

***Interactive comment on* “Comparison of  
MODIS-derived land surface temperatures with  
near-surface soil and air temperature  
measurements in continuous permafrost terrain”  
by S. Hachem et al.**

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General Comments:

1. Comparison of MODIS LST to soil temperatures

We clarified the choice of LST as a substitute to ground based measurements (GST or Tair) in permafrost models for both seasons and year round. We then performed comparisons for the snow-free and snow-cover seasons separately, and for the whole year. As recommended, soil temperature has been renamed to ground surface temperature

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(GST) with an introductory statement. We also changed the “good agreement” in the text to be more specific with the Correlation parameter.

## 2. Comparison to air temperatures

As suggested, we made reference to the Hale et al. 2004 paper because of its validation of IST (ice surface temperature) with  $T_{air}$  because, station GST measurements are too few in Arctic areas. We did not use the Scambos et al., 2006 reference which shows relations to IST. In this article we show that the LST cannot be used to substitute GST but that they are close to  $T_{air}$ .  $T_{air}$  is the only measurement available at many stations. For this reason, it is the temperature used by permafrost modellers, and this is a reason we consider worthy to use  $T_{air}$ . But it was important to specify that in a perfect world GST would be better. The reality is different, LST is better correlated with  $T_{air}$ , and of course, a major reason for this is the presence of snow cover in winter.

## 3. Computation of freezing and thawing indices

This was not the purpose of this paper and it was already demonstrated, as a research note, by Hachem et al. (2009) as you mentioned. Since the article demonstrated that LST is very far from GST, we estimated that it was not necessary to calculate n-factors here. Also, the GST data available was too sparse to allow such calculations. We found few papers using n-factors in large scale applications. Klene et al. 2001 show that the intra variability of a 1 ha area makes it difficult to generalize n-factors from station measurements.

## 4. Cloud detection

We explain in the Results (Table 4) and Discussion sections that clouds are a problem with LST but it is difficult to evaluate such an error as it is suggested. First, the stations we used did not have information on cloud cover, then it is not possible to relate a “particular low” LST with the real presence of clouds. Second, the hypothesis we provided about very low LST measurements is true only for the warm period of the year. As

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a result, an error evaluation could not be done during the cold period, so it would be incomplete for our purpose as we wanted to prove a round year correlation.

Detailed comments:

P1584 : The abstract has been shortened.

I.23 : Explanations are given in the Results section.

p. 1585:

I.2 to 12 : Citations are provided.

I.13-14: Brackets have been deleted.

I.17-19: We know that it is a very general statement known and accepted by any researchers, we only used it here to strengthen the importance of using surface temperature. We do not think that using references for this statement is necessary.

I.23 : The sentence has been modified.

p. 1586:

I.7: “horizontal” has been changed to “spatial”

p.1587:

I.12: The sentence has been rewritten.

I.24: Citation has been added.

p.1587-1590:

Sections 2.1.1 and 2.1.2 have been shortened to focus more on the MODIS sensor capabilities/products.

I.7: Has been changed here.

p.1591:

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Please refer to the WERC website where all the data for Alaska are taken. It says that the stations are all located in the Kuparuk river Basin. Nevertheless we had changed the text, “Kuparuk river basin stations” becomes “Kuparuk river basin database”. This is our reference: <http://ine.uaf.edu/werc/projects/NorthSlope/currentconditions.html> (see Figure attached)

p.1592: The paragraph has been moved to previous section 2.1.

2.3. We agree with the comment. We implicitly assumed that the LST values given in the MODIS level 2 products correspond to measurements for a 1km-pixel footprint. Thanks to the team of Nishihama, many improvements have been made to the geolocation algorithm. These new features can be found in Wolfe et al. (2002) – Achieving sub-pixel geolocation accuracy in support of MODIS land science, Rem. Sensing of Env. Vol 83, Issues 1-2, pp 31-49. This information has been added to the text of section 2.3.

p.1595:

l.20. “first” has been deleted.

p.1596:

l.3: “whereas” has been deleted.

l.6-10: The suggested sentence now replaces the old text.

l.12-20: The paragraph has been moved to section 2.4.

l.22: “Salluit” has been changed to “Sila, Tiki”.

l.24: “Table 4” has been changed to “Table 5”. Table 5 has been revised to a clearer one, with SD values added.

The new Table 5 relates values between GST and LST. Relations between Tair and LST are now in Table 7. A new table with info containing GST during the snow free

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season has been added (Table 6), and SD values have been added.

3.1.1: The entire paragraph has been rewritten to take into account the comment made.

p.1597:

I.17: A more precise description on daytime and LST-Day is now given in section 2.

p.1598:

I.2: The entire paragraph has been rewritten with a better explanation. It is now moved to section 2.4

p.1599:

I.3 and I.4-8: I.6-8. The entire paragraph has been rewritten.

p.1600:

I.19: This became a discussion point.

p.1601:

I.13: The sentence has been deleted.

4.1.1 The section has been rewritten, including the snow cover parameter and a reference to Goodrich. It is now 4.2

p.1602:

I.24: Figure numbers have been verified and added for all of them.

I.24: “radiative cooling of the ground and formation of an inversion layer” is now used

p.1603:

I.12: Fairbanks station example has been replaced by Franklin Bluff.

I.15: Sentence has been changed and reference is made to new Table 8.

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I.16: Sentence has been changed.

I.23: A citation has been added that describes surface water conditions of the Alaskan station.

I.24: “The presence of the stagnant water modifies the heat exchanges between the soil surface and the atmosphere at the soil interface, which the 2-m height air temperatures do not measure.” This sentence has been changed to “The presence of the stagnant water modifies the heat exchanges between the ground surface and the atmosphere, liberating warmer flux than frozen water. All the heat exchanges appearing at the ground interface are usually not measured by standard 2-m height air temperature stations.”

I.28: Instead of the affirmation, we added: “Then we can assume that during snowmelt the LST better represents the snow surface (melting snow) temperature than the Tair.”

p.1604:

I.17: The sentence with soil temperature has been deleted.

p.1605:

I.10 to I.21: The entire paragraph has been rewritten to take into account the comments. The paper explains well in general that LST compares well with Tair but not with GST, largely because of snow cover.

p.1621: The figure has been deleted.

p.1624: “measured air temperatures “ has been added to the caption of both figures

References:

The suggested references have been added to the text and the References, except Nishihama et al. (1997) since the more recent Wolfe and al (2002) reference is preferred, and Scambos et al. (2006).

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Interactive comment on The Cryosphere Discuss., 5, 1583, 2011.

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5, C1085–C1091, 2011

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