surface ocean solas lower atmosphere study

Report for the year 2018 and future activities

SOLAS *USA*
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This report has two parts:

***- Part 1:** reporting of activities in the period of January 2018 – Jan-Feb 2019*
***- Part 2:** reporting on planned activities for 2019/2020 and 2021.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies;
Environmental impacts of geoengineering;
Science and society**.**

***IMPORTANT**: 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 2018 to Jan/Feb 2019

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 results of international collaborations. (If you wish to include more than one highlight, feel free to do so).

Storms influence high-latitude oceans by stirring the upper ocean nearly continuously. This wind mixing is usually expected to homogenize properties within the upper layer of the ocean, known as the mixed layer. New water column observations from floats and elephant seal tag confirm homogenization of hydrographic properties that determine density of seawater (e.g., temperature and salinity); however, biogeochemical properties are not necessarily homogenized (Carranza et al., 2018). Most of the time optical measurements of biological properties within the *mixed layer* show vertical structure, which is indicative of

phytoplankton biomass. These vertical inhomogenities are ubiquitous throughout the Southern Ocean and may occur in all seasons, often close to the base of the mixed layer. Within the mixed layer, observations suggest that biological processes create inhomogenities faster than mixing can homogenize. Carranza and co-authors hypothesize that 3- to 5-day periods of quiescence between storm events are long enough to allow *bio-optical* structure to develop without perturbing the mixed layers' uniform density. This may imply that phytoplankton in the Southern Ocean are better adapted to the harsh environmental conditions than commonly thought.

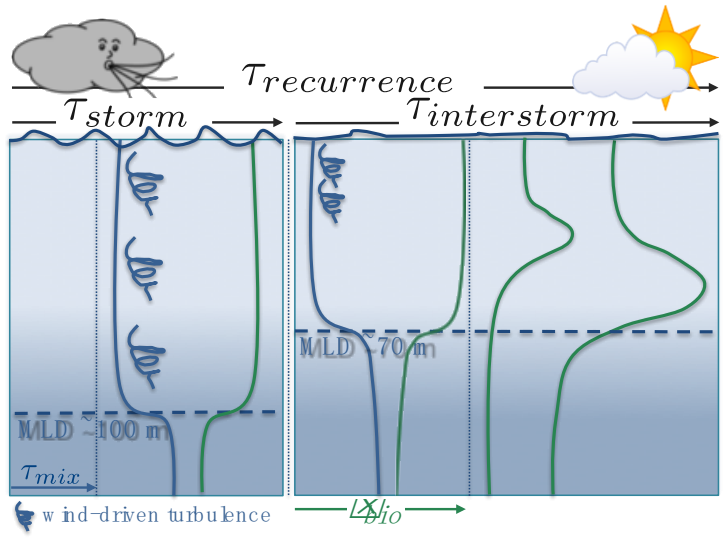

Figure: Schematic illustrating the relationship between storm-mixing and biological timescales, with density profiles depicted in blue and Chl-a fluorescence in green. Interstorm periods are on average longer than storm durations, particularly in summer, allowing for bio-optical gradients to form within mixed layers. Storms are defined to have winds > 10m/s. Mixed-layer depth (MLD) estimates for storm and interstorm periods are means from wind-profile matchups and based on the 0.03 kg/m density threshold criterion.

Reference:

Carranza, M. M., S. T. Gille, P. J. S. Franks, K. S. Johnson, R. Pinkel, and J. B. Girton (2018), When Mixed Layers Are Not Mixed. Storm-Driven Mixing and Bio-optical Vertical Gradients in Mixed Layers of the Southern Ocean, *Journal of Geophysical Research Oceans*, *123*(10), 7264–7289, doi:10.1364/OE.17.005698.

2. Activities/main accomplishments in 2018 (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, social sciences, and media).

EXPORTS: The first EXPORTS (Export Processes in the Ocean from RemoTe Sensing) field campaign took place in August and September, 2018. EXPORTS is a NASA funded project that is seeking to develop a predictive understanding of the export of global ocean net primary productivity.https://oceanexports.org/about.html

New committee: The Ocean-Atmosphere Interaction (OAIC) Committee was formed in 2018 as a topical subcommittee of the OCB Scientific Steering Committee (SSC) to strengthen communication and collaboration between ocean and atmospheric scientists within the U.S. The committee primarily seeks to provide a support system for scientists working at the air-sea interface, especially to overcome the disciplinary segregation that can result from separate atmospheric or oceanic science community platform. The chair of the committee is Rachel Stanley (rachel.stanley@wellesley.edu) and members are Yuan Goa, Cassanra Gason, David Ho, David Kieber, Kate Mackey, Nicholas Meskhidze, Bill Miller, Henry Potter, Penny Vlahos, and Thomas Bell. https://www.us-ocb.org/about/ocb-subcommittees/subcommittee-on-ocean-atmosphere-interactions/

Iron Speciation Workshop: A workshop on Identifying and Characterizing the Processes Controlling Iron Speciation and Residence Time at the Atmosphere-Ocean Interface, organized by Ncholas Meskhidze and Christoph Volker took place in early August, 2018 in order to discuss the physicochemical speciation of Fe at the atmosphere-ocean interface and its cycling between the two oxidation states in soluble, colloidal, dissolved, amorphous, and crystalline forms, in the presence/absence of atmospheric/oceanic organic compounds and sunlight. A perspective paper in Marine Chemistry will be forthcoming.

Methane and Nitrous Oxide Workshop: A workshop on Oceanic Methane and Nitrous Oxide, sponsored by the Ocean Carbon and Biogeochemistry program, took place in October, 2018. T he workshop was designed to sit at the interface between laboratory analysis of trace gases, comprehension of the relevant microbial processes, and observational and predictive capacity to resolve spatial-temporal variability associated with methane and nitrous oxide in the oceans. A report will be forthcoming. https://web.whoi.edu/methane-workshop/

Aquatic Primary Productivity Workshop: A NASA/IOCCG workshop on building consensus on protocols for contemporary aquatic primary productivity field measurements took place in December, 2018. The workshop brought together 26 researchers from 16 institutions to discuss the key differences, nuances, scaled, uncertainties, definitions and best practices for measurements of primary productivity from many different techniques. The specific deliverable resulting from of this activity will be a living, community-vetted (open public comment period) protocol document, published in coordination with ongoing IOCCG protocol series.

Role of bubbles: Steven Emerson and co-authors have analysed in situ N_2 gas measurements from 10 years in the subarctic Pacific to calculate bubble fluxes and used them to evaluate existing bubble flux models. A paper will be forthcoming in Journal of Geophysical Research Oceans.

Dust Effects: Kate Mackey and co-authors are investigating the effects of playa dust on phytoplankton in the Salton Sea. As the Sea continues to evaporate, more

playa sediment that is contaminated with metals and pesticides is exposed to the atmosphere and is transported with winds. Mackey is investigating whether the dust is harmful to planktonic communities in the Sea.

Gas exchange in the Baltic Sea: David Ho and colleagues, including SOLAS scientists from Germany, conducted the Baltic Sea Gas Exchange Experiment (Baltic GasEX) in 2018 whose main goals are to determine the influence of surfactants on gas exchange and also to see whether the influence of wind on gas exchange is different in an inland sea.

Air-sea chemical exchange in Antarctic: Yuan Gao and co-workers have been conducting research on the air-sea chemical exchange in high-latitude ocean, particularly on atmospheric iron deposition over the West Antarctic Peninsula. The Gao group finished field sampling at Palmer Station in Spring 2017. In 2018, they performed the analyses of aerosol samples collected in coastal Antarctic peninsula by ICPMS for total Fe, by UV/Vis spectrophotometry for Fe solubility, and by synchrotron X-ray spectroscopy for Fe oxidation state and aerosol composition.

3. Top 5 publications in 2018 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Harding, K., K. A. Turk-Kubo, R. E. Sipler, M. M. Mills, D. A. Bronk, and J P Zehr (2018), Symbiotic unicellular cyanobacteria fix nitrogen in the Arctic Ocean, *Proceedings of the National Academy of Sciences of the United States of America,* 115(52), 13371-13375.

Ho, D. T., E. H. De Carlo, P. Schlosser. (2018) “Air sea gas exchange and CO2 fluxes in a tropical coral lagoon”. *Journal of Geophysical Research: Oceans.* 123. 8701-8713. https://doi.org/10.1029/2018JC014423

Howard, E. M., I. Forbrich, A. E. Giblin, D. E. Lott III, K. L. Cahill. R. H. R. Stanley, (2018) Using Noble Gases to Compare Parameterizations of Air-Water Gas Exchange and to Constrain Oxygen Losses by Ebullition in a Shallow Aquatic Environment. *Journal of Geophysical Research: Biogeosciences.* 123,2711–2726. doi: 10.1029/2018JG004441

Sedwick, P.N., P. W. Bernhardt, M. R. Mulholland, R. G. Najjar, L. M. Blumen, B. M. Sohst, C. Sookhdeo, and B. Widner. (2018). "Assessing phytoplankton nutritional status and potential impact of wet deposition in seasonally oligotrophic waters of the Mid‐Atlantic Bight." *Geophysical Research Letters* 45, no. 7: 3203-3211.

W. Tang, S. Wang, D. Fonseca-Batista, F. Dehairs, S. Gifford, A. G. Gonzalez, M. Gallinari, H. Planquette, G. Sarthou, N. Cassar. (2018). Revisiting the distribution of oceanic N_2 fixation and estimating diazotrophic contribution to marine production**.** *Nature Communications*, 2019; 10 (1) DOI: 10.1038/s41467-019-08640-0

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2018? If yes, who? How did you engage?

PART 2 - Planned activities for 2019/2020 and 2021

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

EXPORTS: The NASA EXPORTS program will continue its modelling efforts and will conducting sample and data analysis from data collected on its first cruise in support of EXPORT's goal of understanding and predicting the fate of marine net primary production.
https://cce.nasa.gov/ocean_biology_biogeochemistry/exports/index.html

CLIVAR GO-SHIP Cruises: US CLIVAR will be conducting GO-SHIP (formerly known as Repeat Hydrography) Cruises that aim to quantify changes and storage of CO_2, heat and freshwater in the ocean. The cruises reoccupy WOCE lines and scientists onboard measure many variables from the atmosphere, the surface ocean and the deep ocean. Upcoming planned cruises consist of cruises in the Indian Ocean (I05, I06S) in 2019 and 2020, and in the Atlantic Ocean (A13.5) in 2020.

Ongoing US Time-series: Regular cruises (typically monthly but each time-series differs) will occur in 2018 and 2019 in the Pacific Ocean near Hawaii as part of the Hawaii Ocean Time-series (HOT), in the Sargasso Sea as part of the Bermuda Atlantic Time-series Study (BATS), in the Cariaco Basin as part of the CARIACO Ocean Time-series, and in coastal California waters as part of of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) time series.

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

Ocean Carbon Biogeochemistry Workshop: June 24-27, 2018, Woods Hole, Massachusetts. Annual workshop that highlights research and includes substantial time for community discussion of new directions. Themes for this year's workshop include anthropogenic changes in ocean oxygen, approaches and challenges to understanding biogeochemical cycling across the land-ocean aquatic continuum, calcification and the carbon cycle, carbon cycle feedbacks from the seafloor, and the effect of size on ocean processes and implications for export.

Ocean Circulation Inverse Model (OCIM) workshop: June 23, 2019. Woods Hole, MA This 1 day workshop is for those interested in using OCIM in their research. The OCIM is a data-constrained, lightweight, MATLAB-based ocean circulation model for global modeling of biogeochemical tracers.

Cornell Satellite Remote Sensing Training Program: June 3-June 14, 2019. The goal of the course is to teach participants the basic skills needed to work independently to acquire, analyze and visualize data sets derived from a variety of satellite sensors (e.g., SeaWiFS, MODIS, MERIS, VIIRS, OLI on Landsat-8, OLCI on Sentinal-3, AVHRR, SeaWinds, SSM/I and AVISO Merged Altimetry).

Ocean-Atmosphere Interactions: Scoping directions for U.S. research - October 1-3, 2019: Sterling, VA. This workshop will gather U.S. scientists working at the air-sea interface to identify research priorities and facilitate the communication and collaboration required for future significant research advances. Leadership for this workshop will be provided by the Ocean Atmosphere Interaction Committee (OAIC). The workshop will serve as a critical next step in strengthening the U.S. air-sea interaction research community and encouraging synergistic activities across disciplines and nations. This 3-day scoping workshop will be open to interested members of the community, but attendance will be limited to ~60-65 scientists who are prepared to contribute to in-depth discussions about research priorities and engagement with international SOLAS. Participants will present and share cutting edge research and participate in discussions to identify key knowledge gaps and prioritize research needed to advance the field. From the discussions at the workshop, the OAIC will assemble a "grassroots" document to help coalesce the U.S. air-sea interaction research community around a common set of science goals and research priorities. The workshop and its outcomes are expected to strengthen ties between the ocean and atmosphere research communities and foster a more cohesive U.S. contribution to international SOLAS.

Gordon Research Conference on Coastal Ocean Dynamics: Advances in Coastal and Estuarine Physics from Nearshore to Continental-Margin Scales. June 16-21, Manchester NH

Gordon Research Conference on Atmospheric Chemistry: New Science in Quality and Climate from Charney to AR6. July 28-Aug 2, 2019. Newry, ME.

Gordon Research Conference on Chemical Oceanography: Discovering Chemical Processes and Mechanisms in a Changing Ocean. July 14-19 Holderness, NH

Fall American Geophysical Union (AGU) Meeting: Dec. 9-13, 2018. San Francisco, A,

American Meteorological Society Annual Meeting: Jan 12-16, Boston MA

3. Funded national and international projects / activities underway.

Too many to report though some major ones are listed in the upcoming studies section of this report (section 2).

4. Plans / ideas for future projects, programmes, proposals national or international etc. (please indicate the funding agencies and potential submission dates).

Too many to report.

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

Too many to report.

Comments