

## Author's Response

### Manuscript:

Innerkofler, J., Kirchengast, G., Schwärz, M., Marquardt, C., and Andres, Y.: *GNSS radio occultation excess phase processing for climate applications including uncertainty estimation*, Atmos. Meas. Tech. Discuss. [preprint], <https://doi.org/10.5194/amt-2023-28>, in review, 2023.

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We revised the manuscript along the editors comments and addressed the final issues. Additionally, we replaced “in submission” or “in press” citations with the final publication references. The authors thank the editor for the professional handling of the manuscript.

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### Comments by the editor

The authors have done a hard work in answering the comments made by the reviewers and modifying the manuscript. However, I see that two important requests have not been totally tackled. Before final acceptance they must be addressed:

1) Referees 1 and 3 are concerned about the use of ERA5 for validation of RO data and request consideration and discussion of this issue. In the new version of the manuscript a sentence has just been extended on this subject. More explanations are needed.

Ok, we further extended the discussion in Section 2.1 on this subject as follows:

“Although the assimilation of RO data has an influence on the ERA5 analysis data, we consider this analysis suitable for supporting the task of evaluation of the quality and robustness of the implemented excess phase processing in this study. We note that for actual validation of data, which is not the focus here, further independent datasets should be used.”

In addition, we checked the text of the whole manuscript whether we inadvertently had used the term “validation” instead of “evaluation” at other places. We found three cases and either replaced the term by “evaluation” or found we can drop it in the context of these sentences.

2) Referee 1 states: "Another concern is the 3 data periods used in the study – they do not cover the most challenging regimes that RO has to track in. Analyzing a more challenging period may shed more light on RO error sources and uncertainty and better inform the community." Later he also writes: "If the authors can't include analysis of these data, then they should at least discuss any issues seen in these more challenging data." The authors replied: "After careful consideration however, we came to the conclusion that the test data periods chosen serve the demonstrative purpose of this introductory paper of the L1a excess phase processing including uncertainty estimation and that reprocessing would be beyond the scope of this purpose." So, what have been the careful considerations of the authors and their conclusions ? And in addition, why would they preclude the authors from even taking into account the request by the reviewer to "at least discuss any issues seen in these more challenging data".

We chose data periods for our study that are representative for different solar cycle conditions, with July to September 2013 representing a period of maximum solar activity with increased challenges for RO signal tracking. In comparison to the other periods of low solar activity, the evaluation of the sensitivity analysis, the rejection rates of the quality control, and estimated uncertainties all showed rather similar behavior. This indicates that the presented algorithmic setup is robustly working over a broad range of geophysical conditions, mainly targeting the rejection of “really un-physical” excess phase profiles for a climate-oriented data processing.

However, as a further crosscheck, we now performed basic analyses of two additional months, October 2013 and January 2014, in the challenging equatorial plasma bubble season. The analysis revealed no major differences again, compared to the data investigated in the manuscript, and also differences in the uncertainty budget for those periods are found to be small. For a truly detailed analysis of different ionospheric conditions, a dedicated study could provide more insights (which we consider beyond the scope of this study, which is already rather comprehensive).

To include information on our further crosscheck, we added the following sentence (*italic*) to the appropriate paragraph in the manuscript:

*“In this study we used three multi-month time periods as basis for the assessment, each comprising 3 months: July to September 2008 (Metop-A); July to September 2013 (Metop-A/B); December 2019 to February 2020 (Metop-A/B/C). These are representative for different solar cycle and summer/winter conditions over more than a decade from 2008 to 2020. As a cross-check, we also investigated data in the equatorial plasma bubble season (September 2013 to March 2014), which involves particularly challenging geophysical conditions, but found no appreciable differences in comparison to the three time periods chosen.”*