Review of Shao et al.: Characterizing the tropospheric water vapor spatial variation and trend using 2007-2018 COSMIC radio occultation and reanalysis data

We thank the reviewers for the helpful comments and suggestions on the minor revision. We have revised the manuscript and addressed the reviewer's comments. The manuscript has been largely improved. In the following, we summarize our reply to the reviewer.

Reviewer #1's Comments:
I really appreciate the effort the authors have put in the revision of their manuscript. However, there are still some technical/minor issues that should be considered before publication.

General comments:
P5, Section 2.2: This section is too long is not entirely describing the data. Here you have a mixture between data set description (L141-L167), method description (L169 to L202) and results (L204-227). The method part should be put into an extra subsection and the results part either there in a extra subsection or moved in an extra subsection to the results section.

Following the reviewer's suggestion, we have inserted two section titles "2.3 Method of comparing COSMIC and ERA5 water vapor data" (L168) and "2.4 Impact of ERA-Interim as *a priori* on COSMIC water vapor retrieval" (L203) to separate Section 2.2 into three subsections.

P9, L264: Not clear why you consider reanalysis data for cloud-free scenes if there should be data available for cloud and cloud-free scenes.
ERA5 provides atmospheric water vapor data for both cloudy and cloud-free scenes. However, there are two aspects to consider in this context. On one hand, it poses a challenge for reanalysis models to accurately represent atmospheric conditions over cirrus or thin clouds, often leading to misclassification as cloud-free scenes. This misclassification introduces uncertainties in the water vapor data obtained from ERA5 for the cloud-free scenes. On the other hand, the water vapor concentration derived from COSMIC in the RO retrieval system may include some effects from the thin or cirrus clouds, resulting in a slightly higher reported value. We have revised the sentence as "In contrast, there are uncertainties in the water vapor from the reanalysis data over the cloud-free scenes since these scenes can be over thin or cirrus cloud due to the difficulty in the data assimilation system over these types of clouds. The water vapor concentration derived from COSMIC is expected to be higher than ERA5 at 300 hPa when the thin or cirrus cloud are present. Our evaluation of water vapor at 300 hPa indicates that the difference between RO and ERA5 about 5.7% is likely due to the uncertainty in classifying cloud-free scenes in the data assimilation and in the RO retrieval system. Such assessment is consistent with the water vapor biases between COSMIC-2 and ERA5 presented in Johnston et al., 2021.".

P11, L292-293: "…….large uncertainties in retrieving water vapor in the reanalyses model……… " Please rephrase. This is simply not correct. A model does not retrieve any data. In a model data is calculated.
We agree with the reviewer and have changed "retrieving" to "calculating".

P11, L295: You should formulate this more carefully. How can you be sure that if there is a bias this is a bias of the ERA5 data? What about the COSMIC RO data? Nowhere in the paper the quality of the RO data is discussed.
We agree with the reviewer. This is still an open question and will need further study. We revised the sentence as "Further comparisons of reanalysis model data with collocated

radiosonde measurements and RO retrievals can help assess and understand the uncertainties in estimating the upper troposphere water vapor.".

P12, L340-341:"……..affecting interhemispheric temperature difference, can affect the interhemispheric water vapor difference". Sentence not clear. It seems in the latter part of this sentence something is missing. Please correct/rephrase the sentence.
We revised the sentence as "These factors, including cross-equatorial ocean heat transport, albedo difference in polar regions, intensified warming of land areas, and reduction of Arctic ice/snow cover, which affect interhemispheric temperature difference, can also be the primary driving factors of the interhemispheric water vapor difference.".

Technical corrections:
P1, L23: upward -> increasing
Corrected.

P1, L24: downward -> decreasing
Corrected.

P1, L26: higher than ERA5 data -> higher than the ones derived from ERA5 data
Corrected.

P17, L453: trending -> trend
Corrected.

P17, L454: delete "than" and move "300 and 500 hPa at the end of the sentence and add "at" before so that the sentence reads: …….is lower by 1.44 and 1.22%/Decade at 300 and 500 hPa, respectively.
Corrected.

P20, L514: is -> are? Consider rephrasing sentence. It is difficult to understand what you want to say.
We have rephrased the sentence to "This indicates that the relatively lower global water vapor trends estimated from COSMIC data compared to ERA5 data at the 850 hPa level (as presented in Table 1) are mainly due to the lower values of COSMIC trends within the middle and low latitude bins.".

P21, L546: slope -> trend
Corrected.

P22, Figure 7 caption: replace 2 times "slope" with "trend"
Corrected.

P23, L584: add "the" -> in the affected regions
Corrected.

P23, L599: replace "degree" by the degree sign "°"
Corrected.