Atmos. Chem. Phys. Discuss., 10, C1348–C1351, 2010
www.atmos-chem-phys-discuss.net/10/C1348/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Water vapor budget associated to overshoots in the tropical stratosphere: mesoscale modelling study of 4–5 August 2006 during SCOUT-AMMA" *by* X. M. Liu et al.

D. Grosvenor

daniel.grosvenor@manchester.ac.uk

Received and published: 7 April 2010

I have a short comment about the use of increases in ppmv as a measure of the amount of moistening produced by the overshoots in Liu et al. (2010), hereafter L10, and as quoted for other simulations from the literature. On p. 3997 and in the conclusions the Chad simulation is quoted as causing an increase in the domain mean total of 0.21 ppmv at a potential temperature of 400 K and of 0.67 ppmv at 380 K. Quoting in terms of ppmv might be useful for comparison to observations but it is not so useful for comparing between models as the size of the model domain needs to be known as

well as the thickness of the layer and the air density (to give the mass of air).

In order to work towards a global budget for overshoot input of water into the stratosphere it would be useful to quote the total extra mass of water (in tonnes) that remains in the stratosphere after all the ice has either evaporated or fallen out. This is likely to be what is important for global budget studies and it removes the dependence on the model domain size, etc.

Table 3 gives the totals of the upward mass input of total water but does not specify whether this is the net (upward minus downward) transport (as mentioned by referee #2). In addition, this does not include losses through ice sedimentation (as mentioned on p. 3998). Thus, the numbers are not too useful when wishing to deal with the overall input of water into the stratosphere through this mechanism. In table 3 it should be possible to include a number for the overall mass of water (in tonnes) that was input into the stratosphere and that remained there (at least for as long as the plume took to reach the edge of domain 3). As mentioned above, this would be a much more useful quantity for comparisons to other models. Since, according to p. 3998, only 15% of the water mass injected remains as ice in the Chad case the number produced should be a reasonable estimate of the moistening in this case as most of the ice has already evaporated.

The ppmv values from the Chad case are compared (p. 3997) to quoted ppmv values from simulations in other papers in the literature. An increase of 0.12 ppmv is quoted for the Chemel et al. (2009; hereafter C09) paper for their WRF simulation. They also performed a UM simulation and the increase for this simulation was quoted at 5.6 ppmv. However, since the model domain area, the depth of the layer involved, nor the air density is given it is not a useful (or fair) comparison to the values in the Chad simulation of L10. At the very least the domain area in the C09 paper and the depth of the layer should be quoted. The domain sizes in question from C09 were 341x341 km for the WRF simulation and 290x290 km for the UM simulation.

The value of 0.12 ppmv from the C09 paper is actually the mean increase over the potential temperature range 405-410 K. This represented the maximum mean increase out of all the increases that were computed in 5 K bins up to 425 K. The value for the 400-405 K bin was similar but slightly lower. The height range of the 0.12 ppmv quote should also be mentioned to make the comparison meaningful. For the UM simulation the 5.6 ppmv mean increase was for the range 410-415 K.

The moistening was not constant with height, though, and so it is useful to calculate the total mass of water that was input by the simulations. In C09 a mean increase in vapour of 0.06 ppmv between 380 and 420 K over the whole of the domain was quoted for the WRF simulation. Using an estimate of the air density over this height range (taken from one of my own WRF simulations of this region on that day) gives an increase in vapour of 1055 tonnes. For the UM case the mean increase was 2.24 ppmv, which gives 28,484 tonnes using the same mass of air.

There is also a quote from the paper of Grosvenor et al. (2007), hereafter G07. The value quoted is an increase of 0.26 ppmv of moistening. However, this figure is actually an estimate of the moistening effect on an air parcel (extending from 16 to 17 km) traversing a convective region for a certain period of time in which an assumed rate of overshooting cloud occurrence is assumed (based on radar statistics). It is assumed that each of those overshoots produces the same amount of moistening as those simulated in the strongest case of G07. Thus, this value of 0.26 ppmv is not comparable to those in L10. As it happens, the mean increase in the 16-17 km region (just above the tropopause in that region) of the most vigorous simulation of Grosvenor et al. (2007) is close to that quoted in L10 being $\sim$0.3 ppmv (see Fig. 14 or table 4 in G07). Again, though, a domain size needs to be quoted for such figures to be meaningful. In G07 the domain sizes were 150x150 km.

I have calculated the stratospheric increases in vapour in tonnes for the simulations in G07 using the original model data. The most vigorous simulation produced 1116 tonnes of stratospheric vapour increase, the less vigorous (medium) case 194.3 tonnes

and the weak case 86.4 tonnes. However, it is unclear which of these cases is the most realistic.

Again, I think it would be useful to be able to compare these figures to those in L10.

References

Chemel, C., M. R. Russo, et al. (2009), Quantifying the Imprint of a Severe Hector Thunderstorm during ACTIVE/SCOUT-O3 onto the Water Content in the Upper Troposphere/Lower Stratosphere, Monthly Weather Review, 137(8): 2493-2514.

Grosvenor, D. P., T. W. Choularton, et al. (2007), A study of the effect of overshooting deep convection on the water content of the TTL and lower stratosphere from Cloud Resolving Model simulations, Atmospheric Chemistry and Physics, 7(18): 4977-5002.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 3975, 2010.