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Convergence properties of the spatial schemes in the COSMO model and requirements on higher order spatial convergence

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Wicker and Skamarock (2002) suggested higher order spatial schemes for the advection term of the WRF model. The convergence properties have been demonstrated by a one-dimensional advection test. These schemes (2nd, 4th and 6h central differences and 3rd and 5th upwind) have been also implemented in the non-hydrostatic COSMO model.

We analysed the convergence properties of the schemes in the COSMO model investigating the 2D stationary mountain flow idealized test case. The main assumptions of this test case are stationarity and a z-dependent basic flow with a zero vertical velocity (i.e. w0 = 0).

A systematic series of simulations was conducted for the RK dynamical core. The configuration was chosen in such a way, that other error sources like test assumptions, discretisation in time and vertical discretisation were sufficiently small. The domain size of the idealized test case was 500x30(20) km2. The classical error norms have been calculated and the characteristics of the convergence have been investigated (amplitude and phase error, order of accuracy).

The results exhibit an order of convergence much smaller than the theoretical values for all horizontal schemes available. This exhibits the need for adequate testing of the numerical properties of the models.

The series of simulations has been repeated for an improved discretisation of the advection operator where the interpolation and the discretisation truncation error were chosen the same. The results will be discussed.