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Investigating the relation of thermodynamic processes to local budgets Investigating the relation of thermodynamic processes to local budgets in a mesoscale weather prediction model

R. Petrik (1), A. Gassmann (2), and H. Schlünzen (3)

(1) Max-Planck Institute, Meteorology, Hamburg, Germany (ronny.petrik@zmaw.de), (2) Max-Planck Institute, Meteorology, Hamburg, Germany (almut.gassmann@zmaw.de), (3) Meteorological Institute, Hamburg, Germany (heinke.schluenzen@zmaw.de)

Recent models apply the non-hydrostatic compressible equations and include various physical parameterizations. On the one hand, such models are able to resolve flow structures on a very wide range of spatial and temporal scales. On the other hand, their complexity makes it difficult to evaluate and later on to improve the model. One usually verifies the model with meteorological data coming from remote sensing systems or in-situ measurements. Besides the evaluation of the model results, it is essential to evaluate the physical adequacy of the model itself.
In this context, a finite volume diagnostic approach, that diagnoses the local budget of various quantities like energy, water mass and total mass in a predefined control volume, is applied for evaluating the physical quality of the mesoscale model COSMO [1]. The monitoring of the conservation properties is essential for model development and for the investigation of the hydrological cycle, as well. E. g., the application of different discretization schemes, a variety of physical parameterizations and even non-physical artificial damping mechanisms, added explicitly and implicitly, can detrimentally influence the desired conservation properties.
In that talk, it is presented how the introduced diagnostic approach should be applied in order to minimize errors originating from discrete grids and flux reconstructions using an idealized test bed. Starting with a first dry convection test case, the application of our tool to the COSMO model shows good conservation properties far away from the lateral and upper relaxation boundaries. If cloud or rain processes are involved in the simulations, large errors in energy and total mass conservation will reveal. Interestingly, the water mass is not contaminated. It is shown, how physical processes and numerical schemes contaminate the local budgets. Regarding this fact, it is demonstrated how to construct a saturation adjustment technique (SAT) for COSMO to reduce these errors.
The advantage of the diagnostic tool is that any weather or climate model can be evaluated, including the limited area models. It is discussed with a realistic test case, which dimension the conservation errors can reach within a operational forecast. Using various radio sounding data we want to address the physical relevance and model performance of the new and old SAT-scheme.

[1] Doms, G. and Schäettler, U. 2002, A Description of the Non-hydrostatic Regional Model LM - Part I: Dynamics and Numerics, DWD Documentation, 140 p., available on www.cosmo-model.org/content/model/documentation/core/cosmoDyncsNumcs.pdf