Geoscientific
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Interactive comment on "Inherently mass-conservative version of the semi-Lagrangian Absolute Vorticity (SL-AV) atmospheric model dynamical core" *by* V. V. Shashkin and M. A. Tolstykh

V. V. Shashkin and M. A. Tolstykh

vvshashkin@gmail.com

Received and published: 11 December 2013

Dear Prof. Heikes,

Thank you for throughout review of our manuscript. Below is point by point response to your comments.

Reviewer: Page 4810, line 9. I'm never really sure, but I think it should be "a posteriori" (with a space).

Reply: "a posteriori" is correct, thank you.

Reviewer: Page 4810, line 21. The "1 Introduction" section is blank.
Reply: It is a section numbering issue (should be "1.1 Motivation for the research"). We will correct it in the revised manuscript.

Reviewer: Page 4811, line 2. Maybe delete "The" so that it reads "Both conservation properties..." where "both" refers to "local" and "global" conservation.
Reply: The sentence will be improved.

Reviewer: Page 4811, line 14. Space in "abovementioned"
Reply: corrected.

Reviewer: Page 4811, line 15. Maybe "... is very suitable for use in general circulation models because .."
Reply: corrected.

Reviewer: Page 4811, line 17. Maybe "Attempts were made...."
Reply: corrected.

Reviewer: Page 4812, line 5. Maybe "The SL-AV (semi-Lagrangian absolute vorticity) is a global semi-Lagrangian ..."
Reply: corrected.

Reviewer: Page 4812, line 14. Maybe "... coordinates are used."
Reply: corrected.

Reviewer: Page 4812, line 18. Maybe "In particular, there is the non-hydrostatic ..."
Reply: corrected.

Reviewer: Page 4813, line 2. Maybe "reviewed" instead of "overviewed".
Reply: corrected.

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Reviewer: Page 4814, line 18. "Sect 3.2"
Reply: it is the section numbering issue again. We will correct it.

Reviewer: Page 4816, line 11. Maybe "It can be excluded from (10) by integrating ..."
Reply: corrected.

Reviewer: Page 4817, line 1. Maybe "A similar technique ..."
Reply: corrected.

Reviewer: Page 4818, line 8. Maybe "... midpoint and trapezoidal rules ..."
Reply: corrected.

Reviewer: Page 4822, equation 20. missing dot on sigma dot.
Reply: corrected.

Reviewer: Page 4822, line 6. Maybe "as follows:"
Reply: corrected.

Reviewer: Page 4822, line 15. I would like to know a little bit about the elliptic solver used here.
Reply: The elliptic solver used here is the same as in the non-conservative version of the model (Tolstykh and Shashkin, 2012). Some details about the solver will be given in the text in Sect. 3.2.

Reviewer: Page 4823, line 11. It seems a bit strange to me that same diffusion coefficient is used for all resolutions. Wouldn't that make the higher resolutions unnecessarily diffusive? Have you run with a smaller diffusion? You conclude that the model has converged as you increase resolution from 400x250 grid to 1200x750 grid since the results are very similar. However, it might be the case that the diffusion is killing the development of any new details or sharper gradients.

Reply: The revised manuscript will present the results with lower diffusion coefficients for finer grids. Lower diffusion in high resolution grid runs resulted in small scale features being better resolved (especially in the relative vorticity field). In the baroclinic instability test, the amplitude of the relative vorticity field in low diffusion high-resolution runs significantly increased as compared to the 400x250 grid run.

Reviewer: Page 4824, line 2. Shouldn't the SL method allow for a much larger CFL than 0.72?

Reply: The presented relatively small Courant numbers of 0.72 (in the mountain induced Rossby wave test) and 1.3 (in the baroclinic instability test) are the initial Courant numbers. The maximum developed circulation Courant numbers observed with the chosen time steps are $C_\lambda \approx 3.0$, $C_\varphi \approx 1.8$ in the mountain induced Rossby wave test case and $C_\lambda \approx 3.5$, $C_\varphi \approx 1.3$ in the baroclinic instability test case. This will be clearly stated out in the revised version of the manuscript.

Reviewer: Page 4824, line 4. I'm a little surprised the results for 400X250 and 1200X750 are so similar. Have you looked at plots of the vorticity? Typically relative vorticity shows enhanced details as resolution increases from 1° degree to 0.3° degree.

Reply: The resolution independent diffusion was the reason for the similar results of the 400X250 and 1200X750 runs. The impact of the lower diffusion in high resolution grid runs is indeed most significant in the relative vorticity field.

Reviewer: Page 4828, line 7. Bates et al. reference. "... a vector semi-Lagrangian finite-difference scheme ..."
Reply: corrected.

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Interactive comment on Geosci. Model Dev. Discuss., 6, 4809, 2013.