Addendum to the SOLAS Report to SCOR:

<u>Reporting period</u>: June 2011- June 2012
Version of 10 July 2012 by Dr Emilie Brévière

- National SOLAS networks 2011 annual reports

- 2011/12 SOLAS endorsed projects submission forms

- SOLAS endorsed projects 2011 annual reports

- SOLAS Task Team 2011 annual report

- IGBP/SCOR FTI SOLAS-relevant 2011 annual report

- SCOR WG SOLAS-relevant 2011 annual report

SOLAS Australia

compiled by Sarah Lawson and Andrew Bowie

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)

Biogeochemical cycling - Iron in the Antarctic sea ice zone and its role in the past and future climate

Marine phytoplankton play a key role in the global cycling of carbon and sulfur. However in remote regions like the Southern Ocean and the subarctic Pacific Ocean, primary productivity is effectively limited by the availability of micro-nutrient iron (Fe). Antarctic sea ice hosts high concentration of Fe and organic matter, which triggers ice-edge phytoplankton blooms during austral spring. Given that sea ice formation and retreat affects every year an area of about 14 million km^2 in the Southern Ocean and 10 million km^2 in the Arctic Ocean, the "frozen ocean" may constitute the dominant source of Fe to polar waters during seasonal melting. Sea ice-bearing Fe may therefore play a key role in drawing down atmospheric carbon dioxide levels in these climatically-important regions. The high Fe concentrations in sea ice may also help sustain the growth of dimethyl sulfide producers, such as phaeocystis. Recent studies carried out by researchers at the Antarctic Climate and Ecosystems CRC (University of Tasmania) in Hobart have shown that micro-nutrients other than iron could co-limit primary production in the Southern Ocean, therefore, we extended our research to the study of other trace elements in sea ice.

Outcome 1:

The first detailed study on the distribution of trace metals other than iron in Antarctic pack ice was achieved during the SIPEX voyage conducted in September/October 2007. This work indicated the studied trace metals are concentrated in Antarctic sea ice, however the levels do not seem limiting or toxic for algal growth in the marginal ice zone. These findings also aid in fingerprinting iron source(s) in the sea ice environment (Lannuzel et al., 2011, van der Merwe et al., 2011a).

Outcome 2:

Field sampling was carried out in land-fast ice off the coast of Australia's Casey station in Antarctica during austral spring/summer 2009 (van der Merwe et al., 2011b). The fertilization potential of the study site was highlighted. Detailed particulate size fractionation of metals (>10µm, 10µm-2µm, 2µm-0.4µm and 0.4µm-0.2µm) during the melting of sea ice was assessed for the first time in sea ice and under-ice water (Lannuzel et al., in prep).

High precision atmospheric CO_2 network to observe the Southern Ocean CO_2 sink

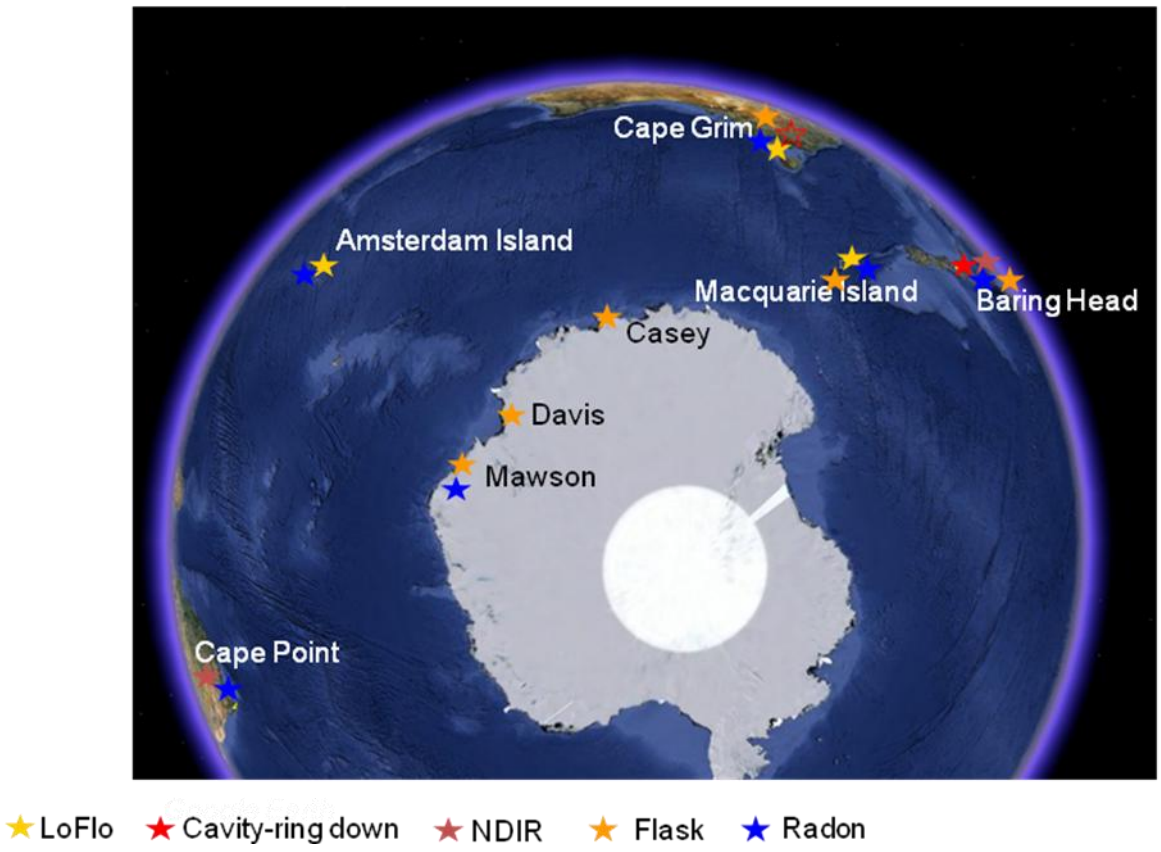
One of the main challenges in assessing the Earth's capacity to mitigate future climate change is to understand how the natural sinks for global CO_2 emissions will change over time. Of these sinks, the Southern Ocean currently accounts for about one sixth of the global CO_2 emissions. If climate change reduces oceanic circulation transport of CO_2 into the deep ocean, the capacity of the Southern Ocean to absorb CO_2 would be expected to decrease. Le Quéré et al. (2007, 2008) concluded that the strength of the Southern Ocean CO_2 sink is weakening due to increased Southern Ocean zonal winds, a climate change response to growing greenhouse gases and depletion of Antarctic stratospheric ozone. This result has generated considerable debate in the literature, including being questioned as possibly an artefact of data selection and/or calibration biases between the different Southern Ocean observation sites (Law et al., 2008).

This work being carried out by the Centre for Australian Weather and Climate Research (CAWCR) at

CSIRO Marine and Atmospheric Research Aspendale is aimed at developing both the scientific observation framework and a research tool to more accurately determine the efficiency and temporal behaviour of the Southern Ocean CO_2 sink. This tool will provide scientific understanding of and more reliable prediction of global atmospheric CO_2 concentrations into the future.

This framework involves atmospheric inversion modelling utilising a high precision Southern Ocean atmospheric observation network combined with state of the art oceanic modelling. Currently, possible instrumental and site biases are being addressed, as well as linking of datasets collected at Baring Head, Macquarie Island, Cape Grim, and Amsterdam Island, to a common derived calibration scale. Calibration hubs are located at CSIRO, Australia and LSCE, France.

Figure 1. Map of Southern Ocean network for atmospheric CO_2



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

In addition to the highlights above:

- Australia's new Ocean-going future research vessel, the *RV Investigator*, is currently being constructed, with completion expected in June 2013. This new vessel can accommodate 40 scientists and will be used by Australian universities, research organisations and international collaborators. The first call for EOI has been made for ship time in 2013-14 and 2014-15. For more information please see

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

http://www.marine.csiro.au/nationalfacility/Investigator/eoi-update.htm

- The GEOTRACES section GP13 leg (voyage ss2011_v02) in Southwest Pacific Ocean was completed by Australian scientists, 13 May – 5 June 2011, along approximately 30oS (see Science Highlight at: http://www.marine.csiro.au/nationalfacility/sciencehighlights/2011/MNF-SH_ss2011_v02.pdf and Report at: http://www.marine.csiro.au/nationalfacility/voyagedocs/2011/MNF-SS2011_v02_summary.pdf; Chief Scientist: Andrew Bowie). Leg 2 further east was undertaken by NZ colleagues on RV Tangaroa from June 6 to 30 (Chief Scientist: Philip Boyd)
- Ongoing atmospheric Mercury sampling has begun at Cape Grim Baseline Station as part of the Global Mercury Observation System
- The XXV IUGG General Assembly: Earth on the Edge – Science for a Sustainable Plant was held June-July 2011 in Melbourne. The scientific program comprised of 4758 presentations including 2831 oral and 1926 poster presentations from leading scientists from around the globe. The conference included many oral presentations of strong relevance to SOLAS, in particular in sessions run by the following associations: International Association for the Physical Sciences of the Ocean, the International Association of Cryosphere Sciences and International Association of Meteorology and Atmospheric Sciences.
- The Centre for Australian Weather and Climate Research (CAWCR), a joint venture between CSIRO and the Australian Bureau of Meteorology, held its fifth annual workshop in November 2011, exploring the composition of the atmosphere and incorporating the Cape Grim Annual Science Meeting with a particular focus on Chemistry-Climate interactions, Budgets (carbon cycle, fluxes), Emerging tools/opportunities.

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

Media-television program- Iron Wales
Nicol S., van der Merwe P., Lannuzel D., Townsend A., April 2011, Iron Whales, Reporter: Mark Horstman for ABC Catalyst (http://www.abc.net.au/catalyst/stories/3191797.htm)

Media-newsprint and radio- Iron Wales
Bowie A.R. Whales fertilising the Southern Ocean. Various national and international interviews.

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

Deep Sea Research Part II Special Edition– The SOLAS Air-Gas Exchange (SAGE) Experiment 2004 (http://www.sciencedirect.com/science?_ob=PublicationURL&_hubEid=1-s2.0-S0967064511X00048&_cid=271722&_pubType=J&_auth=y&_acct=C000052220&_version=1&_urlVersion=0&_userid=1526876&md5=c0b0efa7c5279b4c40c38cf22167d5fd)

Harvey, M. J., C. S. Law, M. J. Smith, J. A. Hall, E. R. Abraham, C. L. Stevens, M. G. Hadfield, D. T. Ho, B. Ward, S. D. Archer, J. M. Cainey, K. I. Currie, D. Devries, M. J. Ellwood, P. Hill, G. B. Jones, D. Katz, J. Kuparinen, B. Macaskill, W. Main, A. Marriner, J. McGregor, C. McNeil, P. J. Minnett, S. D. Nodder, J. Peloquin, S. Pickmere, M. H. Pinkerton, K. A. Safi, R. Thompson, M. Walkington, S. W. Wright, and L. A. Ziolkowski, The SOLAS airâ€“sea gas exchange experiment (SAGE) 2004, Deep Sea Research Part II: Topical Studies in Oceanography, 58(6), 753-763, 2011.

Peloquin, J., J. Hall, K. Safi, W. O. Smith Jr, S. Wright, and R. van den Enden, The response of phytoplankton to iron enrichment in Sub-Antarctic HNLCLSi waters: Results from the SAGE experiment, Deep Sea Research Part II: Topical Studies in Oceanography, 58(6), 808-823, 2011.

Deep Sea Research Part II Special Edition– Biogeochemistry of the Australian Sector of the Southern Ocean (http://www.sciencedirect.com/science?_ob=PublicationURL&_hubEid=1-s2.0-S0967064511X00115&_cid=271722&_pubType=J&_auth=y&_acct=C000052220&_version=1&_urlVersion=0&_userid=1526876&md5=0f737f34b5f485d536103693d57fea5f)

A.R. Bowie , T.W. Trull and F. Dehairs, 2011. Estimating the sensitivity of the subantarctic zone to environmental change: The SAZ-Sense project. Deep-Sea Research II, 58(21-22), 2051-2058

A.R. Bowie , F. Brian Griffiths , F. Dehairs and T.W. Trull, 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

L. Herraiz-Borreguero and S.R. Rintoul, 2011. Regional circulation and its impact on upper ocean variability south of Tasmania. Deep-Sea Research II, 58(21-22), 2059-2070

M. Mongin , R. Matear and M. Chamberlain, 2011. Seasonal and spatial variability of remotely sensed chlorophyll and physical fields in the SAZ-Sense region. Deep-Sea Research II, 58(21-22), 2082-2093

D. Lannuzel , A.R. Bowie , T. Remenyi , P. Lam , A. Townsend , E. Ibisanmi , E. Butler , T. Wagener and V. Schoemann, 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

E. Ibisanmi , S.G. Sander , P.W. Boyd , A.R. Bowie and K.A. Hunter, 2011. Vertical distributions of iron-(III) complexing ligands in the Southern Ocean. Deep-Sea Research II, 58(21-22), 2113-2125

M. Mongin , R. Matear and M. Chamberlain, 2011. Simulation of chlorophyll and iron supplies in the SubAntarctic Zone South of Australia. Deep-Sea Research II, 58(21-22), 2126-2134

M.F. de Salas , R. Eriksen , A.T. Davidson and S.W. Wright, 2011. Protistan communities in the Australian sector of the Sub-Antarctic Zone during SAZ-Sense. Deep-Sea Research II, 58(21-22), 2135-2149

C. Evans , P.G. Thomson , A.T. Davidson , A.R. Bowie , R. van den Enden , H. Witte and C.P.D. Brussaard, 2011. Potential climate change impacts on microbial distribution and carbon cycling in the Australian Southern Ocean. Deep-Sea Research II, 58(21-22), 2150-2161

K.J. Westwood , F. Brian Griffi ths , J.P. Webb and S.W. Wright, 2011. Primary production in the Sub-Antarctic and Polar Frontal Zones south of Tasmania, Australia; SAZ-Sense survey, 2007. Deep-Sea Research II, 58(21-22), 2162-2178

W. Cheah , A. McMinn , F.B. Griffiths , K.J. Westwood , S.W. Wright , E. Molina , J.P. Webb and R. van den Enden, 2011. Assessing Sub-Antarctic Zone primary productivity from fast repetition rate fluorometry. Deep-Sea Research II, 58(21-22), 2179-2188

M.A. Doblin , K.L. Petrou , K. Shelly , K. Westwood , R. van den Enden , S. Wright , B. Griffi ths and P.J. Ralph, 2011. Diel variation of chlorophyll- a fl uorescence, phytoplankton pigments and productivity in the Sub-Antarctic and Polar Front Zones south of Tasmania, Australia. Deep-Sea Research II, 58(21-22), 2189-2199

K. Petrou , C.S. Hassler , M.A. Doblin , K. Shelly , V. Schoemann , R. van den Enden , S. Wright and P.J. Ralph, 2011. Iron-limitation and high light stress on phytoplankton populations from the Australian Sub-Antarctic Zone (SAZ). Deep-Sea Research II, 58(21-22), 2200-2211

A.-J. Cavagna , M. Elskens , F.B. Griffiths , F. Fripiat , S.H.M. Jacquet , K.J. Westwood and F. Dehairs, 2011. Contrasting regimes of production and potential for carbon export in the Sub-Antarctic and Polar Frontal Zones south of Tasmania. Deep-Sea Research II, 58(21-22), 2235-2247

I. Pearce , A.T. Davidson , P.G. Thomson , S. Wright and R. van den Enden, 2011. Marine microbial ecology in the sub-Antarctic Zone: Rates of bacterial and phytoplankton growth and grazing by heterotrophic protists. Deep-Sea Research II, 58(21-22), 2248-2259

F. Ebersbach , T.W. Trull , D.M. Davies and S.G. Bray, 2011. Controls on mesopelagic particle fluxes in the Sub-Antarctic and Polar Frontal Zones in the Southern Ocean south of Australia in summer — Perspectives from freedrifting sediment traps. Deep-Sea Research II, 58(21-22), 2260-2276

S.H.M Jacquet , P.J. Lam , T. Trull and F. Dehairs, 2011. Carbon export production in the

subantarctic zone and polar front zone south of Tasmania. Deep-Sea Research II, 58(21-22), 2277-2292

W.R. Howard , D. Roberts , A.D. Moy , M.C.M. Lindsay , R.R. Hopcroft , T.W. Trull and S.G. Bray, 2011. Distribution, abundance and seasonal fl ux of pteropods in the Sub-Antarctic Zone. Deep-Sea Research II, 58(21-22), 2293-2300

M. Kidston , R. Matear and M.E. Baird 2301 Parameter optimisation of a marine ecosystem model at two contrasting stations in the Sub-Antarctic Zone. Deep-Sea Research II, 58(21-22), 2301-2315

Ozone Trends in the MBL:

Galbally, I.E., Tully M.B., Klekociuk, A., and Molloy, S. (2011) Long tern trends in ozone in the Southern Hemisphere Marine Boundary Layer and in the Southern Hemisphere Free Troposphere. In Second Tropospheric Ozone Workshop. Tropospheric Ozone Changes: observations, state of understanding and model performances, Eds Martin G. Schultz and Valerie Thouret, World Meteorological Organisation, GAW Report No 199, 66-71.

Phytoplankton modelling: Understanding plankton ecosystem dynamics is essential for correct biogenic transfer of gases between the ocean and atmosphere. These papers are intended to provide a more rigorous basis for the construction of plankton ecosystem models and to provide tools to understand and indeed construct the complex models that are used to predict biogenic gas exchanges.

Cropp, R. and Norbury, J.The Mechanisms of coexistence and competitive exclusion in complex plankton ecosystem models, Ecosystems, 2011.

Cropp, R. and Norbury, J. Constructing ecologies, Journal of Theoretical Biology, 294, 1-8, 2012.

Ship emissions in Australia:

Goldsworthy, L. and I. E. Galbally, Ship engine exhaust emissions in waters around Australia - an overview, Air Quality and Climate Change, 45(4), 24-32, 2011.

Southern Ocean Gas Exchange Experiment:

Ho, D. T., C. L. Sabine, D. Hebert, D. S. Ullman, R. Wanninkhof, R. C. Hamme, P. G. Strutton, B. Hales, J. B. Edson, and B. R. Hargreaves, Southern Ocean Gas Exchange Experiment: Setting the stage, Journal of Geophysical Research-Oceans, 116, 19, 2011.

Oceanography

Spooner, M. I., P. De Deckker, T. T. Barrows, and L. K. Fifield, The behaviour of the Leeuwin Current offshore NW Australia during the last five glacial-interglacial cycles, Global and Planetary Change, 75(3-4), 119-132, 2011.

Ehlert, C., M. Frank, B. A. Haley, U. Boniger, P. De Deckker, and F. X. Gingele, Current transport versus continental inputs in the eastern Indian Ocean: Radiogenic isotope signatures of clay size sediments, Geochemistry Geophysics Geosystems, 12, 17, 2011.

Rogers, J. and P. De Deckker, Environmental reconstructions of the upper 500 m of the southern Indian Ocean over the last 40 ka using Radiolarian (Protista) proxies, Quaternary Science Reviews, 30(7-8), 876-886, 2011.

Russon, T., M. Elliot, A. Sadekov, G. Cabioch, T. Correge, and P. De Deckker, The mid-Pleistocene transition in the subtropical southwest Pacific, Paleoceanography, 26, 13, 2011.

Surface Energy balance measurements over coral reef:

Wiebe, A., A. Sturman, and H. McGowan, Wavelet Analysis of Atmospheric Turbulence over a Coral Reef Flat, Journal of Atmospheric and Oceanic Technology, 28(5), 698-708, 2011.

Marine biogeochemical cycling

de Jong, J.T.M, Schoemann, V., Lannuzel, D., Croot, P., de Baar, H. & Tison, J.-L. 2011. Natural iron fertilization of the Atlantic Southern Ocean by continental shelf sources, JGR-Biogeosciences, accepted with major revision in September 2011 (A*, 3.147)

Cossa D., Heimbürger L.-E., Lannuzel D., Rintoul S. R., Butler E. C. V., Bowie A. R., Averty B., Watson R. & Remenyi T. 2011. Mercury in the Southern Ocean, Geochimica et Cosmochimica Acta, 75 (14):4027-4052, DOI: 10.1016/j.gca.2011.05.001 (A*, 4.385)

van der Merwe P., Lannuzel D., Bowie A.R., & Meiners K. M., 2011b. High temporal resolution observations of spring fast-ice melt and seawater iron enrichment in East Antarctica. JGR-Biogeosciences, 116, G03017, DOI:10.1029/2010JG001628 (A*, 3.147)

Lannuzel D., Bowie A.R., van der Merwe, P., Townsend, A. & Schoemann V., 2011b. Distribution of dissolved and particulate metals in Antarctic sea ice, Marine Chemistry, 124:134-146, DOI: 10.1016/j.marchem.2011.01.004. (A, 2.977)

van der Merwe, P., D. Lannuzel, C. A. Mancuso Nichols, K. Meiners , A.R. Bowie, 2011a Iron fractionation in pack and fast ice in East Antarctica: temporal decoupling between the release of dissolved and particulate iron during spring melt, Deep-Sea Research II, 58, 9-10, 1222-1236, DOI:10.1016/j.dsr2.2010.10.036 (B, 1.965)

Norman, L., D. N. Thomas, C. A. Stedmon , M. A. Granskog, S. Papadimitriou, K. M. Meiners, D. Lannuzel, P. Van de Merwe and G. S. Dieckmann, 2011. Dissolved Organic Matter (DOM) and absorption characteristics of Chromophoric Dissolved Organic Matter (CDOM) in Antarctic sea ice, Deep-Sea Research II, 58, 9-10, 1075-1091, DOI:10.1016/j.dsr2.2010.10.030 (B, 1.965)

Lannuzel D., Bowie A.R, van der Merwe, P., Townsend, A. &. Schoemann V., 2011. Size fractionation of particulate metals during a time series in East Antarctic fast ice, EGU General Assembly, 03-08 April 2011, Vienna, Austria, Geophysical Research Abstracts, EGU2011-2334

Baeyens W., Bowie A.R., Buesseler K., Elskens M., Gao Y., Lamborg C., Leermakers M., Remenyi T.A., Zhang H., 2011. Size-fractionated labile trace elements in the Northwest Pacific and Southern Oceans. Marine Chemistry, 126, 108–113, doi: 10.1016/j.marchem.2011.04.004

Cassar N., DiFiore P., Barnett B.A., Bender M.L., Bowie A.R., Tilbrook B., Petrou K., Westwood K., Wright S., Wagener T., 2011. The influence of iron and light on net community production in the Subantarctic and Polar Frontal Zones. Biogeosciences, 8, 227-237, doi: 10.5194/bg-8-227-2011

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

- Joint Australian-French collaboration during the oceanographic fieldwork project KEOPS2 (Kerguelen Ocean and Plateau compared Study), a natural iron fertilisation experiment on the Kerguelen plateau in the Southern Ocean (Australian PIs: Bowie A, Trull T, Armand L.; French PIs: Blain S, Queguiner B)
- Dr Véronique Schoemann and Ing Jeroen de Jong (The Royal Netherlands Institute for Sea Research, The Netherlands): iron isotopes in archived sea ice samples, uptake of iron in algal cells using radioactive technology, iron solubility, cycling of iron in the Southern Ocean. Additional collaboration planned in 2012 during the SIPEX2 voyage.
- Prof Frank Dehairs and Dr Anne-Julie Cavagna (Vrije Universiteit Brussel, Belgium): interactions between iron and the mesopelagic zone during SIPEX2 voyage in Sept/Oct 2012.
- Prof David Thomas, Dr Stathys Papadimitriou, Dr Shazia Aslam and Louiza Norman (Bangor University, United Kingdom): distribution of nutrients and organic matter in East Antarctic sea ice.

- Dr Daniel Cossa (Ifremer, French Research Institute for Exploration of the Sea, France): Study of Mercury in sea ice from Casey Station, Antarctica. Additional collaboration planned in 2012 during the SIPEX2 voyage.
- The 2012 Surface Ocean Aerosol Production (SOAP) study (see section 6 below for details), will involve an international team of scientists from NIWA (NZ), CSIRO (Australia), QUT (Australia), UEF (Finland), UC Irvine (US), U Chapman (US), U Laval (Canada).
- Ian Galbally, a member of the WMO GAW Scientific Advisory Group on Reactive Gases is leading the revision of the measurement guidelines for surface ozone at GAW sites, and in Dec 2011 visited 5 key participating groups including Martin Schultz, Institute of Energy and Climate Research, Forschungszentrum Juelich, Germany, Oksana Tarasova WMO Geneva, Switzerland, Brigitte Buchmann, Christoph Zellweger, Martin Steinbacher EMPA Zurich, Switzerland, Hans-Eckhart Scheel, Karlsruhe Institute of Technology, Garmisch-Partenkirchen, Germany, and Sam Oltmans and Laura Patrick NOAA ESRL, Boulder, Colorado, USA.

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

- The Surface Ocean Aerosol Production (SOAP) study scheduled for February 2012 has been endorsed by SOLAS. This study will involve a measurement campaign onboard NIWA's RV *Tangaroa* over Chatham Rise which runs from east NZ to the Chatham Islands, to investigate links between surface water biogeochemistry, gaseous aerosol precursors, and production and size distribution of aerosols in the MBL. For more information see http://www.solasint.org/science/researchendorsements/resendprojects/endorsedprojects.html#soap

- University of Wollongong have recently bid successfully for time on the first 3 transit voyages on the Southern Surveyor in 2012, to make measurements of CO_2, CO, CH_4, N_2O and $^{13}CO_2$ in the atmosphere across the transit path. Uni Wollongong also have a PhD student (Chris Caldow) working with the University of Bremen to develop a method using an equilibrator to also measure the flux of CO_2 from the surface waters.

- SIPEX-2 (Sea Ice Physics and Ecosystems Experiment) will take place in the Antarctic sea-ice zone in September and October 2012 on board RSV *Aurora Australis*. The international fieldwork will be led from researchers from the Antarctic Climate and Ecosystems CRC in Hobart. A campaign has also been proposed on SIPEX-2 to measure atmospheric reactive halogens and mercury in the polar springtime. Funding dependent, this work will allow the international team lead by University of Melbourne's Robyn Schofield, to quantitatively link high atmospheric bromine levels to the high deposition of toxic mercury into the biosphere occurring annually with the Antarctic sunrise.

7. Other comments

SOLAS Belgium

compiled by Christiane Lancelot

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)

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

- 43rd International Liege Colloquium on Ocean Dynamics "Tracers of physical and biogeochemical processes, past changes and ongoing anthropogenic impacts", 2 - 6 May 2011.
- Set up of a SCOR working group on Biogeochemical Exchange Processes At the Sea- Ice Interfaces (BEPSII)

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

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

Brabant, F., El Amri, S. and Tison, J.-L. (2011) A robust approach for the determination of dimethylsulfoxide in sea ice, Limno. & Oceano. : Methods 9- DOI 10:4319/lom.2011.9.XXXc

Gypens N., G. Lacroix, C. Lancelot & A.V. Borges (2011) Seasonal and inter-annual variability of air-sea CO2 fluxes and seawater carbonate chemistry in the Southern North Sea, Progress in Oceanography, 88, 59–77.

Harlay J., L. Chou, C. De Bodt, N. Van Oostende, J. Piontek, K. Suykens, A. Engel, K. Sabbe, S. Groom, B. Delille & A.V. Borges (2011) Biogeochemistry and carbon mass balance of a coccolithophore bloom in the northern Bay of Biscay (June 2006), Deep-Sea Research I, 58, 111-127.

Lewis, M.-J., Tison, J.-L., Weissling, B. Delille, B., Ackley, S.F., Brabant, F. and H. Xie (2011) Sea ice ans snow cover characteristics during the winter-spring transition in the Bellingshausen Sea: an overview of SIMBA 2007, Deep Sea Research II, 2011, vol. 58, 1019-1038, doi: 10.1016/j.dsr2.2010.10.027.

Rysgaard S, J. Bendtsen, B. Delille, G.S. Dieckmann, R.N. Glud, H. Kennedy, J. Mortensen, S. Papadimitriou, D.N. Thomas & J.-L. Tison (2011) Sea ice contribution to the air-sea CO2 exchange in the Arctic and Southern Oceans, Tellus, 63B, 823–830

Stefels, J., Carnat, G., Dacey, J.W., Goossens, T., Elzenga, T.M. and Tison J.-L. (2011) The analysis of dimethylsulfide and dimethylsulphoniopropionate in sea ice: dry-crushing and melting using stable isotope additions, Marine Chemistry, doi:10.1016/j.marchem.2011.09.007.

Vancoppenolle, M., Timmerman, R., Ackley, S.F., Fichefet, T., Goosse, H., Heil, P., Lieser, J., Leonard, K., Niclaus, M., Papakyriakou, T. and Tison, J.-L. (2011) Assessment of model forcing data sets for large-scale sea ice models in the Southern Ocean, Deep Sea Research II, 2011, vol. 58, 1237-1249, doi:10.1016/j.dsr2.2010.10.039

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

- Further development of the 3D MIRO-CO2 model with a module calculating DMS emission in the Southern North Sea.
- Initiation of a year-round (2011-2013) survey of land fast sea ice biogeochemistry in McMurdo Sound, Antarctica: C, S, N and Si fluxes to the atmosphere and/or to the Ocean, quantification and driving processes (YROSIAE [FNRS funding] and BIGSOUTH [BELSPO funding] projects)
- Modelling of gas processes in sea ice and exchanges with the atmosphere and the ocean

7. Other comments

SOLAS Brazil

compiled by Amauri Pereira de Oliveira

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)

Project 1. Turbulent fluxes over the Tropical Atlantic. Coordinator: Jacyra Soares. Air-Sea Interaction Laboratory. Institute of Astronomy, Geophysics and Atmospheric Sciences University of São Paulo, São Paulo, Brazil (jacyra@usp.br).

The local ocean-atmosphere interaction has been investigated through the direct observation of air-sea variables, using a set of slow and fast micrometeorology sensors installed in a 10-meter tower in the Brazilian Archipelago and through atmospheric and oceanic numerical models. The major goals are to characterize observationally and numerically the interaction between the atmosphere and the ocean in micro, meso and macro scales in order to develop, calibrate and verify the parameterization formulae used to indirectly estimate flux from conventional meteorological variables.

An 1 ½ layer oceanic numeric model is coupled to the Topographic Vorticity-mode Mesoscale-Non Hydrostatic (TVM-NH) atmospheric model to study the influence of the sea surface temperature (SST) on the planetary boundary layer of the coastal upwelling area of Cabo Frio (RJ, Brazil). The coupling is tested and then two experiments are performed, the first using just the atmospheric model and the second using the coupled models, to compare the resulting interface fluxes of both experiments. The uncoupled experiment showed smaller values of heat fluxes during all the integration period than the coupled experiment. At last, the mixing ratio vertical profiles of both experiments are compared to observations. It was found that the coupled model results compare better to the observations than when using only the oceanic or the atmospheric models.

The k-ε version using a second-order closure of an one-dimensional oceanic turbulence model, the General Ocean Turbulence Model, is used to investigate the oceanic mixing layer (OML) over the equatorial Atlantic Ocean. Meteorological and oceanographic dataset from the Prediction and Research Moored Array over the Tropical Atlantic Ocean and complementary radiation dataset from the NASA Langley Research Center Atmospheric Science Data Center are used to compute the surface boundary condition and for data assimilation during the simulations. Numerical simulations were performed for two seasons: the first one, when the Inter-tropical Convergence Zone (ITCZ) is over the region, characterized by lower wind velocity and annual extremes of precipitation, and the second season when the wind and the surface heat balance are enhanced. Emphasis was given to the role of the terms of the turbulent kinetic energy equation in the evolution of the OML. Numerical results show that the OML is mainly generated by mechanical turbulence in both seasons and that the thermal production of turbulence is only important on the first 30% of the OML depth at nighttime. During ITCZ season the OML depth estimated, using turbulence criterion is around 5 m at daytime and 10 m at nighttime. During the other season, the OML depth is about 10 m at daytime to around 55 m at nighttime. The turbulent fields simulated in this work show qualitative agreement to observational and numerical studies performed over the equatorial Pacific Ocean.

Project 2.Study of the Atmospheric Boundary Layer in the Region of Brasil-Malvinas Confluence. Coordinator: Marcelo Dourado. Centre for Ocean Studies. Federal University of

Paraná, Pontal do Sul, PR, Brazil (dourado@ufpr.br).

A subproject entitled “Coupled Modeling the Ocean and Atmospheric Boundary Layer in upwelling region” was the major activity developed during 2010. Turbulence in the oceanic (OBL) and atmospheric (ABL) boundary layer plays a vital role in the interaction between ocean and atmosphere, by controlling exchanges of heat, momentum and mass at the sea surface. These air-sea exchanges have great importance on determining the weather and the climate. The assessment of air-sea interactions is particularly relevant over the coupled oceanic regions. In the Cabo Frio region (23oS, 42oW), the upwelling has great influence on the primary productivity and in local climate. The coupling between the ABL and OBL has to be understood as a problem of fluid dynamics, where the main difference is the fluid’s density. Basic dynamic equations, in which the density is one of the variables, can be applied to both sides of the interface, and in some cases the similarity of the physical processes in the two media, can be notable. For instance, a vertical profile of normalized dissipation rate of the turbulent kinetic energy in the OBL and ABL are very similar when turbulence is kept by thermal convection. Figure 1 indicates the impact of thermal contrast in the upwelling region of Cabo Frio, considering (a) and (c) upwelling and (b) and (d) downwelling conditions.

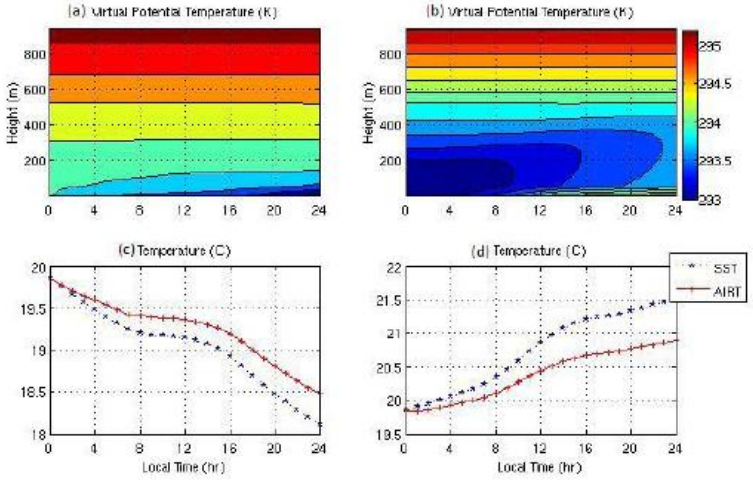


Figure 1. Diurnal evolution of virtual potential temperature in the ABL and thermal contrast between ABL and OBL.

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

It was made significant progress in the understanding of the PBL interaction between the atmosphere and ocean at tropical regions using modelling technique. Data analysis of FluTuA and other tropical sites are ongoing now.

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

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

Skielka, U.T.; Soares, J. and Oliveira, A.P., 2010: Study of the equatorial Atlantic oceanic mixing layer using a one-dimensional turbulence model. *Brazilian Journal of Oceanography,* 58, 57-69 *(doi:* 10.1590/S1679-87592010000700008).

Fonseca, F., Soares, J., 2010: Numerical experiments on the development of the boundary layer in the equatorial Atlantic ocean. *The Meeting of the Americas*, Foz do Iguaçu, Brazil, 8-12 August, AGU, 91(26), Meet. Am. Suppl., OS31E-04.

Ribeiro, F.N.D.; Soares, J. and Oliveira, A. P. 2011: The co-influence of the sea breeze and the coastal upwelling at Cabo Frio: a numerical investigation using coupled models. *Revista Brasileira de Oceanografia*, 59, 131-144 (doi: 10.1590/S1679-87592011000200002).

Dutra, L.M.M., Soares, J., 2011: Energy Balance at the Air-Sea Interface of the Tropical Atlantic Ocean. *Canadian Meteorological and Oceanographic Society Congress* (*CMOS) 2011: "Ocean, Atmosphere and the Changing Pacific"*, June 5-9, 2011, Victoria, British Columbia.

Skielka, U.T., Soares, J., Oliveira, A.P., 2011: Diagnostic of the diurnal cycle of turbulence of the Equatorial Atlantic Ocean upper boundary layer. *Natural Science*, 03, 444-455 (doi: 10.4236/ns.2011.36061).

Ribeiro, F.N.D.; Soares, J. and Oliveira, A.P. 2011: A coupled numerical model to investigate the air-sea interaction at the coastal upwelling area of Cabo Frio, Brazil. *Environmental Fluid Mechanics*, (doi: 10.1007/s10652-011-9220-5).

Dourado, M. S.; Oliveira, A. P., 2011: Modelling the Atmospheric Planetary Boundary layer over the Cabo Frio Upwelling Region. Procedings of the XIV Congresso Latino Americano de Ciências do Mar. Camboriu, Sta Caratina, Brazil.

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

Main objective of the Solas Brazil is to incorporate new projects and promoting the development of the air-sea interaction in Brazil by involving new research groups.

7. Other comments

Annual Report for the year 2011:

SOLAS Canada

compiled by Maurice Levasseur

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)

i) Importance of under-ice phytoplankton blooms in the Arctic (Arctic-ICE project: CJ Mundy, V Galindo - PhD candidate, M Levasseur, M Scarratt, M Gosselin)

Significant under-ice phytoplankton blooms were observed near Resolute Bay, Nunavut in both 2010 and 2011, during the Arctic-ICE project. Bloom formation was linked to the demise of the springtime bottom ice algal bloom and surface snow melt, both of which contributed to a deepening of the euphotic zone under the ice (Fig. 1). With a trend towards an earlier melt onset and a thinning Arctic ice cover associated with the relative increase in first-year ice coverage across the Arctic, under-ice phytoplankton blooms are hypothesized to become more prevalent across the Arctic. If this hypothesis holds true, these blooms could represent a major response of the polar marine ecosystem to climate change, the implications of which still need to be determined.

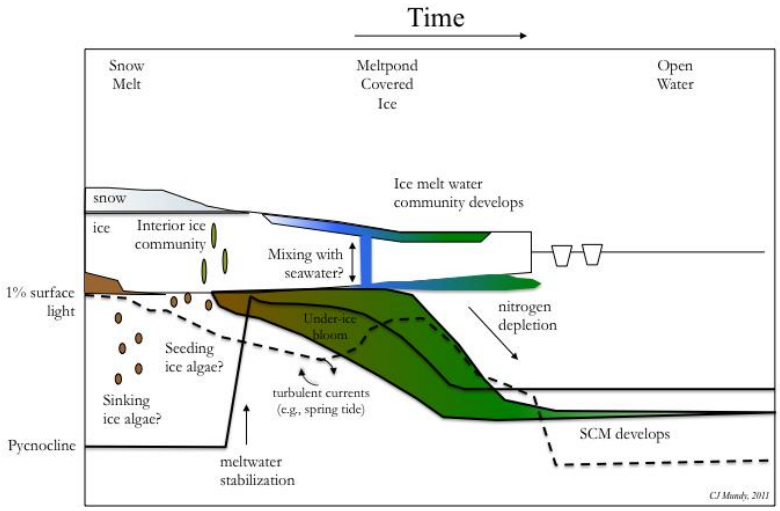


Figure 1. Diagrammatic representation of the timing of marine primary producers during the spring-summer transition near Resolute Bay, Nunavut, Canada.

As schematized in figure 1, the under-ice phytoplankton blooms are preceded by the release of ice algae in the water column. Both ice algae and phytoplankton contribute to the increase in particulate dimethylsulfoniopropionate (DMSP) in the water column at that time (Fig. 2). The concentrations of dissolved DMSP (DMSPd) were very high at the bottom of the ice, but less than 10% of the dissolved DMSP lost from the ice during the warming period was found in the water column. This intriguing 'vanishing' of DMSPd was also observed in 2010. Bacteria, which are known to use DMSP as a source of carbon and sulfur, could be responsible for the rapid disappearance of the DMSPd released from the ice. The DMSPd consumed by the bacteria could be efficiently converted into DMS, especially if the bacteria use DMSP mostly as a carbon source. This hypothesis will be tested during our field program in 2012. These new observations suggest that ice algae released in the water column and under-ice phytoplankton blooms could be responsible for the high concentrations of dimethylsulfide (DMS) generally measured at the marginal ice zone.

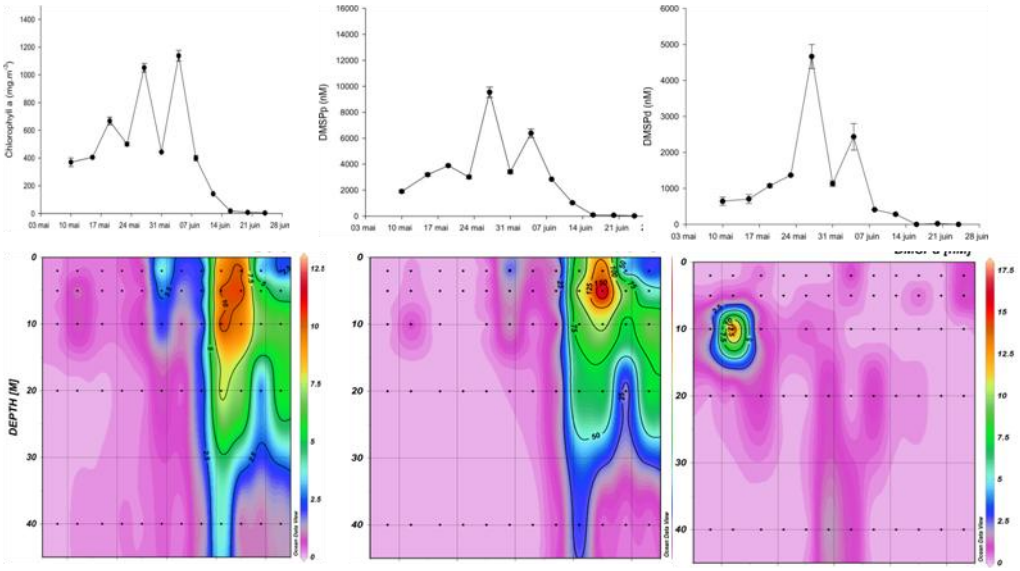


Figure 2. Temporal variations in the concentrations of chlorophyll a, DMSPp and DMSPd in the last 3 cm of the ice (upper panels) and in the water column (lower panels) in 2011 at a station located in Allen Bay, northwest of Resolute Bay (74° 43 N; 95° 09 W).

ii) Impact of ash deposition on the North-East Pacific (J Mélançon - PhD candidate, M Levasseur, M Lizotte, L Miller, P Tortell, N Steiner, M Scarratt)

Onboard incubation experiments were conducted on the effect of volcanic ash on the plankton community and its capacity to produce DMS during the June 2011 Line P cruise in the Northeast subarctic Pacific. Results show a strong and rapid response of the community to ash addition, providing additional support the hypothesis that the 2008 Kasatochi eruption was responsible for the unusual large phytoplankton bloom observed in the North Pacific during that year (data presented at the 2011 SOLAS Summer School – poster Mélançon et al.).

iii) Mobility of CO_2 in sea ice and impact of ice on CO_2 fluxes (L Miller, T Papakyriakou, et al.)

Work conducted in the Canadian Archipelago and the Beaufort Sea on CO_2 fluxes and dynamics in sea ice confirmed that CO_2 is indeed mobile in sea ice (Papakyriakou and Miller, 2011). The different processes at play are schematised in figure 3 (from Miller et al. 2011).

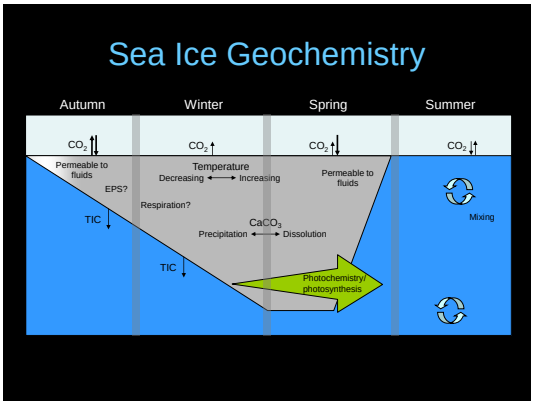


Figure 3. Summary of processes controlling sea ice inorganic carbon dynamics.

Members of our research group also show how the presence of sea ice enhances atmospheric CO_2 drawdown into undersaturated winter waters that are only partially ice-covered (Else et al. 2011). See figure 4 for a summary.

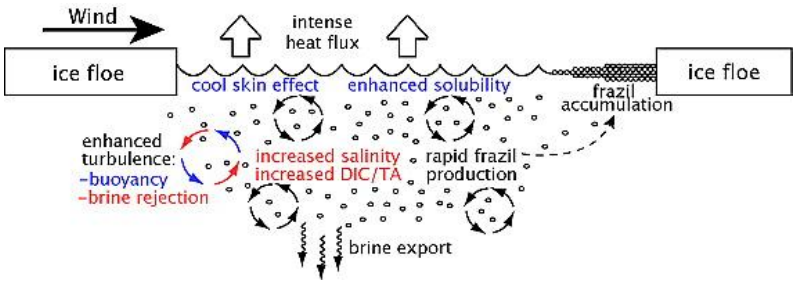


Figure 4. Schematic summarizing the important processes occurring during a wind-driven lead event. The processes highlighted in blue/red are those which likely have a direct effect on air-sea gas exchange. Processes in red are associated with frazil ice formation, and those in blue are associated with the surface cooling.

iv) Factors controlling the sea-surface microlayer enrichment factors (Wurl, Vagle, Miller, et al.)

Work focusing on the microlayer generated unexpected results. We found that across oceanographic regimes, the sea-surface microlayer enrichment factors (i.e., the extent to which the microlayer is different from the bulk waters) was actually anticorrelated with both trophic state and organic surfactant concentration – a rather counterintuitive result that had been hinted at in other work (Wurl et al. 2011). We are also currently working on how exopolymeric substances end up in the microlayer through abiotic, as well as biotic processes (Fig. 5).

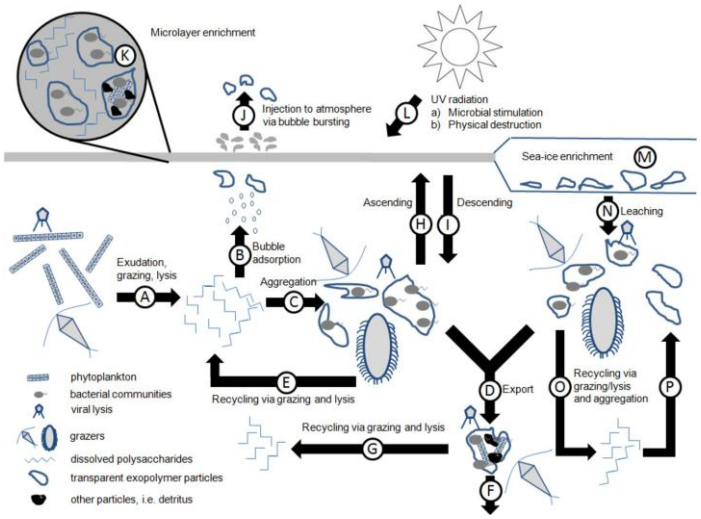


Figure 5. Schematic representation of the different processes leading to the formation of exopolymeric substances and to their accumulation in the microlayer.

v) Relating atmospheric and oceanic DMS levels to particle nucleation events in the Canadian Arctic (Chang, Sjostedt, Pierce, Papakyriakou, Scarratt, Michaud, Levasseur, Leaitch, Abbatt)

Measurements of ocean surface and atmospheric dimethyl sulfide (DMS) and particle size distributions were made in the Canadian Arctic Archipelago during the fall of 2007 and the late summer of 2008 aboard the Canadian Coast Guard Ship Amundsen. Nucleation mode particles were observed during the 2008 cruise, which took place in the eastern Arctic from August to September when the atmosphere and ocean were more photoactive as compared to the October 2007 transit in the Beaufort Sea during which no nucleation/growth events were observed. The observed nucleation periods in 2008 coincided with high atmospheric and ocean surface DMS concentrations, suggesting that the particles originated from marine biogenic sources. An aerosol microphysics box model was used to simulate nucleation given the measured conditions in the marine boundary layer. Although other sources may have contributed, we find that the newly formed particles can be accounted for by a marine biogenic DMS source.

vi) Dimethyl sulfide air-sea fluxes and biogenic sulfur as a source of new aerosols in the Arctic fall (Rempillo, Seguin, Norman, Scarratt, Michaud, Chang, Sjostedt, Abbatt, Else, Papakyriakou, Sharma, Grasby, Levasseur)

Dimethyl sulfide (DMS) and its oxidation products, which have been proposed to provide a climate feedback mechanism by affecting aerosol and cloud radiative properties, were measured on board the Canadian Coast Guard ship Amundsen in sampling campaigns in the Arctic in the fall of 2007 and 2008. DMS flux was calculated based on the surface water measurements and yielded 0.1–2.6 mmol m^{-2} d^{-1} along the Northwest Passage in 2007 and 0.2–1.3 mmol m^{-2} d^{-1} along Baffin Bay in 2008. DMS oxidation products, sulfur dioxide (SO_2), methane sulfonic acid (MSA), and sulfate in aerosols were also measured. The amounts of biogenic SO_2 and sulfate were approximated using stable isotope apportionment techniques. Calculating the threshold amount of SO2 needed for significant new particle formation from the formulation by Pirjola et al. (1999), the study suggests that instances of elevated biogenic SO_2 concentrations (between 8 and 9 September 2008) derived using conservative assumptions may have been sufficient to form new aerosols in clean air conditions in the Arctic region.

vii) DMS Oxidation Pathways and Aerosol Size in the Arctic - Alert (A-L Norman et al.)

MSA and non sea salt sulfate (NSS) in size segregated aerosols generally followed a similar pattern with maximum concentrations in the finest aerosols sampled (<0.49 micrometers in diameter; Fig. 6). It is interesting to note, however, that sea salt sulfate was often at a maximum concentration in the finest aerosol size fraction (F) rather than in larger diameter aerosols (A, B and C in Figure 6) as has been generally found over oceans at lower latitudes.

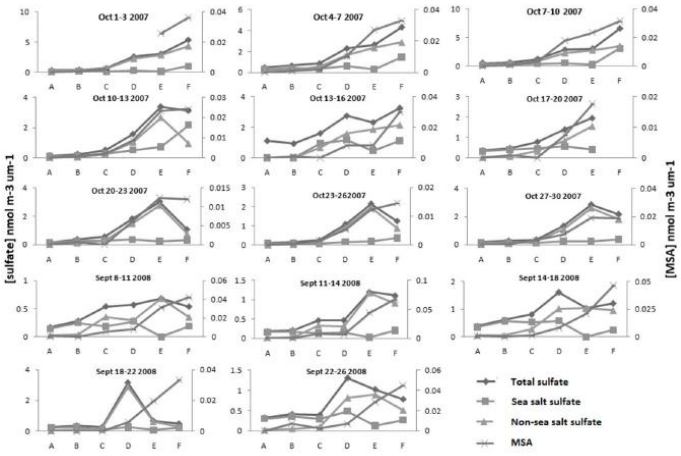


Figure 6. Alert - Sulfate and MSA distributions in aerosols for size segregated samples from fall 2007 and 2008.

Size bins indicate the range of aerodynamic diameter as follows: F (<0.49 µm), E (0.49-0.95 µm), D (0.95-1.5 µm), C (1-5-3 µm), B (3-7.2 µm), A (7.2–10 µm).

Evidence that MSA formation (and DMS oxidation pathways) is strongly affected by the presence of existing aerosols in the Arctic environment is demonstrated in Figures 7 and 8. Atmospheric DMS averaged over three days follows a similar pattern to MSA and non sea salt sulfate in the fine aerosol fraction in the fall of 2007 which is surprising given the differences in expected transport and lifetime for gases and aerosols.

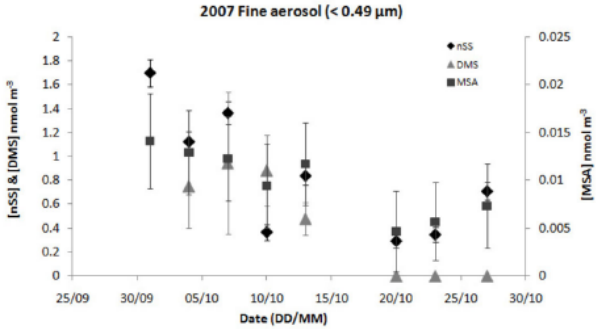


Figure 7. Temporal distribution of three-day averaged DMS, MSA and nSS in the fine aerosol showing the correspondence between non sea salt sulfate, and MSA in the fine aerosol size fraction (<0.49 µm diameter), and DMS in air which suggests DMS oxidation pathways (and MSA formation) are strongly influenced by the presence of existing aerosol irrespective of whether the aerosols are of biogenic origin.

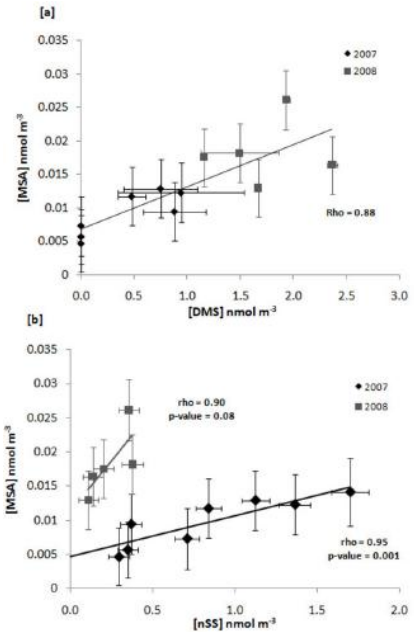


Figure 8. [a] MSA from the fine aerosol (<0.49 µm) filter plotted versus the DMS averaged over the 3 day sampling periods give a linear correlation with Spearman rank correlation, rho = 0.88. [b] MSA versus non-sea salt sulfate from the fine aerosol (<0.49 µm) filter measure over a 3 day sampling periods give a linear correlation with Spearman rank correlation, rho = 0.95 for 2007 and rho = 0.90 for 2008.

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

Research projects:

Arctic-ICE Program – Arctic-Ice Covered Ecosystem in a rapidly changing environment (Arctic-ICE 2011). Climate warming has induced rapid change on the ice-covered marine ecosystem of the high Arctic. In this project we investigated physical and biological processes controlling the timing of marine primary production and its influence on the drawdown/release of climatically active

gases. Location – land fast ice in Allen Bay (74.708N 95.250W) near Resolute Bay, Nunavut, Canada; Dates - 16 April - 9 July, 2011. A third ice camp is planned for May-July 2012. Main investigators are CJ Mundy, M Gosselin, D Barber, T Papakyriakou, L Miller, and M Levasseur.

Biogeochemical Impacts of Asian Dust and Volcanic Ash on the North Pacific Ecosystem and Climate - Onboard incubation experiment were conducted on the effect of volcanic ash on the plankton community and its capacity to produce DMS during the June 2011 Line P cruise in the Northeast subarctic Pacific. Main investigators are J Mélançon (PhD candidate), M Levasseur, M Lizotte, L Miller, P Tortell, N Steiner, M Scarratt. Results show a strong and rapid response of the community to ash addition, providing additional support the hypothesis that the 2008 Kasatochi eruption was responsible for the unusual large phytoplankton bloom observed in the North Pacific during that year.

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

Several MsC and PhD students are trained in the different programs.

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

Chang R Y-W, Leck C, Graus M, Müller M, Paatero J, Burkhart JF, Stohl A, Orr LH, Hayden K, Li S-M, Hansel A,Tjernström M, Leaitch WR, Abbatt JPD (2011) Aerosol composition and sources in the central Arctic Ocean during ASCOS, Atmos. Chem. Phys., 11, 10619-10636, 2011

Chang RY-W, Sjostedt SJ, Pierce JR, Papakyriakou TN, Scarratt MG, Michaud S, Levasseur M, Leaitch WR, Abbatt JPD. (2011) Relating atmospheric and oceanic DMS levels to particle nucleation events during the Canadian Arctic summer. J Geophys Res (Atmospheres) 116: D00S03, doi : 10.1029/2011JD015926

Else BGT, Papakyriakou TN, Galley RJ, Drennan WM, Miller LA, Thomas H (2011). Wintertime CO_2 fluxes in an Arctic polynya using eddy covariance: Evidence for enhanced air-sea gas transfer during ice formation. J. Geophys. Res. 116, C00G03, doi:10.1029/2010JC006760.

Levasseur, M (2011). If Gaia could talk. News and Views. Nature Geoscience 4: 351-352.

Loose B, Miller L, Elliott S, Papakyriakou T (2011). Sea ice biogeochemistry and material transport across the frozen interface. Oceanography 24(3): 202-18.

Luce M, Levasseur M, Scarratt MG, Michaud S, Royer S-J, Kiene R, Lovejoy C, Gosselin M, Poulin M, Gratton Y, Lizotte M. (2011) Distribution and microbial metabolism of dimethylsulfoniopropionate and dimethylsulfide during the 2007 Arctic ice minimum. J Geophys Res (Oceans) 116: C00G06, doi: 10.1029/2010JC006914

Martin M, Chang R Y-W, Sierau B, Sjogren S, Swietlicki E, Abbatt JPD, Leck C, Lohmann U (2011) Cloud condensation nuclei closure study on summer arctic aerosol. Atmos. Chem. Phys., 11, 11335-11350, 2011

Miller LA, Carnat G, Else BGT, Sutherland N, Papakyriakou TN (2011). Carbonate system evolution at the Arctic Ocean surface during autumn freeze-up. J. Geophys. Res. 116, C00G04, doi: 10.1029/2011JC007143.

Miller LA, Papakyriakou TN, Collins RE, Deming JW, Ehn JK, Macdonald RW, Mucci A, Owens O, Raudsepp M, Sutherland N (2011). Carbon dynamics in sea ice: A winter flux time series. J. Geophys. Res. 116, C02028, doi: 10.1029/2009JC006058.

Motard-Côté J, Levasseur M, Scarratt M, Michaud S, Gratton Y, Rivkin RB, Keats K, Gosselin M, Tremblay J-E, Kiene RP, Lovejoy C. (2011) Distribution and metabolism of dimethylsulfoniopropionate (DMSP) and phylogenetic affiliation of DMSP-assimilating bacteria in northern Baffin Bay/Lancaster Sound. J Geophys Res (Oceans) (in press) doi:10.1029/2011JC007330

Papakyriakou TN, Miller L (2011). Springtime CO_2 exchange over seasonal sea ice in the Canadian Arctic Archipelago. Ann. Glaciol. 52(57): 215-24.

Rempillo O, Seguin M, Norman A-L, Scarratt M, Michaud S, Chang R, Sjostedt S, Abbatt J, Else B, Papakyriakou T, Sharma S, Grasby S, Levasseur M (2011) Dimethyl sulfide air-sea fluxes and biogenic sulfur as a source of new aerosols in the Arctic fall J Geophys Res (Atmospheres)

116: D00S04, doi:10.1029/2011JD016336
Song G, Xie H, Aubry C, Zhang Y, Gosselin M, Mundy CJ, Philippe B, Papakyriakou TN. (2011) Spatiotemporal variations of dissolved organic carbon and carbon monoxide in first-year sea ice in the western Canadian Arctic. J Geophys Res (Oceans) 116: C00G05, doi: 10.1029/2010JC006867
Steiner N, Robert M, Arychuk M, Asher L, Levasseur M, Lizotte M, Merzouk A, Pená A, Tortell P, Richardson W (in press). A decade of DMS measurements and modelling in the Subarctic Pacific. Biogeochemistry.
Wurl O, Wurl E, Miller L, Johnson K, Vagle S (2011). Formation and global distribution of sea-surface microlayers. Biogeosci. 8: 121-35.

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

i)Arctic-ICE 2011 was planned in collaboration with a parallel study carried out by the Centre for Ice, Climate and the Environment (ICE) of the Norwegian Polar Institute (NPI). The project include a collaboration between Levasseur and Stefels's lab (Netherlands).

ii) A number of Canadian SOLAS scientists (Miller, Azetsu-Scott) are participating in the preparation of the upcoming AMAP assessment of Arctic Ocean Acidification.

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

To continue tightly coupled physical-biological landfast sea ice based process studies in support of one- and three-dimensional ecosystem model development.

The development of the High Arctic Research Station may offer opportunities to position SOLAS research for better sustained work in the Arctic.

Question of ocean acidification impacts on ecosystem structure and function appears to be something that will not be resolved quickly or easily, possibly facilitating continuing research on air-sea CO_2 exchange feedbacks.

The possibility to study the impacts of ash and other iron sources on the North Pacific biogeochemical cycles and ecosystems in a large, integrated project will be considered during the year.

7. Other comments

SOLAS China (Beijing)

compiled by Minhan Dai & Huiwang Gao

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)

1.1 Short-term dynamics of oxygen and carbon in productive nearshore shallow seawater systems off Taiwan: observations and modeling.

Jiang, Z.P., J.C. Huang, M.H. Dai, S.J. Kao, D.J. Hydes, W.C. Chou and S. Jan, 2011. ***Limnology and Oceanography,*** 56(5): 1832-1849.

The diurnal to weekly dynamics of carbon and oxygen in two productive tropical–subtropical nearshore shallow water systems were investigated using a combination of time-series observation and modeling. The two sites, Aodi (121.93°E, 25.06 °N) and Nanwan (120.85°E, 21.91°N), were characterized by limited freshwater input, strong tidal advection and, at Nanwan, upwelling. The diurnal ranges were 96–234 mol kg^{-1} for dissolved inorganic carbon (DIC), 8.9–42.2 Pa for partial pressure of carbon dioxide (*p*CO2), and 37–239 mol kg^{-1} for dissolved oxygen. The diurnal variability increased from spring to neap tidal states at both sites. A model accounting for gas exchange, biological activities, tidal advection, and upwelling was developed to assess the biophysical interactions modulating the biogeochemical dynamics. The strongest driver of the diurnal variability was the net ecosystem production of the benthic-dominated nearshore ecosystem. Tidal advection buffered the accumulation of biological effects and the intensified dispersion lowered the diurnal amplitudes at spring tides.

Tide-induced upwelling at Nanwan increased the surface inorganic carbon, and its decreasing intensity resulted in declines in DIC and pCO_2 from spring toward neap tide. The maximum community photosynthetic rates at Aodi and Nanwan were 295 and 120 mmol C m^{-2} h^{-1}, with ecosystem respiratory rates of 122 and 53 mmol C m^{-2} h^{-1}. The two autotrophic ecosystems were sinks for atmospheric CO_2 during the study period, with the average air–sea fluxes being 20.30 and 20.56 mmol C m^{-2} d^{-1} for Aodi and Nanwan.

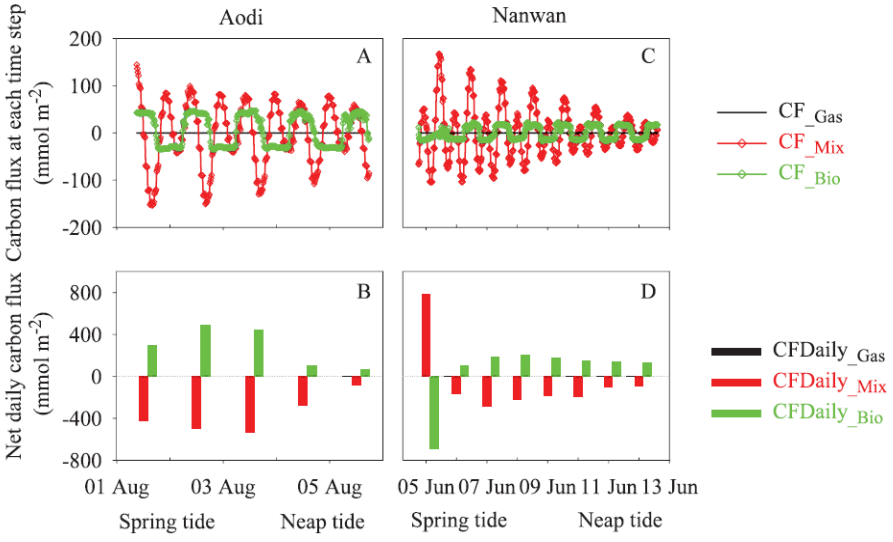


Fig. 1 (A,C) Modeled carbon fluxes at each 0.25-h time step (CF); (B,D) modelled net daily carbon fluxes (CFDaily). The positive values correspond to the fluxes exported from the nearshore water. The subscripts Gas, Mix, and Bio refer to the fluxes resulted from gas exchange, mixing processes, and biological activities.

1.2 Correlation of Asian dust with chlorophyll and primary productivity in the coastal seas of China during the period from 1998 to 2008.

Tan, S.C., G.Y. Shi, J.H. Shi, H.W. Gao and X.H. Yao, 2011. ***Journal of Geophysical Research***, 116, G02029, doi:10.1029/2010JG001456.

Satellite chlorophyll a (Chl a) concentrations and estimated primary production in the coastal seas of China were correlated with Asian dust events during 1998–2008. Dust events were identified using two approaches, i.e., historical record and satellite aerosol index (AI). Severe and very severe dust events correlated well and positively with Chl a concentrations and primary production in the south Yellow Sea and East China Sea, but it was not statistically significant in the Bohai Sea and the north Yellow Sea. In the south Yellow Sea, Chl a concentration and primary production increased and eventually bloomed 1–21 days after the occurrence of the 16 out of 22 dust storms. Granger causality test showed that AI, photosynthetically available radiation (PAR) and sea surface temperature (SST) did Granger cause primary production in the Yellow Sea, suggesting that past values of the above three variables contain statistically meaningful information about current values of primary production. A stepwise multiple linear regression was used to examine the relative importance of the three factors. PAR and SST accounted for most of the variability of primary production in the north Yellow Sea, while AI was not quite as useful. In the south Yellow Sea, PAR and AI accounted for most of the variability of primary production for all storms; in addition, spring algae blooms were due to dust particles transported in the <3 km layer of the atmosphere which passed through the loess plateau and/or megacities, while the higher- level (>5 km) dusts, originated mainly from the Taklimakan Desert, Mongolia, and/or west of Inner Mongolia, had no impact.

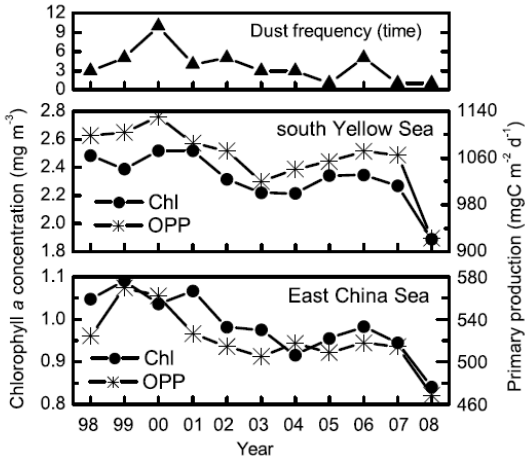


Fig. 2 The yearly variations of FDS, annual average Chl a concentration and OPP in the south Yellow Sea and East China Sea.

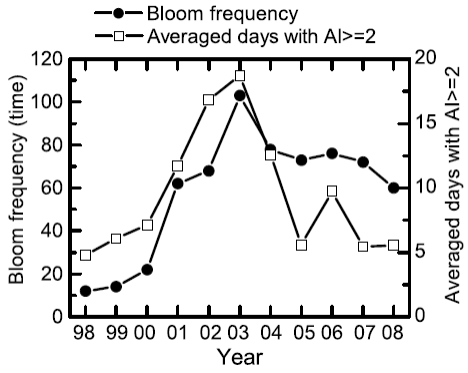


Fig. 3 Annual variations of bloom frequency and average days with AI ≥ 2.

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

2.1 Cruises and field experiment on island

2.1.1 A 40-day long and multidisciplinary CHOICE-C (SOLAS endorsed project) cruise was conducted onboard R/V Dongfanghong II on Apr. 29-Jun. 10, 2011, covering the CHOICE-C domains of northern South China Sea, East China Sea and southern Yellow Sea (Fig. 4).

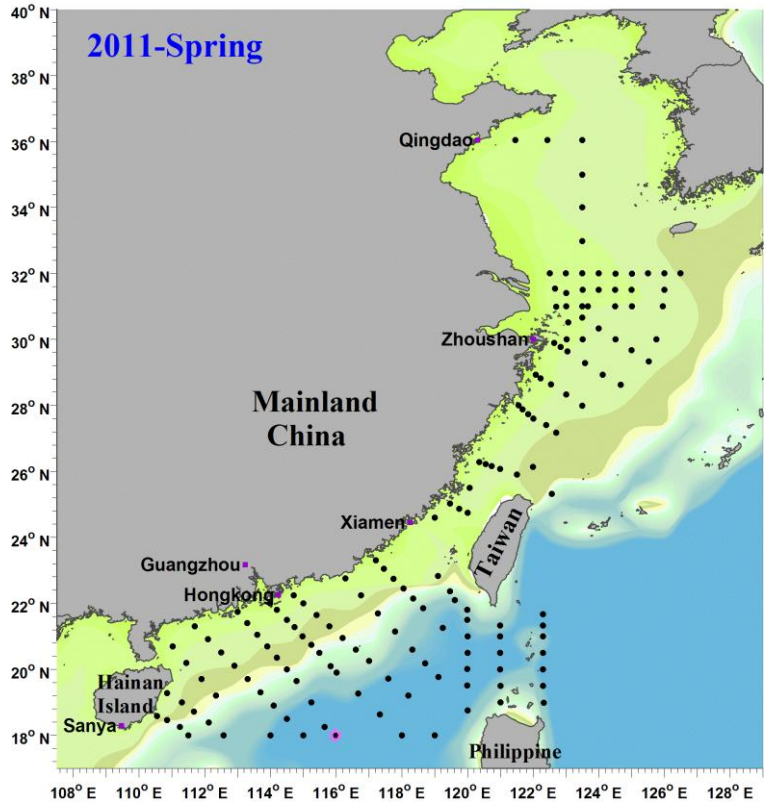


Fig. 4 Map of the China Seas showing the sampling stations in the CHOICE-C spring cruise in 2011

2.1.2 Yellow Sea-East China Sea Cruise: Researchers from Ocean University of China conducted two 3-weeks cruise experiments over Yellow Sea and East China Sea onboard R/V Dongfanghong II, during Mar.17-Apr.10 and Oct. 16-Nov.6, 2011. Fig.5 shows the cruise track during two cruise experiments.

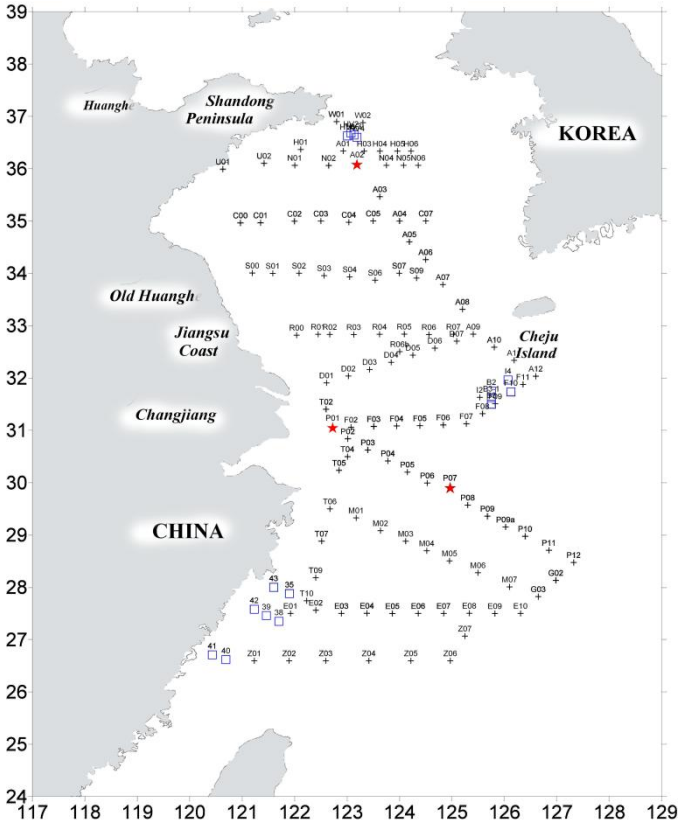


Fig 5. Sampling stations in the two Yellow Sea –East China Sea Cruise in 2011

2.1.3 Field observation on Qianliyan Island (within the Yellow Sea): During Apr. 23-May 7, 2011, Ocean University of China conducted 2-weeks field observation on Qianliyan Island which is 64 km away from the inland of Shandong Peninsula. Fig.6 shows the location of sampling instruments.

Fig.6 Location of sampling instruments

2.2 Workshops

(1) A Joint International Workshop of OCCOS and CHOICE-C, Apr.3-4, 2011, Xiamen, China.

(2) The 2nd CHOICE-C Scientific Advisory Committee Meeting, Apr.5-6, 2011, Xiamen, China.

(3) Ocean Science Session, Carbon cycle study in Pacific / Indian Oceans and their marginal seas, 8th Asia Oceania Geosciences Society (AOGS) Annual Meeting, Aug. 9-12, 2011, Taiwan (Co-Chaired by Tsuneo Ono*, C.T. Arthur Chen and Minhan Dai).

(4) International Symposium on Carbon Cycling in China Seas and CHOICE-C (973Project) 2011 Annual meeting, Dec.9-11, 2011, Hong Kong, China.

(5) Joint 6th Workshop on Asian Dust and Ocean EcoSystem (ADOES) with Asian SOLAS, Oct. 5-9, 2011, Qingdao, China.

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

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

(1) Cao, Z.M. and M.H. Dai, 2011. Shallow-depth $CaCO_3$ dissolution: evidence from excess calcium in the South China Sea and its export to the Pacific Ocean. ***Global Biogeochemical Cycles***, 25, GB2019, doi:10.1029/2009GB003690.

(2) Cao, Z.M., M.H. Dai, N. Zheng, D.L. Wang, Q. Li, F.F. Meng, and J.P. Gan, 2011. Dynamics of the carbonate system in a large continental shelf system under the influence of both a river plume and coastal upwelling. ***Journal of Geophysical Research-Biogeosceinces***, 116, G02010, doi:10.1029/2010JG001596.

(3) Wang, D.Z., H.P. Dong, Z.X. Xie, M.H. Dai, and H.S. Hong, 2011. Metaproteomic characterization of dissolved organic matter in the water column of the South China Sea. ***Limnology and Oceanography***, 56(5): 1641-1652.

(4) Xu, K., K. Gao, V.E. Villafane, and E.W. Helbling, 2011. Photosynthetic responses of Emiliania huxleyi to UV radiation and elevated temperature: roles of calcified coccoliths. ***Biogeosciences***, 8(6): 1441-1452.

(5) Yao, X.H. and L. Zhang, 2011. Sulfate formation in atmospheric ultrafine particles at Canadian inland and coastal rural environments, ***Journal of Geophysical Research***, 116, D10202, doi:10.1029/2010JD015315.

(6) Tan, S.C., G.Y. Shi, J.H. Shi, H.W. Gao, and X.H. Yao, 2011. Correlation of Asian dust with chlorophyll and primary productivity in the coastal seas of China during the period from 1998 to 2008, ***Journal of Geophysical Research***, 116, G02029, doi:10.1029/2010JG001456.

(7) Xue, L., L.J. Zhang, W.J. Cai, and L.Q. Jiang, 2011. Air–sea CO_2 fluxes in the southern Yellow Sea: An examination of the continental shelf pump hypothesis, ***Continental Shelf Research***, 31(18): 1904-1914.

(8) Qi, J.H., H.W. Gao, L.M. Yu, and J.J. Qiao, 2011. Distribution of inorganic nitrogen-containing species in atmospheric particles from an island in the Yellow Sea, ***Atmospheric Research***,

101: 938-955.

(9) Yang, G.P., C.Y. Ren, X.L. Lu, C.Y. Liu, and H.B. Ding, 2011. Distribution, flux and photoproduction of carbon monoxide in the East China Sea and the Yellow Sea in spring. ***Journal of Geophysical Research***, 116, C02001, doi:10.1029/2010JC006300.

(10) Yang, J. and G.P. Yang, 2011. Distribution of dissolved and particulate dimethylsulfoxide in the East China Sea in winter. ***Marine Chemistry***, 127: 199-209.

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

(1) As the corresponding member of GEOTRACES, Dr. Minhan Dai hosted the 2012 GEOTRACES SSC Meeting and Date Management Meeting in Xiamen during Sept. 4-8, 2011.

(2) Representing SOLAS, Minhan Dai also participated in the PICES 2011 Annual Meeting during Oct. 14-23 in Khabarovsk, Russia.

(3) Porf. Huiwang Gao organized the IOC/WESTPAC Side Workshop on Asian Dust and its Impact on Ocean Ecosystem in the Western Pacific (WESTPAS-ADOES) in Busan, Republic of Korea on March 30, 2011. This workshop mainly focus on impacts of Asian dust on biogeochemistry and productivity in marine ecosystem and transport path of Asian dust and its deposition flux to the Western Pacific. Prof. Adina Paytan from University of California, Santa Cruz delivered an invited talk entitled as “Aerosol impacts on marine phytoplankton”. Prof. Xiaohong Yao from Ocean University of China gave an invited talk related to atmospheric chemistry in marine environment. And Prof. Jing Zhang from East China Normal University presented a study on nitrogen deposition from the Yellow and East China seas to NW Pacific Ocean.

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

(1) Submit the proposal of “Ocean primary productivity and its effect on climate change driven by atmospheric deposition” to the MOST (Ministry of Science and Technology, China).

(2) Organize the 7th Workshop on Asian Dust and Ocean EcoSystem (ADOES) during second half of 2012.

7. Other comments

SOLAS China (Taipei)

compiled by Gwo-Ching Gong

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)

The integrated project of Long-term Observation and Research of the East China Sea (LORECS) is a Taiwanese contribution to the international SOLAS. One of the major goal of LORECS related to SOLAS is to understand the effects of atmospheric forcing on marine biogeochemistry and ecosystem of the East China Sea. We found the events of Asian Dust Storm may not contribute much to the sequestration of atmospheric CO_2 in the oligotrophic subtropical northwest Pacific Ocean, although it may enhance biological production, promote the growth of *Synechococcus* and the export of particulate organic carbon (Chou et al., 2011; Chung et al., 2011).

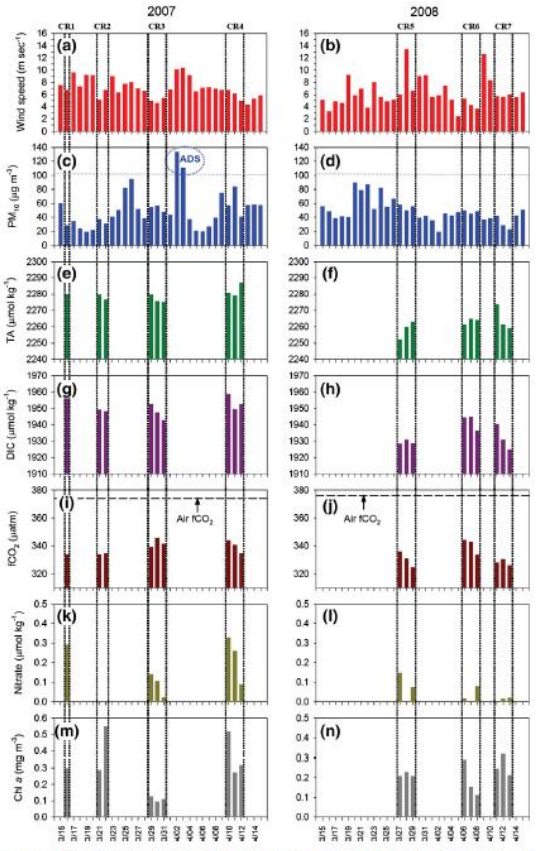


Fig. 2 Temporal variations of (a) and (b) daily wind speed, (c) and (d) daily concentration of aerosols (PM_{10}, averaged from hourly data); and (e) and (f) TA, (g) and (h) DIC, (i) and (j) fCO_2, (k) and (l) nitrate, and (m) and (n) Chl *a* for the surface waters (0 to 25 m) during the ADS season (between 15 March and 15 April) of 2007 (a, c, e, g, i, k and m) and 2008 (b, d, f, h, j, l and n). Asian dust storm (ADS) event is defined as when the concentrations of aerosols (PM_{10}) > 100 μg m^{-3}.

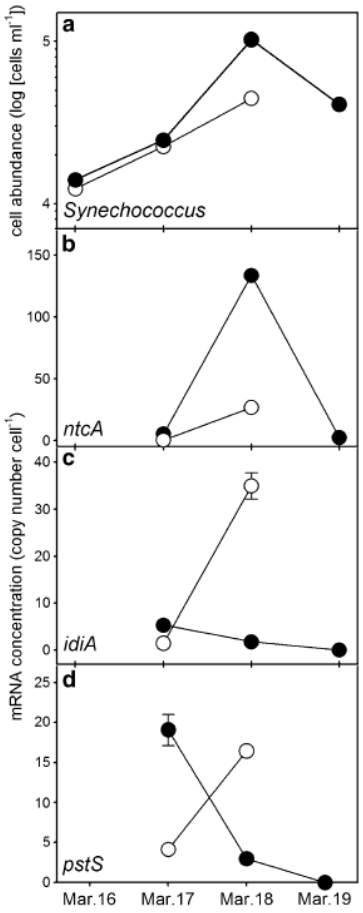


Fig. 5 Time courses of a *Synechococcus* abundances, and b *ntcA*, c *idiA*, and d *pstS* mRNA levels in surface and deep waters at the Asian dust storm (ADS) station during cruise 1 (March 16–19, 2006). The data points obtained from depths of 3 and 50 m are denoted by *solid* and *open circles*, respectively. *Error bars* in panels b, c, and d indicate standard errors (n = 3). For data points without an error bar, the error bar was smaller than the symbol

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

Ten cruises on board R/V Ocean Researcher I and II were conducted for the East China Sea in the year 2011 under LORECS project. A one-day workshop was organized by Director Gwo-Ching Gong in Keelung, Taiwan to present and discuss recent findings and the next phase of LORECS.

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

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

1. Chou, W.-C., G.-C. Gong, W.-J. Cai, D. D. Sheu, C.-C. Hung, H.-Y. Chen, C.-C. Chung (2011) CO_2 system in the oligotrophic northwest Pacific Ocean during the Asian dust storm season, ***Marine Chemistry***, 127, 210-222. ***(SCI)*** **(Oceanography, 6/59; IF=2.751)**
2. Chung, C.-C., J. Chang, G.-C. Gong, S.-C. Hsu, K.-P. Chiang and C.-W. Liao (2010) Effects of Asian dust storms on *Synechococcus* populations in the subtropical Kuroshio Current, ***Marine Biotechnology***, DOI 10.1007/s10126-010-9336-5. ***(SCI)*** **(Marine and Freshwater Biology; 11/93; IF=2.962)**
3. Gong, G.-C., K.-K. Liu, K.-P. Chiang, T.-M. Hsiung, J.-R. Chang, C.-C. Chen, C.-C. Hung, W.-C. Chou, C.-C. Chung, H.-Y. Chen, F.-K. Shiah, A.-Y. Tsai, C.-H. Hsieh, J.-C. Shiao, C.-M. Tseng, S. C. Hsu, H.-J. Lee, M.-A. Lee, I.-I. Lin, and F. Tsai (2011) Yangtze River Floods Enhance Coastal Ocean Phytoplankton Biomass and Potential Fish Production, ***Geophysical Research Letters***, 38, L13603, doi:10.1029/2011GL047519. ***(SCI)*** **(Geosciences Multidisciplinary; 12/167; IF=3.505)**
4. Cai, W.-J., X. Hu, W.-J Huang, M. C. Murrell, J. C. Lehrter, S. E. Lohrenz, W.-C. Chou, W. Zhai, J. T. Hollibauh, Y. Wang, P. Zhao, X. Guo, K. Gundersen M. Dai and **G.-C. Gong** (2011) Acidification of subsurface coastal waters enhanced by eutrophication, Nature Geoscience, doi:10.1038/NGEO1297. **(Geosciences Multidisciplinary; 1/167; IF=10.39)**
5. Tseng, C.-M., K.-K. Liu, G.-C. Gong, P.-Y. Shen and W.-J. Cai (2011) CO_2 uptake in East China Sea relying on Changjiang runoff is prone to change, ***Geophysical Research Letters***, 38, L24609, doi:10.1029/2011GL049774. ***(SCI)*** **(Geosciences Multidisciplinary; 12/167; IF=3.505)**
6. Hung, C.-C. and G.-C. Gong (2011) Biogeochemical responses in the southern East China Sea after Typhoon, ***Oceanography***. 24(4), 42-51. ***(SCI)*** **(Oceanography, 18/59; IF=1.891)**
7. Chou, W.-C., G.-C. Gong, C.-M. Tseng, D. D. Sheu, C.-C. Hung, L.-P. Chang and L.-W. Wang (2011) The carbonate system in the East China Sea in winter, ***Marine Chemistry***, 123, 44-55. ***(SCI)*** **(Oceanography; 6/59; IF=2.751)**

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

We have joined an international program, "A comparative study of natural and anthropogenic factors influencing two river dominated coastal ecosystem (Mississippi and Changjiang): A combined observation and modelling approach", leaded by T. S. Bianchi (TAMU).

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

The LORECS project will end in July 2012. For the next phase of LORECS, we will study the effects of global change (climate change and ocean acidification) on ocean biogeochemistry and ecosystem in the seas surrounding Taiwan in the northwest Pacific (ECOBEST). There are 20 subprojects in the proposal of ECOBEST and have submitted to National Science Council Taiwan in the end of 2011.

7. Other comments

SOLAS Denmark/Greenland

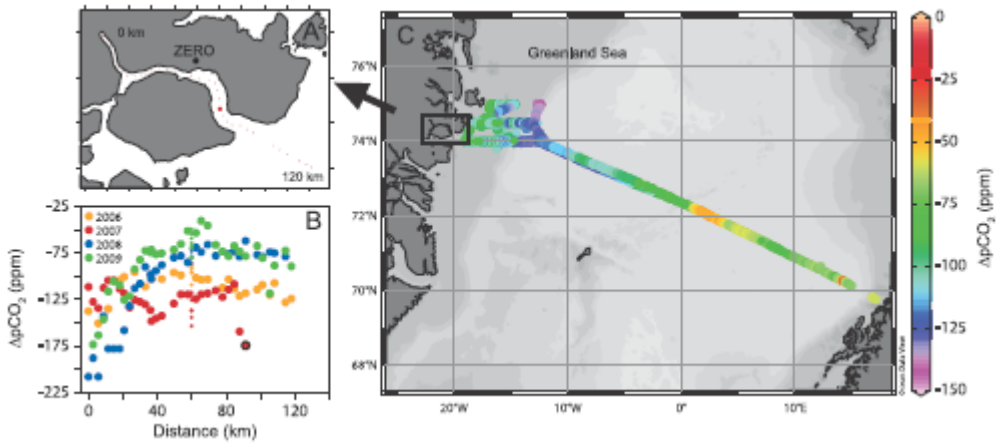
compiled by Lise Lotte Sørensen and Mikael Sejr

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)

Air-sea CO_2 fluxes in Arctic coastal areas

Annual air–sea exchange of CO_2 in Young Sound, NE Greenland was estimated using pCO_2 surface-water measurements during summer (2006–2009) and during an ice-covered winter 2008. All surface pCO_2 values were below atmospheric levels indicating an uptake of atmospheric CO_2. The observation that the surface water is under-saturated in pCO_2 in both summer and winter implies that Young Sound is a sink for atmospheric CO_2 on an annual scale. The average annual uptake of atmospheric CO2 was estimated at 2.7 mol CO_2 m^{-2} yr^{-1} or 32 g C m^{-2} yr^{-1} for the study area, which is lower than estimates from the Greenland Sea. However, large uncertainties are associated with the actual flux estimate, most notably related to the choice of gas exchange formulation, and neglecting gas exchange of CO_2 from melt water ponds and polynya areas outside the fjord may potentially underestimate the size of the CO_2 sink.



Formation and melting of sea ice also play a role, the size of which depends on the water masses affected by this annual carbon pump. Moreover, glacial melt-water has been shown to act as a sink of atmospheric CO_2 (Brown, 2002) but whether this process is of importance only locally near glaciers or contributes to lowering pCO_2 more widely in Young Sound or along the East Greenland coast is unknown. In any case, a warmer future climate is expected to increase the amounts of melt water, which would act to lower surface-water pCO_2 levels. As these main factors identified to cause low surface-water pCO_2 levels all respond to warming, it is highly likely that annual air–sea CO_2 exchange in Young Sound, and potentially the East Greenland coastal region, will change in response to global warming, which is expected to increase the open-water period from the present 3 months to 5 months by the end of the century (Rysgaard and Glud, 2007).

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

A new national project ECOCLIM to estimate CO_2 exchange between the atmosphere and the biosphere is initiated. The project has a key focus on air-sea CO_2 exchange in coastal regions. The project is coordinated from the Dep. of Environmental Science, Aarhus University.

Furthermore a new Nordic Centre of Excellence named DEFROST has started in 2011, and a WP

within this project focus on air-sea-ice exchange of CO_2. Activities in DEFROST is coupled to activities in the projects: “Air-sea-ice exchange of CO_2 in the Arctic coastal area”, which is a Nordic Council of Ministry funded project and “ECOCLIM”. As a part of these projects a measurement station for air-sea exchange of CO_2 is established in the Nuuk Basin, Greenland.

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

Two new Ph.D. students started projects related to the oceans uptake of CO2. One project focus on air-sea ice exchange of CO_2 in the Arctic and the other on determining whether Danish coastal water are a sink or source of atmospheric CO_2

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

Hilligsøe K M, Richardson K, Bendtsen J, Sørensen L L, Nielsen T G, Lyngsgaard M M, 2011, Linking phytoplankton community size composition with temperature, plankton food web structure and sea-air CO_2 flux, *Deep Sea Research Part I*. 58, 826-838, DOI:10.1016/j.dsr.2011.06.004

Sejr M K, Krause-Jensen D, Rysgaard S, Sørensen L L, Christensen B P, Glud R N, 2011, Air-sea flux of CO_2 in Arctic coastal waters influenced by glacial melt water and sea ice, *Tellus B.* 63B, 815-822, DOI: 10.1111/j.1600-0889.2011.00540.x

Rysgaard S, Bendtsen J, Delille B, Dieckmann G S, Glud R N, Kennedy H, Mortensen J, Papadimitriou S, Thomas D N, Tison J L, 2011, Sea ice contribution to the air-sea CO_2 exchange in the Arctic and Southern Oceans, *Tellus B*, 63, 823-830, DOI: 10.1111/j.1600-0889.2011.00571.x

Sørensen L L, Jensen B, Sejr M K, Larsen S E, Rysgaard S, 2011, Measurement and Parameterization of Air-Sea Ice exchange of CO_2, Abstract In: *The Arctic as a Messenger for Global Processes - Climate Change and Pollution.* Ed: Lillian Magelund Jensen ; Jesper Madsen. National Environmental Research Institute, Aarhus University, s. 40-41

Sejr M K, Rysgaard S, Sørensen L L, Juul-Pedersen T, 2011, Air-sea exchange of CO_2 in Greenland waters - current knowledge and future challenges, Abstract In: *The Arctic as a Messenger for Global Processes - Climate Change and Pollution.* Ed: Lillian Magelund Jensen ; Jesper Madsen. National Environmental Research Institute, Aarhus University, s. 50.

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 the NMR project; “CO2 fluxes in the coastal Arctic region”, the Nordic Centre of Excellence SVALI and a planned summer school:

http://ncoe-svali.org/xpdf/course_boundary.pdf .

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

An experiment to study the air-sea exchange of CO_2 over Arctic waters during ice formation and melting is planned to take place in Young Sound near Zackenberg, Greenland in March 2012.

A thorough study of the CO_2 air-sea exchange processes in costal regions and fjord areas will take place in spring and summer 2012 in Denmark.

An cruise is planned for May 2012 in Greenland which will focus on determining the effect of the biological pump for regulating surface pCO_2 in Greenland coastal waters.

An experiment in Northeast Greenland is planned for March 2012 to investigate the effect of exchange between the sea ice and the atmosphere on aerosol composition in the high Arctic. The experiment is a part of the Nordic Centre of excellence CRAICC and DEFROST and the Danish national project “Short Lived Climate Forcers”.

SOLAS France

compiled by Rémi Losno, Véronique Garçon and Cécile Guieu

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)

Two meetings for SOLAS in France

SOLAS-IGAC France joint meeting: "Chemistry, Transport and Biogeochemistry feedback: Frontiers in Chemistry, Physics and Biology" (29-30 June 2011, Paris)

Year 2011 was a SOLAS-IGAC joint meeting held in june (29th and 30th) in Paris (web site is: http://www.lisa.u-pec.fr/SOLAS/2011/). Why a joint SOLAS-IGAC meeting? IGAC (http://igac.jisao.washington.edu/) is an international action which can have a common interest with SOLAS: Atmosphere. IGAC is dedicated to studying the chemical composition of the atmosphere and its impact on climate and air quality. The research conducted in SOLAS extends from the physical transport of matter and energy in ocean, water and air, atmospheric chemistry and photochemistry at the interface of these two systems. SOLAS program covers the study of biogeochemical cycles in the ocean-atmosphere interface, which includes: Emissions and the processes of chemical transformation and deposition of gases and aerosols species, Characterization of exchange between the two reservoirs integrating layer processes in Oceanic and Atmospheric boundary, Study the flux of CO2 and other gases and their radiative link with climate. These themes feed directly on the issues of atmospheric chemistry community in terms of stress sources and sinks of reactive species to short or long life. Improved parameterizations of emissions and deposition of halogenated species, sulfur and nitrogen and aerosols (DMS, marine aerosols, ...) is such a major challenge for both communities to an understanding of the coupled climate pollution in the Earth system. The attendance of the meeting was between 30 and 50 people during the 7 sessions and the guest lecture was given by Alex Baker: "Climatological estimates of atmospheric nutrient deposition to the Atlantic Ocean - problems and potential". Abstract, extended abstracts and some full text presentations are available on SOLAS-France web pages.

International EUR-OCEANS Conference "Ocean deoxygenation and implications for the marine biogeochemical cycles and ecosystems" (24-26 October 2011, Toulouse):

The International EUR-OCEANS Conference "Ocean deoxygenation and implications for the marine biogeochemical cycles and ecosystems" (24-26 October 2011, Toulouse, France) has been organized by the LEGOS (Véronique GARCON, Aurélien PAULMIER, Boris DEWITTE). This Gordon-like Conference (>90 scientists from 19 different countries) has been supported by EUR-OCEANS, IRD, CNRS-INSU, Académie des Sciences, LEGOS, OMP, the French Embassy in Washington DC (USA), IMBER and SOLAS. The conference brought together biological, biogeochemical and physical oceanographers to discuss the very relevant "hot" topic issue of deoxygenation in the world ocean and its implications for ocean productivity, nutrient cycling, carbon cycling, and marine habitats. In particular, OMZs are key regions in the climatic gases budgets. The conference (3 days) provided a science arena (plenary and posters sessions; round table) where to discuss the state of the art of our knowledge on all topics: description and control mechanisms of the deoxygenation and of the OMZ and hypoxia sites; deoxygenation impacts on the biogeochemical cycles, climatic gases, microbial activity and ecosystems; deoxygenation in the past ocean; inter-comparisons of OMZs systems; efforts towards new parameterizations for addressing regional and global modeling challenges. In perspective, the "ocean deoxygenation" community wishes to keep the ball rolling in maintaining tight

scientific exchanges (e.g. Special Issue, E-lecture), with the idea of international coordination (objective, approach) for observations (e.g. O_2), experiments (e.g. protocols) and modeling efforts (e.g. numerical tools) and inter-comparisons of the major OMZs systems. More details about the conference can be found at: http://www.eur-oceans.eu/conf-oxygen. An e-Lectures series from the American Limnology and Oceanography is underway on the deoxygenation topic.

Research orientation and SOLAS lobbying

- Two sessions were held at the ASLO Puerto Rico Aquatic Sciences Meeting ("Limnology and Oceanography in a changing world") during the week of 13-18 February 2011: (1) Session S28 on "*Biogeochemical, Ecological and Physical Dynamics of Eastern Boundary Upwelling Systems*" with Carol Robinson and Véronique Garçon as chairmen. (2) Session S49, entitled '*Atmospheric Control of Nutrient Cycling and Production in the Surface Ocean*' was convened by Cecile Guieu, Doug Wallace, Cliff Law and chaired by Cécile Guieu and Julie La Roche. This session was directly related to the Mid Term Strategy initiative and its objective was to discuss new results on key aspects such as the bioavailability of atmospheric inorganic and organic nutrients, impact on marine community structure, future variation of atmospheric nutrient deposition and its impact on carbon and nitrogen fixation at different time scales. The session consisted of 13 oral presentations and was indeed the occasion to learn from recent research from field work to modeling approaches. (more details in SOLAS Special Reports, Issue 11, SOLAS News, 2011).

- Following up the last SOLAS OSC Conference in Barcelona and the COST Action 735 meeting in Toulouse in March 2010, an ESA call entitled Support to Science Element OceanFlux (ESRIN/AO/1- 6668/11/I-AM) on SOLAS Science was launched early this year. Among the 3 themes selected by ESA, Theme 3 was on upwelling. A proposal on this theme was submitted early April and approved in fall with a KickOff starting date as of November 1st, 2011 with the following PIs and co-PIs: Christoph Garbe, Véronique Garçon, André Butz, Boris Dewitte, Aurélien Paulmier, Joël Sudre, Isabelle Dadou and Hussein Yahia.

- A EUR-OCEANS Flagship on Ocean deoxygenation in Eastern Boundary Upwelling Systems has been awarded to IFM-GEOMAR, Kiel, Germany, LEGOS CNRS and IRD, Toulouse and LOCEAN, Paris, France; with IMARPE, IGP, Lima, Peru as co-partners. A two year post-doctorate, between Toulouse, Lima and Kiel, has been recruited and has started on 1 September 2011.

- 5th International Summer School, 29 August-10 September 2011 in Cargese, France (see http://www.solas-int.org/summerschool/), Director : Véronique Garçon

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

Here is a list of talks given at the SOLAS-IGAC joint meeting. All details, abstracts and some presentations are on the web site (http://www.lisa.u-pec.fr/SOLAS/2011/).

Speaker	**Title**
Emilie Journet	A new mineralogical database for atmospheric dust to estimate soluble iron fluxes to surface ocean.
Cécile Guieu	Atmospheric deposition onto oligotrophic marine systems: new insights from mesocosm studies
Alexie Heimburger	Dust deposition over South Ocean measured at Crozet an Kerguelen Island
Rémi Losno	Mercury total deposition at Kerguelen Island

Véronique Garçon	Climatically-active gases in the Eastern Boundary Upwelling and Oxygen Minimum Zone (OMZ) systems
Anna Lourantou	Variability of CO_2 fluxes in the NE part of the Kerguelen Plateau (Indian sector of the Southern Ocean) at a seasonal to decadal scale
Joelle Tassel	Presentation of SHOM
Aurélie Colomb	Impact on OCEANIC Frontal ZONES on atmospheric TRACE GASES composition
Sophie Tran	Influences of biology and water masses on the variability of the marine source of CO and NMHC in the Arctic Ocean in summer 2010.
Raluca Ciuranu	Heterogeneous reactivity of atomic chlorine with aerosol particles of atmospheric interest in the marine boundary layer
Barbara Nozière	Biosurfactants on aerosols: a link between biogenic activity and cloud formation?
Karine Sellegri	Sources of marine aerosol from the Mediterranean sea as a function of the sea water biochemical composition and photochemical conditions: the SAM project
Marc Mallet	Impact of sea-surface aerosol radiative forcing on the oceanic primary production
Elvira Pulido	Dust pulses enhance bacterial mineralization of dissolved organic matter in P-depleted waters : results from mesocosm experiments in the Mediterranean Sea (DUNE project)
Thibaud Wagener	Temporal Changes in trace metal concentrations during an artificial dust deposition to Large Mesocosms (DUNE-2 Experiment)
Virginie Racapé	Anthropogenic carbon changes in the North Atlantic Subpolar Gyre: what do we learn from $\delta^{13}C$?
Nathalie Lefèvre	The role of the salinity on the CO_2 variability in the western tropical Atlantic
Jacqueline Bouti	High frequency variability observed by CARIOCA drifters in Winter - A starting point for future studies
Lil iane Merliv t	Biological net community production (NCP)of carbon and oxygen based on high frequency measurements of fCO2 and O2 on a Pirata mooring in the tropical Atlantic

Many research projects relevant to SOLAS science are running in 2011:

AMOP project: "Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific"

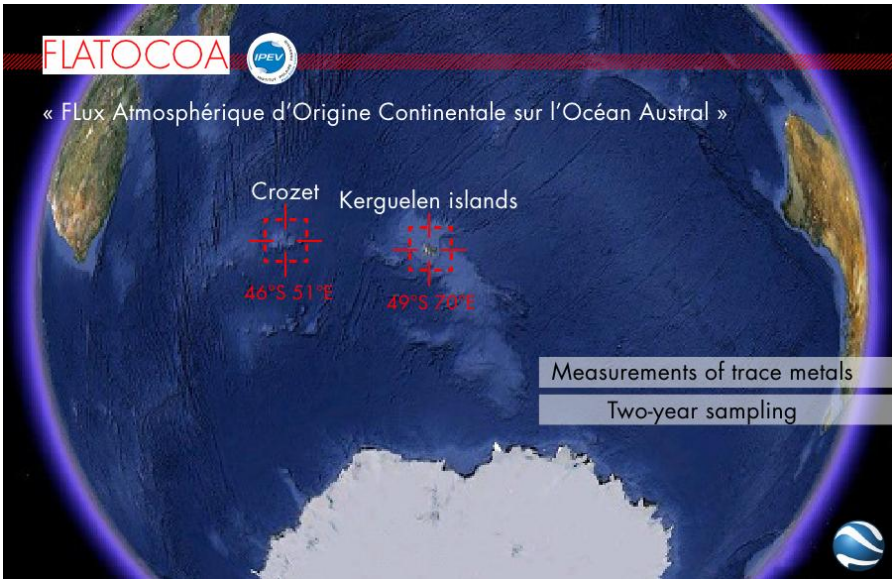
The AMOP project "Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific (Peru)" aims to carry out a complete O_2 budget taking into account physical (advection/diffusion) and biological (O_2 consumption/production through bacteria, phytoplankton and zooplankton) contributions. The transdisciplinary approach is based on: i) a 30-day cruise with two ships in simultaneous (L'Atalante from IFREMER and the Olaya from IMARPE), associated with gliders and Argo floats experiments; ii) a mooring (> 3-yr) coupling water column and sediments; iii) a modeling platform in order to assist the interpretation of our full data set (from *in vitro* to *in situ* and satellite observations) at different spatio-temporal scales. AMOP, led by the LEGOS (PI: A. PAULMIER), involves 13 research units in France, 2 Institutes (7 units) in Peru and 6 other countries acting as an international consortium (90 participants). Presently, the AMOP project is approved and labelled by LEFE-CYBER and LEFE-GMMC (INSU), considered as a priority for Fleet (CNFH) and Glider commissions, and submitted to the ANR (01/2012). Contact: Aurélien Paulmier, LEGOS, Toulouse.

MedSeA: Mediterranean Sea Acidification under changing climate

The European Mediterranean Sea Acidification in a changing climate (MedSeA) initiative is a project

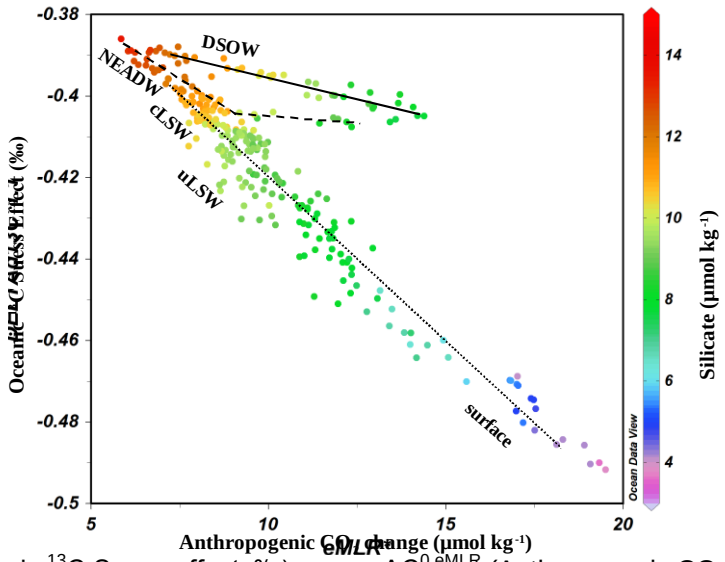
funded by the European Commission under Framework Program 7 (http://medsea-project.eu/). It involves 16 institutions from 10 countries. MedSeA assesses uncertainties, risks and thresholds related to Mediterranean acidification at organismal, ecosystem and economical scales. It also emphasizes conveying the acquired scientific knowledge to a wider audience of reference users, while suggesting policy measures for adaptation and mitigation that will vary from one region to another.
MedSeA project objectives: i) identify where the impacts of acidification on Mediterranean waters will be more significanttaking into account the sequence of causes and effects, from ocean chemistry through marine biology to socio- economic costs, ii) generate new observational and experimental data on Mediterranean organism andecosystem responses to acidification and fed into existing fine-scale models of the Mediterranean Sea that are modified to better represent key processes, and then used to project future changes. The MedSeA focuses on a selected set of key ecosystem and socio-economic variables that are likely to be affected by both acidification and warming, studying the combination of both effects through ship-based observations, laboratory and mesocosm experiments, physical-biogeochemical-ecosystem modeling, and economical analyses, and iii) provide best estimates and related uncertainties of future changes in Mediterranean Sea pH, $CaCO_3$ saturation states, and other biogeochemical-ecosystem variables, assessing the changes in habitat suitability of relevant ecological and economically-important species.

FLATOCOA: Atmospheric flux of continental origin over the Southern Ocean
The endorsed FLATOCOA project ends its experimental milestone on the deposition fields at Kerguelen and Crozet (South Indian ocean, ~50°S). Numerous elemental analyses were made to calculate and validate deposition data of trace metals, especially micronutrients as Fe, Co, Zn, …. First results show deposition flux do not vary significantly from Crozet to Kerguelen but may exhibit seasonal variability. Average deposition flux over South Indian Southern Ocean is 500 nmol/m²/day of iron, well predicted by models but much larger than those calculated from dry aerosol concentration. The major deposited flux is wet deposition (>90%) and the dry aerosol remaining near ground or sea level is not representative of the scavenged aerosol flying at higher altitude.
Next step of the program is to collect aerosols at source regions to measure its chemical properties and especially solubility. A sampling station was set up at Rio Gallegos (Argentina, 51°S 69°W) to collect new emitted aerosol from Patagonia. Contact: Rémi Losno, LISA, Paris.



Total deposition measurement sites for FLATOCOA program.

OCEANS^{13}C: observe and model · 13C variability in the oceans.
This program, funded by LEFE/CYBER (CNRS/INSU) will synthetize and analyze all ^{13}C data of DIC in the global ocean to provide additional constraints in studies dealing with the oceanic carbon cycle variability and its anthropic component. Web pages are: http://www.locean-ipsl.upmc.fr/OCEANS13C/



$\Delta\delta^{13}C_{DIC}^{eMLR}$ (Oceanic ^{13}C Suess effect, ‰) versus $\Delta C^{0\ eMLR}$ (Anthropogenic CO_2 change calculated from extented MultiLinear Regression, µmol kg^{-1}) and the silicate concentration (µmol kg^{-1}) in the Irminger Basin. The black line symbolize the Denmark Strait Overflow Water (DSOW), the black dashed line show the North East Atlantic Deep Water (NEADW) and the black dotted line point out the classical Labrador Sea Water (cLSW), the upper LSW and the surface. Figure extracted from Racapé et al. 2011. Anthropogenic carbon changes in the Irminger Basin: What do we learn from δ13CDIC. Journal of Marine System, GEOTRACE special issue. In review

MaCloud (Marine Aerosol Cloud Interactions): aims to build on recent advances in marine aerosol formation processes. In addition to coastal iodine-driven nucleation and growth events, it has been recently established that open ocean particle production and growth is quite frequent over the NE Atlantic and appears to be driven by organics. This project aims to better characterize these coastal and open ocean events. Further, aerosol mass spectrometry has revealed unique marine aerosol organic characteristics with effective cloud nucleating properties despite low growth factors. The project aims to characterize the growth factor and CCN activity of varying enrichments of sea-spray aerosol. Particularly, LaMP has contributed to a better quantification of hygroscopic and CCN properties of marine aerosols by using a novel VT-CCN instrument. The VT-CCN instrument was used to infer the ability of marine particles to form cloud droplets, with a focus on their volatile organic fraction during an intensive field campaign at Mace Head, Ireland, in May 2011. During the campaign, open ocean nucleation events and primary organic formation events occurred regularly. The measured marine aerosol hygroscopicity parameter "kappa" was relatively high: average values between 0.5 and 0.7 were defined, depending on the method of analysis and the particle size. The more volatile fraction of the aerosol is typically less CCN-active and tends to hinders aerosol CCN-activation. The dependence of this property on the origin of the organics emitted from the ocean surface (primary during bubble bursting processes or secondary during nucleation) is still to be determined.
Contact: K. Sellegri, (LaMP)
Coll. : C. O'Dowd (NUYG, Irland, G. Mc Figgans, UMIST, UK, T. Petaja¨, Univ. Helsinki; J. Smith, U. Boulder)

New projects are rising:

Marine Ecosystems Response in the Mediterranean Experiment (MERMEX).

MERMEX is dedicated to study the response of Mediterreanean ecosystems and biodiversity to climate changes and anthropogenic pressure. MERMEX aims to deepen the current understanding of the Mediterranean marine ecosystems to better anticipate their upcoming evolution. It will focus on the response of ecosystems to modifications of physico-chemical forcing at various scales, both in time and space, linked to changing environmental conditions and increasing human pressure. It proposes a comprehensive, integrated approach considering the continuum between the coastal

zone and the open sea and its interfaces, including ocean-continent, ocean-atmosphere and water-sediment to precisely describe and model the current state of the Mediterranean ecosystems and the complex interactions existing between the environmental and human factors. MERMeX White Book was published in 2011 in Progress in Oceanography – 95 authors, 130 pages, 630 references.

The MERMEX group, 2011, Marine Ecosystems Responses to climatic and anthropogenic forcing in the Mediterranean, Progress In Oceanography, Volume 91, Issue 2, October 2011, Pages 97-166

The project is divided into several thematic approaches that were grouped into five work packages (WP): 1- Impact of hydrodynamic changes on Mediterranean biogeochemical budgets (WP1), 2-Ecological processes; biogeochemistry and food web interactions (WP2), 3-Land-ocean interactions including extreme events (WP3), 4-Natural and anthropogenic air-sea interactions (WP4), 5-Ecosystem based management (WP5). Each WP is led by 2-3 coordinators and includes several actions that should be funded through different funding agencies [MISTRALS,ANR, FRB, UE...]. In 2011 MERMEX was endorsed by SOLAS as mainly 2 WPs are directly relevant to SOLAS thematics (WP4 and WP2). Among other actions, in 2011, the MERMEX group has been working on setting up a special observation period (SOP) representing an unprecedented intensive effort in the observation in the NWM. This project is currently submitted for fundings. More details on activities in 2011 can be found in the special report (see SOLAS endorsed projects).

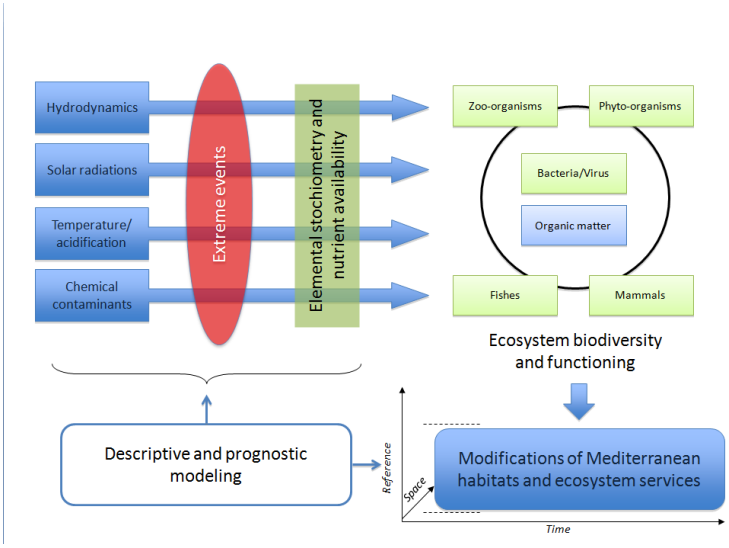


Figure 1. Schematic of the key forcing variables influencing the marine ecosystems' diversity and functioning, and use of modeling as an integrative tool at the intersection of the different objects considered in MERMEX. From MERMEX Group, 2011.

As part of the MISTRALS (Mediterranean Integrated STudies at Regional And Local Scales) French program (www.mistrals-home.org), MERMEX was presented during the International MISTRALS Workshop –Malta 30 March to 1st April 2011-, which brought together nearly 200 participants -by invitation- involved in the Mediterranean question, projects holders and potential developers, scientists and policy makers. Web site MERMEX: http://mermex.com.univ-mrs.fr/.

VAHINE which will study the fate of newly fixed N by *Trichodesmium* in the pelagic food web in the South West Pacific.

Former SOLAS projects are in their synthesis phase of data interpretation:

Saharan dust : more than a simple fertilizer for the clear waters of the Mediterranean Sea

In the frame of the DUNE project, two original methods (1- reproducing a real atmospheric deposition event necessary for the controlled seeding in seawater and 2-conception of seeding experiments in large clean mesocosms) have been developed, validated and published and can be used in the frame of other projects (for example, the DUNE mesocosms are going to be used in the frame of the MedSea European project on Mediterranean acidification; other projects related to marine biogeochemisty at the atmosphere-ocean interface based on that tool are currently being submitted).

Main results: Chemical and biological changes, along with modification of the dynamic of particles following a dust event have been followed and the multidisciplinary results obtained are bringing new insights regarding the role of atmospheric deposition on oligotrophic ecosystem and carbon export. Among those results, we have shown that the cycles of elements of biogeochemical interest (nutrients, metals) are modified by the atmospheric deposition; that new nutrients introduced are uptake by biota very rapidly; that there is a competition for the new nutrients and that this competition is in favor for heterotrophic bacteria; that among phytoplankton, diazotrophs – although only responsible for few percent of the induced new production - are well stimulated by atmospheric input; that particulate carbon export is in part due to aggregation processes between organic matter and lithogenic particles. All those results indicate that the role of atmospheric deposition on oligotrophic area cannot be seen only like a simple fertilization effect but, induce also a significant export of particulate organic carbon to the deep ocean, through aggregation processes.

Scientific outputs. The DUNE project was officially ending recently (July 2011) and a large number of papers in international journals are already published, others are in preparation and the group decided during a meeting in october 2011 to write a Special Issue devoted to the DUNE project. A series of 14 papers was proposed. In 2011, several oral presentations specific to the DUNE project were done during the ASLO conference in Puerto Rico in Feb. 2011, during the SOLAS-IGAC France joint open meeting in Paris in June 2011 (see details in DUNE web site).

Web site of the project: http://www.obs-vlfr.fr/LOV/DUNE/

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

A short movie made by Alexie Heimburger and Fanny Mazoyer entitled "Qui sème la poussière récolte le phytoplancton", was awarded and available here for downloading or visualization: http://www.science.gouv.fr/fr/telesciences/bdd/res/4336/qui-seme-la-poussiere-recolte-le-phytoplancton/

This movie outreachs a large public to the methods in use to collect and analyze dust in remote oceanic areas.

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

Alderkamp, A-C., Garçon, V., de Baar H.J.W., and Arrigo, K., 2011, Short-term photoacclimation effects on photoinhibition of phytoplankton in the Drake Passage (Southern Ocean), Deep Sea Research Part I, 9, 58, 943-955, doi:10.1016/j.dsr.2011.07.001.

Bressac M., C. Guieu , D. Doxaran, F. Bourrin, G. Obolensky and JM Grisoni, 2011, A mesocosm experiment coupled with optical measurements to observe the fate and sinking of atmospheric particles in clear oligotrophic waters, Geo-Marine Letters , DOI 10.1007/s00367-011-0269-4.

Raluca Ciuraru, Sylvie Gosselin, Nicolas Visez and Denis Petitprez, Heterogeneous reactivity of chlorine atoms with sodium chloride and synthetic sea salt particles, Phys. Chem. Chem. Phys., 2011, 13, 19460–19470.

Fahrbach , E., H.J.W. de Baar , V.C. Garçon and C. Provost, 2011, Introduction to physics, carbon dioxide, trace elements and isotopes in the Southern Ocean: The Polarstern expeditions ANT-XXIV/3 (2008) and ANT-XXIII/3 (2006), Deep Sea Research Part II, 58, 25 – 26, 2501-2509, doi:10.1016/j.dsr2.2011.07.008.

Gattuso J.-P., Bijma J., Gehlen M., Riebesell U. & Turley C., 2011. Ocean acidification: knowns, unknowns and perspectives. In: Gattuso J.-P. & Hansson L. (Eds.), Ocean acidification, pp. 291-311. Oxford: Oxford University Press.

Gattuso J.-P. & Hansson L., 2011. Ocean acidification: history and background. In: Gattuso J.-P. & Hansson L. (Eds.), Ocean acidification, pp. 1-20. Oxford: Oxford University Press.

Jonca, J., V. Leon-Fernandez, D. Thouron, A. Paulmier, M. Graco, and V. Garçon, 2011, Phosphate determination in seawater: Toward an autonomous electrochemical method, Talanta, 87, 161-167, doi:10.1016/J.talanta.2011.09.056.

Laghdass M., S. Blain, M. Besseling, P. Catala, C. Guieu, I. Obernosterer, 2011, Impact of Saharan dust deposition on the bacterial diversity and activity in the NW Mediterranean Sea. Aquatic Microbial Ecology, vol 62: 201-213, 2011.

Lourantou, A., and N. Metzl (2011), Decadal evolution of carbon sink within a strong bloom area in the subantarctic zone, Geophys. Res. Lett.,38, L23608, doi:10.1029/2011GL049614

Monteiro, P.M.S., Dewitte, B., Scranton, M.I., Paulmier, A., van der Plas, A.,2011, The role of open ocean boundary forcing on seasonal to decadal-scale variability and long-term change of natural shelf hypoxia,Environmental Research Letters, 2011, 6, 18pp, doi:10.1088/1748-9326/6/2/025002.
Paulmier, A., Ruiz−Pino, D. and Garçon, V., 2011, CO_2 maximum in the oxygen minimum zone (OMZ), Biogeosciences, 8, pp.239-252, doi:10.5194/bg-8-239-2011
Raimund, S., Quack, B., Bozec, Y., Vernet, M., Rossi, V., Garçon, V., Morel, Y., and Morin, P., 2011, Sources of short-lived bromocarbons in the Iberian upwelling, Biogeosciences, 8, 1551-1564, doi:10.5194/bg-8-1551-2011.
Ridame, C., Le Moal, M., Guieu, C., Ternon, E., Biegala, I., L'Helguen, S. and Pujo-Pay, M., 2011, Nutrient control of N_2 fixation in the oligotrophic Mediterranean Sea and the impact of Saharan dust events,Biogeosciences, 8, 2773–2783, 2011
Smith S. V. & Gattuso J.-P., 2011. Balancing the oceanic calcium carbonate cycle: consequences of variable water column Ψ. Aquatic Geochemistry 17:327-337.
Ternon E. C. Guieu, C. Ridame, L'Helguen, S, Catala, P., 2011, Longitudinal variability of the biogeochemical role of Mediterranean aerosols in the Mediterranean Sea, Biogeosciences, 8, 1067–1080, 2011
The MERMEX group, 2011, Marine Ecosystems Responses to climatic and anthropogenic forcings in the Mediterranean, Progress In Oceanography, Volume 91, Issue 2, October 2011, Pages 97-166
Ye Y., Wagener T., Volker C., Guieu C., Dieter A. Wolf-Gladrow D.A., 2011, Dust deposition: iron source or sink? A case study, Biogeosciences, 8, 2107–2124, 2011
Zeebe R. E. & Gattuso J.-P., 2011. Chemistry of the seawater carbonate system. In: Gattuso J.-P. & Hansson L. (Eds.), Ocean acidification, pp. 2-3. Oxford: Oxford University Press.

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

Joint experiment in 2012:

In order to assess the Mediterranean pelagic ecosystem's response to ocean acidification, the Laboratoire d'Océanographie de Villefranche (LOV, UPMC; http://www.obs-vlfr.fr/LOV/) will organize two *in situ* large pelagic mesocosm joint experiments. A first experiment will be conducted in June/July 2012 in Corsica (Stareso station; http://www.stareso.com/; Bay of Calvi). Nine in situ mesocosms (54 m3) will be deployed: i.e. 3 controls and 6 high pCO_2 levels (450, 550, 650, 750, 1000, 1250 µatm), for a period of 1 month. The acidification of the mesocosms will be achieved by addition of various amounts of CO_2 saturated seawater using a diffusing system designed and constructed at LOV. A nutrient (N, P and Si) enrichment will be performed approximately at the middle of the experiment in order to stimulate the production of the community. The nine mesocosms will be sampled on a regular basis using several integrating water samplers. A total of 25 persons, originating from 6 different European countries (Spain, Greece, Italy, UK, Belgium and France) will be involved in the Corsica experiment. An important list of parameters and processes among which primary production, community respiration, bacterial production, calcification, nitrogen fixation etc... will be measured on a regular basis. Contacts: Amélie Sallon (salon@obs-vlfr.fr), Cécile Guieu (guieu@obs-vlfr.fr) and/or Frédéric Gazeau (f.gazeau@obs-vlfr.fr). Web site of the project: http://medsea-project.eu/

South Hemisphere

Dust cycle is only poorly known in the South Hemisphere, and particularly in the Austral sub-antarctic region. East Patagonia seems to be a major source of dust. Sampling and measurements, including chemical properties, of dust will be performed in Patagonia. Aerosol Lidar measurements will contribute to better know the vertical distribution of aerosol from the Patagonian emission areas.

Upwelling off Peru : AMOP Experiment

A 30-day cruise is planned in December 2012 or early 2013 with two ships in simultaneous (R/V L'Atalante from IFREMER and R/V the Olaya from IMARPE), associated with gliders and Argo floats experiments. A mooring deployment (> 3 yr) will also be performed which will allow to couple water column processes with the sediments. (Contact : aurelien.paulmier@legos.obs-mip.fr)

7. Other comments

Acknowledgements: University Paris7 Denis Diderot and CNRS/INSU to support the join SOLAS-IGAC meeting in june 2011.

SOLAS Germany

compiled by Hermann W. Bange (GEOMAR | Helmholtz-Zentrum für Ozeanforschung Kiel)

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)

Iodine containing species in the remote marine boundary layer: A link to oceanic phytoplankton

Lai, C. S., J. Williams, S. R. Arnold, E. L. Atlas, S. Gebhart, and T. Hoffmann (2011), *Geophysical Research Letters*, *38*, L20801, doi:10.1029/2011GL049035.

Iodine containing species have been measured in the particle phase (PM2.5) and the gas phase during a ship campaign between January and February 2007 in the South Atlantic marine boundary layer (MBL). Methyl iodide (CH3I) in the gas phase and soluble iodine species, i.e. iodide, iodate and an unidentified organic iodine species (UOI), in PM2.5 were measured. Temporal variations of gaseous and particulate iodine species were investigated. The exposure of the sampled air masses to phytoplanktonalong the back-trajectories was studied using a lagrangian transport model and satellite observations of oceanic chlorophyll-a concentration. Significant correlations were found between the concentrations of iodine species and the average chlorophyll exposure along back-trajectories, indicating an emission from phytoplankton in the open ocean. Good correlations were found when the ship approached or crossed the active biological region in the West-southern Atlantic. These results strongly suggest a connection between iodine species and the phytoplankton in the ocean. This study was extended to examine the relation of the iodine measurements to satellite derived phytoplankton distributions. We show that specific phytoplankton species may have impact on different iodine containing species.

The effect of surface films on the air-sea gas exchange in the Baltic Sea

Schmidt, R., and B. Schneider (2011), *Marine Chemistry*, *126*, 56-62.

Gas exchange experiments were performed with water from a coastal station in the southwestern Baltic Sea in order to investigate the effect of organic films on the gas transfer velocity. Samples were taken on a weekly basis during January to July in 2007 and 2008. Using a 1.5 L glass vessel, the evasion of oxygen from the sample into an O_2-free headspace was recorded with an O_2 optode. The transfer velocities were calculated and related to the surface film coverage that was characterized by the reduction of the surface tension with respect to a surfactant-free water sample (Δσ). For the determination of Δσ, surface tension measurements of organicfree water samples were performed and an equation was derived that describes σ as a function of temperature and salinity. The normalized transfer velocity (Schmidt number=660), k_{660}, decreased by 55%–65% at low film densities (Δσ<0.3 mN m^{-1}) and remained almost constant at this level despite increasing film coverage (Δσ up to 10 mN m^{-1}). These findings are qualitatively consistent with other studies which, however, report a less drastic film-induced decrease of k_{660}. The Δσ were low in January (0.1–0.2 mN m^{-1}) but increased during the development of the spring bloom. This implies a seasonality of the k_{660} which may have a strong effect on gas exchange calculations. It was shown that the annual net CO_2 uptake of the Baltic Sea decreases by a factor of two when a seasonal k_{660} amplitude of ±20% is included into the flux calculations.

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

* SOPRAN Annual Meeting 2011, Heidelberg, 22/23 March 2011.

* SOPRAN mesocosm CO_2 enrichment study in Bergen (Norway), April/May 2011, PI Ulf Riebesell (IFM-GEOMAR, Kiel)

* SOPRAN cruise R/V Merian MSM 18/3 to the equatorial Atlantic Ocean, 22 June – 21 July 2011, PI Arne Körtzinger (IFM-GEOMAR, Kiel)

* SHIVA SONNE cruise with RV Sonne: Exchange of halocarbons between the ocean and the stratosphere, 14 – 30 Nov 2011, South China and Zulu Seas, PI: Brigit Quack (IFM-GEOMAR, Kiel)

* The Ocean Component (i.e. WP6) of InGOS is led by H. Bange (GEOMAR). InGOS (Integrated non-CO_2 greenhouse gas observing system, http://www.ingos-infrastructure.eu/) is an EU funded IA (Integrating Activities) project targeted at improving and extending the European observation capacity for non-CO_2 greenhouse gases. The project will run from October 2011 to September 2015. InGOS is coordinated by ECN (The Netherlands) and involves 34 partners from 15 countries.

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

Several newspaper articles, TV features, etc. about SOPRAN activities (such as the mesocosm experiment in Bergen) have been produced.

Brochures which have been produced under leadership of SOPRAN scientists:

* Ocean Fertilization- A scientific summary for policy makers, D. Wallace et al, 18 pp., IOC/UNESCO, Paris, 2011.
* Foschungsstandort Kap Verde, A. Körtzinger et al., 32pp., GEOMAR, Kiel, 2011.

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

Bahlmann, E., I. Weinberg, R. Seifert, C. Tubbesing, and W. Michaelis (2011), A high volume sampling system for isotope determination of volatile halocarbons and hydrocarbons, *Atmos. Meas. Tech.*, *4*, 2037-2086.

Dammshäuser, A., T. Wagener, and P. L. Croot (2011), Surface water dissolved aluminium and titanium: Tracers for specific time scales of dust deposition to the Atlantic?, *Geophysical Research Letters*, *38*(24), L24601, doi: 10.1029/2011GL049847.

Heller, M. I., and P. L. Croot (2011), Superoxide decay as a probe for speciation changes during dust dissolution in tropical Atlantic surface waters near Cape Verde, *Marine Chemistry*, *126*, 37-55.

Lai, C. S., J. Williams, S. R. Arnold, E. L. Atlas, S. Gebhart, and T. Hoffmann (2011), Iodine containing species in the remote marine boundary layer: A link to oceanic phytoplankton, *Geophysical Research Letters*, *38*, L20801, doi:10.1029/2011GL049035.

Laß, K., and G. E. Friedrichs (2011), Revealing structural properties of the marine nanolayer from vibrational sum frequency generation spectra, *Journal of Geophysical Research*, *116*, C08042; doi:10.1029/2010JC006609.

Richter, K., and B. Jähne (2011), A laboratory study of the Schmidt number dependency of air-water gas transfer, in *Gas Transfer at Water Surfaces 2010*, edited by S. Komori, W. McGillis and R. Kurose, pp. 322-332.

Schimpf, U., L. Nagel, and B. Jähne (2011), First results of the 2009 SOPRAN active thermography pilot experiment in the Baltic Sea, in *Gas Transfer at Water Surfaces 2010*, edited by S. Komori, W. McGillis and R. Kurose, pp. 358-367.

Schmidt, R., and B. Schneider (2011), The effect of surface films on the air-sea gas exchange in the Baltic Sea, *Marine Chemistry*, *126*, 56-62.

Tagliabue, A., and C. Völker (2011), Towards accounting for dissolved iron speciation in global ocean models, *Biogeosciences*, *8*, 3025-3039.

Ye, Y., T. Wagener, C. Völker, C. Guieu, and D. A. Wolf-Gladrow (2011), Dust deposition: Iron source or sink? A case study, *Biogeosciences*, *8*, 2107-2124.

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 Mesocosm experiment at the Finnish research station of Tvärminneis will take place in June-July 2012 (PI Ulf Riebesell, GEOMAR).

A third phase of SOPRAN (Surface Ocean Processes in the Anthropocene, www.sopran.pangaea.de) from Feb. 2013 to Jan 2016 is currently in the planing stage.

7. Other comments

SOLAS India

compiled by Dileep Kumar

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)

a. Influence of discharge of monsoonal rivers on the biogeochemistry and carbon dioxide emissions in estuaries and coastal regions of east coast of India

Changes in river discharges alter material loads and the consequent estuarine and coastal biogeochemical process. Evidence for biogeochemical response to variable rainfall over catchment area or changes in river discharges due to dam regulations is sparse; India is the best suited to test the influence of altered discharges, as the monsoon rainfall is annually variable, on estuarine biogeochemistry. Experiments in Godavari estuary over three years revealed that a decrease in precipitation over the Indian subcontinent from 2007 to 2009 resulted in the lowering of its mean annual discharge from 748.63 $m^3 s^{-1}$ in 2007 to 218.40 $m^3 s^{-1}$ in 2009. The reduced water discharge, during the peak discharge period, slowed the flushing of the estuary from 1.2 days to 6.3 days. The consequent increase in stability of water column and reduced suspended material load facilitated intense phytoplankton blooms (Chl *a* 18 µg l^{-1} in 2007 to 28 µg l^{-1} in 2009).

Eighteen month long daily monitoring in the tropical Godavari estuarine system revealed a pH decrease by 1.5 units, during peak discharge period, due to high bacterial activity (20.6 ± 7.2 µMC l^{-1} d^{-1}). The strong heterotrophic processes resulted in anomalously high pCO_2 of 30,000 µatm during peak discharge period in the estuary (Figure 1).

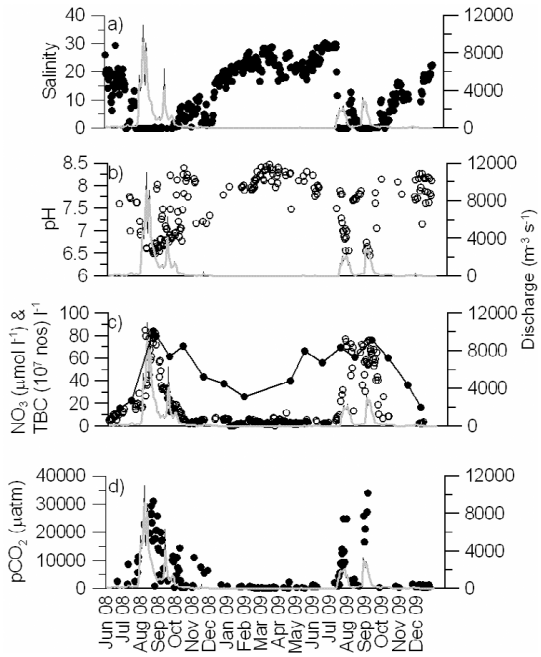


Figure 1: Daily variations in salinity, pH, nitrate, total bacterial counts and pCO2 in the Godavari estuary

An extensive study of 27 estuaries along the east and west coasts of India revealed that the emission of CO_2 to atmosphere to be 4-5 times higher during wet than in dry period. The average pCO_2 ranged between ~300 and 18492 μatm, which is within the range found for world estuaries. The mean pCO2 and particulate organic carbon (POC) showed positive relation with rate of discharge suggesting availability of high quantities of organic matter that led to enhanced oxygen consumption (Fig. 2). The annual CO_2 fluxes from the Indian estuaries amount to 1.92 TgC which is far less than that from the European estuaries.

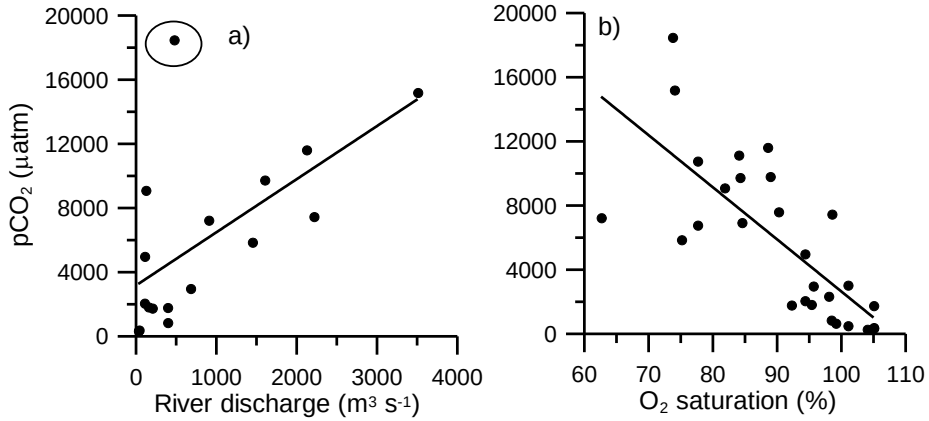


Figure 2: Relationship of pCO2 with a) river discharge and b) oxygen saturation in the Indian monsoonal estuaries.

The pCO_2 levels in the peninsular rivers were an order of magnitude higher (5000-17000 atm) than that of atmospheric levels and glacial river Ganges (~500 atm). The discharge from the penninsular rivers have a stronger influence in the SW region whereas Ganges river discharge influences in the NW region. Our results suggest that the coastal Bay of Bengal acts as a net source for CO2 to the atmosphere throughout the year except for a brief winter.

1. Sarma. V.V.S.S., N.A. Kumar, et al. 2011. High CO2 emissions from the tropical Godavari estuary (India) associated with monsoon river discharges. *Geophysical Research Letters,* 38, L08601, doi:10.1029/2011GL046928.

2. Sarma, V.V.S.S., M.S. Krishna, V.D. Rao, R. Viswanadham, N.A. Kumar, T.R. Kumari, L. Gawade, S. Ghatkar, and A. Tari, 2012. Sources and sinks of CO2 in the west coast of Bay of Bengal. *Tellus-B*, 64, 10961, doi: 10.3402/tellusb.v64i0.10961.

3. Sarma, V.V.S.S., 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.R. Krishna, N.P.C. Reddy, Y. Sadhuram, and T.V.R. Murty. 2012. Carbon dioxide emissions from Indian monsoonal estuaries. *Geophysical Research Letters*., in press.

b. Atmospheric disturbances and biological productivity in the Bay of Bengal

Influence of extreme atmospheric events, such as heavy rainfall and cyclone *Sidr*, on phytoplankton biomass in the western Bay of Bengal using both *in situ* time-series observations and satellite derived chlorophyll *a* (Chl *a*) and sea surface temperature (SST) was studied. Excessive supply of nutrients by the episodic heavy rainfall (234 mm) on 4–5 October 2007 and the subsequent runoff caused an increase in Chl *a* abundance by four times in the coastal Bay than before. Similar increase in Chl *a*, by 3 to 10 times, was observed on the right side of the cyclone *Sidr* track in the central Bay of Bengal after its passage. These two episodic events caused phytoplankton blooms in the western Bay of Bengal that enhanced ~40% of fishery production

during October–December 2007 compared to that in the same period in 2006.

1. Manisha, K., V.V.S.S. Sarma, N.P.C. Reddy et al., 2011. Meso-scale atmospheric events promote phytoplankton blooms in the coastal Bay of Bengal. *Journal of Earth System Sciences,* 120, 4, 1-10.

c. Atmospheric deposition of nitrogen and iron over the Bay of Bengal

Atmospheric dry-deposition of water soluble inorganic and organic nitrogen (N_{Inorg} & N_{Org}) to the Bay of Bengal has been studied during the continental outflow (Jan-April) from south and south-east Asia. The analysis of these species has given insight of the relative importance of inorganic versus organic nitrogen in the MABL and their air-sea deposition. The abundance of NH_4^+-N (> 90 % of N_{Inorg}) dominates the total water soluble nitrogen (> 80 %) in the MABL. Nevertheless, contribution of N_{Org} to N_{Tot} (N_{Inorg}+N_{Org}) is significant along coastal regions. A significant linear relationship among N_{Org}, NH_4^+ and nss-K^+ suggests their common source from biomass burning emissions and fertilizers. A comparison of atmospheric input of soluble N with the riverine supply suggests that both are of comparable magnitude. The dry-deposition flux of nitrogen to the Bay of Bengal ranges from 2 to 165 µmol m^{-2} d^{-1}; and can account up to 13 % of the Primary Production in the Bay of Bengal (Srinivas et al., 2011a). The fractional solubility of aerosol-Fe (Fe_{ws} % = Fe_{ws}/Fe_{Tot} *100; Fe_{ws} = water-soluble iron; Fe_{Tot} = total aerosol iron) over the Bay of Bengal is another important issue associated with the continental outflow of pollutants. The high solubility of aerosol-Fe (1.4 to 24 %) over the Bay of Bengal compared to Arabian Sea (0.02 to 0.4 %), is attributable to chemical processing of fine mode alluvial dust during long range transport and combustion products of fossil-fuel and biomass burning emissions. These results have implications to air-sea deposition of micro-nutrients and their impact on the biogeochemistry of surface waters of the Northern Indian Ocean.

1. Srinivas, B., M. M. Sarin and V. V. S. S. Sarma, (2011a). Atmospheric deposition of inorganic and organic nitrogen to the Bay of Bengal: Impact of continental outflow, Mar. Chem, 127, pp: 170-179, doi:10.1016/j.marchem.2011.09.002.

2. Srinivas, B. M. M. Sarin and A. Kumar, (2011b). Impact of anthropogenic sources on aerosol iron solubility over the Bay of Bengal and the Arabian Sea, Biogeochemistry, doi:10.1007/s10533-011-9680-1.

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)

Four Indian research students participated in SOLAS Summer School. Ms V. P. Vidya was declared as one of the Best Poster winners.

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

T. Acharyya, V.V.S.S. Sarma, B. Sridevi, V. Venkataramana, M.D. Bharathi, S. Naidu, B.S.K. Kumar, V.R. Prasad, D. Bandopadhyay, N.P.C. Reddy, M.D. Kumar. 2012. Reduced river discharge intensifies phytoplankton bloom in Godavari estuary, India. *Marine Chemistry*, in press.

Manisha, K., V.V.S.S. Sarma, N.P.C. Reddy et al., 2011. Meso-scale atmospheric events promote phytoplankton blooms in the coastal Bay of Bengal. *Journal of Earth System Sciences,* 120, 4, 1-10.
Sarin, M. M., Ashwini Kumar, B. Srinivas, A. K. Sudheer and Neeraj Rastogi (2011). Anthropogenic sulphate aerosols and large Cl-deficit in marine atmospheric boundary layer of tropical Bay of Bengal, J Atmos Chem, DOI 10.1007/s10874-011-9188-z.

Sarma, V.V.S.S., M.S. Krishna, V.D. Rao, R. Viswanadham, N.A. Kumar, T.R. Kumari, L. Gawade, S. Ghatkar, and A. Tari, 2012. Sources and sinks of CO2 in the west coast of Bay of Bengal. *Tellus-B*, 64, 10961, doi: 10.3402/tellusb.v64i0.10961.

Sarma. V.V.S.S., N.A. Kumar, et al. 2011. High CO2 emissions from the tropical Godavari estuary (India) associated with monsoon river discharges. *Geophysical Research Letters,* 38, L08601, doi:10.1029/2011GL046928.

Sarma, V.V.S.S., 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.R. Krishna, N.P.C. Reddy, Y. Sadhuram, and T.V.R. Murty. 2012. Carbon dioxide emissions from Indian monsoonal estuaries. *Geophysical Research Letters*., in press.

Sarma, V.V.S.S., J. Arya, Ch.V. Subbaiah, S.A. Naidu, L. Gawade, P. Praveen Kumar, N.P.C. Reddy. 2012. Stable isotopes of carbon and nitrogen in suspended matter and sediments from the Godavari estuary, *Journal of Oceanography*, in press.

Srinivas, B., M. M. Sarin and V.V.S.S. Sarma (2011). Atmospheric deposition of inorganic and organic nitrogen to the Bay of Bengal: Impact of continental outflow, *Marine Chemistry,* 127, pp:170–179, doi:10.1016/j.marchem.2011.09.002.

Srinivas, B., M. M. Sarin and Ashwini Kumar (2011). Impact of anthropogenic sources on aerosol iron solubility over the Bay of Bengal and the Arabian Sea, Biogeochemistry, DOI 10.1007/s10533-011-9680-1.

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

Dr. V. V. S. S. Sarma is the chairman for Indian Ocean sub-group in the preparation of Surface Ocean Carbon Atlas (SOCAT) for the world ocean of IOCCP, UNESCO, Paris, which was released recently.

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

Future activity focuses on air-water interactions in Indian estuaries and coastal systems with a sustained time-series approach.

7. Other comments

SOLAS Ireland

compiled by Brian Ward

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)

RV Knorr Bloomcruise

Participated in the R/V Knorr Bloomcruise in July in collaboration with Scott Miller and Eric Saltzman. This project was funded by the NSF (see http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0851472) and participation by NUIG was funded with grants from the Science Foundation Ireland (SFI). The following measurements were conducted by NUIG personnel:

- Upper ocean turbulence with the Air-Sea Interaction Profiler (ASIP)
- Eddy covariance flux measurements of carbon dioxide using two licor gas analysers
- Wave measurements at the bow of the R/V Knorr using a time of flight acoustic device
- Underway pCO2 measurements with a General Oceanics system

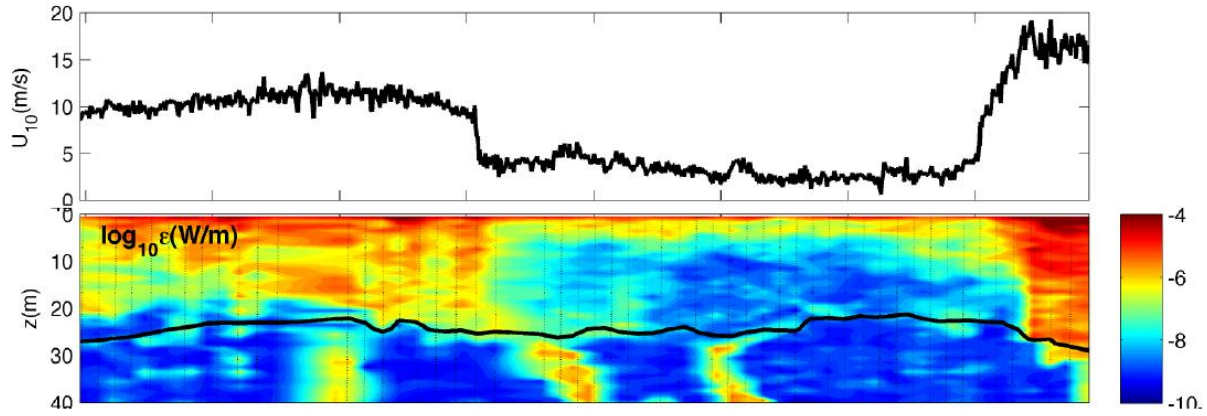


Figure above shows measurements of upper ocean turbulence in response to the wind forcing. This deployment captured the crossing of a front, where the wind suddenly dropped from 10 to 4 m/s, and then subsequently ramped up to about 18 m/s. The response of the upper ocean exhibited little time lag with the atmospheric forcing. The dissipation of turbulent kinetic energy (ε) is one of the most important parameters for driving air-sea exchange, and our ability to make profiles within the footprint of an eddy covariance flux measurement provides a unique ability to study the ε-k (transfer velocity) relationship.

Air-Sea Iodine Transfer

This work is the result of an interdisciplinary collaboration between atmospheric physicists at UCC (Dr Sophie Dixneuf, Dr Albert A. Ruth, Laser Spectroscopy Group, Physics Department) and marine botanists of NUI Galway (Udo Nitschke, Dr. Dagmar B. Stengel, Botany and Plant Science, School of Natural Sciences, and Ryan Institute). While the Incoherent-Broadband Cavity-Enhanced absorption Spectroscopy (IBBCEAS) instrument was setup at NUI Galway by the group of Cork (Sophie Dixneuf) the data presented below were measured by the group at Galway (Udo Nitschke).

Although sea-to-air iodine transfer is a key part of the iodine cycle in the global environment, our understanding of the marine sources and mechanisms of the release of elemental iodine into the atmosphere as well as its partitioning into either I_2 or various volatile iodo-carbons is far from complete. In this research time-resolved flux measurements of I_2 emitted by the brown macroalga *Laminaria digitata*, probably the strongest iodine accumulator amongst living organisms, were achieved by applying IBBCEAS [1,2,3] to algal samples freshly collected at Finavarra, Co. Clare, Ireland.

I_2 emission of air-exposed blades of *L. digitata* was investigated as a function of light intensity and temperature. As observed in a previous study [3], the new measurements confirmed the high variability of I_2 release into air. Moreover, investigated irradiances and temperatures did not affect significantly I_2 release into air (Figure 1, *P*-values >0.05). Since such environmental factors were in the normal range of conditions occurring in the naturally habitat of this species, these findings could be expected and further research will be required to examine the metabolic function of iodine in *L. digitata*.

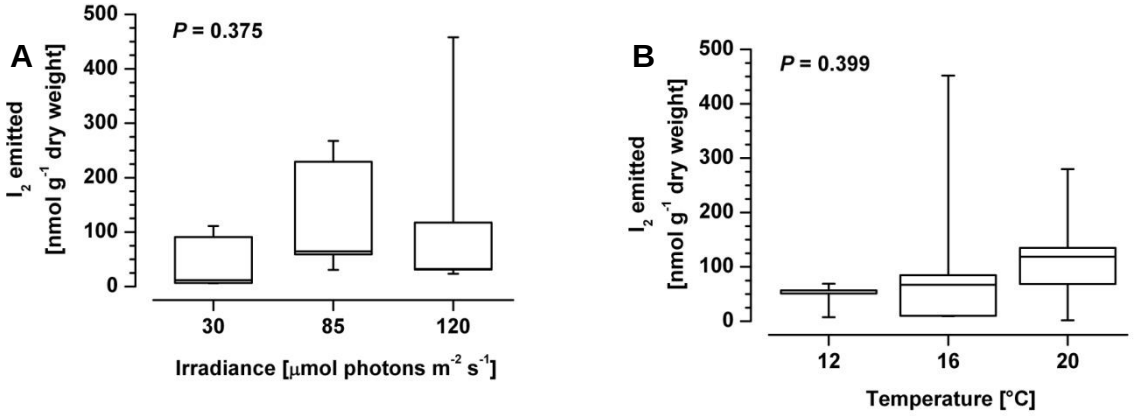


Fig. 1 Total amount of I_2 emitted from blades (including meristematic area) of *L. digitata* under **A** defined irradiances (at 20°C) and **B** defined temperatures (at 30 µmol photons m^{-2} s^{-1}). Data are presented as box plots showing median (black line), 25th and 75th percentile (indicating 50% of the data range), and minimum and maximum (whisker) of n = 6 replicates. Significant effect of irradiance or temperature on I_2 emission was calculated using one-way ANOVA, *P*-values are given.

During a biodegradation experiment blades from *L. digitata* were allowed to die off and degrade at 20°C and low irradiances (50 µmol photons m^{-2} s^{-1}). I_2 emission into air and I^- release into seawater was determined after 0, 1, 4 and 29 days of degrading algae. Seawater samples were sent to laboratories of Service Central d'Analyse, CNRS, Solaize (France) and results are still pending. However, preliminary results indicate that major amounts of iodine from degrading *L. digitata* are released into seawater and not into the atmosphere.

Different brown macroalgae, which usually form kelp beds at Irish shores and which are known to retain high amounts of iodine (i.e. *Saccharina latissima*, *L. digitata*, *Saccorhiza polyschides*, *L. hyperborea*: old and new blade) were investigated for their I_2 emission in a controlled environment: 12°C and 30 µmol photons m^{-2} s^{-1}. Preliminary results are shown in Table 1. These indicate that *L. digitata* was the strongest I_2 emitter amongst the species studied, followed by *L. hyperborea*, but I_2 emission was observed only from newly formed blades. I_2 release into air from other investigated seaweeds or old blades of *L. hyperborea* was below the limit of detection of the IBBCEAS instrument. The results suggest that *Laminaria* species are the main contributors to overall I_2 emission from kelp beds which certainly depends on biomass distribution and tidal levels. Further experiments will be required to confirm such findings.

[1] Fiedler *et al.* (2003) *Chem. Phys. Lett.* **371**, 284–294.

[2] Dixneuf *et al.* (2009) *Atmos. Chem. Phys.* **9**, 823-829.

[3] Nitschke *et al.* (2011) *Planta* **233**, 737-748.

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

- Participated in the ESA-SOLAS conference held at Frascati in December. Several oral and poster contributions were made (Dr Brian Ward, NUIG)
- Oilwave cruise on the R/V Johan Hjort near the Lofoten Islands in Norway in collaboration with Met.NO (Olso). The objectives of the cruise were to study the interaction between waves and turbulence at the ocean surface (Dr Brian Ward, NUIG).
- Bloomcruise experiment on the R/V Knorr from Woods Hole to Woods Hole to study air-sea gas exchange (Dr Brian Ward, NUIG).
- Participation in the SOLAS Summer School by PhD student Sebastian Landwehr (Dr Brian Ward, NUIG).
- Travel grant from SFI for Sebastian Landwehr to spend 6 months at Scott Miller's Laboratory at SUNY, Albany to improve eddy covariance flux techniques, and to participate in the SOAP research cruise (Dr Brian Ward, NUIG).
- Oilwave workshop help in Galway in December to discuss the results from the successful cruise in the Norwegian fjord in April (Dr Brian Ward, NUIG).
- Project funding from Marine Institute "Sea surface alkalinity across the Irish shelf from underway temperature and salinity data collected during the INFOMAR project" €29,985 Feb -Nov 2012 (Dr Rachel Cave, NUIG)
- Experiment conducted at Scripps for controlled wave-breaking and bubbling experiments for identification of organic matter in marine aerosols (Dr Darius Ceburnis, NUIG)

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

- AIRSEA Lab participatied in the Sea2Sky outreach event which was funded by the Marie Curie Research Nights (Dr Brian Ward, NUIG)
- AIRSEA lab participated in Galway Science and Technology Festival (Dr Brian Ward, NUIG)

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

Ovadnevaite, J., C. O'Dowd,M. Dall'Osto, D. Ceburnis, D. R.Worsnop, and H. Berresheim (2011), Detecting high contributions of primary organic matter to marine aerosol:A case study, Geophys. Res. Lett., 38, L02807, doi:10.1029/2010GL046083.

Ovadnevaite, J., D. Ceburnis, G. Martucci, J. Bialek, C. Monahan, M. Rinaldi, M. C. Facchini, H. Berresheim, D. R. Worsnop, and C. O'Dowd (2011), Primary marine organic aerosol: A dichotomy of low hygroscopicity and high CCN activity, Geophys. Res. Lett., 38, L21806, doi:10.1029/2011GL048869.

D. Ceburnis, A. Garbaras, S. Szidat, M. Rinaldi, S. Fahrni, N. Perron,*, L.Wacker, S. Leinert, V. Remeikis, M. C. Facchini, A. S. H. Prevot, S. G.Jennings, M. Ramonet, and C. D. O'Dowd, Quantification of the carbonaceous matter origin in submicron marine aerosol by 13C and 14C isotope analysis, Atmos. Chem. Phys., 11, 8593–8606, 2011

Triona McGrath; Caroline Kivimäe; Toste Tanhua; Rachel R Cave; Evin McGovern, Inorganic carbon and pH levels in the Rockall Trough 1991-2010, Submitted to Deep-Sea Research (Dr Rachel Cave, NUIG)

Enowmbi R. Ashu-Ayem, Udo Nitschke, Ciaran Monahan, Jun Chen, Steven B. Darby, Paul D. Smith, Colin D. O'Dowd, Dagmar B. Stengel, Dean S. Venables, Coastal iodine emissions: Part 1. Release of I2 by Laminaria digitata in chamber experiments, SUBMITTED to Environmental Science and Technology (Dr Dean Veneables, UCC)

Ciaran Monahan, Enowmbi R. Ashu-Ayem, Udo Nitschke, Steven B. Darby, Paul D. Smith, Dagmar B. Stengel, Dean S. Venables and Colin D. O'Dowd, Coastal Iodine Emissions: Part 2. Particle Formation from Laminaria digitata and I2 in chamber experiments, SUBMITTED to Environmental Science and Technology (Dr Dean Veneables, UCC)

Dixneuf, S., Ruth, A.A., Nitschke, U. and Stengel, D.B. Molecular iodine emission rates of different thallus parts of *Laminaria digitata* using incoherent broadband cavity-enhanced absorption spectroscopy. 43rd Liège Colloquium on Ocean Dynamics, Liège (Belgium), 2-6 May 2011 (oral).

Nitschke, U., Ruth, A.A., Dixneuf, S. and Stengel D.B. Iodine in the brown macroalga *Laminaria digitata* and its significance in atmospheric processes. Ryan Institute Research Day, Galway (Ireland), 9 June (poster).

Nitschke, U., Dixneuf, S., Muniyappa, M.K., Ruth, A.A., Spillane, C. and Stengel, D.B. Iodine emission from *Laminaria digitata* and potential effects on breast cancer. 4th Congress of the International Society for Applied Phycology, Halifax (Canada), 19-24 June 2011 (poster).

Dixneuf, S., Ruth, A.A., Nitschke, U., Stengel, D.B. Molecular iodine emission rates from *Laminaria digitata* as a function of algal part, irradiance and temperature. Goldschmidt 2011, session Significance of Iodine in Biogeochemistry and the Environmental Sciences : Special Session Commemorating the Bicentennial of the Discovery of Iodine, August 15-19 2011, Prague, Czech Republic.

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

- Partner in FP7 project Carbochange and will host second annual meeting in march 2012
- Participation in the NASA SPURS (Salinity processes in the upper ocean regional study) workshop in February 2012

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

- Participating in the New Zealand SOAP cruise in collaboration with Scott Miller at SUNY. A NUIG student (Sebastian Landwehr) will be responsible for the instrumentation on the R/V Tangoroa.
- Will participate in the STRASSE/SPURS cruise in collaboration with LOCEAN (Paris) in the sub-tropical North Atlantic to study the processes governing the salinity maximum, and the air-sea exchange of freshwater.
- Brian Ward will chair a session at Ocean Sciences 2012 in Salt Lake City
- Participation in the SOLAS OSC in May with 2 students from AIRSEA lab at NUIG
- NUIG will host the second annual Carbochange meeting in March 2012

7. Other comments

SOLAS Japan

compiled by Mitsuo Uematsu

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)

i) Responses of marine ecosystem to typhoon passages in the western subtropical North Pacific by Shibano, R., Yamanaka, Y., Okada, N., Chuda, T., Suzuki, S., Niino, H., Toratani, M.

Strong phytoplankton blooms are occasionally observed around a recurvature point of typhoon tracks in the western subtropical Pacific. These are noteworthy events in subtropical regions where both nutrient concentrations and biological production are persistently low. We investigated the response of phytoplankton to typhoon passage using a numerical model with/without biogeochemical processes. The model reproduced the observed patch-like phytoplankton bloom around a recurvature point of Typhoon Keith in 1997. The strong bloom is caused by the typhoon-centered upwelling of nutrient-rich water from below the euphotic layer, which supplies the nutrients required for phytoplankton growth, resulting in higher chlorophyll-a concentrations. Biogeochemical processes then play essential roles in determining the response after the passage of typhoons in subtropical regions.

ii) Population dynamics of phytoplankton, heterotrophic bacteria, and viruses during the spring bloom in the western subarctic Pacific by Suzuki, K., Kuwata, A., Yoshie, N., Shibata, A., Kawanobe, K. and Saito, H.

An index for diatom bloom development has been established. Bloom-forming diatoms were mainly Thalassiosira and Chaetoceros species. Fucoxanthin can serve as a strong indicator of the diatom carbon biomass. Abundance of heterotrophic bacteria changed little during the spring diatom bloom. Viral abundance increased toward the end of the spring diatom bloom.

iii) Single-Particle Chemical Characterization and Source Apportionment of Iron-Containing Atmospheric Aerosols in Asian Outflow by Furutani, H., J. Jung, K. Miura, A. Takami, S. Kato, Y. Kajii, and M. Uematsu

Using a single‐particle mass spectrometer, the size and chemical composition of individual Fe‐containing atmospheric aerosols (Fe aerosols) with diameter from 100 to 1800 nm were characterized during Asian outflow season (spring of 2008) in Okinawa Island, Japan. The results show that anthropogenic sources contributes significant portion of Fe aerosols in Asian outflow. Excluding the vanadium type, relative contribution of the remaining four particle types was constant over the course of study, which remained even when the total concentration of Fe aerosols changed and fraction of the Fe aerosols among atmospheric aerosols decreased significantly by the switch of air mass type into marine type. The observed constant relative abundance reflected the relative source strength of Fe aerosols in Asian outflow, particularly emphasizing the importance of coal combustion source in East Asia.

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

The science projects, which have been planned to investigate responses of Antarctic marine ecosystems to such global environmental changes as global warming and oceanic acidification, and to study on plankton community structure and environmental parameters, under the six year plan Phase VIII of the Japanese Antarctic Research Expeditions (JARE-52 to -57, 2010/11-2015/16). The marine science cruises were conducted in January by RT/V Umitaka-Maru (Tokyo University of Marine Science and Technology) and in March by Icebreaker Shirase. The intensive study areas were around marginal sea ice zone along 110°E and 140°E in the Antarctic Ocean. On the other hand, shore based observations were conducted around Syowa Station (69°00'S, 39°35'E). Temporal changes in plankton communities and pCO2 under fast ice were investigated.

We postponed the Final Symposium for the W-PASS project in Tsukuba on March to Sapporo on 13 September 2011. We finalized the publication of final report both in Japanese and English version.

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)

After 5 year W-PASS project, we traced for young scientists involved the project. Seven students continued their PhD study from 37 students for master degree. Eleven scientists obtained PhD have been working as post doc or assistant professor. A new PhD got a job in a private industry. Among 34 post docs working for the W-PASS project, 7 obtained now faculty positions and 22 are keeping their post doc positions. Substantial numbers of young scientist are working in the SOLAS field in Japan, but we see some decrease of PhD candidates for the last 5 years.

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

See attached file “Top 10 paper”

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

A SOLAS-Japan research cruise will be carried out coincidentally with the TORERO (Tropical Ocean tRoposphere Exchange of Reactive halogen species and Oxygenated VOC) expedition over the Eastern Equatorial Pacific Ocean in February 2012. We will discuss a joint workshop or session at the AGU SFO meeting in future.

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

For W-PASS scientific outcome, the final report in Japanese version will be published by the end of February. The English version planned to be a hard cover book is under editing process. Our expecting publishing date is by the end of March 2012. Unfortunately, the East Japan great earthquake made all publication schedule postponed.

7. Other comments

The person in charge of the National report preparation will take the place from Uematsu to Nojiri from 2012.

SOLAS Mexico

compiled by Jose Martin Hernandez Ayon

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

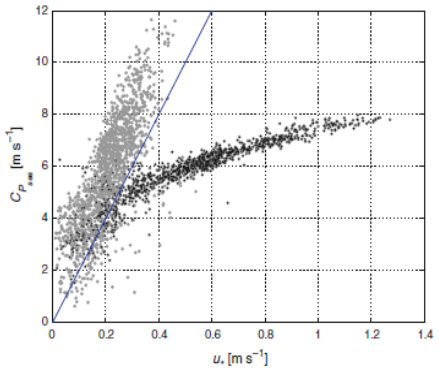
1. Key scientific SOLAS-relevant highlights/findings (you may include figures and references)

Ocean-Atmosphere Interactions Under Moderate to Strong Offshore Winds in the Gulf of Tehuantepec

Momentum exchange between the atmosphere and ocean, together with the vertical fluxes of heat and moisture, play a fundamental role on weather and climate, and their variability over a wide range of time and space scales. Knowledge on how wind stress varies with environmental parameters is of increasing importance, especially for the modelling of air–sea interaction for ocean current and wave prediction. The Gulf of Tehuantepec air–sea interaction experiment (intOA) took place, under the Programme for the Study of the Gulf of Tehuantepec (PEGoT, Spanish acronym for Programa para el Estudio del Golfo de Tehuantepec). PEGoT is underway aiming for better knowledge of the effect of strong and persistent offshore winds on coastal waters and their natural resources, as well as performing advanced numerical modelling of the wave and surface current fields. One of the goals of the intOA experiment is to improve our knowledge on air–sea interaction processes with particular emphasis on the effect of surface waves on the momentum flux for the characteristic and unique conditions that occur when strong *Tehuano* winds blow offshore against the Pacific Ocean long period swell. For the field campaign, an air–sea interaction spar (ASIS) buoy was deployed in the Gulf of Tehuantepec to measure surface waves and the momentum flux between the ocean and the atmosphere. High frequency radar systems (phase array type) were in operation from two coastal sites and three acoustic Doppler current profilers were deployed near-shore. Synthetic aperture radar images were also acquired as part of the remote sensing component of the experiment. The present paper provides the main results on the wave and wind fields, addressing the direct calculation of the momentum flux and the drag coefficient, and gives an overview of the intOA experiment. Although the effect of swell has been described in recent studies, this is the first time for the very specific conditions encountered, such as swell persistently opposing offshore winds and locally generated waves, to show a clear evidence of the influence on the wind stress of the significant steepness of swell waves.

Fig. Distribution of friction velocity $u*$ and spectral peak phase speed for wind-sea encountered during observations in the intOA Experiment, to provide an idea of the range of wave age. Cases for *Tehuano* events are identified as *dark dots*, while all the other cases are *grey dots*. Indication of underdeveloped waves are noticed for these limited-fetch growing conditions as from the characteristic offshore winds measured at the ASIS buoy specific location. The *straight line* defines *CPsea* = 20$u*$ typically for well-developed waves

1. F. J. Ocampo-Torres, H. García-Nava, R. Durazo, P. Osuna, G. M. Díaz Méndez and H. C. Graber, (2011). The intOA Experiment: A Study of Ocean-Atmosphere Interactions Under Moderate to Strong Offshore Winds and Opposing Swell Conditions in the Gulf of Tehuantepec, Mexico. Boundary-Layer Meteorology .138(3): 433-451.



offshore export of total organic carbon along the eastern boundary of the Subtropical North Pacific

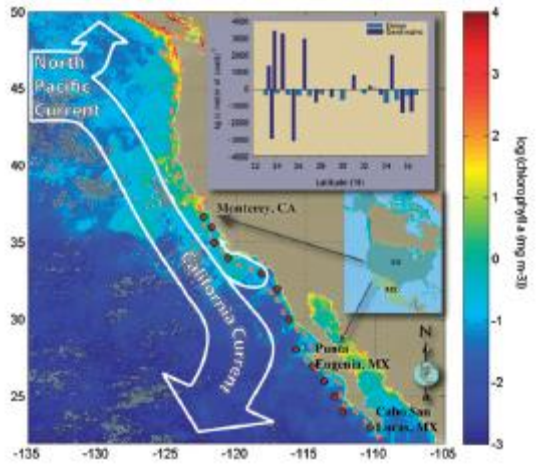
Highest TOC concentrations (470 mM) were observed for waters above the nitracline and associated with both California Current and southern surface waters. The northward advection of tropical waters in the California Undercurrent did not have any discernible impact on TOC distributions. An estimate of the average rate at which TOC in surface waters was exported offshore by Ekman transport in February 2003 was 1.73_103kgCyr_1 for each

meter of coastline. The offshore flux estimate is thought to be conservative with respect to the annual mean offshore flux because the offshore Ekman transport and primary production increase in late spring and early summer and the contribution of upwelling filaments has not been considered. Analysis of TOC contributions to pelagic respiration suggested that TOC accounted for 45% of the oxygen decrease in southern oxic waters. In California Current and oxygen minimum zone waters, TOC did not contribute to pelagic respiration.

Figure. Station locations along the ship's track superimposed on satellite (MODIS) chlorophyll estimates (http//seawifs.gsfc.nasa.gov) with the surface circulation overlain. The chlorophyll image is an eight day average from February 19 to 26, 2003. Chlorophyll (mg m_3) uses a logarithmic scale. The inset shows the Ekman and geostrophic transports for the upper 125 m along the study section. Transport units are kg (s per m of coast)$^{-1}$.

2.- C.G. Castro, C.A. Collins, J.T. Pennington, D. Zun iga and F.P. Chavez, (2011). Spatial distribution and offshore export of total organic carbon along the eastern boundary of the Subtropical North Pacific. Advances in Oceanography and Limnology. 2(2): 93–106.

Oceanographic anomalies and sea-level rise drive mangroves inland in the Pacific coast



Recent studies have ranked mangrove forests among the most threatened ecosystems on Earth (Valiela et al. 2001; Alongi 2002; Duke et al. 2007; FAO 2007). In agreement with this view, Mexican governmental agencies have reported that the mangrove area in the nation has been decreasing in the last decades at an annual rate of around 2% (INE 2005). Some large-scale remote-sensing studies in northwest Mexico, however, suggest that mangrove cover in many lagoons, despite common perception, is not being lost. Comparing satellite images, some regional reports have argued that the area covered by mangrove forests has in fact been increasing during the last decades in some lagoons of the Pacific coast of Mexico. A significant increase in mangrove cover has occurred in backwaters of the lagoons during the last 40 years, and especially during the El Niño anomalies of the 1980s and 1990s, while at the same time the mangrove fringe has been receding. The observed change can be attributed to the combined action of the warm surface waters of El Niño events and sea-level rise. Jointly, these two effects are sufficient to flood large areas of previously non-flooded salt flats, dispersing mangrove seedlings inland. The inland expansion of mangroves, however, does not ease conservation concerns, as it is the seaward fringes, and not the inland margins, that provide the most valuable environmental services for fisheries and coastal protection.

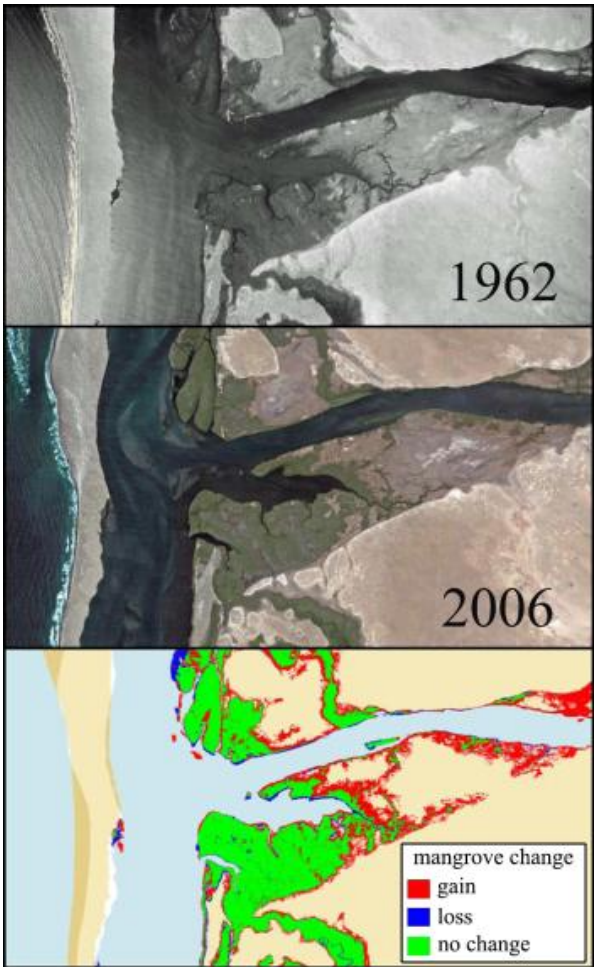


Fig. Boca de Santo Domingo in high-resolution images. The top plate shows an aerial photograph taken in 1962, the middle one is a GoogleEarth image from August 2006. The image at the bottom highlights the differences between the two timed photos.

3.- Xavier Lopez-Medellın, Exequiel Ezcurra, Charlotte Gonzalez-Abraham, Jon Hak, Louis S. Santiago & James O. Sickman, (2011). Oceanographic anomalies and sea-level rise drive mangroves inland in the Pacific coast of Mexico. Journal of Vegetation Science. 22: 143-151.

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

Third Symposium on Carbon in Mexico was held in the premises of the Centre for Research in Sustainable Chemistry, Autonomous University of Mexico State (http://simposiodelcarbono.org/). The symposium aims to bring together specialists in the study of carbon in the different environments of Mexico, in order to learn more about recent advances inresearch on this subject are underway in the country and thus propose future of research.

First national workshop develop at Centro de investigacion Cientifica y de Educacion Superior de Ensenada Baja California Mexico, about marine biogeochemical cycles: Impacts of global change and ecosystems at regional level in Mexico.

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

Ocean acidification may be causing problems for shellfish producers on the northwest coast, the deep-bay field station manager for the Centre for Shellfish Research at Vancouver Island University. Over the past few years, operations in Washington and Oregon have had difficult getting shellfish larvae to grow. Although it wasn't clear whether this issue extended north to Baja California Mexico, shellfish community now believes it could be the cause of some problems are happening in the Mexican coast as well. For the above, several

fisheries are now requesting collaboration to several institution and results will coming up.

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

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

Mortyn, P. G., J. C. Herguera, and M. A. Martínez-Botí (2011). Instrumental validation of Globigerinoides ruber Mg/Ca as a proxy for NE Pacific summer SST, Geophys. Res. Lett., 38, L16601, doi:10.1029/2011GL047803.

Huerta-Diaz M.A., Delgadillo-Hinojosa F., Otero X.L., Hernandez-Ayon J.M., Segovia-Zavala J.A., Galindo-Bect M.S. and Amaro-Franco E. (2011). Iron and trace metals in microbial mats and underlying sediments: results from Guerrero Negro saltern, Baja California Sur, Mexico. *Aquat. Geochem.* (17),4-5: 603-628.

Janet J. Reimer and Miguel Angel Huerta-Diaz, (2011). Phosphorus Speciation and Sedimentary Fluxes in Hypersaline Sediments of the Guerrero Negro Salt Evaporation Area, Baja California Sur, Mexico. Estuaries and Coasts. 33(3): 514-528.

Carlos Neira, Guillermo Mendoza, Lisa A. Levin, Alberto Zirino, Francisco Delgadillo-Hinojosa, Magali Porrachia, Dimitri D. Deheyn, Macrobenthic community response to copper in Shelter Island Yacht Basin, San Diego Bay, California, Marine Pollution Bulletin, (62), 4:701-717.

Nancy Aranda Cirerol N; Comín Francisco, Herrera-Silveira J., (2011). Nitrogen and phosphorus budgets for the Yucatán littoral: An approach for groundwater management. Environ Monit Assess. (172):493–505.

M. Ribas-Ribas, J.M. Hernández-Ayón, V.F. Camacho-Ibar, A. Cabello-Pasini, A. Mejia-Trejo, R. Durazo, S. Galindo-Bect, A.J. Souza, J.M. Forja, A. Siqueiros-Valencia, (2011). Effects of upwelling, tides and biological processes on the inorganic carbon system of a coastal lagoon in Baja California, Estuarine, Coastal and Shelf Science. 95(4): 367-376.

Carriquiry, José;Villaescusa, Julio;Camacho-Ibar, Víctor; Walter Daesslé, L.; Castro-Castro, Pedro, (2011). The effects of damming on the materials flux in the Colorado River delta. Environmental Earth Sciences. (62),7: 1407-1418.

Lugo-Ibarra K, Daessle LW, Macıas-Zamora V, Ramirez-A lvarez N, (2011). Persistent organic pollutants associated to water fluxes and sedimentary processes in the Colorado River delta. Baja California, Mexico. Chemosphere 85:210–217.

F. J. Ocampo-Torres, H. García-Nava, R. Durazo, P. Osuna, G. M. Díaz Méndez and H. C. Graber, (2011). The INTOA Experiment: A Study of Ocean-Atmosphere Interactions Under Moderate to Strong Offshore Winds and Opposing Swell Conditions in the Gulf of Tehuantepec, Mexico. Boundary-Layer Meteorology .138(3): 433-451.

Hwang, Paul A., Héctor García-Nava, Francisco J. Ocampo-Torres, 2011: Dimensionally consistent similarity relation of ocean surface friction coefficient in mixed seas. J. Phys. Oceanogr., 41, 1227–1238.

JA Segovia-Zavala, F Delgadillo-Hinojosa, ML Lares-Reyes, MA Huerta-Diaz, A Munoz-Barbosa, E Santa María del Angel, EV Torres-Delgado, SA Sanudo-Wilhelm, (2011).Vertical distribution of dissolved iron, copper, and cadmium in Ballenas Channel, Gulf of California. Ciencias Marinas. 37(4): 457-469.

Hernández-Terrones, Laura;Rebolledo-Vieyra, Mario; Merino-Ibarra, Martin; Soto, Melina;Le-Cossec, Adrien; Monroy-Ríos, Emiliano, (2011). Groundwater Pollution in a Karstic Region (NE Yucatan): Baseline Nutrient Content and Flux to Coastal.- Water, Air, & Soil Pollution. (218), 1:517-528.

Chris D. Metcalfe, Patricia A. Beddows, Gerardo Gold Bouchot, Tracy L. Metcalfe, Hongxia Li a, Hanneke Van Lavieren, (2011). Contaminants in the coastal karst aquifer system along the Caribbean coast of the Yucatan Peninsula, Mexico. Enviromental Pollution. 159, (4): 991-997.

García Pámanes, J.; Trasviña Castro, A.; Lara Lara, J.R.; Bazán Guzmán, C. , (2011). Seasonal variability of the particulate organic matter vertical flux in the central region of the Gulf of California. Ciencias Marinas. 37(1): 33-49.

Evgueni Shumilin, Vyacheslav Gordeev, Griselda Rodríguez Figueroa, Liudmila Demina and Konstantin Choumiline, (2011). Assessment of Geochemical Mobility of Metals in Surface Sediments of the Santa Rosalia Mining Region, Western Gulf of California. 60(1): 8-25.

María de la Luz Vázquez-Sauceda, G. Aguirre-Guzmán, J. G. Sánchez-Martínez and R. Pérez-Castañeda,

(2011). Cadmium, Lead and Zinc Concentrations in Water, Sediment and Oyster (*Crassostrea virginica*) of San Andres Lagoon, Mexico. Bulletin of Enviromental Contamination and Toxicology. 86(4): 410-414.

Xavier Lopez-Medellın, Exequiel Ezcurra, Charlotte Gonzalez-Abraham, Jon Hak, Louis S. Santiago & James O. Sickman, (2011). Oceanographic anomalies and sea-level rise drive mangroves inland in the Pacific coast of Mexico. Journal of Vegetation Science. 22: 143-151.

Alejandra G. Vovides & Jorge López-Portillo &Yoav Bashan, (2011). N2-fixation along a gradient of long-term disturbance in tropical mangroves bordering the gulf of Mexico. Biol Fertil Soils (2011) 47:567–576.

C.G. Castro, C.A. Collins, J.T. Pennington, D. Zun iga and F.P. Chavez, (2011). Spatial distribution and offshore export of total organic carbon along the eastern boundary of the Subtropical North Pacific. Advances in Oceanography and Limnology. 2(2): 93–106.

D.M. Pérez-Mayorga, L.B. Ladah , J.A. Zertuche-González , J.J. Leichter, A.E. Filonov, M.F. Lavín, (2011). Nitrogen uptake and growth by the opportunistic macroalga Ulva lactuca (Linnaeus) during the internal tide. Journal of Experimental Marine Biology and Ecology. 406:108–115.

Sánchez Barredo Mariana, Ladah Lydia B., Zertuche González José A. 2011. Nitrate uptake and duration of internal nitrogen reserves in the kelp Eisenia arborea. Botánica Marina. Vol. 54, doi:10.1515/BOT.2011.058 (PA: 102333).

Cepeda Morales Jushiro C. A., Gaxiola Castro Gilberto, Beier Emilio J. 2011. El fitoplancton y la zona del mínimo de oxígeno en México. En: *, Editores. "El fitoplancton y la zona del minimo de oxígeno en México". Lambert Academic Publishing. ISBN: 978-3-8443-4174-4. Vol. 1, Publicado (PA: 102096)

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

Mexican researchers have developed many productive international collaborations, particularly with regard to fieldwork, workshops and samples analysis support. But also a bi-national collaborations but also participation to international assessment:

- UCMEXUS projects. The University of California Institute for Mexico and the United States (UC MEXUS), established in 1980, is an academic research institute dedicated to encouraging, securing, and contributing to binational and Latino research and collaborative academic programs and exchanges.

- Mexican paticipation in the IPCC Ocean Acidification at Otawa Japon Workshop. January 2011.

- The National Data Center Exchange (CEND) is already given an official high in the IODE / IOC / UNESCO.

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

The Mexican government goal is to develop a Research Thematic Networks set by CONACYT for group researchers, technologists and entrepreneurs with common interests and willingness to collaborate and contribute their knowledge, skills and abilities to synergistically promote solutions to problems and strategic issues for the development the country. The objective is to promote and strengthen the construction and development of national scientific networks on strategic issues that respond to problems (scientific, technological and social) and seek the linkages between academia, government and society. In the present there are two subnetwoks includes the ocean studies with a lot of participation from several institution. However, if this this idea still as a part of the new future government, many work will be coming up.

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 Norway

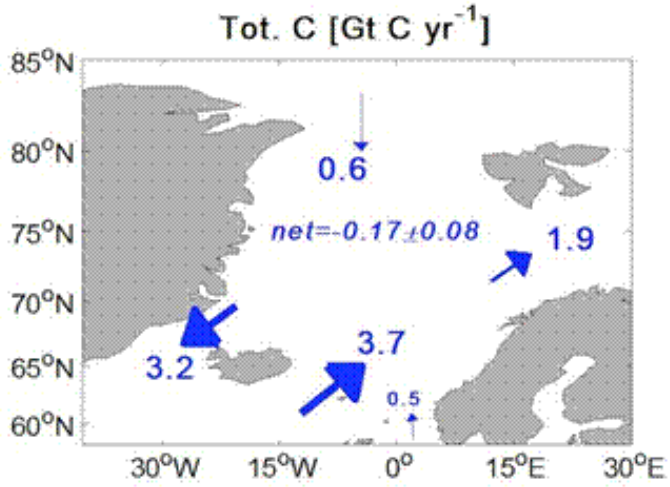
compiled by Abdirahman Omar

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

1. Scientific highlight

Carbon budget for the Nordic Seas

In a study recently published in Global Biogeochemical Cycles - and quoted as a 'Research highlight' in the November issue of Nature Geoscience , Emil Jeansson and colleagues at the Bjerknes Centre for Climate Research, University of Bergen, present a carbon budget of the Nordic Seas, the ocean area connecting the North Atlantic with the Arctic Ocean. The authors found that the dominating exchange of carbon takes place across the Greenland-Scotland Ridge. Horizontal transport of carbon in the region is almost two orders of magnitude larger than the uptake from the atmosphere – 12.3 Gt of carbon imported, annually, and 12.5 Gt carbon is exported.



The figure shows the net horizontal transport of total carbon in the different gateways of the Nordic Seas. The 'net' term (in italic) shows the resulting transport, when adding all horizontal in and outflows, where the negative sign means that the budget gives a net transport out of the region. Thus, balancing the budget requires an uptake of CO2 the same amount from the atmosphere. Figure: from Jeansson et al., (2011).

Jeansson and colleagues estimate an annual export of about 0.09 Gt anthropogenic carbon (excess carbon resulting from perturbations of the "natural" carbon cycle), from the Nordic Seas to the deep North Atlantic. This is a crucially important pathway for removing the climatically important CO2 from the atmosphere to the interior ocean and thus moderating the potential global warming of global fossil fuel combustion and land-use change.

Reference

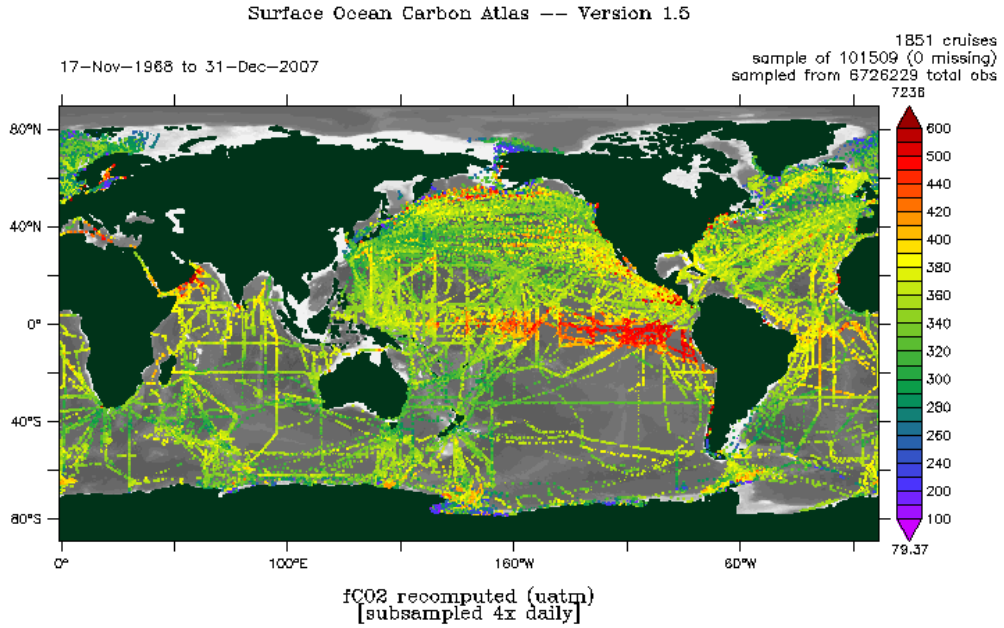
Jeansson, E., A. Olsen, T. Eldevik, I. Skjelvan, A. M. Omar, S. K. Lauvset, J. E. Ø. Nilsen, R. G.J. Bellerby, T. Johannessen and E. Falck, 2011, *The Nordic Seas carbon budget: Sources, sinks and uncertainties*. Global Biogeochemical Cycles, doi:10.1029/2010GB00396.

2. Main accomplishments

First public release of Surface Ocean CO2 Atlas (SOCAT)

The Surface Ocean CO_2 Atlas (SOCAT) is a global synthesis of surface ocean carbon dioxide (CO_2) measurements collected on research vessels, voluntary observing ships and buoys. The first public release of SOCAT (version 1.5) was published in September 2011. This global data set consists of data from 1851 voyages between 1968 and 2007 with approx. 6.3 million recalculated surface water fCO_2 (fugacity of CO_2) measurements (Figure 1). The following

researchers from the University of Bergen and the Bjerknes Centre for Climate Research contributed to this international effort: *Benjamin Pfeil, Are Olsen, Abdirahman Omar, Ingunn Skjelvan Siv Lauvset, Truls Johannessen, Richard Bellerby, Christoph Heinze and Jerry Tjiputra.*



The figure shows an overview of SOCAT cruises using Live Access Server (courtesy of NOAA/PMEL)

In 2007, surface water CO_2 data were archived in a wide range of formats at numerous sites around the world, each with its own rules for access, making it virtually impossible to generate a comprehensive data synthesis product. At a meeting in UNESCO headquarters (IOCCP, 2007), the international ocean carbon community decided to initiate the SOCAT to improve access to global surface water CO_2 data. It took four years of hard work by marine carbon scientists around the world to assemble and quality control the first version of SOCAT.

Two SOCAT products are available via http://www.socat.info/ (1) A global data set of recalculated surface water fCO_2 values in a uniform format, which has undergone 2nd level quality control; (2) A global, gridded product of monthly mean surface water fCO_2, with no temporal or spatial interpolation, and individual cruise files with recalculated fCO_2 values.

The methods in SOCAT are transparent and fully documented (Pfeil et al., 2012; Sabine et al., 2012). The products and cruises are citable through their respective Digital Object Identifiers (doi-s). Cruises in SOCAT have an Expocode (a code containing Cruise ID, Year, Month and Day of Cruise), a doi and metadata documentation (e.g. investigator, vessel, methods).

The SOCAT website is maintained at the University of Bergen. It has a large number of visitors (average of 1,000 per month) which demonstrates the intense interest in these carbon synthesis products.

References:
IOCCP, 2007. Surface Ocean CO2 Variability and Vulnerabilities Workshop. IOCCP Report 7. UNESCO, Paris, France, 11-14 April 2007. http://www.ioccp.org/
Pfeil, B. et al. (2012) A uniform, quality controlled, Surface Ocean CO2 Atlas (SOCAT). Earth System Science Data (in preparation)
Sabine, C. et al. (2012) Gridding of the Surface Ocean CO2 Atlas (SOCAT). Earth System Science Data (in preparation)

Launch of EU FP7 project CARBOCHANGE

On 8-11 March 2011, 80 scientists from Europe, North America and Africa gathered in Bergen, for the official launch of CARBOCHANGE - *Changes in carbon uptake and emissions by oceans in a changing climate* – which is a large-scale

integrating collaborative research project of 7 million Euros funded by the EU's 7th Framework Programme in the period 2011-2015.

The goal of CARBOCHANGE is to quantify the oceanic uptake of human-produced carbon dioxide from the atmosphere. It is coordinated by the Geophysical Institute at the University of Bergen and the Bjerknes Centre for Climate Research, Norway.
CARBOCHANGE gathers a consortium of 28 research institutions from Europe, North America (USA and Canada) and Africa (Morocco and South Africa) with outstanding scientific expertise in the field of carbon cycle research.

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

CARBOCHANGE is endorsed by SOLAS.

Other projects launched in 2011

Several other projects lead by the partners of the Bjerknes Centre for Climate Research started during the 2011. These include:

1. The EU FP7 project Development of global plankton data base and model system for eco-climate early warning (GreenSeas) which is to advance the quantitative knowledge of how planktonic marine ecosystems, including phytoplankton, bacterioplankton and zooplankton, will respond to environmental and climate changes. To achieve this GreenSeas will employ a combination of observation data, numerical simulations and a cross-disciplinary synthesis to develop a high quality, harmonized and standardized plankton and plankton ecology long time-series, data inventory and information service.
2. MONitoring and Assessing Regional Climate change in High latitudes and the Arctic (MONARCH-A) with the objective to generate a dedicated information package tailored to a subset of multidisciplinary Essential Climate Variables and their mutual forcing and feedback mechanisms associated with changes in terrestrial carbon and water fluxes, sea level and ocean circulation and the marine carbon cycle in the high latitude and Arctic regions http://www.nersc.no/project/monarch

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

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

Bernard, C., H. Dürr, C. Heinze, J. Segschneider und E. Maier-Reimer, 2011, Contribution of riverine nutrients to the silicon biogeochemistry of the global ocean – a model study. Biogeosciences, 8, 551- 564.

Frigstad, H., Andersen, T., Hessen, D. O., Naustvoll, L.-J., Johnsen, T. M., and Bellerby, R. G. J.: Seasonal variation in marine C:N:P stoichiometry: can the composition of seston explain stable Redfield ratios?, Biogeosciences, 8, 2917-2933, doi:10.5194/bg-8-2917-2011, 2011.

Jeansson, E., A. Olsen, T. Eldevik, I. Skjelvan, A. M. Omar, S. K. Lauvset, J. E. Ø. Nilsen, R. G.J. Bellerby, T. Johannessen and E. Falck, 2011, *The Nordic Seas carbon budget: Sources, sinks and uncertainties*. Global Biogeochemical Cycles, doi:10.1029/2010GB00396.

Lauvset, S.K., McGillis, W.R., Bariteau, L., Fairall, C.W., Johannessen, T., Olsen, A., Zappa, C.J., 2011. Direct measurements of CO2 flux in the Greenland Sea. Geophys. Res. Lett. 38 (12), L12603.

Pfeil, Gerrit Benjamin; Olsen, Are; Bakker, Dorothee CE (2011): Surface Ocean CO2 Atlas (SOCAT). doi:10.1594/PANGAEA.767698.

Roy, T., L. Bopp, M. Gehlen, B. Schneider, P. Cadule, T. Frölicher, J. Segschneider, J. Tjiputra, C. Heinze, and F. Joos, 2011, Regional Impacts of Climate Change and Atmospheric CO2 on Future Ocean Carbon Uptake: A Multimodel Linear Feedback Analysis. J. Climate, 24(9), 2300-2318

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

Christoph Heinze is **SOLAS SSC member** and a **reviewer editor for IPCC AR5** (WG I) chapter 6. He is also **coordinator of EU FP7 project CARBOCHANGE** which is endorsed by SOLAS (CARBOCHANGE will send a separate activity report). Heinze participated in the IPCC WGI+II ocean acidification workshop in Okinawa, Japan, 17-19 January 2011 and acted as rapporteur for the breakout group on paleo-aspects. He contributed to the final workshop report:
Schmidt, Daniela; and Heinze, Christoph.
Breakout Group II-1: Learning from the past and present to predict the future, in: IPCC, 2011: Workshop Report of the Intergovernmental Panel on Climate Change Workshop on Impacts of Ocean Acidification on Marine Biology and Ecosystems [Field, C.B., V. Barros, T.F. Stocker, D. Qin, K.J. Mach, G.-K. Plattner, M.D. Mastrandrea, M. Tignor and K.L. Ebi (eds.)]. IPCC Working Group II Technical Support Unit, Carnegie Institution, Stanford, California, United States of America, pages 33-35.. Stanford, California, United States of America: Working Group II Technical Support Unit, Carnegie Institution 2011 (ISBN 978-92-9169-132-6) 3 s.

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

7. Other comments

SOLAS Peru

compiled by Michelle Graco

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)

SOLAS Perú projects

1- CO_2, Carbonate system an acidification off Perú

At the end of 2009, the Instituto del Mar de Perú (IMARPE) and the State Key Laboratory of Marine Environmental Science from the Xiamen University established a general agreement in order to develop scientific, technical and training cooperation activities particularly in the study of CO_2 and in general the carbonate system in order to explore the ocean acidification in the context of the global change. During 2011 as part of this cooperation, scientist Violeta León from the Instituto del Mar del Perú (IMARPE) participated in a training stage (March-May) under the supervision of Dr. Deli Wang from the Ocean Carbon Group led by Prof. Minhan Dai, supported by the visiting fellowship program of the State Key Laboratory of Marine Environmental Science (Xiamen University). The goal of the stage was to learn the different techniques associated with the carbonate system. Additionally to the capacitation, in 2011, in the frame of the cooperation, we collected samples off Callao (Central Perú) during the monitoring performed by the Chemical Oceanography Unit in order to analyze total CO_2, pH and alkalinity in the Laboratories of the MEL (Xiamen University).

2- N_2O Time Series Measurements off Peru –A Cooperation between SFB 754/IFM GEOMAR and IMARPE.

After the SOLAS workshop "Air-Sea fluxes at the Eastern Boundary Upwelling and OMZ systems" (SOLAS mid-term strategy initiative) on 8-10 November 2010 in Lima (Perú) at the Instituto del Mar del Perú (IMARPE), we established a cooperation between IMARPE and the SFB754/IFM-GEOMAR. The main objective of the cooperation is to investigate the distribution of N_2O in dependence of the oxygen concentration in the OMZ off Perú, in order to understand and predict the role of the OMZs-EBUES in the ocean under climate change. During 2011 we started different activities with the goal of establishing time series measurements off Peru. The sampling activities were initialized during a visit of SFB754/IFM-GEOMAR-staff at IMARPE in May 2011. During this visit the Chemical Oceanography Staff (IMARPE) was introduced to the technique of sampling trace gases. Also a first cruise including N_2O sampling was conducted. A second sampling cruise took place in October 2011, where N_2O was sampled. The samples from both cruises were analyzed at the Biogeochemistry Laboratory of Dr. Hermann Bange, at the IFM-GEOMAR in Kiel, Germany. As a second phase of the training plan, two professionals from IMARPE-Georgina Flores and Michelle Graco, visited the IFM-GEOMAR in November 2011, to be introduced to the N_2O analysis method using the static headspace method and gas chromatography. The first results obtained from May and October 2011, show that most of the water column along the sampled transect was oversaturated with N_2O, indicating N2O production within the sampled region (see Figure 1). N_2O concentrations found in the water column ranged from 4.7 nmol/kg to 156 nmol/kg. Maximum N2O concentrations were observed in October coincident with a period characterized by an intense and shallow Oxygen Minimum Zone (OMZ < 25 ?M/Kg). We plan to continue during 2012 with the N_2O sampling off Callao.

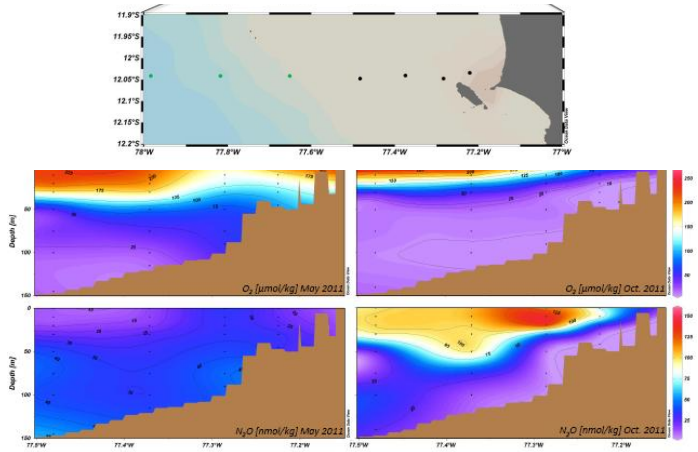


Figure. Upper panel: Location of the seven stations off Callao associated with an intense Oxygen Minimum Zone (OMZ) off central Peru (12º S). **Lower panel:** Comparison of O2 and N2O concentrations off Callao in May and in October 2011.

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

See point 1.

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

Participation of the Peruvian student, Maria del Carmen Igarza MSc candidate -Master of Marine Science Cayetano Heredia University, at the SOLAS Summer School (SSS) 2011.

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

Graco, M., Paulmier, A. Air-Sea gas fluxes at Eastern Boundary Upwelling and Oxygen Minimum Zones (OMZs) systems. A SOLAS Mid-Term Strategy initiative. 2011, SOLAS Special Reports. SOLAS Newsletter. N° 12.

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

In October 2011, several Peruvian scientists from the Instituto del Mar del Perú (IMARPE) and the Instituto Geofísico del Perú (IGP) participate in the international conference "Ocean Deoxygenation and implications for marine biogeochemical cycles and ecosystems" Toulouse (24-26 October 2011; http://www.eur-oceans.eu/conf-oxygen). France. This Eur-oceans conference was an excellent opportunity to discuss about one of the relevant topics associated with the global climate change, “the ocean loss of oxygen and the “extension of the Oxygen Minimum Zones (OMZs)” that is also one of the focus of the SOLAS OMZs-EBUEs Mid-Term Strategy Iniciative.

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 cruises focus in the SOLAS OMZs-EBUEs Mid-Term Strategy Iniciative topics, as the French Iniciative AMOP, and also at the SOLAS cruise/ SFB 754-IFM/GEOMAR.

-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

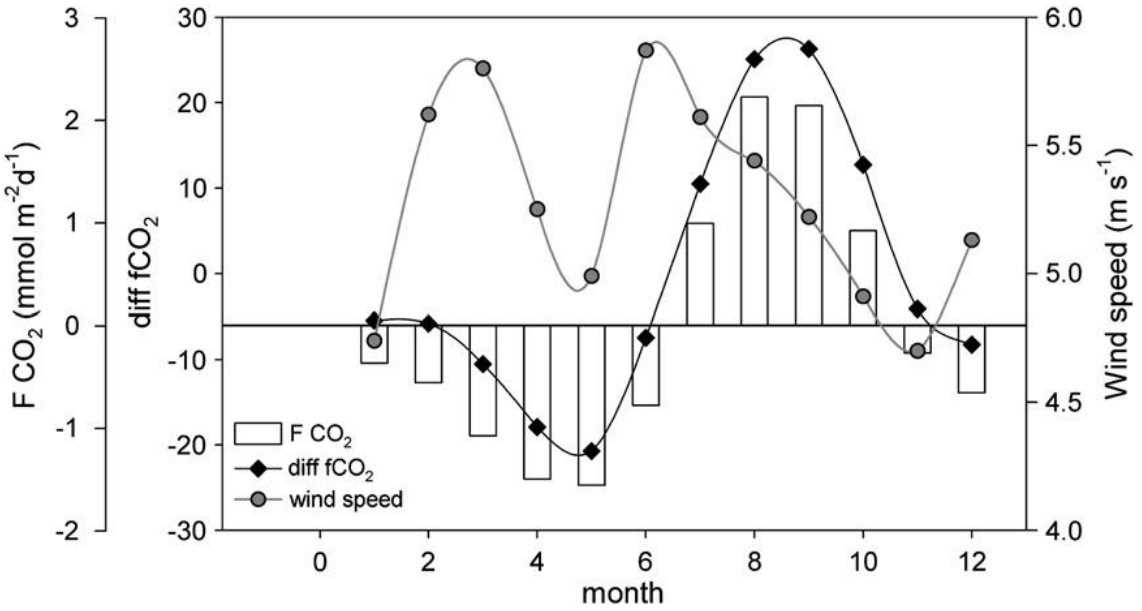
compiled by Rafel Simó

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)

CO_2 exchange patterns in the Strait of Gibraltar

Reconstruction of the temporal variability of the air-sea CO_2 exchange in the Strait of Gibraltar from 1997 to 2009 (data gathered in 36 cruises conducted in the area) has allowed to construct the seasonality of the marine source/sink of this important gas in that region of the sea. Contact person: E. Huertas (ICMAN-CSIC).



Climatological seasonal cycle of the monthly wind speed, air-water fCO_2 gradient and CO_2 fluxes in the Strait of Gibraltar (de la Paz et al. *Mar. Chem*. 2011).

Upwelling of CO_2-rich Antarctic waters was more important than the action of marine microorganism to account for the CO_2 increase during the last deglaciation

Research at the Institut de Ciències del Mar of Barcelona (CSIC) shows that, during the last deglaciation that began nearly 17.000 years ago, the retrait of Antarctic sea ice and the consequent upwelling of CO2-rich water from the deep was more determinant tan the action of planktonic microorganisms for the simultaneous rise of atmospheric CO2.

The research team is led by Eva Calvo and Carles Pelejero with co-investigators Isabel Cacho (University of Barcelona), Leopoldo D. Pena (University of Columbia) and Graham A. Logan (Geoscience Australia). Contact person: E. Calvo (ICM-CSIC).

La investigación ayuda comprender mejor los mecanismos naturales que determinan la concentración y distribución de CO_2 en el planeta, de especial relevancia en el contexto actual de aumento de emisiones y de calentamiento global.

The evolution of phytoplankton, and particularly diatoms and coccolithophores, in the Eastern Equatorial Pacific over the last 40,000 years was investigated for its role in CO2 regulation. Diatoms are known to be more efficient at removing CO2 from seawater and atmosphere because the process of calcification in coccolithophores cause a return of part of the utilized CO2. The study of biomarkers in sediment cores reveals that, at the onset of deglaciation, the upwelling of deep waters around Antarctica and their transport northwards favored the outburst of diatoms over coccolithophores. The associated potential increase in the capacity to remove CO2 was outcompeted by the efflux caused by the increased upwelling.

(Calvo et al. *PNAS* 2011)

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

Research Projects:

-The CSIC and the University of Las Palmas de Gran Canarias are partners of CARBOCHANGE (Changes in carbon uptake and emissions by oceans in a changing climate, # 264879) funded by European Commission (7^{th} frame program), 2011-2014.

- The CSIC and the CEAM are partners of INGOS (Integrated non CO_2 greenhouse gas observing system) funded by European Commission (7^{th} frame program), 2011-2015.

-ICOS (Integrated Carbon Observation System)-SPAIN 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.

- Contribution of Doñana (NP) wetlands to the regional atmospheric CO_2 exchange (049/2010), funded by the Spanish Ministry of Environment, 2011-2013. PI: E. Huertas (ICMAN-CSIC)

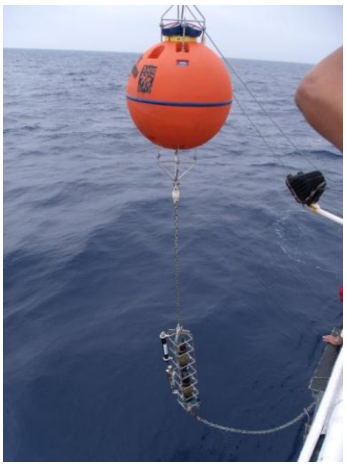
Cruises:

-The Malaspina 2010-11 Expedition, coordinated by C. Duarte (IMEDEA-CSIC), completed its trip around the global oceans (Dec 2010-Jul 2011). SOLAS activities aboard the RV Hespérides and Sarmiento de Gamboa included measurements of O2, CO2, isotopic ratios in CO2 and water vapour, pH, alkalinity, NH3, total volatile carbon, DMS, semivolatile organics, organic pollutants, aerosols, bioaerosols, atmospheric halogens, plankton metabolism, N2 fixation.

-E. Huertas (ICMAN-CSIC) led three oceanographic campaigns at the Strait of Gibraltar on board the RV García del Cid (July and November) and Cornide de Saavedra (August) to sample the GIFT time series to keep tracking carbon fluxes between the North Atlantic and Mediterranean Sea.

-Mooring of the autonomous sensors SAMI-pCO_2 and SAMI-pH in the Strait of Gibraltar for

monitoring temporal variability of CO_2 and ocean acidification in the outflow of Mediterranean water



-Mooring of SAMI-pCO_2 in Doñana wetlands to assess spatio-temporal variability of CO_2 in permanent freshwater lagoons.

-R. Simó (ICM-CSIC) led the SUMMER cruise (12-23/9/2011) to the Western Mediterranean. Drifters were deployed for a lagrangian study of a surface water patch over two weeks. The effects of the changing underwater light fields on plankton and trace gas dynamics at hourly to weekly timescales were investigated. High temporal and spatial resolution vertical profiles of DMS concentration were obtained for the first time with the use of a yoyo pump coupled to a miniCIMS instrument.

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

R. Simó (2011). The role of marine microbiota in short-term climate regulation. En *The Role of Marine Biota in the Functioning of the Biosphere* (C. Duarte, ed.). Fundación BBVA, Rubes Ed., Bilbao, pp. 107-130.

Collaborations with the media have been frequent during 2011 as a consequence of the Malaspina 2010-11 Expedition, which has been taken as a good opportunity to tell the society about the functioning of the coupled ocean-atmosphere-climate system.

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

Calvo E., C Pelejero, LD. Pena, I Cacho and GA. Logan (2011). Eastern Equatorial Pacific productivity and related-CO_2 changes since the last glacial period. *Proc. Nat. Acad. Sci. USA*, doi: 10.1073/pnas.1009761108

Berrojalbiz,N., J Dachs,S Del Vento,MJ Ojeda,MC Valle,J Castro-Jimenez,G Mariani, J Wollgast,G Hanke (2011). Persistent Organic Pollutants in Mediterranean Seawater and Processes Affecting Their Accumulation in Plankton. *Environ. Sci. Technol*. 45, 4315–4322

Berrojalbiz N,J Dachs,MJ Ojeda, MC Valle,J Castro-Jiménez, J Wollgast, M Ghiani, G Hanke, JM Zaldivar (2011). Biogeochemical and physical controls on concentrations of polycyclic aromatic hydrocarbons in water and plankton of the Mediterranean and Black Seas. *Global Biogeochem. Cycles* 25, GB4003, doi:10.1029/2010GB003775.

Lana A., T.G. Bell, R. Simó, S.M. Vallina, J. Ballabrera-Poy, A.J. Kettle, J. Dachs, L. Bopp, E.S. Saltzman, J. Stefels, J.E. Johnson, P.S. Liss (2011). An updated climatology of surface dimethlysulfide concentrations and emission fluxes in the global ocean. *Global Biogeochem Cycles* 25, GB1004, doi:10.1029/2010GB003850.

Galí M., V. Saló, R. Almeda, A. Calbet, R. Simó (2011). Stimulation of gross dimethylsulfide (DMS) production by solar radiation. *Geophys Res Lett* 38, L15612, doi:10.1029/2011GL048051.

de la Paz M, Huertas IE, Padín XA, Gónzalez-Dávila M, Santana-Casiano M, Forja JM, Orbi A, Pérez FF, Ríos AF (2011) Reconstruction of the seasonal cycle of air-sea CO_2 fluxes in the Strait of Gibraltar. *Mar. Chem* 126, 155-172.

Calvo E., R. Simó, R. Coma, M. Ribes, J. Pascual, A. Sabatés, J.M. Gili, C. Pelejero (2011). Impact of climate change on Mediterranean marine ecosystems: The case of the Catalan Sea. *Clim Res* 50: 1–29.

Flecha S, Pérez FF, Navarro G, Ruiz J, Olive I, Rodriguez-Galvez S, Costas E, Huertas IE (2011) Anthropogenic carbon inventory in the Gulf of Cadiz. *J. Mar. Syst*.10.1016/j.jmarsys.2011.10.010

Padin, X. A., Castro, C.G., Ríos, A. F., and Pérez, F. F. (2011). Oceanic CO_2 uptake and biogeochemical variability during the formation of the Eastern North Atlantic Central water under two contrasting NAO scenarios, *J. Mar. Syst*. 84, 3-4, 96-105.

Pardo, P. C., Vázquez-Rodríguez, M., Pérez, F. F. and Ríos, A. F. (2011). CO_2 air-sea disequilibrium and preformed alkalinity in the Pacific and Indian oceans calculated from subsurface layer data, *J. Mar. Syst* 84, 3-4, 67-77.

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

E. Huertas (ICMAN, CSIC) has been elected to the Executive Board of ICOS (Integrating Carbon Observation System) to implement the insertion of the ocean component in the infrastructure

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

2012 brings the launch of a new project: ADEPT (Aerosol deposition and ocean plankton dynamics), led by F. Peters (ICM-CSIC). ADEPT addresses the study of the effect of atmospheric aerosol deposition on the dynamics of a marine LNLC (low nutrient low chlorophyll) system, namely the Mediterranean. To achieve its goal, ADEPT uses a multiscale and complementary approach. Relationships between atmospheric deposition and ocean nutrient and plankton dynamics are studied at a coastal scale and at the Mediterranean basin scale. Laboratory experiments focus to understand some of the underlying mechanisms.

7. Other comments

SOLAS Turkey

compiled by Mustafa Kocak and Baris Salihoglu

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)

Iron solubility in crustal and anthropogenic aerosols: The Eastern Mediterranean as a case study

Seguret et al., 2011

Study presents seawater dissolution experiments for aerosol samples simultaneously collected across the Levantine Basin (LB, Eastern Mediterranean Sea), a marine system influenced by seasonal atmospheric inputs. Two distinct populations exhibited contrasting kinetic profiles, those representative of strong Saharan dust events which had variable iron release profiles with a maximum solubility of 0.94±1.48 % (1 s.d.) whereas those which had a relatively greater anthropogenic influence had consistent profiles (fast release, ≤ 2h,of dissolved iron in seawater followed by removal) with a maximum solubility of 11.5±9.3 % (1 s.d.). First estimates of atmospheric fluxes of soluble iron a represented, ranging from 8.64±10.76 $mgm^{-2}y^{-1}$ for the Northern LB to 6.48±7.78 $mgm^{-2}y^{-1}$ for the Southern LB. Estimates of Fe fluxes to oceanic basins are important for constraining the global iron budget, and dust dissolution kinetic profiles provide information on the mechanisms involved during the release of aerosol Fe in seawater post atmospheric deposition.

Kinetic dissolution profiles of the two aerosol populations

All anthropogenically influenced aerosols showed similar dissolution profiles (Fig.1.a) with the maximum dFe concentration occurring after 2h of contact with seawater, followed by a fast decrease. The mean maximum solubility for these aerosols was 11.5±9.3 %. The decrease in solubility after 2h may be a result of

(i) re-adsorption onto the aerosol particles on the filter (not the filter itself as no adsorption was apparent while equilibrating the blank filter in seawater) and/or

(ii) conversion of dissolved Fe to particulate species and/or organic complexes.

The mean seawater concentrations of released dissolved Fe for each of the equilibration periods (2, 4 and 8 h) were 11.5±9.3 nM; 4.0±3.5nM; 2.9±3.4 nM, respectively. After 8h, four aerosol samples had dFe concentrations > 2.0 nM. This indicates either (i) equilibrium between dissolved and particulate Fe was not reached after 8h or (ii) equilibrium may have been reached but soluble organic material had also been released, stabilizing higher dFe concentrations. For three of these four aerosol samples, dFe concentrations were not significantly different after 4 and 8h of dissolution, suggesting that equilibrium had been reached and hence the release of soluble organic matter played an important role.

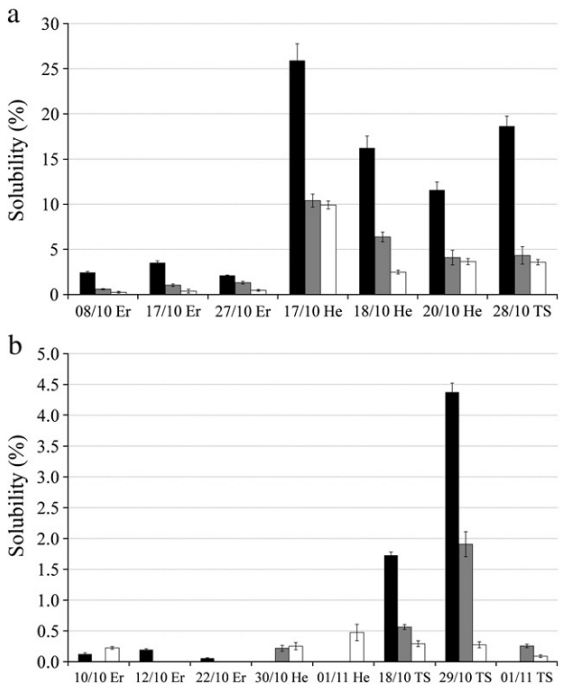


Figure 1. Percent solubility of iron during dissolutions of
a) anthropogenically influenced samples (n=8) and
b) crustally derived samples (n=7) from the three sites overtime (h).
ER= Erdemli,
HE= Heraklion,
TS= Tel-Shikmona
with the corresponding sampling dates (day/month) in 2007.

Black bars= 2h,
Gray bars= 4h and
White bars= 8h.
Error bars= ±1 s.d.

The changes in solubility of crustal aerosol samples with time of seawater equilibration are plotted in Fig.1.b. The overall mean maximum solubility was 0.94±1.48 % for all the samples considered and the maximum was reached at different equilibration times. In contrast to the anthropogenic aerosols, different kinetic trends were observed;

(i) a maximum solubility reached within 2–4 h followed by a decrease,

(ii) an increase in solubility without the attainment of equilibrium during the 8 h study period, and

(iii) no change insolubility with time.

These differences illustrate the contrasting behavior of aerosols from different sources due to their chemical composition and atmospheric aging processes.

Dry atmospheric fluxes of seawater soluble iron over the Levantine Basin

The calculated soluble iron fluxes for the two Levantine sub-basins were 8.79±10.23 $mgm^{-2}y^{-1}$ for the NLB and 9.01±9.94 $mgm^{-2}y^{-1}$ for the SLB. Having calculated the depositional fluxes it is then possible to calculate the atmospheric inputs across the Northern and Southern Basins, assuming the surface areas are 111,000 and 436,000 km^2 respectively (Ludwing and Maybeck,2003). The soluble iron inputs for the two basins ranged from 960±1100 ty^{-1} for NLB to 3900±4300 ty^{-1} for SLB. The NLB had lower inputs of soluble iron compared with the SLB, mainly as a result of the larger defined surface area of the SLB. Such a difference between the two basins has also been observed by Koçak et al. (2005).

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

sensing used, model and data intercomparisons etc)

IMS METU is granted an infrastructure project by the state funding agency to establish the Center for Marine Ecosystems and Climate Research (CMECLIM). CMECLIM aims to develop and to test analysis systems for the operational synoptic description of the environmental status of the Mediterrenean, Marrmara and Black Sea coastal waters. ECOCLIM aims to provide knowledge tools that can help authorities and other stakeholders to manage routine tasks, emergency situations and evaluate trends. Within the framework of CMECLIM a new atmospheric sampling site with a tower will be established on the Black Sea coast.

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

Marine Ecosystem Evolution in a Changing Environment (MEECE) Summer School 7-14 September 2011, Ankara, METU campus

Venue: Functioning and Evolution of marine ecosystems

The main objective of this course was to advance the scientific knowledge in a group of young people, with a marine sciences academic background. More specifically, the aims of the summer school are to help the students to:

- Understand the mechanisms, functioning and evolution of marine Ecosystems
- Assess the state of these ecosystems by taking into account their unique environmental drivers and pressures from natural and anthropogenic sources
- Learn innovative ways of integrating predictive models that resolve global change driver, changes in ocean circulation, climate, ocean acidification, pollution, over fishing and alien invasive species into available circulation-biogeochemical models.
- Address non linear combinations of driver impacts in a dynamic environment by using numerical simulation models which include dynamic feedbacks.
- Learn what is ecosystem-based approach to management?

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

Im, U., Poupkou, A., Incecik, S., Markakis, K., Kindap, T., Unal, A., Melas, D., Yenigun, O., Topcu, S., Odman, M. T., Tayanc, M., Guler, M., (2011) The impact of anthropogenic and biogenic emissions on surface ozone concentrations in Istanbul. Science of the Total Environment, 409, 7, 1255-1265

Kanakidou, M., Mihalopoulos, N., Kindap, T., Im, U., Vrekoussis, M., Gerasopoulos, E., Dermitzaki, E., Unal, A., Kocak, M., Markakis, K., Melas, D., Kouvarakis, G., Youssef, A.F., Richter, A., Hatzianastassiou, N., Hilboll, A., Ebojie, F., Wittrock, F., von Savigny, C., Burrows, J.P., Ladstaetter-Weissenmayer, A., Moubasher, H., (2011) Megacities as hot spots of air pollution in the East Mediterranean. Atmospheric Environment, 45, 6, 1223-1235.

Korotaev, G.K., Oguz, T., Dorofeyev, V.L., Demyshev, S.G., Kubryakov, A.I., Ratner, Yu.B., (2011) Development of Black Sea nowcasting and forecasting system. Ocean Science, 7, 5, 629-649.

Kose, N., Akkemik, U., Dalfes, H.N., Ozeren, M.S., (2011) Tree-ring reconstructions of May-June precipitation for western Anatolia. Quaternary Research, 75, 3, 438-450.

Koçak, M., Theodosi, C., Zarmpas, P., Im, U., Bougiatioti, A., Yenigun, O., Mihalopoulos, N., (2011) Particulate matter (PM10) in Istanbul: Origin, source areas and potential impact on surrounding regions. Atmospheric Environment, 45, 38, 6891-6900.

Philippart, C.J.M., Anadon, R., Danovaro, R., Dippner, J.W., Drinkwater, K.F., Hawkins, S.J., Oguz, T.,

O'Sullivan, G., Reid, P.C., (2011) Impacts of climate change on European marine ecosystems: Observations, expectations and indicators. Journal of Experimental Marine Biology and Ecology, 100, 1-2, 52-69.

Salihoglu B., Fach B. A., Oguz T., (2011) Control mechanisms on the ctenophore Mnemiopsis population dynamics: A modeling study. Journal of Marine Systems, 87, 1- 55-65.

Seguret, M.J.M., Kocak, M., Theodosi, C., Ussher, S.J., Worsfold, P.J., Herut, B., Mihalopoulos, N., Kubilay, N., Nimmo, M., (2011) Iron solubility in crustal and anthropogenic aerosols: The Eastern Mediterranean as a case study. Marine Chemistry, 126, 1-4, 229-238.

Sen, O. L., Unal, A., Bozkurt, D., Kindap, T., (2011) Temporal changes in the Euphrates and Tigris discharges and teleconnections. Environmental Research Letters , 6, 2. DOI: 10.1088/1748-9326/6/2/024012

Tugrul, S., Uysal, Z .,Erdogan, E., Yucel, N., (2011) Changes of Eutrofication Indicator Parameters (TP, DIN, Chl-a and TRIX) in the Cilician Basin (Northeast Mediterranean). Ekoloji, 20, 80, 33-41.

Vladymyrov, V., Kideys, A. E., (Myroshnychenko, V., Slipetsky, D., Shiganova, T., Abolmasova, G., Bingel, F., Tezcan, D., Ak, Y., Anninsky, B., Bat, L., Finenko, G., Gorbunov, V., Isinibilir, M., Kamburska, L., Mihneva, V., Ozdemir, Z. B., Romanova, Z., Sergeyeva, O., Stefanova, K., Xalvashi, M., (2011) A basin-wide Black Sea Mnemiopsis leidyi database. Aquatic Invasions, 6, 1, 115-122.

Yigiterhan, O., Murray, J.W., Tugrul, S., (2011) Trace metal composition of suspended particulate matter in the water column of the Black Sea. Marine Chemistry, 126, 1-4, 207-228.

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

IMS- METU collaborates with Barak Herut (group leader), Ilana Berma-Frank, Michael Krom, Travis Meador, Christos Panagiotopoulos, Eyal Rahav and Nikolaos Mihalopoulos in the framework of mesocosm experiment BioDustMix (MESOAQUA, EC contract no: 228224).

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

IMS-METU group is planning to improve laboratory infrastructures and obtain new instruments. The first year's motto is to have a Central Laboratory and instruments such as moored profiler, profiling floats, gliders and ion chromatography.

7. Other comments

SOLAS-UK

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

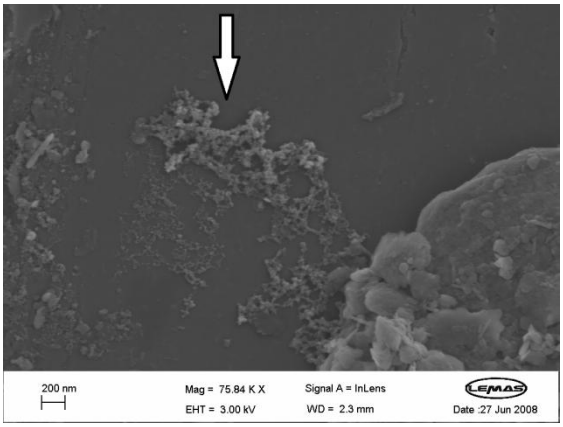
Notes:

- *Reporting Period is January – December 2011*
- *Information will be used for: reporting, fundraising, networking, strategic development & outreach*
- *This report summarises outputs and outcomes from the NERC-funded UK SOLAS Research Programme (now completed), also from other ongoing SOLAS-relevant programmes and projects, including the UK Ocean Acidification research programme.*

1. Key scientific SOLAS-relevant highlights/findings

1.1 How atmospheric processes alter the bioavailability of Fe and P in dust

Studies at the University of Leeds supported by the UK SOLAS programme have demonstrated that chemical weathering and aging of iron oxide minerals are important controls of iron solubility during acid processes in the atmosphere[1]. In the film of water around aerosol particles pH can be as low as 2, dissolving iron minerals[2]. When the pH is subsequently raised to ~5, as commonly happens during cloud formation, some of the dissolved iron is precipitated as nanoparticles of ferrihydrite (see figure), likely to be bioavailable if deposited to the ocean[3]. It was also found that iron dissolution on dust could be described by a three phase model in which the fastest phase was similar to ferrihydrite (by dissolution rate)[2]. Contrary to previous hypotheses, grain size alone was found to have only a minor effect on the Fe solubility in Sahara dust[4]. Additional, preliminary studies provide evidence for the first time that similar acid processes in the atmosphere also increase the solubility – and hence bioavailability – of P in mineral dust[5].



Iron nanoparticles (arrow) found in a dust filtered from rainwater collected from the West Mediterranean[3]

1 Shi Z, Krom MD, Bonneville S, Baker AR, Bristow C, Drake N, Mann G, McQuaid JB, Carslaw K, Jickells T & Benning LB. 2011. Influence of chemical weathering and aging of iron oxides on the potential iron solubility of Saharan dust during simulated atmospheric processing. *Global Biogeochem.Cycles*, 25, GB2010; doi: 10.1029/2010GB003837..

2 Shi Z, Bonneville S, Krom MD, Carslaw KS, Jickells TD, Baker AR & Benning LG. 2011. Iron dissolution kinetics of mineral dust at low pH during simulated atmospheric processing, *Atmos. Chem. Phys*. 11, 995-1007; doi: 10.5194/acp-11-995-2011.

3 Shi Z, Krom MD, Bonneville S, Baker AR, Jickells TD & Benning LG. 2009. Formation of iron nanoparticles and increase in iron reactivity in mineral dust during simulated cloud processing. *Environ. Sci. Technology* 43, 6592-6596; doi: 10.1021/es901294g

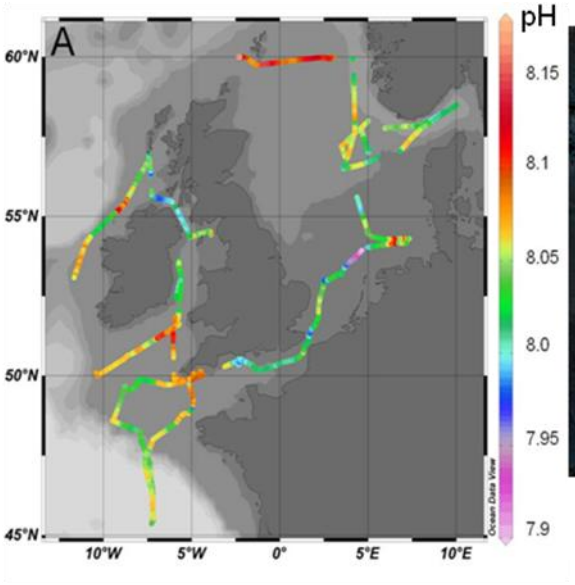
4 Shi Z, Woodhouse M, Carslaw K, Krom M, Mann G, Baker A, Savov I., Fones G, Brooks B, Drake N, Jickells T & Benning L. 2011, Minor effect of physical size sorting on iron solubility of transported mineral dust. *Atmos. Chem. Phys.* 11, 8459-8469, doi: 10.5194/acp-11-8459-2011.

5 Nenes A, Krom MD, Mihalopoulos N, Van Cappellen P, Shi Z, Bougiatioti A, Zarmpas P & Herut B. 2011. Atmospheric acidification of mineral aerosols: A source of bioavailable phosphorus for the oceans. *Atmos. Chem. Phys*. 11, 6265-6272, doi:10.5194/acp-11-6265-2011.

1.2 First research cruise to investigate ocean acidification effects in shelf seas

Few field-based studies have investigated the biogeochemical effects of natural pH variability, other than at 'extreme' environments of CO_2 vent sites. The first of a series of three research cruises with that aim took place on RRS *Discovery*, 6 June –9 July 2011, supported by the UK Ocean Acidification research programme. Led by the University of Southampton, researchers from eight institutions investigated the impacts of changing seawater chemistry on marine organisms, ecosystems, and relevant interactions with the atmosphere (including via DMS). The cruise covered a wide range of environmental conditions around the UK; it involved 60 CTD stations (~1500 sampling bottles), 320 underway sampling points, and 5 bioassay experiments (each ~80 bottles). Analyses of data and samples are in progress, with additional laboratory experiments. Cold-water coral sampling and short-term experiments were also included.

Preliminary pH data along the cruise track are shown below (data may be subject to correction). A few weeks earlier, a dramatic coccolithophore bloom had occurred in the NE North Sea, as shown in the satellite image. When that area was sampled, the water was still visibly milky-blue, but very few living coccolithophores were found. For further information, see cruise blog at http://noc.ac.uk/news/rrs-discovery-cruise-366 and the UKOA sea surface consortium website www.surfaceoa.org.uk.



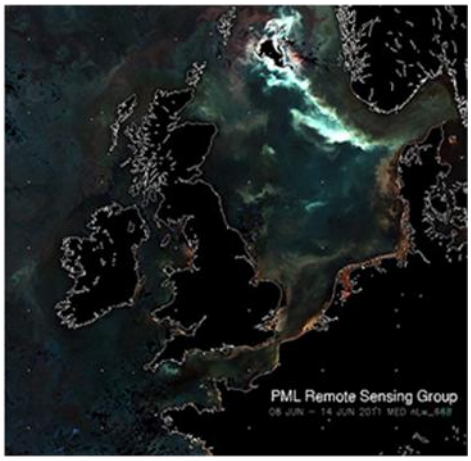
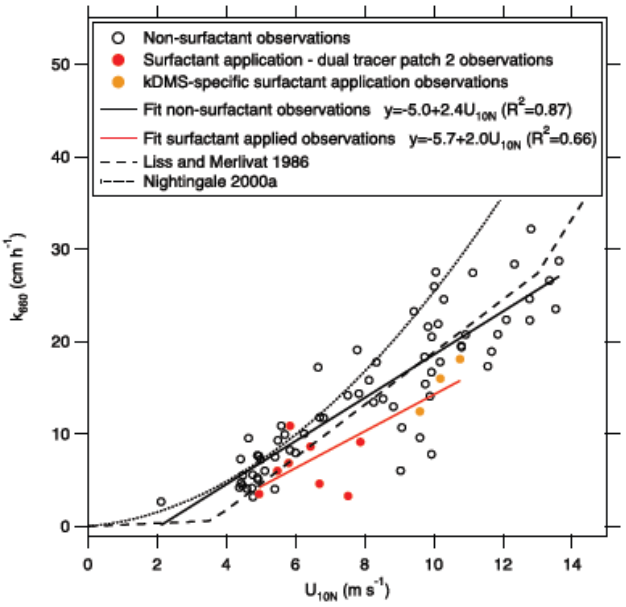


Image credits: left, Victoire Rerolle; above, Plymouth Marine Laboratory.

1.3 Added surfactant reduces air-sea gas exchange

During the UK SOLAS Deep Ocean Gas Exchange Experiment (DOGEE) in the North East Atlantic, led by the University of Newcastle, several independent estimates were simultaneously made of gas transfer velocities and air-sea fluxes of CO_2 and DMS[1]. A highlight of DOGEE was the first-ever study of the effect of a deliberately released surfactant (oleyl alcohol) on gas transfer velocity (k_w) in the open ocean, estimated with the $^3He/SF_6$ dual tracer technique designed to estimate k_w on the timescale of hours to days, and from measured sea-to-air fluxes and surface water concentrations of DMS[2].



Transfer velocity (k_w) as a function of wind speed at 10 m (U_{10N}) determined from measurement of DMS air-sea fluxes and surface water concentrations. Open circles (with black solid line as linear fit) are estimates unaffected by added surfactant; red and gold circles (with red line) are estimates influenced by surfactant. The relationships of Liss & Merlivat[3] and Nightingale et al[4] (dashed and dotted black lines respectively) are added for reference. Reproduced by permission of American Geophysical Union.

Of seven independent k_w estimates derived from $^3He/SF_6$, two were influenced by the surfactant and showed a k_w suppression of between ~5% and ~55% for wind speeds in the range 7.2–10.7 m s^{-1} relative to surfactant-free waters[2]. Similarly, k_w devolved from simultaneous measurements of DMS flux and concentration was also depressed by the surfactant[2], ranging from ~39% at 5.0 m s^{-1} to ~24% at 10.8 m s^{-1} (see figure). Surfactant thus has the potential to measurably suppress air-sea gas exchange rates even at

moderate to high wind speeds when wave breaking is frequent. This is important because the presence of surfactant could to some degree offset the expected abrupt increase in k_w due to wave-breaking.

1 Brooks IM et al. 2009. Physical exchanges at the air‐sea interface: UK SOLAS field measurements, *Bull. Am. Meteorol. Soc*., 90(5), 629–644, doi:10.1175/2008BAMS2578.1.

2 Salter ME, Upstill-Goddard RC, Nightingale PD, Archer SD, Blomquist B, Ho DT, Huebert B, Schlosser P & Yang M. 2011. Impact of an artificial surfactant release on air‐sea gas fluxes during Deep Ocean Gas Exchange Experiment II, *J. Geophys. Res*., 116, C11016, doi: 10.1029/2011JC007023.

3 Liss PS & Merlivat L. 1986. Air‐sea gas exchange rates: Introduction and synthesis, in *The Role of Air‐Sea Exchange in Geochemical Cycling*, edited by P. Buat‐Ménard, pp. 113–129, D. Reidel, Dordrecht, Netherlands.

4 Nightingale P, Malin G, Law CS, Watson AJ, Liss PS, Liddicoat MI, Boutin J & Upstill-Goddard RC. 2000. In situ evaluation of air-sea gas exchange parameterizations using novel conservative and volatiletracers, *Global Biogeochem. Cycles*, 14, 373–387, doi:10.1029/1999GB900091.

1.4 New dataset for air-sea fluxes obtained with wide coverage of conditions and regions

The Waves Aerosol and Gas Exchange Study (WAGES) was developed from the UK-SOLAS HiWASE, SEASAW and DOGEE projects in order to better quantify the effects of sea state and wave breaking on the air-sea exchange of greenhouse gases. In May 2010, the NERC research vessel RRS *James Clark Ross* was equipped with a suite of systems and sensors to provide data on air-sea fluxes of CO_2, sea spray aerosol, heat and momentum as well as on sea state and wave-breaking. These sensors have operated continuously since then, sampling a very wide range of conditions and regions (Fig 1). In addition, four WAGES cruises have been successfully completed, with deployment of a novel wave-breaking buoy[1] (Fig 2). The most recent Southern Ocean cruise in December 2011 obtained flux and wave-breaking data at wind speeds >15 m s^{-1} both in extreme open-ocean conditions, encountered in Drake Passage, and in short-fetch conditions, off the Falkland Islands. Preliminary results suggest that the number of wave-breaking events depend strongly on fetch (Fig. 3). Underway measurements will continue until at least the end of 2012. WAGES is a joint project between NOC (Margaret Yelland) and the University of Leeds (Ian Brooks). For blog of the most recent WAGES cruise, see http://frictionvelocity.wordpress.com.

1 Pascal RW, Yelland MJ, Srokosz MA, Moat BI, Waugh E, Comben D, Cansdale A, Hartman M, Coles D, Huseh PC & Leighton TG. 2011. A spar buoy for high frequency wave measurements and detection of wave breaking in the open ocean. *J. Atmos. & Ocean Technol.,* 28, 590-605; doi: http://dx.doi.org/10.1175/2010JTECHO764.1

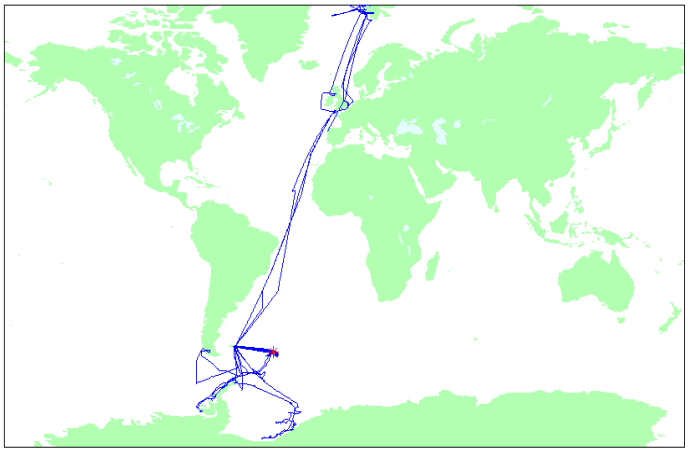
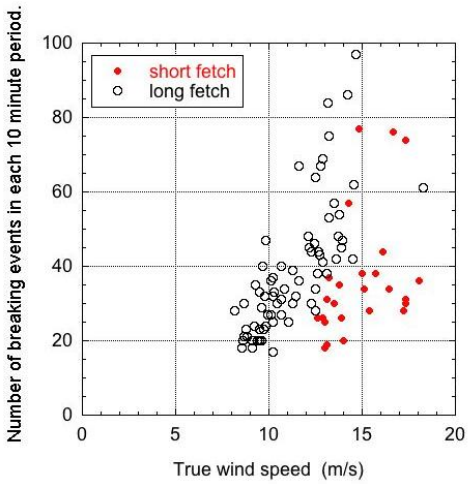


Figure 1 (above). Cruise track of RRS *James Clark Ross* since May 2010.

Figure 2 (above right). The NOC wave - breaking buoy.

Figure 3 (right). Wave breaking events vs wind speed; preliminary data.



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

2.1 Major programmes and projects

- The ***Final Report for UK SOLAS*** as a coordinated, NERC-funded programme was posted online in March 2011, at www.nerc.ac.uk/research/programmes/solas/results.asp. Additional information on UK SOLAS research cruises, data inventories and data access is available through the British Oceanographic Data Centre, www.bodc.ac.uk/projects/uk/uksolas.
- The £11m ***UK Ocean Acidification*** (UKOA) research programme, co-funded by NERC, Defra and DECC, is now fully underway, contributing to SOLAS research in five main areas:
  - Observations and synthesis to establish variability and trends of oceanic pH
  - Ocean acidification impacts on sea surface biogeochemistry and climate [*see Section 1.2*]
  - 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.

  There are also biologically-focussed components, primarily IMBER-related. For details see www.oceanacidification.org.uk or contact p.williamson@uea.ac.uk (UKOA Science Coordinator).
- The £3.8m ***OSMOSIS (Ocean Surface Mixing, Ocean Sub-mesoscale Interaction Study)*** research programme began in 2011. This NERC-funded project 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. Two research cruises are planned. Contact: Prof Stephen Belcher s.e.belcher@reading.ac.uk.
- The NERC multi-Centre ***Oceans 2025 programme*** is now nearing completion; SOLAS-relevant work has mostly been supported through its 'Marine Biogeochemical Cycles' theme, involving PML, NOC and MBA; see www.ocean2025.org
- ***WAGES (Waves, Aerosol & Gas Exchange Study),*** a joint project between NOC and Leeds, has completed ~18 months of 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. In addition to the autonomous measurements, there are two manned cruises each year with tethered and free-drifting spar buoys [*see Section 1.4*]. Measurements continue until at least summer 2012; details: http://homepages.see.leeds.ac.uk/~lecimb/WAGES
- The ***UK GEOTRACES*** project is now fully underway, funded by NERC and addressing micronutrient cycles and ocean paleoproxies with focus on two Atlantic sections. Participants at Oxford, Bristol, Cambridge, Edinburgh, Imperial College. Manchester, NOC, PML, Plymouth, Southampton and UEA. Details: www.ukgeotraces.com.
- The UK-led, ESA-funded ***Oceanflux Greenhouse Gases*** project began in 2011, with 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

- UK provides leadership for ***COST Action 735*** "Tools for assessing global air-sea fluxes of climate and air pollution relevant gases". Four meetings were held in 2011: on the sea-surface microlayer (25-26 January, Plymouth); sea-ice biogeochemistry (12-14 April, Amsterdam), and preparing the publication *Ocean-Atmosphere Interactions of Gases and Particles* (4-6 May, Brussels; 28 November, Frascati); www.cost-735.org
- 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 fieldwork

There were eight SOLAS-relevant research cruises in 2011, all on NERC research vessels and supported by a range of funding mechanisms. As follows:

- *Discovery* 361 (7 Feb- 9 Mar; led by Eric Achterberg) – linking Fe supply and N_2 fixation in (sub-) tropical Atlantic
- *James Clark Ross* 254C (19 Mar – 5 Apr; Ian Brooks) – Waves, Aerosol & Gas Exchange Study (WAGES), in Southern Ocean
- *Discovery* 366 (6 Jun -8 Jul; UKOA cruise, led by Eric Achterberg) – upper ocean biogeochemistry and ocean acidification around UK
- *Discovery* 369 (9 Aug -16 Sep; Mike Zubkhov) – upper ocean biogeochemistry in tropical Atlantic
- *Discovery* 371 (29 Sep – 12 Nov; Glen Tarran) – Atlantic Meridional Transect (AMT) #21; upper ocean biogeochemistry in both North and South Atlantic
- *James Clark Ross* 254D (25 Nov –8 Dec; Margaret Yelland) – Waves, Aerosol & Gas Exchange Study (WAGES), in Southern Ocean
- *Discovery* 373 (7 Dec 2011 - 20 Jan 2012; Mark Trimmer) – N_2O formation in Oxygen Minimum Zone (OMZ) in eastern tropical Pacific
- *James Cook* 68 (24 Dec 2011 - 27 Jan 2012; Gideon Henderson) – trace nutrient dynamics, including Fe in South Atlantic 40°S transect).

2.3 Other activities

- The UK continued to host the SOLAS nodal office at UEA, with NERC support.
- A national workshop on marine trace gases was held at Plymouth, 24-25 March 2011, supported by NERC's Strategic Ocean Funding Initiative (SOFI)
- Eight UK-based research students attended the 2011 SOLAS Summer School, with NERC support. There were also three UK-based lecturers.

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

The UK Ocean Acidification programme has been active in this area, with three major outreach activities:

- Production of a short film *Ocean Acidification: Connecting Science, Industry, Policy and Public*, available online at www.youtube.com/watch?v=BPS8ctVW2s
- Lead role in production of *Hot, Sour & Breathless – Ocean under Stress* brochure for UNFCCC CoP17); 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 .

Public engagement achievements in other SOLAS science areas included David Sproson, a postdoc researchers at Leeds, winning the marine section of the Welcome Trust's 2011 competition "I'm a Scientist Get Me Out Of Here" (http://marinej11.imascientist.org.uk/profile/davesproson).

Capacity building and training included strong UK involvement in the 2011 SOLAS Summer School (see above). Policy-relevant activities are detailed in Section 5 below.

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

A list of known 2011 SOLAS-UK publications is given here in three groups, based on community-wide input. 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. [* Indicates publications already mentioned in Section 1 above].

4.1 Direct linkage to UK SOLAS research programme, peer-reviewed (n = 22)

Archer SD, Tarran GA, Stephens JA, Butcher LJ & Kimmance SA. 2011. Combining cell sorting with gas chromatography to determine phytoplankton group-specific intracellular dimethylsulphoniopropionate. *Aquatic Microbial Ecol.*, 62, 109-121.

Beale R, Liss PS, Dixon JL & Nightingale PD. 2011. Quantification of oxygenated volatile organic compounds in seawater by membrane inlet-proton transfer reaction/mass spectrometry. *Anal. Chim. Acta*, 706, 128-134; doi: 10.1016/j.aca.2011.08.023

Carpenter LJ, Fleming ZL, Read KA, Lee JD, Moller SJ, Hopkins JR, Purvis RM, Lewis AC, Müller K, Heinold B, Herrmann H, Wadinga Fomba K, van Pinxteren D, Müller C, Tegen I, Wiedensohler A, Müller T, Niedermeier N, Achterberg EP, Patey MD, Kozlova EA, Heimann M, Heard DE, Plane JMC, Mahajan A, Oetjen H, Ingham T, Stone D, Whalley LK, Evans MJ, Pilling MJ, Leigh RJ, Monks PS, Karaunaharan A, Vaughan S, Arnold SR, Tschritter J, Pöhler D, Frieß U, Holla R, Mendes LM, Lopez H, Faria B, Manning AJ & Wallace DWR. 2011. Seasonal characteristics of tropical marine boundary layer air measured at the Cape Verde Atmospheric Observatory, *J. Atmos.Chem*., 67, 87-140; doi: 10.1007/s10874-011-9206-1

Cunliffe M, Upstill-Goddard RC & Murrell JC. 2011. Microbiology of aquatic surface microlayers. *FEMS Microbiol. Rev.*, 35, 233-246; doi: 10.1111/j.1574-6976.2010.00246.x

Dixon JL, Beale R & Nightingale PD. 2011. Rapid biological oxygenation of methanol in the tropical Atlantic: significance as a microbial carbon source. *Biogeosciences*, 8, 2707-2716; doi: 10.5194/bg-8-2707-2011

Dixon J, Beale R & Nightingale PD. 2011. Microbial methanol uptake in northeast Atlantic waters. *ISME Journal,* 5, 704-716; doi: 10.1038/ismej.2010.169

Fuentes E, Coe H, Green D, & McFiggans G. 2011. On the impacts of phytoplankton-derived organic matter on the properties of the primary marine aerosol – Part 2. Composition, hygoscopicity and cloud condensation activity. *Atmos. Chem. Physics*, 11, 2585-2602; doi: 10.5194/acp-11-2585-2011

Hughes C, Franklin DJ & Malin G. 2011. Iodomethane production by two important marine cyanobacteria: *Prochlorococcus marinus* (CCMP 2389) and *Synechococcus* sp. (CCMP 2370). *Mar. Chem.*,125, 19-25; doi: 10.1016/j.marchem.2011.01.007

Jones CE, Hornsby KE, Sommariva R, Dunk RM, von Glasow R, McFiggans G & Carpenter LJ. 2011. Quantifying the contribution of marine organic gases to atmospheric iodine. *Geophys. Res. Letters*, 37, L18804; doi: 10.1029/2010GL043990

Lana A, Bell TG, Simo R, Vallina SM, Ballabrera-Poy J, Kettle AJ, Dachs J, Bopp L, Saltzman ES, Stefels J, Johnson JE & Liss PS. 2011. An updated climatology of surface dimethylsulfide concentrations and emission fluxes in the global ocean. *Global Biogeochem. Cycles* 25, GB1004, doi: 10.1029/2010GB003850

Lapina K, Heald CL, Spracklen DV, Arnold SR, Allan JD, Coe H, McFiggans G, Zorn SR, Drewnick F, Bates TS, Hawkins LN, Russell LM, Smirnov A, O'Dowd CD & Hind AJ. 2011. Investigating organic aerosol loading in the remote marine environment. *Atmos. Chem. Physics,* 11, 8847-8860; doi: 10.5194/acp-11-8847-2011

Lawler MJ, Sander R, Carpenter LJ, Lee JD, von Glasow R, Sommariva R & Satzman ES. 2011. HOCl and Cl_2 observations in marine air. *Atmos. Chem. Physics,* 11, 7617-7628; doi: 10.5194/acp-11-7617-2011

Lowe D, Ryder J, Leigh R, Dorsey JR & McFiggans G. 2011. Modelling multi-phase halogen chemistry in the coastal marine boundary layer: investigation of the relative importance of local chemistry vs. long-range transport. *Atmos. Chem. Physics,* 11, 979-994; doi: 10.5194/acp-11-979-2011.

***Pascal RW, Yelland MJ, Srokosz MA, Moat BI, Waugh E, Comben D, Cansdale A, Hartman M, Coles D, Huseh PC & Leighton TG. 2011: A spar buoy for high frequency wave measurements and detection of wave breaking in the open ocean. *J. Atmos.Ocean Technol.,* 28, 590-605; doi: http://dx.doi.org/10.1175/2010JTECHO764.1**

Rees AP, Brown IJ, Clark DR & Torres R. 2011. The Lagrangian progression of nitrous oxide within filaments formed in the Mauritanian upwelling. *Geophys. Res. Letters*, 38, L21606; doi: 10.1029/2011GL049322

***Salter ME, Upstill-Goddard RC, Nightingale PD, Archer SD, Blomquist B, Ho DT, Huebert B, Schlosser P & Yang M. 2011. Impact of an artificial surfactant release on air-sea gas fluxes during Deep Ocean Gas Exchange Experiment II. *J.Geophys. Res. - Oceans*, 116, C110106; doi: 10.1029/2011JC007023**

*Shi Z, Bonneville S, Krom MD, Carslaw KS, Jickells TD, Baker AR & Benning LG. 2011. Iron dissolution kinetics of mineral dust at low pH during simulated atmospheric processing. *Atmos. Chem. Physics*, 11, 995-1007; doi: 10.5194/acp-11-995-2011

***Shi ZB, Krom MD, Bonneville S, Baker AR, Bristow C, Drake N, Mann G, Carslaw K, McQuaid JB, Jickells T &**

Benning LG. 2011. Influence of chemical weathering and aging of iron oxides on the potential iron solubility of Saharan dust during simulated atmospheric processing. *Glob. Biogeochem. Cycles*, 25, GB2010; doi: 10.1029/2010GB003837

*Shi ZB, Woodhouse MT, Carslaw KS, Krom MD, Mann GW, Baker AR, Savov I, Fones GR, Brooks B, Drake N, Jickells TD & Benning LG. 2011. Minor effect of physical size sorting on iron solubility of transported mineral dust. *Atmos. Chem. Physics*, 11, 8495-8469; doi: 10.5194/acp-11-8459-2011

Smyth, T.J. (2011) Penetration of UV irradiance into the global ocean. *J. Geophys. Res.*, 116, C11020, doi: 10.1029/2011JC007183

Turk KA, Rees AP, Zehr JP, Pereira N, Swift P, Shelley R, Lohan M, Woodward EMS &. Gilbert J. 2011. Nitrogen fixation and nitrogenase (nifH) expression in tropical waters of the eastern North Atlantic. *ISME Journal*, 5, 1201-1212; doi:10.1038/ismej.2010.205

Vaughan S, Ingham T, Whalley LK, Stone D, Evans MJ, Read KA, Lee JD, Moller SJ, Carpenter LJ, Lewis AC, Fleming ZL & Heard DE. 2011. Seasonal observations of OH and HO_2 in the remote tropical marine boundary layer, *Atmos. Chem. Phys. Discuss*., 11, 21429-21487, 2011

4.2 Other SOLAS-relevant peer-reviewed publications (including those on biogeochemical aspects of ocean acidification, but mostly limited to those with UK first author; n = 15)

Archer SD, Safi K, Hall A, Cummings DG & Harvey M. 2011. Grazing suppression of dimethylsulphonio- propionate (DMSP) accumulation in iron-fertilised, sub-Antarctic waters. *Deep-Sea Res. II – Topical Studies*, 58, 839-850

Boden R, Murrell JC & Schafer H. 2011. Dimethylsulfide is an energy source for the heterotrophic marine bacterium *Sagittula stellata*. *FEMS Microbiol. Letters*, 322, 188-193; doi: 10.1111/j.1574-6968.2011.02349.x

Brooks IM, Andreas EL, McFiggans G, Anguelova MD & O'Dowd C. 2011. Primary marine aerosol fluxes; progress and priorities. *Bull. Am. Met. Soc.*, 92, 489-491; doi: 10.1175/2010BAMS3112.1

Brading P, Warner ME, Davey P, Smith DJ, Achterberg EP & Suggett DJ. 2011. Differential effects of ocean acidification on growth and photosynthesis among phylotypes of *Symbiodinium* (Dinophyceae) *Limnol. Oceanogr.*, 56, 927-938; doi: 10.4319/lo.2011.56.3.0927

Goddijn-Murphy L, Woolf DK & Callaghan AH. 2011. Parameterizations and algorithms for oceanic whitecap coverage. *J. Phys. Oceanogr.,* 41, 742-756, doi: 10.1175/2010JPO4533.1.

Held A, Brooks IM, Leck C, & Tjernström M. 2011. On the potential contribution of open lead particle emissions to the central Arctic aerosol concentration. *Atmos. Chem. Phys.* 11, 3093-3105, doi: 10.5194/acp-11-3093-2011.

Hunter KA, Liss PS, Surapipith V, Dentener F, Duce R, Kanakidou M, Kubilay N, Mahowald N, Okin G, Sain M, Uematsu M & Zhu T. 2011. Impacts of anthropogenic SO_x, NO_x and NH_3 on acidification of coastal waters and shipping lanes. *Geophys. Res. Letters*, 38, L13602; doi: 10.1029/ 2011GL047720

Jones CE, Andrews SJ, Carpenter LJ, Hogan C, Hopkins FE, Laube JC, Robinson AD, Spain TG, Archer SD, Harris NRP, Nightingale PD, O'Doherty SJ, Oram DE, Pyle JA, Butler JH & Hall BD. 2011. Results from the first national UK inter-laboratory calibration for very short-lived halocarbons. *Atmospheric Measurement Techniques*, 4, 865-874; doi: 10.5194/amt-4-865-2011

Manning AC, Nisbet EG, Keeling RF & Liss PS. 2011. Greenhouse gases in the Earth system: setting the agenda to 2030. *Phil. Trans. Roy. Soc. A,* 369, 1885-1890; doi: 10.1098/rsta.2011.0076

Nenes A, Krom MD, Mihalopoulos N, Van Cappellen P, Shi Z, Bougiatioti A, Zarmpas P & Herut B. 2011. Atmospheric acidification of mineral aerosols: A source of bioavailable phosphorus for the oceans. *Atmos. Chem. Phys*. 11, 6265-6272, doi:10.5194/acp-11-6265-2011.

Norris SJ, Brooks IM, de Leeuw G, Sirevaag A, Leck C, Brooks BJ, Birch BE & Tjernström M. 2011. Measurements of bubble size spectra within leads in the Arctic summer pack ice. *Ocean Science*. 7, 129-139, doi:10.5194/os-7-129-2011.

Turley C & Boot K. 2011 The ocean acidification challenges facing science and society. Chapter 14 in: *Ocean acidification* (Eds J-P Gattuso & L Hansson), Oxford University Press.

Turley C, Gattuso J-P & Hoegh-Guldberg O. 2011. Ocean acidification: examples of potential impacts. In: *Climate Change: Global Risks, Challenges and Decisions* (ed. K Richardson et al.) Cambridge University Press

Watson AJ, Metzl N & Schuster U. 2011. Monitoring and interpreting the ocean uptake of atmospheric CO_2. 2011. *Phil. Trans.Roy. Soc. A,* 369, 1997-2008; doi: 10.1098/rsta.2011.0060

Zeebe RE & Ridgwell A. 2011. Past changes in ocean carbonate chemistry. Chapter 2 in: *Ocean acidification* (Eds J-P Gattuso & L Hansson), Oxford University Press.

4.3 Other high-profile, SOLAS-relevant publications and presentations, not peer-reviewed

Eight oral presentations with UK lead authorship at ASLO Aquatic Sciences Meeting, Puerto Rico, 13-18 February 2011:

- Archer SD, Stephens JA. Stefels J, Hopkins FJ & Kimmance SA. Explanation of the temporal progression of DMS flux from a coastal upwelling system.
- Bayindirli C, Thomas S, Gilbert J, Tarran G, Widdicombe C, Woodward M, Torres R, Achterberg E, Mingkwan P &

Robinson C. Temporal succession in microbial community structure and gene expression during a Lagrangian study in the North West African upwelling.

- Hill PG, Purdie DA & Zubkov MV. High spatial variability of microbial amino acid uptake in an eastern boundary upwelling system, North West Africa.
- Loucaides S, Tyrrell T, Achterberg EP, Robinson C & Hardman-Mountford N. Biogeochemical cycling of carbon dioxide along an upwelling filament off Cape Blanc, NW Africa: Results from a Lagrangian study.
- Ridgwell, AJ. Ocean acidification: the 'other CO_2 problem?'?
- Robinson C, Hardman-Mountford N, Serret P, Kitidis V, Tilstone G, Loucaides S, Torres R, Nightingale P, Smyth T & Stephens J. The impact of coastal upwelling on the cycling of dissolved oxygen and carbon dioxide.
- Serret P, Kitidis V, Robinson C, Hill P, Zubkov MV & Tarran G. Lagrangian observations of plankton community and bacterial production and respiration along NW African upwelling filaments.

Four oral presentations with UK lead authorship at AGU Fall meeting, San Francisco, 5-9 December 2011:

- Carpenter LJ, Shaw MD, Parthipan P, Plane JMC & Macdonald S. Globally important emissions of iodine from the sea surface
- Jiang Z, Hydes DJ, Hartman SE & Hartman MC. Key controls of surface carbonate system dynamics around the northwest European continental margin.
- Liss PS. How does ocean biology affect cloud properties?
- McFiggans G, Allan JD, Coe H, Crosier J, Fuentes E, Good N, Green D, Topping DO, Whitehead J & Williams PI. Composition and hygroscopicity of real and synthetic marine aerosol.

Other oral presentations with UK lead authorship at major international meetings included:

- Brooks IM, Held A, Leck C, Tjernström M, Norris SJ, de Leeuw G, Sirevaag A, Birch CE & Brooks BJ. Linking the Arctic Ocean and clouds - bubble and aerosol flux measurements from ASCOS, AMS 11th Conference on Polar Meteorology and Oceanography, 2-5 May 2011, Boston, USA.

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

In 2011, the SOLAS-UK research community maintained (and, in many areas, strengthened) its wide range of international linkages. These relate to both science and policy, and include:

- Co-support of **Observatório Atmosferico de Cabo Verde: Humberto Duarte Fonseca** (Cape Verde Atmospheric Observatory), through the NERC National Centre for Atmospheric Sciences jointly with the Leibniz-Institut für Meereswissenschaften,Germany (IFM-GEOMAR), the Max Planck Institut für Biogeochemie, Germany (MPIB Jena) and the Leibniz-Institut für Tropo-sphärenforschung, Germany (IfT Leipzig), and the Cape Verde National Institute of Meteorology and Geophysics (INMG). Details at http://ncasweb.leeds.ac.uk/capeverde
- UK leadership (Chair: Dorothee Bakker) of the international **Surface Ocean CO_2 Atlas (SOCAT)** project, with online publication of v1.5 in September 2011. Details at www.socat.info
- UK leadership (Chair: Peter Liss) for **COST Action 735** "Tools for assessing global air-sea fluxes of climate and air pollution relevant gases" www.cost-735.org; information on 2011 meetings given in Section 2.
- Participation (by Jerry Blackford, Daniela Schmidt, Carol Turley & Stephen Widdicombe) in **Intergovernmental Panel on Climate Change** workshop (WGs I & II) on Impacts of Ocean Acidification on Marine Biology and Ecosystems, Okinawa, Japan, 17-19 Jan 2011. Selection of Schmidt and Turley to be Lead Author and Review Editor for Chapters in IPCC 5th AR WGII.
- Participation (by Turley) in the **UN Framework Convention on Climate Change** Conference of Parties (CoP 17) in Durban, 28 November - 9 December, with *Ocean under Stress* display and associated publications (jointly between PML, Scripps, Oceana, UKOA, EPOCA and MedSeA); also involvement in UN-Oceans side event (with IOC). Participation (by Carol Turley & Phil Williamson) in preparatory UNFCCC Science Workshop, Bonn, 2-3 June.
- Participation in **Convention on Biological Diversity** Expert Group meetings on geoengineering, London, 29 June-1 July (Phil Williamson) and ocean acidification, Montreal, 19-20 October (Stephen Widdicombe & Murray Roberts).
- Participation (by Phil Williamson, as SOLAS/IGBP representative) in 43rd Executive Council of **Intergovernmental Oceanographic Commission**, Paris, 9-11 Jun 2010, for discussion of IOC-SOLAS *Scientific Summary for Policy Makers on Ocean Fertilization*

- Establishment of **US-UK Collaborative Development Award Scheme** (UK support via FCO/ BIS) to support exchange travel for ocean acidification research; 10 awards made, for visits in early 2011.

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

SOLAS-UK activities will continue through a range of funding mechanisms, as indicated above (*Section 2*). Although the Oceans 2025 programme ends in March 2012, SOLAS-relevant sustained observations, modelling and technology development will continue to be supported in NERC marine centres (as National Capability). In addition to UKOA, UK GEOTRACES, OSMOSIS and WAGES, two new multi-institution research programmes that include SOLAS-relevant components are under development:

- **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.

7. Other comments

The SOLAS-UK research community is extremely active and productive, as indicated above. It is pleased to have made a major contribution to international SOLAS in 2011, and to have benefitted from the work of the SOLAS IPO and the SOLAS SSC.

- 2011/12 SOLAS endorsed projects submission forms

Submitting your research for SOLAS endorsement *(* required fields)*

1. Summary

Title of the research project* ADEPT: Aerosol deposition and ocean plankton dynamics

Status* ☒Funded ☐Submitted ☐Proposed

Is your project part of a larger national/regional programme?

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

2. Contact Information

Principal Investigator* Francesc Peters Institution (include address)* Institute of Marine Sciences (ICM, CSIC), Pg. Marítim de la Barceloneta 37-49, 08003 Barcelona, Catalunya, Spain Phone* +34932309598 Fax +34932309555 Email* cesc@icm.csic.es	Other Investigators (indicate institution in brackets) Cèlia Marrasé (ICM), Marta Estrada (ICM), Josep Sánchez (ICM), Laura Arin (ICM), Nixon Bahamón (CEAB, Spain), Cristophe Brunet (Stazione Zoologica Anton Dohrn, Naples, Italy), Òscar Guadayol (U. Hawaii, US), Víctor Martínez-Vicente (PML, UK), Estela Romero (SISYPHE, CNRS-UPMC, France)

3. Details of the Project

Summary / Abstract of Project* ADEPT addresses the study of the effect of atmospheric aerosol deposition on the dynamics of a marine LNLC (low nutrient low chlorophyll) system, namely the Mediterranean. To achieve its goal, ADEPT will use a multiscale and complementary approach. At the Mediterranean basin scale we will relate satellite chlorophyll data with modeled Saharan dust deposition. At the coastal scale, we will measure deposition directly at 6 locations across the NW Mediterranean and simultaneously sample chemical and biological parameters of the water column. At 3 locations this sampling will be daily. We will analyze relationships between both sets of variables. For such a sampling intensity we will count with the collaboration of non-scientists. In addition we will conduct laboratory experiments with aerosol amendments to seawater in order to study plankton stimulation dynamics, utilization of organic matter by bacteria, and changes in bacterial composition and diversity, all for a better mechanistic understanding of the processes involved.

The bulk input of nutrients to the Mediterranean through atmospheric deposition is equivalent to the land-based input, thus having utmost importance in biogeochemical budgets. However,

contrary to HNLC (high nutrient low chlorophyll) oceanic areas where iron produces a clear stimulation of system production, in the Mediterranean various nutritional elements may show very low concentrations and limit production in temporal succession, which makes it difficult to detect event driven stimulation. Using time series with many events and experimental manipulations, ADEPT aims to evaluate the conditions for the stimulation of plankton owing to deposition in the Mediterranean and the degree of such stimulation.

Key words of project* Aerosol deposition, Mediterranean, events, cross-correlation analyses, coastal time series, experimental manipulation

Relevant SOLAS Activities *(tick all that apply)**

FOCUS 1	**FOCUS 2**	**FOCUS 3**	**CROSS-CUTTING ACTIVITIES**
1.1 Marine Particle Emissions ☐	2.1 Air-Sea Interface ☒	3.1 Air-Sea CO_2 Fluxes ☐	Modelling ☐
1.2 Trace Gas Emissions ☐	2.2 Oceanic Boundary Layer ☒	3.2 Surface Laye Carbon ☒	Remote Sensing ☒
1.3 Dimethylsulphide & climate ☐	2.3 Atmospheric Boundary Layer ☐	3.3 Air-Sea Flux of N_2O and CH_4 ☐	Time Series ☒
1.4 Iron & Marine Productivity ☒			Palaeo-SOLAS ☐
1.5 Nitrogen cycling ☒			

4. Data

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

Where will this data be reported / archived?* ICM

When will your data be submitted?* 2014

5. Budget

Start date and end date of funding* January 1, 2012 until December 31, 2014

Total funding secured to date* 222640 euro

Total proposed funding* 365078 euro

Sources of funding* Spanish Plan Nacional

6. Submission

Please indicated whether you have contacted your national representative?

Yes ☒ No ☐

If no, are you happy for us to send the details that you submit to your national representative?

Yes ☐ No ☐

If not, please clarify why

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

Please email this document with the 'Subject' as 'SOLAS Project Endorsement' to solas@uea.ac.uk

Submitting your research for SOLAS endorsement *(* required fields)*

1. Summary

Title of the research project* bCARBOCHANGE - Changes in carbon uptake and emissions by oceans in a changing climate

Status* ☒Funded ☐Submitted ☐Proposed

Is your project part of a larger national/regional programme?

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

CarboChange has further asked for endorsement by IMBER. CarboChange also contributes to the RECCAP project of the Global Carbon Project.

2. Contact Information

Principal Investigator* Christoph Heinze Institution (include address)* Geophysical Institute, Allégaten 70, 5007 Bergen, Norway Phone* +47 555 898 44 Fax +47 Email* 555 898 83	Other Investigators (indicate institution in brackets) Total > 100 scientist from 28 institutions. Contact PIs of project partners: Jørgen Bendtsen (Vituslab, Denmark) Pascale Lherminier (IFREMER, France) Marion Gehlen (CEA, France) Jacqueline Boutin (UPMC, France) Christoph Voelker (AWI, Germany) Toste Tanhua (IFM-GEOMAR, Germany) Joachim Segschneider (MPG, Germany) Reiner Steinfeld (University of Bremen, Germany) Jon Olafsson (MRI-UI, Iceland) Brian Ward (University of Galway, Ireland) Karim Hilmi (INRH, Morocco) Hein de Baar (NIOZ, Netherlands)

	Laurent Bertino (NERSC, Norway) Truls Johannessen (UNIRESEARCH, Norway) Aida F. Rios (CSIC, Spain) M. Santana-Casiano (ULPGC, Spain) Leif Anderson (University of Gothenburg, Sweden) Nicolas Gruber (ETH Zurich, Switzerland) Fortunat Joost (University of Bern, Switzerland) Ian Totterdell (MetOffice, UK) David Hydes (NERC, UK) Nick Hardman-Mountford (PML, UK) Marko Scholze (University of Bristol, UK) Andrew Watson (UEA, UK) Pedro Monteiro (CSIR, South Africa) Robert Key (Trustees of Princeton University, USA) Helmuth Thomas (Dalhousie University, Canada)

3. Details of the Project

Summary / Abstract of Project* CARBOCHANGE - Changes in carbon uptake and emissions by oceans in a changing climate - is a large-scale integrating collaborative research project of 7 million Euros funded by the EU's 7th Framework Programme in the period 2011-2015 (start 1 March 2011). The goal of CARBOCHANGE is to quantify the oceanic uptake of human-produced carbon dioxide from the atmosphere. It is coordinated by the Geophysical Institute at the University of Bergen and the Bjerknes Centre for Climate Research, Norway. CARBOCHANGE gathers a consortium of 28 research institutions from Europe, North America (USA and Canada) and Africa (Morocco and South Africa) with outstanding scientific expertise in the field of carbon cycle research. Carbon dioxide from fossil fuel burning and land use changes is the main contributor to a human-induced climate change. Currently, the ocean takes up about 25% of the worldwide annually produced carbon dioxide but this rate is subject to continuous change. CARBOCHANGE investigates how large this uptake rate has been in the past, how it is changing at present, and how it will evolve in the future. Carbon dioxide in the surface ocean has to pass through the bottleneck of oceanic mixing on its way to the deep ocean. Climate change and biogeochemical processes further modify the oceanic

absorption of carbon dioxide. CARBOCHANGE employs cutting edge measurement and modelling techniques to watch the ongoing carbon dioxide uptake by the oceans, to understand the underlying processes, and to predict changes in uptake to come. The project places special emphasis on a systematic combination of ocean carbon observations and ocean models through advanced model performance assessments and data assimilation methods. CARBOCHANGE will provide science-based guardrails for political decisions on mitigation actions in order to in order to control and alleviate the impact of carbon dioxide emissions and climate change.

Key words of project* carbon cycle - ocean - carbon uptake and emissions - biogeochemical processes - physical processes - feedbacks - observing systems - data model integration - global synthesis

Relevant SOLAS Activities *(tick all that apply)**

FOCUS 1	**FOCUS 2**	**FOCUS 3**	**CROSS-CUTTING ACTIVITIES**
1.1 Marine Particle Emissions ☐	2.1 Air-Sea Interface ☒	3.1 Air-Sea CO_2 Fluxes ☒	Modelling ☒
1.2 Trace Gas Emissions ☒	2.2 Oceanic Boundary Layer ☐	3.2 Surface Laye Carbon ☒	Remote Sensing ☒
1.3 Dimethylsulphide & climate ☐	2.3 Atmospheric Boundary Layer ☐	3.3 Air-Sea Flux of N_2O and CH_4 ☐	Time Series ☒
1.4 Iron & Marine Productivity ☐			Palaeo-SOLAS ☐
1.5 Nitrogen cycling ☐			

4. Data

Will new date be collected as part of this project?*	Yes ☒ No ☐
Where will this data be reported / archived?*	Databases will be available through project website: www.carbochange.eu
When will your data be submitted?*	continuously during project

5. Budget

Start date and end date of funding*	01/03/2011 until 01/03/2015
Total funding secured to date*	6 989 906,00 €
Total proposed funding*	6 989 906,00 €

Sources of funding* EU FP7- ENV - 2010; ENV.2010.1.1.3-1

6. Submission

Please indicated whether you have contacted your national representative?

Yes ☒ No ☐

If no, are you happy for us to send the details that you submit to your national representative?

Yes ☐ No ☐

If not, please clarify why

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

Please email this document with the 'Subject' as 'SOLAS Project Endorsement' to solas@uea.ac.uk

Submitting your research for SOLAS endorsement *(* required fields)*

1. Summary

Title of the research project* Mediterranean Sea Acidification in a changing climate

Status* ☒Funded ☐Submitted ☐Proposed

Is your project part of a larger national/regional programme?

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

NO

2. Contact Information

Principal Investigator* Patrizia Ziveri Institution (include address)* Institut de Ciencia I Tecnologia Ambientals, Universitat Autonoma de Barcelona, Edifici Cn - Campus UAB E-08193 Bellaterra (Cerdanyola), Spain Phone* +34 93586 8485 Fax +34 93 581 3331 Email* patrizia.ziveri@uab.cat	Other Investigators (indicate institution in brackets) Maoz Fine (BIU), Catherine Goyet (UPDV), Marcello Vichi (CMCC), Jeroen van den Bergh (UAB), Carol Turley (PML) Jim Orr (CEA), Jean-Pierre Gattuso (UPMC), Paulo A.L.D. Nuñes (CIESM), Jelle Bijma (AWI), Jason Hall Spencer (UPM), Nayrah A. Shaltout (NIOF), Neijb Kallel (U. Sfax)

3. Details of the Project

Summary / Abstract of Project*

Increases of atmospheric CO2 and associated decreases in seawater pH and carbonate ion concentration this century and beyond are likely to have wide impacts on marine ecosystems including those of the Mediterranean Sea. Consequences of this process, ocean acidification, threaten the health of the Mediterranean, adding to other anthropogenic pressures, including those from climate change. Yet in comparison to other areas of the world ocean, there has been no concerted effort to study Mediterranean acidification, which is fundamental to the social and economic conditions of more than 400 million people living in Mediterranean countries and another 175 million who visit the region each year.

The MedSeA project addresses ecologic and economic impacts from the combined influences of anthropogenic acidification and warming, while accounting for the unique characteristics of this key region. MedSeA will forecast chemical, climatic, ecological-biological, and socio-economical

changes of the Mediterranean driven by increases in CO2 and other greenhouse gases, while focusing on the combined impacts of acidification and warming on marine shell and skeletal building, productivity, and food webs. We will use an interdisciplinary approach involving biologists, earth scientists, and economists, through observations, experiments, and modelling. These experts will 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, 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.

Key words of project* Mediterranean Sea, ocean acidification, climate change, biogeochemistry, ecosystems, modelling, socio-economic impacts, adaptation strategies

Relevant SOLAS Activities *(tick all that apply)**

FOCUS 1	**FOCUS 2**	**FOCUS 3**	**CROSS-CUTTING ACTIVITIES**
1.1 Marine Particle Emissions ☐	2.1 Air-Sea Interface ☐	3.1 Air-Sea CO_2 Fluxes ☒	Modelling ☒
1.2 Trace Gas Emissions ☐	2.2 Oceanic Boundary Layer ☒	3.2 Surface Laye Carbon ☒	Remote Sensing ☐
1.3 Dimethylsulphide & climate ☐	2.3 Atmospheric Boundary Layer ☐	3.3 Air-Sea Flux of N_2O and CH_4 ☐	Time Series ☒
1.4 Iron & Marine Productivity ☐			Palaeo-SOLAS ☒
1.5 Nitrogen cycling ☐			

4. Data

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

Where will this data be reported / archived?* PANGAEA

When will your data be submitted?* Throughout project

5. Budget

Start date and end date of funding*	01/02/2011 until 31/01/2014
Total funding secured to date*	EUR 3490169.31 (total costs ~EUR6000000)
Total proposed funding*	EUR 3490169.31
Sources of funding*	European Commission

6. Submission

Please indicated whether you have contacted your national representative?

Yes ☐ No ☒

If no, are you happy for us to send the details that you submit to your national representative?

Yes ☒ No ☐

If not, please clarify why

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

Please email this document with the 'Subject' as 'SOLAS Project Endorsement' to solas@uea.ac.uk

Submitting your research for SOLAS endorsement *(* required fields)*

1. Summary

Title of the research project* Marine Ecosystems Response in the Mediterranean Experiment (MerMex) http://mermex.com.univ-mrs.fr/

Status* ☒Funded ☒Submitted ☐Proposed

Is your project part of a larger national/regional programme?

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

MerMex is a component of the MISTRALS French national program (Mediterranean Integrated STudies at Regional And Local Scales, http://www.mistrals-home.org/

2. Contact Information

Principal Investigator* Xavier Durrieu de Madron1, Cécile Guieu2, Richard Sempéré Institution (include address)* 1 : CEFREM, CNRS-Université de Perpignan, Perpignan, France 2 : LOV, CNRS-Université Pierre et Marie Curie, Villefranche-sur-Mer, France 3 : COM/MIO, CNRS/IRD-Université de la Méditerranée, Marseille, France Phone* 33(0)4.93.76.39.95 Fax 33(0)4.93.76.39.92 Email* 1 : demadron@univ-perp.fr 2 : guieu@obs-vlfr.fr 3 : richard.sempere@univmed.fr	Other Investigators (indicate institution in brackets)

3. Details of the Project

Summary / Abstract of Project* The Mediterranean Sea is unique and evolves rapidly, with large interannual to decadal variability and abrupt fluctuations. The semi-enclosed nature of the Mediterranean, together with its smaller inertia compared to large oceans, makes it more sensitive to natural variations in fluxes (between, e.g., the air and sea, freshwater and the sea) and water flows. These natural pressures interact with the trend of increasing human activities in the coastal regions, making the sea even more sensitive. French biogeochemical oceanographers have raised the issue of Mediterranean marine ecosystems response to changes in physical, chemical and socio-economical forcings induced by climate change and by growing anthropogenic pressures. This debate has focused on the current understanding of the effects of key natural and anthropogenic forcings on ecosystems (from coastal zones to open-ocean, from pelagos to benthos) and organisms (from viruses to fishes and mammals). It has further aimed to identify knowledge gaps and to contribute to the emergence of a large integrated research project, the Marine Ecosystems' Response in the Mediterranean Experiment (MerMex). There are still considerable uncertainties in our understanding of the complex interactions between the different forcings and their impacts on Mediterranean ecosystems. There is therefore a strong need to reach a mechanistic understanding of the relevant processes in order to predict changes in ecosystems. These changes clearly influence the cycles of major biogenic elements, biodiversity, fisheries, invasive species and ultimately have socio-economic impacts. There is a need to develop a comprehensive and holistic approach to address particular questions at the proper spatial and temporal scales. The most relevant issues for the future of marine ecosystems in the Mediterranean are listed here and constitute the main research axes that MERMEX propose to tackle in the next 10 years:

• How would changes in stratification and destratification mechanisms and in the overall thermohaline

circulation alter the spatio-temporal distribution of nutrients and their budgets? More specifically, what is the influence of dense water formation on the spatial and temporal variability of biogenic elements, the triggering of planktonic blooms, and the sequestration of biogenic elements, particularly carbon)?

• How would likely changes in nutrient inputs from physical transport, rivers, the atmosphere (including extreme events) and straits affect the nutrient availability in the photic layer of the Mediterranean Sea, the relative abundance of primary producers, and the higher trophic levels?

• What are the typical concentrations of chemical contaminants in the various water masses of the Mediterranean? What are their sources and sinks (e.g., atmosphere versus rivers, especially for organic contaminants) and seasonal variations?

• What is the role of the land-sea boundary (rivers, large cities, groundwater discharge) in the material balance of the Mediterranean Sea (carbon, nutrient, contaminants)?

• Will changes in the frequency or magnitude of extreme events lead to the dispersion or dilution of carbon, nutrients, and pollutants or, in contrast, to their accumulation in specific compartments?

• What will be the impact of changes in light radiation on biogeochemical processes, including primary production, POC-degradation processes, and degradation of DOM and pollutants?

• What is the actual rate of change of both temperature and pH in the Mediterranean Sea? How will these variables evolve and impact the Mediterranean solubility pump? What impacts will they have on the functioning of pelagic and benthic Mediterranean ecosystems?

• Will the functioning of mesopelagic and deep sea Mediterranean ecosystems be strongly affected by changes originating from surface ecosystem production and vertical fluxes or by changes in the hydrodynamics of the intermediate and deep waters?

• As the surface seawater warms, will the planktonic community of the pelagic ecosystem become dominated by nanophytoplankton and jellyfish, as suggested by several recent studies?

Key words of project* Mediterranean Sea, climate change, anthropogenic pressure, atmosphere-ocean-continent coupled system, land-sea interactions, natural and anthropogenic air-sea interactions, gas fluxes, solar radiation, warming, acidification, hydrodynamics, chemical contaminants, trace elements, groundwater discharges, atmospheric deposition, extreme events, Saharan dust, heat waves, nutrients, stoichiometry, ecological processes, coastal and shelf ecosystems, pelagic realm ecosystems, meso and deep sea pelagic ecosystems, biodiversity, modeling, ecoregionalisation, multidisciplinary research, laboratory and in situ experiments, long-term observations.

Relevant SOLAS Activities *(tick all that apply)**

FOCUS 1	**FOCUS 2**	**FOCUS 3**	**CROSS-CUTTING ACTIVITIES**
1.1 Marine Particle Emissions ☐	2.1 Air-Sea Interface ☒	3.1 Air-Sea CO_2 Fluxes ☒	Modelling ☒
1.2 Trace Gas Emissions ☐	2.2 Oceanic Boundary Layer ☐	3.2 Surface Laye Carbon ☒	Remote Sensing ☒
1.3 Dimethylsulphide & climate ☐	2.3 Atmospheric Boundary Layer ☒	3.3 Air-Sea Flux of N_2O and CH_4 ☐	Time Series ☒
1.4 Iron & Marine Productivity ☒			Palaeo-SOLAS ☐
1.5 Nitrogen cycling ☒			

4. Data

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

Where will this data be reported / archived?* specific actions within the Mermex project will have their own database but we will ensure a common portal on the MerMex website: http://mermex.com.univ-mrs.fr/

When will your data be submitted?* starting 2012

5. Budget

Start date and end date of funding* 2010 until 2020

Total funding secured to date* 3.1 Meuros for 2011-2013

Total proposed funding* 2.6 M euros/year

Sources of funding* Agence Nationale de la Recherche, European Commission Framework Programme, INSU, Mistrals, Regional programs

6. Submission

Please indicated whether you have contacted your national representative?

Yes ☒ No ☐

If no, are you happy for us to send the details that you submit to your national representative?

Yes ☐ No ☐

If not, please clarify why

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

Please email this document with the 'Subject' as 'SOLAS Project Endorsement' to solas@uea.ac.uk

Submitting your research for SOLAS endorsement *(* required fields)*

1. Summary

Title of the research project* SOAP (Surface Ocean Aerosol Production)

Status* ☒Funded ☐Submitted ☐Proposed

Is your project part of a larger national/regional programme?

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

Contributes to New Zealand MSI (Ministry of Science & Technology) funded research on Ocean-Atmosphere exchange

2. Contact Information

Principal Investigator* Cliff Law Institution (include address)* NIWA Phone* +64-43860478 Fax +64-43862153 Email* c.law@niwa.co.nz	Other Investigators (indicate institution in brackets) Mike Harvey, Murray Smith, Carolyn Walker, Kim Currie, Craig Stevens (NIWA, NZ), Eric Saltzman, Tom Bell (UCI , US), Warren de Bruyn (Chapman, US), Scott Miller (SUNY , US), Christa Marandinio (IFM_GEOMAR), Zoran Ristovski (QUT , Australia), Petri Vaatovaarra (UEF, Finland), Sarah Lawson, Melita Keywood (CSIRO, Australia)

3. Details of the Project

Summary / Abstract of Project*

Clouds and their radiative properties are partially influenced by the production of primary aerosols through mechanisms such as the generation of sea salt particles from bubble bursting associated with breaking waves. Theoretical and applied research has indicated that phytoplankton produce a range of compounds that exchange with the atmosphere, and also directly or indirectly influence aerosol via secondary aerosol production in the marine boundary layer. The CLAW hypothesis, which links the release of precursor compounds by phytoplankton and emission of dimethylsulphide to subsequent oxidation to sulphate aerosols and production of cloud condensation nuclei, is well-studied but still remains to be proven. More recently, other secondary aerosol production pathways and precursors associated with phytoplankton have been identified, including via volatile organic hydrocarbons such as isoprene and halocarbons, organic particles and ammonia.

New Zealand has a maritime climate that is dominated by the interaction between oceanic and weather systems. The frontal regions around New Zealand are highly productive, with the Sub-Tropical Front that runs eastwards along the Chatham Rise characterised by intensive phytoplankton blooms. A preliminary survey of this region in February 2011 during the PreSOAP voyage encountered blooms of different phytoplankton groups with differing DMS & CO2 signatures. Surface distributions of both gases were mapped and related to phytoplankton indicators, including chlorophyll & backscatter, and exchange of DMS & CO2 determined using sensors & collectors on the ship and at the sea surface using a free-floating catamaran. Particle production in the MBL was continuously monitored, with additional experiments in a bubble chamber to examine particle formation.

An international team will further determine the production of aerosol precursors by phytoplankton blooms, their subsequent emissions to the atmosphere, and the production and size distribution of aerosols in the overlying marine boundary layer (MBL) during the SOAP voyage in 2012. Initial mapping of phytoplankton blooms around the productive Sub-Tropical Front along the Chatham Rise will be followed by selection of sites for focussed studies. The surface mixed layer and microlayer will be characterised in terms of biological, trace gas and organic composition, to determine how these influence exchange, with the structure of the mixed layer determined by microstructure measurements and SPAR buoy-mounted sensors. Measurements in the MBL will establish the spatial variability in DMS and aerosol concentration and composition, with different approaches used to determine DMS & CO2 exchange for the development of gas exchange parameterisations. Aerosol size spectrum and composition will be related to the potential for aerosol production as determined by onboard experiments, with a focus on establishing the broader role of volatile organic emissions in aerosol production. Sampling will be augmented by measuring aerosol & gas gradients up and downwind of the foucus sites. The results will be interpreted in the context of seasonal variation in aerosols recorded at the Baring Head coastal sampling station.

Objectives

Do phytoplankton blooms influence aerosol production in the marine boundary layer?

1. Direct & indirect measurement of DMS, CO2 & aerosol flux;

2. Determination of physical controls on air sea exchange;

3. Determination of biogeochemical influences on DMS & other volatile organics on aerosol flux;

4. Examination of the role of the surface microlayer in influencing DMS & aerosol flux

Key words of project* Aerosols, DMS, phytoplankton, microlayer, flux, volatile organic compounds,

Relevant SOLAS Activities *(tick all that apply)**

FOCUS 1	FOCUS 2	FOCUS 3	CROSS-CUTTING ACTIVITIES
1.1 Marine Particle Emissions ☒ 1.2 Trace Gas Emissions ☐ 1.3 Dimethylsulphide & climate ☒ 1.4 Iron & Marine Productivity ☐ 1.5 Nitrogen cycling ☐	2.1 Air-Sea Interface ☒ 2.2 Oceanic Boundary Layer ☐ 2.3 Atmospheric Boundary Layer ☒	3.1 Air-Sea CO_2 Fluxes ☒ 3.2 Surface Laye Carbon ☐ 3.3 Air-Sea Flux of N_2O and CH_4 ☐	Modelling ☐ Remote Sensing ☒ Time Series ☐ Palaeo-SOLAS ☐

4. Data

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

Where will this data be reported / archived?* Yes

When will your data be submitted?* By 2014

5. Budget

Start date and end date of funding* July 2011 until July 2014

Total funding secured to date* N/A

Total proposed funding* N/A

Sources of funding* NZ MSI, US NSF

6. Submission

Please indicated whether you have contacted your national representative?

Yes ☒ No ☐

If no, are you happy for us to send the details that you submit to your national representative?

Yes ☐ No ☐

If not, please clarify why

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

Please email this document with the 'Subject' as 'SOLAS Project Endorsement' to solas@uea.ac.uk

- SOLAS endorsed projects 2011 annual reports

Biological Impacts of Ocean ACIDification

compiled by Michael Meyerhöfer & Ulf Riebesell

Reporting Period is January 2011 – December 2011

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

In 2011 BIOACID published 23 papers on the impacts of ocean acidification on marine organisms and communities and the impacts of biological responses on biogeochemical cycling (see point 4 below). Much of this work is only marginally relevant to SOLAS. Two research highlights are selected based on the overall importance to marine sciences:

Ocean Acidification effects on commercially important fish species (Frommel et al. 2011)

While it is common knowledge that commercial fish stocks are globally threatened by over-fishing, a new study shows that they may also be vulnerable to ocean acidification. In the past, scientists have primarily focused on calcifying organisms, which are believed to be particularly at risk due to the dissolution of their calcium carbonate structures. A recent study by an international research group led by GEOMAR shows that commercial fish species may also be threatened by increasing acidification. Cod offspring were exposed to three different carbon dioxide concentrations (380,1800 and 4200 µatm) to examine the influence of ocean acidification. In order to mimic natural conditions for the larvae, the experiment was carried out in large open-air mesocosms in Bergen, Norway. The larval development was monitored for a time span of seven weeks after hatching. Tissue damage with possible lethal consequences was documented in a range of vital organs in the larvae. During this critical stage many structural alterations take place in the larvae, requiring a large amount of energy. As larvae hatch without functional gills, the main site for effective acid-base regulation, the mechanisms to cope with a low pH environment are particularly costly. Therefore, they may not have the energy needed for development, making them more prone to damage. As the larval stage is the bottleneck to recruitment in commercial mass-spawning fish, ocean acidification must be considered as yet another anthropogenic stressor in future stock analysis of already exploited fish.

Fig.1: Cod larvae as reared in the mesocosm experiment (left); Mesocosm facility at Marine Biological Station at Espegrend, Norway (right) Photo source: GEOMAR

Frommel, A.Y., R. Maneja, D. Lowe, A.M. Malzahn, A.J. Geffen, A. Folkvord, U. Piatkowski, T.B.H. Reusch, and C. Clemmesen, 2011: Severe tissue damage in Atlantic cod larvae under increasing ocean acidification. Nature Climate Change, doi: http://dx.doi.org/10.1038/NCLIMATE1324.

A joint SOPRAN/BIOACID mesocosm experiment on ocean acidification was conducted in the Raunefjord in southern Norway. Stationed at the Marine Biological Station of the University of Bergen, 26 scientists from 8 German, Norwegian und UK institutes followed the development of the enclosed plankton community over a 5-week period.

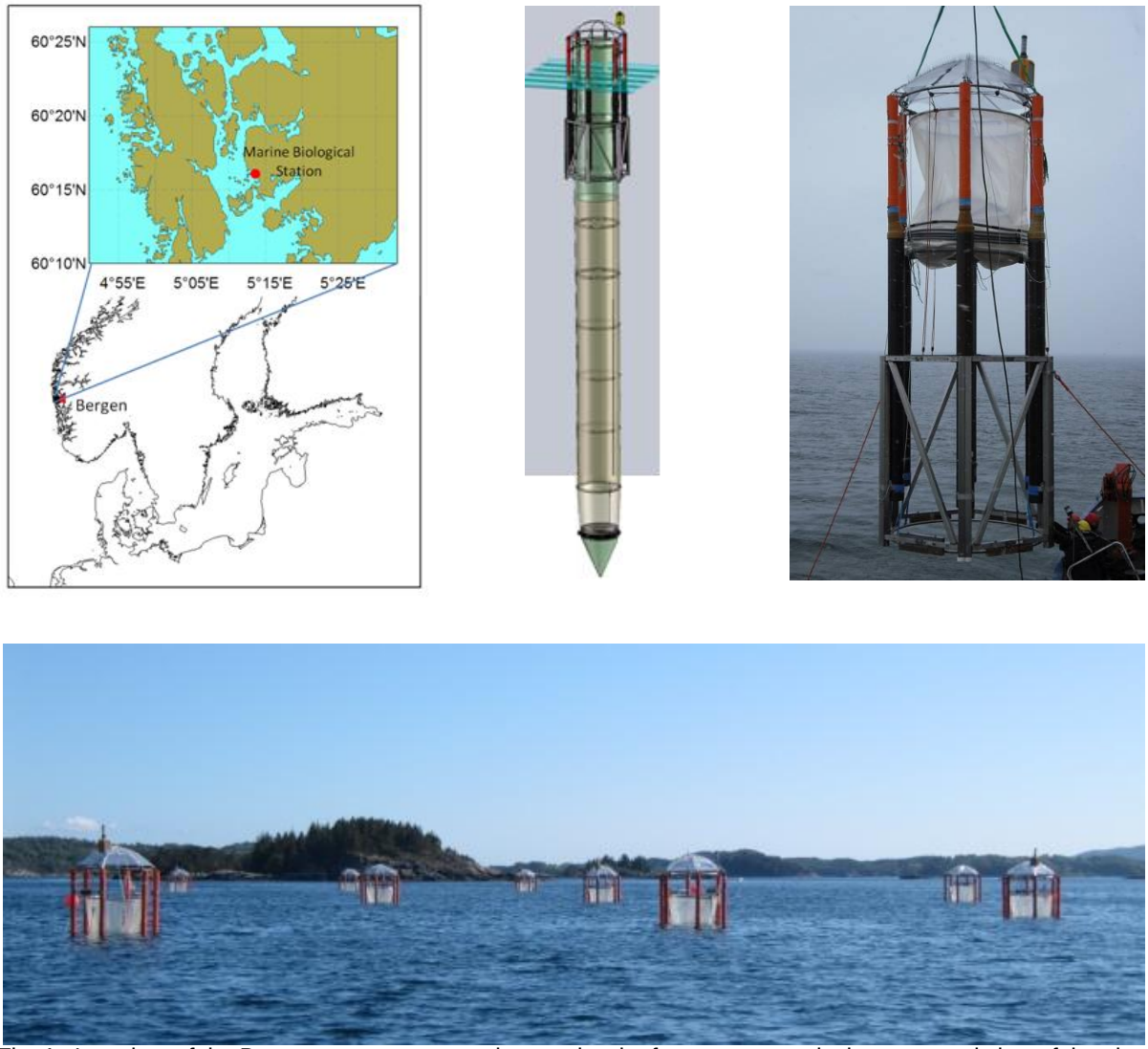


Fig. 1.: Location of the Bergen mesocosm experiment, sketch of a mesocosm, deployment, and view of the nine moored mesocsms in the Raunefjord.

Preliminary results show major changes in plankton community composition and biogeochemical cycling in response to ocean acidification. Some of the surprising community-level responses to ocean acidification include:

- strong CO_2 fertilization effect on picophytoplankton and dinoflagellates
- reduced productivity of diatoms under high CO_2 (probably due to nutrient competition)
- absence of coccolithophores under high CO_2
- reduced abundance of pteropod larvae and juveniles

The fact that some of these responses could not be predicted based on results obtained in laboratory experiments highlights the importance of community-level experiments.

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

The 2nd Annual Meeting of BIOACID took place on September 26th - 30th, at the Universitiy of Bremen, Germany (please see agenda at http://www.bioacid.de/front_content.php?idart=716&idlang=22). The last two days of the meeting were used to discuss the joint proposal of the second phase of BIOACID (2012 – 2015)

A pre-proposal for a BIOACID phase 2 (2012-2015) was prepared and submitted to the German Ministry for Education and Research (BMBF). The proposal is presently under review. A decision about a possible extension of the project is expected for June/July.

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

Capacity building

BIOACID scientists contributed to preparing the *Guide for best practices in ocean acidification research and data reporting*, an initiative led by the European Project on Ocean Acidification. This guide is intended to provide the rapidly growing community of researchers working on ocean acidification with guidelines and recommendations on best approaches, agreed standards, and minimum requirements for research in this field.

Outreach and communication

BIOACID has played an active role in various outreach activities. In 2011 these included:

- producing a brochure and CD describing 8 simple experiments to visualize and explain the process of ocean acidification; this brochure is intended for teachers and school children grade 5-7, the experiments can easily be conducted with the materials available in school; 10.000 copies of the brochure were printed and are being distributed to schools in the framework of school programmes by various BIOACID partners
- working together with school teachers to incorporate aspects of ocean acidification in the natural sciences curricula of local schools
- producing a TV-quality animation visualizing ocean acidification; the animation is without copyright and freely available to all BIOACID partners for use with TV reports, in outreach activities and for institutional purposes; the clip has already been used in a recent TV production and in a GEOMAR film on ocean acidification (http://www.ifm-geomar.de/index.php?id=6109).
- working together with the International Ocean Acidification Reference User Group (IOA-RUG) to disseminate its various outreach products, including translating the latest brochure *Questions answered* into German; 5000 copies were printed and distributed among BIOACID partner institutes
- presenting public lectures on ocean acidification at various occasions
- giving interviews to newspaper, radio and TV journalists; these have led to various high profile reports on ocean acidification, including leading articles in *Zeit-Wissen* and *GEO*, a 45-minute TV documentary on ocean acidification in the WDR-series *Quarks & Co*, contributions to 90-minute documentary by SPIEGEL TV „Klimawandel: Ist die welt noch zu retten“, a portrait in the NDR-series *DAS!* and various radio reports in Deutschlandradio, NDR 1, WDR, BR, and RBB.

As a regular form of outreach, BIOACID has produced and distributes a flyer and maintains a multifactorial website.

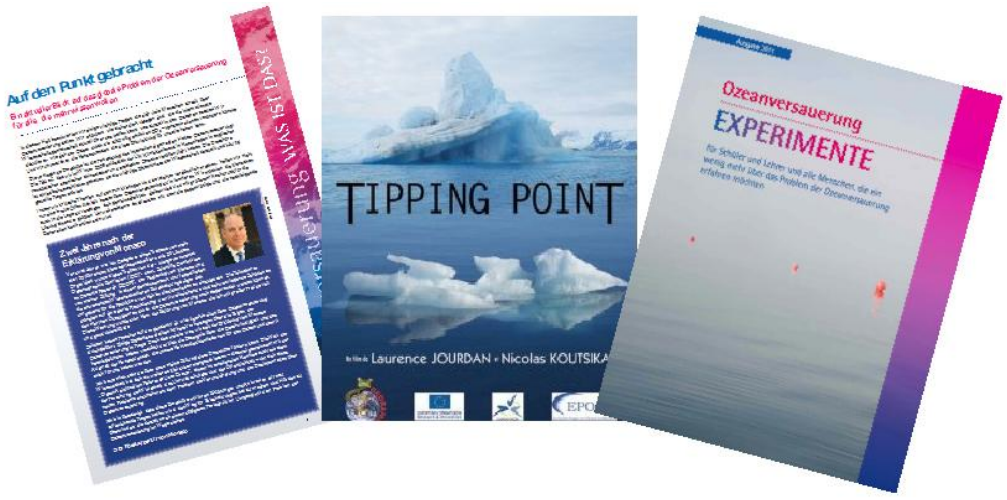


Fig. 2: Examples of BIOACID outreach activities; the German translation of the IOA-RUG brochure Questions answered, the documentary Tipping Point, and the brochure for school teachers and school children describing 8 simple experiments visualizing ocean acidification

Reference User Group

The formation of the EPOCA Reference User Group (RUG) has enabled a two way exchange of information between research scientists and the user community. This has ensured that the knowledge is provided in a format and style suitable for the target audience. As the RUG has recently been adopted also by the UKOA programme and BIOACID and to some extent by MedSeA, it has evolved to become the International Ocean Acidification Reference User Group (IOA-RUG) and as such continues is very successful work now representing an even broader community of ocean acidification researchers. Ultimately, a successful program will have an approach that integrates basic science with decision support.

4. Selection of publications in 2011 (Reports, articles, models, datasets, products, website etc)

Bach, L.T., Riebesell, U., Schulz, K.G. (2011): Distinguishing between the effects of ocean acidification and ocean carbonation in the coccolithophore *Emiliania huxleyi*. Limnology and Oceanography, 56 (6). pp. 2040-2050. DOI 10.4319/lo.2011.56.6.2040

Büdenbender, J., Riebesell, U., Form, A. (2011) Calcification of the Arctic coralline red algae *Lithothamnion glaciale* in response to elevated CO_2. *Marine Ecology Progress Series* 441, 79-87

Denman K., J. Christian, N. Steiner, H.O. Pörtner, and Y. Nojiri (2011) Potential impacts of future ocean acidification on marine ecosystems and fisheries: present knowledge and recommendations for future research. ICES J. Mar Sci. doi:10.1093/icesjms/fsr074

Fabricius, K.E., Langdon, C., Uthicke, S., Humphrey, C., Noonan, S., De'ath, G., Okazaki, R., Muehllehner, N., Glas, M.S. and Lough, J.M. (2011) Losers and winners in coral reefs acclimatized to elevated carbon dioxide concentrations. NATURE CLIMATE CHANGE; DOI: 10.1038/NCLIMATE1122

Form, A. & Riebesell, U. (2011) Acclimation to ocean acidification during long-term CO_2 exposure in the cold-water coral *Lophelia pertusa*. Global Change Biology . DOI 10.1111/j.1365-2486.2011.02583.x

Franke, A. and Clemmesen, C. (2011) Effect of ocean acidification on early life stages of Atlantic herring (*Clupea harengus* L.) Biogeosciences Discuss., 8, 7097–7126.

Haynert, K., Schönfeld, J., Riebesell, U, Polovodova, I. (2011) Biometry and dissolution features of the benthic

foraminifer *Ammonia aomoriensis* at high pCO_2. *Marine Ecology Progress Series* 432, 53-67

Hofmann LC, Yildiz G, Hanelt D, Bischof K (2011). Physiological responses of the rhodophyte, *Corallina officinalis* (L.), to future CO2 levels. Marine Biology; DOI 10.1007/s00227-011-1854-9

Hoppe, C.J.M., Langer, G., Rost, B.(2011). *Emiliania huxleyi* shows identical responses to elevated pCO2 in TA and DIC manipulations, Journal of Experimental Marine Biology and Ecology, 406(1-2), 54-62., doi:10.1016/j.jembe.2011.06.008

Hu, M.Y., Tseng, Y.C., Stumpp,M., Gutowska, M. A., Kiko, R., Lucassen, M., and Melzner, F. (2011) Elevated seawater Pco2 differentially affects branchial acid-base transporters over the course of development in the cephalopod *Sepia officinalis*. Am J Physiol Regul Integr Comp Physiol 300:R1100-R1114, 2011. First published 9 February 2011; doi:10.1152/ajpregu.00653.2010

Joassin, P., Delille, B., Soetaert, K., Harlay, J., Borges, A.V., Chou, L., Riebesell, U., Suykens, K., Grégoire, M. (2011). Carbon and nitrogen flows during a bloom of the coccolithophore *Emiliania huxleyi*: modelling a mesocosm experiment. *Journal of Marine Systems* 85, 71-85

Koeve, W., Kim, H.-C., Lee, K., Oschlies, A., Potential impact of DOC accumulation on fCO_2 and carbonate ion computation in ocean acidification experiments. (Biogeosciences Discussions, 8 (2). pp. 3797-3827. DOI 10.5194/bgd-8-3797-2011.

Krug, S. A., Schulz, K. G., and Riebesell, U. (2011) Effects of changes in carbonate chemistry speciation on *Coccolithus braarudii*: a discussion of coccolithophorid sensitivities, *Biogeosciences* 8, 771-777

Langer, G., Bode, M.(2011).CO_2 mediation of adverse effects of seawater acidification in *Calcidiscus leptoporus*, Geochem. Geophys. Geosyst., 12, Q05001, doi:10.1029/2010GC003393.

Langer, G., Probert, I., Nehrke, G., Ziveri, P.(2011).The morphological response of *Emiliania huxleyi* to seawater carbonate chemistry changes: an inter-strain comparison, Journal of Nannoplankton Research 32 (1), 29-34

Lischka, S., Büdenbender, J., Boxhammer, T., Riebesell, U. (2011) Impact of ocean acidification and elevated temperatures on early juveniles of the polar shelled pteropod *Limacina helicina*: mortality, shell degradation, and shell growth. *Biogeosciences*, 8, 919–932

Müller, N.M., Kısakürek, B., Buhl, D., Gutperlet, R., Kolevica, A., Riebesell, U., Stoll, H., Eisenhauer, A. (2011) Response of the coccolithophores *Emiliania huxleyi* and *Coccolithus braarudii* to changing seawater Mg^{2+} and Ca^{2+} concentrations: Mg/Ca, Sr/Ca ratios and $\delta^{44/40}$Ca, $\delta^{26/24}$Mg of coccolith calcite. *Geochimica et Cosmochimica Acta* 75, 2088–2102

Parker, L.M., P.M. Ross, W.A. O'Connor, B. Larissa, D.A. Raftos, and H.O. Pörtner (2011) Adult exposure influences offspring response to ocean acidification in oysters. Global Change Biology in press.

Pörtner H.O., M. Gutowska, A. Ishimatsu, M. Lucassen, F. Melzner and B. Seibel (2011) Effects of ocean acidification on nektonic organisms. In: Ocean Acidification (ed. J.-P. Gattuso, L. Hansson). Oxford University Press, Oxford.

Specht, M. et al., 2011. Concerted action of the new Genomic Peptide Finder and AUGUSTUS allows for automated proteogenomic annotation of the *Chlamydomonas reinhardtii* genome. Proteomics, p.n/a-n/a. Available at: http://doi.wiley.com/10.1002/pmic.201000621 [Accessed March 14, 2011].

Specht, M. et al., 2011. Proteomics to go: Proteomatic enables the user-friendly creation of versatile MS/MS data evaluation workflows. Bioinformatics. Available at: http://bioinformatics.oxfordjournals.org/cgi/content/abstract/btr081v1 [Accessed February 20, 2011].Stanke, M. et al., 2004. AUGUSTUS: a web server for gene finding in eukaryotes. Nucleic acids

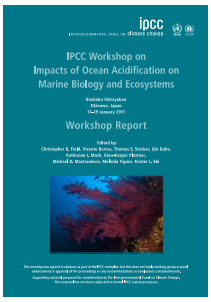
research, 32(Web Server issue), pp.W309-12. Available at: http://www.ncbi.nlm.nih.gov/pubmed/15215400.

Suffrian, K., Schulz, K.G., Gutowska, M., Riebesell, U., Bleich, M. (2011) BCECF measurements in *Emiliania huxleyi* reveal dominant membrane proton permeability. *New Phytologist* 190, 595–608

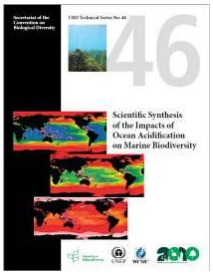
Walther, K., F.J. Sartoris, H.O. Pörtner (2011) Impacts of temperature and acidification on larval calcification of the spider crab *Hyas araneus* from different latitudes (54° vs. 79°N) Marine Biology 158:2043-2053.

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

Assessment and decision support:



Assessment Report (2007) mentions ocean acidification for the first time in an IPCC report. Since then an IPCC WGII/WGI Workshop on Impacts of Ocean Acidification on Marine Biology and Ecosystems was held in Okinawa, Japan 17-19 January 2011, with participation by several BIOACID scientists. The findings of this meeting are in a workshop report. The 5th IPCC Assessment Report due in 2014 will include a more in depth assessment of both ocean climate change and acidification. BIOACID scientists serve as coordinating and lead authors and reviewers of this report.



The IPCC 4th Assessment Report (2007) mentions ocean acidification for the first time in an IPCC report. Since then an IPCC WGII/WGI Workshop on Impacts of Ocean Acidification on Marine Biology and Ecosystems was held in Okinawa, Japan 17-19 January 2011, with participation by several BIOACID scientists. The findings of this meeting are in a workshop report. The 5th IPCC Assessment Report due in 2014 will include a more in depth assessment of both ocean climate change and acidification. BIOACID scientists serve as coordinating and lead authors and reviewers of this report.

International Cooperation

International collaboration provides an opportunity for BIOACID to broaden and strengthen its research portfolio. Since its launch in 2009, BIOACID worked in close collaboration with the European Project on Ocean Acidification (EPOCA). Several of the BIOACID members are also active in EPOCA. A close collaboration has also been established with the UK Ocean Acidification Research Programme (UKOA). The coordinators of EPOCA, UKOA and BIOACID maintain an open information flow between the three programmes and closely work together in various outreach and communication activities. To facilitate this exchange, the coordinators of each project serve as members of the executive board or scientific advisory board of each of the other projects. Cooperation of the three projects encompasses joint training workshops, student exchange, joint experiments and exchange of samples, joint annual meetings and the shared Reference User Group (RUG), a group of key stakeholders interested the knowledge gained in ocean acidification research. In addition, EPOCA and BIOACID use the same data portal at WDC-MARE/PANGEA.

The EPOCA-UKOA-BIOACID partnership has been further broadened to include the recently launched EU-project Mediterranean Sea Acidification in a Changing Climate (MedSeA).

BIOACID partner programmes on ocean acidification.

To further strengthen the international partnership in ocean acidification research the UK funding agencies opened an opportunity for participants in the UKOA programme to seek additional financial support for international research collaborations, in particular with BIOACID. In turn, BIOACID has offered its members additional financial support to establish and/or strengthen active collaboration with UK partners funded through the UKOA Programme. Several BIOACID partners have responded to this offer and will receive funding ear-marked for UKOA-BIOACID collaboration during phase 2 of the BIOACID project.

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

The growing evidence of potential biological impacts of ocean acidification affirms that this global change phenomenon may pose a serious threat to marine organisms and ecosystems. Despite a wealth of knowledge on specific effects of acidification and the related changes in seawater chemistry on the physiology of individual marine taxa, many uncertainties still remain. Because the majority of studies are based on single species experiments, little is presently known about possible impacts on natural communities, food webs and ecosystems. Moreover, few studies have addressed possible interacting effects of environmental changes occurring in parallel, such as ocean acidification, warming, and deoxygenation and changes in surface layer stratification and nutrient supply. Almost completely unknown at present is the potential for evolutionary adaptation to ocean acidification. To pave the way for a more encompassing assessment of future biological responses to ocean change and their possible socio-economic consequences phase 2 of BIOACID will

- 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 biological mechanisms, through individual organism responses, through food web and ecosystem effects, to economic impacts***

7. Other comments

Data management

The data management in BIOACID is carried out by the World Data Center for Marine Environmental Sciences WDC-MARE (www.wdc-mare.org) at the University of Bremen. WDC-MARE uses the information system PANGAEA (Publishing Network for Geoscientific & Environmental Data – www.pangaea.de), which is a system for acquisition, processing, long-term storage, and publication of geo-referenced data related to all earth science fields. Specifically, WDC-MARE is responsible for

1. Coordination of data capture, integration and quality control activities for the five BIOACID Themes.
2. Archiving and publishing data sets and data collections online and as offline products (DVD) using persistent Digital Objects Identifiers (DOI).
3. Implementation of the BIOACID data infrastructure
    - enabling a distributed storage of observational and model simulation data within a common networked structure, and
    - establishing a robust and long lasting data network which can be extended by or integrated into ongoing projects and programmes.
4. Maintain the website and data portal for BIOACID.

DUNE

compiled by Cecile Guieu

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)

New methodologies developed during DUNE and successfully implemented for the first time.

The project comprised strong risk-taking as it was based on 2 methodological challenges:

1. To be able to reproduce a real atmospheric deposition event necessary for the controlled seeding in seawater. The goal was to produce hundreds of grams of particulate material identical to aerosols depositing at the surface of the ocean. This was achieved by experimental simulation of (i) production of desert aerosols and (ii) chemical aging mimicking their transport in the atmosphere.
2. Conception of seeding experiments in large clean mesocosms. With a list of specifications (such as that those systems should be totally made with plastic material, transportable etc.), the DUNE team worked on the concept of holding structures, enclosure (52 m^3), sampling systems, anchoring. Those systems were successfully deployed twice (DUNE1 experiment in 2008 and DUNE2 experiment in 2010) in the preservation area of Scandola in Corsica.

Main results of the project.

The original methods developed and validated during DUNE have been published and can be used in the frame of other projects (for example, the DUNE mesocosms are going to be used in the frame of the MedSea European project on Mediterranean acidification ; other projects related to marine biogeochemisty at the atmosphere-ocean interface based on that tool are currently being submitted).

Chemical and biological changes, along with modification of the dynamic of particles following a dust event have been followed and the multidisciplinary results obtained are bringing new insights regarding the role of atmospheric deposition on oligotrophic ecosystem and carbon export. Among those results, we have shown that the cycles of elements of biogeochemical interest (nutrients, metals) are modified by the atmospheric deposition; that new nutrients introduced are uptake by biota very rapidly; that there is a competition for the new nutrients and that this competition is in favor for heterotrophic bacteria; that among phytoplankton, diazotrophs – although only responsible for few percent of the induced new production - are well stimulated by atmospheric input; that particulate carbon export is in part due to aggregation processes between organic matter and lithogenic particles. All those results indicate that the role of atmospheric deposition on oligotrophic area cannot be seen only like a simple fertilization effect but, induce also a significant export of particulate organic carbon to the deep ocean, through aggregation processes.

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

During this last year 2 workshops were organized in Villefranche sur Mer among the DUNE group: a final workshop event in Avril 2011 (20 people) and a specific meeting in October 2011 dedicated to the final publications of the project during which it was decided to propose a series of 14 papers to constitute a Special Issue to BIOGEOSCIENCE (work in progress).

Several oral presentations specific to the DUNE project were done during the ASLO conference in Puerto Rico in Feb. 2011, during the SOLAS-IGAC France joint open meeting in Paris in June 2011 (see details in DUNE web site).

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

During the course of the project, in addition to several undergrad students, 5 PhD were involved (2 in France, 1 Italie and 2 German) and 4 post-doc were recruited among which 2 have now permanent positions in Research Institute in France.

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

Bressac M., C. Guieu, D. Doxaran, F. Bourrin, G. Obolensky and JM Grisoni, 2011, A mesocosm experiment coupled with optical measurements to observe the fate and sinking of atmospheric particles in clear oligotrophic waters, *Geo-Marine Letters*, DOI 10.1007/s00367-011-0269-4.

Ye Y., Wagener T., Volker C., Guieu C., Dieter A. Wolf-Gladrow D.A., 2011, Dust deposition: iron source or sink? A case study, *Biogeosciences*, 8, 2107–2124, 2011

Wagener, T., Guieu C., Leblond N., 2010, Effects of dust deposition on iron cycle in the surface Mediterranean Sea: results from a mesocosm seeding experiment., *Biogeosciences,* 7, 3769-3781, 2010

Laghdass M., S. Blain, M. Besseling, P. Catala, C. Guieu, I. Obernosterer, 2011, Impact of Saharan dust deposition on the bacterial diversity and activity in the NW Mediterranean Sea. *Aquatic Microbial Ecology*, vol 62: 201-213, 2011.

Guieu C., F. Dulac, K. Desboeufs, T. Wagener, E. Pulido-Villena, J.-M. Grisoni, F. Louis, C. Ridame, S. Blain, C. Brunet, E. Bon Nguyen, S. Tran, M. Labiadh, and J.-M. Dominici, 2010, Large clean mesocosms and simulated dust deposition: a new methodology to investigate responses of marine oligotrophic ecosystems to atmospheric inputs, *Biogeosciences*., 7, 2765-2784, 2010

Pulido-Villena E. , Rerolle V., Guieu C. , 2010, Transient fertilizing effect of dust in P-deficient LNLC surface ocean, *Geophysical Research Letters* , 37, L01603, doi:10.1029/2009GL041415, 2010

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

International interactions and collaborations were reinforced and several papers will be proposed for publication in the planned Special Issue. Following the success of the methodology established during DUNE, the DUNE-type large clean mesocosms will be used in the framed of the FP7 MedSea project (9 mesocosms to be deployed in June in Corsica).

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

Main goal is to prepare the Special Issue dedicated to the DUNE project (a meeting 'before submission is scheduled for the end of February.

7. Other comments

The DUNE project a DUst experiment in a low Nutrient, low chlorophyll Ecosystem, is a fundamental research project coordinated by Cécile Guieu at LOV. It was conducted in partnership with the laboratory of LISA (Créteil), LEMAR (Brest), LOCEAN (Paris), and in collaboration with the laboratories LOMIC (Banyuls), IRD/LOBP/COM (Marseille), CEFREM (Perpignan), ERES/ERTI, ENS (Paris) and the Regional Parc of Corsica, Preservation Area of Scandola. DUNE was also conducted in strong collaboration with foreign research institute: the Institut des Régions Arides (IRA), Médenine (Tunisie), IFM-GEOMAR, Kiel (Germany), Station Zoologique-Naples (Italie) and Alfred Wegener Institute, Bremerhaven (Germany).

The project started in nov-2007 and ended in July 2011 (43 months). Funding from ANR (Agence Nationale pour la Recherche) was 500 000 € for a total estimated cost of 1 500 000 € excluding permanent personal costs. Original project bringing together scientists from atmospheric and ocean fields, it was endorsed by the international SOLAS program in Feb 2009, see: (http://solas-int.org/science/researchendorsements/resendprojects/endorsedprojects.html#dune).

Web site of the project: http://www.obs-vlfr.fr/LOV/DUNE/

EPOCA

compiled by Jean-Pierre Gattuso

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)

- The decrease in summer sea ice in the Arctic Ocean could **increase the uptake of atmospheric CO_2** thus lowering pH. In the Siberian shelf, the **degradation of organic matter has a major impact** causing high pCO_2 and low pH levels.
- The key nitrogen fixer ***Trichodesmium*** **will likely be a "winner"** of ocean acidification with large implication for the future C and N cycling. It also has an unforeseen role in biogeochemical cycling due to its ability to induce $CaCO_3$ precipitation.
- New transient simulations up to 2050 demonstrate the **accelerated rate of acidification in the California Current System (CCS)**, particularly in the north. **By 2050, the aragonite saturation horizon shoals by 180 m to reach an annual average depth of 40 m.**
- A model of the **Northwestern European Seas** forced with an atmospheric CO_2 of 1000 ppm projects that seawater **will become corrosive to aragonite over the entire shelf during winter**; in the stratified areas on the shelf, this undersaturation persists throughout the year.
- Global and basin-scale models dramatically **underestimate the magnitude, extent, and evolution** of ocean acidification in **Eastern boundary upwelling systems** compared to high resolution regional models.
- Climate change is projected to **shift the total abundance and diversity of foraminifera deeper and polewards** into waters that have lower and decreasing calcite saturation states.
- A **decrease in marine emissions of two major climate-active gases** is projected for the end of the 21st century.
- The **changes in $CaCO_3$ production and dissolution** induced by ocean acidification provide only a **small negative feedback on atmospheric CO_2**.
- A Pinatubo-scale **volcanic eruption has a much lower influence on ocean pH than past anthropogenic emissions**.
- The **volume of supersaturated water providing habitat to calcifying organisms is reduced** from preindustrial 40 to 25% in 2100 and to 10% in 2300 for a high 21st century emission commitment scenario.
- The largest simulated pH changes worldwide occur in Arctic surface waters, where hydrogen ion concentration increases by up to 185%. **Projected climate change amplifies the decrease in Arctic surface mean saturation and pH** by more than 20%, mainly due to freshening and increased carbon uptake in response to sea ice retreat.

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

- The documentary "Tipping Point", following the EPOCA Svalbard 2010 experiment and other EPOCA work was released in the beginning of the year.
- The book "Ocean Acidification" was released in September 2011 as the first book on the subject, edited by J.-P. Gattuso and L. Hansson and with contributions from many EPOCA scientists.
- EPOCA organized an information event for EU officials and the general public in Brussels, on 9 May 2011. The 1-day event entitled "Ocean acidification – European contribution and perspectives" included presentations by J.-P. Gattuso, U. Riebesell, D. Laffoley, C. Turley, N. Cyr, S. Seitzinger, L. Hansson and F. Gazeau, a screening of the 52' documentary "Tipping Point", as well as an exhibition with hands-on chemistry experiments, models of research tools, screenings of short movies and cartoons and a the opportunity to talk to EPOCA scientists.
- The year 2011 was a very productive one for the EPOCA data management. Part of the Svalbard

2010 mesocosm experiment data has been archived: http://doi.pangaea.de/10.1594/PANGAEA.769833 and more is expected before the end of the project. 215 data sets are archived from which 88 are EPOCA, combining in a total of 241 studies. All the archived EPOCA data sets are listed here: http://www.epoca-project.eu/index.php/data/data-sets.html. All the EPOCA/EUR-OCEANS data compilation with additional meta data are available here: http://doi.pangaea.de/10.1594/PANGAEA.735138

- The SOLAS-IMBER working group on ocean acidification (SIOA), in which the EPOCA Executive Board are members, continued to strengthen international collaboration outside Europe and put extensive efforts into a proposal for an international coordination office on ocean acidification.

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

EPOCA public day in Brussels (see above), numerous outreach and educational activities at the partner institutes. Several EPOCA scientists contributed to the 52-minute long documentary, "Tipping Point", by Laurence Jourdan. The movie covers several aspects of EPOCA research and in particular the Svalbard 2010 campaign.

During the 2011, EPOCA continued to actively disseminate key research on ocean acidification, in particular via the Reference User Group (RUG). The RUG produced a new guide to policymakers, following the 2 previous guides, called "Acting on evidence" launched at the COP17 conference in Durban in December 2011. All guides are available in several languages at the EPOCA web site: http://www.epoca-project.eu/index.php/what-do-we-do/outreach/rug.html.

Dissemination also took place via regular updates of the project web site (www.epoca-project.eu) and the blog: http://oceanacidification.wordpress.com/. EPOCA also contributed to an "Ocean Under Stress" guide presented at COP17: http://epoca-project.eu/index.php/what-is-ocean-acidification/key-documents/256-oceans-under-stress.html.

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

Anderson L. G., Björk G., Jutterström S., Pipko I., Shakhova N., Semiletov I. P. & Wåhlström I., 2011. East Siberian Sea, an Arctic region of very high biogeochemical activity. *Biogeosciences* 8:1745-1754.

Beaufort L., Probert I., de Garidel-Thoron T., Bendif E. M., Ruiz-Pino D., Metzl N., Goyet C., Buchet N., Coupel P., Grelaud M., Rost B., Rickaby R. E. M. & de Vargas C., 2011. Sensitivity of coccolithophores to carbonate chemistry and ocean acidification. *Nature* 476:80-83.

Charalampopoulou A., Poulton A. J., Tyrrell T. & Lucas M. I., 2011. Irradiance and pH affect coccolithophore community composition on a transect between the North Sea and the Arctic Ocean. *Marine Ecology Progress Series* 431:25-43.

Franke A. & Clemmesen C., 2011. Effect of ocean acidification on early life stages of Atlantic herring (*Clupea harengus* L.). *Biogeosciences Discussions* 8:7097-7126.

Gattuso J.-P. & Hansson L., 2011. *Ocean acidification*, 352 p. Oxford: Oxford University Press.

Gruber N., 2011. Warming up, turning sour, losing breath: ocean biogeochemistry under global change. *Philosophical Transactions of the Royal Society A* 369:1980-1996.

Gangstø R., Joos F. & Gehlen M., 2011. Sensitivity of pelagic calcification to ocean acidification. *Biogeosciences* 8:433-458.

Hoppe C. J. M., Langer G. & Rost B., 2011. *Emiliania huxleyi* shows identical responses to elevated pCO2 in TA and DIC manipulations. *Journal of Experimental Marine Biology and Ecology* 406:54-62.

Krug S., Schulz K. & Riebesell U., 2011. Effects of CO2-induced changes in seawater carbonate chemistry speciation on *Coccolithus braarudii*: a discussion of coccolithophorid sensitivities. *Biogeosciences Discussions* 8:771-777.

Rodolfo-Metalpa R., Houlbrèque F., Tambutté E., Boisson F., Baggini C., Patti F. P., Jeffree R., Fine M., Foggo A., Gattuso J.-P. & Hall-Spencer J. M., 2011. Coral and mollusc resistance to ocean acidification adversely affected by warming. *Nature Climate Change* 1:308-312.

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

Continued links have been established with EU (CARBOOCEAN, MESOAQUA, EUROSITES, ATP, CALMARO and MEECE) and national projects (BIOACID, UK Ocean Acidification Programme, CHOICE-C and US initiatives as part of the FOARAM Act). EPOCA has developed particularly strong interactions with BIOACID, UKOA and the recently launched EU FP7 project MedSea. The EPOCA Executive Board members sit in the SOLAS-IMBER subgroup on ocean acidification. International links have also been continued via the International Scientific Advisory Panel (ISAP) with members from the US and Korea.

Several EPOCA scientists are lead or contributing authors of the IPCC AR5 Report.

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

Results from the project will be published in time for consideration in the Fifth Assessment Report of the IPCC and be available for studies of the socio-economic impact of ocean acidification. Results will cover new information on the rate at which ocean acidification proceeds and the hotspots where critical pH values will be reached first; the consequences of ocean acidification in terms of biodiversity, ecological services provided by marine ecosystems, biogeochemical processes and feedbacks on the climate system; the ecosystems which are most vulnerable to ocean acidification. EPOCA will come to an end on 30 April 2012. The final meeting will take place in Saint Jean Cap Ferrat (close to Nice) from 2-6 April 2012.

7. Other comments

FLATACOA

compiled by Remi Losno

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)

Year 2011 have seen the last samples back to the lab from Crozet and Kerguelen Islands. We performed analyses of total deposition by ICP-AES and HR-ICP-MS and have now a database with deposition flux of Li, Na, Rb, Mg, Ca, Sr, Ba, Ti, V, Cr, Mn, Fe, Co, La, Ce, Nd, Sm, Yb, U, Al, P, S, As and Pb (Ni and Zn in progress), for 2 years at Kerguelen and one year at Crozet (Heimburge et al. 2011, ASLO communication). For example, the total deposited iron flux is about 500 nmol/m²/year at Kerguelen, in good agreement with models.

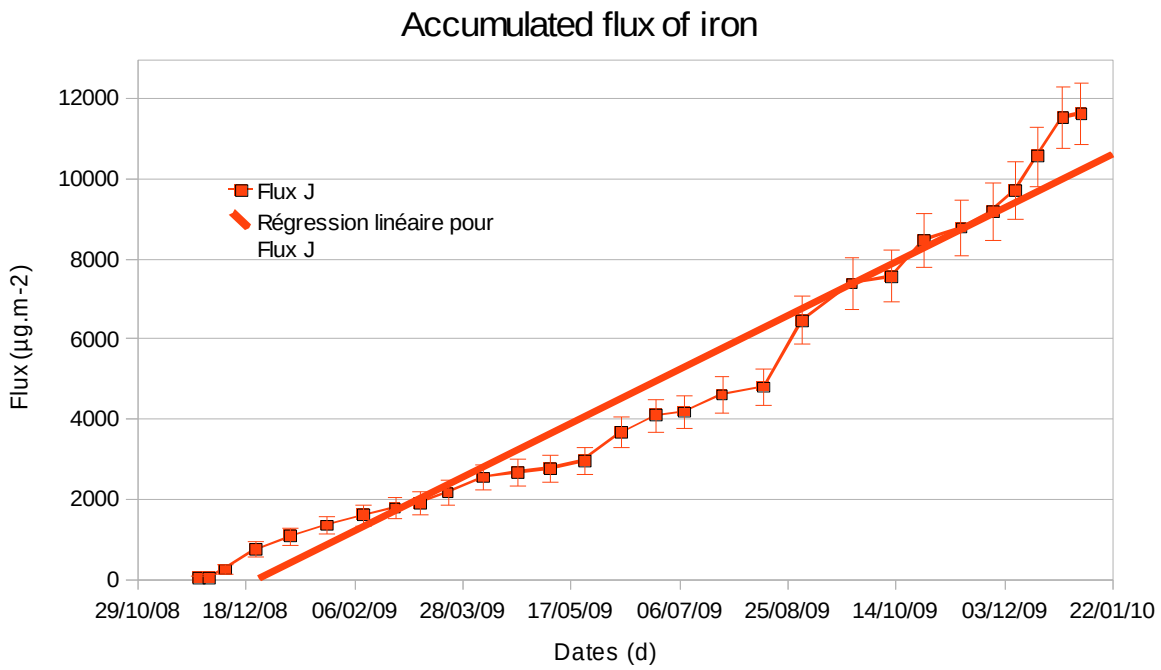


Figure 1: *accumulated iron flux at Kerguelen from December 2008 to January 2010. The slope of the linear regression is the average flux over the period.*

Another result is that there is no large gradient between both stations neither at Kerguelen (30 km distance) nor between Crozet and Kerguelen (1500 km).

The evolution of the project moved our attention to source regions. Because the South Hemisphere is mainly constituted of oceans, the only possible dust sources are East Patagonia, South Africa and Australia. Patagonia is suspected to be the major dust source for the oceanic region ranging between 40°S and 60°S. We begin to investigate the relevant properties of the aerosols emitted from Patagonia, including their chemical composition, the factors controlling their emission and transport, and their bioavailability by looking at their solubility and other ad-hoc assessments. We have instrumented a sampling station in Rio Gallegos (Argentina, 51°37'57.70"S; 69°13'41.64"W) including aerosol sampling, Lidar measurements and meteorological records. This station is situated at the circumpolar atmospheric circulation latitude and may intercept emitted dust as well as locally as transported from the west border (250 km) of this region. In complement and in order to investigate at

a limited cost the spatial (2D) distribution of the atmospheric concentration of trace metals in Patagonia, we collect and analyses lichens harvest in a large area around. Lichens are slow-growing organisms which, over their lifespan, are expected to accumulate and retain high levels of mineral elements present in the atmosphere, but not from the host tree limb or rocks from which they are suspended. It can not be used for temporal studies but it has been shown through large and systematic investigations that the variations in lichens chemical composition are reflecting the variations of local aerosol chemical composition integrated on large time periods (Monna et al., 2006, Monna et al., 2011). In an emission area, lichen chemical composition will reflect the average composition of the emitted aerosol.

Figure 2: *Atmospheric sampling station set up at Rio Gallegos.*

First results will come in the year 2012.

F. Monna, M. Poujol, R. Losno, J. Dominik, H. Annegarn, H. Coetzee, Origin of atmospheric lead in Johannesburg, South Africa, Atmospheric Environment, Volume 40, Issue 34, November 2006, Pages 6554-6566, ISSN 1352-2310, 10.1016/j.atmosenv, 2006.

Monna, F., Bouchaou, L., Rambeau, C., Losno, R., Bruguier, O., Dongarrà, G., Black, S., Chateau, C. Lichens used as monitors of atmospheric pollution around Agadir (Southwestern Morocco) – A case study predating lead-free gasoline, Water air and soil pollutions DOI 10.1007/s11270-011-0942-2, 2011.

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

A new project was proposed at the French agency CNRS/INSU through the LEFE/CHAT action: "Dust From Patagonia". Today, we are expecting the answer for the end of January. A positive answer will give 2 years continuity of our investigation in the Patagonian source region (sea section 6).

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

Alexie heimburger, PhD student working on FLATOCOA made a short movie with Fanny Mazoyer intitled "Qui sème la poussière récolte le phytoplancton", awarded and available here for download or show:
http://www.science.gouv.fr/fr/telesciences/bdd/res/4336/qui-seme-la-poussiere-recolte-le-phytoplancton/
This movie tells a large public the methods in use to collect and analyse dust in remote oceanic areas.

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

The first publications in journals will be submitted during the year 2012, including dust deposition at Kerguelen and a comparison of dust flux measured at Kerguelen and Crozet and model outputs. Two communications were made in 2011.

Heimburger, A., Losno, R. and Dulac, F, **Atmospheric deposition of trace elements over the South Indian ocean: a time series at kerguelen islands**, 2011 ASLO Aquatic Sciences Meeting, San Juan de Porto Rico, 14-18 february 2011.
A.Heimburger, R. Losno, S. Triquet, E. Bon and A. Perot, **Dust deposition over South Ocean measured at Crozet an Kerguelen Island**, SOLAS-France meeting, 29-30 june 2011, Paris. (http://www.lisa.u-pec.fr/SOLAS/2011/Docs/FSOLAS2011Alexie_Heimburger.pdf).

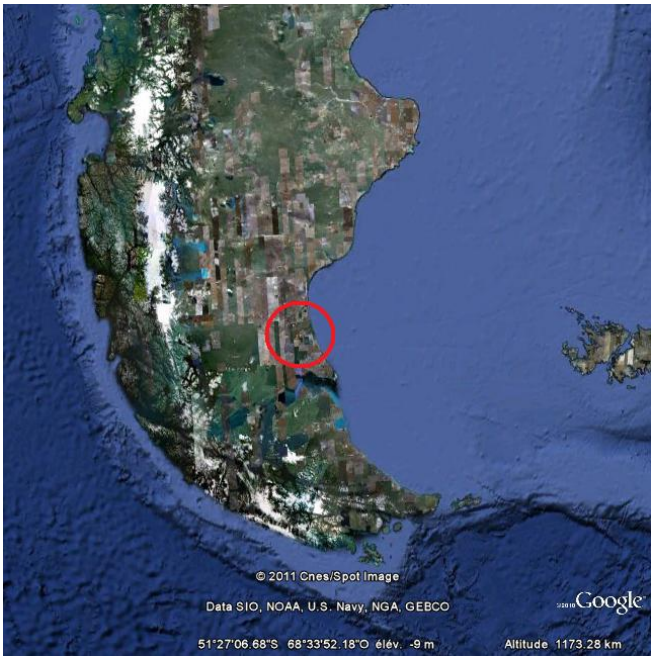
5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)

We began collaboration with CEILAP (Buenos Aires, Rio Gallegos) in Argentina. CEILAP bring their LIDAR expertise and the facilities of the laboratory installed at Rio Gallegos.

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

Experimental work

Next step will be to work on the chemical properties of source aerosols from Patagonia (Rio Gallegos sampling station). This will include sampling but also laboratory experiments with collected aerosols. We will use an aerosol Lidar at Rio Gallegos to help us selecting dust events with a vertical extension large enough for long range transport. The main conclusions we expect of Lidar profile will be information on the continuity of the aerosol layer from ground to higher altitudes. In case of continuity, we will assume that the aerosol layer is homogeneous from ground to its top and extrapolate the measured chemical composition at ground level to the top of the layer.



Location of the new sampling area

Aerosol will be sampled for 2 years, its elemental composition determined and solubility of Fe, Co, Zn... investigated with laboratory experiments.

Aerosol will be produced from soils collected in emission zones using the techniques developed in LISA (Lafon et al., in preparation). This technique allows collecting dust aerosol samples on bulk filters and cascade impactors. This cascade impactor will be useful to obtain the size-resolved elemental composition. This material will be processed as natural samples to determine their mineralogical and chemical properties, including solubility. The various soil samples will be processed in the LISA device in order to study the regional of Patagonian dust.

Model

The coupled LMDz model with a zoom that can go down to 50x50km2 resolution will be used over the region coupled with INCA module (Interactions between Chemistry and Aerosols). Five aerosols components are simulated (sulphate, black carbon, organic carbon, dust and seasalt) and particular emphasis will be put on the analysis of dust fields that include emission, dry and wet deposition fluxes, optical depth, radiative forcing in the SW and LW. We will simulate the distribution of dust over the 2 years of the experiments by nudging the winds of the model to the ones from the ECMWF analysis. To evaluate the model performance, we will compare the LIDAR retrieved profiles of extinction with the vertical profile of dust extinction computed by the model. In addition, we will use the 10x10km MODIS product of optical depth to compare the simulated aerosol optical depth from LMDz-INCA to the ones retrived from MODIS.

7. Other comments

Aknowledgements: the staff of theIPEV and TAAF for their help at Kerguelen and Crozet, the Argentine millitary for their hosting at Rio Gallegos.

MERMEX

compiled by Cecile Guieu, Xavier Durieu de Madron and Richard Sempéré

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)

MERMEX is dedicated to study the response of Mediterranean ecosystems and biodiversity to climate changes and anthropogenic pressure. MERMEX aims to deepen the current understanding of the Mediterranean marine ecosystems to better anticipate their upcoming evolution. It is focusing on the response of ecosystems to modifications of physico-chemical forcing at various scales, both in time and space, linked to changing environmental conditions and increasing human pressure (figure 1). It proposes a comprehensive, integrated approach considering the continuum between the coastal zone and the open sea and its interfaces, including ocean-continent, ocean-atmosphere and water-sediment to precisely describe and model the current state of the Mediterranean ecosystems and the complex interactions existing between the environmental and human factors.

MERMeX White Book was published in 2011 in Progress in Oceanography – 95 authors, 130 pages, 630 references.

Mermex Group, F., 2011 Marine Ecosystems Responses to climatic and anthropogenic forcings in the Mediterranean. Progress in Oceanography, 2, 91: 97-166.

The project is divided into several thematic approaches that were grouped into five work packages (WP): 1-Impact of hydrodynamic changes on Mediterranean biogeochemical budgets (WP1), 2-Ecological processes; biogeochemistry and food web interactions (WP2), 3-Land-ocean interactions including extreme events (WP3), 4-Natural and anthropogenic air-sea interactions (WP4), 5-Ecosystem based management (WP5). Each WP is led by 2-3 coordinators and includes several actions currently funded or submitted for fundings through different funding agencies [MISTRALS, ANR, UE...].

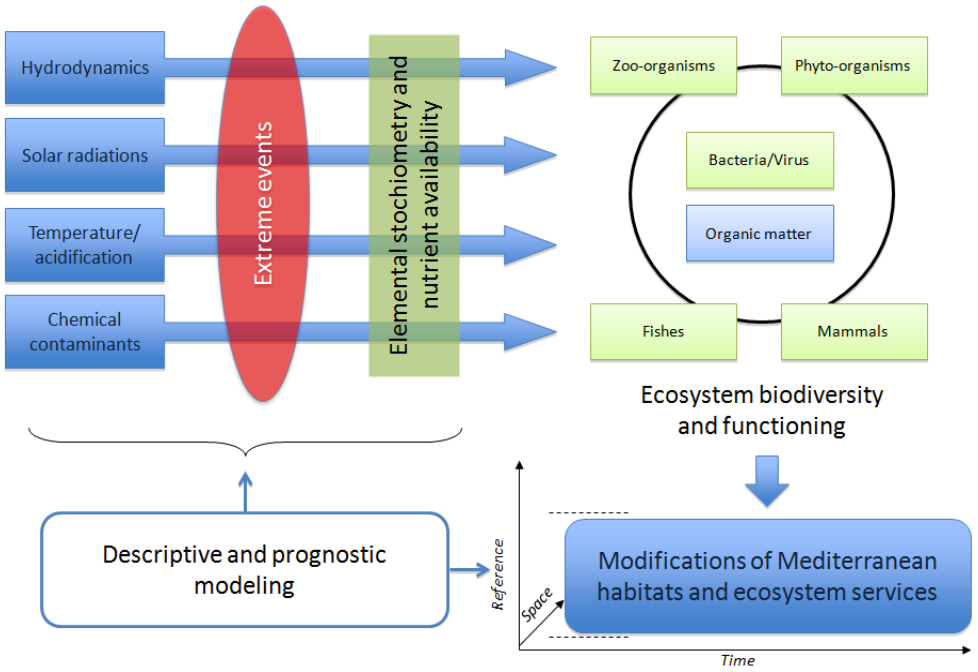


Figure 1. Schematic of the key forcing variables influencing the marine ecosystems' diversity and functioning, and use of modeling as an integrative tool at the intersection of the different objects considered in MERMEX.

From MERMEX Group, 2011.

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

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

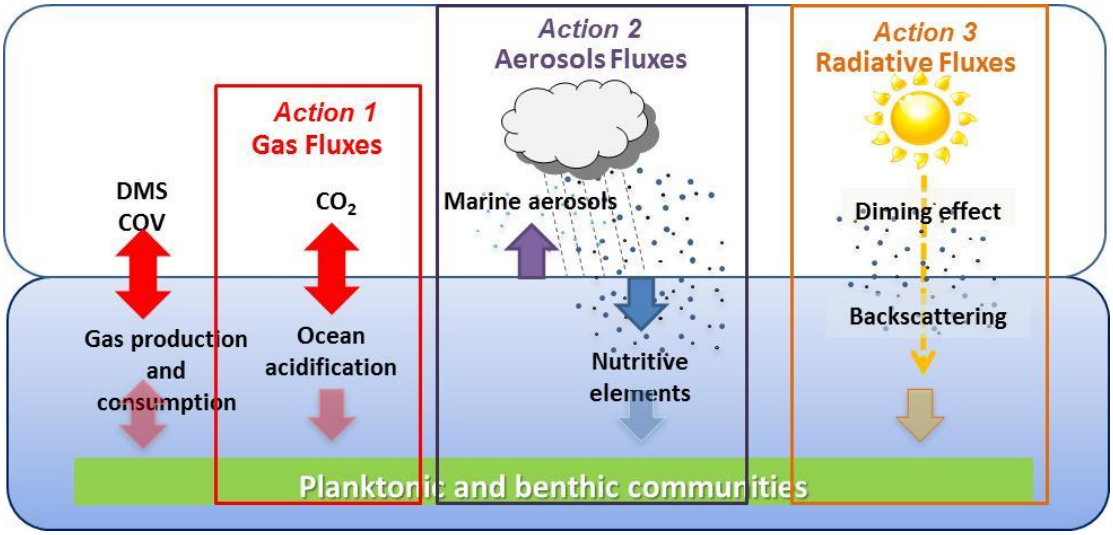


Figure 2. Main MERMEX activities relevant to SOLAS : several actions concern the assessment of gas fluxes (CO2) and acidification and the impacts on ecosystems and biogeochemical cycles and strongly connected with the FP7-MedSea project. A large project on the assessment of fluxes of atmospheric particles to the air-sea interface and their impact on biogeochemical cycles have been recently submitted for funding (Collaboration with CHARMEX). The influence of solar radiations on biogeochemical cycles is studied in MERMEX and includes the potential effect of aerosol and tropospheric ozone attenuation on marine ecosystems.

MERMEX projects related to actions 1, 2 and 3 in figure 2:

• **CALIBORON**: past pH reconstructions in the Mediterranean Sea based on the boron isotopic signature in biogenic carbonates – calibration using Mediterranean mussels and corals (started in 2011)

• **CARBORHONE**: pCO_2 and DIC dynamics in the Rhone estuary and the Gulf of Lions (started in 2011)
  • 2 field cruises in spring and fall 2011
  • 2 field cruises planned in summer and winter 2012

• **PHOTOMED**: Metabolic and structural changes of the bacterial community in response to the phototransformations of dissolved and particulate organic matter in Mediterranean Sea

Other relevant projects with strong links with Mermex

• **MedSeA** (EU FP7, started in February 2011): Mediterranean Sea Acidification in a changing climate

• Joint experiment using large pelagic mesocosms in Corsica (summer 2012) and in Crete (summer 2013) – Effects of ocean acidification on planktonic communities in oligotrophic areas.
• Effects of ocean acidification and warming on the development and physiology of the Mediterranean mussel (collaboration with project CALIBORON).
• Effects of ocean acidification and warming on the development of Mediterranean pteropods and formaminifera.

• **eFOCE** (BNP-Paribas, started in September 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)

• **ANR Blanc SAM (Mermex-Charmex**, started in 2012**):** Quantification and determination of marine organic aerosol fluxes as a function of trophic conditions

• **Site Frioul**: Radiative measurements in the air and in the sea
• 2011: Installation of the instrumented buoy and first measurements

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

The actions mentioned above represented an activity of 58 man month in 2011, including several PhD students and undergraduate students.

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

The MERMEX group, 2011, Marine Ecosystems Responses to climatic and anthropogenic forcings in the Mediterranean, Progress In Oceanography, Volume 91, Issue 2, October 2011, Pages 97-166

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

As part of the MISTRALS (Mediterranean Integrated STudies at Regional And Local Scales) French program (www.mistrals-home.org), MERMEX was presented during the International MISTRALS Workshop – Malta 30 March to 1st April 2011-, which brought together nearly 200 participants - by invitation - involved in the Mediterranean question, projects holders and potential developers, scientists and policy makers.

Web site MERMEX: http://mermex.com.univ-mrs.fr/

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

In 2012, the SOLAS-related projects detailed above will be continued and some new one will start. Among those, a proposal was recently submitted to ANR:

ANR FARE (blanc, Mermex-Charmex, submitted in 2012): Study of the relation between atmospheric deposition fluxes and the pool of seawater nutrients - anticipate the future impact of dust deposition on nutrient cycles.

Another action will concern the setting up of a proposal concerning a field cruise entitled PEAcEtIME "ProcEss studies at the Air-sEa Interface: a Mediterranean Experiment" (joint experiment between MERMEX and ChArMEx was discussed in 2011 and planned in 2015. This project will be submitted for presentation at the 2012 OSC to call for international collaboration on that "SOLAS cruise" in the Mediterranean.

7. Other comments

MERMEX is part of the French MISTRALS program initiated in 2008 and internationally launched in Malta meeting in March 2011. MISTRALS is a decennial meta-program for systematic observations and research dedicated to the understanding of the Mediterranean Basin environmental process under the planet global change. Its aim is to anticipate the behavior of this system over a century, from an interdisciplinary analysis conducted over the 2010-2020 decade. The underlined ultimate goal of this meta-program is to predict the evolution of habitable conditions in this large eco-anthropo-system and to propose policies and adaptative measures that would mitigate and optimize them. MISTRALS is bringing together the main French research organizations and is destined to be shared by co-construction and aggregation of new topics and issues with all Mediterranean countries. Indeed, it is now stretching to other countries in Europe and throughout the Mediterranean Basin, according to a bottom-up approach.

Web site MERMEX: http://mermex.com.univ-mrs.fr/

Web site MISTRALS: http://www.mistrals-home.org

SOAP

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)

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.

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

remote sensing used, model and data intercomparisons etc)

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).

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

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

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.

Z.Ristovski, L.Cravigan, P.Vaattovaara, N.Talbot, G.Olivares, C.Law, M.Harvey, and A.Laaksonen Sea spray aerosol production via bubble bursting during the Surface Ocean Aerosol Production (SOAP) study. EAC 2011, Manchester, UK, 4-9/9/11.

C. Law et al. 2011. Surface Ocean Aerosol Production pilot study (Pre-SOAP) Voyage report (TAN1102). NIWA Internal Report.

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

Planning for SOAP voyage in February 2012, with international participation:-

NIWA (NZ), QUT, CSIRO (Australia), UEF (Finland), UC Irvine, U Chapman (USA), IfM-Geomar (Germany) and U. Laval (Canada).

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

Completion of SOAP voyage in February 2012, with presentation of selected data at the SOLAS OSC in May 2012.

7. Other comments

- SOLAS Task Team 2011 annual report

HitT – Halogens in the Troposphere

compiled by Roland von Glasow

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

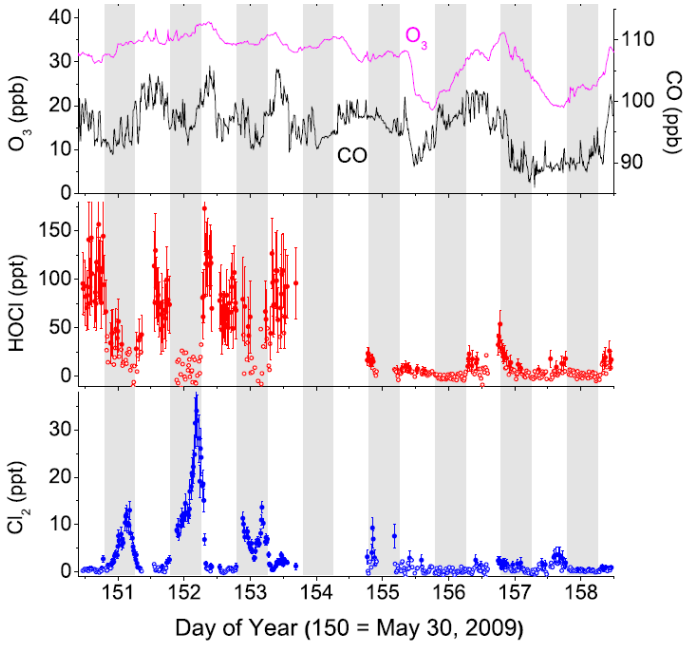
1. Key scientific SOLAS-relevant highlights/findings (you may include figures and references)

(1) Very wide-spread occurrence of iodine oxide (IO) in the marine boundary layer (MBL)

Presentations from Univ Heidelberg (Großmann et al., Tschritter et al.), Bremen (Peters et al.), Boulder (Volkamer et al.) at EGU 2011 showed that IO appears to be almost omnipresent in the tropical North Atlantic and Western Pacific at mixing ratios of 1-2ppt.

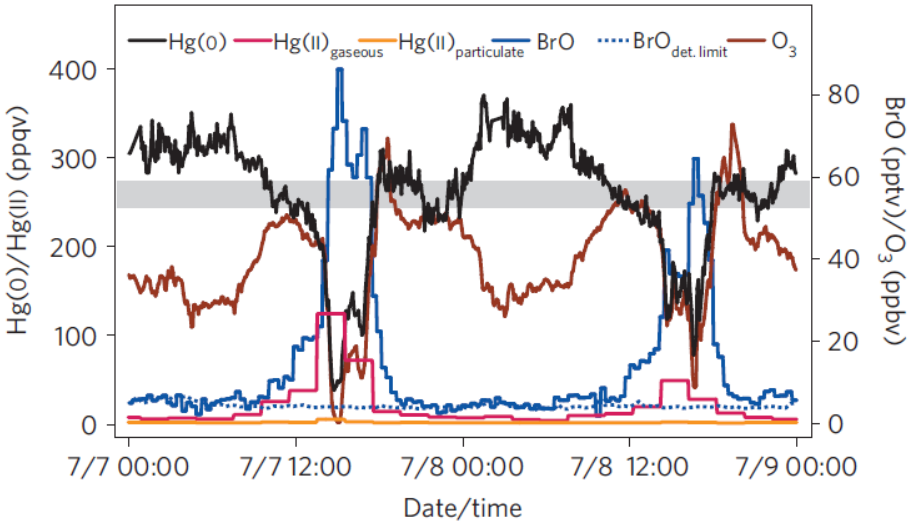
(2) Role of chlorine atoms for methane (CH_4) oxidation underestimated in North Atlantic/globally

Lawler et al (2011) showed very widespread presence of Cl_2 and for the first time HOCl in the tropical North Atlantic (Cape Verde). They estimated that the chlorine atom would be responsible for about 15% of CH_4 destruction in the tropical MBL



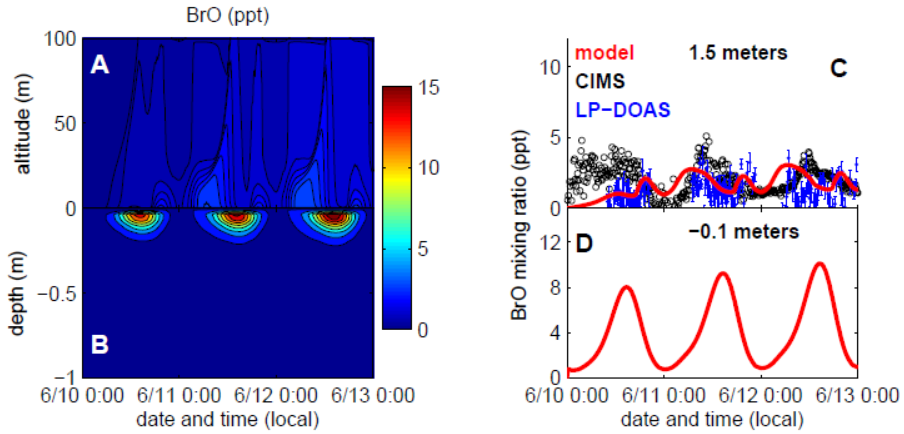
(3) Bromine-induced mercury depletion events in Dead Sea

Obrist et al (2011) showed that not only under polar conditions but also under the very different conditions in the Dead Sea are, bromine explosions can lead to depletion of mercury



(4) Snow photochemistry model

Thomas et al (2011) developed a coupled atmosphere-snow chemistry model that was able to reproduce observed levels of BrO at the Summit research station, Greenland from first principles.



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

- AICI-HitT workshop, New York, June 2011
- EGU session on halogens, Vienna, April 2011
- AGU session on halogens , December 2011
- HALOPROC salt lake campaign in Australia, March/April 2011
- Masaya campaign (UEA, Oxford, Heidelberg)

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

- Various media contacts (e.g. Masaya campaign; TV, radio and newspaper reports following on from press conference, March 2011)
- HALOPROC workshops (Oberjoch, Hohnstein)

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

Baker et al., Investigation of chlorine radical chemistry in the Eyjafjallajökull volcanic plume using observed depletions in non-methane hydrocarbons, J. Geophys. Res., 38, L13801, doi:10.1029/2011GL047571, 2011

Commane et al., Iodine monoxide at a clean marine coastal site: observations of high frequency variations and inhomogeneous distributions, Atmos. Chem. Phys., 11, 6721-6733, 2011

Lawler et al., HOCl and Cl_2 observations in marine air, Atmos. Chem. Phys., 11, 7617-7628, 2011

Lowe et al., Modelling multi-phase halogen chemistry in the coastal marine boundary layer: investigation of the relative importance of local chemistry vs. long-range transport, Atmos. Chem. Phys., 11, 979-994, 2011

Mahajan et al., Concurrent observations of atomic iodine, molecular iodine and ultrafine particles in a coastal environment, Atmos. Chem. Phys., 11, 2545-2555, 2011

Obrist et al., Bromine-induced oxidation of mercury in the mid-latitude atmosphere, Nature Geosc., 4, 22-26, 2011

Saiz-Lopez et al., Atmospheric Chemistry of Iodine, Chem. Rev., doi: 10.1021/cr200029u, 2011

Theys et al., Global observations of tropospheric BrO columns using GOME-2 satellite data, Atmos. Chem. Phys., 11, 1791-1811, 2011

Thomas et al., Modeling chemistry in and above snow at Summit, Greenland - Part 1: Model description and results, Atmos. Chem. Phys., 11, 4899-4914, 2011

Toyota et al., Analysis of reactive bromine production and ozone depletion in the Arctic boundary layer using 3-D simulations with GEM-AQ: inference from synoptic-scale patterns, Atmos. Chem. Phys., 11, 3949-3979, 2011

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)
- Special issues in ACP(D)
    - Radical chemistry over sunlit snow: interactions between HOx and halogen chemistry at Summit, Greenland“
    - The TransBrom Sonne ship campaign in the West Pacific
- Strong link to OASIS/AICI:
    - special sections in JGR and ACP(D)

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

- Workshop on global relevance of reactive chlorine in the MBL
- Robust global assessments of the relevance of tropospheric halogen chemistry
- TORERO project involves ship and aircraft: fieldwork early 2012
- Field campaign in Dead Sea (HALOPROC)

7. Other comments

Web page: www.HitT-task.net

- IGBP/SCOR FTI SOLAS-relevant 2011 annual report

Fast-Track Initiative – 'Upper Ocean Nutrient Limitation'

compiled by Mark Moore

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)

The key SOLAS relevant highlights resulting from the workshop will all be incorporated within the primary review paper which is nearing the submission stage. In particular, a novel meta-analyses of nutrient addition experiments and natural marine microbial responses within dust addition experiments will be included within this manuscript.

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

The main workshop related to the workshop was undertaken in November 2010, consequently the principal activity during 2011 has been preparation of the primary review paper resulting from the workshop. Progress of this has been a little slower than desirable, partly due to the large amount of new information to be incorporated. Novel data meta-analyses have been produced as part of generating the review paper and extensive work has been performed on these during the past 12 months. The third and hopefully final full draft is now nearing completion and submission to Nature Geoscience is planned for early 2012.

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

No specific outreach activities were performed during 2011. International capacity building continues through the involvement of researchers from economies in transition within the FTI.

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

No peer reviewed publications were produced in 2011, work on the draft manuscript continues and all the pre-workshop reports were posted on the FTI website following the meeting in late 2010 (http://ocean.stanford.edu/IGBP_FTI/products.html). Preliminary information related to the novel meta-analyses performed was posted on the website during 2011 (http://ocean.stanford.edu/IGBP_FTI/working_groups.html) and will be disseminated further alongside the published manuscript. An article associated with the workshop was published in issue 12 of the SOLAS Newsletter 'Workshop associated with the IGBP Fast Track Initiative (FTI) on "Upper Ocean Nutrient Limitation: Processes, Patterns and Potential for change"' SOLAS News 12 page 28

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

International interactions continue through collaborations with the workshop participants who represent 10 countries across 4 continents. Collaborations and links with other IGBP projects (AIMES, PAGES/NICOPP) and GEOTRACES. Unfortunately a joint application led by Cecile Giueu for a related session a the 2012 'Planet Under Pressure' conference was unsuccessful.

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

The major goal and priority over the coming months is the submission and guidance through the review process of the principal review paper. As mentioned above, this is planned within the next 2-3 months.

7. Other comments

The final report submitted to IGBP is attached and contains further details on much of the above.

IGBP-FTI: Upper ocean nutrient limitation: processes, patterns and potential for change

Co-ordinators: Dr. Mark Moore (NOCS, UK), Dr. Matt Mills (Stanford University, US), Dr. Emilie Brévière (SOLAS, Germany), Prof. Doug Wallace (SOLAS, IGBP SC liaison, Germany)

Final Report: 08-02-2011

Although the following represents the final report on the IGBP Fast Track Initiative (FTI) on Upper Ocean Nutrient Limitation which commenced in May 2009, activities relating to the FTI are ongoing and in particular publications are planned for the coming 6 months.

Introduction and objectives

The FTI was set up as a mechanism for providing a synthesis of the current state of knowledge concerning patterns of upper ocean nutrient limitation, alongside the subsequent importance of nutrient limitation for wider ocean biogeochemistry. In conceiving the FTI, it was recognised that a large number of observational, experimental and modelling studies had recently addressed issues related to patterns of nutrient limitation in the upper ocean. It was hence realised that an opportunity was available to attempt to review and synthesise this large body of work. In addition to establishing the current state of the art, the FTI also considered the conceptual constructs and techniques used in the evaluation of nutrient limitation and explicitly considered how nutrient limitation may have changed in past and may respond to potential future perturbation. More detailed background, rationale and objectives for the FTI were set out in the original proposal.

Progress

IGBP initially allocated 13k euro to the FTI. Subsequent successful applications to the US Ocean Carbon and Biogeochemistry programme (OCB), SCOR and EU-COST-735 secured an additional $7k, $5k and 2k euro respectively. The high level of support from IGBP and the other sources was much appreciated and facilitated the running of the main workshop at no additional cost to a highly international participant list (see appendix 1).

Implementation of the FTI involved 2 principal activities:

The first was a special session at the joint AGU/ASLO Ocean sciences meeting in Oregon (February 2010) convened by Mills and Moore. These sessions attracted 27 abstracts from experimental oceanographers, modellers and paleoceanographers, full details of both the oral and poster sessions are available on-line: *(http://www.agu.org/meetings/os10/os10-sessions/os10_BO11C.html, oral) (http://www.agu.org/meetings/os10/os10-sessions/os10_BO15G.html, poster).*

Both sessions were well attended and generated considerable cross disciplinary interest.

The main implementation activity followed later in the same year. A dedicated workshop was run from 3rd-5th November 2010 at the National Oceanography Centre, Southampton, UK. A total of 19 participants from 10 countries attended, with a further 2 having to withdraw at the last minute due to illness (see appendix 1). The range of different disciplines and level of expertise facilitated a dynamic environment for stimulating and productive cross disciplinary discussions. A total of 9 pre-workshop reports were prepared by working subgroups and disseminated prior to the workshop. The titles of these reports can be viewed on the dedicated webpage which was set up to facilitate communication and interest for the FTI (http://ocean.stanford.edu/IGBP_FTI/). Following the workshop, full texts of all the reports and presentations were also made available to all participants within a secure region of the website.

The first day of the workshop was devoted to the presentation and subsequent discussion of the material within the pre meeting reports. A wide range of collated information was considered in detail and it was recognised that the reports would be a vital resource for informing a proposed major review paper (see below). Potential wider dissemination of the reports is still under consideration, although transfer of information to the review paper may make this unnecessary. Subgroups met to further consider emerging unifying themes on day 2 of the workshop. In particular *concepts and definitions of nutrient limitation, current patterns of limitation, expected changes in the future* and *implications of changes*, were all discussed in detail. A novel meta-analysis of results from nutrient perturbation experiments was also conceived and the subsequent data-base will become a key aspect of a review manuscript. The data base is likely to represent a highly

useful resource for the biogeochemical modelling community and hence will be disseminated alongside the review paper, for example as 'supplementary information'. We are also investigating independent dissemination via the website following publication. After consideration the group felt that an overview manuscript covering the breadth of material, written for a high profile journal and a general (biogeo-)science audience, was the overall preferred method for dissemination. The majority of the final day thus involved initial condensation of the large volume of information already collected into material suitable for this principal product. The scope of such a manuscript will necessarily leave some material unused. Consequently a number of sub-groups have already indicated interest in developing more specialist manuscripts following completion of the overview.

Outputs

The working papers, presentations and ongoing data-base development constitute major scientific outcomes. The synthesis of this material, initiated at the meeting, will form the basis of a review which should mark a significant statement on the current state of the art. Discussions with the editor of *Nature Geoscience* on whether they would consider such a review article remain very positive. Writing work on this principal product is well advanced with the first complete draft having been disseminated to all workshop participants/coauthors. Incorporation of subsequent substantial comments/suggestions into the second complete draft is nearly complete and one more round of comments will be solicited from the co-authors before subsequent submission to *Nature Geoscience* hopefully within 2 months. A meeting report was also prepared for the SOLAS newsletter. Reports were also delivered to OCB and EU-COST 735. As mentioned above, further products in the form of specialist reviews may follow submission of the overview manuscript. The completed data base will also represent a substantial resource for the community.

Timeline

-Feb 22nd-26th 2010: Special Session at Ocean Sciences meeting *Complete*
-Nov 3rd-5th 2010: Dedicated workshop, NOCS UK *Complete*
-March 2011: Preparation of 1st draft of principal manuscript *Complete*
-Current Preparation of 2nd draft of principal manuscript Ongoing
-September 2011: Submission of manuscript to *Nature Geoscience* Projected

Appendix 1

List of workshop attendees alongside specialisms with affiliations to other projects:

Name *Discipline/specialism* (Country, Gender) **Other affiliation**
Illana Berman-Frank *Nutrient limitation of diazotrophs* (Israel, Female)
Laurent Bopp *Modelling* (France, Male) **AIMES SSC**
Eric Galbraith *Paleoceanography, modelling* (Canada, Male) **NICOPP/PAGES**
Richard Geider *Phytoplankton physiology and stoichiometry* (UK, Male)
Cecil Guieu *Nutrient limitation, atmospheric inputs* (France, Female) **SOLAS SSC**
Samuel Jaccard *Paleoceanography, modelling* (Switzerland, Male) **NICOPP**
Tim Jickells *Atmospheric nutrient inputs* (UK, Male)
Julie La Roche *Diazotroph nutrient limitation* (Germany, Female)
Tim Lenton *Modelling, nutrient stoichiometry* (UK, Male)
Emilio Maranon *Phytoplankton ecology and physiology* (Spain, Male)
Irina Marinov *Nutrient biogeochemistry, modelling* (US, Female)
Mark Moore *Phytoplankton ecology and physiology* (UK, Male)
Matt Mills *Microbial biogeochemistry* (US, Male)
Takeshi Nakatsuka *Paleoclimatology, Paleoceanography* (Japan, Male) **PAGES SSC**
Andreas Oschlies *Biogeochemistry, Modelling* (Germany, Male)
Mak Saito *Nutrient co-limitation, trace metal bioavailability* (US, Male)
Frede Thingstad *Bacterial resource limitation* (Norway, Male)
Atsushi Tsuda *Iron limitation, trophic interactions* (Japan, Male)
Oswaldo Ulloa *Phytoplankton ecology and biogeochemistry* (Chile, Male)

The following people who unfortunately were unable to attend were all involved in the preparation of pre-workshop reports and continue to be involved in post-workshop manuscript preparation:

Kevin Arrigo *Phytoplankton ecophysiology* (US Male)
Phil Boyd *Phytoplankton Fe limitation* (New Zealand, Male) **GEOTRACES SC**
Natalie Mahowold *Atmospheric nutrient inputs* (US, Female)
Keith Moore *Modelling multiple limiting nutrients* (US, Male)
Doug Wallace *Marine biogeochemistry* (Germany, Male)

- SCOR WG SOLAS-relevant 2011 annual report

SCOR WG Sea-Ice

compiled by Jacqueline Stefels

Sea-ice biogeochemistry and interactions with the atmosphere - Progress 2011

First year of SCOR WG on Sea-Ice begins 2012

Background

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

- The impact of biology on climate-relevant gases such as CO2, DMS, N2O, halocarbons, etc.
- Dramatic halogen chemistry on and above the sea ice in springtime that destroys lower tropospheric ozone and mercury.
- Atmospheric aerosol formation from organic material produced by algae during the summer sea-ice melt.
- The impact of biology on ice structure: porosity, energy absorption and associated optical properties.
- Strong precipitation and dissolution processes of CO2 in brines
- The release of macro and trace nutrients (N, P, Fe) for surrounding waters during ice melt

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

Proposed Developments

- To stimulate the development of an international community on sea-ice biogeochemistry.
- To stimulate the interaction between experimentalists and modellers working on this topic.
- To help the community articulate research priorities and identify optimized and cost-effective approaches and research platforms in internationally resource-limited times.

Progress

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

- a proposal for a SCOR working group on 'Biogeochemical Exchange Processes at the Sea-Ice Interfaces (BEPSII)' (contact Jacqueline Stefels: j.stefels@rug.nl); and
- a commitment to compile a review on the current state-of-the-art of methodologies for sea-ice biogeochemical studies. Input from the global community will be solicited for the paper (contact Lisa Miller: lisa.miller@dfo-mpo.gc.ca).

- a commitment to write a white paper in collaboration with the OASIS community.
- an effort will be made to find additional funding for network support.

At the end of 2011, the SCOR WG proposal BEPSII received positive markings: “The National SCOR committees expressed that the proposal is timely because of the rapid changes in sea ice and the lack of sufficient understanding to parameterize global models, and that the topic is a priority for ocean science and for SCOR. A SCOR Working Group should be a good mechanism to advance this topic and will give a strong impulse to assembling existing expertise around this highly interdisciplinary topic. There was a special recognition of the need to improve sea ice components in climate and biogeochemical models.” The WG will start in 2012.
Several participants of the SOLAS-Cost workshop also participated in a workshop organised by the OASIS community in Telluride, Colorado, in June 2011. OASIS is a SOLAS, IGAC, WCRP/SCAR CLiC, AMAP, and IPY (http://www.oasishome.net/) endorsed project that was set-up in 2004 and culminated in several sea-ice field campaigns during IPY. During the workshop there was general agreement that the OASIS team and the SOLAS Mid-Term Strategy on sea ice should join forces. As a first effort, a feature article to be published in EOS was drafted. This is now accepted and will be published in early 2012.