Geophysical Research Abstracts
Vol. 13, EGU2011-7785, 2011
EGU General Assembly 2011

Test of Semi-Lagrangian Methods for Advection in the Danish Eulerian Hemispheric Model.

Ayoe Buus Hansen (1,2), Eigil Kaas (2), Jesper H Christensen (1), and Jørgen Brandt (1)
(1) National Environmental Research Institute, Aarhus University, (2) The Niels Bohr Institute, University of Copenhagen

For air pollution modeling with high resolution, advection schemes of high accuracy and efficiency are essential. In general the advantages of replacing a traditional Eulerian advection scheme with a semi-Lagrangian method can be numerous. The purpose of the present study is to develop a model covering a limited area, specifically Denmark, with very high resolution, in this case 1 km by 1 km. The increase in spatial and there by temporal resolution must in part be compensated by a more efficient method in order for the model to be applicable to forecasting and the like.

In Hansen et al. (2010) several semi-Lagrangian methods were developed and tested on idealized two dimensional tests cases, the traditional slotted cylinder, see e.g. Zerroukat et al. (2002), or the rotating cone, see e.g. Molenkamp (1968) and Crowley (1968), with chemistry. The best performing of the schemes, Locally Mass Conserving (Kaas (2008)) Cascade (Nair et al. (2002)) interpolation with the locally mass conserving monotonic filter (Kaas and Nielsen (2009)) have been implemented and tested in the Danish Eulerian Hemispheric Model. As for the idealized test cases, the focus is accuracy, local mass conservation, and computational efficiency, in respect to high resolution air pollution modeling over a limited domain.

The advantage of semi-Lagrangian methods over strictly Eulerian methods, i.e. the possiblity of long timestepping without development of instability versus the ability of the advection scheme used in DEHM, the Accurate Space Derivatives, to model peak concentrations in the idealized test cases are investigated in order to find the most accurate and efficient scheme for very high resolution over a limited area.

The present study is a part of the research of the Center for Energy, Environment and Health, financed by The Danish Strategic Research Program on Sustainable Energy.

References

Crowley, W. P., January 1968. Numerical Advection Experiments. Monthly Weather Review 96 (1), 1–11.

Hansen, A. B., Brandt, J., Christensen, J. H., Kaas, E., 2010. Semi-Lagrangian methods in air pollution models. Geoscientific Model Development Discussions 3 (4), 2361–2438. URL http://www.geosci-model-dev-discuss.net/3/2361/2010/

Kaas, E., 2008. A simple and efficient locally mass conserving semi-Lagrangian transport scheme. Tellus 60 (2), 305–320.

Kaas, E., Nielsen, J., December 2009. A Mass Conserving Quasi-Monotonic Filter for Use in Semi-Lagrangian Models. Monthly Weather Review 138 (5), 1858 – 1876.

Molenkamp, C. R., April 1968. Accuracy of Finite-Difference Methods Applied to the Advection Equation. Journal of Applied Meteorology 7, 160– 167.

Nair, R. D., Scroggs, J. S., Semazzi, F. H. M., August 2002. Efficient Conservative Global Transport Schemes for Climate and Atmospheric Chemistry Models. Monthly Weather Review 130, 2059–2073.

Zerroukat, M., Wood, N., Staniforth, A., 2002. SLICE: A Semi-Lagrangian Inherently Conserving and Efficient scheme for transport problems. Q. J. R. Meteorol. Soc. 128, 2801–2820.