Project: 1406

Project title: **RESM4CORDEX (Regional Earth System Model simulations for CORDEX)**

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Project RESM4CORDEX aims at the evaluation of the Regional Earth System Models (RESMs) of the CLM-Community before contributing the simulations to the CORDEX network. At Hereon in the last 11 months, we have conducted several hindcast simulations for 60 years (1959-2018) of the RESM GCOAST-AHOIB1-1 model which comprises the atmospheric model COSMO-CLM (or CCLM), the ocean model NEMO, the hydrological discharge model HD and the bio-geochemical model ECOSMO over the EURO-CORDEX domain with the coupling domain over the North Sea and the Baltic Sea. The models were forced by the atmospheric ERA5 reanalysis data and the ocean boundary ORAS5 reanalysis data. Besides, we also conducted a 60-years hindcast simulation with the coupled model NECOS, which includes the NEMO and ECOSMO, to use it as a reference simulation for comparison with the GCOAST-AHOIB1-1 simulation.

To spin-up the coupled models, we ran the NECOS model in a loop of 10 times for the first simulation year of 1959. We used the restart file of the last simulation of NECOS (e.g. NECOS_spinup10) to start the hindcast simulations of NECOS and GCOAST-AHOIB1-1.

First, we found a cold bias of sea surface temperature (SST) in summer in the coupled simulation GCOAST-AHOIB1-1 compared to the NECOS one. This cold SST bias was already shown in the simulations of the coupled model GCOAST-AHOI1-1 conducted in 2024. Note that GCOAST-AHOI1-1 was without ECOSMO and with some different parameter settings in NEMO compared to GCOAST-AHOIB1-1. To reduce the SST cold bias, we made a new simulation with GCOAST-AHOIB1-1 in which the shortwave downward radiation (SWDN) from the atmospheric model CCLM was increased by 20% before sending it to the ocean domain of NEMO.

Second, we found a salinity bias in the Baltic Sea in the ocean model. The first reason of the salinity bias was the missing of the Newa river mouth in NEMO when distributing the runoff from HD to NEMO. After fixing the bug, the salinity simulation of NECOS is fine, but the salinity bias still exists in the coupled model GCOAST-AHOIB1-1. Therefore, we ran several sensitivity tests with different SWDN bias correction ratios, and a 10% runoff increase for the river inflow to the Baltic Sea to find out the origin of the bias. The origin of the salinity bias is still being investigated with the aim to reduce it before conducting the production simulations.

Other RESMs of the CLM-Community involved in the project were the ROAM-NBS (ICON-CLM+NEMO4.2) of DWD, IOW-ESM (CCLM5.0+MOM5) of IOW, GUF-ESM (CCLM5.0+NEMO_MED12+TRIP) of GUF, TSMP1 (CCLM5.0+CLM3.5+ParFlow3.12) and TSMP2 (ICON-CLM+eCLM+ParFlow3.12) of FZJ. The coupled ROAM-NBS model was used to conduct the hindcast simulation for 1979-2021 over the EURO-CORDEX domain with the same ocean coupling domain as GCOAST-AHOIB1-1. An evaluation manuscript has been submitted to GMD this year. The historical and scenarios simulations of ROAM-NBS downscaled CMIP6 MPI-ESM1-2-HR, EC-Earth3-Veg and MIROC6 will be conducted in the next year.

The IOW-ESM was applied to conduct the hindcast simulation (1959-2021) over the EURO-CORDEX domain, but the ocean model covers only the Baltic Sea. This RESM has a similar SST bias in summer and the salinity bias in the Baltic Sea like GCOAST-AHOIB1-1. SWDN bias correction was also applied to CCLM, and the investigation for the salinity is also an on-going work before conducting the production simulations.

The GUF-ESM was used in the hindcast forced by ERA-Interim (1979-2021), historical (1950-2014) and scenario SSP585 (2015-2100) forced by the CMIP6 EC-EARTH-Veg3 over the Mediterranean Sea region.

The TSMP1 of FZJ was applied in the hindcast simulation for 1979-2020, the historical simulation of 1950-2014 and the scenario simulations SSP126 and SSP370 for 2015-2100 while the evaluation simulation of TSMP2 has been conducted for 10 years (2000-2010).

These available RESM simulations have been and will be transferred to the Jülich supercomputing (JSC)

system to join the evaluation of the EURO-CORDEX network. The resource of RESM4CORDEX applied for the next year will be mainly used for the simulations of the RESM GCOAST system for sensitivity tests and the production (hindcast, historical and scenario) simulations. The latter will be cmorised before the transfer to the JSC system. Note that the GCOAST-AHOIB1-1 simulations will be conducted using the computing time of the project CoastalFutures (bg1315) and the raw output should be stored in the /work/bg1315. However, the domain of the GCOAST-AHOIB1-1 simulation is somewhat larger than the EURO-CORDEX domain due to the expansion of the domain to the north. Therefore, the /work/bg1406 of the RESM4CORDEX project will be used to store the cmorised output of the GCOAST-AHOIB1-1 which will be used for the evaluation by Hereon, and to transfer to JSC system for the EURO-CORDEX joint comparison and to other institutions who need the RESM simulations for the impact models.

Beside the GCOAST-AHOIB1-1 and NECOS, in 2026, Hereon plans to apply the GCOAST-AHOI3 which is the ICON-RESM including the ICON-CLM, ICON-O-LAM (i.e. ICON ocean model in the limited area mode) and HD model components to conduct test simulations on the high resolution of about 3 km over the EURO-CORDEX domain for studying extreme event under climate change.