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Atmosphere & ocean modeling on grids of variable resolution

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Grids of variable resolution are of great interest in Atmosphere and Ocean Modeling as they offer a route to higher local resolution and improved solutions. On the other hand there are changes in grid resolution considered to be problematic because of the errors they create between coarse and fine parts of a grid due to reflection and scattering of waves. On complex multidimensional domains these errors resist theoretical investigation and demand numerical experiments. With a low-order hybrid continuous/discontinuous finite element model of the inviscid and viscous shallow-water equations a numerical study is carried out that investigates the influence of grid refinement on critical features such as wave propagation, turbulent cascades and the representation of geostrophic balance. The refinement technique we use is static h-refinement, where additional grid cells are inserted in regions of interest known a priori.

For the specific finite element model under investigation, the simulations suggest that grid refinement does not deteriorate geostrophic balance and turbulent cascades and the shape of mesh transition zones appears to be less important than expected. However, our results show that the static local refinement is able to reduce the local error, but not necessarily the global error and convergence properties with resolution are changed. Our relatively simple tests already illustrate that grid refinement has to go along with a simultaneous change of the parametrization schemes.