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Atmospheric Measurement Techniques Discussions

Interactive comment on "Consistency and structural uncertainty of multi-mission GPS radio occultation records" *by* A K. Steiner et al.

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Consistency and structural uncertainty of multi-mission GPS radio occultation records.

by Steiner et al

General Comments

This paper investigates the consistency of climate data records retrieved from GPS radio occulation measurements, produced by a number of processing centres. It is a very thorough piece of work, and it is generally well explained. Overall, it will be a useful addition to the literature. I recommend publish subject to the minor revisions detailed below.

Specific comments

Section 1

Page 2, Line 2: Suggest inserting "in situ" before obserservations, i.e. => " in situ observations" because it could be argued that there are many satellite radiances available.

Page 2, Line 15: the accuracy requirements, 0.1 K for climate and 1 K for NWP, need further explanation. The 1 K for NWP is presumably a random error for a given observation, but what is the definition of the 0.1 K requirement? Further, on Page 3, line 25 it says the observational uncertainty estimate for an individual RO observation is 0.7 K near the tropopause. Is this consistent with the 0.1 K climate requirement? Please clarify. Similarly, clarify "measurement uncertainty of 0.5 K" on Page 2, line 19.

Section 2

Page 5, Line 18: "Two coherent carrier signals ...". This sentence may give the impression that the ionospheric correction is in phase space. Please clarify.

Page 6, Line 2: It probably should be noted that no centre is currently trying to correct residual ionospheric errors using, for example, techniques such as those in Danzer et al (2015). Although there is still work required to demonstrate this approach (Danzer et al, 2019 submitted), it should be noted that redidual ionospheric errors are a potentially a common error at all the centres.

Page 6, Line 9: Some NWP centres have moved away from Smith and Weintraub (1953) to potentially more accurate formulations including both updates to the assumed C02 concentration and non-ideal gas effects. This is mainly as a result of work by Dr Aparicio. See Appicio and Larosche (2011) and references therein, Cucurull et al (2013), Healy (2011). The NWP implementations should be noted.

Figure 2: The Metop bending angles for WEGC at $\sim$15 km seem to be an outlier. Any reason for this?

Figure 3: The JPL and UCAR appear to have almost equal and opposite bending angle biases. Please discuss.

Page 10, line 21: "Above this altitude, WEGC ...". It might be worth adding that the WEGC dry-temp and temperature differences above 16 km shown in Figure 3 are because of different all centre mean values.

Section 4.2, Page 11, Lines 9-10. "Larger variability ..." for JPL is likely due to bending angle extrapolation? Why is extrapolation relevant here?

Section 5

Page 14, line 16. When quoting the uncertainty in the trends , e.g. "0.06 %", include "per decade".

Page 14, line 26. The bending angles are found to be consistent up to 50 km because they are less sensitive to a priori information. Ringer and Healy (2006) suggested monitoring the climate in bending angle space for this reason, althought the interpretation of bending angle trends is more complicated. Consider adding this reference.

Technical suggestions

The text on many figures is still very difficult to read.

Figure 4b, 5b, 6b, 7b, 8-18km dry temperature time series. The vertical ranges/axes could be expanded.

Figure 6a, 7a. Better vertical ranges could be used in these figures.

Suggested References

Cucurull, L., Derber, J. C., and Purser, R. J. (2013), A bending angle forward operator for global positioning system radio occultation measurements, J. Geophys. Res. Atmos., 118, 14-28, doi:10.1029/2012JD017782.

Aparicio, J. M., and Laroche, S. (2011), An evaluation of the expression of

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Danzer, J., Healy, S. B., and Culverwell, I. D.: A simulation study with a new residual ionospheric error model for GPS radio occultation climatologies, Atmos. Meas. Tech., 8, 3395\u20133404, https://doi.org/10.5194/amt-8-3395-2015 2015.

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