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Adaptive Grids for Future Weather Prediction Models

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Adaptive Mesh Refinement (AMR) provides an attractive framework for atmospheric flows since it allows improved horizontal resolution in a limited region without requiring a fine grid resolution throughout the entire model domain.AMR techniques have recently been applied to a revised version of NCAR/NASA's finite volume dynamical core for climate and weather research. The adaptive model design utilizes a spherical adaptive-grid library which is based on a block-structured data layout.

The paper introduces the underlying software engineering concepts of the AMR approach and discusses the results of idealized model simulations. In particular, statically and dynamically adaptive simulations of the full 3D hydrostatic dynamical core on the sphere and the corresponding 2D shallow water model are shown. Static adaptations are used to vary the resolution in pre-defined regions of interest. This includes static refinements near mountain ranges or static coarsenings in the longitudinal direction for the implementation of a so-called reduced grid in polar regions. Dynamic adaptations are based on flow characteristics and guided by refinement criteria that detect user-defined features of interest during a simulation. In particular, flow-based refinement criteria, such as vorticity or gradient indicators, are assessed that are able to track low pressure systems.