

Report for the year 2021 and future activities

SOLAS USA

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This report has two parts:

- **Part 1:** reporting of activities in the period of January 2021 - Jan/Feb 2022
- **Part 2:** reporting on planned activities for 2022 and 2023.

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 of high sensitivity systems;
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).*

First things first...Please tell us what the IPO may do to help you in your current and future SOLAS activities. ?

It would be great to have an updated email list of all the SOLAS members in the US so I can email them periodically with SOLAS related news or questions.

PART 1 - Activities from January 2021 to Jan/Feb 2022

1. Scientific highlight

*Describe one scientific highlight with a title, text (**max. 300 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).*

For this national report in 2021, the US scientific highlight will not be a typical scientific highlight relating to one group or cruise. Rather, we'd like to highlight our new US SOLAS Science Plan that was published in 2021 (a copy is attached to this report) as it was a major achievement of US SOLAS community and represents the work and thoughts of over a hundred US SOLAS researchers. In October 2019, with funding from the US Ocean Carbon Biogeochemistry office, the US Ocean Atmosphere Interaction Committee (OAIC) convened a multiday open community workshop to discuss high priority science questions that should be included in a US SOLAS Science Plan as well as to foster collaborations and identify knowledge gaps. Over the next two years, the OAIC, with help from other attendees of the workshop, wrote the US SOLAS Science Plan. After some introductory material, the plan steps through the five themes of SOLAS and for each theme, discusses some major unanswered questions that the US community deems as especially important. Then the plan discusses high priority, crosscutting topics and research questions that the US community wants to explore in more depth. These topics include the sea-surface microlayer, surfactants, aerosols, air-sea gas exchange, halogens, reactive nitrogen, and redox chemistry (Fig. 1). An overarching US goal of investigating these crosscutting topics will be to determine (i) the extent to which increased understanding of these topics will improve oceanic and atmospheric chemistry, biogeochemistry, and climate models and (ii) the predicted changes in these systems in response to a changing climate. Each crosscutting topic is discussed in detail with research gaps clearly identified. The plan then includes an implementation section where it describes major types of techniques used to conduct SOLAS related research (i.e. field campaigns, numerical and data analysis, etc.) and lists specific steps that are needed to improve these techniques and make them even more powerful tools. We hope this Science Plan will prove to be a catalyst for US SOLAS research, rejuvenating the community and letting our funders know high priority items that have bubbled up from the community. Indeed, the latter is already starting to happen – NASA referenced the US SOLAS Science Plan in its recent funding call.

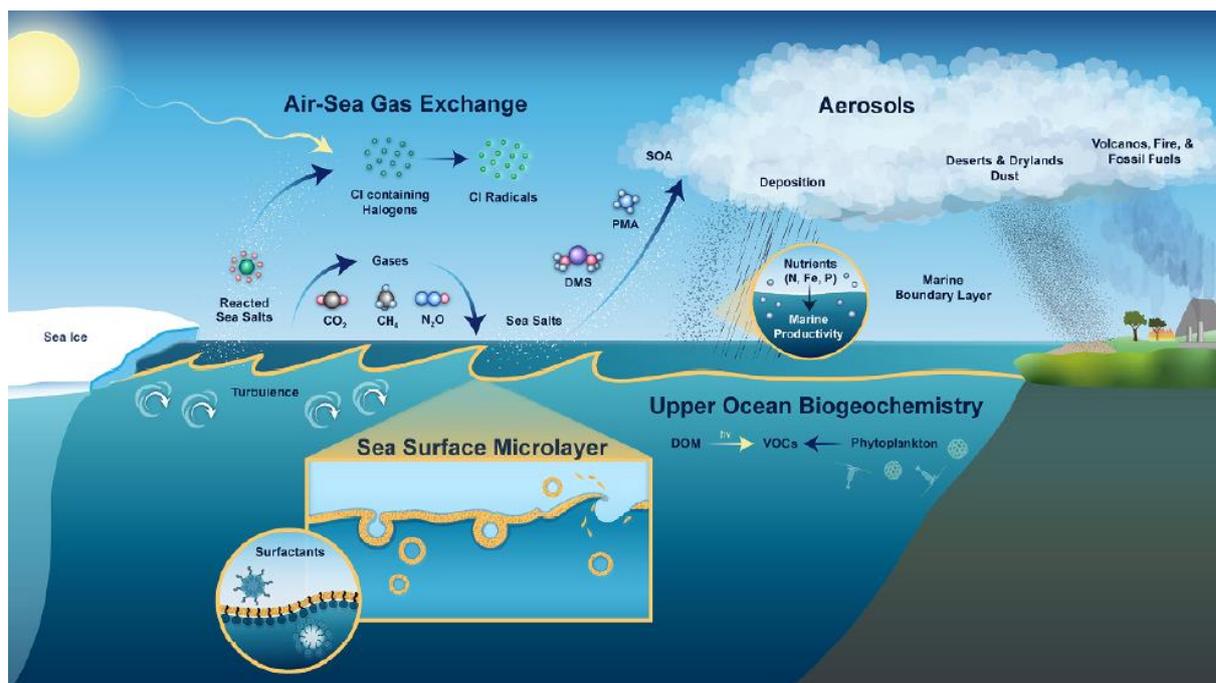


Fig. 1: Schematic showing the interrelationships between the crosscutting themes, identified by US researchers as high priority topics for future SOLAS research within the United States. Figure is from Stanley et al. (2021), US SOLAS Science Report, see full reference below.

Full Reference: Stanley, R, T Bell, Y Gao, C Gaston, D Ho, D Kieber, K Mackey, N Meskhidze, B Miller, H Potter, P Vlahos, P Yager, B Alexander, S Beaupre, S Craig, G Cutter, S Emerson, A Frossard, S Gasso, B Haus, W Keene, W Landing, R Moore, D Ortiz-Suslow, J Palter, F Paulot, E Saltzman, D Thornton, A Wozniak, L Zamora, H Benway. 2021. US SOLAS Science Report. 62pp. DOI 10.1575/1912/27821

2. Activities/main accomplishments in 2021 (e.g., projects; field campaigns; workshops and conferences; model and data intercomparisons; capacity building; international

collaborations; contributions to int. assessments such as IPCC; collaborations with social sciences, humanities, medicine, economics and/or arts; interactions with policy makers, companies, and/or journalists and media).

Major conferences in the US that are relevant to SOLAS themes include the fall meeting of American Geophysical Union (AGU), the American Society of Limnology and Oceanographers (ASLO) 2021 Meeting, and American Meteorological Society (AMS) Annual Meeting. These large meetings always have multiple sessions of interest to SOLAS research. Additionally, the biennial Ocean Sciences Meeting was held virtually in Feb 2022.

A workshop on iron at the air-sea interface in Asheville, NC in July 2021 was organized by Nicholas Meskhidze and Bill Landing. The workshop was dedicated to an improved understanding of how does bioaccessible LFe move across the ocean-atmosphere interface and become bioavailable for uptake in the ocean at scales important for ocean ecosystems and the carbon cycle. A white paper from the workshop will be forthcoming. More information can be found at https://zzqvaay3twhzlhnmvpvdvq.on.driv.tw/Web/Iron_Workshop/

The OCB Summer Science workshop in Woods Hole included several plenary sessions related to SOLAS themes such as filling in gaps in observation-based estimates of air-sea carbon fluxes, carbon capture and biogeochemical cycling in coastal waters, CO₂ transfer between air and atmosphere, and using coastal observing systems to understand and predict changes. More information on the workshop can be found: <https://web.whoi.edu/ocb-workshop/>

A workshop on the New Global Ocean Biogeochemistry (GO-BGC) Array was held in June 2021. Such an array could be used to address some SOLAS relevant questions, particularly in SOLAS themes 1, 2, and 3. The Global Ocean Biogeochemistry (GO-BGC) array is a 5-year effort funded by the US National Science Foundation to produce and deploy 500 profiling floats equipped with biogeochemical sensors in the world ocean. Deployments began in the first quarter of 2021. The objectives of the workshop were to: (1) Introduce the GO-BGC plan to the global scientific community (2) Discuss and innovate on scientific applications of GO-BGC data (3) Provide background information on the flow of data and archiving and (4) Deliver hands-on tutorials and computer code for accessing GO-BGC data.

While not in the US, a workshop that was well attended by US researchers, under the theme: Air-sea interface and fluxes of mass and energy, was carried out in November 2020 under the auspices of GESAMP WG 38 entitled “The Atmospheric Transport of Microplastics to and from the Ocean”. A scientific paper was developed from the workshop and was published in Nature Reviews – Earth and Environment in 2022 entitled “Microplastics and nanoplastics in the marine-atmosphere environment”. The citation is: Allen, D., Allen, S., Abbasi, S. *et al.* Microplastics and nanoplastics in the marine-atmosphere environment. *Nat Rev Earth Environ* (2022). <https://doi.org/10.1038/s43017-022-00292-x>.

A field campaign related to a SOLAS themes 3, 4 and 5 is the Bermuda boundary Layer Experiment on the Atmospheric Chemistry of Halogens (BLEACH), led by Principle Investigator Becky Alexander. The primary activity of this project is a field campaign to measure an unprecedented set of reactive gaseous and particulate halogen abundances at the Bermuda Institute of Ocean Sciences (BIOS) Tudor Hill Marine Atmospheric Observatory (THMAO) in June 2022 and January 2023. As part of this, we are also measuring fluxes of ozone and NO_x. In addition to the field observations, we will also perform model simulations using the GEOS-Chem global chemical transport model for analysis of the

field observations and ongoing model development. Measurements proposed here will provide a quantitative observational constraint for the dependence of reactive halogen abundances on pollution levels, as well as allow us to assess the model's representation of the abundance and speciation of reactive halogens at a tropical, marine location and their interactions with one another.

3. List SOLAS-related publications published in 2021 (only PUBLISHED articles).

If any, please also list weblinks to models, datasets, products, etc.

There are too many SOLAS related publications in the USA to record in this document. Below is a sampling of papers relevant to SOLAS themes published by US scientists.

Theme 1:

Bishop JKB, Amaral VJ, Lam PJ, Wood TJ, Lee J-M, Laubach A, Barnard A, Derr A and Orrico C (2022) Transmitted Cross-Polarized Light Detection of Particulate Inorganic Carbon Concentrations and Fluxes in the Ocean Water Column: Ships to ARGO Floats. *Front. Remote Sens.* 3:837938. doi: 10.3389/frsen.2022.837938.

Bennington, V.S., L. Gloege, and G.A. McKinley (2022) Variability in the global ocean carbon sink from 1959-2020 by correcting models with observations, *Geophys. Res. Lett.* in press. [Read it on ESSOArchive](#)

Bourne, H. L., J. K. Bishop, E. J. Connors, and T. J. Wood, "Carbon export and fate beneath a dynamic upwelled filament off the California coast." *Biogeosciences*, 18, 3053–3086, 2021 <https://doi.org/10.5194/bg-18-3053-2021>

Gloege, L., M. Yan, T. Zheng and G.A. McKinley (2022) Improved quantification of ocean carbon uptake by using machine learning to merge global models and pCO₂ data, *JAMES*, doi:10.1029/2021MS002620 Access the [LDEO HPD data product on Zenodo](#)

Vernet, M., I. H. Ellingsen, C. Marchese, S. Bélanger, M. Cape and P. A. Matrai. 2021. "Net primary production and bloom initiation around Greenland". *Progress in Oceanography*, 198, 102655, 10.1016/j.pocean.2021.102655.

Yang, B., E.H. Shadwick, C. Schultz, and S.C. Doney, 2021: Annual mixed layer carbon budget for the West Antarctic Peninsula continental shelf: insights from year-round mooring measurements, *J. Geophys. Res. Oceans*, <https://doi.org/10.1029/2020JC016920>

Theme 2:

Olivarez, H., N.S. Lovenduski, R. Brady, A.R. Fay, M. Gehlen, L. Gregor, P. Landschützer, G.A. McKinley, K. McKinnon, and D. Munro (2022) Alternate histories: Synthetic large ensembles of sea-air CO₂ flux, *Global Biogeochem. Cycles*, 36, e2021GB007174, [doi:10.1029/2021GB007174](https://doi.org/10.1029/2021GB007174)

Zippel, S.F., J.T. Farrar, C.J. Zappa and A.J. Plueddemann, 2022. Parsing the Kinetic Energy Budget of the Ocean Surface Mixed Layer, *Geophys. Res. Lett.*, 49(2), DOI:10.1029/2021GL095920.

Theme 3:

Lawler, M. J., Saltzman, E. S., Karlsson, L., Zieger, P., Salter, M., Baccharini, A., et al. (2021). New insights into the composition and origins of ultrafine aerosol in the summertime high Arctic. *Geophysical Research Letters*, 48, e2021GL094395. <https://doi.org/10.1029/2021GL094395>

Lewis, S. L., Saliba, G., Russell, L. M., Quinn, P. K., Bates, T. S., & Behrenfeld, M. J. (2021). Seasonal Differences in Submicron Marine Aerosol Particle Organic Composition in the North Atlantic. *Frontiers in Marine Science*, 8, Article 720208. <https://doi.org/10.3389/fmars.2021.720208>

Theme 4:

Aldhaif, A.M., Lopez, D.H., Dadashazar, H., Painemal, H., Peters, A.J., and Sorooshian, A. (2021) An aerosol climatology and implications for clouds at a remote marine site: Case study over Bermuda. *Journal of Geophysical Research: Atmospheres*, 126, doi: 10.1029/2020JD034038

Dadashazar, H., Alipanah, M., Hilario, M.R.A., Crosbie, E., Kirschler, S., Liu, H., Moore, R., Peters, A.J., Scarino, A., Shook, M., Thornhill, K.L., Voigt, C., Wang, H., Winstead, E., Ziemba, L. and Sorooshian, A. (2021) Aerosol responses to precipitation along North American air trajectories arriving at Bermuda. *Atmospheric Chemistry and Physics*, 21, 16121-16141, doi: 10.5194/acp-21-16121-2021

Orellana, M.V., D.A. Hansell, **P.A. Matrai**, C. Leck. 2021. "Marine Polymer-Gels' relevance in the Atmosphere as Aerosols and CCN". *Gels*, 7(4), 185; <https://doi.org/10.3390/gels7040185>.

Twohy, C. H., DeMott, P. J., Russell, L. M., Toohey, D. W., Rainwater, B., Geiss, R., ... McRobert, I. M. (2021). Cloud-Nucleating Particles Over the Southern Ocean in a Changing Climate. *Earths Future*, 9(3), Article e2020EF001673. <https://doi.org/10.1029/2020ef001673>

Theme 5:

Jackson R. L., A. J. Gabric, P. A. Matrai, M. T. Woodhouse, R. Cropp, G. B. Jones, E. S. M. Deschaseaux, Y. Omori, E. L. McParland, H. B. Swan and H. Tanimoto. 2021. "Parameterizing the impact of seawater temperature and irradiance on dimethylsulfide (DMS) in the Great Barrier Reef and the contribution of coral reefs to the global sulfur cycle". *J. Geophys. Res. Oceans*, 126(3), e2020JC016783.

Pendergraft MA, Grimes DJ, Giddings SN, Feddersen F, Beall CM, Lee C, Santander MV, Prather KA. 2021. Airborne transmission pathway for coastal water pollution. *PeerJ* 9:e11358 <https://doi.org/10.7717/peerj.11358>

Zhu, Y., Wang, Y., Zhou, X., Elshorbany, Y., Ye, C., Hayden, M., and Peters, A.J. (2022) An investigation into the chemistry of HONO in the marine boundary layer at Tudor Hill Marine Atmospheric Observatory in Bermuda. *Atmospheric Chemistry and Physics*, 22, 6327-6346, doi: 10.5194/acp-22-6327-2022

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2021? If yes, who? How did you engage?

PART 2 - Planned activities for 2022 and 2023

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

The USA is a large research community that primarily works in small groups so there aren't many major national field studies. Rather, there are huge numbers of field studies with several PI's that are not necessarily embraced "nationally". The EXPORTS project was a national level project but the fieldwork for that project is over.

That being said, some national programs do exist, such as field studies that take place as part of the Longterm Ecological Research Network: LTER, <https://lternet.edu/> which has a number of ocean sites, such as on the Northeastern Shelf, Gulf of Alaska, California Coastal Current, and at Palmer Station in Antarctica. Additionally, cruises take place as part of NOAA GO-SHIP Repeat Hydrography (<https://usgoship.ucsd.edu/>) with section P02 along 30 N in the Pacific being planned for April-July 2022 and perhaps P04E and A16N in 2023 though those cruises are currently on hold. US Geotraces, another national effort, is planning a GP17 Cruise that will take place in December 22 to January 2023 from Tahiti to Chili (<https://usgeotraces.ldeo.columbia.edu/content/gp17>).

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

AGU Fall Meeting 2022 Dec 12 to Dec 16, Chicago <https://www.agu.org/Events/Meetings/Fall-Meeting-2022>

American Meteorological Society AMS Annual Meeting Jan 8-12, 2023 Denver
<https://annual.ametsoc.org/index.cfm/2023/>

NASA's Carbon Cycle and Ecosystems Joint Science Workshop May8-12, 2023 in Baltimore.
https://cce.nasa.gov/meeting_2023/index.html

American Society of Limnologists and Oceanographers (ASLO) Aquatic Science Meeting, June 4-9 2023 in Palma de Mallorca, Spain. <https://www.aslo.org/palma-2023/>

3. Funded national and international projects/activities underway.

There are too many to record.

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

See the US SOLAS Science plan, attached, for ideas for future US SOLAS research.

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

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Comments