Project information

Keywords
Marine Ecology, Biogeochemistry, Physical Oceanography, Mathematical modeling

Project title
Ecosystem modeling of the Arctic Ocean around Svalbard

Year
2017

Project leader
Project leader

Geographical localization of the research project in decimal degrees (max 5 per project, ex. 70,662°N and 23,707°E)
78° N 13° W, 72° N 11° E, 83° N 36° E and 88° N 15° E.

Participants

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Flagship
Arctic Ocean

Funding Source

Fram Center

Summary of Results

As mentioned in the previous reports in 2016 we have been updating our work and coupling Ecodynamo biogeohemistry with the ROMS3.6-CICE coupled model (cf. – previous reports). This task was finished and we are now testing the coupled system.

Since the last report was sent to the Fram Center we identified a problem with the Los Alamos Sea Ice Model (CICE) and the coupling with ROMS, related with the definition of boundary conditions. CICE does not have subroutines to read time varying sea-ice boundary conditions. This is not a problem in global (planetary) or in pan-Arctic domains since all the sea-ice is formed within the domain boundaries. However, it becomes a problem in regional domains such as the one simulated in this project around Svalbard (S800 model, cf. – previous reports). In these cases, it is necessary to force the model with time-varying sea-ice exchanges across its boundaries. Therefore, in close

agreement with colleagues from the Fram Center project “Mesoscale modeling of ice, ocean and ecology of the Arctic Ocean (ModOIE)” and with the Los Alamos National Lab (USA) we decided to implement the necessary code in CICE. The code was tested and the technical details of the implementation may be found at the Git branch and accompanying wiki https://source.uit.no/apn/metroms/commits/biogeochemistry.

Simulation results from the A4 model obtained within the scope of the ModOIE project will be processed for compatibility with the time-varying boundary forcing necessary for the S800 model. Moreover, new simulations will be carried out with the A4 model to extend the temporal domain of the boundaries allowing to run the S800 model until recent years, and compare obtained results with data collected during the N-ICE15 and available at https://data.npolar.no/dataset/7f7e56d0-9e70-4363-b37d-17915e09a935.

Another shortcoming detected recently in the ROMS3.6-CICE coupled system is the CICE biogeochemical version, which allows only computing sea-ice skeletal layer biogeochemistry instead of vertically resolved biogeochemistry, implemented in the “columnar” version of CICE. Therefore, the project project leader (PL) is now trying to update the CICE version in the coupled system to the more recent “columnar” version to be able to simulate biogeochemical processes in the whole sea-ice biologically active layer, defined by the vertical extent of the brine channel network.

The project PL participated in a sea-ice biogeochemical modeling inter-comparison workshop between November 27 and 29th in Helsinki, at the Finish Environmental Institute, organized by the network “Biogeochemical Exchange Processes at the Sea-ice Interface (BEPSII)”. The aim of this workshop and follow-up activities is to compare several biogeochemical sea-ice models using similar datasets and to produce a paper discussing the obtained results and leading to possible improvements of current modeling approaches, which is quite relevant for the goals of the present project.

For the Management

A retreating sea ice cover will produce potentially important changes in associated ecosystems and corresponding services. Therefore, a deep understanding of ecosystem processes is crucial for the implementation of models allowing accurate prediction of future trends so that appropriate measures may be taken. This work will add to the tools already available at the involved institutions, improving their understanding of the Marginal Ice Zone and the Arctic Ocean. Efforts are being done to conciliate the modeling work developed here with that developed in other Fram Center projects to make sure that the model physical background and setup is exactly the same, avoiding any compatibility issues in the future.

Published Results/Planned Publications

A paper was published recently that was partly done with funds from this project.

Duarte, P., Meyer, A., Olsen, L.M., Kauko, H.M., Assmy, P., Rösel, A., Itkin, P., Hudson, S.R., Granskog, M.A., Gerland, S., Sundfjord, A., Steen, H., Hop, H., Cohen, L., Peterson, A.K., Jeffery, N., Elliot, S.M., Hunke, E.C., Turner, A.K., 2017. Sea ice thermodynamics and biogeochemistry in the Arctic Ocean: Empirical and model results. Journal of Geophysical Research Biogeosciences, 122. doi:10.1002/2016JG003660.

Another paper about the coupling methodology ROMS-EcoDynamo is in prep.

Communicated Results

Results were communicated in previous years as described in previous reports but not yet in 2017. However, an Abstract was submitted to the Polar2018 conference.

Interdisciplinary Cooperation

This project benefits from inter-disciplinary cooperation. In fact, the modeling work done so far includes ice physicists and marine biologists. Therefore, the main disciplines involved in the project are Ice and Ocean Physics and Marine Biology and Ecology. Furthermore, contacts were established with colleagues at the University of Alaska Fairbanks regarding biogeochemical modeling that, hopefully, may boost some important collaboration in the near future. Also, contacts were established with the CICE modeling team at the Los Alamos National Laboratory (USA) and the Finnish Environmental Institute.

Budget in accordance to results

Funding from the Fram Centre is fundamental to pay for the project expenses, with emphasis on labor and technical assistance. In spite of the great help of the funding from the Fram Centre, we are struggling with a shortage of man-power due to unexpected technical problems in using ROMS+CICE. However, we expect to deliver the planned work.

Could results from the project be subject for any commercial utilization

No

Conclusions

Project tasks have evolved considerably in spite of some delays due to unforeseen problems. Considering the shortcomings described above it is anticipated some delay to fulfill all project goals. This implies that the project PL will continue the modeling work during 2018 and will keep the flagship informed about the work progresses.