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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "A study of the effect of overshooting deep convection on the water content of the TTL and lower stratosphere from Cloud Resolving Model simulations" *by* D. P. Grosvenor et al.

**Anonymous Referee #3**

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This is an interesting study of transport of water vapour by convection into the stratopshere, using a cloud resolving model. The simulations are of an idealised convective cell, but motivated by observations from the HIBISCUS experiment in Brazil. The approach falls nicely between idealised equilibrium experiments (e.g. Küpper et al.) that fail to represent the more extreme convection over land, and simulations of real cases (e.g. Chaboureau et al.) in complex environments. Quantitative estimates of the moisture transport into the TTL and stratosphere are given, with sensitivity studies to the strength of the convection and, particularly interestingly, to CCN concentration. The paper is well written, and the following comments are minor.

1. Abstract, line 25: When the tropopause height is given, it should be stated, which definition is used, e.g. cold-point tropopause or WMO-tropopause (see also next comment)

2. p.7284, line 10: There is no height scale on Fig. 1, so it is not clear which feature is at 15.9 km. It would be helpful to state the corresponding pressure. Is this the cold point to within model resolution? A forward reference to the discussion on p.7289 might also help.

3. p.7286: A problem with the bubble initialisation that is not mentioned in the paper is the potential lack of turbulence early in the cell's lifetime, leading to a systematic underestimate of entrainment in the lower troposphere (see Carpenter et al., JAS, 55, 3417-3432). In contrast to the coarse horizontal resolution, which changes the balance between resolved and parameterised mixing with unknown results, this effect will give a systematic bias towards excessive vertical velocities. This should be noted in the paper.

4. p.7286: The balance between horizontal and vertical resolution (2000m vs. 75m) is probably not optimal. The downward heat flux due to numerical dissipation of gravity waves noted by Kuang and Bretherton will not have time to affect the temperature greatly in these short simulations. On the other hand, the coarse horizontal resolution implies that there will be strong horizontal diffusion across the highly tilted isentropes in the lower stratosphere, which will be regarded as a net vertical mixing by the end of the simulation when the isentropes have returned to horizontal. More sensitivity studies would be required to sort this out, which I would regard as beyond the scope of this paper, but it will be difficult to progress beyond the current state of the art until the realism of the entrainment processes in this class of simulation is established.

5. p.7294: It would be interesting to see a time-height plot of total water, along with or instead of Fig. 10. Much of the discussion centres around when the moisture precipi-



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tates out of the stratosphere, but that cannot be seen from the figures provided.

6. p.7300: Much of the discussion in section 3.3 seems to miss the point, since it addresses moisture transport into the TTL. Since this air is likely to experience dehydration if it passes through the cold point in the Brewer-Dobson circulation, the magnitude of the transport in lower levels is not particularly important. This is in contrast to the direct transport of moisture into the stratosphere, which is of great significance since it is decoupled from the cold-point temperature. This is mentioned later, in the conclusions, but this does not seem sufficient - I would disagree with the final sentence of the section (p. 7302 lines 27ff),

7. Figure 20 is not referenced in the text.

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Interactive comment on Atmos. Chem. Phys. Discuss., 7, 7277, 2007.