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The coupled Earth-System Model ICON-ESM: developments for physical and technical coupling on unstructured grids

Stephan J. Lorenz (1), Monika Esch (1), Helmuth Haak (1), Moritz Hanke (2), Rene Redler (1), and Reiner Schnur (1)

(1) Max-Planck-Institut for Meteorology, Hamburg, Germany (stephan.lorenz@mpimet.mpg.de), (2) German Climate Computing Centre, Hamburg, Germany

The Max Planck Institute Earth System Model (ICON-ESM) consists of the newly developed generation of component models of the atmosphere, land surface, and ocean including biogeochemical tracers. These sub-models are currently still under development. They share the same icosahedral grid type and technical infrastructure.

Coupling atmosphere and ocean models on grids with different resolution results in diverse representation of coastlines or sea ice edges. Therefore the coupling fluxes of energy, water, and momentum calculated by the sub-models can strongly deviate within one grid-point. These fluxes need specific consideration in order to connect the corresponding sub-models with respect to the physical properties. Here, we present a physical and technical solution within ICON-ESM. It was implemented by (1) using a partial land-sea-mask on the coarser (atmosphere) grid, by (2) aggregating the coupling fluxes on three parts (land, sea ice, open ocean) of each grid-point, and (3) by property-dependent selection of interpolation methods provided by the YAC-coupler.

Multi-century integrations under pre-industrial conditions have been performed with an atmospheric resolution of 160 km and a 40 km resolution in the ocean. Here, we show first results from this early stage of model tuning. These results reproduce main features of the climate system and have biases of similar magnitude as its well-known predecessor MPI-ESM.