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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Kinematic and diabatic vertical velocity climatologies from a chemistry climate model" *by* C. M. Hoppe et. al.

Anonymous Referee #2

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The study by Hoppe et al., presents different vertical velocities as diagnosed from a global Model (EMAC), discusses their differences, and presents the impact of using those velocities for calculating transport (i.e., age of air). Furthermore the age of air comparison includes the usage of two different transport schemes (classic semi-Lagrangian FSSL scheme, and the trajectory-based scheme CLAMS). The issue of the representation of vertical velocities in climate models is certainly an important one, and is of relevance for many modelling groups and analysis done with models. The sensitivity of transport to the advection scheme is likewise an important issue and its exploration is worth publication. The paper is well written in a consistent way. My main concern is that the topics are touched mostly in a descriptive manner, and attribution and/or explanations are lacking or are rather speculative. In my opinion this paper has

a large potential, and is worth publication if the topics are explored in more depth, as suggested in more detail in the comments below.

Major comments:

1. Discussion of vertical velocities (Section 3): The discussion of differences in kinematic versus diabatic velocities is certainly interesting and worthwhile showing. I feel that it could be improved by the following points:

a) Presentation:

- move the monthly Figures 4/5 to Appendix / Supplement. Instead, I would find more illustrative of the relevant differences (e.g. shift of tropical pipe) a latitude-time plot at relevant heights (e.g. 500 K,..), including a difference plot.

- I find it hard to see the relevant features in Fig. 6 (in particular in association with the discussion in Sec. 4). Maybe you can think of a different way to illustrate the relevant differences (see above).

b) Attribution:

While the differences are discussed in great detail, little explanation is given. I understand that this not an easy task, but some discussion should be added. For the diabatic velocities, it should be possible the separate the impact of the different processes. In this respect, the analysis in the Appendix are very interesting, and I encourage the authors to discuss those results more (and maybe move them to the main body of the paper). How large are the differences caused by using different convection parametrizations as compared to the differences between Kinematic to diabatic velocities? Can those sensitivities reveal anything about the causes of differences kinematic vrs. diabatic velocities?

2. Age of Air (Section 4):

Again, the investigation of the AoA differences resulting from the different vertical ve-

locities, as well as different advection schemes is certainly relevant. While some explanations are given, and connections are made between the differences in the vertical velocities and AoA differences, they are on a rather speculative level. For example, in the conclusion it is stated that "there is a clear correlation between vertical velocity and age of air" - However, no correlations or robust connection is made. Possible additions could be:

- If in any way it is possible to run either of the advection schemes with the other vertical velocity this would be a great comparison, and a clean separation of the two factors causing differences in AoA.

- Otherwise, analysis of the differences caused purely by the different vertical velocities could be obtained by an analysis of residual circulation transit times, as done in the cited papers by Garny et al., 2014 and Ploeger et al., 2015.

Minor comments:

- Introduction, page 29942, line 5 to 10: If I'm not mistaken the vertical velocity in a model like ECHAM is a purely diagnostic variable, i.e. it is calculated for output, but not used in the calculation of the dynamics. So the fact that "spectral" and "FSSL" vertical velocities differ is important to keep in mind when analysing model output, but not an inconsistency per se in the model, correct? The fact that w_spec is purely a diagnostic output should be mentioned somewhere.

- page 29942, line: 26-27: "transport and mixing..." is not a good terming, as mixing is also a transport process. Change to e.g. "residual transport and mixing"

- page 29945 / Section 2.1: can you comment on how relevant the discussed issue of different velocities in the dynamical core and the advection scheme is in general for climate models - is this an issue in almost any climate model (that uses an FSSL-like scheme?), or a specific "problem" in Echam ?

- Fig. 1: Is the difference shown the relative difference of the mean values, or the mean

of the relative differences for e.g. each month?

- page 29944, line 18: can you give an equation for the FSSL vertical velocity, i.e. the tracer continuity equation, to make it more clear how w_FSSL is obtained?

- page 29949/59: Do you expect an (computational) error from the transformation of diabatic velocities to w_Theta, and do you expect it to contribute to the comparison to the kinematic velocities? Probably in the continuity equation, the vertical velocity is a small residual compared to the other terms? (so the same problem arises as in the calculation of kinematic velocities).

- Fig. 7: Something is wrong in Fig. 7: My guess is that the difference shows EMAC-FSSL - EMAC/CLAMs and the label is the wrong way round. This would be consistent with the text and the last sentence of the Figure caption. It would also be interesting to show the relative difference here.

Technical / Typos:

- page 29944, line 7: "than the vertical.." (insert the)

- page 29946, line 20: redefining -> redefinition (?)

- page 29949, line 3: E.g. -> For example

- page 29952, line 4: above the equator -> at the equator

- page 29952, line 18: not so -> less

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 29939, 2015.