Meeting 30th October 2003 10am-4:30pm , held at ARPA, Servizio Meteorologico, Bologna

Present:
Stephano Tibaldi and Davide Cesari, ARPA, Servizio Meteorologico, Bologna
Luca Boneventura Max Planck / University di Trento
Stephen Mobbs and Alan Gadian, Leeds' University.

Purpose:
To discuss new developments in the use of different grid structures for numeric atmospheric models, with particular reference to the UK microscale modelling project.

Discussion:
The discussion focused on both general / philosophical issues as well as specific computational aspects of the "new" approach of terrain intersecting co-ordinates. Presentations were made by both groups. Towards the end of the discussion, decisions were made on how to go forwards.

Microscale model (Leeds):
Stephen / Alan. During the morning the microscale model development was discussed, details from the microscale web page were presented.

Terrain intersecting model approach (Italy):
Luca and Davide provided a background to the approach, and then detailed good points and major issues.

References:
"Semi-Lagrangian advection on staggered cartesian grids with cut cells" . In preparation
L. Boneventura, 2000, J.C.R. 158, 186-213. "A semi-implicit semi-lagrangian scheme using the height co-ordinate for a non-hydrostatic and fully elastic model of atmospheric flows"
L. Boneventura et al., 2002, Int.Jou.Num.Meth.Fluids, 40, 217-230. "A cascadic conjugate algorithm for mass conservative semi-inplicit discretization of the shallow water equations"
J. Steppeler et al, 2002, MWR. 2143-2149. "Non-hydrostatic atmospheric modelling using a z-co-ordinate representation"
Web documents from the ICON project and COSMO development

There are a series of advantages in this approach were described and where it has been productive:-

- Use in water / tidal / sea numerical models, where large topographical slopes / shelves are apparent
- Ability to produce a system which does not significant issues with solving the Helmholtz equation. Good results with pressure solver at the boundaries. (see steppler However, Figure 9+ are in error)
- Avoids the issues of terrain following co-ordinates where large errors are produced with the interpolation in the lower layers, where the co-ordinate system is most deformed. E.g. issues of jets produced when isolated mountains are inserted into a stationary atmosphere and unrealistic vertical velocities.
- Hence ill conditioning problems are not present as in terrain following systems.
- Good use of semi-lagrangian schemes.

- Essentially a cubic interpolant inside the fluid, with a linear representation near the boundaries
- Use of regular spaced grids has advantage for errors in numerical solvers. (diagonalisation advantage)

Major issues:-

- Problem with representation at the lower boundary where cut cells intersect the lower boundary.
- 2-d approach, to use zero vorticity in lowest elements, zero vertical velocity and tangential velocity representation
- In the 2-d case there are 3 types of cells. Extending to 3-d not yet completed, but there is still a desire to use the zero vorticity constraint.
- Suggested use of radial basis functions in the boundary strip. See reference of Behrens
- Interpolation accuracy important; linear is del^2, cubic is del^4
- Surface energy fluxes need investigating, and radiation model.
- What order of interpolation needed. (Mac-Alpine, MWR, 1989 .. .reference??)

Other points:

- Turbulence closure, 1st order, not of major concern (at present)
- LES compatability?
- Maybe collaboration on microphysics / energy fluxes/ radiation models?

Future planned development, on time scales of ~ 5years, with significant effort. Meeting mid-November to confirm the approach.

- ICON project. There is an imminent decision on whether to use this approach for the next generation of NWP models (DWD, Max Planck, Poland, + others). This is based on the LOCALE frame work. This is a global non-hydrostic project with geodesic grids.
- The project is part of the COSMO development, which is in parallel to the ICON project and is also a major project.
- The development is aimed at a LAM semi-implicit / semi lagrangian using ECMWF assimilations

Conclusions.

- Invitation to 16th December workshop
- Need to confirm the results of ICON Hamburg meeting (16/11/03). What grid system and equation set to be adopted (looks like C grid to continue)
- Do we want to be involved in the LOCALE model? (???). A series of workshops are available, but may be UK issues with our connection with the UK Met Office, and DWD development. However, perhaps no exchange of code may help.
- Suggest future visit to Hamburg, to give seminar, develop collaboration with DWD etc?.
- Visitors programme to be investigated for UWERN, may-be in context of visit of Luca to ECMWF in March. (also ICFP conference at Oxford)
- Ascertain nature of terrain following inadequacies.