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Discussions

Interactive comment on "Uncertainties in future climate predictions due to convection parameterisations" *by* H. Rybka and H. Tost

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First of all, we would like to thank the anonymous reviewer for the valuable comments. The new version of the manuscript contains changes according to the reviewers comments.

1. I think a brief explanation – a paragraph or two - of the main physical differences in the parameterizations would be very helpful for the reader.

Further information about the differences of the convection parameterisations used in this study can be looked up in the paper of Tost et al. 2006 and the references listed in Table 1. We refrain from a repetition here for sake of the length of the manuscript.

2. Additionally, one aspect that might be interesting would be to look at the averaged tendencies that actually are coming out of the convection schemes.

In order to compare convection schemes in future studies averaged tendencies would help to identify major differences between the parameterisations. These tendencies are not included in our output data and consequently can't be investigated. Especially, it would be required to analyse the full distribution of the tendencies instead of the average to properly consider the different types of convection and the strength of individual convective events.

3. Fig. 1. [. . .] it may be nice to see a magnification of the difference (difference field of the difference). How sure are you about the different representation of microphysics causing these differences? Couldn't it also relate to mass flux assumptions?

The difference of the temperature difference field between the two resolutions has been added. The variability in middle tropospheric temperature changes due to different convection schemes is apart from influences of snow/ice and precipitation formation also related to different detrainment rates (especially for the EC simulation) around 600 hPa. The updraft detrainment rate is strongly enhanced in comparison with the T1, EM and ZM parameterisations.

4. Can you find an argument for why dT is larger for the higher resolution run in the upper levels, and whether that trend might continue with even better resolution?

One possible explanation for larger temperature changes in the UTLS for the higher resolution is that convection schemes have a larger impact on the environment regarding smaller grid box sizes. In other words, if a convection scheme is triggered (less frequently for higher resolutions, see Fig. 4) the convective temperature tendency is higher and results in a temperature profile with a smaller temperature gradient. Thereby inducing a higher temperature for upper tropospheric levels. This concept could be enhanced under climate change and might continue with higher resolutions. Additionally, changes in altitude of the tropical tropopause are of greater extent for the

T63 simulations (higher shift of the tropopause in the 2xCO2 simulation for T63 than T42), whereas changes in cold point temperatures are the same comparing the different resolutions.

5. Why are there such large dT differences over Africa and not so much over South America with the lower resolution? Is the behaviour of the different convection schemes similar for this comparison? Or are there significant regional differences among the simulations?

The high variability over Africa for the coarser resolution is a result of a regional change in precipitation rates. The Tiedtke, Emanuel and Zhang-McFarlane Hack convection scheme displays an 15 % increase in precipitation and evaporation over Africa for the T42 and T63 resolution. Precipitation rates for the EC parameterisation strongly decrease over Africa (-25 % for T42), whereas an increase is observed for the higher resolution. Therefore, the temperature variability over Africa is strongly increased for the coarser resolution. Furthermore, t-tests have been performed in order to specify regions with significant differences in the temperature change.

6. "Impact on cloud types“: Does the chosen microphysics (within the convective parameterizations) also have an impact? Do any of the parameterizations consider aerosol effects?

None of the chosen parameterisations consider aerosol effects. The microphysics within the convection parameterisation should have an impact on the simulated cloud types. However, we can't distinguish if the convective transport (including entrainment/detrainment) of moist air in correlation with the large-scale cloud scheme or the processes of condensation/evaporation will be of more significance on the simulated cloud type. This could be investigated for regions where a high variability of (preferably) one specific cloud type occurs applying different convection schemes.

7. With "cloud scheme" you mean the online calculation with the ISCCP simulator?

Cloud scheme means the calculation of large-scale processes of condensation (precipitation and cloud formation) which interacts with the convection parameterisations.

8. Do you have any advice for convective parameterization developers? Any way to find out what needs improvement most? Or which of the schemes tested may be better for climate simulations?

In our opinion, developing a new convection parameterisation should consider that it can be used under a wide range of resolutions without changing climate mean states. Furthermore, convective tendencies (heating and drying rate profiles) should adjust when approaching to cloud-resolving scales. Additionally, one must be aware that the interdependency of large-scale cloud schemes and convection parameterisaton is important for climate feedback analysis focusing on cloud radiative feedbacks.

Due to personal communication we have changed some parts of section 4.4 (Cloud Radiative Focing and Cloud Types) to avoid misinterpretations, especially table 3. We have clarified the meaning of changing cloud radiative forcing and cloud radiative feedbacks to avoid ambiguities. Additionally, suggestions have been made for further studies to quantify the real cloud radiative feedback.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 26893, 2013.