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The Cryosphere Discussions

Interactive comment on "Some fundamentals of handheld snow surface thermography" *by* C. Shea and B. Jamieson

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Note: The text of the original comment is in *italics*; answers follow each portion.

General Comments:
Shea and Jamieson present an overview of ground-based high resolution snow surface temperature measurement techniques. The paper presents the practical advantages to snow thermography, while elaborating on a few potential limitations. Novel applications include revealing processes of snow surface and substrate crystalization, grain growth, and structural changes such as warm crown fractures. This overview paper has merit for a broad spectrum of snow science, including avalanche forecasting, but also many others not mentioned by the authors.

Specific Comments:
i. The authors should include other potential applications of snow surface thermography...think outside the avalanche community.
ii. The authors might also mention Tomography more prominently as a technique that would nicely complement thermography, such as in the "motivation" section. ie. Schneebeli
iii. It might strengthen the impact of this paper by briefly discussing the implications of thermography for validation of aircraft, balloon, or satellite based remote sensing of snow surface temperature?

To address the above three points, Section 8 (Additional Applications) will be rephrased to include mentions of applications to:
- Tomography and crystal metamorphosis
- Surface radiation balance
- Wind pumping
- Effect of vegetation
- Detection of buried heat – bushes, (lack of) application for rescue, etc
- Downscaling of satellite imagery

iv. The paper is missing an aspect/process affecting snow surface morphology that may be detectable by thermography: wind pumping. ie. Colbeck, S. C. 1989. Air movement in snow due to windpumping. J. Glaciol., 35(120), 209-2 13. and for Greenland: Albert, M.R., McGilvary, W.R., 1992. Thermal effects due to air flow and vapor transport in dry snow. Journal of Glaciology38, 129.

Yes, this is a very interesting application, and we spent some time trying to capture it via thermography. We found that it is difficult to capture, and as yet we have no significant data on the topic. Nevertheless, as listed above, we will add mention of this application to the revised manuscript.

v. This paper does promote interest in thermography applications in snowy environ-

ments and should be publishable after minor revisions that motivate broader appeal.

Technical Corrections:
a. p. 1468: line 24, please rephrase, small-scale refers to a relatively large area, replace small-scale with sub-pixel scale or higher resolution or microscale.

We will rephrase with "higher spatial resolution", so as not to be confused with other resolution types.

b. p. 1470: line 2, to closer than..., replace closer with less than...

It will be done.

c. p. 1470: line 9, again the word choice of small-scale is misleading to those with background in geospatial analysis, please replace with high resolution or similar.

Thank you. This will also be rephrased.

d. p. 1471: line 14, thermal imagers have significantly reduced (NOT lessened) in price, just a suggestion.

And a good suggestion. It will be changed.

e. p. 1471: line 27, what is a pixel-type sensor...do you mean CCD-type sensor; a pixel is generally thought of as the smallest detectable square feature on an image.

Thermal cameras use microbolometers, parts of which are similar to, as you point out, the CCD in a digital visual camera. It is our understanding that the terminology used to refer to a single-point measurement in a microbolometer is a 'pixel', which is similar to referring to a member of the capacitive bins in the image sensor coupled with a CCD. Thus, a pixel-type sensor is a microbolometer with multiple measurement points, like the effective 2D image sensor for visual photography. Image sensors coupled with CCDs work by recording small charges stored when visual light hits the sensor; microbolometer-based imaging works by recording the change in resistance within the material in each pixel.

Interactive comment on The Cryosphere Discuss., 4, 1467, 2010.