Responses to Reviewer's Comments and Suggestions
(Responses are shown in blue.)

Comments to the author:

I have received the review report with significant change requests. Please address them in your revised version of the manuscript.

Review comments on ESSD-2021-83

Yohua Ran et al. present a relevant raster data collection of permafrost related ground quantities, these are the GCOS Essential Climate Variables ECVs: Mean Annual Ground Temperature (MAGT) that the authors refer to at the Zero Annual Amplitude (ZAA), and Active Layer Thickness (ALT) and permafrost probability.
Still there is the mismatch of the MAGT training data set that includes a wide range of non-ZAA measurement depths, e.g. Roshydromet boreholes reach a maximum depth of 3.20 m only, not ZAA.
The MAGT raster product represents mapped MAGT in a ground depth range of around 3 m to 25 m, potential users of the MAGT product Yohua Ran et al. should be made aware of it, specifically if they want to undertake comparisons with their own ground temperature data or with other map products. The authors should make this statement in the abstract, in the manuscript text, in the figure captions when the MAGT product is shown and also in the abstract of the data publication landing site.
Response: Thank you for your suggestion. We have added this statement to the abstract, the manuscript text (Sections 2.1 and 3.1), the caption of Figure 3 and the abstract of the data site.

In their edited new version, the authors added more information on the MAGT training data and the reference of Karjalainen et al. 2019 and added a paragraph discussing the variation in ZAA. It is understandable that from this multitude of contributors and programs no data publication of the ground data can be required. However, transparency is still lacking, specifically information on the range of the depth of the MAGT value. In this context, it is inevitable that the authors need to show an overview – in the form of a table on the content of the MAGT training data covering the time window 2000-2016
This information is needed stratified related to program/source/author contributing the MAGT values: program/source/author for the time window 2000-2016
i) the authors should indicate the number n of stations that they used from the respective sources, ii) important: the authors need also to indicate the potential depth range min, max – or in case of Roshydromet the chosen depth of 3.20 m iii) the authors should indicate the estimated percentage of known ZAA depths to this group (the authors provide in the text an estimation of ca 75% for the full data set), e.g. in case of Roshydromet it would be zero.
Response: According to your helpful suggestion, we have provided an overview of MAGT data in the form of a table (Supplementary Table 1). "For the significant portion of boreholes (>75%)

without confirmed depth of ZAA" is a clerical error. This means that the depths of 75% of the sites are deeper than 8 m. We have removed this statement and improved the description.

The authors should add following discussion points

i) the authors need to include a discussion and a reference on the most actual mapped permafrost GCOS ECV products that are available: the European Space Agency ESA provide in their Climate Change Initiative CCI program also GCOS ECV Permafrost products. The first version of Permafrost CCI MAGT, ALT and permafrost probability products were released already in 2020, these products were already available when Ran et al. composed this manuscript. Since spring 2021, the newest version of Permafrost CCI MAGT, ALT and permafrost probability products are available for download to the permafrost and climate science communities.

Response: Thank you. This product is surprising and provided an annual ALT and ground temperature at various depths during 1997-2019. We have added this in section 1. A citation was also added.

"The European Space Agency (ESA) Climate Change Initiative (CCI) also provide permafrost products including MAGT, ALT and permafrost probability that are derived from a remote sensing-driven CryoGrid model (Obu et al., 2021). The annual ALT and ground temperature at various depths during 1997-2019 with 1-km resolution are uniquely available for the permafrost and climate science communities, although broad validation is needed, especially for ALT products."

ii) the authors should add a paragraph in discussion, on the fact if they are comparing the spatial extent of products, often in discontinuous zones permafrost still may occur at deeper layer but has thawed in lower depths. E.g. if the authors compare permafrost probability a product with a low specific product depth, e.g. 2 m, might contain no permafrost, but the Ran et al. product might contain permafrost because it relates to a deeper ground depth.

Response: Thank you. Our comparison confirms your comments. A short paragraph has been added in section 3.2 to clarify this issue, as follows:

"This result is generally consistent with those of existing studies (Zhang et al., 2008; Gruber, 2012; Chadburn et al., 2017; Aalto et al., 2018; Obu et al., 2019) and logically consistent with the ESA CCI permafrost area defined according to MAGT at 2 m (Obu et al., 2021). Our results contain permafrost in discontinuous zones while ESA CCI data contain no permafrost, because permafrost still may occur in deeper layers but has thawed at shallower depths."

iii) the authors should be more careful in relation to their ALT map product: Training data are rare for the vast Siberian region. E.g. comparing the Ran et al. product with existing ALT and Active Layer Depth measurements in Siberia the ALT product shows unreliable ALT data for the lower latitudes: they are far to low for large parts of Yakutia. In contrast, in several Siberian mountain regions ALT (ranges in the Ran et al. product > 1 m) seem to be overestimated by a magnitude of 3 to 5. The authors should discuss carefully these regional gaps in the training data set.

Response: Thank you. Yes, the uncertainty of the predicted ALT is considerable, which is strongly limited by the availability and spatial representation of training data. According to your very enlightening comments, we have added this passage in Section 3.1.

"Of course, the uncertainty of ALT is considerable, especially in the vast area of western Siberia

where the training data are sparse. The low spatial representativeness of training data may lead to an overestimation in several Siberian mountain regions and underestimation near the lower boundary of permafrost. This highlights the importance and urgency of strengthening global coordinated ALT observation networks."

Data publication:

There is no read me file or product description available in the downloaded data package. The authors need to add a Read me file

They should provide information on the Units for ALT, MAGT, permafrost probability

Also information on no data value is required to enable easy re-use of the product.

Would be good to provide in the read me file the information on the spatial resolution and also in the abstract text of the landing page.

Response: Thank you. These are good suggestions. We have added a short readme file with the data package. The units and spatial resolution of the datasets are provided in the read me file. The abstract of the data landing page will also be updated. Moreover, the ESSD data paper, which the best product description, will be available in the data package. Because it is only several files, not long time series data, we prioritize supporting software reading and keep the "no data" value (i.e., -9999) that is compatible with ArcGIS.