/j.atmosenv.2011.12.044.

Koçak, M., Theodosi, C., Zarmpas, P., Seguret, M.J.M., Herut, B., Kallos, G., Mihalopoulos, N., Kubilay, N., Nimmo, M., (2012) Influence of mineral dust transport on the chemical composition and physical properties of the Eastern Mediterranean aerosol. Atmospheric Environment, 57, 266-277, DOI: 10.1016/j.atmosenv.2012.04.006.

Kubryakov, A.I., Korotaev, G.K., Dorofeev, V.L., Ratner, Y.B., Palazov, A., Valchev, N., Malciu, V., Matescu, R., Oguz, T., (2012) Black Sea coastal forecasting system. Ocean Science, 8, 2, 183-196, DOI: 10.5194/os-8-183-2012.

Mutlu, H., Kose, N., Akkemik, U., Aral, D., Kaya, A., Manning, S.W., Pearson, C.L., Dalfes, N., (2012) Environmental and climatic signals from stable isotopes in Anatolian tree rings, Turkey. Regional Environmental Change, 12, 3, 559-570, DOI: 10.1007/s10113-011-0273-2.

Oguz, T., Akoglu, E., Salihoglu, B., (2012) Current state of overfishing and its regional differences in the Black Sea. Ocean & Coastal Management, 58, 47-56, DOI: 10.1016/j.ocecoaman.2011.12.013,

Oguz, T., Salihoglu, B., Moncheva, S., Abaza, V., (2012) Regional peculiarities of community-wide trophic cascades in strongly degraded Black Sea food web. Journal of Plankton Research, 34, 4, 338-343, DOI: 10.1093/plankt/fbs002.

Ozdemir, H., Unal, A., Kindap, T., Turuncoglu, U.U., Durmusoglu, Z.O., Khan, M., Tayanc, M., Karaca, M., (2012) Quantification of the urban heat island under a changing climate over Anatolian Peninsula. Theoretical and Applied Climatology, 108, 1-2, 31-38, DOI: 10.1007/s00704-011-0515-8.

Renault, L., Oguz, T., Pascual, A., Vizoso, G., Tintore, J., (2012) Surface circulation in the Alboran Sea (western Mediterranean) inferred from remotely sensed data. Journal of Geophysical Research-Oceans, 117, C08009, DOI: 10.1029/2011JC007659.

Unal, Y.S., Deniz, A., Toros, H., Selahattin, I., (2012) Temporal and spatial patterns of precipitation variability for annual, wet, and dry seasons in Turkey. International Journal of Climatology, 32, 3, 392-405, DOI: 10.1002/joc.2274

Uysal, Z., Shmeleva, A.A., (2012) Species composition, abundance and biomass of copepoda in plankton of The Northern Levantine Basin (Eastern Mediterranean). Crustaceana, 85, 8, 909-935, DOI: 10.1163/156854012X650179.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

The atmospheric research group is planning to collaborate with national and international groups to develop marine sensors and the group is willing to contribute OCEAN.2013-1 Biosensors for real time monitoring of biohazard and man-made chemical contaminants in the marine environment.

6. Goals, priorities and plans for future activities/events

IMS-METU atmospheric research group is planning to purchase ICP-MS in 2013 via national infrastructure project (CMECLIM). Moreover, group is planning to submit to national projects. The first project is related to atmospheric aerosols, their chemical composition and bio-availability and possible impact on surface waters of EMED. The second project will focus on development of real-time marine sensor.

7. Other comments

SOLAS-UK

compiled by Phil Williamson p.williamson@uea.ac.uk

Notes:

- *Reporting Period is January 2012 – December 2012*
- *Information will be used for: reporting, fundraising, networking, strategic development & outreach*
- *Following completion of the NERC-funded UK SOLAS Research Programme (2004-2010), this report covers SOLAS-relevant national programmes and projects, including the UK Ocean Acidification research programme.*

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, text (max 200 words), a figure with legend and* ***full references*** *for each highlight. Please focus on results that would not have happened without SOLAS.*

Potential climate feedbacks from polar halogens

Sampling bromocarbons at the Rothera Time Series site, western Antarctica. Upper photo, Claire Hughes (UEAA/York) and Helen Rosetti (BAS); *photo credits, Rod Strachan and Claire Hughes*.

Major changes in sea-ice cover have recently occurred throughout the Arctic and locally in the Southern Ocean. In addition to direct effects on the air-sea fluxes of CO_2 and other greenhouse gases, such physical changes also affect marine production processes, with potential for climatically-significant feedbacks mediated by a wide range of biogenic gases. At the Rothera Time Series site (western Antarctic Peninsula), air and water samples were collected for bromocarbon analysis between 2005 and 2010, with results compared with other environmental data (collected since 1997).

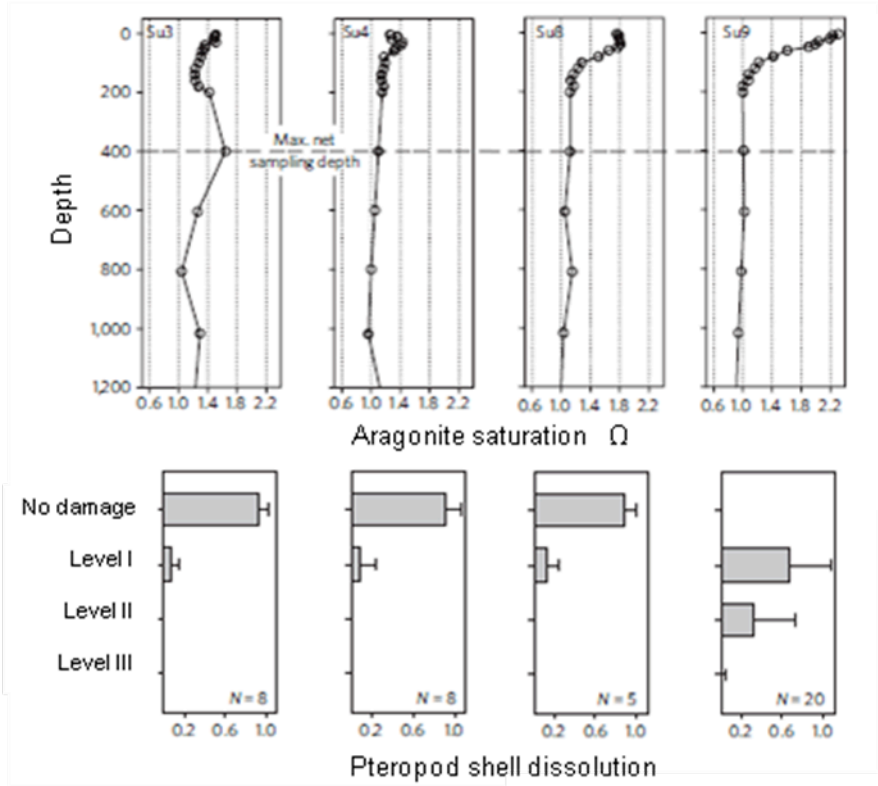
The multi-institute research team found[1,2] that bromoform ($CHBr_3$) and dibromomethane (CH_2Br_2) levels in seawater varied seasonally and year-to-year, with higher $CHBr_3$ concentrations associated with diatom blooms and long-duration winter sea ice. Marine bromine emissions were estimated to contribute 40-80% of total tropospheric inorganic Br at such localities; the 3-4 fold annual changes observed could therefore have major implications for ozone cycling and dimethyl sulphide oxidation.

Additional UK research on polar halogen fluxes has included identification of the Weddell Sea as an important iodine source[3], also studies on halogen-ozone interactions[4,5] in Hudson Bay, as part of the OASIS

[1] Hughes et al (2012) *Glob. Biogeochem. Cycles* 26, GB3019; doi: 10.1029/2012GB004295
[2] Wates B (2012) Algae to atmosphere (Research highlight). *Nature Climate Change* 2, 571
[3] Atkinson HM et al (2012). *Atmos. Chem. Phys.* 12, 11229-11244; doi: 10.5194/acp-12-11229-2012
[4] Muller JBA et al (2012). *Atmos. Environ*. 47, 218-225; doi: 10.1016/j.atmosenv.2011.11.013
[5] Abatt JPD et al (2012) *Atmos. Chem. Phys*. 12, 6237-6271; doi: 10.5194/acp-12-6237-2012
[Full details of references 1, 3, 4 and 5 in Section 4]

Direct ocean acidification impacts on ecologically-important organisms

Biogeochemical impacts of ocean acidification are expected to first occur in cold, polar waters where atmospheric CO_2 dissolves most easily – particularly in regions that may already have high CO_2 due to upwelling. There is now direct evidence for such effects: juvenile pteropods (the planktonic snail



Upper: Aragonite saturation (Ω) as a function of water depth at stations near South Georgia, Scotia Sea (sub-set of published data[6]).

Lower: Observed level of shell dissolution in juvenile pteropods (*Limacina helicina antarctica),* showing greatest effect at station Su9, data at right, that has the lowest Ω (values ≈ 1.0) in depth range 200- 400m

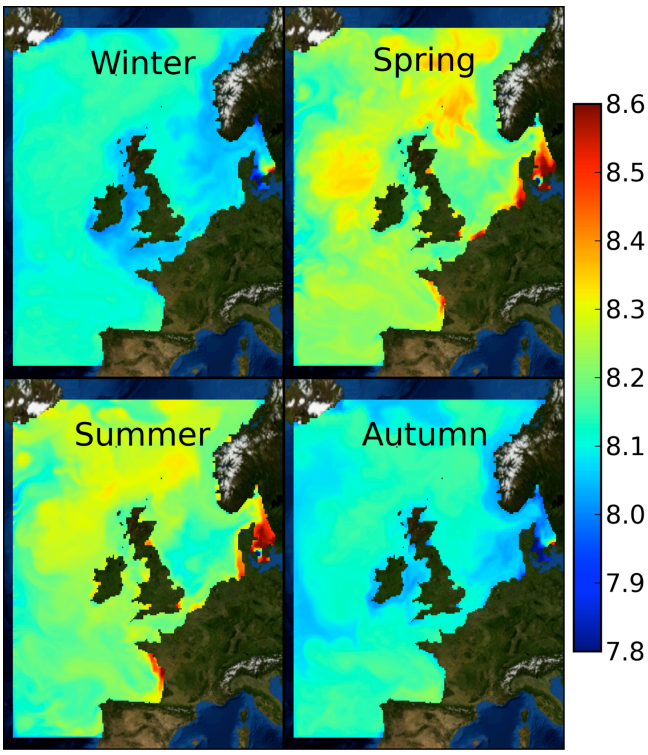
Limacina helicina antarctica) have been found[6,7] with eroded, more fragile shells in those parts of the Southern Ocean where carbonate levels are lowest (saturation state ~ 1.0 within top 400 m). This effect has been validated experimentally[8], and provides strong evidence that anthropogenically-reduced pH is now damaging natural populations. Since pteropods are an important component of Antarctic (and Arctic) food webs, any factor reducing their fitness, and hence survival, has high ecological significance. This UK-led study was carried out with colleagues from the USA, The Netherlands and Slovenia, and was part-supported by UK Ocean Acidification research programme (UKOA). Follow-up work has been carried out of the fourth, and final, UKOA research cruise, on RRS *James Clark Ross* in January-February 2013. Many additional pteropod samples have been collected, together with other zooplankton, phytoplankton and bacteria in the upper ocean to investigate in greater detail ecosystem-level responses to current variability in carbonate chemistry, and the potential impacts of more extreme future changes.

[6] Bednaršek N et al (2012) *Nature Geoscience* 5, 881–5; doi:10.1038/ngeo1635.
[7] British Antarctic Survey news release:www.antarctica.ac.uk/press/press_releases/press_release.php?id=1976
[8] Bednaršek N et al (2012) *Global Change Biology* 18, 2378-2388; doi: 10.1111/j.1365-2486.2012.02668.x
[Full details of references 6 and 8 in Section 4]

Carbonate chemistry dynamics in temperate shelf seas

Global warming involves much more than a mean global temperature rise of (say) 2°C; similarly, there is now much greater awareness that ocean acidification involves much more than a global pH reduction of (say) 0.4 units in the upper ocean, equivalent to decrease of ~50% in carbonate ion concentration. In particular, recent measurements have demonstrated the relatively high spatial and temporal 'baseline' variability in pH and related carbon chemistry variables, with such variability routinely experienced by - and in part driven by – marine organisms. High resolution models are now able to simulate many of those changes and their drivers at the regional level: in particular, the coupled model POLCOMS-ERSEM has been

implemented[9] in the north west European with a new parameterization for alkalinity explicitly accounting for riverine inputs and the influence of biological processes. When compared with observational data, the model showed good agreement for many physical and biogeochemical variables, including nutrients, dissolved inorganic carbon and total alkalinity; it also showed strong seasonal and spatial variability (see maps). However there would still seem scope for improvement in the simulation of derived variables, such as pH and pCO_2. A closely-linked modelling study[10] estimated that there is a net carbon loss of ~6 x 10^{12} mol C yr-1 from the European shelf, primarily by horizontal transport below the permanent pycnocline.

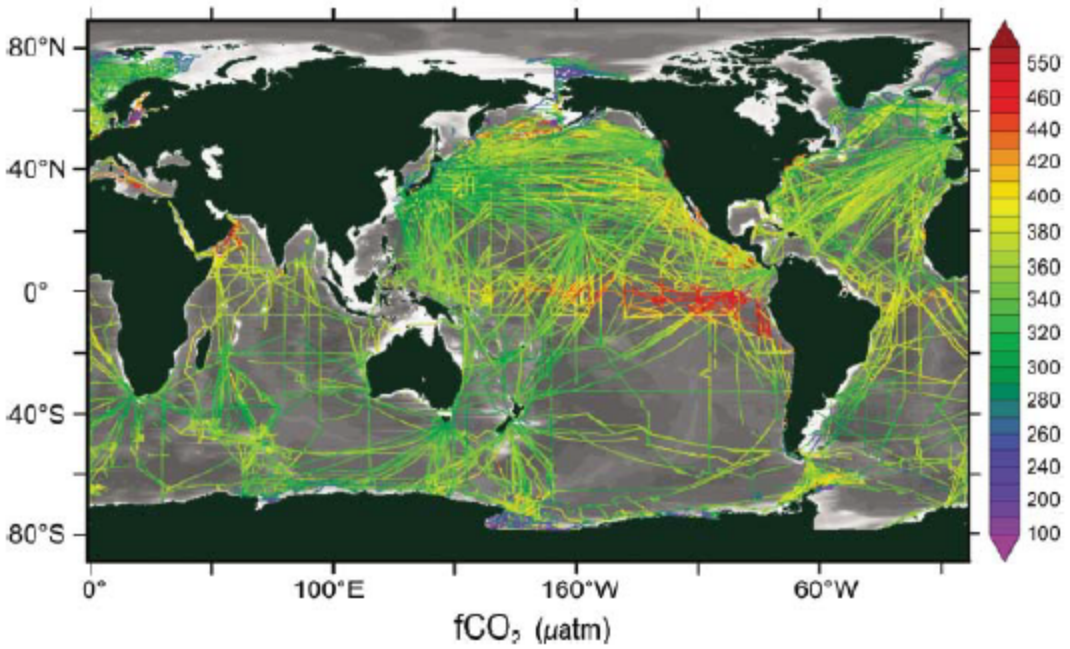


Simulated seasonal changes in present-day (2001--2002) sea surface pH in the north west European shelf[9]. On top of these characteristic patterns, there is a significant variability on shorter scales (both spatial and temporal) linked to hydrodynamic features like tides, eddies, fluctuations of river discharge, and weather variability (not shown).

[9] Artioli Y *et al.* (2012), *J. Mar. Syst.* 102-104, 1-13; doi: 10.1016/j.jmarsys.2012.04.006
[10] Wakelin S *et al* .(2012) *J. Geophys. Res.* 117, C05020; doi: 10.1029/2011JC007402
[Full details of references in Section 4]

Using the Surface Ocean CO_2 Atlas (SOCAT) database

The SOLAS 2012 OSC included a discussion session "Detection and monitoring large-scale impacts of ocean acidification"[11], setting the scene for other initiatives to increase international collaboration and coordination for upper-ocean measurements of the carbon system. These other actions included a workshop in Seattle to develop a global ocean acidification (OA) observing network[12], and the establishment of an OSPAR-ICES Study Group on OA observations, both with strong UK involvement. The Surface Ocean CO_2 Atlas (SOCAT), co-sponsored by SOLAS, IMBER and IOCCP will play a crucial role in providing data and data products for such syntheses and assessments , and the UK is pleased to provide leadership for both the North Atlantic and global SOCAT groups. A summary of the scope and rationale of SOCAT was published[13] in 2012, based on v1.5 of the database (containing 6.3 million surface water CO_2 measurements). In addition, two other SOCAT papers were recently available for discussion [14,15] (now both formally in press) and v2.0 of the database is expected to be online in mid-2013.



Surface water fCO_2 data in the SOCAT database, version 1.5

[11]Heinze C, Y Nojiri & Williamson P (2012) *Solas News* 14, p 43; discussion session report at www.solas.in-int.org/news/conferencemeetings/OSC2012/discsess.html
[12] www.pmel.noaa.gov/co2/OA2012Workshop
[13]Bakker *et al.* (2012) *Eos: Trans. Am. Geophys. Union*, 93, 12; doi:10.1029/2012EO120001.
[14] Sabine CL *et al.* (2012) *Earth Syst. Sci. Data Discuss*. 5, 781-804; doi: 10.5194/essdd-5-781-2012
[15]Rödenbeck C *et al.* (2012) *Ocean Sci. Discuss*. 9, 2273-2326; doi: 10.5194/osd-9-2273-2012
[Full details of references 13-15 in Section 4]

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

2.1 Programmes and projects

Although there is no longer a single 'UK SOLAS' programme, UK research activities contribute to SOLAS science goals in many ways, as detailed below.

- The ***UK Ocean Acidification*** (UKOA) research programme, co-funded by NERC, Defra and DECC (£12m; 2010-2015) includes the following SOLAS-relevant components:
  - Observations and synthesis to establish variability and trends of oceanic pH
  - Ocean acidification impacts on sea surface biogeochemistry and climate
  - Regional ecosystem and biogeochemical impacts of ocean acidification
  - Abrupt ocean acidification events (focus on Paleocene-Eocene Thermal Maximum)
  - Interactions between CO_2, the carbon cycle and climate.

  The 2nd and 3rd UKOA research cruises were successfully completed in May-June and June-July 2012, with focus on cold-water corals off NW Scotland and upper ocean biogeochemistry in the Arctic Ocean. Cruise blogs at http://changingoceans2012.blogspot.co.uk and www.surfaceoa.org.uk/?page_id=1369. For programme-wide information, see www.oceanacidification.org.uk or contact p.williamson@uea.ac.uk (UKOA Science Coordinator).

- The ***Ocean Surface Mixing, Ocean Sub-mesoscale Interaction Study (OSMOSIS)*** is a NERC-funded programme (£3.8m; 2011-2015) that addresses the physical processes affecting exchanges across the ocean boundary layer, with participants at Reading, Bangor, NOC, Oxford, Scottish Marine Institute, Southampton and UEA, in partnership with the UK Met Office and the European Centre for Medium Range Weather forecasting. Contact: Stephen Belcher s.e.belcher@reading.ac.uk.
- The NERC ***Oceans 2025 programme*** ended in early 2012. SOLAS-relevant work is continued through 'national capability' support to the National Oceanography Centre (NOC) and its partners, including Plymouth Marine Laboratory (PML), the British Antarctic Survey (BAS) and the Scottish Association for Marine Sciences; http://noc.ac.uk/about-us/partners
- The ***Waves, Aerosol & Gas Exchange Study (WAGES)*** is a NERC-funded project (£0.9m , 2010-2014) between Leeds and NOC that involves direct flux measurements on *RRS James Clark Ross* using the NOC Autoflux system (for continuous eddy covariance measurements of fluxes of CO_2 and sea-spray aerosol), a wave radar, and a whitecap imaging camera. The closely-linked ***High Wind Gas Exchange Study (HiWinGS)*** supports UK involvement in related US cruise work. Contact: Ian Brooks i.brooks@see.leeds.ac.uk
- ***UK GEOTRACES*** is a NERC-funded consortium (£3.9m, 2010-2014) that addresses micronutrient cycles and ocean paleoproxies with focus on sections in the South Atlantic and Tropical Atlantic. Participants at Oxford, Bristol, Cambridge, Edinburgh, Imperial College. Manchester, NOC, PML, Plymouth, Southampton and UEA. Details: www.ukgeotraces.com.
- ***Aerosol-Cloud Coupling and Climate Interactions in the Arctic (ACCACIA***) is a NERC funded project (£3m, 2012-15) involving groups at Manchester, Leeds, York, UEA, BAS and the Met Office, with international partners. Two field campaigns involve ship-based measurements of surface aerosol sources and a suite of atmospheric properties. Details at http://acrcticaccacia.wordpress.com
- The UK-led, ESA-funded ***Oceanflux Greenhouse Gases*** project (2011-2013) involves partners at University of the Highlands & Islands, PML, NOC and IFREMER; details: http://www.oceanflux-ghg.org
- The ***SOLAS data integration project*** provides synthesis and integration of global air-sea gas and particle fluxes to improve models and assessments of future climate and pollution; contact Shital Rohekar s.rohekar@uea.ac.uk
- The UK-led ***COST Action 735*** "Tools for assessing global air-sea fluxes of climate and air pollution relevant gases" ended in 2012. A synthesis book has been prepared, for publication in early 2013.
- The NERC ***National Centre for Atmospheric Science, NCAS*** www.ncas.ac.uk, continues to support a wide range of SOLAS-relevant research and sustained observations, the latter including the ***Weybourne Atmospheric Observatory*** http://weybourne.uea.ac.uk and UK involvement in the ***Cape Verde Atmospheric Observatory*** (Observatório Atmosferico de Cabo Verde: Humberto Duarte Fonseca; also see Section 5).

2.2 Major meetings

SOLAS science featured strongly in the 15th Biennial Challenger Conference for Marine

Sciences (UEA, 3-6 Sept 2012),with sessions on Biogeochemical Cycles and Changing Seas (20 oral presentations), Ocean Dynamics and Climate (25 presentations), Marine Geochemistry (11 presentations) and Biophysical Interactions (11 presentations), plus >80 SOLAS-relevant posters.

The UK Ocean Acidification (UKOA) research programme held its 2nd Annual Science Meeting at Exeter, 16-18 April 2012 with 106 UK participants and 4 international guests.

UKOA provided co-sponsorship support for the 3rd Ocean in a High-CO2 World Symposium (Monterey, USA; 24-27 Sept 2012). UK researchers provided 22 oral presentations and 33 posters at that meeting.

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

Outreach activities by the UK Ocean Acidification research programme have included:

- UK-led sessions (presentations, discussion and posters) at Planet under Pressure (London, 26-29 March)
- Additional translations (Arabic and Portuguese) of *Hot, Sour & Breathless – Ocean under Stress*; joint publication by PML, Scripps, Oceana, UKOA, EPOCA and MedSeA, online at www.oceanacidification.org.uk/PDF/ocean_under_stress.pdf
- Major contribution to *Ocean Acidification: Acting on Evidence. Messages for Rio+20*, published by international Ocean Acidification Reference User Group, online at www.oceanacidification.org.uk/PDF/oa_11_8pp_web.pdf .
- Provision of written and oral evidence to the House of Commons Select Committee on Science and Technology, for its Marine Science inquiry.

Also see Section 5 for additional international science-to-policy activities.

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

The following list of known peer-reviewed 2012 publications (n = 60) by the SOLAS-UK community is based on community-wide input and Web of Knowledge searches. The 10 papers in bold with UK-based lead authors indicate the range of achievements, without any formal designation that these are the "top 10" in terms of scientific quality or importance. [*Publication directly or indirectly arising from UK SOLAS research programme, 2004-10; **publication mentioned in Section 1 above].

**Abatt JPD, Thomas JL, Abrahamsson K, Granfors A, Jones AE, King MD, Saiz-Lopez A, Shepson PB, Sodeau J, Toohey DW, von Glasow R, Wren SN & Yang X (2012) Halogen activation via interactions with environmental ice and snow in the polar lower troposphere and other regions. *Atmos. Chem. Phys*. 12, 6237-6271; doi: 10.5194/acp-12-6237-2012

Adams CA, Andrews JE & Jickells TD (2012) Nitrous oxide and methane fluxes vs carbon, nitrogen and phosphorus burial in new intertidal and saltmarsh sediments. *Sci. Total Env*. 434, 240-251; doi: 10.1016/j.scitotenv.2011.11.058

****Artioli Y, Blackford JC, Butenschön M, Holt JT, Wakelin SL, Thomas H, Borges AV & Allen I (2012) The carbonate system in the North Sea: Sensitivity and model validation, *J. Mar. Syst*., 102-104, 1-13; doi: 10.1016/j.jmarssys.2012.04.006**

**Atkinson HM, Huang RJ, Chance R, Roscoe HK, Hughes C, Davison B, Schonhardt A, Mahajan AS, Saiz-Lopez A, Hoffman T & Liss PS (2012) Iodine emissions from the sea ice of the Weddell Sea. *Atmos. Chem. Phys.* 12, 11229-11244; doi: 10.5194/acp-12-11229-

2012
Avgoustidi V, Nightingale PD, Joint I, Steinke M, Turner SM, Hopkins SE & Liss PS (2012) Decreased marine dimethyl sulphide production under elevated CO_2 levels in mesocosm and *in vitro* studies. *Environ. Chem*. 9, 399-404; doi: 10.1071/EN11125

****Bakker DCE, Pfeil B, Olsen A, Sabine CL, Metzl C, Hankin S, Koyuk H, Kozyr A, Malcczyk J, Manke A & Telszewski. (2012) Global data products help assess changes to ocean carbon sink. *Eos: Trans. Am. Geophys. Union*, 93, 12; doi:10.1029/2012EO120001**

Beaugrand G, McQuatters-Gollop A, Edwards M & Goberville E (2012) Long-term responses of North Atlantic calcifying plankton to climate change. *Nature Climate Change*, published online 2 Dec; doi: 10:1038/nclimate1753

****Bednaršek N, Tarling GA, Bakker DCE, Fielding S, Jones EM, Venables HJ, Ward P, Kuzirian A, Lézé B, Feely RA & Murphy EJ (2012) Extensive dissolution of live pteropods in the Southern Ocean. *Nature Geoscience* 5, 881-885; doi: 10.1038/ngeo1635**

**Bednaršek N, Tarling GA, Bakker DCE, Fielding S, Cohen A, Kuzirian A, McCorkle D, Lézé B & Montagna R (2012) Description and quantification of pteropod shell dissolution: a sensitive bioindicator of ocean acidification. *Glob. Change Biol*. 18, 2378-2388; doi: 10.1111/j.`1365-2486.2012.02668.x

Belcher SE, Grant ALM, Hanley KE, Fox-Kemper B, Van Roekel L, Sullivan PP, Large WG, Brown A, Hines A, Calvert D, Rutgersson A, Petterssson H, Bidlot J-R, Janssen PAEM & Polton JA (2012) A global perspective on Langmuir turbulence in the ocean surface boundary layer. *Geophys. Res. Lett*. 39, DOI: 10.1029/2012GL052932

Bell TG, Malin G, Lee GA, Stefels J, Archer S, Steinke M & Matrai P (2-012) Global oceanic DMS data intercomparability. *Biogeochemistry* 110, 147-161; doi: 10.1007/s10533-011-9662-3

Birch CE, Brooks IM, Tjernstrom, Shupe MD, Mauritsen T, Sedlar J, Lock AP, Earnshaw P, Persson POG, Milton SF & Leck C (2012) Modelling atmospheric structure, cloud and their response to CCN in the central Arctic: ASOS case studies. *Atmos. Chem. Phys*. 12, 3419-3435; doi: 10.5194/acp-12-3419-2012

Boye M, Wake BD, Garcia PL, Bown J, Baker AR & Achterberg EP (2012) Distributions of dissolved trace metals (Cd, Mn, Pb, Ag) in the southeastern Atlantic and the Southern Ocean. *Biogeosciences* 9, 3231-3246; doi: 10.5194/bg-9-3231-2012

Boyd PW, Bakker DCE & Chandler C (2012) A new database to explore the findings from large-scale ocean iron enrichment experiments. *Oceanogr.* 25, 64-71

Brading P, Warner ME, Davey P, Smith DJ, Achterberg EP & Suggett DJ (2012) Differential effects of ocean acidification on growth and photosynthesis among phylotypes of *Symbiodinum* (Dinophyceae) .*Limnol. Oceanogr*. 57, 1255-

Burdett HL, Aloisio E, Calosi P, Findlay HS, Widdicombe S, Hatton A & Kamenos NA (2012) The effect of chronic and acute low pH on the intracellular DMSP production and epithelial cell morphology of red coralline algae. *Mar. Biol. Res*. 8, 756-763; doi: 10.1080/17451000.2012.676189

Carpenter L, Archer SD & Beale R (2012) Ocean-atmosphere trace gas exchange*. Chem. Soc. Rev.* 41, 6473-6506; doi: 10.1039/c2cs35121h

Caruana AMN, Steinke M, Turner SM & Malin G (2012) Concentrations of dimethylsulphonio-propionate and activities of dimethylsulphide-producing enzymes in batch cultures of nine dinoflagellate species. *Biogeochemistry* 110, 87-107; doi: 10.1007/s10533-012-9705-4

Cheize M. Sarthou G, Croot PL, Bucciarelli E, Baudoux AC, & Baker AR (2012) Iron organic speciation determination in rainwater using cathodic stripping voltammetry. *Analyt. Chim.*

Acta 736, 45-54; doi: 10.1016/j.aca.2012.o5.011

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*Dixon JL & Nightingale PD (2012) Fine-scale variability in methanol uptake and oxidation: from the microlayer to 1000 m (2012) *Biogeosciences* 9, 2961-2972; doi: 10.5194/bg-9-2961-2012

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5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

A comprehensive account of UK researchers' SOLAS-relevant international activities is not possible here. However, as a subset of such activities, relating to international science-to-policy work in 2012 by the UK Ocean Acidification programme has included:

- Involvement in the 18th Conference of Parties of the UN Framework Convention on Climate Change (UNFCCC) at Dohar, through an exhibit (with international partners), presentations at side-events, and input to press conferences
- Participation in the 2012 UN Conference on Sustainable Development ("Rio +20"),

through an exhibit, presentations at side-events, and input to press conferences

- SOLAS-developed expertise on geoengineering resulted in UK lead authorship of the inter-governmental report "Geoengineering in relation to the Convention on Biological Diversity: Technical and Regulatory Matters. Part I: Impacts of Climate-Related Geoengineering on Biodiversity (CBD Technical Series 66; www.cbd.int/doc/publications/cbd-ts-66-en.pdf) with associated participation in the 11th CBD Conference of Parties and 16th meeting of the CBD Subsidiary Body on Scientific, Technical and Technological Advice.

6. Goals, priorities and plans for future activities/events

Two new NERC-supported multi-institution research programmes that include SOLAS-relevant components will start in 2013:

- **Shelf Sea Biogeochemistry**: components to include cycling of N, P, Si and C in shelf waters, the relationship of this cycling to biological processes and air sea exchanges of CO_2 and N_2O, and shelf sea iron cycling and off-shelf export.
- **Greenhouse Gas Emissions and Feedbacks**: components to include quantification of the North Atlantic carbon sink and its interannual variability.

In July 2013, the UK will host the 2nd Workshop of the Global Ocean Acidification Observing Network at St Andrews, with co-sponsorship by NERC, IOCCP, GOOS, NOAA and others.

7. Other comments

As indicated above, the SOLAS-UK research community remains extremely active and productive. Those involved have benefitted greatly from the work of the SOLAS IPO and the SOLAS SSC.

2012/13 SOLAS endorsed project submission form

Research endorsement

Fill out the following page with the required data for your project and send it to our IPO via Email (PDF file):
(* required fields)

1. Summary

Title of the research project*: Dependence of Dissolved Organic matter cycling on atmospheric NUTrient inputs in the surface oligotrophic ocean (DONUT)

Is your project part of a larger national/regional programme? No

If yes, please give details and outline any relation to other IGBP, SCOR, WCRP or iCACGP projects

2. Contact Information

Principal Investigator*: Elvira Pulido-Villena

Institution (include address)* Institut Mediterranean d'Oceanologie (MIO) UMR 7294, Campus de Luminy - Bât TPR1 - Entrée F, 13288 Marseille Cedex 9 (France)

Phone* +33491829510

Fax

Email* elvira.pulido@univ-amu.fr

Other Investigators (indicate institution in brackets): F. Van Wambeke (MIO, France), M. Tedetti (MIO, France), C. Panagiotopoulos (MIO, France), J. Ghiglione (LOMIC, France)

3. Details of the Project

Summary / Abstract of Project* The main goal of DONUT is to assess how and to which extent the response of heterotrophic prokaryotes (Hprok) to atmospheric inputs of nutrients shape the oceanic DOM pool and modify its bioavailability.

In surface waters of the oligotrophic ocean, heterotrophic prokaryotes can be limited by the availability of mineral nutrients which constrains the amount of bioavailable dissolved organic carbon (DOC) they can assimilate. This leads to an accumulation of dissolved organic matter (DOM) in the surface ocean during the stratification period which is exported to depth through winter mixing. This may have important consequences on C cycling in oligotrophic oceanic regions where DOC export has been estimated to be equal to or greater than particulate organic carbon flux. However, Hprok activity not only determines the amount of mineralised DOC; it can also shape the composition of the remaining DOM pool influencing the residence time of the carbon in the ocean (Microbial Carbon Pump, MCP).

Nutrient limitation of Hprok activity can be transiently relieved through the pulsed inputs of new nutrients derived from Saharan dust. Key LNLC regions, such the North Atlantic subtropical gyre and the Mediterranean Sea, are submitted to strong pulses of mineral dust coming from the Sahara Desert and recent research has quantitatively confirmed the fertilizing effect of dust pulses which modify nutrient availability. Our current knowledge on the biogeochemical role of atmospheric deposition is currently biased due to the preferential attention given to autotrophic processes compared to heterotrophic processes. However, recent studies have reported the preferential uptake of these atmospheric nutrients by Hprok resulting in heterotrophic processes being more stimulated by dust pulses compared to autotrophic processes. These results question the nature of the link between atmospheric deposition and carbon cycling which may not directly involve an increase in C sequestration by the ocean.

The few published studies on the effect of atmospheric deposition on Hprok activity have reported significant responses of bacterial respiration and/or production. How can we go further on our understanding of the consequences of these processes on C cycling? The stimulation of bacterial respiration by dust pulses during the stratification period would decrease the amount of carbon susceptible to be exported to depth through

winter mixing. Nevertheless, as said above, the efficiency of the MCP depends not only on the amount of carbon in the dissolved pool but also on the characteristics of the DOM which may modify its residence time in the water column. How and to what extent dust pulses can, through the stimulation of Hprok activity, shape the surface DOM pool remains totally unexplored and constitutes one bottleneck on our advances to understand the role of atmospheric deposition on marine C cycle. This question constitutes the main goal of the DONUT project.

The DONUT strategy is based on the experimental assessment of the transformation of DOM during bacterial degradation under simulated dust inputs. We propose to conduct an original 2-step experiment: The first step of the experiment will consist on long-term incubations in which a natural assemblage of Hprok will be submitted to different dust enrichments. The second step of the experiment will consist on using the transformed DOM to re-initiate short-term incubations in order to check for differences on the DOM bioavailability among the dust enrichment conditions.

Key words of project* dust - heterotrophic prokaryotes - dissolved organic matter - oligotrophic ocean

Relevant SOLAS Activities (tick all that apply)*

FOCUS 1

- 1.1 Marine Particle Emissions ☐
- 1.2 Trace Gas Emissions ☐
- 1.3 Dimethylsulphide & climate ☐
- 1.4 Iron & Marine Productivity ☒
- 1.5 Nitrogen cycling ☐

FOCUS 2

- 2.1 Air-Sea Interface ☐
- 2.2 Oceanic Boundary Layer ☐
- 2.3 Atmospheric Boundary Layer ☐

FOCUS 3

- 3.1 Air-Sea CO_2 Fluxes ☐
- 3.2 Surface Layer Carbon ☐
- 3.3 Air-Sea Flux of N_2O and CH_4 ☐

CROSS-CUTTING ACTIVITIES

- Modelling ☐
- Remote Sensing ☐
- Time Series ☐
- Palaeo-SOLAS ☐

4. Data

Will new data be collected as part of this project?* ☒Yes ☐No

Where will this data be reported / archived?* Not decided yet

When will your data be submitted?* Not decided yet

5. Budget

Start date and end date of funding* 01/02/2013-31/12/2014

Total funding secured to date* 8000 €

Sources of funding* LEFE-CYBER (INSU-CNRS, France)

Please list in order of size of funding

6. Submission

Please indicated whether you have contacted your national representative? ☒Yes ☐No

If you do not have a national representative, please tick this box ☐

SOLAS endorsed projects 2012 annual reports

ADEPT: Aerosol deposition and ocean plankton dynamics

compiled by Francesc Peters

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Relationship between Saharan dust deposition and ocean chlorophyll in the Mediterranean.
Satellite (SeaWiFS) derived upper ocean chlorophyll has been related to aerosols in the atmosphere, showing an overall anticorrelated signal. When chlorophyll is low, aerosols in the atmosphere tend to be high and may interfere with the satellite derived chlorophyll signal. Actual modelled deposition (BSC DREAM8b) does show a different seasonality than aerosols in the atmosphere evidencing that aerosols may at times travel over the Mediterranean at heights where they are not depositing. We show a monthly map of modelled deposition that may help understanding the potential relationship between aerosol deposition of African and Middle East mineral origin and Mediterranean ocean chlorophyll [1]. *1.* Gallisai R, Peters F, Basart S, Baldasano JM. 2012. Mediterranean basin-wide correlations between Saharan dust deposition and ocean chlorophyll concentration. Biogeosciences Discussions. 9: 8611-8639.

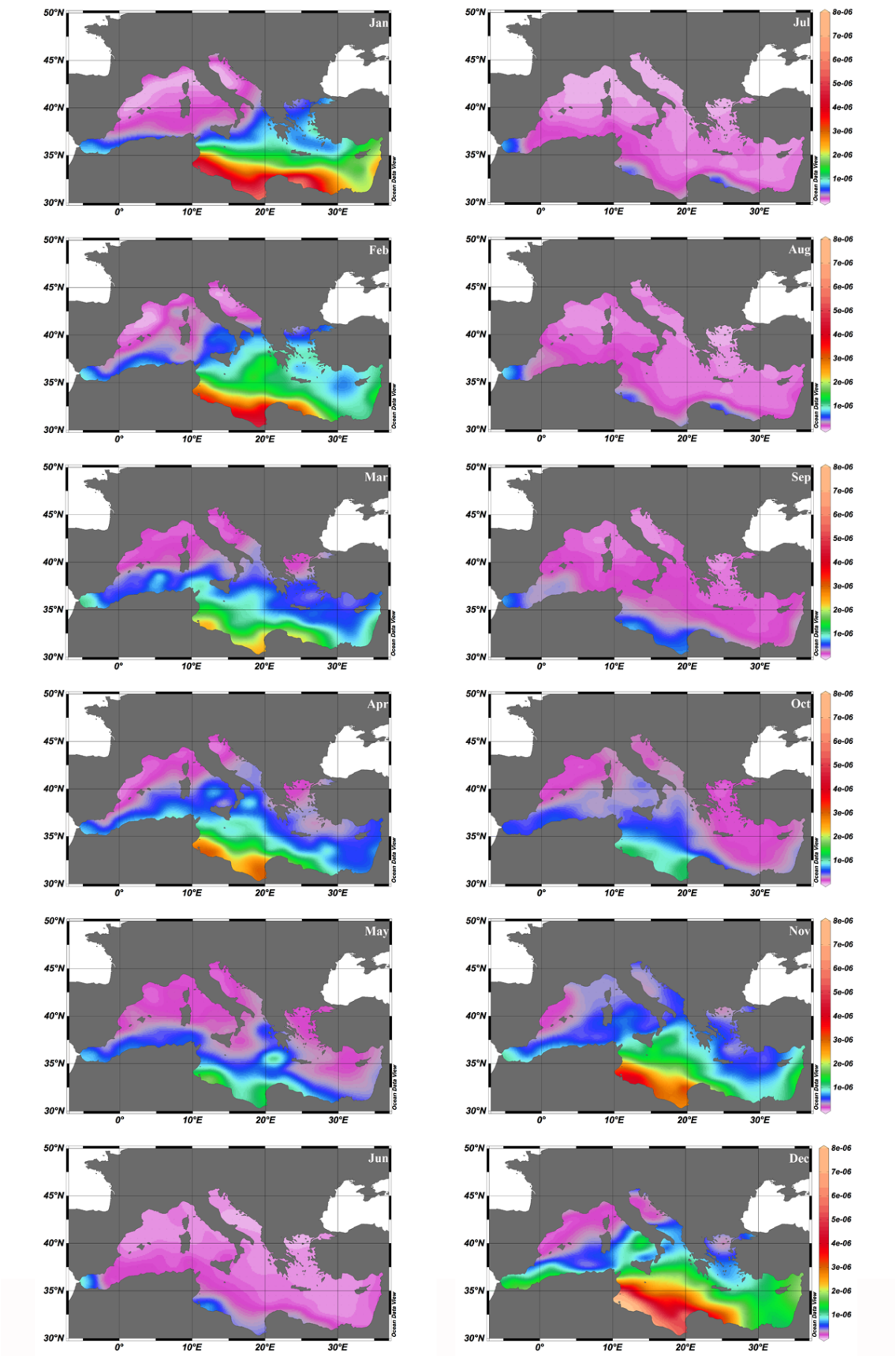

Figure: Monthly climatic modeled deposition (2000–2007) in the Mediterranean Sea from BSCDREAM8b.

2. Activities/main accomplishments (research projects, cruises, special events, workshops,

remote sensing used, model and data intercomparisons etc)

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

- Association for the Advacement of Marine Research (ARM) established. www.facebook.com/recercamarina
- Kuwata, A., Bernal, M., Peters, F., Vaqué, D. 2012. Editorial. Scientia Marina. 76: 7-7. doi: 10.3989/scimar.03583.10B.
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- Pascual, J., Pelejero, C., Peters, F., Vaqué, D. 2012. Editorial. Scientia Marina. 76: 215-215. doi: 10.3989/scimar.03662.05A.
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4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

- Gallisai R, Peters F, Basart S, Baldasano JM. 2012. Mediterranean basin-wide correlations between Saharan dust deposition and ocean chlorophyll concentration. Biogeosciences Discussions. 9: 8611-8639.
- Sheldon, J.E., Griffith, P.C., Peters, F., Sheldon, W.M.Jr., Blanton, J.O., Amft, J., Pomeroy, L.R. 2012. Southeastern U.S.A. continental shelf respiratory rates revisited. Biogeochemistry. 107: 501-506. doi: 10.1007/s10533-010-9552-0.
- Romero, E., Peters, F., Marrasé, C. 2012. Dynamic forcing of coastal plankton by nutrient imbalances and match-mismatch between nutrients and turbulence. Marine Ecology Progress Series. 464: 69-87. doi: 10.3354/meps09846.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

- Gasol, J.M., Massana, R., Simó, R., Marrasé, C., Acinas, S.G., Pedrós-Alió, C., Pelejero, C., Sala, M.M., Calvo, E., Vaqué, D., Peters, F. 2012. Blanes Bay (Site 55). In: O'Brien, T.D., W.K.Li & X.A.G. Morán (eds). ICES Phytoplankton and Microbial Ecology Status Report 2010/2012. ICES Cooperative Research Report No. 313. pp.138-141.

6. Goals, priorities and plans for future activities/events

- Experimental response of plankton communities to aerosol amendments
- Relationships between deposition measurements and coastal plankton dynamics

7. Other comments

BIOACID

compiled by Michael Meyerhöfer and Ulf Riebesell

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights (max 200words),*

Evolution in the Ocean: *Emiliania huxleyi* can adapt to Ocean Acidification

Lohbeck et al. (2012) examined the ability of the world's single most important calcifying organism, the coccolithophore *Emiliania huxleyi*, to evolve in response to ocean acidification in two 500-generation selection experiments. Specifically, they exposed *E. huxleyi* populations founded by single or multiple clones to increased concentrations of CO_2. Around 500 asexual generations later their fitness was assessed. Compared with populations kept at ambient CO_2 partial pressure, those selected at increased partial pressure exhibited higher growth rates, in both the single- and multiclone experiments, when tested under ocean acidification conditions (Fig. 1). Calcification was partly restored: rates were lower under increased CO_2 conditions in all cultures, but were up to 50% higher in adapted compared with non-adapted cultures. These results suggest that contemporary evolution could help to maintain the functionality of microbial processes at the base of marine food webs in the face of global change.

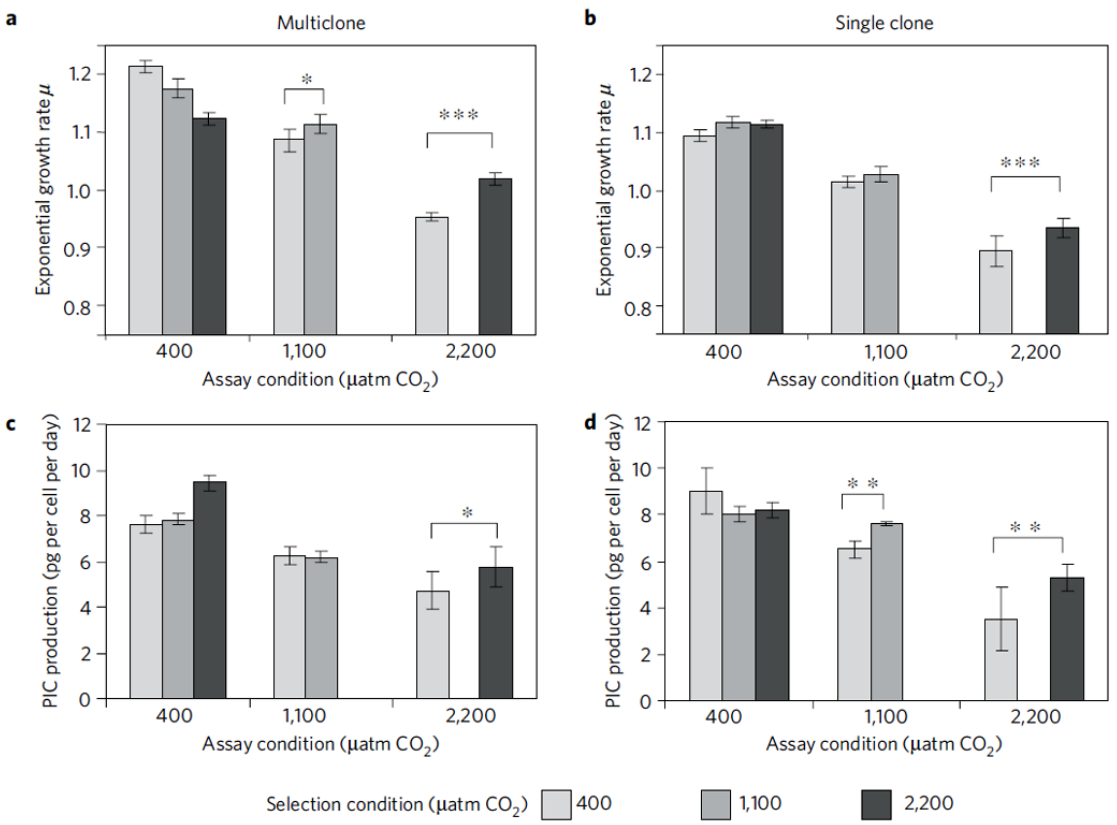


Fig. 1: Phenotypic responses to ~500 generations of selection in *E. huxleyi*. Replicate cultures (n=5) were either founded by six clones (left panels) or a single clone (right panels). **a**, **b**, Mean exponential growth rate (±1 standard deviation). **c**, **d**, Mean production rate of particulate inorganic carbon (PIC). Adaptation to medium (1,100 µatm) and high (2,200 µatm) pCO_2 were assessed in two-way ANOVAs (selection x assay conditions), followed by planned contrasts among CO_2-selected versus ambient-selected population after one full batch cycle of acclimation. Contrasts were carried out only under the assay conditions of increased CO_2 and when the interaction selection x assay condition was significant. For PIC production in the single-clone experiment, a Welch ANOVA was carried out owing to unequal variances, followed by a Wilcoxon planned comparison. *$P \leq 0:05$; **$P \leq 0:01$; ***$P \leq 0:001$.

Original Paper:

Lohbeck, K.T., U. Riebesell, and T.B.H. Reusch, 2012: Adaptive evolution of a key phytoplankton species to ocean acidification. Nature Geoscience, **5**, 346–351 doi: http://www.nature.com/ngeo/journal/vaop/ncurrent/full/ngeo1441.html

Acidic Water Impacts Sea Urchins

Pluteus larvae of the green sea urchin *Strongylocentrotus droebachiensis* are tiny, about 0.3 mm long and possess skeletal elements which support their transparent bodies. These spines are made of calcium carbonate and are formed by special cells (Fig. 1). Only recently has it been discovered that these larvae grow more slowly in acidified seawater. An extended development period, however, increases the risk that the larvae will be eaten by many predators.

As part of BIOACID, scientists from GEOMAR Helmholtz Centre for Ocean Research Kiel and the Cluster of Excellence "The Future Ocean" at Kiel University examined which mechanisms lead to this decrease in growth rate. Using methods developed for research on mammals, the Stumpp et al. (2012) were able to show that pluteus larvae cannot control the pH value in their cavities. These measurements were taken with tiny, 2 µm thin pH-electrodes. In contrast, measurements with pH sensitive colorants revealed that the cells in the bodies of larvae can control their internal pH value under the stress of acidification. This is important as the first skeletal elements are formed inside the cell itself – a process that only functions at very uniform conditions.

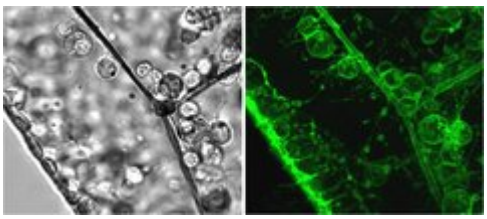


Fig. 1: Left: Microscopic view of a sea urchin larva. Spines visible as dark structures; right: same section, calcifying and other cells, as well as the membranes around the spines are coloured green by a special colorant. Pluteus larvae are capable of controlling the pH value within these cells. In the surrounding body fluid, the pH regulation does not work and the pH value follows that of the seawater (Photos: M. Gutowska).

Original Paper:

Stumpp, M., Hu, M.Y., Melzner, F., Gutowska, M.A., Dorey, N., Himmerkus, N., Holtmann, W., Dupont, S.T., Thorndyke, M.C., Bleich, M., 2012: Acidified seawater impacts sea urchin larvae pH regulatory systems relevant for calcification. Proceedings of the National Academy of Sciences, DOI: 10.1073/pnas.1209174109.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

A joint SOPRAN / BIOACID large-scale mesocosm experiment was conducted at the Tvärminne Zoological Station / Finland (http://luoto.tvarminne.helsinki.fi/english/) from June 13 to August 8, 2012 (Fig. 1). The objective was to investigate the effects of CO_2-induced seawater acidification on plankton communities. This study, which was intended to focus on nitrogen-fixing cyanobacterial communities in the Baltic Sea, involved 44 scientists from nine universities and research institutes of 5 European countries. The study was carried out in nine mobile mesocosms which were deployed off the coast and were sampled daily from zodiacs.

Analyses of the samples not processed on site began immediately after the arrival of the participating scientists at their home laboratories. Sample analyses will continue until the end of 2012 / beginning of 2013. A complete data set is expected for the data workshop in Kiel in summer 2013.

Preliminary results show a possible increased accumulation of phytoplankton biomass in the mesocosms at high CO_2 levels. It further shows that the composition of the phytoplankton community differed between CO_2 treatments. Addition of ^{15}N into the mesocosms will allow to estimate the effects of CO_2 enrichment on nitrogen fixation and on the fate of the fixed nitrogen in the food web

and the biogeochemical cycle.

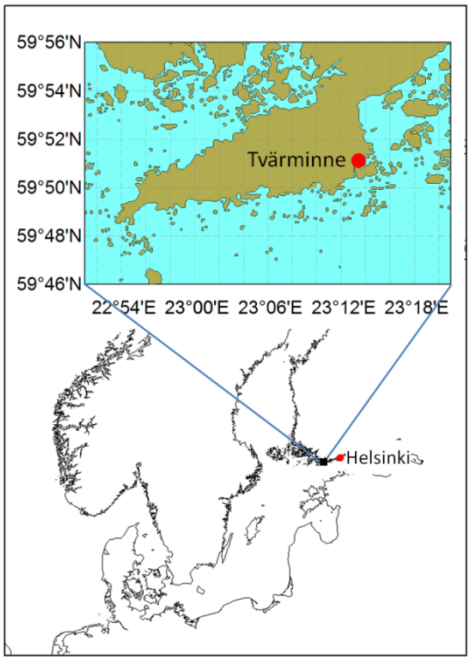
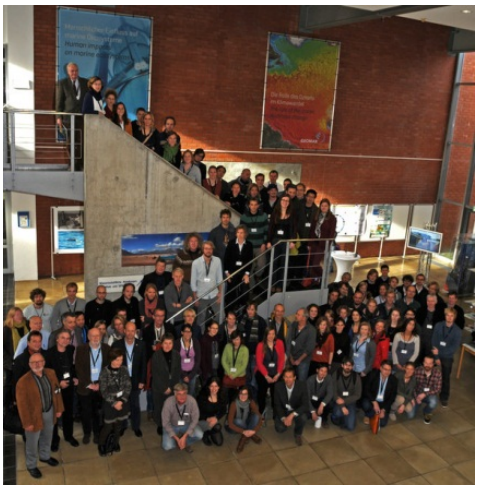


Fig. 1: Location of Tvärminne

The BIOACID Phase II kick-off meeting took place on November 6 - 7 at GEOMAR Kiel, Germany (please see agenda at http://www.bioacid.de/upload/Agenda_BIOACID-II_kick-off_final.pdf). This second phase will last from September 2012 to August 2015 and aims to:

- strengthen the integration within the BIOACID community to allow for more realistic community-level experimentation and field observation
- focus more strongly on interacting affects through multiple stressors
- expand evolutionary biology to assess the potential for adaptation of key taxa
- integrate socio-economic assessments and stakeholder involvement

The overarching focus of BIOACID II will be to address and better understand the chain from individual organism responses and their underlying mechanisms, to community and ecosystem changes and their consequences for food webs and biogeochemical cycling, to economic impacts and feedbacks to the climate system.



BIOACID was represented by presentations of the coordinator and / or manager / BIOACID scientists at the following conferences:

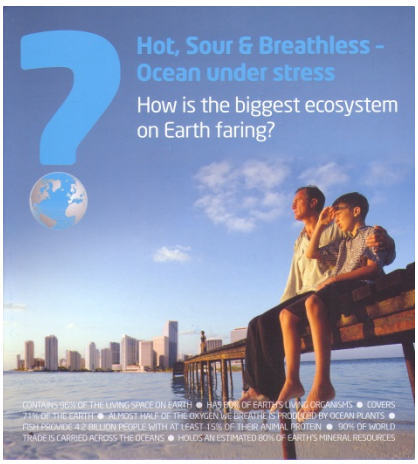
- 1st Annual Science Meeting of the EU-funded Mediterranean Sea Acidification in a Changing Climate (**MedSeA**) project in Rome, Italy, March 4 and 5, 2012.
- **EPOCA** final Meeting Saint Jean Cap Ferrat, France, April 2 – 5, 2012
- The 2nd UK Ocean Acidification Research Programme (**UKOARP**) annual science meeting, University of Exeter, UK, April 16 – 18, 2012
- 3rd International Symposium on **The Ocean in a High-CO_2 World,** Monterey USA, September 24 – 27, 2012
- **MESOAQUA** International Symposium, recent achievements and future directions in Aquatic Mesocosm Research, Crete, Greece, October 16 - 19, 2012 Crete, Greece

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

In collaboration with UKOARP, MedSea, EPOCA, OCEANA, SCRIPPS and the Plymouth Marine Laboratory**, BIOCID contributed to exhibition stands at:**

- **Planet under pressure London**, UK, March 26 – 29, 2012
- **Rio+20 UN Conference on Sustainable Development**, Rio, Brasil, June 20 – 22, 2012
- **Climate Change Conference,** Doha, Qatar, November 26 – December 7, 2012

The information stand



The brochure

BIOACID contributed to the outreach products of the **Ocean Acidification Reference User Group** (OA-RUG), available in various languages:

Messages for Rio+20

RIO+20
United Nations Conference on Sustainable Development

It is amazing to think that just ten years ago hardly anyone had heard of ocean acidification.
It is now much more widely understood that the increasing amount of carbon dioxide (CO_2) we are emitting into the air by our activities is reacting with the ocean to alter its chemistry and push it along the scale towards acidity. One major effect is reducing the availability of carbonate ions needed by many marine animals and plants to build their shells and skeletons.

This briefing paper from the International Ocean Acidification Reference User Group provides essential information and highlights the actions needed on ocean acidification by Governments at Rio+20

There is little doubt that the ocean is undergoing dramatic changes that will impact many human lives now and ever more so in the coming generations, unless we act quickly and decisively. Previous acidification events in the Earth's geological record were often associated with extinctions of many species. Whilst the causes of such extinction episodes are complex, it is notable that the biodiversity recovery took hundreds of thousands and, after mass extinctions, millions of years.

Ocean Acidification: ACTING ON EVIDENCE

Der aktuelle Stand: Was wissen wir über Ozeanversauerung und die wichtigsten globalen Herausforderungen?

Es ist erstaunlich: Noch vor zehn Jahren hatten die wenigsten Menschen von der Ozeanversauerung gehört. Inzwischen ist vielen bekannt, dass die steigende Menge von Kohlendioxid (CO_2), die wir durch die Verbrennung fossiler Brennstoffe in die Atmosphäre entlassen, mit dem Ozean reagiert. Seine chemische Zusammensetzung ändert sich, das Wasser wird sauer. Eine Folge daraus ist, dass immer weniger Karbonat-Ionen verfügbar sind. Genau diese benötigen viele Meerestiere und –pflanzen, um ihre Schalen und Skelette aufzubauen. Diese Broschüre, die von der International Ocean Acidification Reference User Group in Zusammenarbeit mit nationalen Forschungsprogrammen herausgegeben wurde, liefert grundlegende Informationen zur Ozeanversauerung und möglicher Konsequenzen daraus und unterstreicht, welches Vorgehen Entscheidungsträger wählen sollten.

Wenig Zweifel besteht darüber, dass der Ozean dramatische Veränderungen erlebt, die schon jetzt, aber noch weitaus stärker in absehbarer Zukunft das Leben vieler Menschen beeinflussen, wenn wir nicht entschlossen und zügig handeln. Der Untergang vieler Arten wird oft auf Versauerungsprozesse in der Erdgeschichte zurückgeführt, die geologisch dokumentiert sind. Während die Auslöser solcher Episoden komplex sind, fällt deutlich auf, dass es hunderttausende, oder, nach Massensterben auch Millionen von Jahren dauerte, bis sich die Vielfalt der Arten wieder einstellte.

Ozeanversauerung bei Rio 20+ und darüber hinaus

RIO+20
United Nations Conference on Sustainable Development

Im Juni 2012 trafen sich viele Nationen in Rio de Janeiro zur Konferenz der Vereinten Nationen zur Nachhaltigen Entwicklung. Maritime Themen spielten dort eine größere Rolle als je zuvor. Im Abschlussdokument *The future we want* (Die Zukunft, die wir uns wünschen) stellten führende Köpfe der Welt fest (Paragraf 166):

"Wir rufen auf zur Unterstützung von Initiativen, die sich mit der Ozeanversauerung und den Folgen des Klimawandels für marine und küstennahe Ökosysteme und Ressourcen befassen. In diesem Zusammenhang betonen wir, dass es notwendig ist, eine weitere Versauerung des Ozeans in gemeinsamer Anstrengung zu verhindern, die Widerstandsfähigkeit mariner Ökosysteme und der hierauf angewiesenen Gemeinschaften zu verbessern und die Erforschung der Meere sowie die Beobachtung der Ozeanversauerung und besonders empfindlicher Ökosysteme durch eine verstärkte internationale Zusammenarbeit zu fördern."

Als ein Mittel, um dieses Ziel zu erreichen, kündigte die Internationale Atomenergiebehörde (International Atomic Energy Agency, IAEA) in Rio die Einrichtung eines Koordinierungszentrums zu Ozeanversauerung an. Es solle der Wissenschaftsgemeinde, Entscheidungsträgern und der breiteren Öffentlichkeit dienen. Das Zentrum, dessen Gründung auf konzertierten Aktionen der weltweiten Forschung zur Ozeanversauerung und Interessenvertretern basiert, wird einen Schwerpunkt auf internationale Aktivitäten legen, die bisher nicht auf nationaler oder internationaler Ebene gefördert werden. Es wird von mehreren Mitgliedstaaten der IAEA unterstützt und unter anderem von der Zwischenstaatlichen Ozeanografischen Kommission der UNESCO, der US-amerikanischen National Oceanic and Atmospheric Administration (NOAA), der Ernährungs- und Landwirtschaftsorganisation der Vereinten Nationen (Food and Agriculture Organization of the United Nations, FAO), der Stiftung Prinz Albert II von Monaco und der International Ocean Acidification Reference User Group beraten und beaufsichtigt.

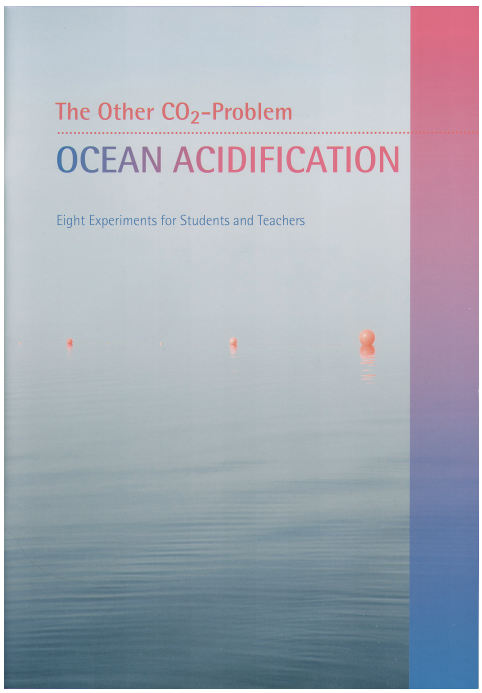
Ozeanversauerung: DIE WISSENSDATENBANK 2012

BIOACID released a **72 pages brochure for school children** with 8 simple experiments on ocean acidification, with background information for teachers, available in German and English:

Das andere CO_2-Problem

OZEANVERSAUERUNG

Acht Experimente für Schüler und Lehrer



The Other CO_2-Problem

OCEAN ACIDIFICATION

Eight Experiments for Students and Teachers

BIOACID also contributed to the production of a **children's book (**in German) "The discovery of Ocean Acidification" written and illustrated by two young BIOACID scientists:

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

In 2011 BIOACID published over 40 peer reviewed articles in 2012. This is only a selection:

Bach, L. T., C. Bauke, K. J. S. Meier, U. Riebesell and K. G. Schulz (2012). Influence of changing carbonate chemistry on morphology and weight of coccoliths formed by *Emiliania huxleyi*. Biogeosciences **9**(8): 3449-3463.

Borchard, C. and A. Engel (2012). Organic matter exudation by *Emiliania huxleyi* under simulated future ocean conditions. Biogeosciences **9**(8): 3405-3423.

Form, A. and U. Riebesell (2012). Acclimation to ocean acidification during long-term CO_2 exposure in the cold-water coral *Lophelia pertusa*. Global Change Biology **18**(3): 843-853.

Gao, K., J. Xu, G. Gao, Y. Li, D. A. Hutchins, B. Huang, L. Wang, Y. Zheng, P. Jin, X. Cai, D.-P. Häder, W. Li, K. Xu, N. Liu and U. Riebesell (2012). Rising CO_2 and increased light exposure synergistically reduce marine primary productivity. Nature Climate Change.

Hofmann, L. C., S. Straub and K. Bischof (2012). Competition between calcifying and noncalcifying temperate marine macroalgae under elevated CO_2 levels. Marine Ecology Progress Series **464**: 89-105.

Lischka, S. and U. Riebesell (2012). Synergistic effects of ocean acidification and warming on overwintering pteropods in the Arctic. Global Change Biology **18**(12): 3517-3528.

Lohbeck, K., U. Riebesell and T. B. H. Reusch (2012). Adaptive evolution of a key phytoplankton species to ocean acidification. Nature Geoscience **5**: 346-351.

Ragazzola, F., L. C. Foster, A. Form, P. S. L. Anderson, T. H. Hansteen and J. Fietzke (2012). Ocean acidification weakens the structural integrity of coralline algae. Global Change Biology **18**(9): 2804-2812.

Schoo, K., A. Malzahn, E. Krause and M. Boersma (2012). Increased carbon dioxide availability alters phytoplankton stoichiometry and affects carbon cycling and growth of a marine planktonic herbivore. Marine Biology: doi.org/10.1007/s00227-012-2121-4

Stumpp, M., M. Y.-A. Hu, F. Melzner, M. Gutowska, N. Dorey, N. Himmerkus, W. C. Holtmann, S. T. Dupont, M. C. Thorndyke and M. Bleich (2012). Acidified seawater impacts sea urchin larvae pH regulatory systems relevant for calcification. Proceedings of the National Academy of Sciences **109**(44): 18192-18197.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

3rd International Symposium on The Ocean in a High-CO2 World, Monterey USA, September 24 – 27, 2012: 2 members on international planning committee (including conference chair)

IPCC Working Group II, contribution to the 5th Assessment Report (AR5): Climate Change 2013: Impacts, Adaptation and Vulnerability

6. Goals, priorities and plans for future activities/events

Contribution to the **Ocean Acidification International Coordination Centre**, which is hosted at the International Atom Energy Agency in Monaco. It was initiated by the SOLAS-IMBER Ocean Acidification Working Group and will be financed through the Peaceful Uses Imitative and other sources (including BIOACID)

7. Other comments

CARBOCHANGE - Changes in carbon uptake and emissions by oceans in a changing climate

compiled by Christoph Heinze and Friederike Hoffmann

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

1.1. The observed evolution of oceanic pCO2 and its drivers over the last two decades

Lenton A, Metzl N, Takahashi T, Kuchinke M, Matear RJ, Roy T, Sutherland SC, Sweeney C, Tilbrook B (2012)
Global Biogeochemical Cycles, 26: doi:10.1029/2011GB004095, 2012

"We use a database of more than 4.4 million observations of ocean pCO_2 to investigate oceanic pCO_2 growth rates. We use pCO_2 measurements, with corresponding sea surface temperature and salinity measurements, to reconstruct alkalinity and dissolved inorganic carbon to understand what is driving these growth rates in different ocean regions. If the oceanic pCO_2 growth rate is faster (slower) than the atmospheric CO_2 growth rate, the region can be interpreted as having a decreasing (increasing) atmospheric CO_2 uptake. Only the Western subpolar and subtropical North Pacific, and the Southern Ocean are found to have sufficient spatial and temporal observations to calculate the growth rates of oceanic pCO_2 in different seasons. Based on these regions, we find the strength of the ocean carbon sink has declined over the last two decades due to a combination of regional drivers (physical and biological). In the subpolar North Pacific reduced atmospheric CO_2 uptake in the summer is associated with changes in the biological production, while in the subtropical North Pacific enhanced uptake in winter is associated with enhanced biological production. In the Indian and Pacific sectors of the Southern Ocean a reduced winter atmospheric CO_2 uptake is associated with a positive SAM response. Conversely in the more stratified Atlantic Ocean sector enhanced summer uptake is associated with increased biological production and reduced vertical supply. We are not able to separate climate variability and change as the calculated growth rates are at the limit of detection and are associated with large uncertainties. Ongoing sustained observations of global oceanic pCO_2 and its drivers, including dissolved inorganic carbon and alkalinity, are key to detecting and understanding how the ocean carbon sink will evolve in future and what processes are driving this change."

http://onlinelibrary.wiley.com/doi/10.1029/2011GB004095/abstract

1.2. Surface Ocean Carbon Atlas – SOCAT

CARBOCHANGE played a significant role in establishing the Surface Ocean Carbon Atlas (SOCAT – www.SOCAT.info). It was accompanied by 2 articles describing this synthesis product (**Pfeil et al. 2012; Sabine et al. 2012**). For the first time scientists have now access

to a data product that was second level quality controlled by regional and global experts. SOCAT gives access to surface ocean carbon dioxide database in a uniform format where all steps are transparent and documented. The public release of SOCAT was of international and national interest resulting in more than 25 newspaper/website articles. SOCAT Version 2 is currently being quality controlled and it is expected to have approx. 60 % more data than the previous version of SOCAT with recent data up to December 2011. Figure 1 illustrates the extension of data within SOCAT.

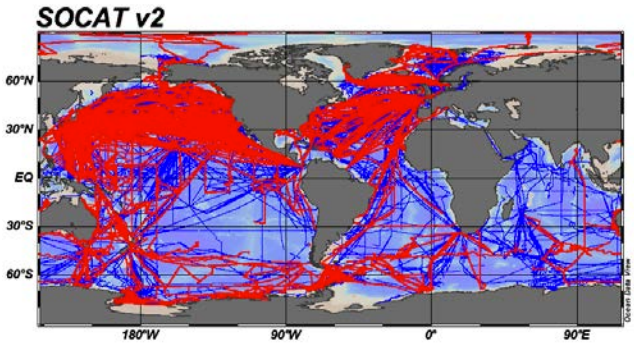


Figure 9.1: Outlook for SOCAT Version 2. Blue lines indicate data from SOCAT Version 1.5 and red lines is data that was added to SOCAT

References – under review in open access journals:

Pfeil, B., Olsen, A., Bakker, D. C. E., Hankin, S., Koyuk, H., Kozyr, A., Malczyk, J., Manke, A., Metzl, N., Sabine, C. L., Akl, J., Alin, S. R., Bellerby, R. G. J., Borges, A., Boutin, J., Brown, P. J., Cai, W.-J., Chavez, F. P., Chen, A., Cosca, C., Fassbender, A. J., Feely, R. A., González-Dávila, M., Goyet, C., Hardman-Mountford, N., Heinze, C., Hood, M., Hoppema, M., Hunt, C. W., Hydes, D., Ishii, M., Johannessen, T., Jones, S. D., Key, R. M., Körtzinger, A., Landschützer, P., Lauvset, S. K., Lefèvre, N., Lenton, A., Lourantou, A., Merlivat, L., Midorikawa, T., Mintrop, L., Miyazaki, C., Murata, A., Nakadate, A., Nakano, Y., Nakaoka, S., Nojiri, Y., Omar, A. M., Padin, X. A., Park, G.-H., Paterson, K., Perez, F. F., Pierrot, D., Poisson, A., Ríos, A. F., Santana-Casiano, J. M., Salisbury, J., Sarma, V. V. S. S., Schlitzer, R., Schneider, B., Schuster, U., Sieger, R., Skjelvan, I., Steinhoff, T., Suzuki, T., Takahashi, T., Tedesco, K., Telszewski, M., Thomas, H., Tilbrook, B., Tjiputra, J., Vandemark, D., Veness, T., Wanninkhof, R., Watson, A. J., Weiss, R., Wong, C. S., and Yoshikawa-Inoue, H. (2012)
A uniform, quality controlled Surface Ocean CO_2 Atlas (SOCAT)
Earth Syst. Sci. Data Discuss., 5, 735-780, doi:10.5194/essdd-5-735-2012, 2012
http://www.earth-syst-sci-data-discuss.net/5/735/2012/essdd-5-735-2012.html

Sabine, C. L., Hankin, S., Koyuk, H., Bakker, D. C. E., Pfeil, B., Olsen, A., Metzl, N., Kozyr, A., Fassbender, A., Manke, A., Malczyk, J., Akl, J., Alin, S. R., Bellerby, R. G. J., Borges, A., Boutin, J., Brown, P. J., Cai, W.-J., Chavez, F. P., Chen, A., Cosca, C., Feely, R. A., González-Dávila, M., Goyet, C., Hardman-Mountford, N., Heinze, C., Hoppema, M., Hunt, C. W., Hydes, D., Ishii, M., Johannessen, T., Key, R. M., Körtzinger, A., Landschützer, P., Lauvset, S. K., Lefèvre, N., Lenton, A., Lourantou, A., Merlivat, L., Midorikawa, T., Mintrop, L., Miyazaki, C., Murata, A., Nakadate, A.,

Nakano, Y., Nakaoka, S., Nojiri, Y., Omar, A. M., Padin, X. A., Park, G.-H., Paterson, K., Perez, F. F., Pierrot, D., Poisson, A., Ríos, A. F., Salisbury, J., Santana-Casiano, J. M., Sarma, V. V. S. S., Schlitzer, R., Schneider, B., Schuster, U., Sieger, R., Skjelvan, I., Steinhoff, T., Suzuki, T., Takahashi, T., Tedesco, K., Telszewski, M., Thomas, H., Tilbrook, B., Vandemark, D., Veness, T., Watson, A. J., Weiss, R., Wong, C. S., and Yoshikawa-Inoue, H.(2012)
Surface Ocean CO_2 Atlas (SOCAT) gridded data products
Earth Syst. Sci. Data Discuss., 5, 781-804, doi:10.5194/essdd-5-781-2012, 2012
http://www.earth-syst-sci-data-discuss.net/5/781/2012/essdd-5-781-2012.html

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Name/type of meeting	Date	Venue	WPs involved	Beneficiaries involved	Comments
CARBOCHANGE kick off meeting (D10.1)	**8-10/03/2011**	**Bergen, Norway**	**All**	**All**	
WP2 planning meeting	09/03/11	Bergen, Norway	2	UIB, IFREMER, CEA, UPMC, GEOMAR, NERSC, ULPGC, UGOT	
OISO/KEOPS, Observing and understanding CO_2 variations in relation to biological activity. KEOPS-2 cruise kick-off meeting	17/03/2011	Banyuls/mer, France	4, 5	UPMC	talk
Working visit and seminar	18-22 /07/ 2011	UEA, Norwich	5, 4	AWI	Includes talk
Working visit	7/09/2011	University Groningen,	5	AWI	

		Netherlands			
The Ocean Carbon Cycle at a Time of Change: Synthesis and Vulnerabilities, Joint SOLAS/IMBER/IOCCP Meeting	14-16/09/2011	UNESCO, Paris	5, 4, 8, 9	UPMC, AWI, GEOMAR, MRI-UI, NIOZ, UNIRESEARCH, CSIC, ULPGC, NERC, UEA	Many talks and posters; discussion among partners
CARBOCHANGE data portal meeting	01/10/2011	Pangaea, University of Bremen, Bremen, Germany	9	UiB, CEA, AWI, UniHB	
Working visit	31/01-09/02/2012	IFREMER, Plouzané	2, 5	CSIC	Write a common paper
Data management and SOCAT meeting	01/03/2012	CARBOCHANGE kick-off, Bergen, Norway	8,9	UiB, CEA, AWI, UniHB, UNIRESEARCH, UEA, PU-AOS	
SOCAT automation meeting	13/09/2011	Surface Ocean CO_2 Data-to-Flux Workshop Paris, France	9	UiB, CEA, AWI, UniHB, PU-AOS	
SOCAT Version 1 and Version 2 meeting	14/09/2011	UNESCO, Paris, France	9	UiB, CEA, AWI, UniHB, PU-AOS	
Seminar	1/03/2012	University Bremen	5	AWI	
CARBOCHANGE Annual meeting	**7-**	**Galway,**	**All**	**All**	

(D10.3)	**9/03/2012**	**Ireland**			
WP2 planning meeting	08/03/2012	Galway, Ireland	2	UIB, IFREMER, CEA, UPMC, GEOMAR, NERSC, ULPGC, UGOT	
Model comparison Workshop (D7.1)	08/03/2012	CARBOCHANGE Annual Meeting, Galway, Ireland	1,2,3,6,7	All	
Data management and SOCAT meeting	08/03/2012	CARBOCHANGE Annual Meeting, Galway, Ireland	8,9	UiB, CEA, AWI, UniHB, UNIRESEARCH, UEA, PU-AOS	
EGU Meeting	22-27/04/2012	Vienna	5	UPMC, UniHB, CSIC, ULPGC, NERC, DU	Talk + Organization of session on changing carbon in the ocean, with partners 16 and 1
SOCAT automation workshop	01/05/2012	SOCAT automation task force meeting, Seattle, USA	9	UiB, CEA, AWI, UniHB, PU-AOS	
TANGGO workshop	22-24/05/2012	LEGI, Grenoble, France	WP2	CEA,ULPGC	

Working visit	29/05 – 01/6/2012	IFREMER, France	2, 5	CSIC	Write a common paper
WP6 Meeting Task 6.2	Summer 2012	Hamburg, Germany	6	AWI, UNIVBRIS	Strategy for data assimilation in MITgcm
SOCAT regional meeting	01/07/2012	NIES, Tsukuba, Japan	9	UiB, CEA, AWI, UniHB, PU-AOS	
Coordination meeting	18/07/2012	Bremen, Germany	1,6	AWI, UNIVBRIS	
Working visit	1/08/2012	GEOMAR, Kiel	5, 8	AWI, GEOMAR	

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

- Dessimination via regular update of the project website (www.carbochange.eu)
- We have attracted further funding for networking between CARBOCHANGE partners from Europe and South Africa with Marie Curie IRSES project SOCCLI (http://carbochange.b.uib.no/soccli/) (support of CARBOCHANGE goal on communication with policy makers, we opt at having relevant events in Europe and South Africa)

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

Bakker D, Pfeil B, Olsen A, Sabine CL, Metzl N, Hankin S, Koyuk H, Kozyr A, Malzcyk J, Manke A, Telszewski M (2012)
Global data products help assess changes to ocean carbon sink
Eos Trans. AGU, 93 (12): 125-132

Fraile-Nuez E, González-Dávila M, Santana-Casiano JM, Arístegui J, Alonso-González IJ, S. Hernández-León, M. J. Blanco, A. Rodríguez-Santana, A. Hernández-Guerra, M. D. Gelado-Caballero, F. Eugenio, J. Marcello, D. de Armas, J. F. Domínguez-Yanes, M. F. Montero, D. R. Laetsch, P. Vélez-Belchí, A. Ramos, A. V. Ariza, I. Comas-Rodríguez & V. M. Benítez-Barrios (2012):
The submarine volcano eruption at the island of El Hierro: physical-chemical perturbation and biological response
Scientific report 2 : 486; DOI: 10.1038/srep00486

Lefèvre N, Merlivat L (2012)

Carbon and oxygen net community production in the eastern tropical Atlantic estimated from a moored buoy
Global Biogeochemical Cycles, 26: doi 10.1029/2010GB004018

Lenton A, Metzl N, Takahashi T, Kuchinke M, Matear RJ, Roy T, Sutherland SC, Sweeney C, Tilbrook B (2012)
The observed evolution of oceanic pCO2 and its drivers over the last two decades
Global Biogeochemical Cycles, 26: doi:10.1029/2011GB004095, 2012

Lévy M, Lengaigne M, Bopp, L, Vincent EM, Madec G, Ethé C, Kumar D, Sarma VVSS (2012)
Contribution of tropical cyclones to the air-sea CO[2] flux: A global view
Global Biogeochem. Cycles, 26 (2), GB2001

Ríos AF, Velo A, Pardo PC, Hoppema M, Pérez FF (2012)
An update of anthropogenic CO2 storage rates in the western South Atlantic basin and the role of Antarctic Bottom Water
Journal of Marine Systems, 94: 197–203, doi:10.1016/j.jmarsys.2011.11.023

Séférian R, Iudicone D, Bopp L, Roy T and Madec G (2012)
Water mass analysis of effect of climate change on air-sea CO2 fluxes: The Southern Ocean
Journal of Climate, 25, 3894-3908

Vázquez-Rodríguez M, Pérez FF, Velo A, Ríos AF, Mercier H. 2012.
Observed trends of anthropogenic acidification in North Atlantic water masses
Biogeosciences discussion, 9(3):3003-3030

Wåhlström I, Omstedt A, Björk G, Anderson LG (2012)
Modelling the CO_2 dynamics in the Laptev Sea, Arctic Ocean: Part I.
Journal of Marine Systems, 102-104, 29-38

Wåhlström, I., Omstedt, A. Björk, G. Anderson, L.G. (2012)
Modeling the CO2 dynamics in the Laptev Sea, Arctic Ocean: Part II. Sensitivity of the fluxes to changes in the forcing.
Journal of Marine Systems, in press, doi: 10.1016/j.jmarsys.2012.09.001

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Type of activity/meeting	Date/ timeframe	Co-ordination with…	Comments
Project cooperation	2011- on-going	SOPRAN project, German and ICOS-D (EU)	A tight cooperation exists between the German SORPAN project and the CARBOCHANGE project, since both projects are scientifically involved in the

			CVOO. Potential synergies for the transition phase between SOPRAN funding and CARBOCHANGE funding were discussed with different research groups working at CVOO. Furthermore, CVOO will be implemented into the European carbon observation network (ICOS), which will be developed and established over the next years. CVOO is supposed to become part of this network (ICOS-D) on the long-term.
Project cooperation Concerns WP 2, 4	2011-ongoing	TANGGO French project	A tight cooperation exists between the French TANGGO project and the CARBOCHANGE project. TANGGO is a French joint research effort which aims at better understanding how the various scales of oceanic physical variability control ocean biogeochemical cycles and ecosystems. The main objective of TANGGO research consortium is to foster collaborative research in order to guide the evolution of global coupled ocean-biogeochemistry models, in particular in view of Southern Ocean observation and analysis work performed in the frame of CARBOCHANGE.
Project cooperation	2011- ongoing	KEOPS 2 project	A close cooperation exists between the French KEOPS 2 and EU CARBOCHANGE projects. KEOPS 2 is the

			second French initiative to investigate the impact of natural iron fertilization on the biogeochemical cycles in the Southern Ocean. Researchers involved in CARBOCHANGE project took this opportunity for better describing and understanding CO_2 variability in the wake of Kerguelen island.
Project cooperation	2011- 2013	CATARINA project, Spain	A close cooperation exists between the Spanish CATARINA and EU CARBOCHANGE projects because both projects are scientifically involved in the repeated section OVIDE.
Carbon Cycle data assimilation system (CCDAS) setup	2011-2014	GEOCARBON (lead INGV)	Collaboration with the terrestrial Carbon cycle community
Royal Society meeting on seawater deoxygenation, Milton Keynes	11-12/04/2011	IPCC	
Presentation of results at the MAREMiP model Intercomparison Workshop	25/06/2011	Marine Ecosystem Model Intercomparison Project	
Meeting, workshop	3-4/05/2012	ANDREX project, U.K.	Cooperation on work performed in the Weddell Gyre.
Ocean flux and observing systems – the oceanic	28/06/2011	ICOS – Marine Sciences and European	

component of ICOS. The future of the 21st century ocean		Research Infrastructures	
SOLAS-IGAC France meeting	29/06/2011	SOLAS	presentations
Session on future SOCAT at the CO_2 Data to Flux workshop	13/09/2011	International Ocean Carbon Coordination Project (IOCCP)	
Ocean Sciences Meeting	20-24/02/2012	IPCC	
Planet under Pressure	26-29/3/2012	Global Carbon Project (GCP)	
SOCAT automation meeting	10-11/05/2012	International Ocean Carbon Coordination Project (IOCCP)	
Coordination meeting	06/09/2012	EU project Greencycles, project manager Kjetil Lygre	Greencycles collects a database of phytoplankton functional type observations; we want to have this database available for validation of models in WP1 task 1.2
EUR-Oceans conference, Toulouse, France	24-26/10/2012	IPCC	
ESA-EGU-SOLAS Earth Observation for Ocean-Atmosphere Interaction Science conference, Frascati, Italy	29/11-02/12/2012	SOLAS. EGU, ESA	Keynote on SOCAT

SOLAS science conference, Suncadia, WA, USA	06-08/05/2012	SOLAS	Invited talk on SOCAT
SOCAT automation meeting	10-11/05/2012	International Ocean Carbon Coordination Project (IOCCP)	
Effects of Climate Change on the World's Oceans, South Korea	15-20/05/2012	Global Carbon Project (GCP)	Keynote talk summarizing the effects of climate change on the world's oceans
SOCAT progress meeting	03-05/07/2012	International Ocean Carbon Coordination Project (IOCCP)	

6. Goals, priorities and plans for future activities/events

- The overall goals of the project will be followed during the project period (see www.carbochange.eu for details)
- Achieved data and the plan for the next year will be discussed at the CARBOCHANGE Annual Meeting which will be held in Norwich, UK, 24. – 26. April 2013 http://carbochange.b.uib.no/what/meetings/annual-meeting-2013/
- We are planning 3 events at ICDC9 conference: 1) A booth where all EU FP7 projects related to carbon cycling present themselves; 2) Release of an information brochure about these projects; 3) A discussion meeting between these projects, international projects and programs, and national and international funding agencies to plan priorities for future carbon cycle research.
- Project results will be presented at a series of international meetings (e.g. Gordon Research Conference on Polar Marine Science http://www.grc.org/programs.aspx?year=2013&program=grs_polar; EGU General Assembly http://www.egu2013.eu/home.html; International Ocean Colour Science http://iocs.ioccg.org/; ICDC9 Conference http://icdc9.lasg.ac.cn/dct/page/1; U.S. CLIVAR workshop http://www.usclivar.org/meetings/griso-workshop; IMDIS 2013 http://imdis2013.seadatanet.org/; CESM Workshop http://www.cesm.ucar.edu/events/ws.2013/; International Liège Colloquium http://modb.oce.ulg.ac.be/colloquium/)

7. Other comments

CHOICE-C Carbon cycling in China Seas - budget, controls and ocean acidification

compiled by Minhan Dai

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight.*

(1) Rising CO_2 and increased light exposure synergistically reduce marine primary productivity

Gao, K.S., Xu, J.T., Gao, G., Li, Y.H., Hutchins, D.A., Huang, B.Q., Wang, L., Zheng,Y., Jin, P., Cai, X.N., Hader, D.-P., Li, W., Xu, K., Liu, N.N., Riebesell, U.,***Nature Climate Change***, 2012, 2:519-523.

Carbon dioxide and light are two major prerequisites of photosynthesis. Rising CO_2 levels in oceanic surface waters in combination with ample light supply are therefore often considered stimulatory to marine primary production. Here we show that the combination of an increase in both CO_2 and light exposure negatively impacts photosynthesis and growth of marine primary producers. When exposed to CO_2 concentrations projected for the end of this century, natural phytoplankton assemblages of the South China Sea responded with decreased primary production and increased light stress at light intensities representative of the upper surface layer. The phytoplankton community shifted away from diatoms, the dominant phytoplankton group during our field campaigns. To examine the underlying mechanisms of the observed responses, we grew diatoms at different CO_2 concentrations and under varying levels (5–100%) of solar radiation experienced by the phytoplankton at different depths of the euphotic zone. Above 22–36% of incident surface irradiance, growth rates in the high-CO_2-grown cells were inversely related to light levels and exhibited reduced thresholds at which light becomes inhibitory. Future shoaling of upper-mixed-layer depths will expose phytoplankton to increased mean light intensities. In combination with rising CO_2 levels, this may cause a widespread decline in marine primary production and a community shift away from diatoms, the main algal group that supports higher trophic levels and carbon export in the ocean.

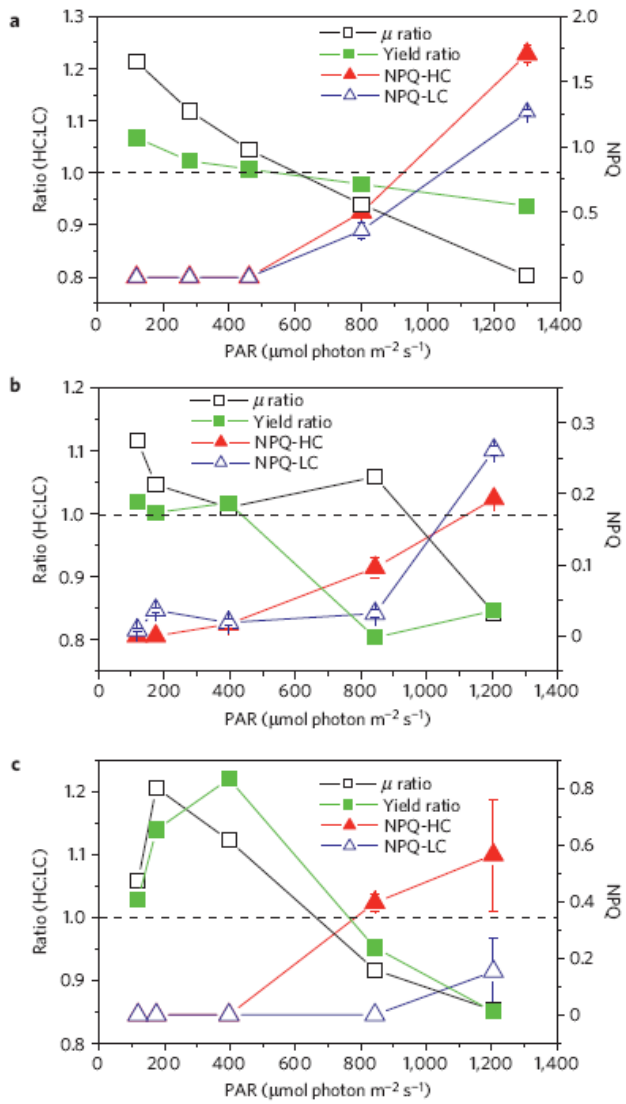


Figure 1 High- to low-pCO_2ratios for growth rates and photosynthetic parameters in cultured diatoms. **a**–**c**, The ratios of _ (open square) and effective yields (green filled square) in high-CO_2-grown cells (HC, 1,000 μatm) to those in low-CO_2-grown cells (LC, 390 μatm), and their NPQ (red filled triangle for HC and blue open triangle for LC) in the diatoms, *Phaeodactylumtricornutum*(**a**), *Thalassiosirapseudonana*(**b**) and *Skeletonemacostatum*(**c**), as a function of PAR levels, equivalent to solar PAR levels during noon period for the same cultures grown outdoors. Note, both growth rate and yield reversed with increased PAR levels and NPQ increased faster with increased PAR levels in the high-CO_2-grown cells.

(2) On the Variations of Sea Surface pCO_2 in the Northern South China Sea - A Remote Sensing Based Neural Network Approach

Jo, YH; Dai, MH; Zhai, WD; Yan, XH; Shang, SL.***Journal of Geophysical Research***, 117, C08022, doi:10.1029/2011JC007745.

Using a neural networking (NN) approach, we developed an algorithm primarily basedupon sea surface temperature (SST) and chlorophyll (Chla) to estimate the partial pressure ofcarbon dioxide (pCO_2) at the sea surface in the northern South China Sea (NSCS).Randomly selected in situ data collected from May 2001, February and July 2004 cruiseswere used to develop and test the predictive capabilities of the NN based algorithm withfour inputs (SST, Chla, longitudes and latitudes). The comparison revealed a highcorrelation coefficient of 0.98 with a root mean square error (RMSE) of 6.9 μatm. Wesubsequently applied our NN

algorithm to satellite SST and Chla measurements, withassociated longitudes and latitudes, to obtain surface water pCO_2. The resulting monthlymeanpCO_2 map derived from the satellite measurements agreed reasonably well with the insitu observations showing a generally homogeneous distribution in the offshore regions.The pCO_2 exerts a very dynamic feature in nearshore regions, especially in the coastalupwelling and estuarine plume regions. We identified three low pCO_2 zones (<330 μatm),two of which are influenced by coastal upwelling: off Hainan island in the western partof the NSCS; and off Guangdong province in the eastern part of the NSCS. The path ofthe Pearl River plume on the shelf was another zone with low *p*CO2. For the monthlymean *p*CO2 variations estimated based on the MODIS-SST and -Chla values, an RMSEof ~6 μatm may be attributable to the measurement errors associated with MODISmeasurements. As a first order estimation, we used the same sampling periods of remotesensing and in situ measurements, and were able to estimate pCO_2 with an accuracy of12.05 μatm for onshore regions and 13.0 μatm for offshore regions, but with combineduncertainties associated with the NN Testing algorithm and MODIS SST and Chlameasurements.

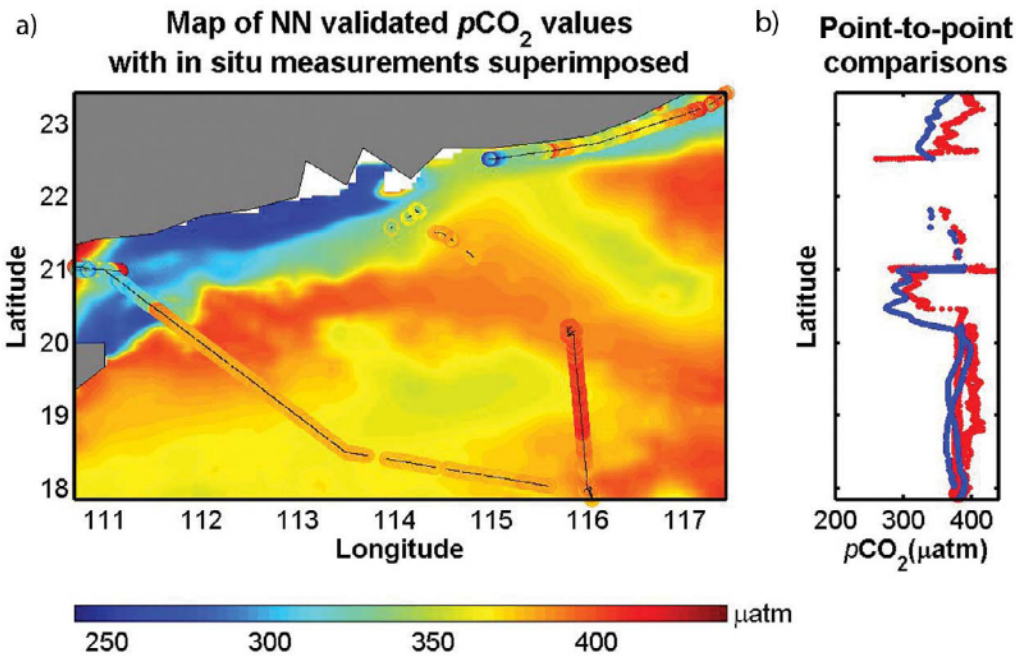


Figure 2. (a) Map of the NN validated pCO_2 values for the July 2004 cruise with the locations of thefield measurements superimposed. (b) A comparison of the in situ (red dots) and NN (blue dots) pCO_2 measurementsalong the same latitudes.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisonsetc)

2.1 Cruise and field experiment

A 24-day long and multidisciplinary CHOICE-C summer cruise was conducted onboard R/V Dongfanghong II on July29-August 21, 2012, covering the northern South China Sea. The cruise map is shown in Figure 3.

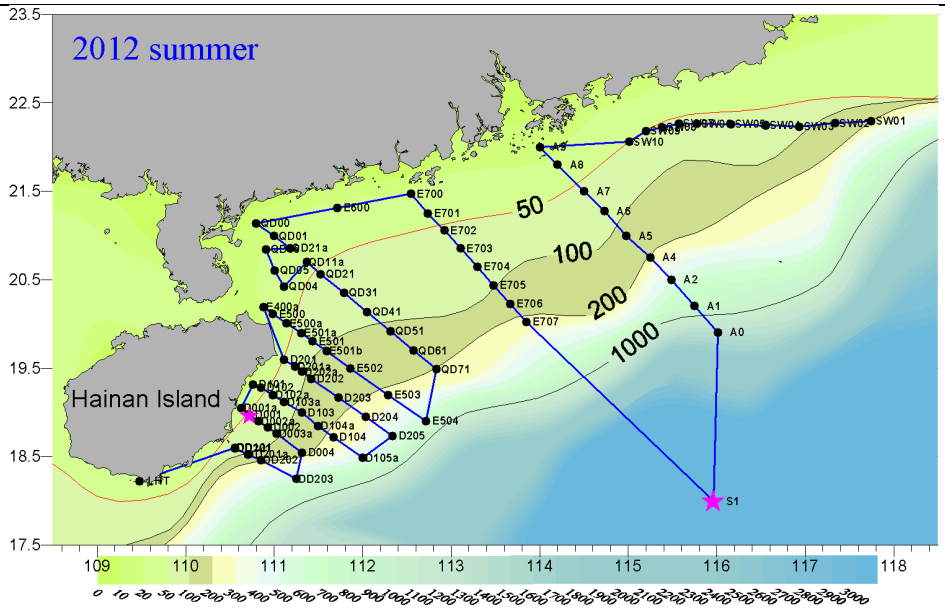


Figure 3. Map of the South China Sea showing the sampling stations in the CHOICE-C 2012 summer cruise.

2.2 Workshop convened or organized

1) 2012 CHOICE-C annual meeting, November 30-December 2, 2012, Guangzhou, China.

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

The Ocean and Me---2012 Xiamen University Ocean Sciences Open House, November 4, 2012, Ocean Building, Xiamen University, China

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

1. Gao, K.S., J.T. Xu, G. Gao, Y.H. Li, D.A. Hutchins, B.Q. Huang, L. Wang, Y. Zheng, P. Jin, X.N. Cai, D.-P. Hader, W. Li, K. Xu, N.N. Liu, and U. Riebesell, 2012. Rising CO_2 and increased light exposure synergistically reduce marine primary productivity. ***Nature Climate Change***, 2: 519-523.
2. Cao, Z.M., M. Frank, M.H. Dai, P. Grasse, and C. Ehlert, 2012. Silicon isotope constraints on sources and utilization of silicic acid in the northern South China Sea. ***Geochimica et Cosmochimica Acta***, 97: 88-104.
3. Jo, Y.-H., M.H. Dai, W.D. Zhai, X.-H. Yan, and S.L. Shang, 2012. On the Variations of Sea Surface pCO_2 in the Northern South China Sea - A Remote Sensing Based Neural Network Approach. ***Journal of Geophysical Research***, 117, C08022, doi:10.1029/2011JC007745.
4. Han, A.Q., M.H. Dai, S.J. Kao, J.P. Gan, Q. Li, L.F. Wang, W.D. Zhai, and L. Wang, 2012. Nutrient dynamics and biological consumption in a large continental shelf system under the influence of both a river plume and coastal upwelling. ***Limnology and Oceanography***, 57(2): 486-502.
5. Yang, D.Z., B.S. Yin, Z.L. Liu, T. Bai, J.F. Qi, and H.Y. Chen, 2012. Numerical study on the pattern and origins of Kuroshio branches in the bottom water of southern East China Sea in summer. ***Journal of Geophysical Research***, 117, C02014, doi:10.1029/2011JC007528.
6. Dong, Q., S.L. Shang, and Z.P. Lee, 2013. An algorithm to retrieve absorption coefficient of chromophoric dissolved organic matter from ocean color. ***Remote Sensing of Environment***, 128: 259-267.
7. Gan, J.P., H. Ho, and L.L. Liang, 2012. Dynamics of intensified downwelling circulation over a widened shelf in the northeastern South China Sea. ***Journal of Physical Oceanography***, DOI: 10.1175/JPO-D-12-02.1.
8. Jia, G.D., J. Zhang, J.F. Chen, P.A. Peng, and C.L. Zhang, 2012. Archaeal tetraether lipids record subsurface water temperature in the South China Sea. ***Organic Geochemistry***, 50: 68-77.
9. Wang, X.C., H.Q. Ma, R.H. Li, Z.S. Song, and J.P. Wu, 2012. Seasonal fluxes and source variation of

organic carbon transported by two major Chinese Rivers: The Yellow River and Changjiang (Yangtze) River. ***Global Biogeochemical Cycles***, 26, GB2025, doi:10.1029/2011GB004130.

10. Guo, C., J. Yu, T.-Y. Ho, B.Z. Chen, L. Wang, S.Q. Song, L. Kong, and H.B. Liu, 2012. Dynamics of phytoplankton community structure in the South China Sea in response to the East Asian aerosol input. ***Biogeosciences***, 9: 1519-1536.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

1) Minhan Dai, Coastal Ocean Carbon Cycling – Current Understanding and Challenges, 2012 ASLO (the Association for the Sciences of Limnology and Oceanography) Aquatic Sciences Meeting, 8-13 July 2012, Lake Biwa, Otsu, Shiga, Japan. (Plenary Talk)

2) Kunshan Gao,Rising carbon dioxide and increasing light exposure act synergistically to reduce marine primary productivity ,Third International Symposium on the Ocean in a High-CO_2 World, (September,24-27 2012, Monterey, USA)

6. Goals, priorities and plans for future activities/events

CHOICE-C is at its final stage in her funded period, and will be reviewed late 2013. We are doing the vigoroussynthesisanalysis and will seek opportunities for another round of financial support. The scope of the research will however haveto be adjusted.

7. Other comments

MedSeA

Mediterranean Sea Acidification in a changing climate

compiled by Patrizia Ziveri

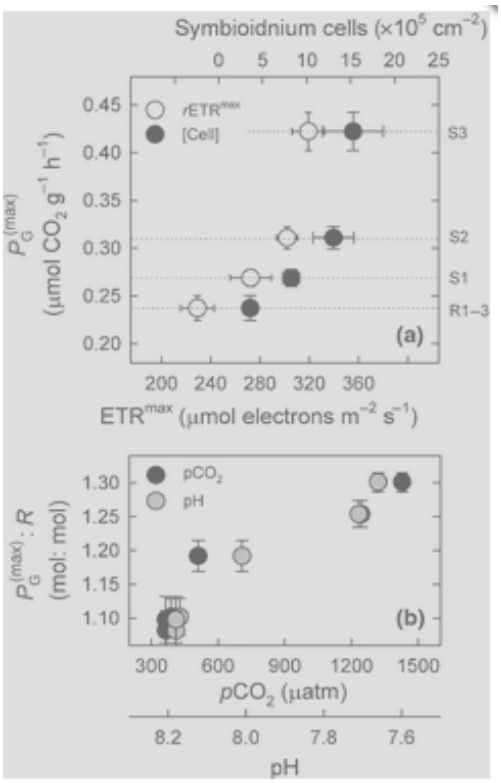
Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight.*

Sea anemones may thrive in a high CO2 world

We show that OA-like conditions can simultaneously enhance the ecological success of non-calcifying anthozoans, which not only play key ecological and biogeochemical roles in present day benthic ecosystems but also represent a model organism should calcifying anthozoans exist as less calcified (soft-bodied) forms in future oceans. Increased growth (abundance and size) of the sea anemone (*Anemonia viridis*) population was observed along a natural CO_2 gradient at Vulcano, Italy. Both gross photosynthesis (PG) and respiration (R) increased with pCO_2 indicating that the increased growth was, at least in part, fuelled by bottom up (CO2 stimulation) of metabolism. The increase of PG outweighed that of R and the genetic identity of the symbiotic microalgae (Symbiodinium spp.) remained unchanged (type A19) suggesting proximity to the vent site relieved CO_2 limitation of the anemones' symbiotic microalgal population. Our observations of enhanced productivity with pCO_2, which are consistent with previous reports for some calcifying corals, convey an increase in fitness that may enable non-calcifying anthozoans to thrive in future environments, i.e. higher seawater pCO_2. Understanding how CO_2-enhanced productivity of non- (and less-) calcifying anthozoans applies more widely to tropical ecosystems is a priority where such organisms can dominate benthic ecosystems, in particular following localized anthropogenic stress.



Sugget D, Hall-Spencer J M, Rodolfo-Metalpa R, Boatman T G, Payton R, et al., 2012. Sea anemones may thrive in a high CO_2 world, *Global Change Biology*, 18,10, 3015-3025.

Figure: Relationships of (a) the maximum rate of gross productivity (inline image, µmol CO2 g−1 h−1) vs. the maximum electron transfer rate (ETRmax, µmol electrons m−2 s−1) and Symbiodinium cell density (cell × 105 cm−2 tentacle) for the reference (R) and elevated CO2 (S) sites at Vulcano. Note that each point is the mean ± standard error of all replicates (and also that data for all of the reference sites, R1–R3 has been pooled for figure clarity); and (b) the mean (± standard) ratio of the maximum gross photosynthesis to respiration rate (inline image:R, mol CO2 fixed: mol CO2 released) vs. the median pCO2 and

pH) across all sites.

Ocean acidification on marine bivalve shell geochemistry and ultrastructure

We investigated carbon, oxygen and trace element records from different shell layers in the mussels *Mytilus galloprovincialis* combined with detailed investigations of the shell ultrastructure. Mussels from the harbour of Ischia (Mediterranean, Italy) were transplanted and grown in water with mean pH_T 7.3 and mean pH_T 8.1 near CO_2 vents on the east coast of the island. Geochemical data from all test sites show a strong metabolic effect that exceeds the influence of the low-pH environment. These field experiments showed that care is needed when interpreting potential ocean acidification signals because various parameters affect shell chemistry and ultrastructure. Besides metabolic processes, seawater pH, factors such as salinity, water temperature, food availability and population density all affect the biogenic carbonate shell archive.

Hahn S, Rodolfo-Metalpa R, Griesshaber E, Schmahl WW, Buhl D, Hall Spencer JM, Baggini C, Fehr KT, Immenhauser A, 2012, Marine bivalve shell geochemistry and ultrastructure from modern low pH environments: environmental effect versus experimental bias, Biogeosciences, 9, 1897–1914

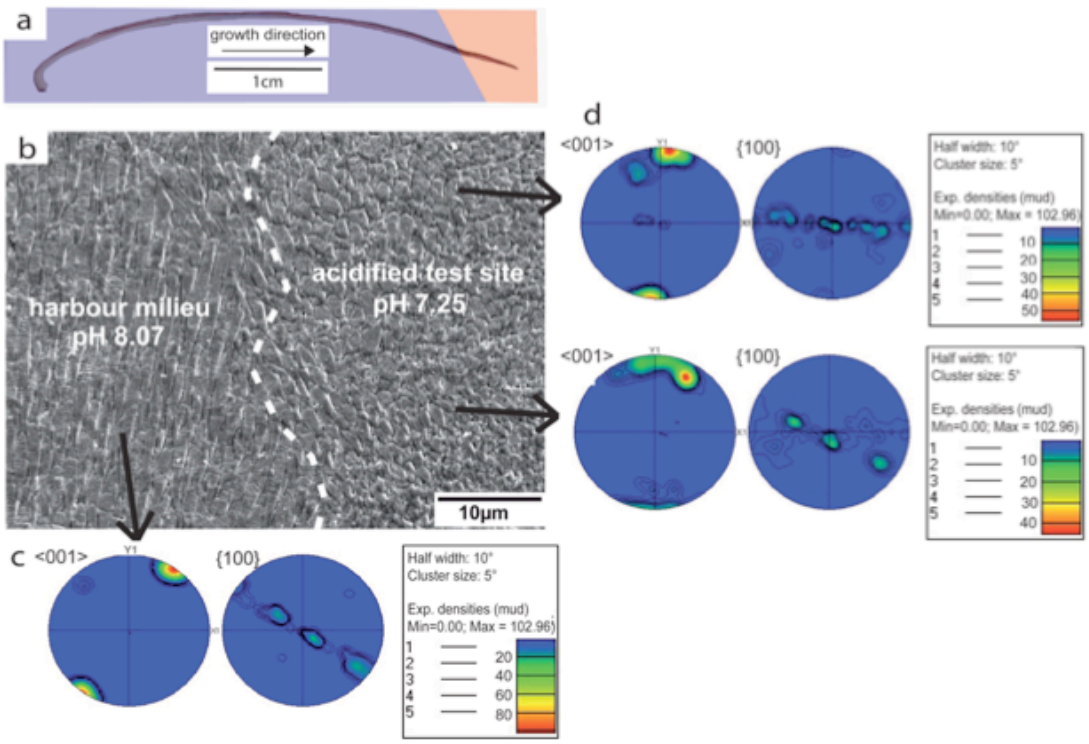


Figure: Thin section view of calcite layer of *M. galloprovincialis* from acidified seawater site B1. (a) Blue colour indicates shell precipitated prior to transplantation and red colour indicates shell precipitated after transplantation to acidified test site B1. (b) SEM image of shell precipitated parallel to the longest growth axis and directly before and after transplantation. Note pronounced differences in the orientation of the calcite layer across transplantation event (white, stippled line). Locations of respective pole figures (c) and (d) are indicated. (c and d) Pole figures representing stereographic projections of crystallographic axes and planes. The strength of clustering is specified with the MUD (multiples of uniform density) value that gives the distribution pattern of EBSD data relative to that of a random distribution.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Within the MedSeA project we organized 3 major training activities listed below:

- Carbon biogeochemistry training: 19 participants from 7 countries (Egypt, France, Greece, Italy, Morocco, Spain, U.K.) attended it. The main structure of this activity developed in a theoretical part the carbonate system fundamentals, and in a practical one sampling and measurements, data analyzing, processing, mapping and reporting procedures.

- Training on Mediterranean acidification: perturbation experiments on planktonic organisms. A total of 23 Ph.D. students, postdoctoral researchers and PIs from 8 countries (Egypt, France, Italy, Morocco, UK, Spain, Greece, Sweden) attended the workshop.

- Training on CO_2 vents as natural laboratory for acidification studies: a total of 44 participants attended the workshop, including 12 research students from France, Germany, Greece, Israel, Italy, Morocco, Portugal, Spain, UK and the USA.

The first mesocosm experiment was performed in June-July 2012 off the North of Corsica. The main goals of the MedSeA mesocosm experiments is to assess the Mediterranean pelagic ecosystem response to ocean acidification. Large-scale in situ mesocosms were adapted to allow the manipulation and the control of pCO_2. We conducted various simulations using six degrees of CO_2-related ocean acidification impacts in the marine environment and biogeochemistry. See also the blog related to these activities and results at http://medseastareso2012.wordpress.com.

Regular sampling in the 4 MedSeA monitoring stations in the eastern, western and Adriatic basins has continued for 2012. In addition, field work in Vulcano Island using the CO_2 vents for studying the impacts of ocean acidification in target benthic organisms and biogeochemical processes has been performed.

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

We conducted several activities that widened the public access and exposure to the MedSeA project, including various forms of outreach, capacity building, and public engagement. For examples, the Brussels Policy meeting on ocean acidification that occurred in May 2011, the United Nations Framework Convention for Climate Change (UNFCCC) SBSTA (Bonn, June 2011), and the UNFCCC COP17, (Durban, December 2011), Planet under Pressure Conference (London, April 2012), and at the meeting at the European Parliament

The MedSeA website (http://medsea-project.eu/) and MedSeA Blog make a significant contribution to MedSeA's outreach to scientists, policy makers and the public (contribution to Objectives a and b). For example, there are outreach and MRUG pages as well as descriptions of the science work packages and project objectives on the web site. MedSeA has also worked with school children to produce Italian, Spanish and Catalan versions of the award-winning animation and DVD *The Other CO_2 Problem* produced by Ridgeway School and PML during EPOCA. These are available as DVD's and on YouTube (contribution to Objective a).
MedSeA scientists have given a number of TV, radio and newspaper interviews related to the Mediterranean vent work and ocean acidification activities in the UNFCCC COPs and Planet under Pressure meetings.

Several groups within MedSea are performing ocean acidification research for the first time, and there is significant interchange among and between groups to ensure that thèse efforts are coordinated and consistent, thus maximizing their overall impacts. There is significant capacity

building for each of the research groups involved, such that skills and abilities have demonstrably widened to levels not previously reached. Furthermore, there have been significant training activities (described above) made available to those scientists from rapidly developing countries (e.g. N. Africa) ; thèse have been exploited by those groups that can readily incorporate the outcomes into their host institutions, thus rapidly and widely expanding research capacities in parts of the world where they have been traditionally lower.

Several articles related to MedSeA project studies were published on the web or newspapers and outreach documents (e.g. Sarah Everts, The Mediterranean beneath the surface, cover story, ACS News Service Weekly PressPac: April 11, 2012, 12-17; Turley C, Keizer T, Williamson P, Gattuso J-P, Ziveri P, Monroe R, Boot K, Huelsenbeck M: Hot, Sour and Breathless – Ocean under stress, Plymouth Marine Laboratory, UK Ocean Acidification Research Programme, European Project on Ocean Acidification, Mediterranean Sea Acidification in a Changing Climate project, Scripps Institution of Oceanography at UC San Diego, OCEANA; 2011 6pp.)

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

1. Arnold T, Mealey C, Leahey H, Miller AW, Hall-Spencer JM, Milazzo M, Maers K., 2012, Ocean Acidification and the Loss of Phenolic Substances in Marine Plants, *PLoS ONE*, 7(4), PLOS, 1-10

2. Glas, M. Langer, G. Keul, N. , 2012, Calcification acidifies the microenvironment of a benthic foraminifer (*Ammonia* sp.), *Journal of Experimental Marine Biology and Ecology*, 424–425, 53-58.

3. Grelaud M, Marino G, Ziveri P, Rohling E J, 2012, Abrupt shoaling of the nutricline in response to massive freshwater flooding at the onset of the last interglacial sapropel event, *Paleoceanography*, 27, PA3208.

4. Hahn S, Rodolfo-Metalpa R, Griesshaber E, Schmahl WW, Buhl D, Hall Spencer JM, Baggini C; Fehr KT, Immenhauser A, 2012, Marine bivalve shell geochemistry and ultrastructure from modern low pH environments: environmental effect versus experimental bias, *Biogeosciences*, 9, 5, 1897-191a.

5. Johnson VR, Russell BD, Fabricius KE , Brownlee C, Hall-Spencer JM, 2012, Temperate and tropical brown macroalgae thrive, despite decalcification, along natural CO2 gradients, *Global Change Biology*, 18, 9, 2792–2803

6. Kadar E, Fisher A, Stoplpe B, Harrison R M, Parello F, Lead J , 2012, Metallic nanoparticle enrichment at low temperature, shallow CO2 seeps in Southern Italy, *Marine Chemistry*, 140–141, 24-32.

7. Rodrigues LC, van den Bergh, JCJM, Ghermandi, A, in press, Socio-economic impacts of ocean acidification in the Mediterranean Sea, *Marine Policy*, 38, 447-456.

8. Suggett DJ, Hall-Spencer JM, Rodolfo-Metalpa R, Boatman TG, Payton R, Pettay DT, Johnson VR, Warner ME, Lawson T, 2012, Sea anemones may thrive in a high CO2 world, *Global Change Biology*, 18, 10, 3015-3025.

9. Turley, C, Gattuso, JP, 2012, Future biological and ecosystem impacts of ocean acidification and their socioeconomic-policy implications, *Current Opinion in Environmental Sustainability*, 4, 3, 278-286.

10. Ziveri, P, Thoms, S, Probert, I, Geisen, M, Langer G, 2012, A universal carbonate ion effect on stable oxygen isotope ratios in unicellular planktonic calcifying organisms, *Biogeosciences*, 9, 1-8.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Several MedSeA scientists contributed to major international programs with an enormous degree of exposure and projection. These activities ensure a wider degree of collaboration and foster a higher degree of coordinated networking that will benefit the advancement of the science for decades to come. Below are some of the international interactions and collaborations:

- The IPCC Working Group II involvement.
- The IPCC WGII / WGI Workshop on Impacts of Ocean Acidification on Marine Biology and Ecosystems, Japan Bankoku Shinryokan, Okinawa, Japan, 17-19 January 2011.
- SOLAS-IMBER working group on ocean acidification.
- CBD Expert Meeting on Impacts of Ocean Acidification on Marine and Coastal Biodiversity.
- OSPAR-ICES Study Group on Ocean Acidification.

6. Goals, priorities and plans for future activities/events

The MedSeA project is addressing ecologic and economic impacts from the combined influences of anthropogenic acidification and warming, while accounting for the unique characteristics of this key region. A main final goal is to provide science-based projections of Mediterranean acidification under the influence of climate change as well as associated economic impacts. Projections will be based on new observations of chemical conditions as well as new observational and experimental data on the responses of key organisms and ecosystems to acidification and warming, which will be fed into existing ocean models that have been improved to account for the Mediterranean´s fine-scale features. These scientific advances will allow us to provide the best advice to policymakers who must develop regional strategies for adaptation and mitigation.

All of the above activities and achievements from the first project period have naturally led and evolved to a series of near- and long-term future goals and priorities. These result from the various levels of collaboration, coordination, networking, international involvement, impacts toward policy, and more. Four major plans for activities that will be performed in 2013 include:

- Large-scale in situ ocean acidification mesocosm experiments will take place in the Bay of Villefranche (February, 2013).
- Ocean acidification and warming mesocosm experiment in Crete (June 2013). This will be done in the land-based facilities of CRETACOSMOS (http://mesocosm.eu/cretacosmos), thereby allowing for the first time simultaneous pCO_2 and temperature manipulations in mesocosms.
- A trans-Mediterranean oceanographic cruise focusing on the study of ocean acidification and warming impacts of Mediterranean biogeochemistry and target organisms (Cadiz, Crete, Barcelona, May 3 – June 1, 2013).
- Further exploration and work on naturally acidified seawater sites will continue at Vulcano Island and Methana.

7. Other comments

MERMEX

compiled by Cécile GUIEU

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Attenuation of UVR and PAR in relation with chromophoric dissolved organic matter in surface coastal waters of the Northwestern Mediterranean Sea

Radiometric and chromophoric dissolved organic matter (CDOM) measurements were performed monthly between November 2007 and December 2008 at a coastal station in the Northwestern Mediterranean Sea during MERMEX WP4 project. Surface irradiance ($E_s(\lambda)$) (Figure 1) strongly varied with season (particularly for UVR-B) and was from 0.14 to 4.6, 12 to 59 and 30 to 159 µW cm^{-2} for UVR-B (305 nm), UVR-A (340 nm) and PAR (490 nm), respectively. Examination of the UVR-B/UVR-A, UVR-B/PAR and UVR-A/PAR surface irradiance ratios indicated that UVR-A and PAR were similar and evolved temporally. In contrast, the UVR-B increased 7 to 8 fold more than its UVR-A and PAR counterparts during the summer. The diffuse attenuation coefficients for downward irradiance [$K_d(\lambda)$] of UVR-B, UVR-A and PAR were from 0.21 to 0.48, 0.16 to 0.27 and from 0.04 to 0.09 m^{-1}, respectively. These values indicated that the waters were highly transparent throughout the year. These results suggest that during the summer, the higher relative abundance of UVR-B and the stratification of the water column promote photochemical reactions in the surface waters of the Bay of Marseilles.The relationships between CDOM absorption and $K_d(\lambda)$ in this oligotrophic system suggested that CDOM contributed to UVR attenuation in the UVA domain, but also played a significant role in PAR attenuation. [1]

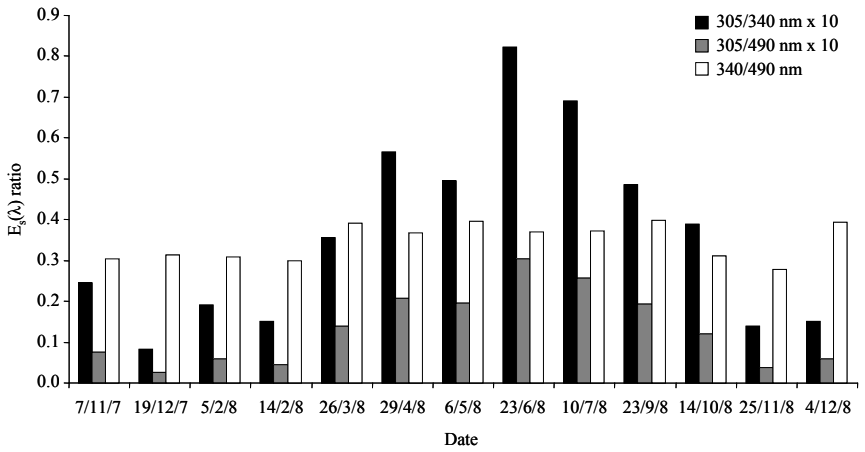


Figure 1.Temporal variability of surface irradiance [Es(λ)] ratios measured at the SOFCOM station at solar noon, including UVR-B/UVR-A (305/340 nm), UVR-B/PAR (305/490 nm) and UVR-A/PAR (340/490 nm). The UVR-B ratios are multiplied by 10.

(contact : richard.sempere@univ-amu.fr)

[1] Para J., Tedetti M., Charrière B., Mallet M., Sempéré R., Attenuation of UVR and PAR in relation with chromophoric

dissolved organic matter in surface coastal waters of the Northwestern Mediterranean. Submitted.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Various activities of MERMEx program, via the WP4 are running in 2012 concerning:

1. The assessment of gas fluxes (CO_2) and acidification and the impacts on ecosystems and biogeochemical cycles, through different projects:

CALIBORON (**CALI**bration of paleo-pH reconstruction technique based on **BORON** isotopes in calcareous species (corals and bivalves) from the Mediterranean Sea: quantification of surface water acidification due to industrial era; Eric.Douville@lsce.ipsl.fr). This project aims to develop and apply the paleo-pH technique based on boron isotopes for new specific calcifying species (bivalves and corals) for the reconstruction of recent past pH changes in the Mediterranean Sea. The first measurements of boron isotopes for Mediterranean shallow, deep-sea corals or red corals were conducted in 2012.

CARBORHONE (pCO_2 and DIC dynamics in the Rhone river estuary and the Gulf of Lions; Y. Bozec, bozec@sb-roscoff.fr). This project investigates the processes controlling the air-sea CO_2 fluxes from the inner Rhône estuary to the estuarine plume located in the surface waters of the Gulf of Lions. Two cruises have been carried out in 2012 covering the winter (February) and summer (July) periods, in complement of cruises of 2011 covering spring (April) and fall (early December) periods . This additional datasets allowed the determination of the physical, biological and chemical (mixing, NCP, thermodynamic) processes driving the air-sea CO_2 fluxes over an annual cycle. Collaborations with colleagues involved in the CASCADE and MERMEX-rivers (WP3) projects allowed further determination of the processes controlling the air-sea CO_2 dynamics, notably for the plume dispersal and processes occurring at the benthic interface. Moreover, our pCO_2 data has been made available for the SOCAT database (http://www.socat.info/) for a complete assessment of the role of estuarine plume on global estimates of air-sea CO_2 fluxes.

2. The study of aerosol fluxes at the interface air-sea which is coupled with the component ChArMEx of MISTRALS (Chemistry-Aerosol Mediterranean Experiment)

SAM (Quantification and determination of marine organic aerosol fluxes as a function of trophic conditions; B. D'Anna, barbara.danna@ircelyon.univ-lyon1.fr). A first lab experiment has been conducted in November 2012 for the measurements of primary marine particles (Number distribution of chemical, hygroscopic, volatile and CCN properties) and of trace gas fluxes (PTRMS). Fluxes of primary marine particles have been also measured during MedSea campaign in Corsica during this summer (dimensional spectra, CCN properties and chemical composition resolved in size).

3. The influence of solar radiations on biogeochemical cycles includes the potential effect of aerosol and tropospheric ozone attenuation on marine ecosystems.

PHOTOMED (Metabolic and structural changes of the bacterial community in response to the phototransformations of dissolved and particulate organic matter in Mediterranean Sea; joux@obs-banyuls.fr). Due to high solar radiation, Mediterranean Sea is the place of intense photochemical transformations of both DOM and POM. The consequences of these alterations on the metabolism and the diversity of the marine bacteria are explored in the PHOTOMED project. (1) Photodegradation of DOM from the Rhone River resulted in contrasting effects on both bacterial activity and diversity (DNA fingerprint)

depending of the dates: when a stimulation and a change in diversity were observed in March, no effects on both parameters were measured in June. Photodegradation of the phytoplanktonic DOM (Chaetoceros sp.) induced a decrease in the bacterial activity and a shift in the diversity. A detailed analysis of the diversity changes by pyrosequencing is in progress. (2) During irradiation of senescent cells of Emiliania huxleyi from non-axenic cultures experiments we measured the production of epoxyacids, attributed to the intervention of peroxygenases (enzymes allowing the bacteria to reduce the concentration of toxic hydroperoxides). These results confirm the role played by singlet oxygen in the transfer of photooxidation processes from phytodetritus to attached bacteria. It now remains to determine if this stress has a significant effect on the growth and diversity of attached bacteria.

SUNMEX (richard.sempere@univ-amu.fr). This project aims to determine the potential effect of aerosol and tropospheric ozone attenuation on marine ecosystems. In this purpose, simultaneous radiometric measurements of radiation in the atmosphere by sunphotometer (AERONET network) and in seawater by deploying of a mooring line (SUNMEX MIO buoy**)** allowing also the determination of biogeochemical parameters are carried out in the Bay of Marseilles. First results showed higher relative abundance of UVR-B among other radiations in the atmosphere in summer and allowed study of solar radiation attenuation by CDOM and Chlorophyll in the surface waters of coastal Med. Sea.

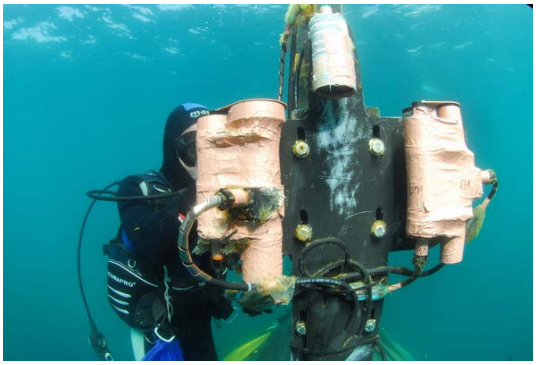


Figure 2: SUNMEX MIO buoy deployed in the bay of Marseille

- **New projects that started in 2012:**

CHIPIE: Comportement des éléments d'intérêt biogéocHImiques et du carbone Particulaire aux Interfaces atmosphère-océan et continent-océan dans un contexte d'évolution des conditions Environnementales (guieu@obs-vlfr.fr). The objective of this project is to study the impact of climate and environment change (temperature, acidification) on the behavior of biogeochemical elements and particulate carbon at the atmosphere-ocean interface. The experimental approach ('clean minicosm in abiotic conditions') initiated at the end of the DUNE project (see Bressac, 2012) will be completed by temperature and turbulence controls and an integrated sampling system will be developed. Such developments are currently done in order to perform three experiments in 2013. A PhD started in fall 2012 (J. Louis, LOV) and 3 experiments are scheduled in 2013. (funding University Paris VI).

A working group started concerning the setting up of a proposal for a field cruise entitled **PEAcEtIME** "ProcEss studies at the Air-sEa Interface: a Mediterranean Experiment" (joint experiment between MERMEX and ChArMEx planned in 2015). This project was presented at the 2012 OSC to call for international collaboration on that "SOLAS cruise" in the Mediterranean, it will be submitted for funding at the autumn 2013.

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

Several pHD are conducted under the actions presented above (1 CARBORHONE, 1 CALIBORON, 2 PHOTOMED, 1 CHIPIE, 4 MEDSEA mesocosms,

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

SOLAS NEWS issue 14, summer 2012:

- SOLAS ENDORSED PROJECT: MERMeX, p 53
- Bressac M., Dust depositionn: the fate of atmospheric new nutrients, interactions with organic matter and the impact on carbon export. P6-7
- MedSea project: p 53-54

Website: http://mermex.pytheas.univ-amu.fr

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

MedSeA (EU FP7, started in February 2011, Mediterranean Sea Acidification in a changing climate. A first joint experiment using large pelagic mesocosms took place in Corsica (summer 2012) to assess the effects of ocean acidification on planktonic communities in oligotrophic areas (see article in this issue). Another experiment will take place in the Bay of Villefranche in Feb- March 2013. (see report in SOLAS NEWS issue 14, summer 2012).

eFOCE (BNP-Paribas, started in 2011, European Free-Ocean Carbon dioxide Enrichment experiments: development of benthic experimental systems to study the effects of ocean acidification of benthic communities in the field (Bay of Villefranche, Mediterranean Sea); started in 2011; J.-P. Gattuso, gattuso@obs-vlfr.)

6. Goals, priorities and plans for future activities/events

In 2013, all the described actions will be continued. Several experiments are schedules (CHIPIE, MedSea etc.). An important focus will be the drafting of a proposal for the PEACETIME cruise project; several group meeting are scheduled to prepare this proposal.

7. Other comments

The activities of MERMEX deal in part with natural and anthropogenic air-sea interactions (those activities being the WP4 coordinated by Frédéric Gazeau (gazeau@obs-vlfr.fr), LOV/OSU Villefranche/Mer, Karine Desboeufs (Karine.Desboeufs@lisa.univ-paris12.fr), LISA/IPSL Paris and Marc Mallet (Marc.Mallet@aero.obs-mip.fr), LA/OMP Toulouse. Those projects are strongly connected to IGBP-SOLAS programs and operationally connected to CharMex (The Chemistry-Aerosol Mediterranean Experiment; http://charmex.lsce.ipsl.fr) and MOOSE (Mediterranean ocean observing system on environment. http://www.insu.cnrs.fr/co/expeditions-et-campagnes/moose-mediterranean-ocean-observing-system-on-environment

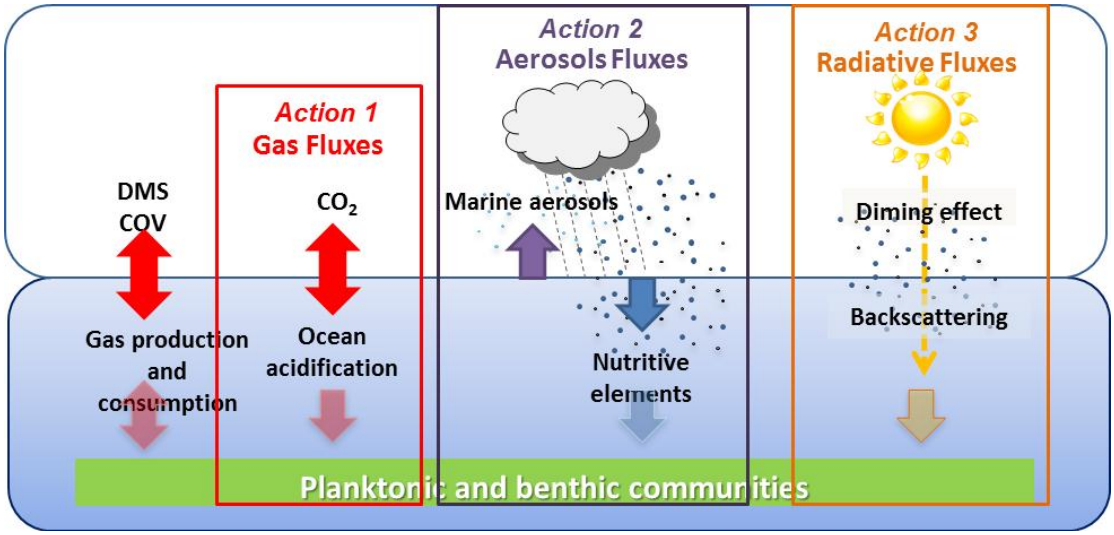


Figure 2. . Main MERMEx activities relevant to SOLAS (WP4 objectives and actions): The assessment of gas fluxes (CO_2) and acidification and the impacts on ecosystems and biogeochemical cycles, the study of aerosol fluxes at the air-sea interface [coupled with the component ChArMEx of MISTRALS (Chemistry-Aerosol Mediterranean Experiment)] considers both the formation of marine aerosol and the atmospheric deposition of nutrients. The influence of solar radiations on biogeochemical cycles includes the potential effect of aerosol and tropospheric ozone attenuation on marine ecosystems.

SOAP Surface Ocean Aerosol Production

compiled by Cliff Law

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight.*

No publications to date

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Biologically-active regions of the surface ocean support production of a range of compounds that influence the production, composition and properties of aerosols in the marine boundary layer. The SOAP voyage in February-March 2012 examined biotic influences on aerosol production in a productive frontal system in the south-west Pacific Ocean. Sampling took place along the Sub-Tropical Front east of New Zealand, primarily in three phytoplankton blooms with different characteristics dominated by dinoflagellates and coccolithophores.

Work-package 1 examined the relationships between the distribution of DMS and pCO_2, and phytoplankton biomass & species composition, and related spatial variation in aerosol number distribution and composition properties of the surface microlayer. Underway measurements showed regional covariance between atmospheric and surface water DMS. Process measurements indicated that a significant proportion of dissolved DMSP in surface waters was consumed by bacteria and cleaved into DMS; however, there was little evidence of near-surface or microlayer enrichment or depletion of DMS.

Work-package 2 measured DMS & CO_2 flux to and from the atmosphere, and examined relationships between gas transfer velocity and physical drivers, such as near-surface turbulence, sea-state and whitecap coverage. Different DMS flux measurement approaches were employed, including eddy correlation measurements from the ships bow and gradient flux measurements at distance from the ship on a catamaran. Preliminary data from the latter, augmented by measurements on the foredeck and crows-nest showed a consistent gradient of decreasing DMS with height.

Work-package 3 addressed the relative importance of primary and secondary organic sources to nuclei production. Aerosol size range was well-characterised by a range of instruments, which facilitated the study of interactions between sea salt aerosol, precursor gases and nucleation. In addition to DMS, other candidate aerosol precursor gases were measured in the atmosphere, including methyl halides, halogen oxides and VOCs. Instances of particle nucleation were observed, with nucleation (10 nm and 15 nm) and Aitken mode sized particles (50 nm) typically including a significant secondary organic component. This generally occurred during periods of high solar radiation in biologically active regions, whereas the organic contribution to particles was lower during cloudy conditions. *In vitro* bubble bursting chamber measurements also indicated a moderately oxidised primary organic fraction in the produced particles. SOAP is a SOLAS endorsed project, and a NZ SOLAS contribution to the SOLAS Mid-Term Strategy Ocean-derived

aerosols: production, evolution and impacts.

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

Law, C.S., Harvey, M., Smith, M. and the SOAP team. Surface Ocean Aerosol Production (SOAP) in NZ waters. NZ Met Soc Conference, 19/11/2012

Harvey, M., Law, C.S., Smith, M., Lawson, S., Walker, C. and the SOAP team. Surface Ocean Aerosol Production (SOAP) in NZ waters. Cape Grim Baseline Air Pollution Station Annual Science Meeting, November 2012.

Lawson, S., Keywood, M., Galbally, I., Harvey, M. Law, C., Selleck, P., Cheng, M. and Z. Ristovski. The Surface Ocean Aerosol Production (SOAP): Voyage characterising volatile organic (VOCs) over Chatham Rise 44oS. 2012. ANZ Aerosol workshop. 28-29/11/2012, Canberra

Cravigan, L., Mallet, M., Vaattovaara, P., Talbot, N., Olivares, G., Harvey, M., Law, C.S. and Ristovski, Z.D. 2012. Volatile and Hygroscopic properties of South Pacific remote marine aerosol during SOAP cruise. ANZ Aerosol workshop. 28-29/11/2012, Canberra

Cravigan, L., Mallet, M., Vaattovaara, P., Talbot, N., Olivares, G., Harvey, M., Law, C.S. and Ristovski, Z.D. 2012. Primary aerosol production from biologically active waters of the South Pacific. ANZ Aerosol workshop. 28-29/11/2012, Canberra

Law, C.S. and the SOAP Team. Surface ocean aerosol production (SOAP) in the South-West Pacific. SOLAS Open Science Conference, Seattle, USA, May 7-10/5/2012. Poster

Lawson, S., Keywood, M., Galbally, I., Harvey, M., Law, C.S., Selleck, P. Cheng, M. and Z. Ristovski. Characterising VOCs in the Marine Boundary Layer during the SOAP voyage, Chatham Rise 44oS. SOLAS Open Science Conference, Seattle, USA, May 7-10/5/2012

C. Walker, M. Harvey, C.S. Law, A. Marriner & J. McGregor. Air-sea interface production and emission of dimethylsulphide during the 2012 soap voyage. SOLAS Open Science Conference, Seattle, USA, May 7-10/5/2012

De Bruyn, W., Bell, T.G., Marandino, C.A., Saltzman, E.S., Miller, S., Law, C.S. & M. Smith. Dimethylsulfide air/sea gas transfer in the Southern Ocean. AGU Meeting 2012.

4. Top 10 publications in 2012 (Reports, <u>ACCEPTED</u> articles, models, datasets, products, website etc)

https://www.niwa.co.nz/atmosphere/projects/soap
http://solas-int.org/science/researchendorsements/resendprojects/endorsedprojects.html#soap

Law, C.S., Mike Harvey, Murray Smith and the SOAP Team. 2012. Surface Ocean Aerosol Production (SOAP) in the south-west Pacific. SOLAS Newsletter 14:1156-1157

Law. C.S. , Harvey, M. and Smith M. SOAP (TAN1203) voyage report

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)
SOAP Research voyage in March 2012 (participation SOAP scientists from 7 different countries) Data workshop in March 2013
6. Goals, priorities and plans for future activities/events
Publication of Special Issue
7. Other comments

SOLAS Task Team 2012 annual report

Asian Dust and Ocean EcoSystem (ADOES)

compiled by Hui-wang Gao and Mitsuo Uematsu

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight.*

1) Direct observation evidences for the Asian dust input of nutrients in triggering a spring bloom

Dust deposition can deliver new nutrients to the surface water and support primary productivity, but study of the impact of dust supply on ocean biota based on direct monitoring is rare. We captured two Asian dust storms accompanied by precipitation that were probably responsible for the observed algal bloom over the Yellow Sea. A new approach was used to estimate the deposition flux of the nutrients into the surface waters, based on the concentrations, solubility, size distributions of nutrients in the aerosols as well as simultaneous observations in the ocean. Our data indicated that atmospheric deposition dominated the supply of new nutrients to the surface water in the central Yellow Sea during the dust events. Calculated dust-derived N and Fe supplies can satisfy the bloom phytoplankton needs at the initiation of the bloom. The calculated dust-derived P input was slightly less than the estimated upward fluxes of PO_4^{3-}, and the sum of the two sources satisfied about 25% of P demand of the phytoplankton at the initiation of the bloom. Granger causality test results further supported that dust-derived nutrients deposition was the cause for the observed bloom with a lag of 3-5 days.

Shi, J.H., Gao, H.W., Zhang, J., Tan, S.C., Ren, J.L., Liu, C.G., Liu, Y., Yao, X., 2012. Examination of causative link between a spring bloom and dry/wet deposition of Asian dust in the Yellow Sea, China. Journal of Geophysical Research, 117, D17304, doi:10.1029/2012JD017983.

2) Iron speciation and mixing in single aerosol particles from the Asian continental outflow

Bioavailable iron from atmospheric aerosol is an essential nutrient that can control oceanic productivity, thereby impacting the global carbon budget and climate. Particles collected on Okinawa Island during an atmospheric pollution transport event from China were analyzed using complementary single particle techniques to determine the iron source and speciation. Comparing

the chemical composition and spatial distribution of iron within ambient particles and standard Asian mineral dust, it was determined that field-collected atmospheric Fe-containing particles have numerous sources, especially anthropogenic sources such as coal combustion. Fe-containing particles were found to be internally mixed with secondary species such as sulfate, soot, and organic carbon. The mass weighted average Fe(II) fraction (defined as Fe(II)/[Fe(II) + Fe(III)]) was determined to be 0.33 ± 0.08. Within the experimental uncertainty, this value lies close to the range of 0.26–0.30 determined for representative Asian mineral dust. Previous studies have indicated that the solubility of iron from combustion is much higher than that from mineral dust. Therefore, chemical and/or physical differences other than oxidation state may help explain the higher solubility of iron in atmospheric particles.

Moffet, R. C., H. Furutani, T. C. Rödel, T. R. Henn, P. O. Sprau, A. Laskin, M. Uematsu, and M. K. Gilles. 2012. Iron speciation and mixing in single aerosol particles from the Asian continental outflow. J. Geophys. Res., 117, D07204, doi:10.1029/2011JD016746.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

Two multiple-discipline survey cruises have been performed in the marginal seas including the Yellow Sea and the East China Sea in the spring and the fall of 2012. Simultaneous measurements included high time resolution particle number concentration spectra and chemical composition, filter particle samples from 10 nm to 18 µm.

Most of the research cruises for coastal and marginal seas were focused on the oceanic region of the off Fukushima. Many ADOES members in Japan devoted the investigation for ocean radioactive material contamination.

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

4. Top 10 publications in 2012 (Reports, <u>ACCEPTED</u> articles, models, datasets, products, website etc)

1) Shi, J.H., Gao, H.W., Zhang, J., Tan, S.C., Ren, J.L., Liu, C.G., Liu, Y., Yao, X., 2012. Examination of causative link between a spring bloom and dry/wet deposition of Asian dust in the Yellow Sea, China. Journal of Geophysical Research, 117, D17304, doi:10.1029/2012JD017983.

2) Yang Gui-Peng, Zhuang Guang-Chao, Honghai Zhang, Yuan Dong, Jian Yang, 2012. Biogeochemistry of dimethylsulfide and dimethylsulfoniopropionate in the Yellow Sea and the East China Sea during spring: spatio-temporal variability and controlling. Marine Chemistry 138-139: 21-31.

3) Zhen He, Gui-Peng Yang, Xiao-Lan Lu, 2012. Distributions and sea-to-air fluxes of volatile halocarbons in the East China Sea in early winter. Chemosphere 90: 747-757.

4) Yao and Zhang, Chemical processes in sea-salt chloride depletion observed at a Canadian rural coastal site. Atmospheric Environment, 46, 189-194, 2012.

5) Tan, S.C., Shi, G.Y., Gao, H.W., Yao, X. 2013. Variability in the Correlation between Asian Dust Storms and Chlorophyll a Concentration from the North to Equatorial Pacific. PLOS ONE, accepted.

6) Shi, J.H., Gao, H.W., Tan, S-C., Yao, X., Ren, J.L. 2013. Concentration, solubility and deposition flux of atmospheric particulate nutrients over the Yellow Sea. Deep Sea Research (II). accepted

7) Wang, L., Qi, J.H., Gao, H.W., Shi, J.H. 2013. Source apportionment of particulate pollutants in the atmosphere over the Northern Yellow Sea. Atmospheric Environment, accepted

8) Feng Wu, Daizhou Zhang, Junji Cao, Hongmei Xu, Zhisheng An. 2012. Soil-derived sulfate in atmospheric dust particles at Taklimakan desert. Geophys. Res. Lett. 39, L24803, doi:10.1029/2012GL054406.

9) Jung, J., Furutani, H. and Uematsu, M. 2011. Atmospheric inorganic nitrogen in marine aerosol and precipitation and its deposition to the North and South Pacific Oceans. Journal of Atmospheric Chemistry, 68, 157–181, I 10.1007/s10874-012-9218-5.

10) Moffet, R. C., Furutani, H., Rödel, T. C., Henn, T. R., Sprau, P. O., Laskin, A., Uematsu, M., Gilles, M. K. 2012. Iron speciation and mixing in single aerosol particles from the Asian continental outflow. Journal of Geophysical Research, 117, D07204, doi.org/10.1029/2011JD016746.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

6. Goals, priorities and plans for future activities/events

The Joint 7th Workshop on Asian Dust and Ocean EcoSystem (ADOES) with Asian SOLAS will be planned in 2013.

JST–MOST Joint Workshop Climate Change ~ Progress reports of Japan-China research cooperative program will be held in Tokyo Japan on March 4, 2013. Huiwang Gao and Mituso Uematsu will present ADOES/METMOP activity and discuss the future plans.

7. Other comments

AICI

Compiled by Thorsten Bartels-Rausch

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Review on Organics in environmental ices.

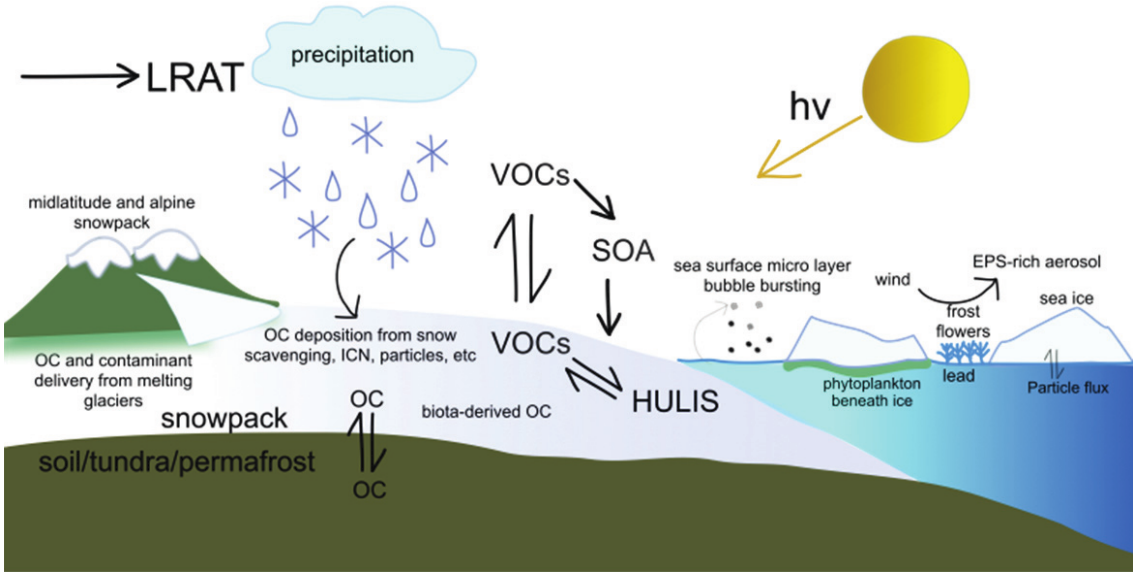


Figure: Biogeochemical cycle of organic carbon in the cryosphere. LRAT: long range atmospheric transport. VOC: volatile organic compound. SOA: secondary organic aerosol. HULIS: humic-like substances. EPS: exopolymeric substances.

The physical, chemical, and biological processes involving organics in ice in the environment impact a number of atmospheric and biogeochemical cycles. Organic material in snow or ice may be biological in origin, deposited from aerosols or atmospheric gases, or formed chemically in situ. In this manuscript, we review the current state of knowledge regarding the sources, properties, and chemistry of organic materials in environmental ices. Several outstanding questions remain to be resolved and fundamental data gathered before an accurate model of transformations and transport of organic species in the cryosphere will be possible. For example, more information is needed regarding the quantitative impacts of chemical and biological processes, ice morphology, and snow formation on the fate of organic material in cold regions. Interdisciplinary work at the interfaces of chemistry, physics and biology is needed in order to fully characterize the nature and evolution of organics in the cryosphere and predict the effects of climate change on the Earth's carbon cycle.

McNeill, V. F., Grannas, A. M., Abbatt, J. P. D., Ammann, M., Ariya, P. A., Bartels-Rausch, T., Domine, F., Donaldson, D. J., Guzman, M. I., Heger, D., Kahan, T. F., et al.: Organics in environmental ices: sources, chemistry, and impacts, Atmos Chem Phys, 12(20), 9653–9678, doi:10.5194/acp-12-9653-2012, 2012.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

European Geosciences Union General Assembly 2012
Boundary Layers in High Latitudes: Physical and Chemical Processes Including Atmosphere-Ice Chemical Interactions (AICI)

Convener: WD Neff
Co-Conveners: G Heinemann, A. Jones, S. Argentini, P. Anderson, T. Bartels-Rausch , V. F. McNeill

This session is intended to provide an interdisciplinary forum to bring together researchers working in the areas of high-latitude tropospheric meteorology, chemistry, oceanography, and climate with an emphasis on the role of boundary layer processes that mediate exchanges between the Earth's surface (snow, ice, ocean and land) and the atmosphere. We invite contributions in the following areas:

(1) Results from field programs and observatories
(2) Insight from laboratory studies
(3) Surface processes including snow, ice, ocean, land/atmosphere chemical exchange
(4) The role of boundary layers in polar climate change and implications of climate change for surface exchange processes, especially in the context of reduced Arctic sea ice
(4) Advances in modelling and reanalysis, including model assessment of boundary layer processes
(6) Research that bridges atmospheric chemistry and boundary-layer meteorology in the polar regions
(7) Observation and modelling of surface energy budgets
(8) Coastal processes
(9) Application/demonstration of new technology.
(10) Application to other fields including, for example, astronomical siting, biogeochemistry etc.

In past years we have requested a schedule where poster sessions follow oral sessions to allow for oral poster introductions. For those who indicate a `no preference` request for the presentation style, we encourage a poster supplement to allow for further discussion.
We would like to encourage young scientist/student presentations by reserving at least one oral unit per session for such papers.

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

None.

4. Top 10 publications in 2012 (Reports, <u>ACCEPTED</u> articles, models, datasets, products, website etc)

New perspectives on Air-Ice Chemical Interactions (AICI)
Editor(s): V. F. McNeill, E. Wolff, T. Bartels-Rausch, and H. Pfeiffenberger
Special Issue jointly organized between Atmospheric Chemistry and Physics and Earth System Science Data

Understanding and quantifying the chemical interactions of ice and snow with trace gases in the atmosphere is a major challenge in atmospheric chemistry. Ice in the environment, from ice particles in clouds, to sea ice and snow at the Earth's surface, has a profound influence on atmospheric composition and climate. A quantitative, mechanistic understanding of trace gas-ice interactions is critical for predicting the effects of climate change on atmospheric composition, for the interpretation of ice core chemical records, and for modelling atmospheric chemistry. There are significant gaps in our current understanding of the uptake of gases by ice, including uncertainty regarding the microphysical location of species upon uptake, rates and mechanisms of chemical processes taking place in/on ice, the role of interfacial layers at the ice surface, and the role of biological activity in the ice.

This special issue is comprised of a series of review articles originating from the 3rd Workshop on Air-Ice Chemical Interactions, which was held at Columbia University in New York, NY from June 6-8, 2011

Halogen activation via interactions with environmental ice and snow in the polar lower troposphere and other regions
J. P. D. Abbatt, J. L. Thomas, K. Abrahamsson, C. Boxe, A. Granfors, A. E. Jones, M. D. King, A. Saiz-Lopez, P. B
D. W. Toohey, C. Toubin, R. von Glasow, S. N. Wren, and X. Yang
Atmos. Chem. Phys., 12, 6237-6271, 2012
Abstract Final Revised Paper (PDF, 2576 KB) Supplement (2586 KB) Discussion Paper (ACPD)

Organics in environmental ices: sources, chemistry, and impacts
V. F. McNeill, A. M. Grannas, J. P. D. Abbatt, M. Ammann, P. Ariya, T. Bartels-Rausch, F. Domine, D. J. Donaldso
T. F. Kahan, P. Klán, S. Masclin, C. Toubin, and D. Voisin
Atmos. Chem. Phys., 12, 9653-9678, 2012
Abstract Final Revised Paper (PDF, 1567 KB) Discussion Paper (ACPD)

A compilation of tropospheric measurements of gas-phase and aerosol chemistry in polar regions
R. Sander and J. Bottenheim
Earth Syst. Sci. Data, 4, 215-282, 2012
Abstract Final Revised Paper (PDF, 1580 KB) Discussion Paper (ESSDD)

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

None

6. Goals, priorities and plans for future activities/events

Our plans for AICI are to expand scientific cooperation and specifically address biologist and oceanographers.

7. Other comments

None

Halogens in the Troposphere (HitT)

compiled by Roland von Glasow

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight.*

[Please note: I did not communicate with the authors or copyright holders. Text is copied from their abstracts]

First detailed speciation of bromine chemistry in polar spring

Liao, et al., Observations of inorganic bromine (HOBr, BrO, and Br_2) speciation at Barrow, Alaska, in spring 2009. J. Geophys. Res., 117, D00R16, doi:10.1029/2011JD016641, 2012

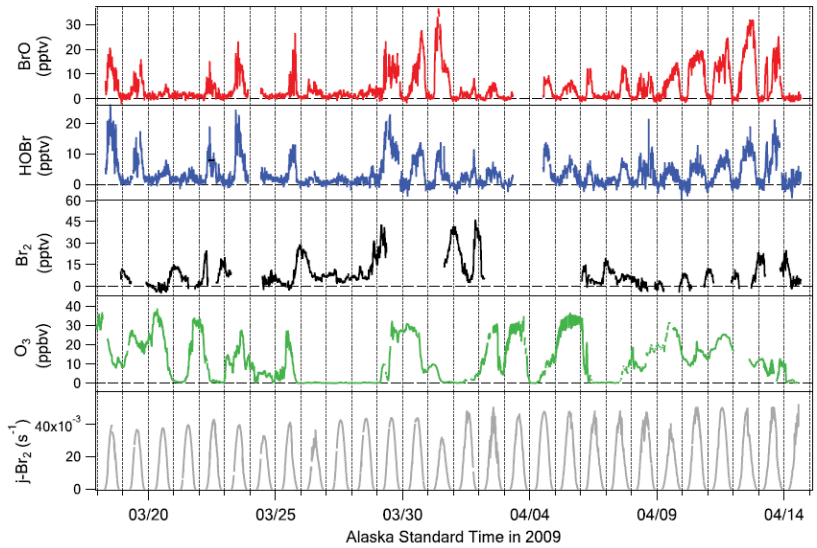


Figure 3. A time series of measurements of BrO (red), HOBr (blue), Br_2 (black), O_3 (green) and j values of Br_2 (gray) averaged to 10 min from March 18 to April 14 2009 during the OASIS campaign. Ticks on the bottom axis represent the starting time 00:00 of each day.

Inorganic bromine plays a critical role in ozone and mercury depletions events (ODEs and MDEs) in the Arctic marine boundary layer. Direct observations of bromine species other than bromine oxide (BrO) during ODEs are very limited. The first direct measurements of hypobromous acid (HOBr) as well as observations of BrO and molecular bromine (Br_2) by chemical ionization mass spectrometry were performed at Barrow, Alaska in spring 2009 during the Ocean-Atmospheric-Sea Ice-Snowpack (OASIS) campaign.
Diurnal profiles of HOBr with maximum concentrations near local noon and no significant concentrations at night were observed. The measured average daytime HOBr mixing ratio was 10 pptv with a maximum value of 26 pptv. BrO levels were found to be higher at elevated wind speeds. Br_2 was observed in significant mixing ratios (maximum = 46 pptv; average = 13 pptv) at night and was strongly anti-correlated with ozone. The diurnal speciation of observed gas phase inorganic bromine species can be predicted by a time-dependent box model that includes efficient

heterogeneous recycling of HOBr, hydrogen bromide (HBr), and bromine nitrate ($BrONO_2$) back to more reactive forms of bromine.

IO in open ocean

Mahajan, et al., Latitudinal distribution of reactive iodine in the Eastern Pacific and its link to open ocean sources, Atmos. Chem. Phys., 12, 11609 – 11617, 2012

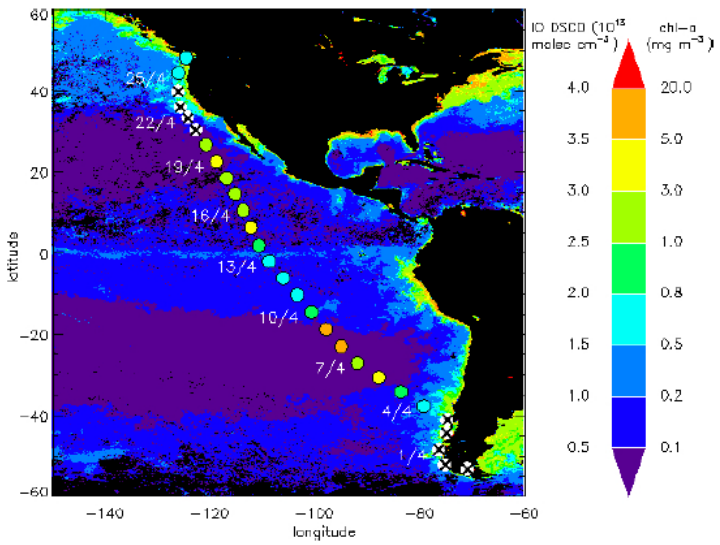


Fig. 4. The daily average IO DSCDs over the detection limit in the 1° viewing elevation angle after the data was filtered for clouds along with satellite estimated Chl *a* distribution for April 2010 (NASA-GSFC, 2011). The empty white circles with crosses show days where measurements were not possible.

Ship-based Multi-Axis Differential Optical Absorption Spectroscopy measurements of iodine monoxide (IO) and atmospheric and seawater Gas Chromatography- Mass Spectrometer observations of methyl iodide (CH_3I) were made in the Eastern Pacific marine boundary layer during April 2010 as a part of the HaloCarbon Air Sea Transect- Pacific (HaloCAST-P) scientific cruise. The presence of IO in the open ocean environment was confirmed, corresponding to approximately 1 pptv measured in the oligotrophic region of the Southeastern Pacific. Such low IO mixing ratios and their observed geographical distribution are inconsistent with satellite estimates and with previous understanding of oceanic sources of iodine. A strong correlation was observed between reactive iodine (defined as IO + I) and CH_3I, suggesting common sources. In situ measurements of meteorological parameters and physical ocean variables, along with satellite-based observations of Chlorophyll a (Chl a) and Chromophoric Dissolved Organic Matter (CDOM) were used to gain insight into the possible sources of iodine in this remote environment. Surprisingly, reactive iodine showed a negative correlation (>99% confidence) to Chl a and CDOM across the cruise transect. However, a significant positive correlation (>99% confidence) with sea surface temperature (SST) and salinity instead suggests a widespread abiotic source related to the availability of aqueous iodine and to temperature.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

- Halogen sessions at EGU 2012, AGU 2012
- SOLAS/IGAC funded workshop on "Climate impact of chlorine" Dec 2012
- Field work element of US TORERO project (Jan/Feb 2012)
- Various field campaigns by individual research groups incl. field work at Mt Etna, Sicily (July/August 2012), Dead Sea (HALOPROC project)
-

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

Publication of 3 halogen-related review papers (Abbatt et al is mainly an AICI product):

Abbatt, J. P. D., J. L. Thomas, K. Abrahamsson, C. Boxe, A. Granfors, A. E. Jones, M. D. King, A. Saiz-Lopez, P. B. Shepson, J. Sodeau, D. W. Toohey, C. Toubin, R. von Glasow, S. N. Wren and X. Yang. Halogen activation via interactions with environmental ice and snow. Atmos. Chem. Phys., 12, 6237-6271, 2012

Saiz-Lopez, A., R. von Glasow. Reactive halogen chemistry in the troposphere. Chem. Soc. Rev., 41, 6448-6472, 2012

Saiz-Lopez, A., J. M. C. Plane, A. R. Baker, L. J. Carpenter, R. von Glasow, J. C. Gomez Martin, G. McFiggans and R. W. Saunders. Atmospheric Chemistry of Iodine. Chem. Rev., 112, 1773-1804, 2012

About 7 (out of 22) participants of the HitT-CI workshop were early career scientists, helping with capacity building in the next generation of scientists.

4. Top 10 publications in 2012 (Reports, <u>ACCEPTED</u> articles, models, datasets, products, website etc)

Buxmann, et al., Observations of bromine explosions in smog chamber experiments above a model salt pan. Inter. J. Chemical Kinetics, 44, 312-326, 2012

Liao, et al., Observations of inorganic bromine (HOBr, BrO, and Br_2) speciation at Barrow, Alaska, in spring 2009. J. Geophys. Res., 117, D00R16, doi:10.1029/2011JD016641, 2012

Mahajan, et al., Latitudinal distribution of reactive iodine in the Eastern Pacific and its link to open ocean sources, Atmos. Chem. Phys., 12, 11609 – 11617, 2012

Murray, et al., Glass formation and unusual hygroscopic growth of iodic acid solution droplets with relevance for iodine mediated particle formation in the marine boundary layer, Atmos. Chem. Phys., 12, 8575 – 8587, 2012

Parrella, et al., Tropospheric bromine chemistry: implications for present and pre-industrial ozone and mercury, Atmos. Chem. Phys., 12, 6723 – 6740, 2012

Riedel, et al., Nitryl Chloride and Molecular Chlorine in the Coastal Marine Boundary Layer, Env. Sci. Tech., 46, 10463 – 10470, 2012

Saiz-Lopez, et al., Estimating the climate significance of halogen-driven ozone loss in the tropical marine troposphere, Atmos. Chem. Phys., 12, 3939 – 3949, 2012

Schönhardt, et al., Simultaneous satellite observations of IO and BrO over Antarctica, Atmos. Chem. Phys., 12, 6565 – 6580, 2012

Sommariva, R. and R. von Glasow. Multi-phase halogen chemistry in the tropical Atlantic Ocean. Env. Sci. Tech., 46, 10429-10437, 2012

Stephens, et al., The relative importance of chlorine and bromine radicals in the oxidation of atmospheric mercury at Barrow, Alaska, J. Geophys. Res., 117, D00R11, doi:10.1029/2011JD016649, 2012

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

- Participation in international field campaigns
- Conferences and workshops (see above)

6. Goals, priorities and plans for future activities/events

- Web page update
- Establish link with water purification community working on aqueous halogen processes
- Continue momentum from HitT-Cl workshop

7. Other comments

Web page: www.HitT-task.net

ESA OceanFlux projects 2012 annual report

OceanFlux Greenhouse Gases

compiled by David Woolf and Jamie Shutler

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

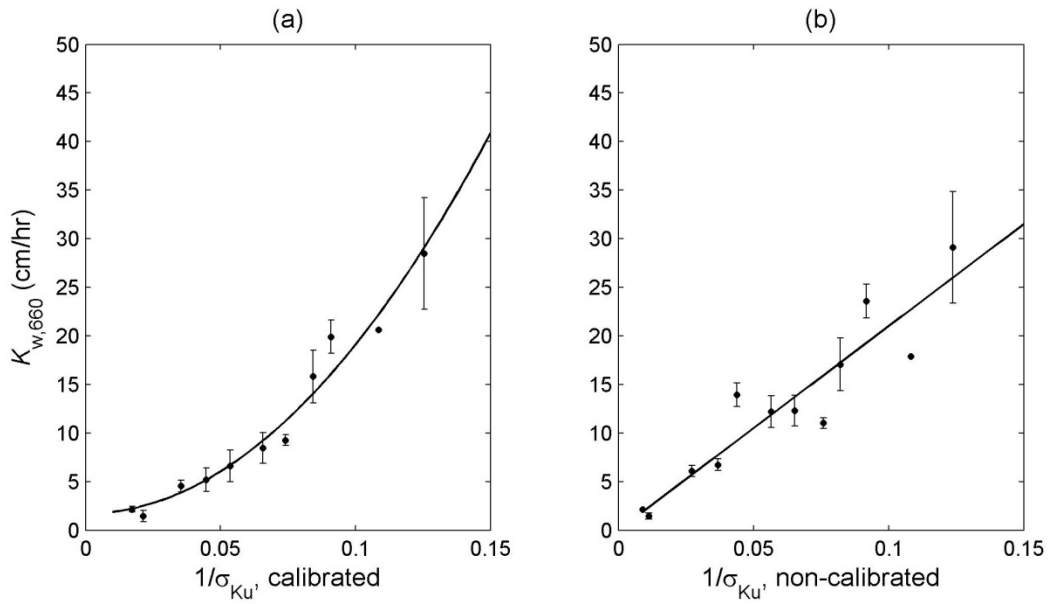
1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight.*

The calculation of the air-sea exchange of gases requires values of the air-sea transfer velocity of each gas at each time and location on the sea surface. This requires a parameterisation that can be applied globally. We developed an algorithm that can be applied using satellite-borne instrumentation (radar altimeters) directly for dimethyl sulphide and as part of a methodology for other gases. Transfer velocity can be related either to altimeter backscatter (σ_{Ku}; see figure) or to the wind speed apparent from altimetry. This is the first time a satellite algorithm has been directly calibrated from field measurements of gas fluxes.

Goddijn-Murphy, L., D.K. Woolf and C.A. Marandino. 2012. Space-based retrievals of air-sea gas transfer velocities using altimeters: Calibration for dimethyl sulphide. *Journal of Geophysical Research* 117, C08028, doi:10.1029/2011JC007535

Figure:



Measurements of $K_{w,660}$ plotted against $1/\sigma_{Ku}$ from coinciding altimeter data binned in 0.01 intervals of $1/\sigma_{Ku}$. The vertical error bars indicate the standard error of the mean $K_{w,660}$ values; for dots without an error bar only one data point was present in the interval. Curve fitting over the binned data resulted in (a) $K_{w,660}=1.7x10^3/(\sigma_{Ku})^2+1$ (R^2 = 0.97, RMSE = 1.7) , and (b) $K_{w,660}=2.1x10^3/\sigma_{Ku}$ (R^2 = 0.86, RMSE = 3.0).

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

The OceanFlux Greenhouse Gases project aims to improve the quantification of air-sea exchanges of greenhouse gases, through the exploitation of in situ and satellite Earth observation data and modelling systems.

The aim of the project is to develop and validate new and innovative products combining field data, satellite observation, and models. The main scientific challenges concern the estimate of the gas transfer velocity parameter and the quantification of the impact of biological slicks, rainfall, sea surface temperature and salinity variability on the air-sea CO_2 flux.

The Oceanflux Greenhouse Gases is a two year project funded by European Space Agency involving Heriot Watt University, Environmental Research Institute (ERI) in Thurso, UK, The UK National Oceanography Centre (NOC), the Plymouth Marine Laboratory (PML) and Institut français de recherche pour l'exploitation de la mer (Ifremer).

The project has produced a number of documents and journal publications which are available through the project website. These detail the planned activities and the methods being used within the project.

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

The OceanFlux Greenhouse Gases project has setup a project website (http://www.oceanflux-ghg.org/), a blog (http://oceanflux-ghg.blogspot.co.uk/), produced a video (http://www.youtube.com/watch?v=4uak0vVGgGY) and has an international Reference User Group which consists of field scientists, Earth observation scientists and users, modelling scientists and users and service providers (e.g. ECMWF). Monthly summary reports are also provided on the website and sent to the international SOLAS office.

4. Top 10 publications in 2012 (Reports, ACCEPTED articles, models, datasets, products, website etc)

The OcenFlux Greenhouse gases project has produced the following publications:

Goddijn-Murphy, L., D.K. Woolf and C.A. Marandino. 2012. Space-based retrievals of air-sea gas transfer velocities using altimeters: Calibration for dimethyl sulphide. *Journal of Geophysical Research* 117, C08028, doi:10.1029/2011JC007535 ..

Woolf, D. K., Land, P. E., Shutler, J. D., and Goddijn-Murphy, L. M.: Thermal and haline effects on the calculation of air-sea CO_2 fluxes revisited, Biogeosciences Discuss., 9, 16381-16417, doi:10.5194/bgd-9-16381-2012, 2012

Land, P. E., Shutler, J. D., Cowling, R. D., Woolf, D. K., Walker, P., Findlay, H. S., Upstill-Goddard, R. C., and Donlon, C. J.: Climate change impacts on sea-air fluxes of CO_2 in three Arctic seas: a sensitivity study using earth observation, Biogeosciences Discuss., 9, 12377-12432, doi:10.5194/bgd-9-12377-2012, 2012.

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

The Science Leader, David Woolf attended the SOLAS Open Science Conference in Cle Elum, Washington in May 2012. A poster on the project was presented. All three OceanFlux projects were presented at a workshop co-chaired by three leaders of these projects (Christoph Garbe, Veronique Carcon and David Woolf). David Woolf also gave invited presentations on related research at two other workshops.

The project has a Reference User Group (RUG) which is being used to communicate progress and to invite feedback.

We are grateful for the co-operation of SOCAT and expect to interact and collaborate with that community further during the next year.

6. Goals, priorities and plans for future activities/events

The project is currently developing a global climatology data processing capability using a Cloud approach. This approach is exploiting a large number of quality controlled Earth observation datasets and the SOCAT and Takahashi CO_2 in situ datasets. This capability will allow researchers to exploit the project datasets and methods to generate their own CO_2 flux climatologies and to evaluate and compare their results with the project outputs.

We are holding a science workshop 24-27 September (Brest, France) (http://www.oceanflux-ghg.org/Workshop). This workshop is to present the outputs of the OceanFlux Greenhouse Gases project, to allow international scientists present recent results and to plan future aims and collaborations.

We expect also to present results from the project at the ESA Living Planet Symposium, 9-13 September (Edinburgh, UK).

7. Other comments

The project has 12 months left to run and should be complete in December 2013.

Source and sinks of climatically-active gases in the Eastern Boundary Upwelling and Oxygen Minimum Zone (OMZ) systems

compiled by Christoph Garbe

Notes:
Reporting Period is January 2012 – December 2012
Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

Describe 1 or 2 ***published*** *scientific highlights with a title, a text (max 200words), a figure with legend and* ***full references*** *for each highlight.*

CLIMATICALLY-ACTIVE GASES IN THE EASTERN BOUNDARY UPWELLING AND OXYGEN MINIMUM ZONE (OMZ) SYSTEMS

Climatically-Active Gases In The Eastern Boundary Upwelling And Oxygen Minimum Zone (Omz) Systems, C.S. Garbe, A. Butz, I. Dadou, B. Dewitte, V. Garçon, S. Illig, A. Paulmier, J. Sudre, H. Yahia, in: IEEE International Geoscience and Remote Sensing Symposium, IEEE, (2012), pp. 6150-6153.

The EBUS (Eastern Boundary Upwelling Systems) and OMZs (Oxygen Minimum Zone) contribute very significantly to the gas exchange between the ocean and the atmosphere, notably with respect to the greenhouse gases. From in-situ ocean measurements, the uncertainty of the net global ocean-atmosphere CO2 fluxes is between 20 and 30%, and could be much higher in the EBUS-OMZ. Off Peru, very few in-situ data are available presently, which justifies alternative approaches for assessing these fluxes. In this contribution we present a technique for assessing sources of GHGs from satellite remote sensing and resolution improvements from the “Singularity Exponent” (See Figure).

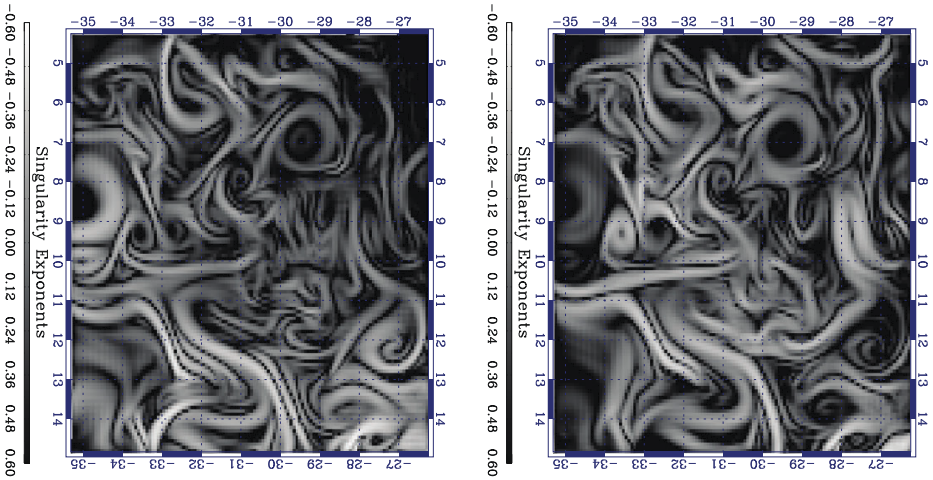


Fig. 2. Left : singularity exponents computed on simulated SST signal from the ROMS simulation model. Right: singularity exponents computed on simulated p_{CO2}^{ocean} signal from the ROMS simulation model. Note the similarity of coherent structures and the turbulent character of the p_{CO2}^{ocean} signal. These images are computed using the ROMS model and FluidExponents software. The p_{CO2}^{ocean} and SST signals used in the computation of the two images are averaged on a 5 days time interval.

2. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc)

22. – 27. April 2012 European Geosciences Union, General Assembly 2012, "Earth Observation for Ocean/Atmosphere Interactions Science" & IMBER/SOLAS special session, "Sensitivity of marine ecosystems and biogeochemical cycles to global change", Vienna, Austria, Co-convenor: Christoph Garbe & Véronique Gaçon

07.-10. May 2012 SOLAS Open Science Conference 2012, "Earth Observation for Ocean/Atmosphere Interactions Science special session, Co-convenor: Christoph Garbe & Véronique Gaçon

26-28 November 2012 Workshop on "Towards an integrative regional coupling in the Eastern Boundary Upwelling Systems (EBUS)" Instituto Geofísica del Perú (IGP) Lima, Perú, Convenor: Véronique Gaçon

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

26-28 November 2012 Day of Lecture for Peruvian Students, in conjunction with Workshop on "Towards an integrative regional coupling in the Eastern Boundary Upwelling Systems (EBUS)" Instituto Geofísica del Perú (IGP) Lima, Perú, Convenor: Véronique Gaçon

4. Top 10 publications in 2012 (Reports, <u>ACCEPTED</u> articles, models, datasets, products, website etc)

[1] Inferring CO$_2$ fluxes from space: A multiscale approach, V. Garçon, J. Sudre, H. Yahia, B. Dewitte, A. Paulmier, S. Illig, I. Dadou, C.S. Garbe, *in: Workshop on "Towards an integrative regional coupling in the Eastern Boundary Upwelling Systems (EBUS)", (2012), pp. 13.*

[2] Climatically-Active Gases In The Eastern Boundary Upwelling And Oxygen Minimum Zone (Omz) Systems, C.S. Garbe, A. Butz, I. Dadou, B. Dewitte, V. Garçon, S. Illig, A. Paulmier, J. Sudre, H. Yahia, *in: AGU Ocean Sciences, (2012).*

[3] Climatically-Active Gases In The Eastern Boundary Upwelling And Oxygen Minimum Zone (Omz) Systems, C.S. Garbe, A. Butz, I. Dadou, B. Dewitte, V. Garçon, S. Illig, A. Paulmier, J. Sudre, H. Yahia, *in: SOLAS Open Science Conference, (2012)*

[4] Climatically-Active Gases In The Eastern Boundary Upwelling And Oxygen Minimum Zone (Omz) Systems, C.S. Garbe, A. Butz, I. Dadou, B. Dewitte, V. Garçon, S. Illig, A. Paulmier, J. Sudre, H. Yahia, *in: IEEE International Geoscience and Remote Sensing Symposium, IEEE, (2012), pp. 6150-6153.* [10.1109/IGARSS.2012.6352740]

[5] Assessing atmospheric gas concentrations and interfacial fluxes from remote sensing, C.S. Garbe, A. Butz, V. Garçon, J. Vihharev, J. Sudre, H. Yahia, B. Dewitte, A. Paulmier, S. Illig, I. Dadou, *in: Workshop on "Towards an integrative regional coupling in the Eastern Boundary Upwelling Systems (EBUS)", (2012), pp. 14.*

[6] Climatically-Active Gases in the Eastern Boundary Upwelling and Oxygen Minimum Zone (OMZ) Systems, C.S. Garbe, V. Garçon, A. Butz, H. Yahia, J. Sudre, S. Illig, B. Dewitte, A. Paulmier, I. Dadou, *in: Geophysical Research Abstracts, (2012), **14**, pp. EGU2012-7779-1.*

5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

Collaboration between University of Heidelberg, Karlsruhe Institute for Technology (both German), CNRS & INRIA (both French), Instituto del Mar del Perù (Peruvian), Heriot-Watt University (UK).

6. Goals, priorities and plans for future activities/events

Extracting of sources and sinks of CO2 from atmospheric concentrations of CO2, Resolution improvements from multiscale, physically based analysis. Contributions to two workshops planned in 2013.

7. Other comments