SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year 2017…………………………………………………….……

Project Title: CMIP6 BSC contribution to HighResMIP (HighResMIP_BSC)

Computer Project Account: spesiccf…………………………………………….……

Principal Investigator(s): Virginie Guemas

……………………………………………………………….…
…

Affiliation: Barcelona Supercomputing Center

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

Etienne Tourigny, Laurent Brodeau, Eleftheria Exarchou, Roberto Bilbao, Francois Massonnet, Louis-Philippe Caron, Mario Acosta, Oriol Tinto, Miguel Castrillo, Chloe Prodhomme, Martin Menegoz, Domingo Manubens, Pierre-Antoine Bretonniere

Start date of the project: January 2017 …………………………………….……

Expected end date: December 2018

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)	0	0	41500000	5735280.95
Data storage capacity	(Gbytes)	0	0	30000	

Summary of project objectives
(10 lines max)

Recent studies investigating the role of increasing the atmospheric and oceanic resolution in global climate models well beyond the typical resolutions used for the Fifth Phase of the Coupled Model Intercomparison Project have suggested a clear added-value both in terms of mean state and variability. The HighResMIP coordinated exercise, as part of the Sixth Phase of the Coupled Model Intercomparison Project offers a framework for building a large multi-model ensemble of high resolution simulations with a low resolution counterpart following a common experimental protocol, i.e. a common integration period, forcing and boundary conditions. The HighResMIP simulations will focus on present-day and near-term future climate. Hence, process-based assessment will not focus on climate sensitivity but on the representation of mean state, variability and teleconnections on a wide range of timescales. HighResMIP_BSC supports the contribution of BSC to this international coordinated exercise.

Summary of problems encountered (if any)
(20 lines max)

For HighResMIP_BSC, we intend to use the final Ec-Earth 3.2 model version since it will be the one used by the whole EC-Earth consortium for the various Model Intercomparison Projects (MIP) of CMIP6 (6th Phase of the Coupled Model intercomparison Project) and therefore the EC-Earth version known as the CMIP6 version. Unfortunately, the development of this version was substantially delayed due to a series of bugs to be fixed and unrealistic features to be solved (sea ice cover, ocean circulation strength …) as well as the CMIP6 forcings which were available later than expected and implementation of new schemes such as the stratospheric aerosol forcings which took more time than initially expected. As a result, the final code of the EC-Earth 3.2 version has only been very recently settled and the EC-Earth consortium is currently in the process of tuning the model. We expect to be able to launch our final simulations for HighResMIP_BSC in a few weeks at most. In the meantime, we have been carrying out a preliminary version of the model spinup with previous versions of EC-Earth which were in development. The objective was to develop the technical skills to run this particular high-resolution configuration with the HighResMIP protocol so as to save time when the final version would be ready as well as potentially detect any scientific issue which did not occur. As can be seen in the next session, our scientific results were reasonable.

Summary of results of the current year (from July of previous year to June of current year)
This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project

Since the final EC-Earth 3.2.2 CMIP6 version was not ready yet, we have carried out a preliminary version of the HighResMIP_BSC spinup with the earlier EC-Earth versions. According to the HighResMIP protocol that was described in our initial proposal, this spinup consists of a 50-year simulation initialized from the EN4 climatology in the ocean and a sea ice cover which would be in agreement with the EN4 sea surface temperature. We carried out 10 years initialised from EN4 with EC-Earth version 3.2.0 and using CMIP5 radiative forcings followed by 34 more years with EC-Earth version 3.2.1 using CMIP6 radiative forcings (which became available at this point). A spectral truncation of the atmospheric model (IFS) at T511 (approx. 40 km globally) and 91 vertical levels has been used as well as grid resolution of the ocean model (NEMO3.6) of 0.25° globally (approximately 25 km) with 75 vertical levels which thickness increases from 1m below surface up to 500m in the deep ocean.

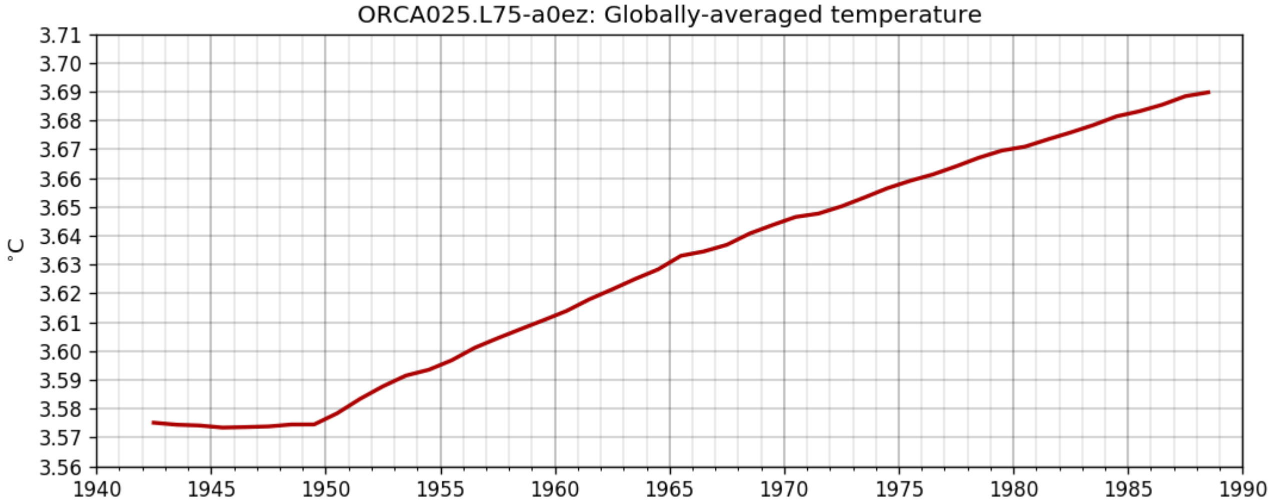

Figure 1: *Annual global 3-dimensional average of ocean temperature. Years are not historical years since this simulation is a perpetual 1950-climate experiment.*

The ocean component and in particular the deep ocean is the longest to equilibrate in the climate system under a spinup experiment due to the large ocean heat capacity. The global 3-dimensional average of ocean temperature (Figure 1) indicates that the EC-Earth version 3.2.0 was close to equilibrium under the CMIP5 radiative forcings during the first 10 years of the simulation. When changing to a more recent model version and more recent radiative forcings used for the CMIP6 exercise, the model starts drifting. This is essentially due to the lack of model tuning of this newer version. Tuning is currently in progress on the version EC-Earth 3.2.2 to be used in the rest of this project.

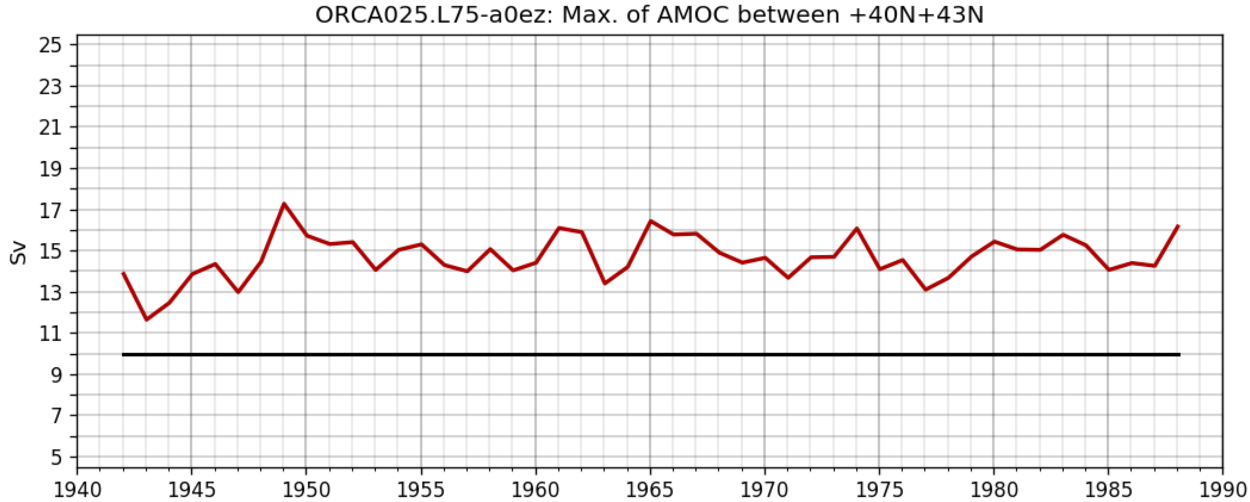

Figure 2: *Annual Atlantic meridional overturning circulation indice estimated as the maximum of the Atlantic Meridional Overturning Streamfunction taken between 40N and 43N. Years are not historical years since this simulation is a perpetual 1950-climate experiment.*

The Atlantic Meridional Overturning Circulation is the part of the global ocean circulation which is thought to have the longest memory and the largest impact on the atmosphere. Its strength with the high resolution configuration used in this spinup (Figure 2) is reasonable strength compared to observational estimates. Its tends however to exhibit a relatively weak decadal variability with a weak amplitude (about 4Sv peak-to-peak).

.

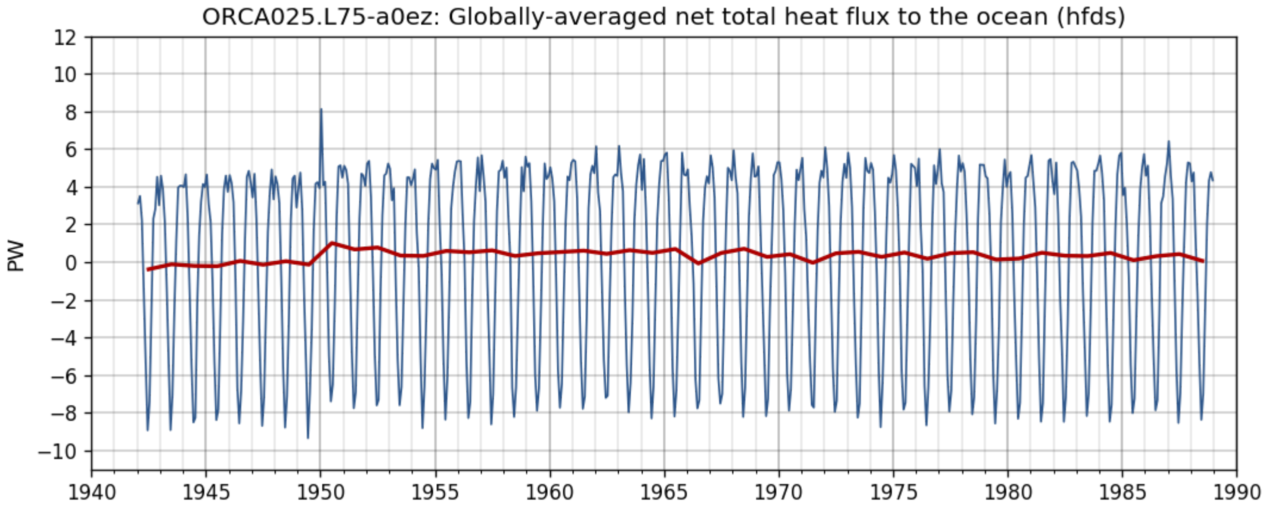

Figure 3: *Monthly globally integrated (2D) total net heat flux to the ocean. Years are not historical years since this simulation is a perpetual 1950-climate experiment.*

The global average total net heat flux into the ocean indicates how balanced the heat exchanges between the ocean and atmosphere are and how far from equilibrium the model is. Under constant radiative forcings and model equilibrium, we expect its value to be 0. In our spinup simulation (Figure 3), its value tends to be 0 in the first decade and slightly positive afterwards, in agreement with the positive drift in global ocean heat content with a change in model version and radiative forcing (Figure 1).

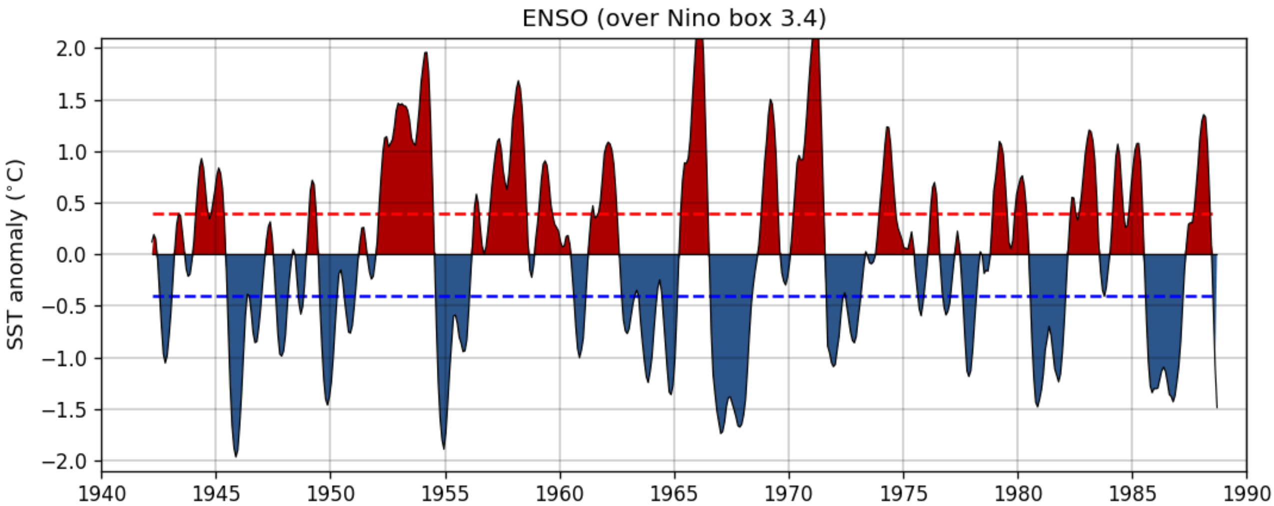

Figure 4: *El Niño Southern Oscillation index estimated as the average SST in the Nino3.4 box (5S-5N and 170-120W). Horizontal dashed lines give the one standard deviation amplitude (positive in red and negative in blue)*

The El Niño Southern Oscillation (ENSO) is the most impactful mode of interannual variability on global scales through all its teleconnections. In our spinup simulation (Figure 4), the ENSO has a periodicity of about 2 to 5 years which is in agreement with the observations with a few extreme events.

List of publications/reports from the project with complete references

None yet

Summary of plans for the continuation of the project

(10 lines max)

The spinup will be carried out again starting from EN4 climatology and run for 50 years with the final EC-Earth 3.2.2 CMIP6 model version. We expect to launch this simulation in a few weeks at the latest and this simulation will be finished by the end of the year. Following the plans from the initial proposal, this spinup will provide initial conditions for a transient simulation covering 1950-2050 as well as a control simulation in perpetual 1950 climate.