The new very-high-resolution coupled global configuration for EC-Earth 4

Recent studies have established that the typical atmospheric and oceanic resolutions used for the CMIP5 coordinated exercise, i.e., around 40km-150km globally, are limiting factors to correctly reproduce the climate mean state and variability. In the framework of the ESiWACE project, the Barcelona Supercomputing Center (BSC) developed a coupled version of the EC-Earth 3 climate model at a groundbreaking horizontal resolution of about 15km in each climate system component. In the atmosphere, the horizontal domain was based on a spectral truncation of the atmospheric model (IFS) at T1279 (15 km) together with 91 vertical levels. The ocean component (NEMO) ran on the ORCA12 tripolar (cartesian) grid at a horizontal resolution of about 1/12° (16 km), with 75 vertical levels.

This very-high-resolution (VHR) configuration was used in the Glob15km project to run a 50-year spinup from which one historical and one control simulation of 50 years each were started, following the HighResMIP protocol from CMIP6. These experiments are currently being used to identify the improvements in process representation with respect to coarser resolution and to pin down physical and dynamical reasons behind these differences induced by resolution change.

The VHR coupled configuration was a great benchmark to reveal the most critical scalability problems of the EC-Earth 3 model. Within the ESiWACE2 project, those issues have been tackled to allow operational climate predictions at more than 1 SYPD (Simulated Years Per Day) with production-mode configurations. The new Tco639-ORCA12 configuration is based on the community EC-Earth 4 model, made up of OpenIFS cycle 43r3 and NEMO 4, and uses a cubic octahedral grid in the atmosphere. In this version of EC-Earth, both the atmospheric and the oceanic component output diagnostics through the asynchronous XIOS servers, contributing to reducing the I/O overhead and improving scalability, which will be evaluated at the end on one of the forthcoming pre-exascale EuroHPC systems.

This new configuration has already been scaled in MareNostrum 4 with a peak performance of 2 SYPD. It will be subject to the last phase of development and optimization until it is finally deployed in one of the forthcoming Pre-Exascale platforms to facilitate the execution of experiments with an unprecedented time-to-solution and allowing additional output capabilities to help understand the climate mean state, variability, and extremes.