surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *UK*
compiled by: Tom Bell

This report has two parts:

***- Part 1:** reporting of activities in the period of January 2016 – Jan-Feb 2017*
***- Part 2:** reporting on planned activities for 2017/2018 and 2019.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan.

***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, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

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. (If you wish to put more than one, feel free to do so).

Effects of pollution on aerosol iron solubility

Li et al. (2017) provide a 'smoking gun' for the theory of acid iron dissolution - acids formed from human-generated pollution and natural emissions dissolve iron in airborne particles. We know that air pollution seriously damages human health and terrestrial ecosystems but this 'new' source of soluble iron can potentially alter the amount of carbon dioxide stored in the oceans.

Individual particles were collected from the Yellow Sea, the northern part of the East China Sea located between mainland China and the Korean Peninsula. Sophisticated microscopic instruments were used to look for iron-containing nanoscale particles. We showed that iron-rich, fly ash, and mineral dust particles had travelled from the Asian continent. Most of the individual iron-rich and fly ash particles contained a significant amount of sulphate containing soluble iron. This provides first observational evidence that iron dissolution takes place in the atmosphere.

Reference:

Li, W., Xu, L., Liu, X., Zhang, J. Lin, Y., Yao, X., Gao, H., Zhang, D., Chen, J., Wang, W., Harrison, R.M., Zhang, X., Shao, L., Fu, P., Nenes, A., Shi, Z., 2016. Aerosol – pollution interaction produces more soluble iron for the ocean ecosystems. Science Advances, 3, e1601749

2. Activities/main accomplishments in 2016 (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.)

Meetings

- *GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) WG 38* held a week long meeting (hosted by A. Baker and T. Jickells, UEA) looking at:
  - Changing Atmospheric Acidity and the Oceanic Solubility of Nutrients
  - Impact of Ocean Acidification on Fluxes of non-CO_2 Climate-Active Species

  25 people came to the meeting from around the world. It was co-sponsored by SOLAS, SCOR GESAMP NSF and UEA and a report of the meeting will be published shortly by SOLAS

- *Air-sea gas flux: Progress and future prospects*
  Science workshop held during 6-9 September 2016 in Brest, France. Organized by the OceanFlux Greenhouse Gases Evolution project.

Workshop was a forum to bring the international and interdisciplinary air-sea gas flux scientific community together to present recent advances, report results from key initiatives and importantly to identify new goals, challenges and opportunities. The key focal point of the workshop was the synergistic use of models, in situ and remote sensing data and techniques for studying, and furthering this important area of climate research.

106 participants from 18 countries and 5 continents attended the 4 day workshop. Importantly much of the work and advances that were presented here in 2016 were identified as opportunities and challenges at the first workshop that was held 3 years ago in 2013. The participants included 8 young or early career researchers who received travel bursaries provided by the European Space Agency.

Open discussions took place during and at the end of the workshop, and have provided clear avenues for future work, that fit within the International Surface Ocean and Lower Atmosphere Study (SOLAS) scientific plans, aims and priorities, whilst also being relevant for agencies like the European Space Agency to support.

Reports

- GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection – IMO /FAO /UNESCO-IOC /WMO /UNIDO /IAEA /UN /UNEP /UNDP) (2016) Pollution in the open oceans: 2009-2013. A report by a GESAMP Task Team. Boelens, R., Kershaw, P. (eds), Task Team members: Angelidis, M., Baker, A., Bakker, D. C. E., Bowmer, T., Hedgecock, I., Tyack, P. GESAMP Reports and Studies 91, 87 pp. http://www.gesamp.org/publications/gesamp-reports-and-studies-91---100/reports-and-studies-91. ISSN 1020-4873.

- Metzl, N., Bakker, D. C. E. (2016) Actualisation de la base internationale Socat de CO2 océanique. La Météorologie 94: 2-3. doi:10.4267/2042/60695.

- Carbon dioxide and ocean acidification observations in UK waters. Synthesis report with a focus on 2010 – 2015 by C. Ostle *et al.* (2016) 44 pp. doi: 10.13140/RG.2.1.4819.4164.

Fieldwork

- The Leeds group (I. Brooks et al) participated in a 6 week cruise in the central Arctic Ocean, including a visit to the North Pole, on the Swedish Icebreaker Oden, during August and September 2016. Our measurements focussed on surface turbulent fluxes of momentum, heat, moisture, and in collaboration with Stockholm University of CO_2 and CH_4.
- Ship emissions testing in Plymouth (T. Smyth et al., PML, in collaboration with GASMET, Valmet and SRT-Marine in March 2017). This work proved the concept of sending data to shore live using AIS technology. This paves the way for mass, large scale reporting of emissions against IMO regulations for individual vessels.

3. Top 5 publications in 2016 (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 2016 publications (n = 62) 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.

1. Andrews, S. J., Carpenter, L. J., Apel, E. C., Atlas, E., Donets, V., Hopkins, J. R., Hornbrook, R. S., Lewis, A. C., Lidster, R. T., Lueb, R., Minaeian, J., Navarro, M., Punjabi, S., Riemer, D., and Schauffler, S.: A comparison of very short lived halocarbon (VSLS) and DMS aircraft measurements in the tropical west Pacific from CAST, ATTREX and CONTRAST, Atmos. Meas. Tech., 9, 5213-5225, 10.5194/amt-9-5213-2016, 2016.
2. Baker, A.R. and Jickells, T.D. (2016) Atmospheric deposition of soluble trace elements along the Atlantic Meridional Transect (AMT). Prog. Oceanogr. in press. http://dx.doi.org/10.1016/j.pocean.2016.10.002
3. Baker, A. R., Landing, W. M., Bucciarelli, E., Cheize, M., Fietz, S., Hayes, C. T., Kadko, D., Morton, P. L., Rogan, N., Sarthou, G., Shelley, R. U., Shi, Z., Shiller, A., and van Hulten, M. M. P.: Trace element and isotope deposition across the air-sea interface: progress and research needs, Philos. Trans. R. Soc. A-Math. Phys. Eng. Sci., 374, 10.1098/rsta.2016.0190, 2016.
4. Baker, A. R., Thomas, M., Bange, H. W., and Sanchez, E. P.: Soluble trace metals in aerosols over the tropical south-east Pacific offshore of Peru, Biogeosciences, 13, 817-825, 10.5194/bg-13-817-2016, 2016.
5. Bakker, D. C. E., Pfeil, B., Landa, C. S., Metzl, N., O'Brien, K. M., Olsen, A., Smith, K., Cosca, C., Harasawa, S., Jones, S. D., Nakaoka, S. I., Nojiri, Y., Schuster, U., Steinhoff, T., Sweeney, C., Takahashi, T., Tilbrook, B., Wada, C., Wanninkhof, R., Alin, S. R., Balestrini, C. F., Barbero, L., Bates, N. R., Bianchi, A. A., Bonou, F., Boutin, J., Bozec, Y., Burger, E. F., Cai, W. J., Castle, R. D., Chen, L., Chierici, M., Currie, K., Evans, W., Featherstone, C., Feely, R. A., Fransson, A., Goyet, C., Greenwood, N., Gregor, L., Hankin, S., Hardman-Mountford, N. J., Harlay, J., Hauck, J., Hoppema, M., Humphreys, M. P., Hunt, C. W., Huss, B., Ibánhez, J. S. P., Johannessen, T., Keeling, R., Kitidis, V., Körtzinger, A., Kozyr, A., Krasakopoulou, E., Kuwata, A., Landschützer, P., Lauvset, S. K., Lefèvre, N., Lo Monaco, C., Manke, A., Mathis, J. T., Merlivat, L., Millero, F. J., Monteiro, P. M. S., Munro, D. R., Murata, A.,

Newberger, T., Omar, A. M., Ono, T., Paterson, K., Pearce, D., Pierrot, D., Robbins, L. L., Saito, S., Salisbury, J., Schlitzer, R., Schneider, B., Schweitzer, R., Sieger, R., Skjelvan, I., Sullivan, K. F., Sutherland, S. C., Sutton, A. J., Tadokoro, K., Telszewski, M., Tuma, M., van Heuven, S. M. A. C., Vandemark, D., Ward, B., Watson, A. J., and Xu, S.: A multi-decade record of high-quality fCO_2 data in version 3 of the Surface Ocean CO_2 Atlas (SOCAT), Earth System Science Data, 8, 383-413, 10.5194/essd-8-383-2016, 2016.

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4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

End user engagement: The parameterisation in Elvidge et al. (2016) is currently being incorporated into the UK Met Office operational forecast model. This work provides the first test of a recently proposed surface drag parameterization over sea ice.

Measurements were obtained from both the FAAM aircraft and BAS Twin Otter over sea ice around Svalbard during the spring field campaign of the NERC ACCACIA project. The measurements were used to tune the theoretically derived parameterization of Lüpkes et al. (2012) for the marginal ice zone. They demonstrate a high degree of spatial variability in surface roughness and drag coefficient dependent upon the sea ice properties.

External research user engagement: Ship atmospheric emissions testing of Plymouth in collaboration with industry (GASMET, Valmet and SRT-Marine). This work was performed in 1st – 2nd March 2017 and proved the concept of sending real-time data to shore using Automatic Identification System (AIS) technology. This paves the way for large scale reporting and monitoring of atmospheric emissions from individual ships. This is

envisaged to be particularly useful given recent and future regulatory controls introduced by the International Maritime Organisation.

Societal UK end user engagement: UK MP's inquiry into ocean acidification (December 2016). The House of Commons Science and Technology Committee announced that it would carry out an inquiry into ocean acidification: "Now that the UK's five year Ocean Acidification Research Programme has ended, we are launching the first parliamentary inquiry on this concerning topic to examine what has been learned and make recommendations to Government." Of the 18 submissions of written evidence (now published on the HoC STC site: https://www.parliament.uk/business/committees/committees-a-z/commons-select/science-and-technology-committee/inquiries/parliament-2015/inquiry5/publications/), 11 were from groups or individuals that had participated in the UK Ocean Acidification (UKOA) programme and a further two from UKOA's main funders (NERC and Defra). Oral evidence at the session on 1 March 2017, involving representatives from Plymouth Marine Laboratory (PML), British Antarctic Survey, National Oceanography Center and the universities of Exeter and Southampton, all of which had involvement in UKOA, as well as a NERC representative. The Department for environment, food and rural affairs (Defra) gave evidence on 22 March 2017.

Societal Intergovernmental end user engagement: UKOA strongly supported international science-to-policy engagement, particularly through outreach activities at the annual Conference of the Parties (COPs) of the UN Framework Convention on Climate Change (UNFCCC) since 2009. That involvement was maintained via the NERC Knowledge Exchange (KE) Open Fellowship to Carol Turley (PML) for a wide range of 'ocean action' events at COP22, held at Marrakech, 6-18 November 2016. PML organised side events in the Britain is Great Pavilion, the EU pavilion, an official UN side event, an official UN press event and another side event with Egypt in the Civil Society area. PML also presenting science evidence and KE information at two exhibition stands (led by PML, and jointly funded by the German BIOACID programme, the Ocean Acidification International Coordination Centre and the University of Brest). Ocean-related issues were given a relatively high profile at COP22, including a high level UN Ocean Action Event which was, for the first time included within the UN sessions.

The work of Li et al. (2017) on the effects of pollution on aerosol iron solubility has been widely reported:

- Interview in BBC Radio 4's *Inside Science* on 2 March 2017 (**http://www.bbc.co.uk/programmes/b08g2tvp**). Also featured on the BBC World Service compilation show of the best of the week's science output.
- |30 international outlets, including *The Smithsonian*, *China.org* and *Voice of America*.

The ESA OceanFlux Greenhouse Gases Evolution project:

- FluxEngine output (PI J. Shutler, U. of Exeter) was covered by the BBC: http://www.bbc.co.uk/news/science-environment-35654938
- D. Woolf also wrote a more 'accessible' piece (Woolf, D.K. 2016 The forgotten carbon sink. Laboratory News http://www.labnews.co.uk/features/forgotten-carbon-sink-27-06-2016/)

PART 2 - Planned activities from 2017/2018 and 2019

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

Multi-million £ NERC-funded field programs will be taking place in the Southern Ocean during the summer seasons of the next 4 years.

For more details see:

Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports (ORCHESTRA) https://www.bas.ac.uk/project/orchestra/

Role of the Southern Ocean in the Earth System (RoSES) http://www.nerc.ac.uk/research/funded/programmes/roses/

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

Shipping and the Environment - From Regional to Global Perspectives
An international conference on the environmental impact of shipping and its importance within policy, marine spatial planning and the maritime transport sectors.
Gothenburg, 24-25 October, 2017
http://shipping-and-the-environment-2017.ivl.se/

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 and Organisation (downloadable from the SOLAS website) the activity topics relate – including the core themes and the cross cutting ones)

2016 projects
Ongoing (no specific order)

- Radiatively Active Gases from the North Atlantic Region and Climate Change (RAGNARoCC) – Lead PI: A. Watson (www.greenhouse-gases.org.uk/ragnarocc)
- 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
- Atlantic BiogeoChemical fluxes (ABC) – PI: E. McDonagh (http://www.rapid.ac.uk/abc/)
- 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.
- A novel pathway for the production of the climate cooling gas dimethyl sulfide - how important is the mddA gene to global DMS emissions? (NERC) – Lead PI: Jonathan

Todd
- Importance of marine gases and particles for tropospheric chemistry (NERC). PI: Claire Reeves
- Determining the Impact of Seawater Chemistry on the Solubility of Atmospheric Trace metals: DISCOSAT (Marie Curie) – Lead PI: Simon Ussher
- Oceanic Reactive Carbon: Chemistry-Climate impacts: ORC3 (NERC) – Lead PI: Steve Arnold
- Biogeochemical cycling of N-osmolytes in the surface ocean (NERC) – Lead PI: Y. Chen.
- Microbial degradation of dimethylsulfoxide in the marine environment (NERC) – Lead PI: H. Schaefer.
- 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
- The Global Methane Budget (NERC Highlight Topic) – Lead PI: Euan Nisbet
- Eco-interactomics: From microbial interactions to the fate of dissolved organic matter in the oceans (NERC Fellowship for J. Christie-Oleza).
- North Atlantic Climate System: Integrated Study (ACSIS) – Lead PI: Rowan Sutton (https://www.ncas.ac.uk/index.php/en/acsis-home)
- Ocean Regulation of Climate through Heat and Carbon Sequestration and Transports (ORCHESTRA) – Lead PI: Mike Meredith (https://www.bas.ac.uk/project/orchestra/)

Newly-funded (no specific order)
- Bacteria make DMSP - how significant is this process? (NERC) – Lead PI: Jonathan Todd
- Iodide in the ocean: Distribution and impact on iodine flux and ozone loss (NERC) – Lead PI: L. J. Carpenter.
- How do eukaryotic CO_2 fixers co-exist with faster growing prokaryotic CO_2 fixers in the oligotrophic ocean covering 40% of Earth? (NERC) – Lead PI: Mike Zubkov
- A multidisciplinary study of DMSP production and lysis – from enzymes to organisms to process modelling (NERC) – Lead PI: Jonathan Todd
- Does Ozonolysis Chemistry affect Atmospheric Marine Boundary Layer Sulphur Cycling? (NERC) – Lead PI: William Bloss
- Climate and Air Quality Impact of Airborne Halogens (NERC Fellowship for Ryan Hossaini).
- Zinc, iron and phosphorus co-limitation in the Ocean (ZIPLOc). (NERC) – Lead PI: Claire Mahaffey

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

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

Lucy Carpenter was joint lead author on Chapter 6 (Scenarios and Information for Policymakers) of the 2018 WMO/UNEP Scientific Assessment of Ozone Depletion.

Comments