The Cryosphere
Discussions

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Interactive comment on "Eurasian snow depth in long-term climate reanalyses" *by* Martin Wegmann et al.

Martin Wegmann et al.

martin.wegmann@univ-grenoble-alpes.fr

General comments: Overall, this a informative and relevant paper with some issues, which need to be resolved. The paper investigates the performance of different reanalyzes products in representing snow depth in the NE part of Eurasia. The authors use daily snow depth measurements from 820 Russian meteorological stations to compare climatologies and 13 long-term stations to analyze temporal differences. The topic of the investigation fits very well into the journal's scope. It is one of the very few studies that thoroughly evaluates the snow depth represented in different reanalyzes products. As such, I consider the work as being relevant for the scientific community. For most parts, the methods are described appropriately and the conclusions are well-based on the results obtained. The paper however suffers from a simple overview (look up table) of the underlying datasets. Please see the listing below for further details. These

issues should be improved before publication of the paper. For this purpose, only very few new analyses are required and the basic structure of the paper does not have to be changed. I'd therefore suggest returning the manuscript to the authors for minor revisions.

Response: We thank the reviewer for the support and valuable comments and suggestions that we address in detail below. The overhaul suggestions improve the clarity of the manuscript.

Major issues: - For readers not familiar with reanalysis products a paragraph is missing where it is explained which snow variables are provided in such products and how they are calculated.

R : Indeed, this information was missing. We added a paragraph about snow computation in the reanalyses at the end of section 2.1

- A table is missing where the characteristics of the different reanalysis products are listed. Such a table should contain which product belongs to which of the two families, what are the differences in regard to the assimilated data, what are the differences in spatial and temporal resolution, etc.

R : Thanks for this suggestion. A good overview table was needed. We added Table 1 in the manuscript with details concerning the differences in the reanalyses.

- I miss a kind of uncertainty assessment. Could you please mention that there is some uncertainty due to the elevation differences between the grid cell and the station. Did you also try to use the neighboring grid cell with smallest elevation difference instead? The temporal resolution of the reanalysis products may also not fit the snow observation time. Do products with finer spatial or higher temporal resolution perform better?

R : Thank you for pointing that out. We mention this uncertainty now in line 209. We did not include gridboxes with the smallest elevation difference since especially in the

case of 20CR, topography is rather coarse in the model and we wanted to keep the procedure the same in all gridded datasets. We also added in line 228 the information about temporal resolution. Indeed, observation time does not fit 100 % the daily (or 6-hourly resolution) in the reanalyses. We used a finer grid in ERA20C than was used for 20CR and we only see minor improvements. Assimilated data and model physics play a more important role.

- In order to be able to properly assess the different errors measures for the 15 long-term stations presented in different figures the reader needs to have an idea about the mean and standard deviation of the different analyzed snow depth values of each individual station. I suggest to add this information to table 1 or to add a new table. The information of the percentage of missing values is currently hard to read and could be easily combined with the climatological information of each station.

R : For better assessment of missing data we averaged the missing data for all three months and changed Table 2. Standard deviation can be seen in the Taylor diagrams. For mean value investigation, we initially had Figure 1 in mind. However, we see the point Reviewer #1 makes and added additional standard deviation and mean value analysis boxplots for the 13 long-term stations in the supplement, so it is easier for the reader to access these values.

- In order to test if the relatively poor hitrate is influenced by temporal issues between reanalysis and observation, I suggest to also calculating the hitrate when +/- 1 day shift in the reanalysis is allowed.

R : Very good point. We exchange this analysis in the manuscript and mention the results for the fixed date just briefly.

Minor issues: L30: On order to prevent misunderstanding, replace "data sets" with "reanalysis prod- ucts"

R : Changed

L66: Why "slowly"? Often the state of the snow cover changes very fast.

R : Changed to "corresponding"

L116-117: The last sentence in this paragraph cannot be understood by readers unfamiliar with reanalysis products.

R : Clarified L116

L163-174: What is the difference to the "Historical Soviet Daily Snow Depth (HSDSD) product [Armstrong, 2001]"? Would there be more long-term data series than only 15?

R : The dataset we used contains overall more stations, but the long-term stations are mostly the same. Therefore, unfortunately no more long-term data series than just 15.

L163-174: Please add some information how snow depth was measured. Point measurement on a stake or mean snow depth from snow courses? Just out of personal interest: What did change in the measurement procedure after 1965?

R : We added that information in section 2.2. The procedure of snow observations changed in the past: size of the stake (1924,1939) rules for the use of stake (1935, 1939), requirements for observation platform (1940, 1954), in the rules archiving (1966)

L192: I cannot find "red marked" stations?

R : That was an artifact, deleted

L199: daily accumulated snow depth

R : Changed

L213-214: To be able to better follow your explanations, the meridians should be indicated in Figure 1.

R : For clearer assessment of Figures 1&2, we added meridians.

L222-225: Please add a sentence mentioning that the depicted snow depth represents

the mean maximum snow depth for each shown month.

R : Added that information

L252-253: Please explain why you compare Northern Russia (and e.g. not Eastern Russia) in this step.

R : We use this area based on the climatology maps of snow cover. In our view this is the region with the highest snow depths. We added that explanation to the text.

Figure 3: Is there any argument not to use the same scale on all three graphs?

R : No there is not. We now use the same scale in all three graphs.

Figure 4: Is there any argument not to use the same scale on all three graphs?

R : No there is not. We now use the same scale in all three graphs.

L293: "Daily" still means monthly maximum snow depth?

R : Daily in this case means Âń as measured Âż, on a day to day basis. These are used for all following analysis procedures, like correlation, hitrate etc. This allows us to have a very strong statistic.

Figure 7: Is there any argument not to use the same scale on all six graphs? Are these hitrates based on 1981-2010 or on the longest period available?

R : No there is not. We now use the same scale in all three graphs. Hitrates are based in the longest period possible. We added that statement to the text.

L388-390: Please add links to the table and figure where these results can be seen. What are the arguments to call the correlations "very" high? They are mostly below 0.8.

R : Thanks for pointing that out. If we have the daily resolution and spatial grids in mind, the results are quite remarkable. However, our wording here was wrong. We changed the wording accordingly.

L391: I don't understand what you mean with "although dealing with a large sample size"?

R : Again, thanks for pointing that out. Wording was not correct. Is changed.

L400-402: To which period does this statement apply?

R : Longest period possible

L403-404: I guess the RMSE is smallest in October because absolute values are smallest in October!

R : We agree! This point is made in L406.

L449: Crutemp: Please add version and reference.

R : Reference and version is added.

Supplementary Table 1: What period do these numbers refer to?

R : Longest period possible, except for ERA-Interim where they refer to 1981-2010

Supplementary Figure 3-5: Is there any argument not to use the same scale on all three graphs?

R : For the boxplot graphs in the supplement we decided to keep different scales since metrics change the scale quite a bit between different months and we want reader to see the maximum amount of details since the Taylor Plots show only median values.

Should the median values of Supplementary Table 1 not be found in Figure 3 and 4?

R : Thank you for pointing that out. Yes, they should be found in these figures. However, we found that the numbers for ERA-Interim were not up to date (wrong time window selected) and there was an error in one entry for ERA20c-land. We updated all numbers accordingly.

Supplementary Figure 5: The unit "cm2" for the variance seems strange? Why not use

the more common measure standard deviation?

R : We added a boxplot for standard deviation

Supplementary Figure 6: Is there any argument not to use the same scale on all three graphs? What is Hadsipr2?

R : No there is not. We now use the same scale in all three graphs. We added the information about the SLP reconstruction

Supplementary Figure 7: Is there any argument not to use the same scale on all three graphs?

R : No there is not. We now use the same scale in all three graphs.

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