

Report for the year 2019 and future activities

SOLAS Norway

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This report has two parts:

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

Norway does not have a dedicated SOLAS scientific project, so funding for SOLAS research is limited and spread on different projects. We want to write a proposal to the Research Council of Norway to attempt to get funding to do more SOLAS research in Norwegian coastal areas. Is there a way we can use SOLAS to our benefit? How do we, for example, best argue that we become part of an international effort that SOLAS is?

PART 1 - Activities from January 2019 to Jan/Feb 2020

1. Scientific highlight

The ocean's chemistry is changing due to the uptake of anthropogenic carbon dioxide (CO₂). This phenomenon, commonly referred to as "Ocean Acidification", is endangering coral reefs and the

broader marine ecosystems. In this study, we combine a recent observational seawater CO₂ data product, i.e., the 6th version of the Surface Ocean CO₂ Atlas (1991–2018, ~23 million observations), with temporal trends at individual locations of the global ocean from a robust Earth System Model to provide a high-resolution regionally varying view of global surface ocean pH and the Revelle Factor. The climatology extends from the pre-Industrial era (1750 C.E.) to the end of this century under historical atmospheric CO₂ concentrations (pre-2005) and the Representative Concentrations Pathways (post-2005) of the Intergovernmental Panel on Climate Change (IPCC)'s 5th Assessment Report. By linking the modeled pH trends to the observed modern pH distribution, the climatology benefits from recent improvements in both model design and observational data coverage, and is likely to provide improved regional OA trajectories than the model output could alone, therefore, will help guide the regional OA adaptation strategies. We show that air-sea CO₂ disequilibrium is the dominant mode of spatial variability for surface pH, and discuss why pH and calcium carbonate mineral saturation states, two important metrics for OA, show contrasting spatial variability.

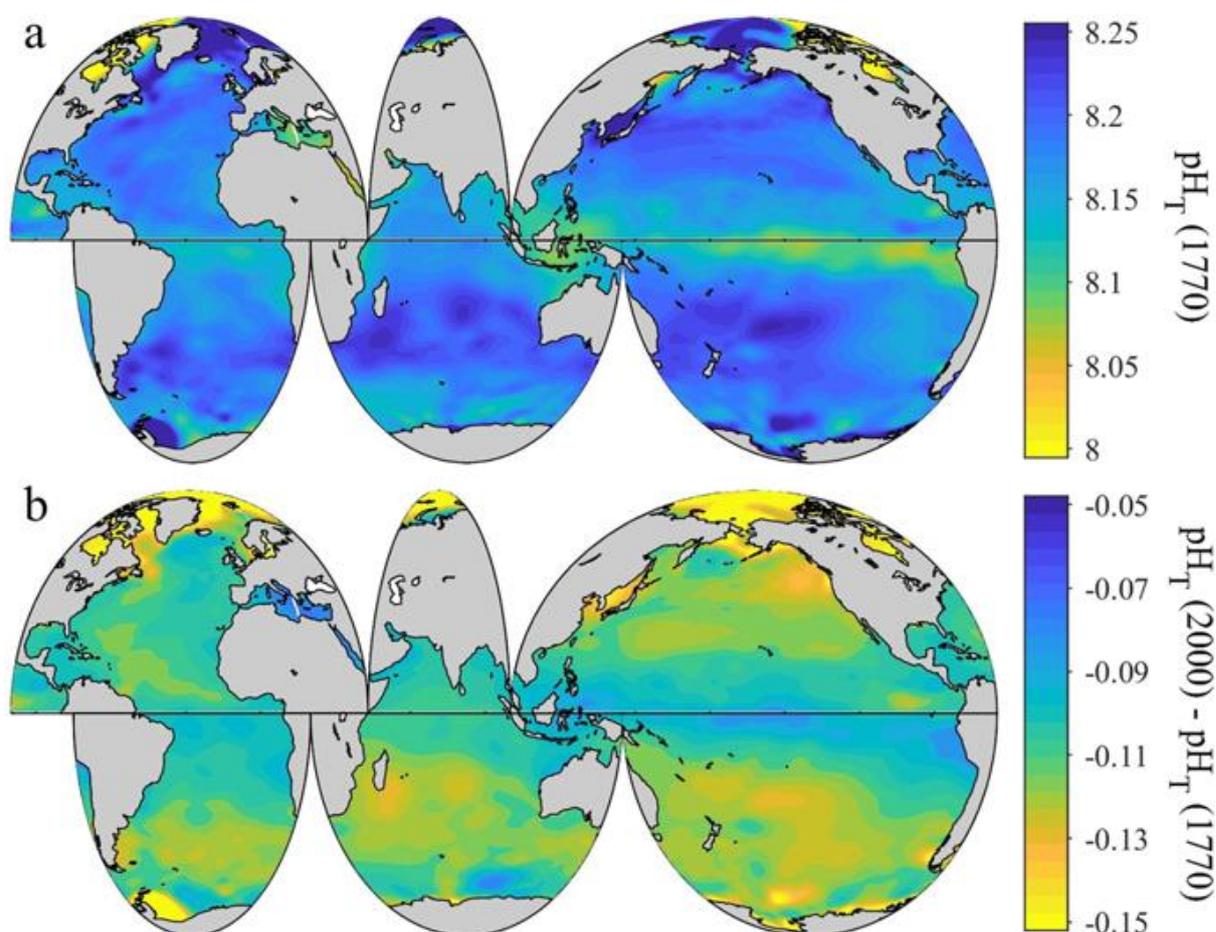


Figure 1: Spatial distribution of global surface ocean pH_T in 1770. Panel a, the annually-averaged surface ocean pH_T adjusted to be approximate for the year 1770. Panel b, the difference between pH_T in 2000 and 1770 ($pH_{2000} - pH_{1770}$) in the global surface ocean.

Citation: Jiang, L.-Q., B. R. Carter, R. A. Feely, S. K. Lauvset, and A. Olsen (2019), Surface ocean pH and buffer capacity: past, present and future, *Scientific Reports*, 9(1), doi:10.1038/s41598-019-55039-4.

2. Activities/main accomplishments in 2019 (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).

OTC workshop in November 2019 (capacity building)

Participation in several Community White Papers for OceanObs'19

Research cruise with R/V Johan Hjort in May-June 2019 where 13 Argo floats, 3 of which are full BGC-Argo floats, were deployed.

Strong participation (as lecturers and participants) in the IOCCP training course on a suite of biogeochemical sensors, Sweden, 10-19 June 2019 (<http://www.ioccp.org/2019-training-course#about>)

SEACRIFOG workshop on practical oceanography and data management, Bergen 1-10 April 2019 (<https://www.seacrifog.eu/news-events/news/>)

"Time-varying ecological geography of the global ocean", workshop at the IMBER Future Oceans 2 Open Science Conference, Brest, France, June 2019

Workshop "Estimating the impact of climate change on Living Marine Resources: Sources of and constraints on uncertainties in climate models", Bergen, October 2019

Establishment of the Northeast Atlantic GOA-ON hub

Start of new EU H2020 project COMFORT coordinated by UiB/Geophysical Institute (project director: christoph.heinze@uib.no, project manager: dagmara.ruseicka@uib.no). Full title: Our common future ocean in the Earth system – quantifying coupled cycles of carbon, oxygen, and nutrients for determining and achieving safe operating spaces with respect to tipping points', website: www.comfort-project.eu. Project start: 1 Sept. 2019, duration 4 years. 32 partners from Europe, India, Canada, and South Africa.

3. Top 5 publications in 2019 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Friedlingstein, P., et al. (2019), Global Carbon Budget 2019, *Earth Syst. Sci. Data*, 11(4), 1783-1838, doi:10.5194/essd-11-1783-2019.

Wanninkhof, R., et al. (2019), A Surface Ocean CO₂ Reference Network, SOCONET and Associated Marine Boundary Layer CO₂ Measurements, *Frontiers in Marine Science*, 6(400), doi:10.3389/fmars.2019.00400.

Steinhoff, T., et al. (2019), Constraining the Oceanic Uptake and Fluxes of Greenhouse Gases by Building an Ocean Network of Certified Stations: The Ocean Component of the Integrated Carbon Observation System, ICOS-Oceans, *Frontiers in Marine Science*, 6(544), doi:10.3389/fmars.2019.00544.

Kitidis, V. et al. (2019). Winter weather controls net influx of atmospheric CO₂ on the north-west European shelf. *Scientific Reports*, 9(1). doi:10.1038/s41598-019-56363-5

Omar, A. M. et al. (2019). Trends of Ocean Acidification and pCO₂ in the Northern North Sea, 2003–2015. *Journal of Geophysical Research: Biogeosciences*, 124(10), 3088-3103. doi:10.1029/2018JG004992.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2019? If yes, who? How did you engage?

Skjelvan, presentation at Research days in Bergen, September 2019, audience: external research users (general public)

Skjelvan, Passion for Ocean festival, experimental stand, August 2019, audience: external research users (general public)

PART 2 - Planned activities for 2019/2020 and 2021

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

ICOS OTC intercomparison in Aug-Sep 2020

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

3. Funded national and international projects/activities underway.

- **ICOS Norway and OTC**, funded by Research Council of Norway until March 2021. Continuation until 2024 applied for in Oct 2018. Funded in January 2020
- **Norwegian Ocean Acidification Monitoring program**
- **NorArgo**, funded by the Research Council of Norway
- **NorEMSO**, funded by the Research Council of Norway

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

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

Participates as Ocean Acidification expert in OSPAR

IOCCP SSC member responsible for ocean carbon synthesis products, including SOCAT.

Executive council member for the Northeast Atlantic GOA-ON hub

Deliveries towards UN's SDG on Ocean Acidification

Comments