Review of

Pan-Antarctic map of near-surface permafrost temperatures at 1 km^2 scale

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General Comments.

This is an extremely interesting paper and represents a large step forward in efforts to understand the distribution of permafrost temperature in the Antarctic. It is a novel contribution and will likely be a benchmark set of predictions for years to come.

Much of the model work here relies on use of ERA-Interim reanalysis products and down-scaling. How do the reanalysis surface temperatures and precipitation values compare to measured surface temperatures and precipitation values at long-term monitoring sites? The model will only be as good as the measurements that underlie it, and microclimate conditions dominate many ice-free areas.

One potential shortcoming of the model is that all surfaces are treated as having the same composition in terms of thermal properties. Yet IFAs can be either solid bedrock (with a variety of different lithologies possible), or soil, or ice cemented soil. How much of the overall uncertainty in the model can be attributed to the choice of subsurface thermal properties? What about active layer characteristics? Where present, wet active layers may significantly increase heat transport into the surface, while dry active layers serve to insulate permafrost.

There are abundant examples of unclear English usage in this paper that should be addressed by a copy editor prior to submission. Many are small, e.g., “the temperature” when “temperature” would suffice, but they are too numerous for me to highlight individually.

Specific Comments.

As a courtesy to reviewers, please remember that continuous line numbers are always more convenient to reference.

P1, Line 20. “under” seems like a slightly odd word choice. Technically, it is mostly correct, since in most ice-free areas there is an active layer, although, not all ice-free areas have active layer conditions. For that reason, “within” might be a more accurate word to use here and throughout, unless subsurface temperatures are being discussed. See, P2, L2

P1, Line 21. “a” is not needed here

P2, L2-4. This sentence has several unclear uses of language and should be revised.

P2, L4. The Landsat-based reconstructions of ice-free area were conducted even earlier in the largest IFA by Levy (2012).

P5, L14. There is commonly not just an elevation gradient in Antarctica, but also a coastal-inland gradient for precipitation. How does proximity to coastal moisture sources affect snow cover at inland sites?

P6, L10. r_k of 0.85 seems very high—especially for sandy, low-organic permafrost typical of the Transantarctics. (McKay et al., 1998) report thermal conductivities of thawed and ice-cemented permafrost of 0.6 and 2.5 W/mK, respectively, which would be less than 1/3 of the proposed value. (Levy and Schmidt, 2016) report a range of wetted soil thermal conductivity values for similar cold desert soils, ranging from ~0.2 to ~1.7 W/mK, which are still on the low end compared to the frozen value. What is the impact of having such a high r_k value?

Fig. 3. It is a little bit confusing having different legends on the two maps, which show both datasets. Can you put both legends on both maps?

P13, L4. East of 90˚E would be a more clear way to phrase this.

Figs 3 – 14. I'd suggest thinking more about the color ramp used to present this temperature data. Why was it selected? Because it is not a single gradient or ramp, it is difficult to tell what color is warmer or cooler than which other color without consulting the legend. It is not extremely intuitive. Either a single color intensity ramp, or a red-blue or green-blue color ramp might be more clear.

P24, L10. Is part of the apparent lapse rate behavior that you have observed a function of changing substrate? In low elevation areas, tills and other soils may dominate, while at high elevations, ice-free areas are largely bedrock. How might this affect the apparent MAGT lapse rate?

P24, L14. The increase in MAGT with elevation at some sites is extremely curious. What do you attribute it to? Is this explained in P30, L25? It might be worth highlighting this curious result sooner.

P27, L4. Given the importance of orientation and insolation in controlling ground surface temperature in Antarctic ice free areas, would it be worth adding an orientation factor to the model? Something like fraction of north-facing surfaces in the grid cell? With datasets like REMA now available, it might significantly reduce the offsets in these numerous "microclimate" sites?

P31, L5. An RMSE of 1.9˚C is really pretty good, but it could be a substantial uncertainty for warmer permafrost sites. How does uncertainty scale with absolute or mean average temperature? Are there particularly warm sites that have high uncertainty? How might the distribution of uncertainty affect our understanding of which permafrost is at risk of thaw?

References.

Levy, J., 2012. How big are the McMurdo Dry Valleys? Estimating ice-free area using Landsat image data. Antarctic Science 25, 119–120. doi:10.1017/S0954102012000727

Levy, J.S., Schmidt, L., 2016. Thermal Properties of Antarctic Soils: Wetting Controls Subsurface Thermal State. Antarctic Science 28, 361–370.

McKay, C.P., Mellon, M.T., Friedmann, E.I., 1998. Soil temperatures and stability of ice-cemented ground in the McMurdo Dry Valleys, Antarctica. Antarctic Science 10, 31–38.