# 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:** | High-resolution ocean reconstructions for initializing decadal climate predictions |
| **Computer Project Account:** | spesiccf |
| **Principal Investigator(s):** | Etienne Tourigny |
| **Affiliation:** | Barcelona Supercomputing Center |
| **Name of ECMWF scientist(s) collaborating to the project** (if applicable) | Aude Carreric, Pablo Ortega, Miguel Castrillo, Pierre-Antoine Bretonnière, Eric Ferrer, Roberto Bilbao, Juan Acosta Navaro, Vladimir Lapin |
| **Start date of the project:** | 01/01/2022 |
| **Expected end date:** | 31/12/2022 |

### 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) | | | 63,6M | 15,8M |
| **Data storage capacity** | (Gbytes) | | | 20k | 13k |

## Summary of project objectives (10 lines max)

The overall objective of this 1-year project is to improve the predictive skill of the Decadal Climate Prediction (DCP) system produced with EC-Earth3.3 in its high-resolution (HR). After a dedicated tuning exercise (spesiccf-2020), the specific goal of this project is to improve the initialization method, by producing new in-house ocean reconstructions. We developed a refined strategy to make the most of the ocean and atmosphere HR reanalyses from ECMWF (ORAS5 and ERA5) avoiding the non-stationary bias reported in the North Atlantic for the ECMWF seasonal forecast system SEAS5, arising from problems in the ORAS5 subsurface fields (Tietsche et al., 2020). Thus, the oceanic initial conditions of the EC-Earth3.3 DCP system will come from HR ocean-only simulations (NEMO3.6), driven by ERA5 surface atmospheric forcings and assimilating sea temperature and salinity at the surface from ORAS5 and 3D ocean temperature and salinity from the EN4 analysis.

## Summary of problems encountered (10 lines max)

We encountered several technical issues delaying the production of the oceanic reconstructions. We produced a first member that was thoroughly validated, which allowed us to realise that the routine dedicated to save the initial conditions (IC) from the ocean-only experiment was outdated on the ECMWF Cray XC40 HPC, generating IC files which were not readable by the coupled version of the model used to make the predictions. We also noticed that the atmospheric forcing fields from the ERA5 reanalysis applied were not correct as the precipitation forcing only included rain, instead of the total precipitation (snow + rain). This difference in the rainfall forcing has an impact in particular in the deep-convection regions where salinity errors associated with the incomplete freshwater fluxes can induce errors in deep convection (see paragraph Summary of results for more details).

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

Due to the technical problems encountered, we have so far only produced one member of the reconstruction, using the wrong precipitation forcings and generating faulty ICs. Now that we have corrected these errors, we will take advantage of our delay to use the recently published final version of the backward extension (1959-1978) of the ERA5-HRES atmospheric reanalysis. We are currently downloading the relevant variables (heat fluxes, precipitation, temperature and velocities at 10m) of ERA5-HRES which were recently made available on MARS. After post-processing them to be (1) readable by the ocean model NEMO3.6 and (2) slightly perturbed to create spread in the ocean reconstruction ensemble, we will run the final in-house reconstruction following the new strategy presented previously. We are thus planning to produce 3 or 4 members depending on how many retrials are needed.

## List of publications/reports from the project with complete references
…………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………
……………………………………………

# Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

While processing the files needed for the simulation, we noticed that there was an error in the way we applied the precipitation forcing to the ocean-only reconstruction. Only the rain was taken into account rather than the total precipitation including the snow. We conducted several short tests to estimate the impact of the difference in this forcing flux, which was found to be non-negligible, in particular in regions of deep convection (for instance the Labrador Sea) where errors in the freshwater impact the salinity and thus the density of water masses.

We also noticed that the ocean ICs, used to initialize the ocean state of the coupled seasonal/decadal forecasts were flawed due to an outdated version of the tool used. This problem was also addressed, and tested in another short simulation to make sure that the new ICs were sound and compatible with the coupled version of EC-Earth3-HR, the one used to make the predictions.

We have used so far 15,8 out of 63,6 M SBU (47,9 M SBU remaining) for the short tests and for running the first incorrect member of the reconstruction. To produce the corrected ensemble reconstructions we need 170000 SBU per reconstructed year, which adds up to 11,6 M SBU per member, considering a buffer of 10% to account for sporadic model crashes. If no major problems are encountered, we therefore expect to produce 4 members of the ocean reconstruction with this correct configuration.

We are currently downloading and processing the forcing fields of the final official back extension of ERA5 (which supersedes the preliminary version used to run the first incorrect reconstruction), a task that should be completed in the first two weeks of July. The final reconstructions will be started in the second part of July and should be concluded before September, thus well on time before the cca machine is decommissioned.