

Below, reviewers' comments are shown in black, and our responses are provided in blue.

Reviewer #1: General comments

This paper describes experiments at NRL with the high-volume GNSS-RO data from ROMEX. Similar to other centres, forecast degradations are seen when the observations are used without any alteration. Experiments using an empirical bias correction and an adjustment of the refractivity formulation are more successful and overall forecast improvements are seen.

The paper is well written, and the conclusions drawn are supported by the evidence that is presented. The paper is a useful addition to the literature, and provides an interesting perspective on the use of large numbers of GNSS-RO observations. My specific comments are largely minor details of presentational clarity.

We sincerely thank the reviewer for their thorough and thoughtful review of our manuscript, and for their kind and encouraging assessment of our work. We have carefully addressed the reviewer's specific comments regarding presentational clarity in the revised manuscript, and we believe these revisions have further improved the overall quality and readability of the paper.

Specific comments

L30, L34 and L40: I would suggest reserving "significant" for contexts in which statistical significance is indicated. In these lines it would be better to use large, substantial or important.

Thanks for pointing that out! We have revised the wording at these lines.

L32: I would add Samrat et al (2025) to the list of references demonstrating the importance of GNSS-RO.

Samrat, N.H., Candy, B., Lewis, O., Cotton, J., Smith, F., Halloran, G., et al. (2025) Observation impact evaluation through data denial experiments in the Met Office global numerical weather prediction system. Quarterly Journal of the Royal Meteorological Society, 151(771), e5002. Available from: <https://doi.org/10.1002/qj.5002>

Thanks for the reference, which is added now.

L41: It should be 6000 COSMIC-2 profiles. I suggest also mentioning that this is a daily number "with the addition of 6,000 COSMIC-2 refractivity profiles per day."

The COSMIC-2 satellites assessed in Cucurull et al. (2018) consist of six equatorial (total of 6000 soundings per day) and six polar (total of 6000 soundings per day) receiver satellites. So it should be 12,000 profiles per day. We added "per day" to clarify.

L43: The CGMS is not part of the WMO. Formally, the WMO is a founding member of the CGMS. Otherwise they are unrelated.

We deleted WMO in that sentence.

L54: 30,000 to 40,000 occultations per day is no longer three times the number of RO observations used in NWP, approximately 20,000 occultations are currently available daily.

It is true that the number of RO profiles available daily has increased substantially in recent years. We have revised the sentence to clarify that the phrase “three times the number of RO observations used in NWP” refers to the number of RO profiles assimilated by operational NWP centers around 2022. At that time, approximately 10,000 RO observations were used daily, whereas the constellation discussed here is expected to provide 30,000–40,000 occultations per day.

L64: Since the data assimilation uses hybrid covariances, it would be useful to note whether the ensemble prediction system is rerun with the additional observations to provide updated covariances with the experiments. Therefore, please can this information be added to the description?

The dependence of background error covariance on the observations is only indirect through the analysis and subsequent ensemble generation from the analysis. There is no additional rerun.

L87: The formatting of this equation makes it difficult to follow how the piecewise linear function is constructed. For instance, the third line is "linearly varies from -0.01% to 0.2% $18 < h < 23$ km". I would normally read that as -0.01% at 18km and 0.2% at 23km. In reality it is the other way around in order to be continuous with the adjacent layers. I would suggest a fundamental reformat of this equation to make the presentation unambiguous. I also note that an em-dash is used in place of a minus sign.

Thanks for noting the inconsistency. We have corrected the end point to make it continuous with the adjacent layers. The appearance of em-dash could be just an artifact of Word equation plugin.

L89: It would be helpful to be clear about whether y' is added to or subtracted from the observation.

The sentence right before the equation was modified to indicate that for each observation, y' was subtracted.

L111: The text indicates that the innovations are normalised by the error estimates. Figure 2 however, also normalises by the background bending angles. Therefore, I would suggest replacing "error estimates" with "the background bending angles and by the estimated observation uncertainties".

Suggested wording added.

L125 and L136: I suggest replacing "error" with "uncertainties", since they are not observation errors.

Replaced.

L135: Please remove "more physically-based". The authors have not presented any arguments for a physical basis for adjusting the refractivity coefficients.

Removed.

L170: Please state what the change is relative to (the ROMEX control presumably).

Added.

L293: It would be worth noting that the RMSE performance at 700 hPa is worse for romex_bc and (to a lesser extent) romex_nl than for romex. This is despite the specific humidity biases (relative to ECMWF) being smaller at this height.

Noted.

L330: The manuscript makes no mention of the possibility of adjusting other coefficients in the refractivity formulation, or the possibility of using more accurate refractivity equations than that of Smith and Weintraub. I feel that these topics should be mentioned, even if they are not addressed directly by the experiments.

Added. Thanks for the suggestions!

Typographical corrections

L9: OSE is normally written as "observing system experiments" rather than "observation".

Corrected.

L18: Please change "treatment of the observation" to "treatment of observations".

Changed.

L25: Please change "low-Earth orbit" to "low-Earth orbiting".

Changed.

L152: Please delete "the most".

Removed.

L199: Presumably you are using the operational analyses from ECMWF. Therefore, please insert "operational" after "ECMWF".

Added.

L229: Please insert a space between "Fig." and "6".

Inserted.

L241: Please delete "change to".

Deleted.

L277: Please change "leads to" to "demonstrates" as this reads more clearly.

Changed.

L298: Please add "analyses" after ECMWF and change "observation" to "observations".

Changed.

L313: Please add "for dry air" after "refractivity coefficient".

Changed.