

Interactive comment on “Evaluating tropospheric humidity from GPS radio occultation, radiosonde, and AIRS from high-resolution time series” by Therese Rieckh et al.

Anonymous Referee #1

Received and published: 20 February 2018

The manuscript “Evaluating tropospheric humidity from GPS radio occultation, radiosonde, and AIRS from high-resolution time series” by Therese Rieckh et al. report validation of GPS RO with different retrieval algorithms for specific humidity against ERA-Interim. Also reported are similar validation for radiosonde measurements and AIRS V6 retrievals. The uniqueness of this article is that the authors focus on 4 locations to highlight high-resolution temporal time series and special events of typhoon passages. I think that this work provides information that the public needs to know when using GPS RO specific humidity data. However, I do have a few comments of clarification.

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Comments

1. The work uses ERA-Interim as reference data to quantify “biases” of other datasets. However, comparison to AMSR total column water vapor shows that ERA-Interim may have dry bias in certain atmospheric conditions. The author also states in Pg. 3 Line 13 that previous work has shown ECMWF reanalysis being drier compared to MERRA and JPL RO (although there may be differences between ECMWF reanalysis and ERA-Interim). If the authors think ERA-Interim can be guaranteed as the “truth” at least at the 4 locations discussed in the paper, they need to clarify with reasons or references to support this. Otherwise, the authors may consider to mitigate the wording such as “biases” when referring to differences between other datasets and ERA-Interim.

2. Different datasets have different footprints as mentioned in the paper. Therefore, AIRS specific humidity represents average value within the 45-km AIRS footprint, while radiosondes are point measurement. While GPS RO is occultation, its equivalent horizontal resolution may be lower. How these differences of resolution of different datasets influence the uncertainty estimates when compared to ERA-Interim with a resolution of 0.7° ?

3. As mentioned on Page 8 Lines 9-13, different datasets have different quality flags that result in different sampling sizes after paired up with ERA-Interim. As quality flag of a particular dataset favors particular atmospheric conditions (e.g., AIRS quality flags favor conditions of less deep-thick clouds). How may these differences in sample sizes influence the general conclusions of the work? For example, if one constraints all datasets to have the same samples after paired up with ERA-Interim, will this give different patterns for plots like Figs. 3-8?

4. Super-refraction seems to be a big problem for GPS retrievals. The authors may consider including some discussion of how the users of GPS can know if bad quality of retrievals caused by super-refraction exists in a particular profile. Or if GPS datasets provide quality flags to inform users if such events occur?

Specific Comments:

Figure 2 caption: “Scatter plots of normalized q for 7 days. . .” It seems that these are not “normalized q ” as the units are g/kg. Normalized q should have no unit.

Pg. 11 Lines 5-8: Such dubious radiosonde profiles with constant humidity profiles are easily detected and should be excluded from the matched up pairs. Otherwise, the comparison is unfair for radiosondes. If such data are excluded, will the plots of Fig. 4a, Figs 6 and 8 be drastically changed?

Pg. 12 Lines 2-3: For deep convective clouds (thick clouds with high cloud top), the dry bias is throughout the troposphere. For low-level, thick clouds (stratocumulus or stratus), the large dry bias is confined in the lower troposphere.

Pg. 12 Lines 12-Pg 13 Lines 1-2: It is good that the authors caution the problem in ERA-Interim. But in general, can ERA-Interim be regarded as a perfect “truth”? (See Main Comment #1).

Pg. 18 Eqn. (4): Need a bracket for $(X_k - X_{\text{kinter-center}})$ in the equation before multiplied by $100/X_{\text{ERAannual}}$.

Pg. 18 Line 14: Need to spend a sentence or two to explain what “inter-center mean” means. Or use an equation to tell readers how it’s calculated.

Pg. 20 and Pg. 21: The authors may consider pointing at the figure number that supports each conclusive bullet.

Pg. 21 Lines 10-11: “. . .RO should have a large positive impact on improving the water vapor analysis in data assimilation in the lower and mid troposphere.” Is this statement contradicting the claim on Pg. 4 Lines 10-14 that “RO makes a relatively small contribution in the ERA reanalysis.”?

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-486, 2018.

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