

Atmos. Meas. Tech. Discuss., author comment AC2  
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## Reply on RC1

Chaiyaporn Kitpracha et al.

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Author comment on "Validation of tropospheric ties at the test setup GNSS co-location site Potsdam" by Chaiyaporn Kitpracha et al., Atmos. Meas. Tech. Discuss.,  
<https://doi.org/10.5194/amt-2021-87-AC2>, 2021

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### General Comments

Four GNSS installations, with the antennas located at different heights, are used to compare the corresponding estimated equivalent zenith propagation delays. The observed offsets in the ZTD agrees with theory together with methods to determine the refractivity in the atmosphere in the layer(s) between the antenna installations.

There are no new findings. All results are predictable. Please excuse a simple example. The study reported in the manuscript is similar to dropping a ball from different heights and using a stop watch and conclude that the longer fall time observed when the ball is dropped from a higher level is in agreement with different models used to predict the value of the acceleration due to gravity.

Although the manuscript is reasonably well structured and parts are also interesting to read I miss new results as already said. Perhaps the authors are aware of this? The last paragraph in the conclusions starts with the sentence: "Further investigation is required as this experiment was conducted only for a short period of about five weeks." I recommend to extend the time series with many months, preferably covering at least one year in order to pin down systematic effects,

to quantify multipath effects (see e.g., King and Watson (2010)), to develop a model for the radome (see e.g., Liu et al. (2019)) and/or calibrate the antenna including the radome (see e.g. Schmid et al., (2016)).

King, M. A., and C. S. Watson (2010), Long GPS coordinate time series: Multipath and geometry effects,

J. Geophys. Res., 115, B04403, doi:10.1029/2009JB006543.

Liu, J., Li, L., Yong Zuo, Y., Huaming Chen, H., and Shaojie Ni, S. (2019),

Analysis of Performance Degradation Introduced by Radome for High-Precision GNSS Antenna,

Int. J. Antennas Propagat., Article ID 1529656, 13 pages,

<https://doi.org/10.1155/2019/1529656>.

Schmid, R., Dach, R., Collilieux, X., Jäggi, A., Schmitz, M., and Dilssner, F. (2016),

Absolute IGS antenna phase center model igs08.atx: status and potential improvements,

J .Geod., 90:343–364, doi:10.1007/s00190-015-0876-3.

### **Response:**

First, we would like to thank you for your time reading our manuscript in detail and for your insightful comments. We carefully considered your comments and addressed all your points in the text. Concerning your concern about the novelty of the study, we would like to express our point of view: tropospheric ties are essential information for connecting atmospheric parameters between space geodetic techniques. Over the past few years, local ties (station coordinates differences) have improved estimated station coordinates from space geodetic techniques, which are very important for reference frame derivation. Likewise, tropospheric ties can also improve space geodetic techniques-derived atmospheric parameters, which are essential for climate studies. However, the systematic effects of tropospheric ties need to be addressed. This comes to our motivation in this study. The key of this experiment is the very precise assessment of the quality of tropospheric ties, excluding instrumental effects. Therefore, we applied the same antenna and receiver types with different heights but quasi no horizontal distance. Our experiment can thus be understood as a best-case scenario, where instrumental effects are mitigated. Due to the various heights, multi-pathing affects the antennas in different ways, as clearly demonstrated. The multi-pathing has been found to be much more of a problem for gradients than for zenith delays. All these error sources will have to be considered if tropospheric ties are used for the combination of space geodetic techniques or if GNSS-derived information is to be used in meteorological models. In our next experiment, we will explicitly study the instrumental effects. This work is currently performed. To our knowledge there is no specific study done in this way. Most of the studies use just available instruments, e.g. at Wettzell, which however are dislocated in horizontal direction and are made of different receiver/antenna combinations, so that individual effects on tropospheric parameters can only quantified as a whole but cannot studied in detail. This is the novelty of this study.

### Specific comments

In the abstract it is stated that the different atmospheric estimates obtained for the antenna with a radome is surprising. This is not consistent with the reference on page 8, line 158, to the IGS guidelines. It is well known that radomes can introduce offsets in atmospheric estimates and depending on the shape of the radome this offset may vary with the elevation cutoff angle used in the analysis.

**Response:**

We have edited the sentence in order to avoid misunderstanding.

In Subsection 3 there is a reference to an Appendix. I would certainly prefer to have this simple table with uncertainties directly in Subsection 3.3. Furthermore, the Appendix can be shortened significantly. The table itself is sufficient.

**Done**

Concerning the data availability I think it shall be made available in an open repository with a doi number. (Who knows the availability of the contact author some (many) years from now?)

**Response:**

The data of this experiment is available from GFZ data services (<https://doi.org/10.5880/GFZ.1.1.2021.005>). We inserted this reference into the manuscript as well.

## Technical Corrections

page, line 6: a antenna --> an antenna

**Done**

page 1, lines 6-7: a meteorological sensor was used for meteorological data recording.

--> sensors were used for meteorological data recording.

**Done**

page 1, lines 15-16: "Nowadays" is followed by a reference from 2014?

**Done**

page 1, line 21: water vapour distribution --> water vapour content

**Done**

page 5, line 75: What is the meaning of SPKE? Please define!

**Response:**

SPKE: SPECTRA PRECISION conical dome with spike, used with the SPP571908273 antenna; also sold by Aeroantenna and NovAtel (<https://semisys.gfz-potsdam.de/semisys/scripts/hardware/radome.php>) . We have added an explanation in our manuscript.

page 3, line 77: to increasing --> to increase

**Done**

page 3, lines 78-79: 300 seconds --> 300 s (SI rule)

**Done**

pages 5-6, Figures 2-3: Fix the axis labels. They cannot be understood.

**Response:**

This problem was caused by the journal side during the generation of the preprint version. I have uploaded the correct figure into the author's comments post on the public discussion page.

page 6, Table 1: there is no need to have a resolution of the result at the micrometre level. This shows that the offset correction is so simple so that any one of the methods can be used to achieve the same accuracy.

The resolution of the results presented in Table 4 is also much too high, i.e. not significant.

**Response:**

We cannot confirm the second statement of the reviewer. The Potsdam experiment is likely the best-case scenario where the various methods agree exceptionally well. However, at other geographical regions and in particular with larger horizontal/vertical distances involved, the demonstrated methods will most likely differ much more. As we do not show this in this study, we do not mention it in the manuscript.

page 7, line 126: "cos" shall not be in an italic font.

**Done**

page 8: The title "Results" of Section 4 is too general. Results have already been presented in Section 3. Perhaps "Results for the GNSS estimates" is better?

**Response:**

We have updated the title of chapter 4 from "Results" to "Comparison of GNSS-derived atmospheric parameters".

page 8, line 159: This reference appears first in the reference list. Why is not IGS in alphabetical order. It took some time until I found it ...

**Response:**

We have fixed this issue in our manuscript. Thank you for pointing out this mistake.

page 9, Figure 4: Only S0 and S4 can be identified in the graph.

**Response:**

We have added the explanation in the caption of this figure in the manuscript.

Journal names do not adhere to standards, see e.g. according to:  
<https://www.library.caltech.edu/journal-title-abbreviations>

**Response:**

We have updated journal abbreviations now following the mentioned standards.

**Response:**

Thank you for a good recommendation. We implemented all these technical corrections into our manuscript.