SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year 2022

Project Title: Enhancing regional ocean data assimilation in high and mid latitude European seas

Computer Project Account: spitstor

Principal Investigator(s): Andrea Storto

Affiliation: CNR ISMAR

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

Start date of the project: 1/JAN/2022

Expected end date: 31/DEC/2024

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

(if applicable)
Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)			5 800 000	450 000 (However, we run mostly on "aa")
Data storage capacity	(Gbytes)			20 TB	10 TB

Summary of project objectives (10 lines max)

The project develops along with four main research topics that are summarized below: i) Stochastic physics formulation and experiments, mostly using a North Atlantic-Arctic-Mediterranean configuration of NEMO at multiple resolutions (1/4°, 1/12°, and 1/36°); ii) Altimetry data assimilation at high latitudes, focussing on the use of high sampling rate (5Hz) altimetry datasets; iii) coupled data assimilation algorithms, using as a target configuration a regional Earth system model; iv) weak-constraint four-dimensional data assimilation algorithms and testing.

Summary of problems encountered (10 lines max)

Most of the code (NEMO, OceanVar (variational data assimilation), Regional ESM (WRF+NEMO+HD)) has been successfully ported on "aa" and is being used therein. The new machine has been working perfectly most of the time, except for some occasional MPI failures (~2 all over the 6 months) during selected NEMO model executions and some I/O failures (during one day). The direct Teleport/TSH service for "aa-login" has allowed faster download/upload of data from our data server located in Rome (earlier during the year, we were forced to triangulate via "cca" in Reading). However, the "ecaccess" service for "cca" seemed easier to use - not requiring a web-based interface that for remote X-server connections takes some time - and guaranteed a longer period of passwordless data exchange.

Summary of plans for the continuation of the project (10 lines max)

We plan to continue running the regional Earth System Model and testing coupled data assimilation algorithms with an incremental complexity approach (weakly to strongly coupled algorithms, focussing on the oceanic observing system and gradually adding in-situ atmospheric observations). We also expect starting soon few experiments devoted to the assessment of the impact of high sampling rate altimetry in the North Atlantic-Arctic-Mediterranean configuration of NEMO, focusing in particular on the observational impact at high latitudes. Finally, we plan to continue developing and testing stochastic physics schemes for NEMO, looking in particular at optimal ways to perturb surface and lateral boundary conditions in retrospective experiments of NEMO over the North Atlantic-Arctic-Mediterranean region.

List of publications/reports from the project with complete references

N/A

Summary of results

During these first six months of the spitstor project, we have focussed our usage of the new "aa" machine on two different scientific topics, summarized below:

1) Ocean Stochastic physics schemes

To this end, we have run 2-year NEMO experiments at multiple resolutions (1/4°, 1/12°, and 1/36°) to estimate the sub-grid variability ("mesoscale" and "submesoscale" like variability), for further use in the tuning of stochastic physics schemes. The three configurations have been run freely and share the same model configuration (except for the scaled diffusivity and viscosity coefficients) and surface and lateral boundary conditions, representing an important dataset to assess the ocean sub-grid variability in the North Atlantic and Arctic regions. Basic sea surface subgrid variability has been calculated as well for use in several follow-up experiments.

Next, we are currently running four four-member ensemble experiments to assess the impact of different atmospheric forcing perturbation strategies: i) using the ERA5 EDA ensemble members to generate time-varying forcing perturbation consistent with the ERA5 ensemble system; ii) using a reformulated SPPT scheme, where the wind stress and the solar and non-solar heat fluxes are perturbed collinearly to their time-varying tendencies; iii) an SPP scheme, where the air-sea transfer coefficients (for wind stress, evaporation, and sensible heat) are perturbed with a log-normal distribution; iv) a coarse-grained perturbation scheme, where the subgrid variability, estimated from the high resolution runs, is used to mimic high-resolution bulk formulas, and then the fluxes are upscaled to the nominal model resolution through simple subgrid averaging, to simulate the effect of the subgrid variability of the sea surface on the resulting fluxes. In the next month, we will complete the experiments and will start assessing the results.

2) Coupled model simulations

We are running a small multi-physics ensemble of the Mediterranean Sea Earth System Model for the period 1993-2020. The regional Earth System model has been recently developed by the CNR ISMAR and includes the WRF atmospheric model (v4.3.3 at 14 km of spatial resolution), the NEMO ocean model (v4.07 at 7 km of spatial resolution), and the HD hydrological model (v5.0.1 at 1/12° of spatial resolution), coupled through the OASIS coupler. After several configuration optimization procedures, performed at the CNR ISMAR in-house small cluster, we are now running these long experiments with the twofold objective of i) evaluating the performance of the regional Earth system model on longer periods in terms of key climate processes and metrics; ii) forming the input datasets to calculate uncoupled and coupled background-error covariances for later use in coupled assimilation experiments, using either ensemble anomalies or high-pass filtered anomalies. We expect to complete the runs during the next month and start the assessment after the summer.