Geosci. Instrum. Method. Data Syst. Discuss.,
doi:10.5194/gi-2015-37-RC1, 2016

Geoscientific Instrumentation Methods and Data Systems Discussions
Open Access

Interactive comment on "Spatial and Temporal Variation of Bulk Snow Properties in North Boreal and Tundra Environments Based on Extensive Field Measurements" *by* H.-R. Hannula et al.

Anonymous Referee #1

Received and published: 16 February 2016

In this paper the authors describe an intensive in situ measurement program over different land cover types in northern Finland during winter 2011-2012. The measurement campaign was carried out over 5 km transects and included manual (every ~100 m) and Magnaprobe (every ~2-10 m) measurements of snow depth (SD), along with manual snow corer measurements (every ~500 m) of snow water equivalent (SWE). Ancillary information was also collected on snowpack structure. The purpose of this detailed measurement campaign was to provide ground-truth for evaluating ESA Snow SAR airborne acquisitions. The paper describes the data collection process, analyzes the spatial and temporal variability in snow cover across nine different land cover types, and makes some conclusions about "optimal" sampling strategies for SD measure-

Full screen / Esc

Printer-friendly version

Discussion paper

ments based on the spatial autocorrelation structure. There is no doubt the authors have collected a valuable dataset. However, the paper is a frustrating read because key concepts (e.g. spatial variability of snow cover) were not discussed at the outset, and the methodology evolves throughout the paper instead of being clearly defined at the outset and linked to specific problems/hypotheses. It is also unclear what new findings are being presented and how the study conclusions relate to previously published work. The authors also make a number of sweeping conclusions about "true" snow cover and "optimal" sampling that are (1) based on a limited sample size, (2) do not take into account the error from the fitted spatial model, and (3) do not take into consideration the spatial scales and uncertainty requirements of users. The paper as it stands requires extensive revisions. However, one option the authors might consider is to remove the spatial analysis component of the paper, and resubmit a much shorter paper that describes the dataset and its importance for the snow research community.

Detailed comments:

1. Introduction: the first two paragraphs are peripheral to the study. The focus of the paper is on measurement uncertainties and scaling issues so you need to plunge into this at the outset. The work of Pomeroy and Gray (1995), the seminal paper by Blöschl (1999), the review paper by Clark et al (2011) and more recent work by McCreight et al (2014), and Trujillo and Lehning (2015) should be consulted to help frame the discussion and framing of the problems being addressed in this paper. You should also look at some of the recent papers appearing in the literature looking at detailed spatial variability in snow cover from airborne or UAS lidar (e.g. Zheng et al. 2016). Some discussion of user needs would also be appropriate in the introduction. For some applications such a runoff monitoring over large basins in non-mountainous terrain, spatially averaged SWE information at 10-25 km scale is probably more than adequate when combined with higher resolution satellite snow cover information in a hydrological modelling framework e.g. Bergeron et al (2014).

2. The terms "optimal" and "true snow conditions" are introduced in lines 81-83 without

rigorous definitions or any discussion. In practice, both these terms depend on user requirements.

3. Study objectives (last para page 4): Given that the objectives listed here have been previously studied by a number of investigators, what is unique about the data collected and the proposed data analysis methods that merit publication in GI? The "aims and scope" of GI on the GI homepage may be helpful in responding to this comment.

4. Data and methods: A figure/schematic showing the different measurement methods and their approximate spatial scales would be helpful background information for this section.

5. Second sentence in Section 2.3.1 is difficult to follow. Suggest rewording to "Land cover class was determined based on the GPS coordinates..."

6. Line 149 page 7: Where does the 30% threshold come from?

7. Line 159 page 7: ". . . has larger effects on the RS . . ."

8. Lines 188-195 page 8: Please provide the equation, the definition and some discussion of the correlation length as this is a central part of your analysis method. Since this is obtained from curve fitting, the regression error should also be discussed and presented. It is not entirely clear to me how this statistical property translates to "optimal" sampling e.g. one could fit an autocorrelation function to SWE data collected over 10 or 25 km grid cells and obtain a correlation length corresponding to this scale of information. You don't discuss how rmsd varies with distance but it seems to me this is more important for uncertainty analysis than the spatial autocorrelation i.e. the rmsd may be within operational requirements over a longer distance than suggested by the correlation length. What about interannual and site variability in the length scale? Do you get similar results repeating the measurements in another year and at another location?

9. Line 219 page 9: what does "percentual" mean?

10. Line 239 page 10: Is the "deviation of snow depth" the standard deviation? I suggest you use consistent terminology to avoid confusion.

11. Section 3.3 lines 328-333 talks about results but does not give any! The presentation of analysis results throughout the paper needs to be more focussed and concise.

12. Line 389: Is "measurement frequency" the correct term here?

13. Line 398: I take issue with your conclusion that observing at resolutions higher than Lex does not provide "meaningful statistical information". The relevance of spatial scale depends on the application and the scales of the processes contributing to variability in the snow or snow-related property of interest. For runoff monitoring, synoptic scale events are important for accumulation and melt and these operate at scales much larger than 5 m! Sub-grid scale variability can also be estimated through distributed snow modelling.

14. Line 438: What do you mean by "correct" RS information retrieval? This is subjective terminology.

15. Line 448: The same comment applies to the "true variation of SD" which is a statistical concept. I suggest you revise this sentence to read ". . . to capture the spatial variation in SD typical of these environments".

16. Lines 449-453: see previous comment in #13. Taking your point to its logical conclusion we should scrap satellites and invest in an army of Lidar-equipped drones for monitoring snow depth :0)

17. Where is the dataset published? I assumed a journal dedicated to datasets would require the dataset to be published online.

References cited:

Bergeron, J., Royer, A., Turcotte, R. and Roy, A. (2014), Snow cover estimation using blended MODIS and AMSR-E data for improved watershed-scale spring streamflow simulation in Quebec, Canada. Hydrol. Process., 28: 4626–4639. doi: 10.1002/hyp.10123

Blöschl, G., 1999. Scaling issues in snow hydrology. Hydrological processes, 13(1415), pp.2149-2175.

Clark, M. P. and Coauthors, 2011: Representing spatial variability of snow water equivalent in hydrologic and land-surface models: A review. Water Resour. Res., 47, doi:10.1029/2011WR010745. http://www.agu.org/pubs/crossref/2011/2011WR010745.shtml (Accessed March 10, 2012).

McCreight, J. L., Slater, A. G., Marshall, H. P., and Rajagopalan, B., 2014: Inference and uncertainty of snow depth spatial distribution at the kilometre scale in the Colorado Rocky Mountains: the effects of sample size, random sampling, predictor quality, and validation procedures, Hydrol. Process., 28, 933–957.

Pomeroy, J.W., and D.M. Gray, 1995: Snowcover - Accumulation, Relocation and Management, National Hydrology Research Institute Science Report No. 7, Saskatoon, Canada, 144 pp.

Trujillo, E. and Lehning, M., 2015: Theoretical analysis of errors when estimating snow distribution through point measurements, The Cryosphere, 9, 1249-1264, doi:10.5194/tc-9-1249-2015.

Zheng et al. 2016: Topographic and vegetation effects on snow accumulation in the southern Sierra Nevada: a statistical summary from lidar data. The Cryosphere, 10, 257-269, 2016 http://www.the-cryosphere.net/10/257/2016/ doi:10.5194/tc-10-257-2016

Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., doi:10.5194/gi-2015-37, 2016.