Towards petascale simulation of atmospheric circulations with soundproof Equations

Zbigniew P. Piotrowski, A.A. Wyszogrodzki, P.K. Smolarkiewicz

We highlight progress with the development of a petascale implementation of EULAG, recently discussed in [Piotrowski et al 2011, Acta Geophys. 59, 1294-1311]. The applications addressed are anelastic atmospheric flows in the range of scales from micro to regional weather prediction to planetary. The new model- domain decomposition into a three dimensional MPI process grid has been implemented to increase model performance and scalability. Scalability of key components of the model, including fully three-dimensional NFT advection scheme MPDATA, preconditioned Krylov-subspace elliptic solver, diffusion operator for generalized time-dependent coordinates and bulk and bin microphysics is disscussed. The performance of the new code is demonstrated on the IBM BlueGene/L and Cray XT4/XT5 supercomputers, up to O(10^5) cores. The results show significant improvement of the model efficacy, as compared to the original decomposition into a two-dimensional process grid in the horizontal - a standard in meteorological models. In particular, for isotropic problems we observe significant decrease of the computation time; for strongly anisotropic problems we are able to significantly decrease time-to-solution when additionally using the domain decomposition in the vertical. We provide an overview of important changes to the Eulag code resulting from the new decomposition (e.g. rewritten preconditioner), as well as briefly discuss a set of general improvements and optimizations.