The Cryosphere Discuss., 5, C1212–C1214, 2011
www.the-cryosphere-discuss.net/5/C1212/2011/

The Cryosphere Discussions

Interactive comment on "Use of a thermal imager for snow pit temperatures" *by* C. Shea et al.

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Received and published: 3 November 2011

The use of thermal imaging for snow studies is very interesting work. The instant visual feedback reveals something that can't be seen with any other method.

Below are some remarks and suggestions for clarifications and things to reconsider for the final version.

Section 7 in general:

What is the effect and level of instrument noise to point gradients calculated from the images? Analyze the overall accuracy of the gained results based on errors mitigating from different sources.

Section 7.2:

In the (sub-)millimeter pixel scale there really is no 0 degree photographic angle, as

the crystal facets are in semi-random orientation. To assume a single incidence angle, perhaps a larger area should be investigated (averaged) to get a statistically significant amount of orientations so that discrete crystal facet angles are not dominating. These values could be compared with the higher resolution data to see whether it has any significance to results.

Use of natural snow when correcting the lens effects is not a good thing. Natural snow has spatially varying thermal structures (the very thing you are looking for!) which will not give satisfactory calibration as the target used for calibration is unknown. The calibration for lens effects should be done using a isothermal target (tens of images, median stack the temperature arrays, normalize, use that as a flat-field correction for all the data). From this target the authors would also gain the level of instrument noise (pixel-to-pixel variance in measured temperature).

All the corrections (atmospheric, lens effects, exposure time) should be done to absolute values, not derivative quantities. Some of the errors are additive (atmosphere), some multiplicative (lens effects) and some function of external forcing (exposure: time of being exposed before imaging and the temperature gradient between snow and air). This is to say: no linear adjustment will give a correct result! The corrections presented in the manuscript seem to be negligible compared to the accuracy (+-2 %) given by the manufacturer (is that +-0.2 °C at -10 °C or +-5.3 K at 263 K? I hope the first. Please check and present in the paper). The data might not need all the corrections, but if a correction is applied, it should be based on theoretically sound principles.

Section 7.3:

In Chapter 1 the authors state that there is error in traditional point measurements due to temporal changes, which is absent in thermographs since the imager records instantaneously the whole field of view. However, there is no indication how to take temporal changes into account when thermographs from different heights are combined, or how these images are related to natural undisturbed condition prior to excavations. In traditional measurements the snow itself acts as a protective insulator towards external disturbance. The temperature is normally measured 10 - 20 cm within the snow. For the exposed wall, there is no such mechanism to stabilize the snow, and the imaged surface starts to react to the change immediately.

Authors should offer an explanation to the jump in absolute value of orange curve in Fig. 3a. By intuition the observed pit wall temperature should move asymptotically towards the air temperature at the same height. A time series (image every 5 or 10 seconds for a few minutes using a tripod to minimize operator heating and camera movement) from the exposed wall (and simultaneous air temperature at different heights!) should also give a good estimate how to correct the absolute values in respect to time of exposure, and yield a method to estimate the true natural thermal state of the undisturbed snow.

Reviewer suggestion: Either recalibrate the temperature data with a scientifically sound method or show that no calibration in post-processing is needed to reach the conclusions presented.

Interactive comment on The Cryosphere Discuss., 5, 2523, 2011.