surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS UK *compiled by:* *Tom Bell*

Please note that this report has two parts!

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

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

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

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

Describe one scientific highlight with a title, text (max. 200 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in international collaboration.

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

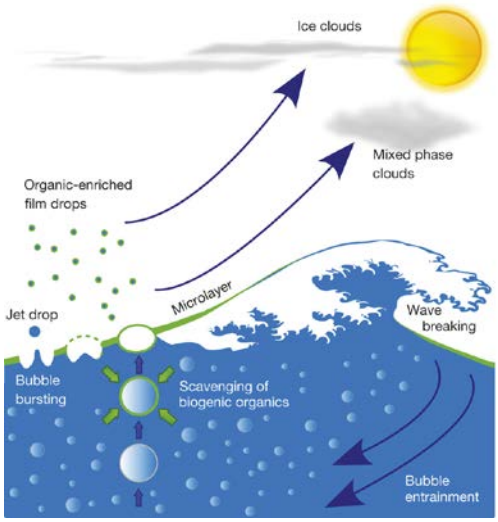


Figure 1 | Sea-spray aerosol particles enriched in organic material are generated when bubbles burst at the air–sea interface. Surface active organic material of biological origin is scavenged at the interfaces of bubbles as they rise through the water column. This process enriches the air–sea interface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

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

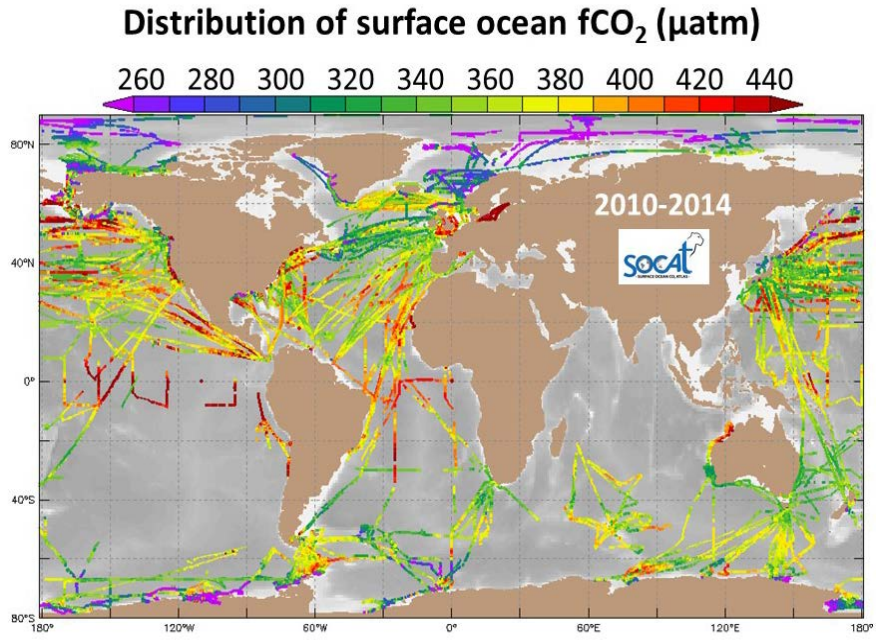
2. Activities/main accomplishments in 2015 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, etc.)

Accomplishments

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

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

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



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

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

Activities/Leadership

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

Newly-funded Projects – see Part 2, Section 3

Ongoing Projects

- NERC/Defra Shelf Sea Biogeochemistry programme – Science Coordinator: P. Williamson (http://www.uk-ssb.org/)
- ESA OceanFlux Greenhouse Gases evolution (http://www.oceanflux-ghg.org) – Lead PI J. Shutler
- ESA Pathfinders-Ocean acidification (http://www.pathfinders-oceanacidification.org) – Lead PI J. Shutler
- Radiatively Active Gases from the North Atlantic Region and Climate Change (RAGNARoCC) – Lead PI: A. Watson (www.greenhouse-gases.org.uk/ragnarocc)
- Turbulent Exchange: Aerosols, Bubbles And Gases (UK contribution to HiWinGS) – Lead PI: I. Brooks
- Co-ordinated Airborne Studies in the Tropics (CAST) – Lead PI: N. Harris (http://www-cast.ch.cam.ac.uk/)
- Atlantic BiogeoChemical fluxes (ABC) – PI: E. McDonagh (http://www.rapid.ac.uk/abc/)
- UK-GEOTRACES consortium – PI: G. Henderson. Final open science meeting was at the Royal Society in London in December. https://royalsociety.org/events/2015/12/ocean-chemistry/
- Coordinated Research in Earth Systems and Climate: Experiments, kNowledge, Dissemination and Outreach (CRESCENDO) H2020 project – PI: C. Jones.
  Aims to improve the representation of key biogeochemical, biogeophysical and aerosol processes and feedbacks in seven European Earth System Models.
- Surface Mixed Layer at Submesoscales (SMILES) – Lead PI: P. Hosegood (http://www.smiles-project.org/)
  Aims to identify the influence of submesoscales upon the structure and properties of the upper ocean, and thereby the transformation of surface water masses, within the Southern Ocean.

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

Outreach

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

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

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

The following alphabetical list of SOLAS-relevant, peer-reviewed 2015 publications (n = 39) with UK authors/co-authors is based on researchers' input and Web of Knowledge searches. There has been no attempt to formally rank the "top 5" in terms of scientific quality or importance.

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

Available online 11 November 2015.

- Carpenter, L. J. and Nightingale, P.D. (2015) Chemistry and Release of Gases from the Surface Ocean, Chemical Reviews 115(10), pages 4015-4034.
- Carpenter, L. J., Andrews, S. J., Lidster, R. T., Saiz-Lopez, A., Fernandez-Sanchez, M., Bloss, W. J., Ouyang, B. & Jones, R. L. (2015) A nocturnal atmospheric loss of CH_2I_2 in the remote marine boundary layer. Journal of Atmospheric Chemistry, DOI 10.1007/s10874-015-9320-6.
- Chance, R., Jickells, T.D., Baker, A.R. (2015) Atmospheric trace metal concentrations, solubility and deposition fluxes in remote marine air over the south-east Atlantic, Marine Chemistry 177, Part 1, pages 45-56, http://dx.doi.org/10.1016/j.marchem.2015.06.028
- Emmons LK; Arnold SR; Monks SA; Huijnen V; Tilmes S; Law KS; Thomas JL; Raut JC; Bouarar I; Turquety S; Long Y; Duncan B; Steenrod S; Strode S; Flemming J; Mao J; Langner J; Thompson AM; Tarasick D; Apel EC; Blake DR; Cohen RC; Dibb J; Diskin GS; Fried A; Hall SR; Huey LG; Weinheimer AJ; Wisthaler A; Mikoviny T; Nowak J; Peischl J; Roberts JM; Ryerson T; Warneke C; Helmig D (2015) The POLARCAT Model Intercomparison Project (POLMIP): Overview and evaluation with observations, Atmospheric Chemistry and Physics, 15, pp.6721-6744. doi: 10.5194/acp-15-6721-2015
- Fuzzi, S., Baltensperger, U., Carslaw, K., Decesari, S., Denier van der Gon, H., Facchini, M. C., Fowler, D., Koren, I., Langford, B., Lohmann, U., Nemitz, E., Pandis, S., Riipinen, I., Rudich, Y., Schaap, M., Slowik, J. G., Spracklen, D. V., Vignati, E., Wild, M., Williams, M., and Gilardoni, S. (2015 Particulate matter, air quality and climate: lessons learned and future needs, Atmos. Chem. Phys., 15, 8217-8299, doi:10.5194/acp-15-8217-2015.
- Goddijn-Murphy, L., D. K. Woolf, A. H. Callaghan, P. D. Nightingale, and J. D. Shutler (2016), A reconciliation of empirical and mechanistic models of the air-sea gas transfer velocity, J. Geophys. Res. Oceans, 121, 818–835, doi:10.1002/2015JC011096.
- Goddijn-Murphy, L. M., Woolf, D. K., Land, P. E., Shutler, J. D., and Donlon, C. (2015) The OceanFlux Greenhouse Gases methodology for deriving a sea surface climatology of CO_2 fugacity in support of air–sea gas flux studies, Ocean Sci., 11, 519-541, doi:10.5194/os-11-519-2015.
- Heinze, C., Meyer, S., Goris, N., Anderson, L., Steinfeldt, R., Chang, N., Le Quéré , C., Bakker, D. C. E. (2015) The ocean carbon sink – impacts, vulnerabilities and challenges. Earth System Dynamics 6:327-358. doi:10.5194/esd-6-327-2015.
- Jones, E.M., Bakker, D. C. E., Venables, H. J., Hardman-Mountford, N. (2015) Seasonal cycle of CO_2 from the sea ice edge to island blooms in the Scotia Sea, Southern Ocean, Marine Chemistry 177: 490-500. doi:10.1016/j.marchem.2015.06.031.
- Land, P.E., J.D. Shutler, H.S. Findlay, F. Girard-Ardhuin, R. Sabia, N. Reul, J.-F. Piolle, B. Chapron, Y. Quilfen, J.E. Salisbury, and others (2015). Salinity from space unlocks satellite-based assessment of ocean acidification. Environmental Science & Technology 49:1,987–1,994, http://dx.doi.org/10.1021/es504849s.
- Landschützer, P., Gruber, N., Haumann, F. A., Rödenbeck, C., Bakker, D. C. E., Heuven, S. van, Hoppema, M., Metzl, N., Sweeney, C., Takahashi, T., Tilbrook, B., Wanninkhof, R. (2015) The reinvigoration of the Southern Ocean carbon sink. Science 349 (6253): 1221-1224. doi:10.1126/science.aab2620.
- Leedham Elvidge, E. C., Phang, S.-M., Sturges, W. T., and Malin, G. (2015) The effect of desiccation on the emission of volatile bromocarbons from two common temperate macroalgae, Biogeosciences, 12, 387-398, doi:10.5194/bg-12-387-2015,.
- Legge, O. J., Bakker, D. C. E., Johnson, M. T., Meredith, M. P, Venables, H. J., Brown, P. J., Lee, G. A. (2015) The seasonal cycle of ocean-atmosphere CO_2 Flux in Ryder Bay, West Antarctic Peninsula. Geophysical Research Letters 42(8): 2934-2942. doi:10.1002/2015GL063796.
- Le Quéré, C., Moriarty, R., Andrew, R. M., Canadell, J. G., Sitch, S., Korsbakken, J. I., Friedlingstein, P., Peters, G. P., Andres, R. J., Boden, T. A., Houghton, R. A., House J. I., Keeling, R. F., Tans, P., Arneth, A., Bakker, D. C. E., Barbero, L., Bopp, L., Chang, J., Chevallier, F., Chini, L. P., Ciais, P., Fader, M., Feely, R., Gkritzalis, T., Harris, I., Hauck, J., Ilyina, T., Jain, A. K., Kato, E., Kitidis, V., Klein Goldewijk, K., Koven, C., Landschützer, P., Lauvset, S. K., Lefèvre, N., Lenton, A., Lima, I. D., Metzl, N., Millero, F., Munro, D. R., Murata, A., Nabel, J. E. M. S., Nakaoka, S., Nojiri, Y., O'Brien, K., Olsen, A., Ono, T., Pérez, F. F., Pfeil, B., Pierrot, D., Poulter,

B., Rehder, G., Rödenbeck, C., Saito, S., Schuster, U., Schwinger, J., Seférian, R., Steinhoff, T., Stocker, B. D., Sutton, A. J., Takahashi, T., Tilbrook, B., Van der Laan-Luijkx, I. T., Van der Werf, G. R., Van Heuven, S., Vandemark, D., Viovy, N., Wiltshire, A., Zaehle, S., Zeng, N. (2015) Global Carbon Budget 2015. Earth System Science Data 7: 349-396. doi:10.5194/essd-7-349-2015.

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- Myriokefalitakis, S., Daskalakis, N., Mihalopoulos, N., Baker, A. R., Nenes, A., and Kanakidou, M. (2015) Changes in dissolved iron deposition to the oceans driven by human activity: a 3-D global modelling study Biogeosciences, 12, 3973-3992, doi:10.5194/bg-12-3973-2015.
- Pang, X., Carpenter, L.J. and Lewis, A.C. Microfluidic derivatisation technique for determination of gaseous molecular iodine with GC-MS, Talanta 137, pages 214-219.
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- Powell, C. F., Baker, A. R., Jickells, T. D., Bange, H. W., Chance, R. J., and Yodle C. (2015) Estimation of the Atmospheric Flux of Nutrients and Trace Metals to the Eastern Tropical North Atlantic Ocean, Journal of the Atmospheric Sciences 72(10), 4029-4045.
- Prytherch, J., M. J. Yelland, I. M. Brooks, D. J. Tupman, R. W. Pascal, B. I. Moat, S. J. Norris. 2015: Motion-correlated flow distortion and wave-induced biases in air-sea flux measurements from ships. *Atmos. Chem. Phys.*, 15, 10619–10629, doi:10.5194/acp-15-10619-2015
- Rap A; Richards NAD; Forster PM; Monks SA; Arnold SR; Chipperfield MP (2015) Satellite constraint on the tropospheric ozone radiative effect, Geophysical Research Letters, 42, pp.5074-5081. doi: 10.1002/2015GL064037
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- Violaki, K., Sciare, J., Williams, J., Baker, A. R., Martino, M., and Mihalopoulos, N. (2015) Atmospheric water-soluble organic nitrogen (WSON) over marine environments: a global perspective Biogeosciences, 12, 3131-3140, doi:10.5194/bg-12-3131-2015.
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acidification and elevated fCO_2 on trace gas production by a Baltic Sea summer phytoplankton community, Biogeosciences Discuss., doi:10.5194/bg-2015-573, in review.

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- Yang, M., Bell, T. G., Hopkins, F. E., and Smyth, T. J.: Attribution of Atmospheric Sulfur Dioxide over the English Channel to Dimethylsulfide and Changing Ship Emissions, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-56, in review.
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PART 2 - Planned activities from 2016 to 2018/19

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

- The release of SOCAT version 4 is planned for June 2016.
- A special issue on Ocean Acidification will be published in DSR-II in 2016, entitled: Impacts of surface ocean acidification in polar seas and globally: a field-based approach
- Ian Brooks' group (Leeds) expects to participate in a research cruise on the Swedish Icebreaker Oden during August-September 2016. Measurements will focus on turbulent exchange over sea ice, and the impact of ice fraction and ice properties (thickness, ridging, melt ponds, etc) on the transfer coefficients. Our measurements (joint with Stockholm University) piggy back on a sea-bed mapping project, and are a first step in longer term plans to develop a semi-permanent instrumentation suite on Oden with which to make longer-term measurements of atmospheric processes and properties in the Arctic, including surface exchange.

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

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

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

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

3. Funded national and international projects / activities underway (if possible please list in order of importance and indicate to which part(s) of the SOLAS 2015-2025 science plan the activity topics relate – including the themes on 'SOLAS science and society' and 'Geoengineering')

Newly-funded Projects (no specific order)

- Biogeochemical cycling of N-osmolytes in the surface ocean (NERC) – Lead PI: Y. Chen. http://gtr.rcuk.ac.uk/projects?ref=NE/M002233/1
- Microbial degradation of dimethylsulfoxide in the marine environment (NERC) – Lead PI: H. Schaefer. http://gtr.rcuk.ac.uk/projects?ref=NE/L006448/1
- Iodide in the ocean: Distribution and impact on iodine flux and ozone loss (NERC) – Lead PI: L. J. Carpenter. http://gtr.rcuk.ac.uk/projects?ref=NE/N009983/1
- The Global Methane Budget (NERC Highlight Topic) – Lead PI: E. Nisbet
- Are sooty ships enhancing the primary productivity in the ocean? (Royal Soc.) – Lead PIs: Zongbo Shi, Huiwang Gao
- Trace gases at the Rothera Time-series Site (BAS Collaborative Gearing Scheme, CGS) – Lead PI: C. Hughes
- Marine particles as sources of ice nucleating particles (MarineIce, ERC consolidator grant) –Lead PI: Ben Murray

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

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

4. Plans / ideas for future projects, programmes, proposals national or international etc. (please precise to which funding agencies and a timing for submission is any)

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

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

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

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

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

Comments