## Interactive comment on "A 7-year dataset for driving and evaluating snow models at an arctic site (Sodankylä, Finland)" *by* R. Essery et al.

**M. Raleigh (Referee)**

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GENERAL COMMENTS

The authors present a seven-year dataset of observed meteorology and snowpack conditions at a site in Finland for the purposes of snow model evaluation. Many recent published datasets at snow sites have been at mid-latitude mountain sites, so this high-latitude dataset is a novel contribution for testing and developing snow models in arctic environments. The authors provide sufficient and succinct descriptions of the site, measurements, and data processing/preparation, and demonstrate the usefulness of the data for running and evaluating the one-dimensional, multi-layer Crocus snow model. The authors include two meteorological datasets, one with wind and radiation measured above the canopy and the other with wind/radiation measurements adjusted

for the sub-canopy. These two datasets make the site data more broadly applicable to a variety of physical snow models (as some do not represent forest canopy). Given the novelty, length, and apparent quality of the data and the excellent presentation, I recommend this paper for publication pending minor revisions (see below).

SPECIFIC COMMENTS

- The driving and evaluation datasets are posted on the website of the Finnish Meteorological Institute (litdb.fmi.fi). What assurances are in place for long-term hosting of these data? Would it be prudent to have the data in a repository such as Pangea (e.g., Morin et al., 2012) or to have the datasets included in the supplemental material associated with the paper (e.g., Landry et al., 2014)?

- It would be useful for future analyses of the forcing data if the meteorological datasets included flags indicating whether the data for each variable is original or filled at each time step (see Landry et al., 2014). Can you please include these flags?

- The posted datasets include most of the evaluation data (SWE, snow depth, temperature profiles) described but not all those found in Table 2. Will the other evaluation data (e.g., snowpit measurements of density and temperature) also be made available?

- In the abstract, please state what years are included in the datasets.

- In the modified dataset ('mod_2007-10-01_2014-09-30.csv'), there are four time steps on 11 April 2010 with negative shortwave values. Please correct these data.

- In comparing the above and below canopy shortwave radiation, I found 1244 time steps where below canopy shortwave is greater than above canopy shortwave, which does not seem to make sense to me. Of those 1244 steps, 828 are when above canopy shortwave = 0, 412 are when above canopy shortwave is between 0 and 10 W/m2, and 4 are when above canopy shortwave is above 10 W/m2. I do not expect that below canopy shortwave can be greater than above canopy shortwave. I assume that most of these inconsistencies are due to processing (e.g., equation 1) and recommend

applying limits on the adjustments to rectify this situation.

- Please state the regularity with which the site is maintained/visited by FMI staff/technicians to check the integrity of instruments and check for measurement errors (e.g., snow on radiometer domes).

- Are the pyranometer and pyrgeometer heated/ventilated? Please clarify in the text. If not, do you have a sense of how often these radiometers were covered in snow or ice and how this may have influenced the quality and completeness of the radiation data? If this is a concern, there are methods for identifying periods of snow cover on the radiometer domes (e.g., Lapo et al., 2015).

- Is the temperature sensor naturally ventilated or mechanically ventilated? Please clarify in the text.

- Is the anemometer heated? Based on specifications, I think it is heated, but it would be good to state this in the text to allay concerns about freezing of the anemometer.

TECHNICAL COMMENTS/CORRECTIONS

- Pg. 2, Lines 22-25: Please consider including a reference to the Wayand et al. (2015) snow and meteorology dataset in the Washington Cascades as another recent example.

- Pg. 3, Line 2: The FMI-ARC site is not only unique for being at a high latitude, but also at a low elevation (with snowfall temperatures close to 0 C, Pg. 6) and having a more shallow snowpack than the other snow sites with published datasets. It might be worth highlighting these distinct features here.

- Pg. 4, Line 2: A minor suggestion: it would be interesting to briefly summarize the data going back to 1908 and compare to the equivalent data summaries over the period represented in this dataset (Oct 2007 – Sept 2014). This would provide context, e.g., which years in this dataset had low/average/high precipitation in terms of the longer data record.

- Pg. 5, Line 12: The supplement lists the ERA-Interim bias as -5.1 W/m2 (relative to observations). Please clarify whether any bias correction was applied to the ERA-Interim data and why/why not.

- Pg. 5, Line 16: Please replace "Raleigh et al., 2015a" with "Raleigh et al., 2016" and update the citations in the references.

- Pg. 6, Lines 2-10: Did this scale factor vary annually? Can you please specify the scale factor(s) here?

- Pg. 6, Lines 24-25: There are potential problems with estimating canopy temperature from air temperature in some situations (see Webster et al., 2016). Please comment on this briefly.

- Pg. 9, lines 26-28: Can you clarify whether the soils are freezing in these cases (as suggested by the observed soil temperatures)? Is anything known about the soil moisture?

- Table 1: Air temperature and precipitation are both measured at 1 m. The maximum snow depth in the dataset is 1.02 m (late March 2010) and in five winters the maximum depth exceeds 0.80 m. Given spatial variability in snow depth, it begs the question whether the temperature sensor and precipitation gauge were ever buried in snow during the observational period. Please comment.

- Table 1: Does the HMP35D measure temperature in addition to humidity? If so, was this used to double check and fill missing data from the PTB201A?

- Figure 1: It would be helpful to include another panel with a map of Finland and a marker showing the site location in the country.

- Figure 3b: The two lines are quite thin and difficult to distinguish to my eye. Can you please take some measures to help me discriminate them better?

- Figure 8: What depth are the soil temperature simulations / observations in this fig-

ure? Please clarify in the caption and/or figure.

- Supplement: The caption of the third figure (multiple pages) with temperature profiles has two errors. First, the figure is called "Figure S1" when it should be "Figure S3". Second, the caption should state "Profiles of snow temperature" instead of "Profiles of snow density".

CITATIONS

Lapo, K. E., L. M. Hinkelman, C. C. Landry, A. K. Massmann, and J. D. Lundquist (2015), A simple algorithm for identifying periods of snow accumulation on a radiometer, Water Resour. Res., 51(9), 7820–7828, doi:10.1002/2015WR017590.

Raleigh, M. S., B. Livneh, K. Lapo, and J. D. Lundquist (2016), How does availability of meteorological forcing data impact physically-based snowpack simulations?, J. Hydrometeorol., 17(1), 99–120, doi:10.1175/JHM-D-14-0235.1.

Wayand, N. E., A. Massmann, C. Butler, E. Keenan, J. Stimberis, and J. D. Lundquist (2015), A meteorological and snow observational data set from Snoqualmie Pass (921 m), Washington Cascades, USA, Water Resour. Res., 51(12), 10092–10103, doi:10.1002/2015WR017773.

Webster, C., N. Rutter, F. Zahner, and T. Jonas (2016), Modeling sub-canopy incoming longwave radiation to seasonal snow using air and tree trunk temperatures, J. Geophys. Res. Atmos., 121, doi:10.1002/2015JD024099.