nextGEMS' Twin JUWELS

Nils Wedi, Irina Sandu, ECMWF, Daniel Klocke, Bjorn Stevens, MPI

This PRACE project is advancing the simulation and understanding of the Earth's weather and climate by building two European Storm-Resolving Earth System Models (SR-ESMs), applying them to study the Earth system and answering important open questions about how its climate will change over the next decades. This is the goal of the associated and recently funded H2020 project NextGEMS (01.09.2021- 01.09.2025), which supports ongoing efforts to create digital replicas of the Earth in initiatives like the European Commission's Destination Earth programme.

The global coupled storm-resolving (or km-scale) simulations proposed by NextGEMS are no longer a dream thanks to recent advances in Earth system modelling, supercomputing and the adaptation of weather and climate codes for novel computing architectures. Such simulations explicitly represent essential climate processes, such as deep convection and mesoscale ocean eddies, that today need to be parametrized even at the highest resolution used in global weather and climate information production. These simulations thus offer a window into the future, with a promise to significantly increase the realism of Earth system simulations. Here we describe our efforts to use the JUWELS BOOSTER to perform several NextGEMS simulations (at 2-5 km in the atmosphere and ocean) during the development of the SR-ESMs. In an interactive process with dedicated evaluation Hackathons we demonstrate progress on assessing both their realism and their ability to run efficiently on novel architectures.

The work builds on the international DYAMOND I and II intercomparisons of several storm-resolving models and also builds on previous and existing INCITE projects which used Summit (currently the number two of the world's most powerful supercomputers (Top500, Nov 2021), where for the first time we demonstrated seasonal 3-4 months simulations for both winter and autumn/summer seasons with an average global grid spacing of 1.4km with the state-of-the-art Integrated Forecasting System (IFS) of ECMWF. So far this has only been possible in limited-area or very short time range simulations, thus lacking the feedback of fundamental energy exchanges onto the larger scales at extended time ranges.

Despite the significant compute and data challenges, there is a real prospect to better support global to local climate change mitigation and adaptation efforts, and complement the existing information derived with today's operational simulations in the range of 10-100 km.