

Interactive comment on “Meteorological, elevation, and slope effects on surface hoar formation” by S. Horton et al.

Anonymous Referee #1

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General comment

This manuscript aims at identifying the influence of meteorological and terrain factors (elevation, slope angle and aspect) on surface hoar formation. In the Columbia Mountains of British Columbia at Glacier National Park and around the town of Blue River three layers of surface hoar were spatially analyzed. Additionally, the snow cover model SNOWPACK was driven with meteorological data from the numerical weather prediction model GEM-LAM in 2.5 km horizontal resolution to simulate the spatial surface hoar formation on virtual slopes during that period. Even though the model could not accurately reproduce surface hoar crystal size on south-facing slopes it was able to simulate surface hoar over different elevation bands where surface hoar formed under warm humid air, light winds and cold surface temperatures. The authors conclude that

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a coupled weather-SNOWPACK model chain could benefit avalanche forecasters by predicting surface hoar on a larger horizontal scale and over varying elevation bands.

The manuscript presents a step towards forecasting surface hoar formation on a regional scale which is of great use for avalanche forecasters. The authors validate large-scale simulated surface hoar layers with various field campaigns. The investigation took place under a high-pressure period in Canada which is one specific meteorological condition. Other terrain parameters than elevation, slope angle and aspect were not included in the study. However, limited sky view variations can also lead to spatially varying LW surface cooling. I would suggest clarifying both limitations in the article. Overall, the manuscript is well written and I suggest this manuscript be published with the minor corrections listed below.

Specific comments

Fig. 10: What were the terrain slope angles at the field sites presented in Fig. 10? How much sky view factor did they have and what is the median elevation of the grid points within the 10 km radius compared to the elevations of the field sites? To summarize, how similar were the field site slope terrain parameters compared to the virtual 30° slopes which do not have surrounding terrain? It might be that SNOWPACK does not exaggerate radiation effects on surface hoar, but that the radiation effects on surface hoar at the field sites simply weren't that comparable.

Abstract: Along my previous comment, I would maybe soften the abstract a bit. Furthermore, I would add "during a high-pressure period" somewhere, e.g. in Line 7. If not I think your statement that the moisture content had the largest impact is misleading the reader with regards to previously found large impacts as light winds, certain net radiation amount or a certain difference in surface and air temperature.

p. 1869, Line 26-28: Mott et al. (2011) observed that in wind-exposed areas turbulent fluxes considerably contributed to snow melt sometimes outperforming net radiation. Since wind-exposure seem necessary I suggest to check if the referred slopes were

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indeed wind-exposed. In the study of Mott et al. (2011) they are also referring to net radiation (net shortwave and longwave radiation) instead of direct solar radiation.

Technical comments

p. 1858, Line 25 and p. 1862, Line 15-16 : replace sublimate with deposit. The transition from solid into gas is called sublimation. However, for surface hoar formation water vapour deposits onto the snow surface.

p. 1861, Line 23 : air or surface temperature, please specify.

p. 1866, Line 15-16 : Do you mean "Radiation forecasts [...]" ?

p. 1869, Line 17-18 : Fig. 10f does not show data from 10 February but from 4 February. Fig. 10g is not described.

p. 1870, Line 2-4 and Line 25-27: Terrain shading is not caused by limited sky view, but generally describes shadows cast by surrounding topography during low sun elevation angles. The sky view factor determines e.g. how much diffuse sky radiation a surface receives and how much LW cooling it experiences during nights. I suggest to change e.g.

Line 2-4 to : [...] radiation absorption "by the surface", snow melt, terrain and vegetation shading, and local sky view effects from topography and vegetation.

Fig. 1 : Please include a description for the locations of field campaigns around Blue River or/and a description for the inset showing Blue River and GNP.

Fig. 9 : Please add the region from where data is shown, e.g. " [...] (1800 to 2200 m) in GNP." Maybe mention that the modelling is again done with the HRDPS/SNOWPACK model.

Fig. 10 : I think the words "with" and "without" allocated to the symbols in the caption were meant to be the other way round. There is a sun crust on south slopes.

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Interactive comment on The Cryosphere Discuss., 9, 1857, 2015.

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