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Interactive comment on "Limitations of using a thermal imager for snow pit temperatures" *by* M. Schirmer and B. Jamieson

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Reviewer's comments are *in italics*, our responses are in normal text.

1. The rapid evolution of the skin temperature after the pit wall has been shaved must balance the turbulent (sensible and latent), radiative, and conductive heat exchanges. The paper's explanation does not truly articulate how these processes might be affected individually by the micro-scale surface geometry. At this stage, a mathematical model is not necessary, but a more fleshed-out conceptual model might help. 2. In this context, data on the air's humidity during the field and lab experiments would be useful.

We added a longer explanation addressing the heat exchange process in the Discussion section. For turbulent heat exchanges, we think that it is quite difficult to apply a conceptual model based on a bulk model of turbulent surface fluxes (Stull 1988, p. 261 ff) to explain differences affected by the micro-scale surface geometry. Small scale air temperature and humidity variations between roughness elements may play a role and are unknown. Similarly unknown is a meaningful mean wind speed near the pit wall or specimen. The variance we are interested in may be expressed in a bulk model in terms of varying bulk transfer coefficients for turbulent heat fluxes dependent on surface roughness and turbulence intensity. This is why we agree with the reviewer that a quantitative physical model may not be necessary, especially having the main aim in mind, that we want to show limitations of a thermal camera. But the mentioned points also limit a conceptual model based on a bulk model. This is why our explanation is rather simple and based on the idea of more turbulence intensity at exposed convex areas and such larger turbulent heat fluxes. We consider here the “effective” turbulent flux including the molecular conduction of heat (Stull 1988, p. 251), since we have no indications on the temperature gradient across the bottom few millimetres of the air. To address the to the conductive heat flux from/into the snow we extended our explanation on possible effects of variant thermal conductivity properties between a crust and other snow layers. We have not measured air’s humidity in the cold lab. In a conceptual model following a bulk model for latent heat fluxes we would be rather interested in differences of this parameter between surface geometries than in one value to explain the faster and slower cooling. To us, the only obvious difference is the increased turbulence intensity at exposed areas. This is why we based our explanation on this.

3. Finally, the images should have real length scales on the axes, rather than pixel dimensions.

Because of lens distortion there is to our opinion no known relationship between pixel and real dimensions. For Figure 2 we accurately measured the distance between camera and pit wall. Together with the information of the field of view of the cameras we could provide the extent of the whole picture. This cannot strictly be divided by

the number of pixels to obtain the pixel dimensions, because of the non-linear lens distortion. For the photos in the cold lab we chose to relate real dimensions with pixel dimensions using visual photos of the specimens with a ruler as a scale (Figure 1). Comparing Figure 1 with the thermal images of those specimens, the reader is able to assess the real dimensions. The given pixel dimensions may help to compare our results with earlier studies, in which differences between pixels were calculated to obtain a thermal gradient.

Reference: Stull, R. B. (1988): An introduction to boundary layer meteorology. Dordrecht, Netherlands.

Interactive comment on The Cryosphere Discuss., 7, 5231, 2013.