

Re-review of “Spatiotemporal variability of snow depth across the Eurasian continent from 1966 to 2012”

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Summary: In this paper, the authors develop a snow depth climatology across the Eurasian continent using ground-based observations over 1966-2012. A total of 1814 stations from 17 countries spanning Eurasia with snow data are used to assess mean annual and maximum snow depth and their trends for each site. The northern reaches of Eurasia typically have the greatest mean annual snow depth, revealing a latitudinal dependence on the results. Trends assessed from linear regressions show significant increases in snow depth poleward of 50°N. These trends are associated more so with increased snowfall rather than rising air temperatures.

This revised paper addresses some of the issues raised in an initial review of the article. However, there are outstanding issues that remain to be addressed before the paper can be considered for publication in *The Cryosphere*. The language requires considerable improvement throughout the paper and my specific comments highlight only a small fraction of these issues. The paper provides only a cursory discussion of the results and the authors appear to be missing an opportunity to place these results in a larger context. For instance, are the observational results consistent with simulations of snow parameters across Eurasia? Furthermore, the authors provide at times incomplete or unsatisfactory responses to comments provided (by both referees) during the initial review of their paper. My report therefore provides further comments the authors need to address in revising their manuscript.

General Comments:

- 1) In my initial review, I commented: “This study examines the characteristics and trends across the Eurasian continent from 1966 to 2012. To do so, the authors assemble snow depth data from 1103 stations across the study area. How representative are the station (point) snow depth data of the overall regional landscapes of interest? For instance, are snow depth data in forested areas collected at airports or other open areas, that may not represent the regional snow characteristics?” The authors acknowledge the shortcomings of the station distribution used in their study but do not address the point in question. Are the results based on point observations representative of the vast region under study?
- 2) The authors provide comprehensive information on snow data collection in the former USSR, but fail to report similar information for other countries. How is snow depth measured across Eurasia? Has sampling changed to automated sensors (e.g. sonic rangefinders) in recent decades? Little information is provided on the data collection process and the accuracy of the measurements. Further to this,

- how is homogeneity in the time series of snow depth, SWE, and other variables assured if sampling techniques or instruments have changed over time? Have the time series been tested for homogeneity (i.e. discontinuities in the data)? Finally, no information is provided on how air temperature and precipitation measurements were made at the meteorological stations. Snowfall measurements are notoriously difficult to make and gauge undercatch correction factors must be applied to obtain improved estimates of snowfall, particularly in windy environments such as Arctic and alpine tundra. The entire section describing the observational data used in the present study must be improved and expanded. Such details may be provided in a supplementary document as necessary.
- 3) In response to another comment I made (as well as by Referee #2), the authors now employ the Mann-Kendall test to assess linear trends in addition to linear regressions. However, they fail to address the issue of serial correlation impacts on the trend analyses (as raised by Referee #2). This must be addressed before the paper can be considered for publication.
  - 4) Further to this, the (revised) Figures 5 and 7 are confusing – what results do these figures represent? The Mann-Kendall trend analysis should give you one slope value over a period of study. No details are provided in the Data/Methods section on how the results presented in these figures are obtained. Further to this, what are “UF” and “UB” in these figures?
  - 5) In my initial review, I commented: “Do the linear trends reported in Section 3.2 exceed the variability in the snow depth data? In other words, are there “detectable” trends in snow depth, i.e. with the signal greater than the noise in the system?” The authors’ response does not fully address this issue, i.e. whether the slopes of the linear trends (signal) exceed the standard deviation (noise) in the snow parameters of interest.
  - 6) The Discussion remains relatively brief and could be augmented by placing these results in a larger context. Do these results concord with modeling studies of snow across Eurasia? What are the prospects for future snow cover changes in Eurasia? What are the broader implications of the results to regional hydrology, permafrost distribution, ecology and society?
  - 7) The names of countries or their abbreviations can be removed on all figures after Figure 1.
  - 8) Please improve the language throughout the paper – there are portions of the text that are difficult to comprehend due to language issues, including all of Section 4.2. Furthermore, the verb tense in the introduction changes constantly and only one tense should be used consistently.

#### Specific Comments:

- 1) P. 3, line 13: Replace “reduced” with “declined”.
- 2) P. 3, lines 15-18: The grammar in this sentence is poor – please rephrase.
- 3) P. 3, line 27: Replace “was” with “were”.
- 4) P. 4, line 20: What aspect of “passive microwave” improved the algorithms?
- 5) P. 4, line 25-27: Language needs much improvement here.
- 6) P. 4, line 29: Delete the hyphen after “longer”. Insert “the” before “climatology”.

- 7) P. 5, line 26: Do you mean “and during the snowmelt period (every five days)”?
- 8) P. 6, line 7: Delete “the following Equation (1)”
- 9) P. 6, lines 25-27: Rephrase this sentence.
- 10) P. 6, line 28: Change to “study period”.
- 11) P. 7, line 14: Replace the colon after “2012” with a period.
- 12) P. 7, lines 23-27: These sentences need to be rephrased.
- 13) P. 8, line 8: What do you mean with “Despite there is a nonlinearity”.
- 14) P. 8, line 9: Delete “a” before “systematic”.
- 15) P. 8, line 19: Delete “In order”.
- 16) P. 8, line 20: Insert “a” before “single”.
- 17) P. 8, lines 27-29: Rephrase this sentence. Insert a space after “(Fig. 2)”.
- 18) P. 11, line 2: What do you mean by “fluctuating changed”?
- 19) P. 11, line 6 and elsewhere: Replace “confident level” with “confidence level”.
- 20) P. 12, line 5: What do you mean by “fluctuant increasing trend”?
- 21) P. 12, line 10 and elsewhere: Replace “confident level” with “confidence level”.
- 22) P. 12, line 30 and elsewhere: Delete spaces between the degree sign and North, i.e. “40°N”.
- 23) P. 13, line 5: Replace “Eurasian areas” with “Eurasia”.
- 24) P. 14, lines 12-13: Language must be improved here.
- 25) P. 14, line 25: Insert the p-value for the correlation coefficient.
- 26) P. 15, line 9: Change to “at most”.
- 27) P. 15, line 22: Replace “lowed” with “lowered”.
- 28) P. 16, line 2: Delete “the” before “northern”.
- 29) P. 16, lines 3-5: This sentence must be re-written.
- 30) P. 17, line 12: Delete “the” before “southern”.
- 31) P. 17, line 16: This entire section is poorly phrased and needs to be completely revised. Why does the font size change in the middle of the paragraph?
- 32) P. 18, line 18: Replace “increase” with “increasing”.
- 33) P. 18, line 25: Delete “the” before “southern”.
- 34) P. 20, line 16: Note spelling mistake in “Atmos.”
- 35) P. 20, lines 27-28: Why are editors of a special journal issue listed here?
- 36) P. 21, line 18: Is this “Hydrol. Sci. J.”?
- 37) P. 21, lines 22-23: Why are upper case letters provided for each word in the title of this article?
- 38) P. 22, line 19: Insert a hyphen in “Snow atmosphere”.
- 39) P. 25, Table 1: Change to “snow courses”.
- 40) P. 26, Figure 1: Why does the orientation of the triangles change across the figure? The top of the triangle should point directly northward to provide a consistent pattern across the figure.
- 41) P. 27, Figure 2 and subsequent figures: Delete all country names/abbreviations on the maps providing spatial results as this can be found on Figure 1.
- 42) P. 30, Figure 4: It is unclear why the authors use wavelets to extract low frequency in the time series of snow depth anomalies. Why not just use a running mean of the data?
- 43) P. 31, Figure 5: The results presented in this figure and in Figure 7 are difficult to interpret as details on what is being shown are not provided. Linear trends

inferred from the Mann-Kendall test should yield only one slope value for a period of record, so it is unclear what the time series in Figures 5 and 7 denote. What do the two lines “UF” and “UB” represent, the figure caption does not state what these are.