

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

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Review of “Inherently mass-conservative version of the semi-Lagrangian Absolute Vorticity (SL-AV) atmospheric model dynamical core”

by

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Reviewer: Eigil Kaas, Niels Bohr Institute, University of Copenhagen

Conclusion

This manuscript can be accepted for publication in GMD after minor revisions addressing the issues listed below.

Concerning principal evaluation criteria:

- **Scientific Significance:** Excellent
- **Scientific Quality:** Excellent

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- **Scientific Reproducibility:** Good
- **Presentation Quality:** Good

Summary and general comments

This manuscript presents a simple way to achieve inherent local mass conservation in a hydrostatic semi-implicit, semi-Lagrangian baroclinic model based on vertical sigma-coordinates. Although many modelling centers are changing to non-hydrostatic models hydrostatic models are still usable for low to moderate resolution simulations, e.g., as used in climate models. So, the results presented are highly relevant, particularly if the methodology is also applied to water constituents and various chemical tracers in a mass-wind consistent manner.

The paper is generally well written, however, there are some missing “the”s, etc., and a few misprints in equations. I have listed some of these below together with a few other questions and comments. Note: I have not performed a proof reading, so, language and grammar need a final check.

Specific comments

- **Page 4810, line 6.** Insert “A” before “Semi-implicit”.
- **Page 4810, line 7.** I suggest to change “while” to “but”.
- **Page 4810, line 11-12.** I suggest to modify the sentence “The inherently ... article ensures ...” to “The new inherently mass-conservative version of the SL-AV model dynamical core presented here ensures ...”.

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- **Page 4810, line 25 - page 4811, line 1.** I suggest to modify the sentence “The constituents ...” to the following: “In the absence of sources and sinks and chemical transformations the mass field of such constituents is characterized by local and global mass conservation.”.
- **Page 4811, line 2.** Delete “both”
- **Page 4812, line 6.** You have described some aspects of the SL-AV model in this article, but I think you should provide a reference to a documentation manual if it exists (although it might be in Russian).
- **Page 4812, line 25.** In the list of equations the continuity is missing.
- **Page 4813, line 1.** Change “Non-conservative” to “The non-conservative”.
- **Page 4813, line 15.** I suggest to change “heat and” to “first equation of thermodynamics and the”
- **Page 4814, line 6.** I suggest to change “the vector” to “a vector”
- **Page 4814, line 18.** Change “Sect. 2.2” to “Sect. 3.2”
- **Page 4814, last line.** Strictly speaking $\delta V(t)$ is not a volume but of course it represents a volume
- **Page 4816, line 11.** Change “while” to “by”
- **Page 4816, Eq. (11).** There are Δt 's missing in front of the last two ()'s
- **Page 4817, line 1.** Replace “The” with “A”
- **Page 4817, line 3.** It is suggested to change “... model top to σ . Equation (11) is ...” to “.. model top to each σ level and Eq. (11) is then ...”

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- **Page 4817 - 4818.** It would ease readability if you briefly explain how the weakly non-linear term $(fD)^{n+1}$ in Eq (8) is dealt with when the equation system is to be solved.
- **Page 4819, line 10.** Although it may sound trivial, you must explain to the reader that one has to divide m or M with gravity g in order to get real mass with the typical unit of kg
- **Page 4819, line 16.** Replace “In” with “On”
- **Page 4820, line 21.** Replace “2012, for the” with “2012, for a”
- **Page 4822, Eq. (20).** On the left hand side replace $\sigma_{K+1/2}^{n+1}$ with $\dot{\sigma}_{K+1/2}^{n+1}$
- **Page 4823, line 10.** Would be nice with reference describing how the implicit diffusion equation is solved
- **Page 4824, line 27.** Replace “one” with “that”
- **Page 4826, line 16.** Change “Semi-implicit” to “A semi-implicit”
- **Page 4827, line 1.** It is proposed to add “have here” before “presented”
- **Page 4827, line 28ff.** It seems a bit old fashioned to use a σ coordinate model. I have not thought carefully about it but I think you should include a discussion on the possibilities for applying the technique outlined in the present paper in a hybrid σ pressure coordinate model.
It would also be nice with some discussion on the stability of the new scheme when long time steps are used (i.e. maximum Courant no's of 2 - 4)