

Interactive comment on “Transient modeling of the ground thermal conditions using satellite data in the Lena River Delta, Siberia” by Sebastian Westermann et al.

Anonymous Referee #1

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In this study the authors present a remote sensing based scheme for transient modelling of the ground surface regime together with the previously published numerical model CryoGrid2. The scheme is applied over a large area in the Lena River Delta (LRD), Siberia. Forcing datasets at 1km and weekly resolution are derived from MODIS LST, MODIS SCE, GlobSnow SWE plus meteo fields from ERA-Interim reanalysis. Spatially distributed ground properties are based on geomorphological observations and mapping drawing on previous studies in the region. Results are compared to in-situ observations of ground temperatures from boreholes, CALM active layer depths and measurements from the Samoylov Island Permafrost observatory. The authors conclude that comparison to in-situ measurements shows that the scheme is capable

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of estimating the thermal state of permafrost and its time evolution in the LRD.

This paper is a further contribution to the work of using remote sensing data together with numerical models (eg. Westermann 2015) which I think is a very interesting and promising approach to large area and/or operational assessments. The paper is well written with a clear methodology, presentation of results and critical discussion. The authors acknowledge shortcomings of the approach such as dependency upon a well estimated snow density and difficulty in applying in heterogeneous terrain due to coarse scale of the LST data. I have one main comment with respect to the forcing timeseries, other comments are reasonably minor.

Comments:

1. P8 Section 3.3: In the merged LST /reanalysis product, 2m air temperature and LST are merged. I think it would be helpful to add some discussion of how comparable surface air temperature and LST are and how this is expected to vary under both different atmospheric and surface cover conditions. The most obvious example is when a snowcover is present and air temperature and snow surface temperature can differ strongly. This reference (Gallo et al 2011) would probably be useful: <http://dx.doi.org/10.1175/2010JAMC2460.1>. This study from Raleigh et al. <http://dx.doi.org/10.1002/2013WR013958> suggests that the 2metre dewpoint temp (also available from ERA-Interim) is perhaps a better approximation of snow surface temperature than 2m air temperature. What kind of biases can be expected by forcing the upper boundary condition of surface temperature with a 2m air temperature field? Or are these different forcings treated differently by the model?

2. P10 l20-22: is this spatial variability due to residual snow patches? Perhaps state the cause here.

3. P7 l3 + 33 on line 3 you say “extensive set of observations available” whereas on l33 you say “which temporally /spatially distributed sets are not available” - are these statements contradictory? Can you describe the snow density data briefly in Section

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2.2, particularly at which times of year these measurements were made.

4. Fig 6: Is there an offset in your measurements as looks like in Fig 6 that zero curtain is occurring 0.5deg or so below the 0degC point.

5. Fig 6: can you explain why there is no zero curtain at phase transition from ice to water in spring/summer in the wet polygon? Would you expect this?

Technical issues:

1. p6 l29: add terms in brackets after items in text so that equation is more easily understood.

2. P7 l6: ...LRD for which... → ...LRD which..

3. P9 l27-29: I think it is more common to use term “layers” when talking about vertical discretisation of model units?

4. P10 l16: Figure 2 seems to lose most bar elements upon printing (not digital form). Perhaps my printer issue - but check this.

5. P10 l24: “well suited as input for ground thermal modelling” - qualify this statement with something like “, at least in homogeneous terrain”.

6. P11 l7 over a an → over an.

7. p11 l10 repeated word “cloudiness” → you mean snow?

8. P14 l32-33: qualify statement with something like ‘in homogeneous terrain’.

9. P17 l11: had → hand.

10. p18 l8: ares → area.

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