Atmospheric Measurement Techniques Discussions

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Comment on amt-2021-197

Anonymous Referee #2

Referee comment on "Towards operational multi-GNSS tropospheric products at GFZ Potsdam" by Karina Wilgan et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-197-RC1, 2021

Dear authors,

Thank you! I enjoyed reading your paper. That said, I sometimes miss clear statement of your novelties and the links/interpretations w.r.t. existing literature. I hope that the questions and suggestions below can help you to improve further your manuscript.

Question 1: (GNSS data processing)

- In Table 2, you mentioned that the antenna model is IGS08-1854. Why didn’t you used a more up-to-date version in IGS14?
- Galileo observations: some authors have seen that adding Galileo observations to compute ZTD may introduce a bias (at few mm-level). Have you seen such bias? Are they comparable to amplitude mentioned any existing the literature?
- Which Galileo satellite PCO/PCVs did you used in your analysis? More recent IGS14 ATX models might include more recent/precise calibrations for Galileo satellites.
- You mentioned that you used atmospheric tidal and hydrostatic loading models. Which models did you used?
- The title of your manuscript state “multi-GNSS” but you have “only” considered the G, R, and E systems. Why haven’t you considered others like Beidou? Particularly since you have stations in Asia and you mention that JMA is operationally assimilating GNSS troposphere products. Btw., they don’t assimilate “GNSS observations” (Intro, line 29)

but “GNSS troposphere products”.

Question 2: (short observation period)

It is well known that the performance of a tropospheric product is not constant over time. Bias and standard deviation will also vary over time and depend on the weather/climatic conditions. How can you conclude about the overall performance of your product based on solely one month of data (Winter, October 2020)? What is the performance of your product during other seasons / under other weather conditions? Including e.g., one year of data or several periods could answer this question.

Question 3: (Dataset sampling and comparison methodology)

- One major advantage of using ERA5 data is its time resolution of 1h. Your GNSS data processing provides ZTDs every 15 min and STDs every 2.5 min. Why did you compare only at 3 h time resolution for ZTDs and at 6 h resolution for STDs? As you included only one month of data, it can’t be a too large number of point (at least for ZTDs and gradients). Also, it seems that for the comparison with ICON, the comparison is done at 1 h time resolution. If yes, why is it not the case for ERA5?
- How did you down-sampled you datasets from 15/2.5 min to 3/6h? have you only considered simultaneous points or did some kind of average?
- How did you compare GNSS solutions and NWP? Did you choice the nearest grid point from the NWP model or have you implemented something like a weighted mean of the 4 nearest grid points? How did you take into account the altitude difference between the NWP surface model and the GNSS station location? Did you apply any height correction for it? If yes, which one and how?

Question 4: (Reconstructing STD using post-fit residuals)

- When reconstructing your STD, have you compared you results with and without adding the post-fit residuals? Not all studies consistently conclude that post-fit residuals should be added when reconstructing STDs. They usually conclude that post-fit residuals obviously contain some tropospheric information but residuals can also be noisy, hence deteriorating the reconstruction of STDs. This is worth to discuss in your paper!

- Also, using a more advanced mapping function (rather than just 1/sin(el)) would be better. Have you considered it? What is the estimated impact of using the 1/sin(el) approximation instead of a better mapping function?

Suggestion 1: About the amount of stations / area of interest

In the introduction, you mention that your area of interest is Germany but processed a global network of 613 stations. Then, the paper alternates/mix results focusing on 218 stations in Germany, other using all stations world-wide, some results on 432 GRE-only stations... This is sometimes a bit confusing. In addition, your results outside Germany clearly emphasize a less good agreement, particularly in the southern hemisphere and low latitudes clearly. If your target is Germany, maybe you can focus on the results of the 218 German station only? This will greatly help in clarity. However, if your targeted area is global (e.g. for data assimilation in global NWP models), then you can still simplify your paper by not mentioning the 613 station but by focusing on the 432 GRE-capable world-wide stations (forgetting to mention about the other 181 station won't affect your findings as your results are based on solely the 432 stations and your are using PPP). Note also that if you retain the world-wide area, your argument of not including Beidou doesn't hold anymore as a significant part of your network is tracking Beidou. Even stations in Europe/Germany does (e.g., PTBB00DEU, https://epncb.eu/_networkdata/data_quality/skyplots/index.php?station=PTBB_14234M001).

Suggestion 2: Merging section 4 (results) and 5 (discussion)

Merging both sections would increase the readability and quality of the paper by making clear links between your results and the existing literature, by comparing your findings with them, and carrying out an in-depth interpretation. It will also help to emphasize your novelties wr.t. to this literature.

Suggestion 3: Galileo observations and Outliers

It seems from your graphs that adding Galileo helps in better solution consistency/stability, i.e., reducing outliers... Developing more this point in your manuscript would be an added value. You can for example analyse the impact of the different solutions on extreme values, outliers... (think e.g., to whisker plots).

Suggestion 4: Improving some plots

In some plots, you can barely see any differences between the G, GR, GRE time series. Three time series that you cannot differentiate by eye are maybe not worth to show? Have you tried to plot instead the difference between GR and G and between GRE and G (i.e., taking G as a reference)? Would it help your interpretation? For some plots, another trial could be to replace the time series by other metric(s) e.g., a whisker/box plot (that includes outliers) for each 3 solutions?

Suggestion 5: ERA5 – ICON agreement

You can also add an information on how do ERA5 and ICON compare during your studies. That way you will have somehow how “observation compare to model” and “how models compare together”.

Suggestion 6: Precipitation data

From your manuscript, it seems you can access precipitation data, at least in Germany. It might be interesting to add this data in your analysis (e.g., aside of ZTD and gradient time series). Does adding more constellation helps estimating ZTD/Gradients/STD during precipitation events? Or does the G, GR, GRE solutions agree together while GNSS solutions and NWP model disagree?...

Suggestion 7: Acknowlegements

Add a reference for IGS and for EPN in the Acknowledgements.