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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Improvement of vertical and residual velocities in pressure or hybrid sigma-pressure coordinates in analysis data in the stratosphere" *by* I. Wohltmann and M. Rex

Anonymous Referee #1

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General Comments:

This article proposes a method of calculating vertical velocities based on the thermodynamic equation. The method is comparable to that used with offline CTMs on isentropic coordinates in which vertical velocities are calculated using diabatic heating rates. The main difference is that this method can be applied to model output on its own vertical (pressure or hybrid sigma-pressure) coordinate.

While the method proposed is very interesting and successful, it is not described in sufficient detail. Also, it is not clear if the comparison between the methods is a fair one. More description and analysis of the new method is requested.

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Specific Comments:

1. The vertical velocity from the continuity equation as in (2) gives an instantaneous estimate and can be expected to be noisy due to the numerics of the calculation, but also to the instantaneous aspect. On the other hand, vertical velocity from the the thermodynamic equation as in (4) involves a Lagrangian time derivative evaluated over a 24 hour time interval. As the authors note, the Lagrangian mean over the start and endpoints of trajectories gives a measure of the residual vertical velocity. Thus the two methods differ in relating to Eulerian or Lagrangian derivatives and instantaneous or slowly varying quantities. What if the vertical velocity from the continuity equation were also averaged over 24 hours? How would the two estimates compare then? How much of the improvement is due to the use of a 24-hour time derivative?

2. p. 13406, section 3: The description of the method used to calculated vertical velocity is not clear. For example, it would appear that there are interpolations between a theta coordinate system and the original p or $\sigma - p$ coordinate since the trajectories are calculated on the theta coordinates. Therefore, are the horizontal winds also interpolated to the theta coordinate surfaces? A clear, step-by-step description of how vertical velocity was actually calculated would be helpful. It appears that (4) was not directly used, for example.

3. If, as I suspect, many interpolations (e.g. of horizontal winds) are needed to go from model levels to theta levels, then additional smoothing is being done through the interpolation. In addition, interpolation of the endpoints of the forward and backward trajectories are needed. Therefore, some information on the kind of interpolator used in each instance would be useful. For example, a bilinear interpolator could be very damping. Interpolators will also introduce interpolation error which can be local or global, depending upon the choice of interpolator. Since highly damping schemes will strongly suppress small scale structure, is

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it fair to compare directly with the vertical velocity from the continuity equation without spatially smoothing it first?

4. p. 13405, line 13: Corrections to the horizontal wind using a method in Weaver et al. (2000) are mentioned in the previous sentence but in this sentence corrections to vertical winds are noted. Is there an inconsistency here, or is further explanation needed?

5. p. 13406, lines 11-12: How was the choice of 12-hour forward and backward trajectories made, for the semi-Lagrangian calculation? Was the choice influence by the diurnal cycle?

6. Section 4. My understanding is that the method is specifically for the application of off-line CTMs for the stratosphere. A discussion of the general applicability of the method would be helpful here.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 13401, 2007.