

## Report for the year 2017 and future activities

### SOLAS Norway

compiled by: *Siv K. Lauvset*

#### PART 1 - Activities from January 2017 to Jan/Feb 2018

##### 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).*

Lauvset et al. (2017) used an Earth System Model with interactive biogeochemistry to project future ocean biogeochemistry impacts from large-scale deployment of three different radiation management geoengineering methods: stratospheric aerosol injection (SAI), marine sky brightening (MSB), and cirrus cloud thinning (CCT). We applied the geoengineering such that the change in radiative forcing in the RCP8.5 emission scenario was reduced to the change in radiative forcing in the RCP4.5 scenario. The resulting global mean sea surface temperatures in the RM experiments were comparable to those in RCP4.5, but with regional variations. The forcing from MSB, for example, is applied over the oceans, so the cooling of the ocean is in some regions stronger for this method. The main goal of Lauvset et al. (2017) was to assess the effects of geoengineering on ocean biogeochemistry. It was found that changes in ocean net primary production (NPP, Figure 1) are much more variable than changes in temperature and oxygen. Depending on the method, the spatially inhomogeneous changes in ocean NPP are mostly dominated by the circulation changes. In general, the SAI and MSB - induced changes are largest in the low latitudes, while the CCT - induced changes tend to be the weakest of the three. The results of this Lauvset et al. (2017) underscores the complexity of climate impacts on NPP, and highlights that changes are driven by an integrated effect of multiple environmental drivers, which all change in different ways. These results stress the uncertain changes to ocean productivity in the future and advocates caution at any deliberate attempt for large-scale perturbation of the Earth system.

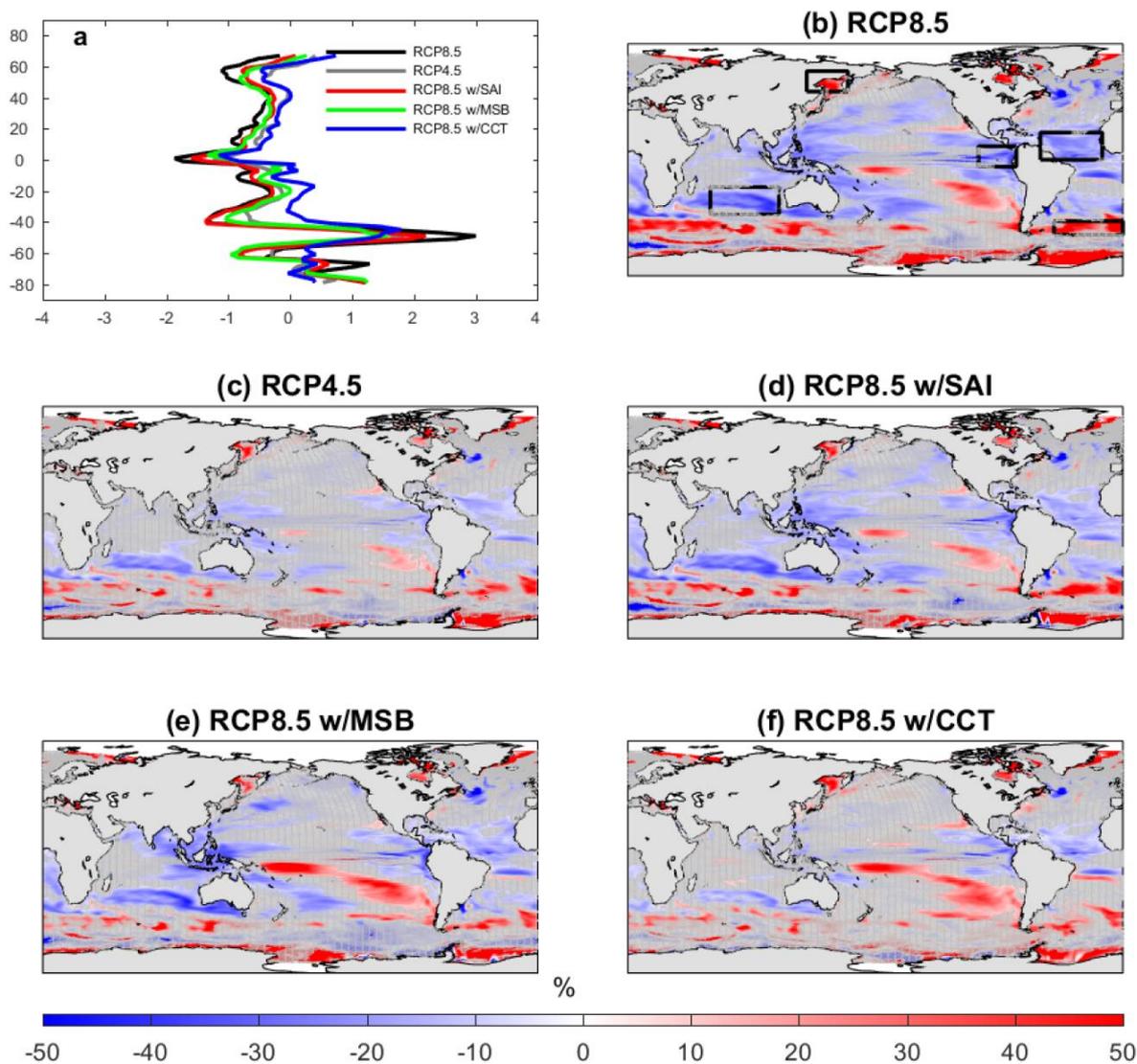


Figure 1. The percent change in the offline calculated NPP in 2071-2100 relative to the 1971-2000 average in the historical run. (a) Zonally averaged (in 2° latitude bands) change for all simulations. (b) RCP8.5, (c) RCP4.5, (d) RCP8.5 with SAI, (e) RCP8.5 with MSB, (f) RCP8.5 with CCT. Gray shading in b)-f) indicates areas where the change is not significantly different from the 1971-2000 average (*i.e.* within one standard deviation of the 1971-2000 mean).

Lauvset, S. K., J. Tjiputra, and H. Muri (2017), Climate engineering and the ocean: effects on biogeochemistry and primary production, *Biogeosciences*, 14(24), 5675-5691, doi:10.5194/bg-14-5675-2017.

**2. Activities/main accomplishments in 2017 (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).**

Outreach: ICOS facebook page and contribution to the Pepperkakebyen in Bergen.

Annual Meeting of the marine Component in ICOS Norway in Bergen. Nov 9<sup>th</sup> 2017

2017 ICOS Spring Seminar, 09-10 May 2017, Kjeller, Norway.

**3. Top 5 publications in 2017 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.**

Fransson, A, M Chierici, I Skjelvan, A Olsen, P Assmy, A K Peterson, G Spreen, B Ward, 2017, Effects of sea-ice and biogeochemical processes and storms on under ice water  $f\text{CO}_2$  during the winter-spring transition in the high Arctic Ocean: Implications for sea-air  $\text{CO}_2$  fluxes, *J. Geophys. Res. Oceans*, doi: 10.1002/2016JC012478.

Schwinger, J., J. Tjiputra, N, Goris, K. D. Six, A. Kirkevåg, Ø. Seland, C. Heinze, C., and T. Ilyina, 2017, Amplification of global warming through pH dependence of DMS production simulated with a fully coupled Earth system model, *Biogeosciences*, 14, 3633-3648, doi:10.5194/bg-14-3633-2017.

F.Fröb, A Olsen, F F Pérez, M I García-Ibáñez, E Jeansson, A Omar, and S K Lauvset, Inorganic carbon and water masses in the Irminger Sea since 1991, *Biogeosciences*, 15, 51-72, 2018

Meike Becker, Benjamin Pfeil, Jörg Schwinger and Ingunn Skjelvan all contributed to the Global Carbon Project (2017) Carbon budget and trends 2017. Le Quéré et al. (2017), <https://doi.org/10.5194/essd-2017-123>, [[www.globalcarbonproject.org/carbonbudget](http://www.globalcarbonproject.org/carbonbudget)] published on 13 November 2017

#### **4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2017? If yes, who? How did you engage?**

Siv K. Lauvset and Benjamin Pfeil has contributed towards the GEO Carbon Flagship

In an effort to improve communication between instrument vendors and PIs, a workshop has been planned for March 2018 by the ICOS ocean thematic center (OTC). Organisation, communications between interested parties, and set up for this workshop has primarily occurred during the second half of 2017.

Nadine Goris participated in a GESAMP-workshop (The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). GESAMP advises the United Nations on the scientific aspects of marine environmental protection: \* N. Goris: "Amplification of global warming through pH-dependence of DMS-production", GESAMP WG 38 workshop on 'Impact of Ocean Acidification on Fluxes of non- $\text{CO}_2$  Climate-Active Species', February 2017, Norwich, UK.

Meike Becker held a presentation to the Norwegian Minister for Climate titled "Karbonsyklus og havforsurning" (in Swedish) on May 29<sup>th</sup> 2017.

## **PART 2 - Planned activities for 2018/2019 and 2020**

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

ICOS lines G.O.Sars, Nuka Arctica and Trans Carrier will be continued measuring  $\text{pCO}_2$  in surface water in the Nordic Seas and north Atlantic.

Biogeochemistry measurements in surface and deep water four times a year south of Bergen at the west coast of Norway.

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

ICOS OTC workshop March 2018

Ocean acidification monitoring of the Norwegian coast (continued)

**3. Funded national and international projects / activities underway.**

ICOS Norway and ICOS OTC

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

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

**Comments**