

## ***Interactive comment on “Laboratory, field, mast-borne and airborne spectral reflectance measurements of boreal landscape during spring” by Henna-Reetta Hannula et al.***

### **Anonymous Referee #2**

Received and published: 13 November 2019

#### Remarks to the Authors

Review of “Laboratory, field, mast-borne and airborne spectral reflectance measurements of boreal landscape during spring” by Henna-Reetta Hannula et al.

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#### General comments:

In this paper, the authors introduce and describe detailed spectral reflectance data for some types of snow, forest canopy, snow-on-canopy, snow-free patches, etc obtained

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from laboratory, field, mast-borne, and airborne optical measurement systems. The study areas are mainly located in the Arctic region of Finland. The main purpose of the data acquisition is to provide basic information for the development of new and improved optical snow mapping methods for boreal forested area using satellite data. This kind of remote sensing study is very important recently, because seasonal snow physical conditions, which would affect water resources around the area for example, are rapidly changing due to the ongoing global warming. This reviewer found the data acquisition methods and procedures described in this paper are solid, and presented data are reliable in my opinion. Overall, this paper is detailed, well written, and structured; however, this reviewer suggests the following points to be considered before the publication.

Please note that page and line numbers are denoted by “P” and “L”, respectively.

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#### Specific comments (major)

P. 16, L. 262: How about showing the standard deviations mentioned here in this paper? I think this information, which show accuracy of the data, is very important.

P. 16, L. 276: What do the authors think about the effects of the tripod on the measured reflectance data? Please discuss briefly here.

P. 20, L. 346 ~ 347: Please explain more in detail about the resampling procedure (about the choice of a weighting function, etc).

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#### Specific comments (minor)

P. 1, L. 16: For the location of Sodankylä Arctic Space Centre, please indicate altitude of the site together with the Lat Lon information.

P. 2, L. 33: Maybe, citing the latest version of the SWIPA report (AMAP, 2017) instead

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of the previous report (AMAP, 2011) would be better here.

P. 2, L. 46: It is better to explain the definition of “spectral endmembers” here especially for non-specialist readers.

P. 2, L. 50 ~ 51: Please consider citing the papers by Aoki et al. (2000), Carmagnola et al, (2014), and Tanikawa et al. (2014).

P. 3, L. 72: What do the authors mean by “samples”?

P. 3, L. 95 ~ 97: Please indicate spectral resolutions of these data here.

P. 4, L. 111: What is fjell?

P. 5, L. 131: What do the authors mean by “upper atmosphere’s perspective”?

P. 6, L. 134: For snow classification, it is better to refer the international snow classification (Fierz et al., 2009).

P. 6, L. 148: Please detail more about the white reference standard used in this study (e.g., manufacturer, location of the manufacturer, and type).

P. 9, L. 211 ~ 213: Maybe, referring to photos in Figures 4 and 6 here would be very helpful for readers.

P. 10, Table. 1: I think there is a higher-resolution version of ASD Field Spec Pro. Do the authors think using a standard version of Field Spec Pro is enough for the purpose of this study (the purpose of the data is summarized well in the second paragraph of the Introduction section)?

P. 10, Table. 1: This reviewer is interested in how the authors determined the distances from the sensors to targets especially for the Lab and Portable cases. Please explain.

P. 11, Table 2 (The following comment is related to the previous comment for “P. 3, L. 72”): If I understand the meaning of “samples” correctly, I would like to know why the numbers of samples per target in Table 2 vary from date to date. I would make the

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number the same throughout the study period when I do this kind of measurements.

P. 19, L. 317: Are “hours 10, 12, and 14” in local time?

P. 22, Figure 10a: Please mention where the sensor is attached in the helicopter.

P. 24, L. 419 and Table 3: Please consider adding “geometric” before “snow grain size” to indicate explicitly the “snow grain size” is not an optical one.

P. 24, Table 3: For air temperature, cloud cover, snow depth, snow patchiness, snow temperature, soil surface temperature, and snow water content, please indicate the types of sensors (as well as manufacturer and location of the manufacturer) used to measure these properties. Regarding IceCube and Snow Fork, please indicate manufacturers and their locations. Also, please explain how the authors measured impurities in snow [%]?

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#### Technical corrections

P. 8, L. 207: “Analytical Spectral Devices” -> “ASD”; already defined.

P. 15, Figure 5: Consider rephrasing “Wet snow with littered surface” to “Wet snow with forest litters”.

P. 16, L. 266: “Jr” -> “JR”

Sections 4 and 5 should be merged, then, please consider add some subsections.

P. 25, Equation (3): “ $L_{sN}$ ” -> “ $L_{sN}(\lambda)$ ”

P. 25, L. 453: “ $L_{s1}$  and  $L_{s2}$ ” should be “ $L_{sN}$ ”?

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#### References

AMAP: Snow, Water, Ice and Permafrost in the Arctic (SWIPA) 2017, Arctic Monitoring

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and Assessment Programme (AMAP), Oslo, Norway. xiv + 269 pp, 2017.

Aoki, T., Aoki, T., Fukabori, M., Hachikubo, A., Tachibana, Y., and Nishio, F.: Effects of snow physical parameters on spectral albedo and bidirectional reflectance of snow surface, *J. Geophys. Res.*, 105, 10219–10236, doi:10.1029/1999JD901122, 2000.

Carmagnola, C. M., Morin, S., Lafaysse, M., Domine, F., Lesaffre, B., Lejeune, Y., Picard, G., and Arnaud, L.: Implementation and evaluation of prognostic representations of the optical diameter of snow in the SURFEX/ISBA-Crocus detailed snowpack model, *The Cryosphere*, 8, 417–437, doi:10.5194/tc-8-417-2014, 2014.

Fierz, C., Armstrong, R. L., Durand, Y., Etchevers, P., Greene, E., McClung, D. M., Nishimura, K., Satyawali, P. K., and Sokratov, S. A.: The International Classification for Seasonal Snow on the Ground, IHP-VII Technical Documents in Hydrology N\_83, IACS Contribution N\_1, UNESCO-IHP, Paris, viii, 80 pp., 2009

Tanikawa, T., Hori, M., Aoki, T., Hachikubo, A., Kuchiki, K., Niwano, M., Matoba, S., Yamaguchi, S., and Stamnes, K.: In-situ measurement of polarization properties of snow surface under the Brewster geometry in Hokkaido, Japan and northwest Greenland ice sheet, *J. Geophys. Res. Atmos.*, 119, 13946–13964, doi:10.1002/2014JD022325, 2014.

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