The ICON dynamical core project: modelling strategies and preliminary results

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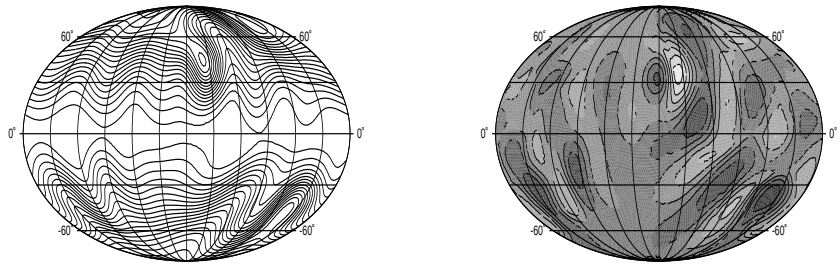
The ICON project is a joint development effort of MPIfM and DWD to achieve a unified climate and NWP model using geodesic grids. The model under development in the ICON project will use the fully elastic, nonhydrostatic Navier-Stokes equations, which provide a framework that is sufficiently general for meteorological applications on most scales relevant to numerical weather prediction and climate simulation.

As an intermediate step, a semi-implicit discretization for the hydrostatic primitive equations is being developed. The proposed horizontal discretization uses the triangular Delaunay cells of the icosahedral grid as control volumes. It achieves mass and potential enstrophy conservation, thus replicating the results of [2] for standard rectangular C grids. Vector radial basis function interpolation is used to reconstruct a uniquely defined velocity field from the velocity components normal to the cell sides, which are the discrete model variables along with the cell averaged value of the geopotential height. A full description of the horizontal discretization can be found in [1]. The results obtained with a preliminary shallow water implementation on an idealized test case (see e.g. [3]) are shown in figure 1, while the results of a convergence test are shown in figure 2. For this test, a spectral transform model developed at NCAR was used to produce a reference solution. An application of the same technique to an hydrostatic model with local grid refinement option equations for global nonhydrostatic modelling are currently being investigated.



(a) (b)

Figure 1: Height field (a) and relative vorticity field at day 15 for test case 5 of [3], computed by the mass conservative shallow water model on the triangular icosahedral grid with 81920 triangles. Contours spacing is 50 m and 10^{-5} s^{-1}, respectively.

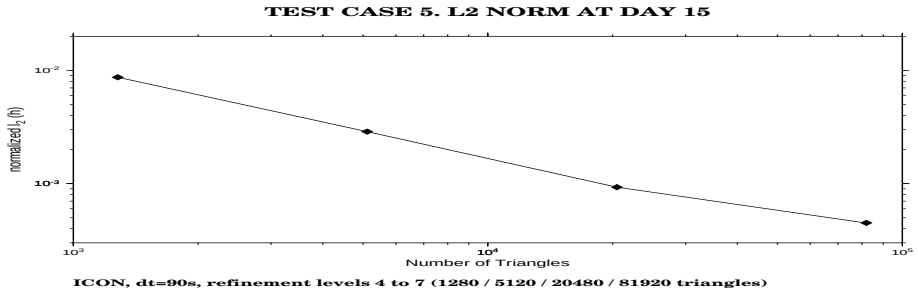


Figure 2: Error on the height field at various spatial resolutions at day 15 for test case 5 of [3].

References

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[3] David L. Williamson, John B. Drake, James J. Hack, Rüdiger Jakob, and Raul N. Swarztrauber. A standard test set for numerical approximations to the shallow water equations in spherical geometry. *Journal of Computational Physics*, 102:221–224, 1992.