Project information

Keywords
Marine Ecology, Biogeochemistry, Physical Oceanography, Mathematical modeling

Project title
Ecosystem modeling of the Arctic Ocean around Svalbard

Year
2018

Project leader
Pedro Duarte

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.

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Flagship
Arctic Ocean

Funding Source

Fram Center

Summary of Results

As mentioned in the previous report describing work developed in 2017 we implemented and tested time-varying sea-ice boundary conditions, updated the Los Alamos Sea Ice Model (CICE) version in the coupled ROMS-EcoDynamo-CICE system, from version 5.1.2 to the columnar version that allows computing vertically resolved biogeochemistry in the ice.

We started long-term simulations of the S800 model in June, in Stallo supercomputer, using 600 processors. We faced various problems: (i) long queue waiting times every time we submitted a job (some times more than a week before the job started to run); (ii) model slowness, taking roughly one day of real time to simulate only 6-7 days;(iii) the need to frequently restart the model due to numerical problems related with convergence and error tolerances of the CICE model. Regarding (i) and (ii), it became clear the urgent need to install the S800 model in Fram. However, we could not do that before UNINETT Sigma2 AS opened computer resource applications for the next

allocation period, starting in October 2018. We applied for cpu time in Stallo and in Fram and we got 500 kCPU hours for the former and 1 MCPU for the latter. After that we employed Dmitry Shcherbin for 2.5 months at 50% to install the model in Fram. This task is now finished and we are about to restart long-term simulations in Fram. Our first tests show that in Fram it is possible to simulate ~one month in one day of real time, which is a significant improvement compared to the performance we got in Stallo. Regarding (iii), the simulations done so far in Stallo allowed us to fine-tune some convergence and error tolerances in CICE, which should prevent the need to restart the model as often as we did. We also spotted a few minor errors in some settings and in model forcing that were corrected in the process of preparing the new simulations in Fram, which we hope to start within the next two weeks.

The project PL participates in other modelling activities related with this project but focused on specific components of the coupled modeling system. These include a sea-ice biogeochemical modeling inter-comparison workshop, 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. Within the scope of this inter-comparison exercise the PL implemented a 1D vertically resolved coupled physical-biogeochemical model of land-fast ice for the Resolute Passage (Canadian Arctic), using the CICE software. Moreover, there is a paper in prep with other colleagues from the Norwegian Polar institute where the same model is being used to calculate the energy budgets of several ice floes monitored during the Norwegian Young Sea Ice expedition in 2015, north of Svalbard. All these modeling efforts have the potential to feedback the S800 coupled system through better parameterizations of several processes.

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

There are plans to participate in a paper that should result from the inter-comparison modeling work organized by BEPSII and in a sea-ice energy budget paper (see above).

Another paper about the coupling methodology ROMS-EcoDynamo is in prep. In fact, this paper has been delayed considerably due to the workload required for the implementation and testing of the modeling system. We believe that the paper will be submitted before next summer. It is more difficult to anticipate the submission of the remaining two papers since they depend more on synergies and contributions with/from several colleagues.

Communicated Results

A poster was presented to the Polar2018 conference, including aspects of the work developed within this project.

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 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.

Could results from the project be subject for any commercial utilization

No

Conclusions

Project tasks have evolved steadily but much slower than anticipated. We clearly underestimated the magnitude of the tasks involved but the progresses so far were enormous. The main bottlenecks of this development process are: (i) the complexity of the modeling system; (ii) limited manpower; (iii) access and performance of computer infra-structure. These bottlenecks explain most of the delays but they will not prevent us from reaching our goals, especially now when most of the hurdles were overtaken and when we have access to the Fram super computer.