The development of anelastic dynamical core for the future NWP model

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ABSTRACT

Institute of Meteorology and Water Management – National Research Institute in collaboration with the COSMO Consortium [1] is carrying out research and development activities on the next-generation dynamical core for the future numerical weather prediction (NWP) model. The framework of the new dynamical core is based on nonhydrostatic, anelastic equations adopted from a well-established parallel research fluid solver EULAG [2]. It is expected that with the new core the COSMO model will provide robust and highly accurate weather forecast simulations including severe weather events triggered by deep moist convection, such as supercell thunderstorms or heavy snowfall from wintertime mesocyclones.

The first step of the project was to perform a set of benchmark tests in order to confirm a feasibility of anelastic approach for a very high-resolution (kilometer and sub-kilometer) atmospheric modeling. Results obtained from a number of experiments [3] demonstrated high accuracy and numerical stability of the EULAG model. In subsequent step our efforts are directed towards setting up the COSMO-EULAG prototype model. The development of the new hybrid implementation started from translating the original EULAG code from FORTRAN 77 into Fortran 90. Currently we are focused on incorporating the new dynamical core into the COSMO framework.

In this presentation, the key technical issues related to the project are reported. The new Fortran 90 code employs modern language syntax, dynamic memory allocation, basic modularization and controlled variable definition. The code translation was based on the “COSMO Standards for Source Code Development” [4]. Strategy for parallelization of the hybrid model is based on the MPI library and follows the original COSMO model. Organization of time stepping is arranged as follows. Dynamical core integrates equations of motion providing the prognostic variables (velocity, temperature). Forcing terms resulting form physical parameterizations are computed by the COSMO model and transferred as physical tendencies to the EULAG dynamical core.

Procedure of implementation of the new core was divided into several tasks. At every stage the code was carefully tested. According to the results, we conclude that the developed prototype is capable to accurately reproduce idealized dry test cases. The current development is targeting to moist simulations and semi-realistic NWP.

References

[1] www.cosmo-model.org
[2] Prusa J. M., Smolarkiewicz P .K., Wyszogrodzki A.A., 2008: EULAG, a computational model for multiscale flows. Computers and Fluids, 2009, Vol. 37, pp. 1193-1207.
[3] Rosa B., Kurowski M., Ziemianski M., 2011: Testing the Anelastic Nonhydrostatic Model EULAG as a Prospective Dynamical Core of a NWP Model Part I: Dry Benchmarks. Acta Geophysica, 2011, Vol. 59, pp. 1236-1266.
[4] COSMO Standards for Source Code Development, 2011.