Overview

This paper considers the effect of additional GNSS-RO observations from the ROMEX experiment with the JEDI and GFS systems. Overall it is well-written, provides an interesting summary and deserves to be published. I have a few questions on the presentation of the paper, which need to be addressed. Otherwise it is generally in good shape.

We greatly appreciate your valuable and insightful feedback. In response to the comments, we have reviewed and revised the manuscript accordingly. A point-by-point response is provided below in blue for clarity.

Specific comments

L46: It would be helpful to add Samrat et al (https://rmets.onlinelibrary.wiley.com/doi/10.1002/qj.5002) to the list of publications which show the value of GNSS-RO observations. Since it is a data-denial study it serves to highlight that GNSS-RO is one of the most important observing systems currently available.

Thank you so much for providing this reference. It has been added. It is very informative.

L52: I feel that 2,000 daily profiles from other government missions is an under-estimate. By my counting we have: Metop-B/C (1100 occs), FY-3D/C (1100 occs), Tandem/Terrasar/Grace/PAZ (900 occs, combined), Sentinel-6A (1100 occs). All that comes to around 4,200 profiles per day, unless my calculations are off.

Thank you for your insight! This is also related to the other comments “The Fengyun missions appear to be missing from this list”. Fengyun RO data are not available in the U.S. operational data fetch. However, we realize that Fengyun should be counted here. We have made revisions based on the data count given in Anthes et al. (2024) and Marquardt (2024), as well as the statistics in our one-month period.

Anthes, R. A., C. Marquardt, B. Ruston, and H. Shao, 2024: Radio Occultation Modeling Experiment (ROMEX): Determining the impact of radio occultation observations on numerical weather prediction. Bull. Amer. Meteor. Soc., ***105****, 1552–1568. https://doi.org/10.1175/BAMS-D-23-0326.1*

Marquardt, C., ROMEX data processing. The First ROMEX workshop, EUMETSAT headquarter, Darmstadt, Germany, 17–19 April 2024. https://cdn.eventsforce.net/files/ef-xnn67yq56ylu/website/61/565d7153-abac-414f-92dc-5466867616fc/20240417_13_marquardt_et_al_eumetsat_romex.pdf

L138: The Fengyun missions appear to be missing from this list.

Thank you for pointing this out. Fengyun has been included in the revised manuscript.

L145: I find this wording confusing "the supplementary profiles are reduced". Perhaps merge this with the previous sentence: "... is 20,000, meaning that ROMEX20K has approximately 12,000 supplementary profiles per day above the BASE experiment."

Thank you for helping improve the readability. Your comment has been incorporated.

L162: I would suggest that the colour scale on Figure 1 is unhelpful, since it is pale in the centre of the range rather than shifting smoothly from light to dark. If possible, please can the authors update this figure?

Thank you for your comments. Figure 1 has been replotted with a different color bar, incorporating also the suggestions of the other two reviewers. The new color bar uses darker colors to indicate higher numbers.

L247: I assume from the large relative errors above 40km that the authors are also using a minimum threshold for the observation error (3 micro-radians is typical). Please can you state what is used.

Thank you very much for pointing out this. Yes, we are using a 3 micro-radians floor. We have missed the description and added in the revised manuscript.

L253: The sentence beginning "All experiments assimilated" is unnecessary, since it is explained in more detail in the following sentence. Please can you remove / reword this sentence.

Thank you for the comments. The sentence and the following one have been combined/revised.

L258: It would be helpful (here or later) to discuss the experimental limitations. The two issues which seem likely to be the largest are the limited experimental period (only one month) and the limited number of other satellite observations used (no hyperspectral IR, geostationary radiances, atmospheric motion vectors, etc.). It would be good to mention these here and in the summary, as well as any other issues of which the authors are aware.

Thank you for your comment. We have added a discussion of these two limitations, along with other relevant limitations, in the final section. We have also state that atmospheric motion vectors are assimilated in our experiments.

L290: Since the acronym MAE is widely used to refer to mean absolute error (similar to the RMSE), the use of MAER could cause some confusion. Perhaps mean absolute bias reduction (MABR) would be a preferable name.

We agree. MABR is used in the revision.

L302: Since Figure 2 goes up to 55 km, I'm surprised that Figure 3 stops at 40 km. Does this imply that the observations are only assimilated to this level (which would need stating if true)? Please could the authors amend the figure, or clarify the assimilation limits?

We do assimilate RO observations from all missions up to 55 km impact height. To clarify, two sentences are added in the figure caption and the content.

> "All RO profiles are assimilated from the surface up to 55 km using the same configuration, i.e., the same observation error specification and QC."

In the revised manuscript, we have replotted Fig. 3 up to 55 km and changed the plotted quantity from OMB/O to OMB/B, as OMB/B is more commonly used in RO space verification (e.g., Lonitz 2025; Bowler and Lewis 2025). While the plots appear slightly different from the previous version, the conclusions remain unchanged.

Bowler, N. E., and O. Lewis: Understanding the impact of additional observations in the Met Office system. The Second ROMEX workshop, EUMETSAT headquarter, Darmstadt, Germany, 25–27 February 2025. https://cdn.eventsforce.net/files/ef-xnn67yq56ylu/website/66/25c71745-2c8d-488b-be58-02f274ecd1c0/7_20250225_neillbowler_metoffice_romex.pdf

Lonitz, K., Updates on running ROMEX experiments at ECMWF. The Second ROMEX workshop, EUMETSAT headquarter, Darmstadt, Germany, 25–27 February 2025. https://cdn.eventsforce.net/files/ef-xnn67yq56ylu/website/66/9326ec50-ce3e-47b8-b714-24bafb99d8d8/6_new_20250225_katrinlonitz_ecmwf_romex.pdf

L379: It is confusing that the figure caption refers to (a) and (c) before (b). Perhaps the individual plots should be reordered so that wind speed appears as Figure 8(b) so that they are in order.

Yes, it makes sense to reorder. Please see the new figure.

L612: Whilst Figure 16 demonstrates a degradation in the standard deviation of forecast error above 50 hPa, the authors speak about sources of the biases. In fact, the changes noted in the presentations from ECMWF and the Met Office largely focused on changes in the forecast bias, rather than the random component of the forecast error. Therefore, it would be helpful to show plots illustrating the change in forecast bias. Additionally, those presentations largely discussed changes in the geopotential height bias in the troposphere, whereas this appears to be a degradation in the stratosphere. It would be helpful for the authors to discuss this difference.

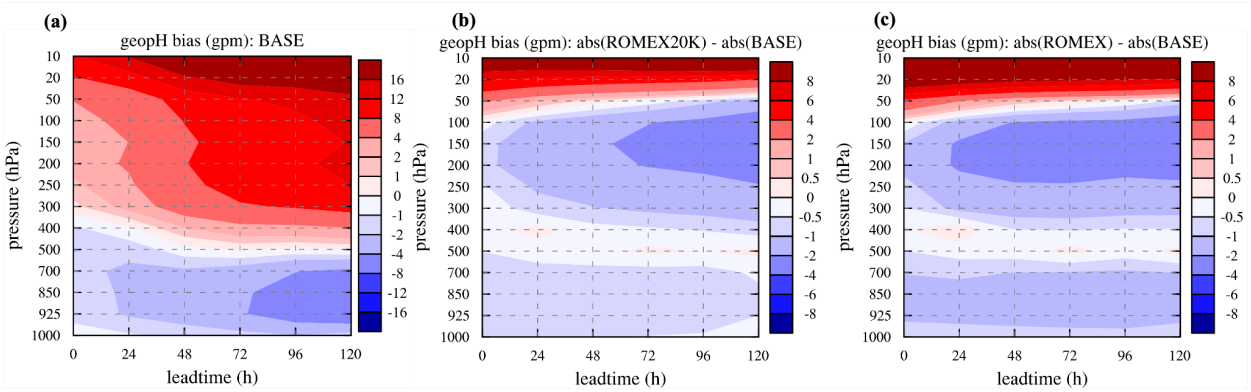

Figure 16: (a) Bias of geopotential height forecast (shaded; unit: geopotential meter or gpm) for BASE verified against ECMWF analysis as a function of forecast lead time for region of NHX (20oN–80oN), and the mean absolute bias (MAB) difference between (b) ROMEX20K and BASE, and (c) ROMEX and BASE. A negative MAB (blue) reflects a beneficial bias reduction relative to BASE, while a positive value (red) indicates a detrimental increase.

Thank you for this very helpful comment. We have replotted Figure 16 and revised the related discussion (see details in the section Summary and Discussion). We have also added remarks on the differences from the results of ECMWF and the Met Office, along with further discussion.