Development of the Mass-Conservative Massively-Parallel Semi-Lagrangian Global Atmospheric Model

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SL-AV global model is used operationally in Russian Hydrometcentre for medium-range and seasonal numerical weather prediction. The core of SL-AV (semi-Lagrangian, based on absolute vorticity equation) model that solves atmospheric dynamics equations was developed by the first author at the Institute of Numerical Mathematics. The distinct feature of the SL-AV atmospheric model is the use of vorticity-divergence formulation on the unstaggered grid.

Some recent developments inside the model dynamical core are described including the new solver for reconstruction of horizontal velocity field from vorticity and divergence. This solver is simpler and enables greater parallel efficiency of the code with respect to the one described in [1].

The mass conservation is essential for potential application of this model for climate modeling. We present a mass-conserving semi-Lagrangian shallow water model prototype of SL-AV model implemented on the reduced latitude-longitude grid. We use the global conservative cascade scheme [2] for advection on the reduced grid [3] and a new conservative Helmholtz problem solver. Cell-averaged Laplacian and divergence operators (which are treated as integrals over the cell contour) are introduced. The second-order and fourth-order solvers for Helmholtz problem in spherical geometry are developed. Standard tests for shallow- water models on the sphere are carried out. The results demonstrate that both mass conserving and standard versions of shallow water model have similar errors. The introduction of the reduced grid causes the acceptable error growth.

References

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