

Interactive comment on “Tropical convection regimes in climate models: evaluation with satellite observations” by Andrea K. Steiner et al.

Anonymous Referee #1

Received and published: 18 October 2017

General comments

Generally I appreciate this work. It is a standing problem to find a method such that climate models can benefit from the accurate GNSS Radio Occultation (RO) technology. Climate models represent the atmosphere in a statistical sense, and they are not expected to correspond to any single measurement at a given time. On the other hand models should be able to resolve processes to some extent in a realistic way, and their ability to do so should be evaluated against state of the art measurements. The method presented in this paper overcomes the gap between models and measurements by extracting classes of profiles belonging to same range of convective activity or "regime" and then collocate RO profiles with model profiles of the same regime. The classification of RO profiles is aided by ERA-Interim analysis. I believe that the method is new

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to RO applications, and that it could possibly be applied in studies of other important atmospheric processes than tropical convection and down welling.

The language is generally clear throughout the paper and I did not see any typos. But there is a list of issues about the method which are not sufficiently clearly described in the paper, and which all needs to be addressed before publication can be allowed. These are listed under "Specific comments".

Specific comments

p5 l2 (About the specific humidity error estimates): There is a loosely thrown reference to Kursinski and Gebhardt, 2014, citing a systematic error of only 0.03 g/kg for climatological averages. I think that is a bit optimistic, since this estimate is based COSMIC data, while a large part of the RO data used in the analysis comes from the CHAMP mission, known to have sampling issues in the troposphere (also mentioned in Kursinski and Gebhardt, 2014). Why not refer to specific error estimates from the WEGC (OPS 5.6) RO data?

Figure 6 and 7: The error bars show the STD of the "classes" I suppose. I would like to see some indication of the expected RO error, which at least would amount to the mentioned 0.03 g/kg.

Sec. 3.1 line 20 (Collocation in time): RO profiles are matched to the nearest grid point in space and time. I fail to see the purpose of matching the exact time of an event, so what is meant here? Is it a requirement that the RO profile belongs to the same time point in the annual cycle? Please describe clearly what is being done.

The spread in temperature and humidity is surprisingly small in all cases, but especially for the HadGEM2. In figure 4 for example, how can "all classes of ω_{500} and T_{2m} " have a spread of only a couple of degrees? Especially when figure 3 shows that a the spread in T_{2m} is around 10 degrees. Clarification is needed.

Especially the following seems like a paradox: In figure 6 the RO specific humidity is

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plotted for all classes. The thickness of the orange area in the 5 plots must reflect the moderate spread of RO specific humidity among the classes. Why is the orange line so narrow in the HadGEM2 plot compared to the rest of the plots? It is based on the same class definitions and the same set of RO profiles after all.

All the climate models, except for HadGEM2, show cold biased tropopause temperature. HadGEM2 sticks out from the other models in many ways besides being least biased in humidity. Some reflection about what could be the reason for that would be appropriate.

This last question is a bit unclear and can maybe not be answered, but please consider it: Since ERA-I resolves updraft / downdraft better than climate models, the classification of RO tends to fall in more extreme vertical winds classes, which are not well represented in the coarse grained climate model. As such a particular vertical wind regime does not necessarily represent the same physical state in ERA-I as it would in a climate model. In that view it may be natural and sound that (some) climate models do not capture the really extreme dry events and therefore appear positively biased in non convective regions.

Technical comments

In figure 3, the upper row: It is not really RO data that is used for this plot. It is ERA-I evaluated at RO locations. I suggest to write ERA-I in the figure legend.

Figure 6 and 7: I do not see the purpose of plotting the specific humidity on a reversed (logarithmic) axis?

The curves in Figures 1 are a bit hard to distinguish in a printed version.

I appreciate the color coding of the climate models. Nevertheless the colored font is a bit hard to read in figures 4-7.

Why not compare RO to ERA-I also, just for reference?

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2017-669>, 2017.

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