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Geoscientific Model Development Discussions

Interactive comment on "ASAM v2.7: a compressible atmospheric model with a Cartesian cut cell approach" *by* M. Jähn et al.

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The author was asking off line about calculating error measures for atmospheric test examples with orography. Many thanks for this request. I have put some more effort into thinking about how you can demonstrate the ACCURACY of your model.

It appears that some papers about cut cells have an easier time demonstrating accuracy than you because they are comparing with a terrain following model. I have been looking at how some others demonstrate accuracy of non-hydrostatic models:

Giraldo et al, SIAM J. Sci Comput. 2010 show: * RMS errors for flow over a mountain using an analytic (linear) solution. But the mountain is small enough to make the linear approximation

Error measures are often reported for tracer advection over orography. (eg Schar et al, MWR 2002). However this type of flow is usually considered too easy for cut cells.

Norman, Nair and Semazzi, JCP, 2011 show: * changes with resolution of max theta for a rising bubble * Error norms as a function of resolution for internal gravity waves (no orography)

Durran and Klemp, MWR 1983 show: * Long's solution for flow over orography * Vertical flux of horizontal momentum, as was requested by one of the reviewers.

Can you reproduce the flow regimes of Miglietta and Buzzi for the same or coarser resolution?

Apologies for citing my own paper in this but: http://journals.ametsoc.org/doi/abs/10.1175/MWR-D-14-00054.1 Show convergence of error metrics for a rising bubble in comparison to a numerical reference solution (no orography)

I really shouldn't be too prescriptive about HOW you demonstrate accuracy since this is your paper. So these are suggestions. But it is important that you demonstrate accuracy rather than just conservation of energy. So I have some more suggestions of how you might demonstrate accuracy for your model:

1. You could do the cold bubble interacting with orography but make sure you compare your results with an independent, higher resolution model (calculate error metrics and differences w.r.t. another model rather than just plots).

2. Calculate an analytic solution for linearised flow over high, steep orography using a superposition of solutions over infinite series of ridges to create a solution for flow over an isolated ridge or a Schar type series of ridges. Then in order to compare quantitatively with your model, you will need to create a linearised version of your model. However this will test a large proportion of the terms discretised. Since you are using Lorenz vertical staggering, it is important that you compare temperature as well

as vertical velocity.

3. To get over the problem that most test cases with analytic solutions do not have orography, you could put some cut cells into a rectangular domain by, say, combining two meshes, one of the domain with the mid-air zeppelin and the other a mesh of the mid-air zeppelin. So you have a mesh of a rectangular domain but with some cut cells in the middle. You could then do a simple linear advection test case which has an analytic solution and look at convergence with resolution.

Having read your paper again, I have some more comments in addition to the reviewers' comments:

1. You call this an "All Scale Atmospheric Model". The model uses a logically rectangular grid, so how are you planning to cope with the pole problem? Lat-lon grid? In order to call the model all scale, you should address this point.

2. I wouldn't call the metric terms associated with terrain following coordinates "artificial forces".

3. What is a "logically orthogonal rectangular grid"?

4. The treatment of the non-linear advection term is not clear (page 4470)

Interactive comment on Geosci. Model Dev. Discuss., 7, 4463, 2014.