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The Cryosphere Discussions

Interactive comment on "Processes influencing near-surface heat transfer in Greenland's ablation zone" *by* Benjamin H. Hills et al.

Anonymous Referee #2

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Hills et al. Investigate heat transfer from the atmosphere to the ice in west Greenland's ablation zone and conclude based that air temperature can not predict the near-surface ice temperature. While the topic is interesting and the data presented is valuable, the modelling part does not lead to strong conclusions. I would recommend to rework the paper, focus on the data analysis, especially the very interesting transient heating events, ideally deriving quantitative conclusions on the amount of water necessary to reproduce them and modify the modelling part significantly. Some assumptions for the model-part seem inappropriate or at least too weakly constrained in order to judge if the derived conclusions are valid. Comparison with Promice stations in the area may improve the applicability and validate some of the factors. Central is an in-depth check of the boundary (6) for the modelling part. This should be discussed thoroughly. Take a

promice station in the area, convert outgoing longwave radiation with Stefan Boltzmann to surface temperature and plot vs air temperature. This plot is necessary for the paper and will show if (6) is OK to use at all. Also, put more effort into explaining the massive local-scale variability of ice temperatures which is surprising to me. Generally, I would suggest major revisions, a change in focus of the paper and/or a substantial improvement of the modelling part.

P2 L12: add reference? L19 – if it is often used, add more references. This is potentially an important issue. P3 L1: this statement is true for all ablation areas and is not GrIS specific!? L7-8. Can observation resolve these processes quantitatively? In my view this is the 'issue' with observations, that you end up with a 'bulk' signal combining different processes. Consider rewording L13. 30 km below. . . is confusing. Rewrite. Also 1500m elevation in this area? L13: I miss info on elevation of the sites. Please add to Tab1 L24: reduce numbers of sign digits L27: how was the field calibration done? L29: near surface: how near? Did you have a radiation shield? Add a picture of the AWS L34: how often were they re-aligned? Estimating from fig 3 there was a ca 6 m surface elevation change. This pushes your air temperature quite far into the near-surface inversion. How do you account for this.

P4 L4: why five strings? L11: how does that fit with field calibration P3 L27? Fig 2 has a problem as it does not seem to account for changing surface height – I deduce this from the fact that each dot represents a sensor. It is, however, over time in different depths. Especially for the uppermost sensors this creates an issue. Suggest to correct the time-series using the known surface elevation changes. For the mean annual air temperatures. How do promice stations in the area fit to that? I am a bit worried about the height-above terrain and the radiation shield issue. Are air temperatures ventilated? Also: why don't you sort them logically, i.e. from 27, 33 to 46? Add axes descriptions. Label a-g L15: explain what positive and negative means for the gradients L15-17: unclear sentence. What do you mean? L21: makes things difficult. Consider only showing averages for concurrent times or at least full years? The rest

does not make sense to me. L26-27: this is a very large near-surface variability and not easy to understand. How about radiation errors of the uppermost sensors? Figure 3: misleading. The depth of the sensor during installation is shown and not sensor depth. This is a massive difference. Strongly recommend to correct it for that. There are some interesting features and it is impossible to tell whether these are artefacts or reality. Which ones are the warming events you refer to? how about the vertical red lines, i.e. end of 2015 or ca may 2016 further down or again some time in spring 2017. Suggest indicating the warming events you refer to later in the discussion. And what with the horizontal redish bodies in late 2014 for instance in ca 8 m? L29: refer here to something you mark in the fig. Fig. 4: do they cool off again afterwards? Why don't you show the same time-steps in c and d as you do in a and b? how does meteorology play in here? Was there a rain-event preceding this? Impossible to tell if you don't state when it happened. Fig. 5. b) consider combining b and c as surface elevation change D)If you measured with a NRlite p3, L30, you don't get net shortwave radiation to my understanding. P5 L5 see above. NOT net-shortwave L6: sounds low to me. Compare to Promice KAN stations? This could also help discriminating into SW and LW. L9: consider rewording 'warm bias' L15-20: I believe that winter 2016 was particularly snow-poor and thus not particularly 'representative'. Check if that is true on regional scale and include in discussion. Part 4 and 4.1. See issue with boundary condition (6). Boundary condition (7) is clearly not valid as yu state yourself and adapt later. But why then introducing it and calling it a boundary condition? This does not make too much sense to me. The choice of experiments seems arbitrary. How about turbulent heat exchange? P8 L9: net radiation L25: -0.05°C/m, P9 L5: also in other occasions surface temperature and air temperature can be very different L20: and P10 2-4this seems trivial. If you keep the upper part of the 'trumpet' as it is and induce a gradient in 20m you will end up colder there. Is there a value in it? L24-25. What do you mean? Unique to the ablation zone. . ..larger than other areas? Other ablation areas? The sentence does not make sense to me L30-34. Interesting. But what is the reason for such different ice-packages coming to the same site just a few dozens of m away?

This should be better discussed and this high variability is potentially a significant result of the paper. How do satellite-derived surface temperatures vary spatially? P11: L6. Refreezing is a big topic these days. Consider adding more refs Could the amount of water be estimated that would be necessary in order to reproduce the warming caused by latent heat you observe? This would be interesting. L26-29. Check out Colgan et al. Crevasse review. There is a process mentioned of crevasses 'growing' from below to the surface.

P5-9:all that would point to ice being colder than air. But you show in fig 2 it is warmer. I doubt that the modelling serves as a base for this conclusion.

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