

**Reviewer**

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**Paper Title**

Sodankylä manual snow survey program

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**General Comments**

This paper provides a good overview of the snow survey program at the Sodankylä FMI-ARC site and contributes to the scientific literature pertaining to snow observation at a given geographic location in Europe. However, to maximize the effectiveness of the paper, and to make it slightly more self-contained, additional information should be added related to scientific advances made at the site with respect to data collection. This information can be in the form of a brief review with citations to relevant scientific literature or technical reports. There should also be some additional analysis showing how the collected data contributes to an understanding of the environmental processes at the field site. Since this is an overview paper, citations can be used to reference other papers in the special issue.

Moreover, there are other sites in Europe that are being used for measurement of snow (Morin *et al.*, 2012). Is it possible to make a comparison between the Sodankylä FMI-ARC site described in this paper and other sites associated with snow measurement, such as those in France, Switzerland or North America? What are the similarities and differences between sites? Such a comparison would help to identify the importance of the Sodankylä FMI-ARC site with recourse to European and global snow measurement science.

**Specific Comments**

1. Introduction: Please be more explicit with respect to how the "...high albedo, thermal insulation properties, and water content" contributes to the importance of snow. Consider adding a brief overview (a few sentences) clarifying this importance for the reader who is not a snow scientist and showing how these snow properties affect the climate of the Sodankylä site.
2. Introduction: Although this introduction provides a good sampling of papers, another paragraph should be added here about specific scientific discoveries made by researchers using data collected by the Sodankylä manual snow survey program. These references would provide a better context for the snow survey program being introduced in this paper.
3. Pg. 407, Lines 21-23: "Sodankylä manual snow survey program aims at studying the spatial and temporal variability of snowpack in varying environmental conditions typical to the boreal forest zone, including pine and spruce forests, open bogs, and lake ice." How were the different sites selected, and how is the spatial analysis being conducted? Cite papers or technical reports dealing with this spatial and temporal variability.
4. Pg. 407: Lines 23-25: "The data set is also important as a reference for development of remote sensing instruments and interpretation algorithms." Please be more explicit here. Provide paper citations showing how the dataset is being used or how the dataset could be used.

5. Pg. 407: Line 17: Provide the date of first measurement in 1909 if possible. An interesting addition to the paper might be a scanned sample of a page from the first measurement book and the names of the investigators who started the measurements. Would some historical images or photographs be available from the early part of the 20th century? Perhaps this information can be added to Section 2 of the paper. A large majority of other papers that deal with snow measurement instrumentation at a site do not have this interesting historical information.
6. Page 409: Line 25 to end of section: What is the climatological significance of this data?
7. Page 410: Lines 4-12: How were the snow course stations selected? Could geostatistics be used to identify a distance between stations?
8. Page 410: Line 8: How were the measurement locations divided into six categories? Was a remote sensing analysis used? Provide details of this analysis (or citations).
9. Page 410: Lines 13-19: Can exact dates be provided for the start of snow course measurements? Why was there a change in the time when the snow course was sampled? How might this change in time affect scientific analysis of the data?
10. Page 411: Line 4: By situating the snow pits ~50 cm away from each other, how might this establish temporally-comparable observations? What is the topography of each sampling station?
11. Page 411: Line 23: Can citations be provided here to provide a context for photographic measurement of snow? Please provide details of the camera setup (i.e. focal length of the lens and resolution).
12. Page 412: Line 16: What are the errors associated with Snow Fork dielectric measurements?
13. Page 412: Lines 18-19: Can a comparison be made between the wedge sampler and the rectangular sampler? Is there any difference between densities measured using the wedge sampler and the rectangular sampler? What are the dimensions of the rectangular sampler, and does this sampler have a cutting lip or cutting teeth?
14. Page 412: Line 21: For what amount of time is the thermometer placed into the snowpack before thermal equalization occurs?
15. Page 412: Line 24: How does the self-made snow sampler compare with other snow samplers such as the ESC30 snow sampler (Farnes *et al.*, 1980)? What are the errors associated with your custom sampler? What is the volume of snow extracted by this custom sampler?
16. Page 412: Lines 25-26: Are three measurement stakes sufficient for averaging? What can be said about the average standard deviation of the three measurements?
17. Page 413: Line 7: How does wind have a minimal effect on snow accumulation at the site? Can this be justified based on wind speeds or blowing snow mass flux observations?
18. Page 413: Intensive Observation Area: Please provide paper citations or company names for each measurement instrument deployed in the Intensive Observation Area.
19. Page 413, Line 16: Please provide a paper citation when stating that "Bogs are the second most common

land cover type in the northern Finland."

20. Page 413: Line 23: Please explicitly describe how wind affects the accumulation of snow and the microstructure of the snowpack at the site.

21. Page 414: Line 14: Why is density the largest at Lake Orajärvi? Is this due to metamorphic processes and high magnitudes of Liquid Water Content?

22. Page 414: Example Data (Section 3.4.3): How is this data indicative of snowpack physics, and how does the data indicate differences in physical processes that occur between the sites?

23. Page 415: Lake Ice Observations (Section 3.5): Please provide citations related to the instrumentation and sampling procedures.

## Technical Corrections

For commercial instrumentation, please provide the company name and location throughout the paper. This can be provided in parenthesis after the name of the instrument being used. Examples: (Snowmetrics, Fort Collins, Colorado, USA) and (Milwaukee Electronics Kft., Szeged, Hungary). A reference to the company allows for other researchers to utilize similar equipment. Also, custom instrumentation should be documented (i.e. mechanical diagrams or technical reports), and this documentation should be available on request from the authors.

Figure 1: Please provide the map projection for Figure 1 and a locator map showing the position of the FMI-ARC area within Europe. This allows the reader to better understand where the site is situated and how the site is constituted with respect to climate and hydrology. How was the map derived? Was remote sensing data or a raster dataset used?

Figure 3: Indicate what is meant by "std" in the description of this Figure. Is this figure an average of data between 1911–2014? Indicate if all of the individual sites are being averaged.

Figure 5: Why was this snow pit selected as an example?

Figure 6: What can be implied by changes in ice thickness and snow depth between years 2009 and 2015?

## References

- Farnes PE, Goodison BE, Peterson NR, Richards RP. 1980. Proposed metric snow samplers. *Proceedings of the Western Snow Conference* **48**: 107–119
- Morin S, Lejeune Y, Lesaffre B, Panel J-M, Poncet D, David P, Sudul M. 2012. An 18-yr long (1993–2011) snow and meteorological dataset from a mid-altitude mountain site (Col de Porte, France, 1325 m alt.) for driving and evaluating snowpack models. *Earth System Science Data* **4** (1): 13–21 DOI: 10.5194/essd-4-13-2012