Recent studies have established that the typical atmospheric and oceanic resolutions used for the CMIP5 coordinated exercise (Coupled Model Intercomparison Project, phase 5), i.e around 40km-150km globally, are a limiting factor to correctly reproduce the climate mean state and variability. BSC has developed a coupled version of the EC-Earth 3.2 climate model at a groundbreaking horizontal resolution of about 15km in each climate system component. In the atmosphere the horizontal domain is based on a spectral truncation of the atmospheric model (IFS) at T1279 (approx. 15 km globally, i.e. the highest resolution we can use with the standard IFS - higher resolutions would require e.g. nonhydrostatic parameterizations) together with 91 vertical levels. The ocean component (NEMO) is run on the so called ORCA12 tripolar (cartesian) grid at a horizontal resolution of about 1/12° (approximately 16 km), with 75 vertical levels, whose thickness increases from 1m below surface up to 500m in the deep ocean.

The HighResMIP coordinated exercise, as part of the Sixth Phase of the Coupled Model Intercomparison Project (CMIP6), offers a framework for building a large multi-model ensemble of high resolution simulations with a low resolution counterpart following a common experimental protocol. This coordinated exercise will allow for identifying the robust benefits of increased model resolution based on multi-model ensemble simulations. The Glob15km project proposes to follow the entire HighResMIP protocol for coupled climate simulations with this ground-breaking resolution configuration of EC-Earth 3.2. Its experimental protocol consists in running a 50-year spinup under perpetual 1950 conditions followed by: 1) a historical simulation covering the 1950-2050 period, 2) a control simulation under perpetual 1950 conditions run for 100 years. These simulations will represent an extensive source of information for the writing of the next Assessment Report of the Intergovernmental Panel on Climate Change. Our main scientific objective is to pin down physical and dynamical reasons behind differences in model representation induced by resolution change. Process-based assessment will focus on the representation of mean state, variability and teleconnections on a wide range of timescales.

The increase in capability of Earth System Models (ESMs) is strongly linked to the amount of computing power, given that the spatial resolution used for global climate experimentation is a limiting factor to correctly reproduce climate mean state and variability. However, higher spatial resolutions require of new and High Performance Computing (HPC) platforms, where the improvement of the computational efficiency of the ESMs will be mandatory. In this context, porting a new ultra-high resolution configuration into a new and more powerful HPC cluster is a challenging task, involving a technical expertise to deploy and improve the computational performance of such a novel configuration. Our main technical success has been to optimise the T1279-ORCA12 configuration of the EC-Earth 3.2 coupled climate model to run efficiently in the MareNostrum IV supercomputer of the Barcelona Supercomputing Center.

Comments:

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- The team members of the BSC Earth Sciences Department working on the Glob15km proposal, coordinated the recent HiResClim and HiResClim2 projects supported by PRACE.
- The PI of Glob15km has been PI of the recent PRACE LHSIP project.
- The performance team of the BSC Earth Sciences Department was granted a Type-C Preparatory Access (2010PA4064) to optimise the EC-Earth model for this configuration.
- The Global 15km configuration constitutes the coupled global demonstrator featured in the ESiWACE project, which has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 675191.
- The outputs of model simulations produced during Glob15km will be made available publicly through an ESGF node, in the framework of CMIP6.
- These outputs will be exploited in multi-model analyses to be performed during the HighResMIP CMIP6 project as well as the PRIMAVERA project funded by the European commission through the H2020 Framework programme in support of HighResMIP.