Atmos. Chem. Phys. Discuss., 10, C8020–C8024, 2010
www.atmos-chem-phys-discuss.net/10/C8020/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelling deep convection and its impacts on the tropical tropopause layer" *by* J. S. Hosking et al.

Anonymous Referee #1

Received and published: 27 September 2010

This paper models the atmosphere and focuses the analysis on deep convection and its impacts in the TTL. Specifically, it presents different month long simulations with a climate model using fixed SSTs and a relatively high horizontal resolution (for climate work). The focus of the analysis is the behavior of the deep convection and its behavior in and around the TTL. It is clearly written and the figures are clear too.

I do have two major concerns which should be addressed before the paper is acceptable for publication. The first I suspect is easy to deal with, the second I suspect will be somewhat harder but should be tackled to make this a valuable paper in the literature.

1. The motivation and conclusion to this motivation could be clearer. If the motivation for this is assessing "the suitability of the model for transporting ozone-depleting VSLS into the stratosphere" then I feel that the paper should be clearer on how suitable the

model is and what should be improved.

2a. At ∼60km grid length convective parametrization still dominates the vertical transport. This is why using convective cloud as a proxy for convection and also convective mass flux is probably acceptable. However, discussions of most of, or all of, the results do not talk about the behavior in terms of what the convective parametrization is doing. For this paper to be acceptable, it is critical to discuss how the convection scheme works with a focus on all aspects which would influence the penetration and height of deep convection as well as the general mass flux profile and associated transport. Without this, I feel the results are not in the correct context. For example, what determines the termination height of the convection with any given cape? What does the mass flux look like on a time step basis and why? The when you talk about the features in all the figures which are related to convective height and transport you should then refer back to the details of how the convection scheme works and is influenced by the different large scale conditions and the transport.

At one stage you refer to some grid-point diagnostics and some of these on the time step would be a good way to illustrate how and why the convective parametrization is influencing the transport into the TTL.

2b Related to above, there is little reason to believe the convection parametrization is reasonable in the TTL region. As has been mentioned, these schemes have been developed with an aim of getting moisture and heat transport, and the associated cloud reasonable. Little or no work is referenced here that discussed the performance and development of convection parametrizations in terms of transport in the TTL. I am not particularly aware of any myself but there may be some. I am not saying that this work is not acceptable because of this but I would say:

a) The limitations of convective parametrizations in terms of TTL should be discussed along with perhaps the suggestion that cloud-resolving tropical wide simulations may be a good way to really evaluate or support this study.

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b) There is currently a resolution sensitivity in the paper. However, I was not clear on the reason for this or what was learnt from it. Can there be some discussion here about the implication of moving convection from resolved to parametrized, or is N216 to N96 not a sufficient change to impact strongly the resolved to parameterized partitioning. I would say if there is nothing much to take from the low resolution runs then I would remove this section.

Specific comments

All bits: avoid N216 terminology and stick to a grid-length at some latitude.

Abstract: REPLACE "at a high global res (N216, ...)" WITH "at a climate resolution." This is because N216 is not a high resolution and is only relatively high for climate simulations. AR5 runs will be done at various centers with this kind of horizontal grid-length. Note also that L38 is a relatively low resolution for climate simulations and this may be as important for TTL studies.

Abstract: With a parcel type of thinking, and typical convective thinking, I would expect deep convection to more typically go from the top of the PBl to 12-14km - not 5km.

Introduction: I would expect changes in response to point 2 above so won't go into too many specifics.

p20271: Figure 1 - OLR is often "tuned" in models so while it is a proxy for convection is not as good as precip or convective precip.

p20272: version 6.1 refers to a code number rather than any particular science so is not relevant here. Also delete "New Dynamics UK".

p20272 par 2: This paragraph I would expect to change to focus more on the details of the convection scheme and how it is set up (e.g. cape time scale).

p20272 par 3: After "December 2005" add "and was used in a recent GCSS comparison study of deep convection over the TWP..."

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p20272: Stress L38 is relatively low vertical resolution.

p20273 Are climatological soil temp and moisture prescribed as implied or are they I.C.?

p20274: What are the implications (if any) of using monthly means to define TTL rather than daily or shorter timescales?

p20275 l19: Model OLR is tied closely to convection in the model but what about reality? I might expect there to be a lag between max ppt and OLR as cirrus persists. Any obs to help here?

p20276 l3: There is an implication here that some convective injections into the stratosphere occur (as they are uncommon). Are these partly resolved or entirely from the parametrization?

p20279: Can there be a comparison with analysis of the T in Fig 6?

p20280: I wonder in Fig 7a,b whether there is something more useful in mean mass fluxes during strong events rather than just monthly means. This way you focus more on the strong convective events you care about and are less influenced by frequency of events.

p20281 l20: I would say that the lack of parametrization of the complex microphysics is secondary to the fact the convective transport itself is almost entirely parametrized with no microphysics at all to speak of.

Conclusions: I would expect these to change somewhat in response to major comments.

p20284 l10: I would mention that whether the very deep land convection are real or not, it would be very difficult to represent these in such a coarse model.

p20284 l14: Not sure about this 4-5 km as starting point for air. I guess you are interpreting this based on the mean mass flux profiles but I wonder whether strong

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deep convective event mass flux profiles are the thing to look at here.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 20267, 2010.

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