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Near-global RCM simulations to establish a baseline for global 1 km GCM simulations: How far still to go?

Oliver Fuhrer (1), Tarun Chadha (2), Torsten Hoefler (3), Grzegorz Kwasniewski (3), Xavier Lapillonnne (1), David Leutwyler (4), Daniel Luethi (4), Carlos Osuna (1), Christoph Schaer (4), Thomas Schulthess (5,6), Hannes Vogt (6,1)

(1) Federal Institute of Meteorology and Climatology MeteoSwiss, Numerical Prediction, Zurich, Switzerland (oliver.fuhrer@meteoswiss.ch), (2) ITS Research Informatics, ETH Zurich, (3) Scalable Parallel Computing Lab, ETH Zurich, (4) Institute for Atmospheric and Climate Science, ETH Zurich, (5) Institute for Theoretical Physics, ETH Zurich, (6) Swiss National Supercomputing Centre, CSCS

Reducing the horizontal resolution of global weather and climate models to the kilometer-scale holds the promise of reducing some of the long-standing biases and uncertainties. At these resolutions, some of the key processes such as deep convection, gravity wave drag and ocean eddies can be resolved explicitly on the model grid and thus much closer to first principles. But how far are we from achieving this goal?

The presentation will show results from scaling a regional climate model (COSMO) to cover almost the entire Earth at increasing resolutions of up to 1 km. COSMO has been systematically adapted to make use of hybrid compute node designs with accelerators such as graphics processing units (GPUs) and thus can make efficient use of all of Europe's currently largest supercomputer, Piz Daint. To our knowledge this represents the first complete atmospheric model being run entirely on accelerators at this scale. At a grid spacing of 930 m (1.9 km), we achieve a simulation throughput of 0.043 (0.23) simulated years per day and an energy consumption of 596 MWh per simulated year.

We discuss the implications of these simulations as a baseline for what is achievable when systematically adapting our codes to make use of emerging computer architectures. Already today, modern supercomputers such as Piz Daint would in principle enable global atmospheric convection-resolving climate simulations, provided appropriately refactored global climate models (GCMs) were available, and provided solutions were found to cope with the rapidly growing output volume. Some of the key challenges to achieve this will be discussed.