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The soundproof dynamical core for COSMO model: representation of convective flows.

Damian Wójcik, Zbigniew Piotrowski, Bogdan Rosa, and Michał Ziemiański
IMGW-PIB, Poland (damian.wojcik@imgw.pl)

Research conducted at Polish Institute of Meteorology and Water Management, National Research Institute, in collaboration with Consortium for Small Scale Modeling (COSMO) are aimed at developing new conservative dynamical core for next generation operational weather prediction model. As the result, a new prototype model was developed with dynamical core based on anelastic set of equation and numerics adopted from the EULAG model. An employment of EULAG allowed to profit from its desirable conservative properties and numerical robustness confirmed in number of benchmark tests and widely documented in scientific literature. The hybrid model consists of EULAG dynamical core implemented into the software environment of the operational COSMO model and basic COSMO physical parameterizations involving turbulence, friction, radiation, moist processes and surface fluxes (COSMO-EULAG). The tool is capable to compute weather forecast in mountainous area for the horizontal resolution of 0.28 km and with slopes reaching 60 degrees of inclination.

The presentation is focused on two current research topics. First, the model and especially its dynamics-physics coupling is examined within idealized framework for representation of convective flows. The study is based on two complementary convection benchmarks of Weisman and Klemp (Mon. Wea. Rev. 110:504, 1982) and Grabowski et al. (Q. J. R. Meteorol. Soc. 132:317, 2006). While the first experiment can be used to examine a life cycle of a single convective storm structure in COSMO-EULAG model, the second experiment allows to evaluate the model representation of statistical properties of daytime convective development over land, involving convection initiation as well as is transition into a deep phase. The study involves also the comparison of COSMO-EULAG results with results of standard compressible COSMO-Runge-Kutta model to test the suitability of the anelastic dynamical core for operational mesoscale high-resolution NWP.

Next, the results of a realistic case study of Alpine summer convection simulated by COSMO-EULAG with very high horizontal resolutions ranging from 2.2 to 0.28km are presented. While the simulations, even with highest resolution, do not require any artificial orography smoothing, the influence of such smoothing on simulation results is investigated. The study shows e.g. a comparison of flow, cloud and precipitation structure, and spectral analyses of horizontal wind fields. The Cosmo-Eulag forecast is also compared with available meteorological information.