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The Cryosphere Discussions

Interactive comment on "An assessment of sub snow GPS for quantification of snow water equivalent" *by* Ladina Steiner et al.

Anonymous Referee #2

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The presented paper shows an interesting and well designed study to highlight the strength and shortcomings of using GPS measurements from sub snow antennas to estimate the snow water equivalent. Nearly three years of GPS data together with reference data are used for this task. This paper brings into application the method described in Steiner et al. (2018, J.Geodesy) where the model of a thin water shell was developed to describe the snow water equivalent. The scope of the study fits the topics of this journal. The paper contains significant new material and interesting results. It is very well structured and thus easy to follow.

I have some smaller remarks: The reviewer would like to point the attention of the author to the former IAG study group on site specific effects where among other the impact on snow on the radoms and antennas were studied. Furthermore the following

two references could be useful: Jan M. Johansson: Special Study Group 1.158: GPS Antenna and Site Effects. Two further papers could be useful references: S. Vey, A. Güntner, J. Wickert, T. Blume, H. Thoss and M. Ramatschi, "Monitoring Snow Depth by GNSS Reflectometry in Built-up Areas: A Case Study for Wettzell, Germany," in IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 9, no. 10, pp. 4809-4816, Oct. 2016.doi: 10.1109/JSTARS.2016.2516041 S. Tabibi, F. Geremia-Nievinski and T. van Dam, "Statistical Comparison and Combination of GPS, GLONASS, and Multi-GNSS Multipath Reflectometry Applied to Snow Depth Retrieval," in IEEE Transactions on Geoscience and Remote Sensing, vol. 55, no. 7, pp. 3773-3785, July 2017.doi: 10.1109/TGRS.2017.2679899

Eq.(1) For curiosity: it would be nice to give the typical range of delays.

P7.l11 "which takes these correlations into account". Please specify more clearly what is the meaning of sentence and how this is realized when a common estimation is carried out.

P7.l16 Please could you give a comment on the potential maximum temporal resolution of SWE estimates. Which SWE data rate could reliably be feasible and are there useful applications, such as monitoring intense snow fall during a day or extreme melting?

Table 1. For me, some more explanation how to read the numbers are necessary. Are the values of the first lines (2015/16-2017/18) to combine? If so, please explain how to interpret the number of samples and why b is smaller than all the other values while m is only slightly steeper. Is a weighted average used when combining the "combined" individual years to the overall "combined" solution?

Figures 4, 6, 7, 8, 9: If not regulated differently by the journal style file. I would personally prefer increased figure sizes with a larger line size and a larger caption font size for a better readability.

P14.l1ff I wonder, the large a posteriori variance factor, especially when comparing

to the expected noise of L1 observations of 1-2 mm. My explanation is rather that systematic effects remain in the residuals that yield an increase in the a posteriori variance factor, see also your explanations on P16.l9ff. Do you have any explanation for this problem? We can suppose the antenna positions and the relative distance well known.

P18. Could you give a typical snow volume, the SWE is representative for?

P 21 l22 Please check the reference Rao et al.

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