

## **Future SOLAS workshop summary, 3-5 December 2013, PML**

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The SOLAS Scientific Steering Committee (SSC) has written a draft whitepaper of Themes and future research directions to define the next phase of SOLAS (which is nearing the end of its first 10 years). To inform this process, the SSC has sought input from early career SOLAS scientists who will develop into SOLAS –leaders in the next 10 years. From the 3-5 December 2013, a number of early career scientists from around the world attended a workshop at the Plymouth Marine Laboratories (PML) UK to brainstorm the future scientific directions of SOLAS, and prepare a report of recommendations to the SSC.

The Future SOLAS workshop was hosted by Tom Bell (PML) and was attended by thirteen early career scientists from the UK, Germany, China, Japan, Peru, India, US and Australia, along with Emilie Breviere from the SOLAS IPO. Two social scientists from PML also attended for part of the workshop. The photograph below shows the participants who made up the Advisory Team. The 2 ½ day workshop included introductory science presentations from all participants, a presentation on Future Earth by Tom Bell, and presentations from the social scientists who gave examples of how socio-economics/ecosystem services can be integrated with the natural sciences.

The workshop participants were then divided into four breakout groups according to their areas of expertise, with each group spending several hours discussing in detail two of the SOLAS draft Themes from the whitepaper. Groups reported back their ideas about the Themes to the main group, and a document of recommendations was written for the SSC which provided high level and more detailed comments about the Themes. The main group then discussed and documented more general topics relating to Future SOLAS, including a (hotly debated) revised scientific concept diagram for SOLAS science, strategies to better integrate socio-economics/ecosystem services, and ‘out of the box’ ideas to consider, which would expand the scientific scope of SOLAS in the next 10 years.



Future SOLAS Advisory Team (left to right): Angela Landolfi, Anoop Mahajan, Frances Hopkins, Nicolas Cassar, Mingxi Yang, Aurélien Paulmier, Tom Bell, Sarah Lawson, Hiroshi Tanimoto, Emilie Breviere, Christa Marandino, Caroline Hattam, Damodar Shenoy, Tzung-May Fu, Rosie Chance, Nicola Beaumont

## Main outcomes and recommendations from Future SOLAS Advisory Team

The Advisory Team agreed that while the whitepaper draft research Themes address many of the important topics that exist within SOLAS science, these Themes were sometimes not explicit or ambitious enough in identifying strategies to move the science forward in the next 10 years.

We noted that a discussion of the knowledge gaps in surface ocean biogeochemistry was minimal to absent throughout the draft Themes, despite the strong influence of biological production and consumption processes on SOLAS-relevant gases and particles.

We decided that geoengineering should be addressed (and not ignored) in the future science strategy, as SOLAS is in a unique position to provide advice about uncertainties and likely outcomes of geoengineering activities (as it has previously via the *Ocean Fertilization: A Scientific Summary for Policy Makers* document). In particular, we saw an opportunity for SOLAS to improve understanding of links between biological processes, oceanic uptake and storage of atmospheric CO<sub>2</sub>, highlighted as a future area of focus in the IPCC AR5 document.

There was strong support for an additional Theme of ‘pollution/contamination’ in Future SOLAS which recognizes and directly addresses the processing and impact of pollution in our oceans and atmosphere. We brainstormed and documented a long list of some of the SOLAS-related pollution and contamination issues which could be incorporated, including persistent organic pollutants (POPs) and heavy metals, ship plumes and biomass burning, plastic and radioactive pollution, oil spills, macronutrient/pesticide/surfactant pollution, noise pollution and harmful algal blooms, among others.

We recommended changes to the naming and scope of many of the existing Themes. For example, we proposed that Theme 8 High Sensitivity Systems (HSS), be expanded to also include High Leverage (HL) systems, which are regions in which changes may result in global oceanic and atmospheric effects (for example Polar Regions, OMZ-EBUS, Southern Ocean). We recommended Themes 5 and 6 be merged into *Trace gas exchange, atmospheric chemistry, and ocean biogeochemistry* with the justification that the oxidative capacity of the troposphere influences which species can be transported into the stratosphere. We recommended that Theme 2 be expanded in scope beyond greenhouse gas fluxes to also include aerosol emission and deposition and flux of other trace gases such as DMS, OVOCs and halocarbons. We recommended Theme 3 to be broadened beyond nutrient deposition and carbon cycling, to incorporate deposition of organic aerosol, gases and other pollutants, and to examine the affect of deposition on cycling of climate-relevant gases, de-oxygenation and nutrient scavenging.

After much discussion, it was decided that the Themes proposed in the whitepaper, and our new proposed ‘Pollution/Contamination’ Theme could be better classified into two *Motivations* (Multiple Stressors and Pollution/Contamination), five *Themes* (Greenhouse gases, heat cycling and ocean biogeochemistry, Air/sea gas, aerosol and heat exchange kinetics, Atmospheric deposition fluxes and ocean biogeochemistry, Feedbacks between aerosols, clouds and ecosystems and Trace gas exchange, atmospheric chemistry, and ocean biogeochemistry) and *Focus Regions* (High sensitivity and High Leverage Systems). We envisioned that the *Motivations* would be presented at the beginning of the strategic Future SOLAS document, highlighting the urgent need for SOLAS science in the next 10 years as mankind continues to greatly impact our oceans and atmosphere.

A brainstorming session on 'Out of the box' suggestions for Future SOLAS yielded a diverse collection of ideas that could be categorized broadly as capacity building and changes to the structure of SOLAS, specific scientific ideas, and 'crazy ideas' (further and beyond). We hope that some of these ideas may be incorporated into the Future SOLAS strategic document which would broaden the scope of 'traditional' SOLAS research into new and exciting areas.

The consensus from the Advisory Team was that SOLAS should embrace the opportunity to incorporate socio-economics/ecosystem services into the next phase of SOLAS, providing that fundamental science is still highly valued and supported. We felt that benefits of integration with social sciences could include greater uptake and impact of our research by government and policymakers, an improved public profile for SOLAS, and the opportunity to tailor our research questions to the greatest needs of society. We noted that there are already several successful examples where impacts of multiple stressors on ecosystem services have been explored, including ocean acidification projects such as EPOCA, UKOA as well as GLOBEC/Euro Basin. With the assistance of PML's social scientists, we identified and documented a number of additional key areas and specific examples where we see a natural and beneficial coupling between SOLAS Science and ecosystem services. We also acknowledged that for some areas of SOLAS science, there are too many unknowns about the underlying science to warrant a coupling with ecosystem service research at this stage.

We have suggested a number of methods to incorporate ecosystem services into the next phase of SOLAS, including ecosystem services/ social science sessions at future SOLAS summer schools, invitation of social scientists/economists to SOLAS conferences and workshops, and engagement with and development of collaborative cross disciplinary funding sources. We recommended that natural and social scientists and economists need to be engaged during writing of project proposals and development scientific strategy, for collaboration to be successful.

Finally, after much animated discussion, frantic scribbling on butchers paper, and impromptu breaking out into focus groups, a new scientific concept diagram was born (Fig 1 below). This diagram incorporates our suggested Motivations, Themes and Focus Areas, and also highlights the integration of ecosystem services and earth system models in the wider context of SOLAS Science. It should be noted that the advisory team did not reach a full consensus on the structure of this diagram. However it was agreed that the diagram does capture the interrelatedness of our Motivations, Themes and Focus areas, while also representing the wider applications of SOLAS Science in the scientific community and society.

The final version of our report of recommendations was presented to the SSC in January 2014.

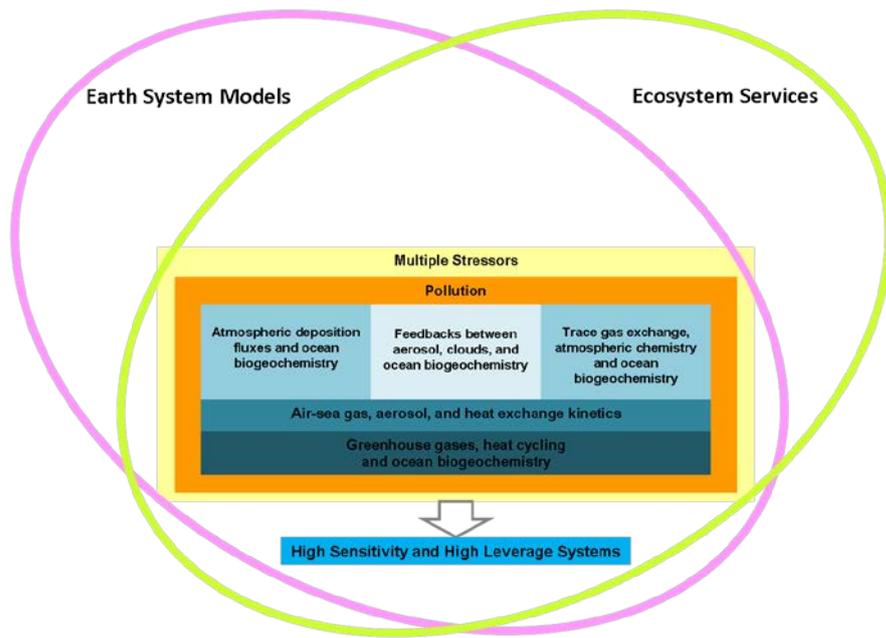


Figure 1: Possible Future SOLAS conceptual structure.