

Interactive comment on “Potential permafrost distribution and ground temperatures based on surface state obtained from microwave satellite data” by Christine Kroisleitner et al.

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We would like to thank the reviewer for the evaluation of our study and the constructive comments.

Regarding general comments '... An across-approach evaluation of where permafrost is likely/unlikely to be, with an estimate of the uncertainty, would be something new and original (and very useful).'

Reply: We would like to thank the reviewer for this very good suggestion. This direction is what we actually had in mind when comparing the results to borehole records

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for different regions separately. We propose to include a direct comparison between the methods focusing on uncertainties and choosing appropriate methods regarding the information types (yes/no versus actual temperatures) and restructuring the paper accordingly.

Comment (1) Preparation of borehole data (sections 3.1 and 3.3)

Reply: The aim of using such a method was to have all regions represented. We have actually tested the approach for all sites where some information on MAGT was available in the meta data before making this choice. MAGT is sometimes provided for a selected, arbitrary recent year. In rare cases, the depth which should be used for MAGT calculation is given. MAGT information is missing for most records in Asia. Figure 1 shows a comparison between the long-term average derived by our method and numbers provided in the meta records. Note that the latter represents single years only, which differ from borehole to borehole. This may add to the deviations. We propose to include a refined version of this analyses where we compare it only for the years for which the MAGT is given in the meta data and quantify the accuracy of this method. In addition we propose to include a comparison of determined sensor depth for those sites where there are recommendations available.

Comment: 'You mention in your discussion(!) that you used a threshold of 1m depth. Why?'

Reply: MAGT near the surface can be much colder than at larger depth as pointed out by you in your comment and as it can be nicely seen in figure 11 of Ekici, et al., 2015. The 1m limit is supposed to account for this. For some specific sites it may still be problematic (like the mountain site Schildhorn shown in Ekici, et al., 2015), but as shown by our test (Figure 1) is valid for most lowland permafrost sites. Thanks for pointing out this oversight, that we did not include this information in the methods section.

Comment: 'Did you only consider data where MAGT was provided, or did you compute

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MAGT from higher temporal resolutions? If so, how did you treat missing values?

Reply: In order to be able to relate the information from the satellite to the boreholes on an annual basis (or actually two consecutive years), we need to derive the information ourselves. Years which contained 'no data' in their records have been excluded from the analyses.

Comment: '(2) Model parameterization for ground temperature retrieval (chapter 3.4) You state that only data in the range of 150 to 330 frozen days of year (DOY) were considered. Does that refer to observational data or satellite data? Why did you use those thresholds?'

Reply: The range was used for both observational data and satellite data. Constraining the analyses to this range allows for reduction of artifacts in the freeze/thaw datasets. They can occur e.g. in areas with larger water bodies. Regarding the applicability of the MAGT determination, see above comment.

Comment: '...the scatter plots in Figures 5 and 6 show no indication that a linear model to fit frozen days to MAGT would be valid.'

Reply: We propose to rephrase related sentences, e.g. in the discussion: The performance of the empirical model for MAGT (coldest sensor) is partially lower than -> The application of a linear function for MAGT (coldest sensor) retrieval leads to partially lower than ... in the conclusions: A linear empirical model can be applied ... -> A linear empirical model may be applicable ...

Comment: 'The figures need improving to be conclusive, and the Results and Discussion sections need to be more concise and refer to figures that actually help to understand them.'

Reply: We propose changed figures with the new structuring and focus and subsequent adaption of the results and discussion section.

Comment: 'Figure 1 Add the outlines of at least continuous and discontinuous per-

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mafrost from the map by Brown et al. (1997) as lines to both subplots as orientation.
Reply: we agree

Comment: 'Figure 3 could very well be a table.' Reply: We agree

Comment: 'page 7, line 3 Why is there a reference to Figure 1 here? The description of Figure 1 states that it shows the permafrost extend based on the 180 days threshold.'
Reply: This reference is indeed not correct. Thanks for pointing this out.

Comment: 'Figure 4 This could easily be shown in just one panel, giving the different data sets different colors.' We agree.

Comment: 'page 7, line 5 The paragraph on MAGT makes no sense.' Reply: We suggest: Old: More locations with positive MAGT fall in areas with values above the threshold for both ASCAT results than for SSM/I New: With the DOY threshold of 180 days, the algorithm tends to overestimate the amount of negative MAGT values, while the threshold found by the Kenall's Tau leads to an underestimation of negative MAGT values below the threshold.

Comment 'Section 4.2 page 7, line 12 The first paragraph needs an introductory sentence.' Reply: We suggest: The comparison of the satellite records with in situ data reveals differences between them.

Comment 'Figure 6 should be included into Figure 5.' We agree.

Comment 'Figures 7 and 8. Your algorithm works well on both of you test years. That could be demonstrated in a simple table, it does not require those two figures.' The figure was intended to show the regional differences between the different approaches. With a direct comparison as discussed above it would become obsolete. Figures for actual comparisons will be included.

Comment 'Figure 9 should be a table.' We agree.

Comment 'page 8, lines 5 to 17 Those paragraphs discuss mapped permafrost extend.

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Why are they in the MAGT section?’

Reply: The derived MAGT (using a 0° threshold) is eventually used to also derive permafrost extent. We propose to add an introductory sentence at the beginning of these paragraphs and to change the subsection title: Mean annual ground temperature -> Mean annual ground temperature and permafrost extent

Comment: ‘Figure 10 The colors referring to Permafrost types are difficult to distinguish from each other. The same for the colors referring to threshold. Stations marked with red dots are not explained.’ Reply: The stations with red dots are included in the legend in the lower centre. This legend has a different orientation than the others. We propose to adjust the orientation for better readability, as well as the colors.

Comment: ‘I would suggest to follow the order in which you presented the results (first permafrost extend and then MAGT) also in the discussion. You mix up the discussion of both with no apparent reason.’ Reply: Thanks for pointing out.

Comment: ‘page 10, line 17 You argue that in shallow boreholes in very cold climate like Cen- tral Russia and Central Siberia, boreholes with depths below five meters would yield positively biased MAGTs. That is not necessarily correct. Have you looked at the temperature profiles of those stations in detail, or are you just stating a hypothesis?’

Reply: We refer here to the validity of the choice of coldest sensor in regions outside of permafrost (with temperatures above zero at coldest sensor depth). As shown in Figure 1, there are almost no stations in this category which list actual MAGT in the meta data which could be used for verification. We propose to remove the statement.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2017-162>, 2017.

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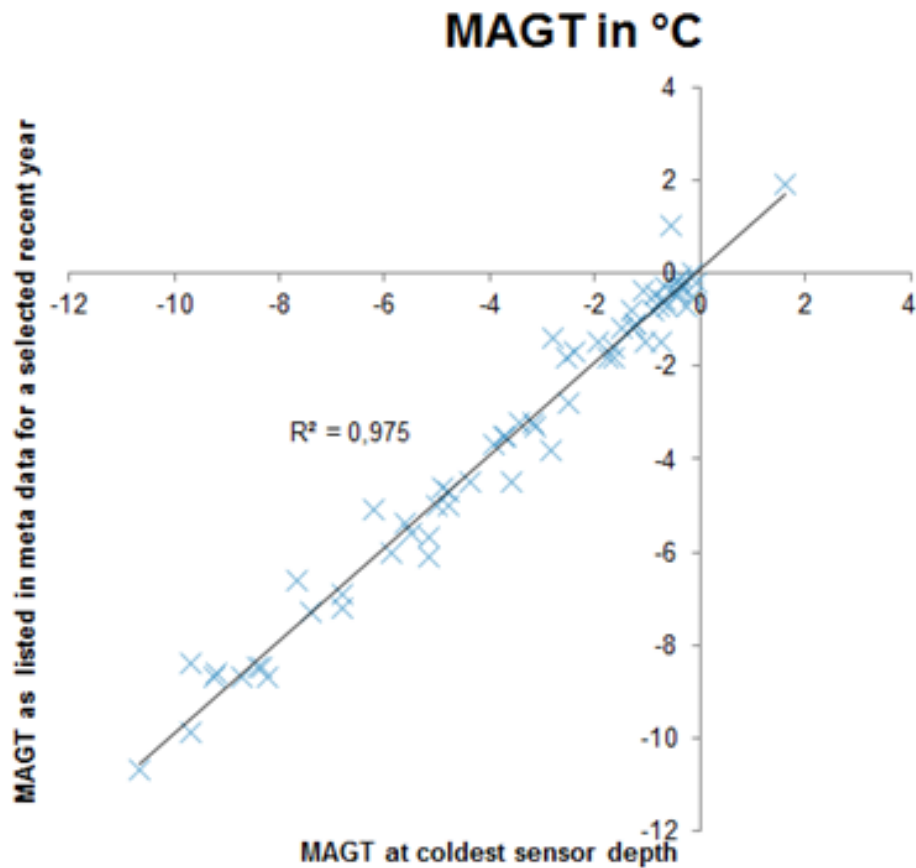


Fig. 1. Comparison of MAGT calculated at the coldest sensor (long-term) and MAGT provided in GTN-P meta records (where available). The latter represents single arbitrary years only.