

## Report for the year 2016 and future activities

### SOLAS USA

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*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**

Coastal waters provide important resources such as economically-important fisheries, but are often susceptible to harmful algal blooms. A recent study by Kate Mackey (University of California, Irvine) and colleagues from Woods Hole Oceanographic Institution, China's Fudan University and Nanjing University, and UC Santa Cruz shows a direct, empirical link between aerosol emissions and increases of bloom-forming species such as dinoflagellates and diatoms in the East China Sea. Mackey and co-authors use observations from bottle incubation experiments of five different aerosols with coastal seawater from two different locations in the East China Sea to determine that dinoflagellates and diatoms were particularly affected by aerosol addition (Fig. 1). They found that dinoflagellates are promoted by the phosphorous limitation induced by the aerosols, which tend to deliver nitrogen and trace metal micronutrients, but not much phosphorous. In contrast, diatoms are promoted by the general increase in nutrients and metals. The effects of the aerosol additions on phytoplankton were muted closer to the mouth of the Yangtze River, where light limitation from high sediment loading occurs. Mackey and co-authors also examined historical data from HAB events and used satellite measurements of aerosol optical thickness to further characterize the link between HABs and aerosols. They find that aerosol deposition supports dinoflagellates and diatom blooms in the East China Sea but that the response is tempered by sea surface temperatures. In short, this study shows a clear connection between aerosol deposition and increase of HAB-forming phytoplankton from both experiments and remote sensing data, exemplifying an important way that the surface ocean and lower atmosphere are connected.

*This study is fully described in the following paper: Mackey, K R M, M T Kavanaugh, F Wang, Y Chen, F Liu, D M Glover, C-T Chien, and A Paytran. Atmospheric and fluvial nutrients fuel algal blooms in the East China Sea, *Frontiers in Marine Science*, 4:2. (2017) doi: 10.3389/fmars.2017.00002*

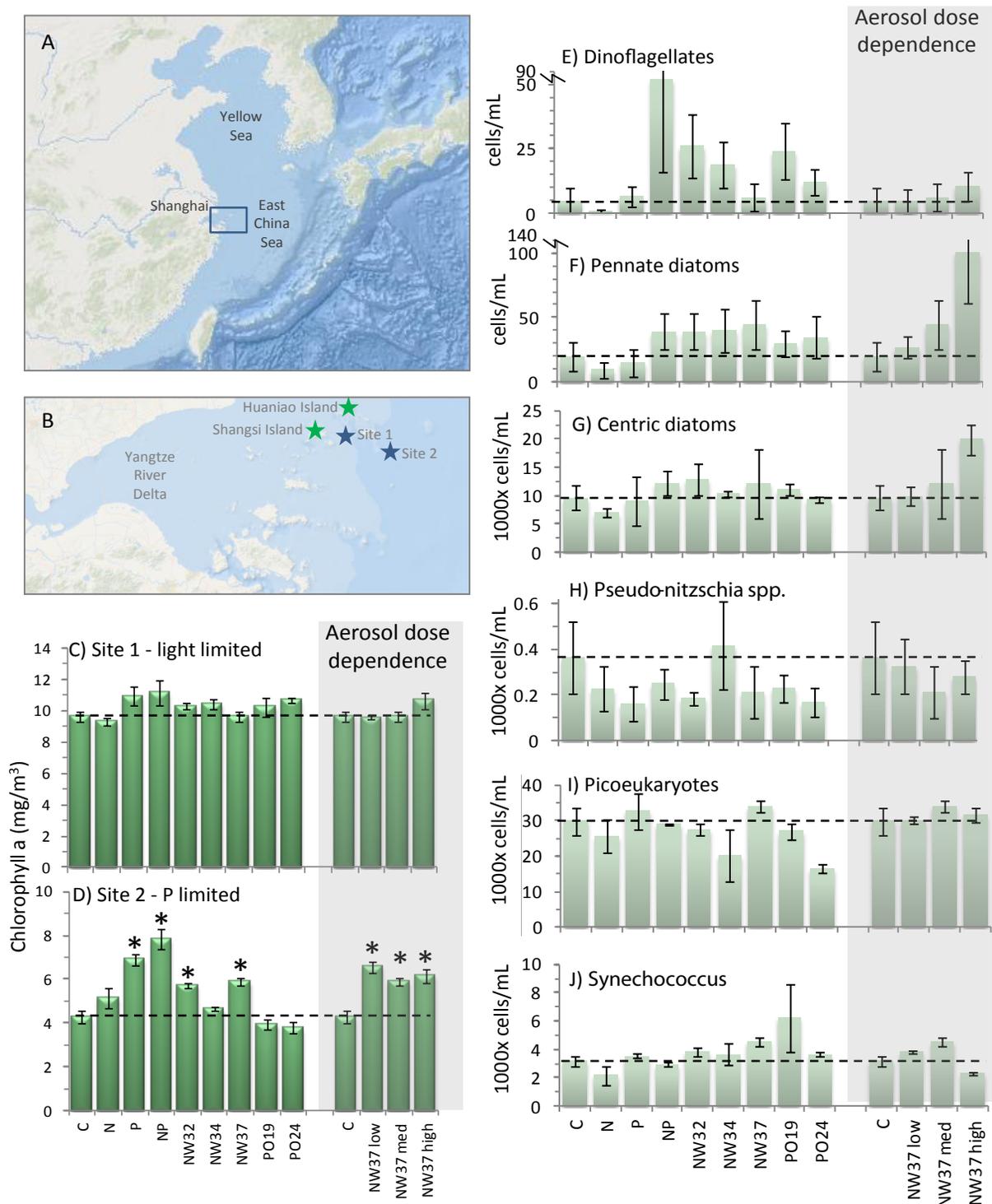


Fig. 1 FIGURE1|Phytoplankton responses from East China Sea bottle incubation experiments. Maps show (A) Chinese marginal seas and (B) the region of the East China Sea sampled near the mouth of the Yangtze River in the Zhoushan Archipelago. Blue stars show site 1 and site 2 water collection stations; green stars show Huaniao-Island where aerosolsamples were collected, and Shengsi Island where the incubation experiments were conducted. (C,D) Chlorophyll a concentrations ( $\pm$ SE) on the final day of the site 1 and site 2 experiments. \*Indicates average is significantly different from the control ( $p < 0.05$ , dashedline) using one-way ANOVA and Bonferroni correction. Cell counts on the final day of the site 2 experiment ( $\pm$ SE) for (E) dinoflagellates, (F) pennatediatoms (notincluding *Pseudonitzschia* spp.), (G) centric diatoms, (H) *Pseudonitzschia* spp., (I) picoeukaryotes, and (J) *Synechococcus*. N = nitrate, P = phosphate, NW32, NW34, NW37, PO16, and PO26 are aerosol additions(1mg/L). Aerosol sample NW37 was also administered at low (0.2mg/L) and high (5mg/L) concentrations to test aerosol dose responses (shadedregions). Dashed lines show control levels at final timepoint. *Figure from Mackey et al., 2017.*

*A large number of SOLAS-related research projects were conducted in the USA in 2016. A summary of all the topics would be too long to include. Thus below is simply a selection of several exciting projects, field campaigns, and other significant contributions.*

**NAAMES:** The NASA-funded North Atlantic Aerosols and Marine Ecosystem Study (NAAMES) project completed a ship and aircraft field campaign between May 11 and June 5, 2016. NAAMES is aimed to study the connection between atmospheric aerosols and key oceanic processes controlling marine ecosystems, with an emphasis on implications for climates. On each cruise, vast amounts of data from the atmosphere and ocean is collected. For example, Emmanuel Boss (University of Maine) and his collaborators are in the process of sorting about 4 million plankton images that were collected using IFCP and a UCP and they are using Eco-Taxa (<http://ecotaxa.obs-vlfr.fr/explore/>), a new European open platform, where all their sorted data can be observed (put 'IFCB107 NAAMES01' and 'IFCB107 NAAMES02' in the Project box). For more information on NAAMES and access to data from the cruise, visit <https://naames.larc.nasa.gov/>

**EXPORTS:** Phase 1 projects involving data mining and OSSE grants commenced on the NASA-funded EXPORTS project, a large multi-year project aimed at predicting the export and fate of ocean net primary production from satellite and other observations. The projects include mining LIDAR data, combining ecosystem modelling and ocean color measurements, developing of hyperspectral datasets, comparing of phytoplankton function types with optical fingerprints and pigments, modeling net primary productivity from the Subarctic Atlantic, and using submesoscale-resolving 3D models to conduct OSSE's. Fieldwork for the EXPORTS project will begin in 2018 (see future work section of this report). More information on EXPORTS can be found at: [https://cce.nasa.gov/ocean\\_biology\\_biogeochemistry/exports/index.html](https://cce.nasa.gov/ocean_biology_biogeochemistry/exports/index.html)

**Bubble modelling:** Jun-Hong Liang (Louisiana State University) and colleagues developed a computer model that follows millions of bubbles in the upper ocean from their generation under breaking waves to their complete dissolution or bursting at the ocean surface. Combining computer model solutions and mooring observations, they showed that sea state plays an important role in bubble-mediated gas flux when the wind is changing. For the same wind speed, bubble-mediated gas flux is larger during strengthening winds than during falling wind because there are more large breaking waves in a developing sea than in a mature sea. The study highlights the importance of sea state as a parameter in bubble-mediated gas flux parameterizations.

**Reactive Halogen Species:** The Volkamer group at the University of Colorado at Boulder was funded by the US National Science Foundation to continue SOLAS activities related to "Tropical Ocean Troposphere Exchange of Reactive Halogen Species and Oxygenated Hydrocarbons" (TORERO) through 2019. This 3-year grant supports field observations, laboratory experiments, and interpretative modeling of tropospheric halogen chemistry and marine sources of organic carbon to the remote marine troposphere. A specific objective is it to assess whether high model bias for bromine radicals in the marine boundary layer applies more broadly, and to investigate possible causes. Laboratory experiments at the National Center for Atmospheric Research (NCAR) investigate reactive pathways of bromine radicals to obtain missing kinetic and product data that inform models. Further, during March 2017 two mountain-top observatories in the remote marine troposphere, i.e., the Mado Observatory at La Reunion Island (2203m a.s.l., 21.1°S, 55.4°E) and Mauna Loa Observatory at Big Island, Hawaii (3397 m a.s.l., 19.5°N, 155.6°W), have been equipped with autonomous MAX-DOAS instrumentation to conduct long-term measurements, investigate seasonal variations, and study hemispheric gradients of tropospheric halogens and oxygenated hydrocarbons. Intensive operating periods are planned at Mado Observatory in 2018, in coordination with the University of La Reunion (PI: Jerome Brioude), and the European project OCTAVE (PI:

Jenny Stavrakou, BIRA). A first project meeting is planned in May 2017 in Brussels, Belgium.

**Workshop: Arctic Change & Its Influence on Mid-Latitude Climate and Weather**, Feb 1-3, 2017, Washington DC. This workshop was convened by the CLIVAR working group on Arctic change and brought together over 100 US and international scientists who study the atmosphere, ocean, and cryosphere to discuss the current science on changes in the Arctic and its connection to mid-latitudes climate and weather. For a full workshop report see <https://usclivar.org/meetings/2017-arctic-mid-latitude-workshop-summary>.

### 3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

*Many excellent SOLAS relevant papers were published by US authors in 2016 and early 2017. The selection below, listed in alphabetical order, is of 5 very interesting, extremely high quality papers but the listing of these papers is not meant to claim them as necessarily the best publications of the year.*

Chiu, R., L Tinel, L Gonzalez, R Ciuraru, F Bernard, C George, and R Volkamer (2017), UV photochemistry of carboxylic acids at the air-sea boundary: A relevant source of glyoxal and other oxygenated VOC in the marine atmosphere, *Geophys. Res. Lett.*, 44, 1079–1087, doi:10.1002/2016GL071240.

Islam, F., DeGrandpre, M., Beatty, C., Timmermans, M.-L., Krishfield, R., Toole, J. and S. Laney (2016). Sea surface pCO<sub>2</sub> and O<sub>2</sub> dynamics in the partially ice-covered Arctic Ocean, *J. Geophys. Res. – Oceans*, 122, doi:10.1002/2016JC012162.

Martins, D., Najjar, R G , Tzortziou, M., Abuhassan, N., Thompson, A M, Kollonige, D W,, (2016). Spatial and temporal variability of ground and satellite column measurements of NO<sub>2</sub> and O<sub>3</sub> over the Atlantic Ocean during the Deposition of Atmospheric Nitrogen to Coastal Ecosystems Experiment (DANCE). *Journal of Geophysical Research - Atmospheres* 121, doi:10.1002/2016JD024998

McKinley, G A, A R Fay, N S Lovenduski, D J Pilcher, (2017) Natural Variability and Anthropogenic Trends in the Ocean Carbon Sink, *Annual Review of Marine Science*. 9, 125-150. DOI: 10.1146/annurev-marine-010816-060529

Palevsky, H I, P D Quay, D E Lockwood, and D P Nicholson (2016), The annual cycle of gross primary production, net community production and export efficiency across the North Pacific Ocean, *Global Biogeochemical Cycles*, 30, doi: 10.1002/2015GB005318.

### 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?

## 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.)

**NAAMES:** Two more ship and aircraft field campaigns are planned as part of the NASA-funded NAAMES project which aims to investigate how the changing climate will influence plankton production, species composition, and aerosol emission. <https://naames.larc.nasa.gov/science.html>

**EXPORTS:** The NASA EXPORTS program is expected to commence its first fieldwork activities with a cruise in the North Pacific in 2018. The cruise will likely use 2 ships and a fleet of autonomous platforms (gliders, floats, etc) to collect data 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](https://cce.nasa.gov/ocean_biology_biogeochemistry/exports/index.html)

**CLIVAR Repeat Hydrography Cruises:** US CLIVAR will be conducting Repeat Hydrography Cruises that aim to quantify changes and storage of CO<sub>2</sub>, 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, I07N) in 2018 and 2019, in the Pacific ocean (P06) in 2017, and in the Atlantic Ocean (A13.5) in 2019.

**GEOTRACES:** US-Geotraces is planning a Pacific Meridional Transect cruise in summer 2018 from Tahiti to Alaska. The cruise will include sampling in the high nutrient low chlorophyll equatorial upwelling regions in the equatorial Pacific and subarctic as well as the oligotrophic subtropical gyres.

**Ongoing US Time-series:** Regular cruises (typically monthly but each time-series differs) will occur in 2017 and 2018 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 the California Cooperative Oceanic Fisheries Investigations (CalCOFI) time series.

**Two New Long-Term Ecological Research Sites:** The US National Science Foundation (NSF) has funded two new marine long-term ecological research sites whose research activities will commence in 2017. The new LTER on the Northeastern US Shelf, an area known for productive fisheries, is focused on understanding the mechanisms that link physical ocean environment to plankton food webs and ultimately to fish stocks. The new LTER on the Northern Gulf of Alaska Coast will allow researchers to make observations across a large geographic region, leading to a better understanding of a thriving ecosystem of fish, crab, birds, and marine mammals. Both programs will have numerous research cruises.

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

**Biogeochemical Processes at Sea Ice Interfaces (BEPSII)**, April 3-5, 2017, Scripps Institute of Oceanography, La Jolla, San Diego. Annual meeting.

**3<sup>rd</sup> Blue Planet Symposium:**, May 31-June 2: 2017, College Park, MD. This meeting will serve as a forum for discussion of societal information needs resulting from the important role the oceans play in Earth's life-support system and the challenge of minimizing the impacts of human activities on the oceans while utilizing the resources of the oceans to meet our needs.

**Ocean Carbon Biogeochemistry Workshop:** June 26-29, 2017, Woods Hole, MA, MA. Annual workshop that highlights research and includes substantial time for community discussion of new directions.

**Cornell Satellite Remote Sensing Program**, June 5-16, 2017, Ithaca, NY. Intensive 2 week summer course to teach scientists how to access and use remote sensing data. Course is intended for scientists with essentially no experience in remote sensing

**Gordon Research Conference on Coastal Ocean Dynamics**, June 11-16, Biddeford, MA.  
Theme: Multi-Scale Coastal Ocean Dynamics and Exchange Processes

**Regional Sea Level Changes and Coastal Impacts**, July 10-14, 2017, Columbia University, New York. International conference on sea level research to address existing challenges in describing and predicting regional sea level changes.

**Ocean Optics Class:** July 10-Aug 4, University of Maine, Walpole Maine. Summer course with goal of preparing a new generation of oceanographers trained in the use of optics to study the oceans.

**Gordon Research Conference on Chemical Oceanography:** July 23-28, 2017. New London, NH. Theme: Synthesizing Multifaceted Data in Chemical Oceanography.

**Gordon Research Conference on Atmospheric Chemistry:** July 30-Aug 4, 2017. Newry, ME.  
Theme: Addressing the Complexity of Our Atmosphere Through Integration Across Scales

**Indian Ocean Science Workshop:** Sept 11-13, 2017, La Jolla, CA. Focus on biological, chemical, physical, and geological oceanography, as well as climate dynamics and atmospheric science to generate integrated observing and process experiment strategies to science questions in the Indian Ocean basin

**Ocean Carbon Hot Spots Workshop:** Sept 25-26, 2017, Monterey Bay Aquarium Research Institute. The goal of the workshop is to develop an interdisciplinary research community that will facilitate a better understanding of carbon uptake and storage in western boundary current regions with an emphasis on the Kuroshio Extension

**American Association for Aerosol Research Annual Conference:** Oct. 16-20, 2017, Raleigh, NC

**Coastal Estuarine Research Federation (CERF):** Nov 5-9, 2017, Providence RI. Theme: Coastal Science at the Inflection Point: Celebrating Successes & Learning from Challenge

**Fall American Geophysical Union (AGU) meeting:** Dec 11-15, New Orleans, LA.

**American Meteorological Society Annual Meeting:** Jan 7-11, 2018, Austin TX.

**Ocean Sciences Meeting:** Feb 11-16, Portland OR

**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)**

Too many to report though some major ones are listed in the upcoming studies section of this report (section 2.1).

**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)**

Too many to report.

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

Too many to report.

**Comments**