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Geoscientific Model Development Discussions

Interactive comment on "Downscale cascades in tracer transport test cases: an intercomparison of the dynamical cores in the Community Atmosphere Model CAM5" *by* J. Kent et al.

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General comments

The paper tackles two different issues: (i) it presents test cases for tracer advection that 'strech the tracer below the scale of coarse resolution', and (ii) it suggests to diagnose the tracer variance as a measure of the quality of an advection scheme (besides others as the well known l2-norm).

The test cases (point (i)) are well chosen.

The investigation of the tracer variance (point (ii)) seems to me new interesting diagnostics. The paper observes the behaviour of some schemes with respect to the l2-norm and the tracer variance but does not try to focus on the reasons for this behaviour. Only the knowledge why we observe these differences brings further insight into numerics and more hints which would be a 'good' scheme.

Specific comments

1) Avoid using the denomination 'dynamical core' because the tracer advection is independent of the dynamics of the model. Here the the velocity is not predicted, thus the flow is not 'dynamic' but prescribed.

2) Please explain more clearly what you think is a physical mechanism for tracer diffusion? Or: What is the physical motivation for diffusion?

3) Distinguish the phrasings 'diffusive' and 'dissipative'. Dissipative means that entropy is produced, see Lauritzen & Thuburn 2011, QJRMS (http://onlinelibrary.wiley.com/doi/10.1002/qj.986/full). It would also be instructive if the entropy is taken as a measure of mixing. One advantage (which is shared with the tracer variance) is that entropy diagnostics does not need the 'true' solution (see the mentioned paper).

4) I doubt that tracer variance is conserved in the strict sense if molecular diffusion would be included. Connected to that is the question: What means 'all the scales' (page 1789)? Stricly speaking 'all the scales' would mean that you compute a DNS where even the molecular diffusion is a resolved process. This is impossible for a global model.

5) Why do you need a filling algorithm for the first order upwind scheme and the van Leer MC scheme? They should not generate negative values at all by definition (besides machine truncation errors).

6) (most interesting) Why do you think that the LW-scheme is non-dissipative? How can you prove this? The LW-scheme possesses diffusive and dispersive terms. Can you explain more why the LW-scheme seems not to dissipate tracer variance? Are there perhaps compensating effects of dispersion and diffusion?

7) Tracer variance must be dissipated to avoid the accumulation of tracer variance at the grid scale: Fig 4 shows increasing tracer variance at some places, especially for coarse resolutions: Why? Is it because of the aggregation of the reference solution to the coarse grid?

8) What means 'whether a numerical scheme has accurately modelled the subgrid term' ? One can measure 'how' accurate, but 'whether..' seems undefined.

Interactive comment on Geosci. Model Dev. Discuss., 5, 1781, 2012.