

## ***Interactive comment on “Spatiotemporal variation of snow depth in the Northern Hemisphere from 1992 to 2016” by Xiongxin Xiao et al.***

### **Anonymous Referee #1**

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#### General comments

The paper presents a new snow product, NHSnow, for SD and SWE derived using the support vector regression method. The product is validated by comparing it and other relevant SD products to in situ observations.

Validation of SWE product was omitted due to unavailability of SWE station observations. However, there is e.g. the ERA-CLIM2 data set available (<http://litdb.fmi.fi/eraclim2.php>). It contains snow course observations (SWE, density, SD) from Russia, Canada and Finland from 1935 to 2014. This does not cover the whole Northern Hemisphere or all of the time period considered in the paper, but provides good in situ data for validation. Please add some validation of the SWE product.

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All map figures have too small fonts and are illegible. Please increase the font size and colorbars. Now over half of the maps shows regions without snow. Consider polar projection for the maps, this would emphasize the northern snow regions.

### Specific comments

p1r18: Specify that the given error estimates are for SD.

p1r21: Specify that 13 % reduction in snow mass is from 1992 to 2016, not yearly.

p6r15-16: If I understand correctly, the data set provides SD and density, and you calculated SWE from these. Then “SWE, which is labelled as SD” is wrong, replace by “We calculated SWE from SD and density”.

p6r18: “The time of this reanalysis data with the analysis type used in this study is to maximize the proximity to descending orbit time” is unclear. Please rephrase.

p7r9-14: List the snow properties and other parameters that you actually used, not examples. Also add a short description of SVR, at least I wasn't familiar with this method at all.

p7r20 and p8r6: How was the measured SD upscaled from station scale to satellite scale? How did you actually use measured SD?

p7r20: What does “indirectly considered” mean?

p10r12: Why did you set SD to 5 cm?

p14r5: Weather station information is very sparse in “the polar region and along the coast”, and this is also probably the area with the deepest snow cover. Passive microwaves have a saturation point, so they cannot estimate deep snow accurately, and also the distance to in situ stations providing a priori information is greater than elsewhere. Please add some discussion on these points.

p14r13-14: From Figs 5-7 it seems like there are more red points (biggest error) in

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NHSnow than in GlobSnow. Still you calculate larger bias and MAE for GlobSnow.

p14r16-17: Your product also uses measured SD. Is it different SD from the one used for validation? Now you claim that only GlobSnow uses the same data in assimilation than what was used in validation.

p15 r1-2: The GlobSnow algorithm and HUT model don't really use "evolution of snow grain size". The measured in situ snow depths are used to retrieve grain size, which is then used as input to the SWE retrieval, but grain size is varied within certain limits in the process. Therefore grain size is varying and not fixed, but I wouldn't call it evolution, as there is no physical snow model driving this change.

p15r10: Insensitivity to high SD is inherent in all algorithms based on attenuation of radiation in a media.

p15r19-21: You could consider fractional land cover, if you want to improve this. The spatial resolution of your land cover data is much better than the resolution of your PM data.

p18r5: If the rate of change is  $-0.11 \pm 0.40$  cm/year, then your error estimate is so large that the trend could actually be positive. Please comment.

p18 Fig9 and p25 FigB and FigC: Where are the black dots in the figure?

p24 FigA: Use same map projection for all maps. Now only c) is different from all others in the paper. Also use the same color scales in all maps of same figure.

Technical corrections p2r11: "clouds have become" -> clouds are p2r22: SSM/S -> SSM/I p2r26: operated -> operate p4r11: equal-area scale earth -> Equal Area Scalable Earth p4r21: "which was created" -> begins? p7r14: us->is p15r2: Remove "was" p15r14: caused -> cause p18r19: 1996->2016 p19r13: Trends -> Trend p20r3: trends -> trend p20 Table 7: The percentage of Changes -> Percentage change p21r8: As same as -> Similar with p21r27: "than that those that" -> than those that p23r16: "undergone an 8% and 13% reduction" from 1992 to 2016.

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-300>, 2019.

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