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The Cryosphere Discussions

Interactive comment on "Variability of snow depth at the plot scale: implications for mean depth estimation and sampling strategies" *by* J. I. López-Moreno et al.

Anonymous Referee #3

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GENERAL COMMENTS

This manuscript examines the variability of snow depth in 10 m by 10 m plots by measuring depths on 1-m grids, and demonstrates that errors in plot-scale average depth can be reduced by taking multiple measurements within a plot using appropriate sampling interval, rather than using a single data point. I can see a clear educational value in demonstrating this basic concept that natural processes, including snow accumulation, have spatial variability and multiple measurements provide a better estimate of population mean than a single measurement. However, I am not entirely sure if this manuscript in its present form contains significant new scientific knowledge that war-

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Discussion Paper

rants publication in a refereed scientific journal. We all know that snow depth varies at all scales, and we make our sampling strategies that optimize the balance between required efforts and desired outcome (e.g. estimate of snow water equivalent distribution within a watershed). This requires consideration of topography, surface roughness (e.g. rocks, tree roots), vegetation, prevailing wind direction, and numerous other factors. The manuscript could be strengthened substantially by presenting the results in the broader context of snow depth measurement. For example, given the variability at a larger scale and limited resource, is it better to sample a larger number of points at a smaller number of plots, or smaller number of points at a larger number of plots within a study area? Will the random error at a plot scale average out over a larger scale? The manuscript could also be strengthened by addressing the specific comments below.

SPECIFIC COMMENTS

1. P1632, L3-5. Had there been snowmelt events between the two sampling dates? A graph showing daily average temperature over the accumulation and melt season will be useful.

2. P1632, L12. How were the plots "randomly" selected? Please describe the procedure.

3. P1632, L13. What were the slope angle and aspect of these plots? What was the condition of the ground surface, e.g. exposed bedrock, grasses, understory shrubs, etc.? These are the important characteristics that influence snow depth variability. Given these factors, how did the authors ensure that plots were randomly selected?

4. P1632, L14-16. I do not understand this sentence. Please be more specific.

5. P1632, L20. How tall were the trees, and what kind?

6. P1632, L25. Did the field data support that snow depth indeed had a Gaussian semivariogram?

7. P1633, L16. What model of semivariogram was used, and why?

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8. P1633, L21. How is standard error (SE) defined? By Eq. (1)?

9. P1634, L12. What criteria were used to classify the distribution as leptokurtic? Can the sample distribution be approximated by a Gaussian distribution? A normal plot of the data will be useful.

10. P1634, L20-23. Discussion of semivariogram without semivariogram shown in figures is hard to follow. A few sample semivariograms will be very useful.

11. P1635, L5-6. Negative correlation between average depth and the coefficient of variation (CV) suggest that the standard deviation is uncorrelated with depth. I would find it more meaningful to present mean and standard deviation, rather than the derived parameter (i.e. CV).

12. P1636, L21-23. In real-world studies, observers always examine the numerous factors affecting snow depth distribution (see my general comment), and place sampling points in most effective locations to minimize errors while optimizing the balance between the amount of work and desired outcome. I do not think that the design of numerical experiment effectively address the relevant issues. It is highly desirable to re-design the numerical experiment in such a way that the results provide significant new insights into optimal sampling strategy in real-world conditions.

13. P1638, L20-21. What are the sources of variability? This needs to be examined using the field data (e.g. ground surface roughness, slope angle and aspect, meteorological conditions), rather than referring to the literature from different regions.

14. P1649, L15-16. It is no surprise that a single measurement does not give the accurate estimate of average. The important issue is whether or not errors in plot-scale measurements lead to "highly biased" estimates of snow depth when depths measurements are taken in numerous plots in a study area. This needs to be clearly discussed using the field data.

Interactive comment on The Cryosphere Discuss., 5, 1627, 2011.