

SPECIAL PROJECT PROGRESS REPORT

Reporting year 2023

Project Title: Organic Particle Export, Remineralization and Advection in the North Atlantic mesopelagic layer

Computer Project Account: spesiccf

Principal Investigator(s): Etienne Tourigny

Other researchers:
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Affiliation: Barcelona Supercomputing Center

Name of ECMWF scientist(s) collaborating to the project (if applicable) N/A

Start date of the project: 01/01/2023

Expected end date: 12/31/2023

Computer resources allocated/used for the current year and the previous one

| | | Previous year | | Current year | |
|--|----------|---------------|------|--------------|---------|
| | | Allocated | Used | Allocated | Used |
| High Performance Computing Facility | (units) | N/A | | 65M | 311,749 |
| Data storage capacity | (Gbytes) | N/A | | 20000 | ? |

Summary of project objectives

This activity takes place in the context of the Spanish National MICINN project OPERA (Organic Particle Export, Remineralization and Advection in the North Atlantic mesopelagic layer). Advances in observation of ocean particles with autonomous robots (biogeochemical Argo boats) and a recent key development in the representation of small particles in a state-of-the-art ocean biogeochemistry model (PISCESv2) now enable comprehensive estimates of mesopelagic particulate organic carbon (POC) cycling pathways. The aim of the OPERA project is to quantify mesopelagic particulate POC budgets and constrain their sources of uncertainty, including (1) biological processes represented in PISCESv2, (2) meteorological forcing of upper-ocean mixing and temperature, which exert a strong control on plankton productivity, and (3) the long-neglected role of the horizontal advection of suspended particles. The resources requested in this ECMWF special computing project will enable us to perform all the simulations planned in the OPERA project.

Summary of problems encountered

A number of scientific-technical issues which required more time than initially anticipated have delayed progress, which explain why the computational resources have not yet been used. Significant time was required to develop the Auto-NEMO workflow manager suite using the Autosubmit software. The NEMO/PISCES namelists parameters had to be revised and adapted when upgrading to NEMO version 4.0.6, which is significantly different from the 3.6 version used up to now by the BSC. Finally, porting the model to the ECMWF HPC2020 supercomputer required some time to accomplish.

Summary of plans for the continuation of the project

We will run a number of simulations using the NEMO4-PISCESv2 model (1° resolution - ORCA1 grid and 75 vertical levels) forced by the JRA-55 atmospheric reanalysis (1958-2019) following the OMIP (Ocean Model Intercomparison Project) protocol, as described in the Special Project Request spsiccf_2023. The model is technically ready to run on the ECMWF HPC2020 supercomputer, but requires some work for proper optimization of computational resources. Once the simulations are performed we will compare them to available observations to evaluate the performance of our model.

List of publications/reports from the project with complete references

Galí, M., Falls, M., Claustre, H., Aumont, O., & Bernardello, R. (2022). Bridging the gaps between particulate backscattering measurements and modeled particulate organic carbon in the ocean. *Biogeosciences*, 19(4), 1245-1275.

Falls, M., Bernardello, R., Castrillo, M., Acosta, M., Llorc, J., & Galí, M. (2022). Use of genetic algorithms for ocean model parameter optimisation: a case study using PISCES-v2_RC for North Atlantic particulate organic carbon. *Geoscientific Model Development*, 15(14), 5713-5737.

Summary of results

A number of technical tasks have been completed in order to prepare the simulation environment. The Auto-NEMO workflow manager suite using the Autosubmit software was implemented. The NEMO/PISCES namelists parameters were revised and adapted to NEMO version 4.0.6 from the

previous version 3.6 used up to now by the BSC. Updated observational datasets from BGC-Argo floats and POC flux and remineralisation rates from the Respiration in the Mesopelagic Ocean (ReMO) group have been downloaded and processed. The porting of the model to the ECMWF HPC2020 supercomputer was accomplished using the resources of this Special Project.