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Atmospheric Measurement Techniques Discussions

Interactive comment on "Evaluation of the 15-year ROM SAF monthly mean GPS radio occultation climate data record" *by* Hans Gleisner et al.

Hans Gleisner et al.

hgl@dmi.dk

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Author's reply to the specific comments in Referee Comment 1 (RC1)

1. A problem with using reanalysis data as a reference for comparison with radio occultation (RO) data is that RO data itself have been assimilated by the reanalysis system. If we interpolate in an ERA-I analysis field to the times and locations of RO events, the interpolated model data will be strongly influenced by the very same RO data that we wish to compare with. Such comparisons would have an obvious problem with circularity. Using ERA-I forecasts instead of analyses removes most of this circularity. ERA-I provides forecasts at 3-hour intervals, initialized at 00 and 12 UTC. The shortest possible forecast times thus vary from 3 hours up to 12 hours. This is what we mean

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Discussion paper

by “short-term” forecasts.

The model resolution is 3 hours and data are interpolated from a 1.0x1.0 degree latitude-longitude grid. In the vertical, as a part of the forward-modelling from model space to observation space, the data are first interpolated from the original ECMWF model levels to the vertical coordinates of the observed data. All data – both observed and model data - are then interpolated to a regular 200-meter grid that is used in this study.

We have extended Section 2.2, which now reads: “*We used ERA-Interim reanalysis (Dee et al., 2011) data as a reference in the evaluation. To avoid the direct impact of the observed data on our comparison reference (RO data are assimilated by ERA-Interim), we used the reanalysis forecasts rather than analyses. ERA-Interim provides forecasts at three-hour intervals, intialized at 00 and 12 UTC. Hence, the shortest possible forecast time vary from 3 hours to 12 hours. For each RO event, a co-located vertical profile of model data was obtained by interpolation in the global forecast fields representing the atmospheric state at three-hour intervals (UTC 00, 03, . . .) on a* $1.0^\circ \times 1.0^\circ$ *latitude-longitude grid. The model data are forward-modelled to the set of geophysical variables used in this study. Dry temperature profiles are computed from the ERA-Interim refractivities using the same method as for the observed profiles (see Section 3.1). This is followed by monthly averaging in latitude bins and interpolation onto an equidistant 200 meter height grid, using the methods described in Section 3.4.*”

2. The 1D-Var retrievals are mentioned for completeness. From a climate perspective, the 1D-Var retrievals come with their own set of problems that are only partly related to the more fundamental errors and uncertainties of the bending-angle, refractivity, and dry-temperature data. A discussion of the problems and errors with the 1D-Var retrievals is out of the scope of this paper. We will mention this in Section 3.1 of the updated manuscript by adding a sentence: “*Discussion of the tropospheric variables retrieved through a 1D-Var algorithm is out of the scope of this paper.*”

3. The ERA-I dry temperatures are computed by first forward modelling ERA-I pressure, temperature, and humidity to ERA-I refractivity. Then we use similar processing as for the observed refractivity: we assume hydrostatic equilibrium and do a downward vertical integration of the hydrostatic integral from the top of the atmosphere to get the dry pressure. The refractivity and the dry pressure then give us the dry temperature under the assumption of zero water vapour pressure. We will update the text in Section 2.2 to be more specific on this — see suggested text update under point 1 above.

4. Yes, many of the results in the paper are global means, as we had to limit the discussions somehow. However, Figure 8, which is a key figure in this paper, gives a quite detailed view of the latitudinal differences. These are discussed in some detail in Section 5.1. There are indications both in the Abstract and in Section 5.2 that the consistency amongst RO missions is lower for limited latitude bands than for global means.

It is true that the environment is challenging for RO in the tropics, particularly in the lower and middle troposphere where humidity has a large impact on the refractivity. In general, the lower troposphere is challenging, and this also where we find the largest biases between the RO missions. The main limitation of the study is actually in the vertical. The large differences between the RO missions below 8 km are only mentioned briefly while the differences above 8 km are discussed in some detail. We will add a sentence in the Introduction to point out this limitation: "*The evaluation is largely limited to the stratosphere and the upper troposphere, above about 6-8 km.*"

5. to 13. We will update the manuscript accordingly.

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