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Interactive comment on "Thermal resistances in the Everest Area (Nepal Himalaya) derived from satellite imagery using a nonlinear energy balance model" *by* D. R. Rounce and D. C. McKinney

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This is a well written, concise contribution that addresses an outstanding problem affecting modelling of debris covered glaciers. The main innovation is the inclusion of a parameter to account for non-linearity in the temperature profile through the debris when solving the energy balance to determine the debris thickness from a satellite field of surface temperature.

General comments and questions:

Is the 0°C ice temperature condition met according to the ice/debris interface measurements for September? This would be interesting to know as half of your satellite

images come from Sept/Oct.

Is the debris thickness range of your 12 samples outside your basin comparable to that inside your sampled basin?

Did you also observe moisture at -0.1m depth in the debris when it was 1m thick? Was this wetted surfaces of the grains or pore spaces filled with water?

Could the contrasting effective thermal conductivity values at -0.1m be caused by anything other than moisture, such as a change in grain size? Was the debris layer strongly stratified?

Was this change evident in all 4 sits with thermistors? What were the different debris thicknesses at LT1-4? Do you know if your top 10cm temperature gradient is robust in different debris thicknesses? If LT1-4 span a range of thicknesses you can examine this point a bit. Or perhaps you can use the data from Ngozumpa to examine this gradient ratio and its consistency in both different debris thicknesses and time?

Figure 2 implies that Qc is only evaluated through a debris laden ice column, but as I understand the text your model evaluates Qc throughout the debris layer from the surface, and only LE is computed from the -0.1m depth? I think you need to redo this figure so that it properly represents your model concept.

Could you describe the slope correction utilized in your model more fully – for example, in its current form it is unclear whether or not you include shadowing by surrounding terrain or just 'self-shading' of the glacier surface itself.

Did you see any systematic change in model performance at different times of year? I would think that the G_ratio will change significantly throughout the year, although it is consistent during your measurements dates.

Similarly, you use the temperature at 10cm depth based on Ts and the temperature gradient measured in September, but this might be quite different to that measured at 10:15 in July. I think this is worth a comment.

So do you think the negative energy balance instances occur due to the resolution of the satellite images being incompatible with the DEM? This seems to differ from the high temperature causes of model failure reported in Foster et al., 2012, but in your case there could be a clear, scale-based reason. I think you can make this case more clearly in the text linking the discussion on p 900 more explicitly with the need to resample at the resolution of the satellite imagery to avoid model errors as detailed on p901.

Why are wind and T the only meteorological parameters of interest? You mention that negative energy balance can be computed on N and W sloping areas, suggesting that radiation might have a significant impact on the results too.

Could you add the impact of the sensitivity test on derived debris thickness as well, I realise this can be easily calculated form the information in your paper, but I think it is a more obvious parameter.

I'm not sure you need Figures 3 and 4, as they illustrate essentially the same thing. Figure 5: Does (d) refer to the non-linear slope results? If so specify this in the caption. Also can you restate the scale of the grid points in (d), I think they are 5m grids as per your high resolution DEM, is that correct?

Can you show us debris thickness maps for Ngozumpa and Khumbu glacier as well as the R maps?

Its interesting to note that the expanding Spillway lake identified by Thompson et al, 2012, is identifiable on your thermal resistivity maps. Might be worth mentioning? The refernce is: Thompson, S., Benn, D. I., Dennis, K., & Luckman, A. (2012). A rapidly growing moraine-dammed glacial lake on Ngozumpa Glacier, Nepal. Geomorphology, 145-146, 1–11. doi:10.1016/j.geomorph.2011.08.015

Interactive comment on The Cryosphere Discuss., 8, 887, 2014.