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Annales Geophysicae Discussions

Interactive comment on "Sensitivity of GNSS tropospheric gradients to processing options" *by* Michal Kačmařík et al.

Anonymous Referee #1

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* General comments *

This paper investigates the estimation and modeling of GNSS tropospheric gradients from a benchmark dataset set up for the COST GNSS4SWEC project. Different analysis strategies are evaluated (gradient mapping function, GNSS constellation, cutoff angle, satellites orbit and clock latency: PP vs RT, data weighting) by cross comparisons and also compared with respect to NWP model retrievals. The results are pretty conclusive; comparisons of tropospheric gradient maps are noteworthy (except for some RT cases). PP analysis agree. Positive impact of low elevation observations and multi-constellation is observed. RT analysis induces increase of standard deviations wrt NWP models. Systematic differences induced by the modeling of elevation-dependency of gradients (mapping functions) are also observed; they may be reduced

by the use of an observation elevation weighting. Some recommendations about the use of gradient mapping-function are then expressed according these results.

This paper is very interesting, clear, well organized and also well written. References are relevant and appropriate (and also well formatted).

I recommend the editor to accept the papers with minor revisions according to the following specific comments and technical corrections.

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* Specific comments *

.p03/l13: is it not hazardous to include post-fit residuals into STD formulation? PFRs represent mis-modeling of troposphere, but also for antenna mis calibration, multipath, liquid water, unmodeled solid earth displacements, etc.

.p03/l30: why do not describe further the tilted mapping function as BS and CH?

.p03/l33: in my opinion "Gn*cos(a)+Ge*sin(a)" is not "the projection of the horizontal gradient vector in the direction of the individual satellites": it has to be multiplied by mfg(e), otherwise it is the projection onto zenith of horizontal gradient magnitude.

.p03/l31-p04/l08: I wonder if figure 1 is really useful. A simple comparison of mapping functions plotted according elevation will highlight the maximum values of each mf. The right part is shortly described in text, but it is not used to support any statements. Moreover, the black dots (for a single epoch, 20:30UTC) do not help to support any statements either. Maybe you could just replace this figure by a mfg comparison.

.p03/l15: why did you not use the tilted mfg? I think that its use is not essential since it takes values between BS and CH, but you have to mention it clearly (as a consequence of figure 1).

.p06/l5-p06/l10: as you mention, gradients retrieved from NWP depends on mfg (BS or CH). Why do not use your ray-tracing algorithm to compute gradient with their closed

form expression depending on NS and EW horizontal gradient of refractivity? (See Davis et al., 1993, RS)

.p06-p07: Did the gradient modeling affect the estimation of positions? Maybe you could complete Table2 with comparisons of position (height?) repeatability?

.p07/Table2: I think it is important to have an overview of gradient time series in order to understand the comparisons. Especially, unlike for ZTD we do not have many ideas about gradients magnitude (maybe some ideas from figure 1): is a 0.01 mm bias significant? and a 0.76 mm stdev? These values may be put into perspectives with gradient magnitude.

.p07/Table2: I wonder if the computation of correlation will be helpful to investigate the comparisons. A linear fit?

.p07/Table3: same comments as for table2. Maybe the computation of correlation or linear fit will be more relevant here.

.p10/l13: the RT3GxCH3 do not use Glonass satellite. Why will this solution be affected by Glonass RT corrections?

.p11/l20: Are there any other indications to help to identify these two outlier stations? ZTD, position estimates? Formal errors?

.p13/l3: I think that figure 4 may be described more deeply. First by comparing the impact of the two OEW, then the combined impact of OEW and mfg.

.p13/l5-12: I do not succeed in fully understanding Figure 5 and your remarks related to it (see also next comments). It should be clarified.

.p13/l5: Are differences cumulated during the full day?

.p13/l6: "In this case ... ": I am not sure to understand: did you mean that this figure helps to highlight that systematic differences affect both magnitude and direction?

.p13/l7-l9: Could you explain these two sentences: "A positive difference... points to east" & "Negative... opposite directions". I do not understand (1) how can differences remain positive if you compute A minus with B>A for example (2) how negative values are obtained when gradients point to the opposite direction. This is maybe trivial, but I do not succeed in getting it!

.p13/l10: The decrease of maximum systematic differences with OEW SINEL2 is not obvious.

.p13/l11: Why do not show other weighting, especially SINEL4 which is mentioned to reduce systematic differences?

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* Technical corrections *

I recommend the authors to improve legibility of figures (by using a better resolution)? I also recommend the use of an equation editor for mathematical expressions.

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