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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.

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Reply to Referee #1

The authors would like to thank the referee for useful comments and suggestions that helped us to improve the manuscript.

Comments

1. Motivation and conclusion could be clearer: We have addressed this by adding text to the introduction and conclusions. The model comparison in Russo et al (2010) and Hoyle et al (2010) use the same model experiments and find that, by comparison with observations, the model is suitable for transporting VSLS into the TTL region. We also now state that, e.g., a tropical wide cloud resolving model needs to be studied in a

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similar way in the future.

2a. Include more information regarding the convective scheme and CAPE: The explanation of the convective scheme is now more detailed, as recommended. Supplementary Figure 1 (attached) shows a 1-gridbox timeseries for a convective region with the TTL levels and convective cloud top height using 3-hourly data. The figure highlights the large variability of convection and the changes of TTL levels for a higly convective region. All the monthly mean mass fluxes in this paper have been calculated in the model using all timesteps (20 mins). The same is true for the monthly mean TTL levels and convective cloud top heights. Due to the high horizontal resolution, and therefore the large file sizes, we couldn't output and store 3-hourly mass fluxes. Therefore we are unable to make a timeseries comparison between mass fluxes, TTL levels and convective cloud top height as suggested by the referee. However, as the grid box size is relatively large compared to the size of convective towers, CAPE is averaged over a large area and consequently will be weaker than similar deep convective towers modelled using a cloud-resolving model.

2b. Discussion of the performance of convective scheme in terms of TTL transport: We feel that this is now addressed by referencing the studies made by Russo et al (2010) and Hoyle et al (2010) – as mentioned in comment 1.

a) Limitations of convection in terms of TTL: Please see answer to 2b. We have added a sentence in the conclusions where we say that even though convection is parameterised, the model is suitable for modelling the transport of VSLS as shown by Russo et al (2010) and Hoyle et al (2010). We also state that such events are not represented in our model as the horizontal resolution is not high enough to resolve clouds or their overshooting turrets.

b) Resolution sensitivity study: The referee makes a very good point here. In light of this we have rephrased the paragraph to concentrate on the forecasting setup experiment first then validate it against the commonly used HadGEM model as used in

ACPD

10, C9966–C9970, 2010

Interactive Comment

SPARC CCMVal (2010). The two models use the same convective scheme so the main difference here is horizontal resolution. The panels in Figure 5 have been switched around accordingly.

Specific comments (in order): [p.C8022] - All bits: avoid "N216". We have removed "N216" where it was not required. - Abstract (1): done. - Abstract (2): This is what our modelling results show and was also seen in some UM mesoscale tracer studies by Dr Maria Russo (currently unpublished). - We know that OLR is tuned in the model, however, this should not change the distribution of low/high OLR, just the intensities. - We agree that "New Dynamics UK" should be removed although we feel "version 6.1" should remain as there. are many differences between the default convection schemes used in different UM versions (e.g., v4.5 and v7.1). - p20272 par2: done. - p20272 par3: done. Search for "GCSS". [p.C8023] - L38. We believe that we have given the reader all the information (including the vertical resolution in the TTL). - The climatological soil temp and moisture are as prescribed in the text (updated every 1 day). - To address the implications of using monthly mean TTL surfaces opposed to daily/shorter timescales we point the referee to Supplementary Figure 1 showing the 3-hourly timeseries. The Q=0 (clear sky) level has temporal variability of about $\pm$1km (which is already mentioned in the text). As we analyse the TTL over 20N:20S this temporal variability is significantly less important compared to the spatial variability (i.e., between areas of strong and weak convection). - We don't have high temporal resolution (e.g., 1 hourly) satellite or model data to investigate this. - A timeseries which shows a rare modelled convective injection into the stratosphere in this model setup is shown in Supplementary Figure 1 (Day 14). - Supplementary Figure 2 has been produced to compare monthly mean temperatures at 100hPa (i.e., near the tropical tropopause) for EOS MLS, ECMWF operational analysis and UM N216. We find that the UM agrees closely with the EOS MLS data and that the ECMWF operational dataset is colder as found by, e.g., Marécal et al. (2007). - By investigating the convective cloud top PDFs, which indicates the frequency of deep convection of the tropics, we can already focus on strong convective events. As the mass flux diagnostics are

ACPD

10, C9966–C9970, 2010

made into monthly means by the model we do not have the data to investigate mass fluxes and convection at a high temporal resolution. - p20281 l20: done. - Conclusions (1): added "as the horizontal resolution is not high enough to resolve clouds or their overshooting turrets.". - Conclusions (2): This is what we found in both this global model setup and a UM mesoscale setup.

Additional References

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Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/10/C9966/2010/acpd-10-C9966-2010-supplement.pdf

ACPD

10, C9966–C9970, 2010

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ACPD

10, C9966–C9970, 2010