Xiao et al., Evaluating the Lower Tropospheric COSMIC GPS Radio Occultation Sounding Quality over the Arctic

We thank the editor and the two reviewers for the very insightful and constructive comments. A list of comments with detailed responses are shown below.

Response to the Anonymous Referee #3:

General comments
The paper "Evaluating the Lower Tropospheric COSMIC GPS Radio Occultation Sounding Quality over the Arctic" by Yu, Xie, and Ao investigates the usefulness of Radio Occultation (RO) observations for studies of the Arctic lower troposphere. The penetration depth of COSMIC RO sounding above 65 degrees north for different seasons is described, and the uncertainties of the lower-tropospheric RO observations are quantified using two type of uncertainty definitions: the structural uncertainty as quantified from the differences between two processing centers, and the parametric uncertainty as quantified by differences between RO and alternative data sources, here radio sondes and reanalysis data.

Overall, the results presented are mostly those expected. The impact of humidity (mainly during Arctic summer) is line with the general understanding of RO behaviour. However, the study makes an important point in stressing the usefulness of RO for the lower troposphere in Arctic, where other data sources are scarce. RO data are most likely under-exploited in this type of application, and the manuscript gives a good description of the advantages and disadvantages of using RO data in the Arctic lower troposphere. The potential shortcomings of the RO method for this particular application are pointed out and at least partly explained.

The paper is suited for publication in AMT.

We thank the reviewer's very positive comments.

Specific comments

1. A question and a suggestion for the future: the parametric uncertainties of the JPL and UCAR data are obtained by identifying RO profiles closer than 3 hours and 300 km to a radiosonde profile. The statistics (mean, medians, and standard deviations) of the RO-radiosonde differences are plotted. These statistics are influenced both by actual RO-radiosonde differences and by the fact that the two type of observations are not perfectly collocated. We are mainly interested in the first component, while the second component acts to disguise the "true" differences. One could consider using the statistics of the double differences (RO-REANRO)-(RDS-REANRDS), where REANRO and REANRDS are reanalysis data collocated to the RO profiles and the radiosondes, respectively. The impact of an imperfect collocation between RO and

radiosondes is much smaller with this type of comparison using a reanalysis model as a transfer medium. I would like to see a comment from the authors on this subject.

Following the reviewer's very interesting suggestion, we generated the statistics of the "double differencing" results between RO and radiosonde by using the collocated ERA-I reanalysis as the medium. Note the overall statistics are very similar to Fig. 5 in the manuscript. This further confirms the robustness of the error statistics in Fig. 5, which is not significantly affected by the spatial and temporal difference between the RO and the radiosonde dataset. However, a slight reduction of the errors below 2 km are seen in all three parameters (*N*, *T*, *q*), implying the slightly increases of collocation errors between the RO and radiosonde profiles in the lower troposphere, where larger spatial inhomogeneity in the atmosphere was expected.

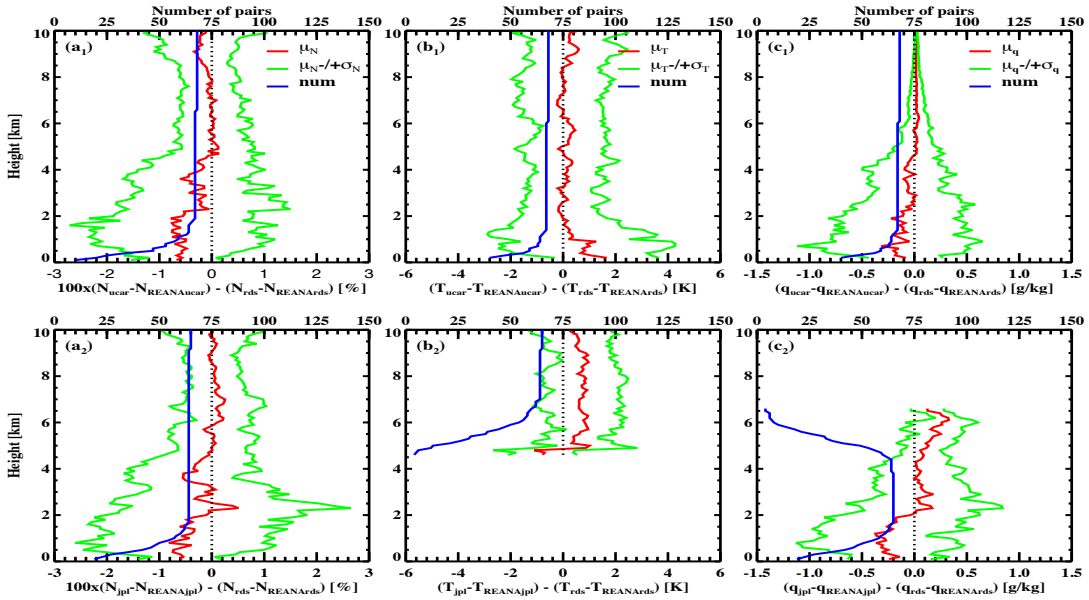

Figure: Fractional difference between ASCOS radiosonde soundings and the near-coincident COSMIC RO from UCAR (top, a_1, b_1, c_1) and JPL (bottom, a_2, b_2, c_2), in terms of refractivity (a_1, a_2), temperature (b_1, b_2) and specific humidity (c_1, c_2). The median difference (μ, red), the median difference plus-minus (±) median absolute deviation (σ, green) for all three parameters are also shown. The number of near-coincident pairs as a function of height is shown in blue with scale marked on the top to each panel. (Similar to Figure 5 in manuscript)

Technical corrections

1. Abstract, line 10: "predication" should be "prediction".

   Corrected.

2. Abstract, line 11: in "... demonstrated as a high-quality observation with ..." something appears to be missing. It should be "observation type" or "observation technique" rather than just "observation".

"technique" is added after "observation".

3. Abstract, line 12: "high-vertical-resolution" should be "high vertical resolution". It is correctly used in the Introduction, line 4, but not here. I'm not an expert in grammar, but this type of construction is only used as an adjective. As an example, this would be a correct sentence: "a measurement with a high vertical resolution is a high-vertical-resolution measurement."

   Corrected. Thanks.

4. Abstract, line 18: "Over 70

   The sentence is updated as follows:
   "*Over 70% RO soundings penetrate deep into the lowest 300 m of the troposphere in all non-summer seasons. However, the fraction of such deep penetrating profiles reduces to only about 50-60% in summer, when near-surface moisture and its variation increase.*"

5. Introduction, line 1: "twice as much as global average rate" should be "twice as much as the global average rate".

   Corrected.

6. "MetOp" should be "Metop".

   Corrected.