

## ***Interactive comment on “Excess heat in the Greenland Ice Sheet: dissipation, temperate paleo-firn and cryo-hydrologic warming” by M. P. Lüthi et al.***

### **Anonymous Referee #1**

Received and published: 28 October 2014

General comments: This paper studies an important topic of the thermodynamics of the marginal ice in the Greenland ice sheet, which is crucial to understand the impact of climate warming to the changes in the ice sheet dynamics and ice sheet extent. The paper is generally well written, however, for a more detailed understanding of what the authors really did, some more explanations are necessary. This in particular concerns the description of the model and the justification of some model assumptions.

Specific comments: Title: “excess heat . . .”: “excess heat” compared to what?

Abstract: it seems that you have a “normal state” of a glacier in mind, and then introduce the deviations (excess). However, what is the normal state? Every glacier is

C2169

flowing, produces strain heating (dissipation), has a history (paleo-firn?), contains a hydraulic system and crevasses (cryo-hydrologic warming).

p. 5170, line 20: the five drill sites of Thomsen (1991) are not even approximately situated along a flow line downstream of Swiss Camp. They seem to lie on flow lines crossing a mountainous region near the margin and thus are warmer likely because the cold advection of inland ice is reduced substantially.

p. 5171, line 5: the two temperature profiles may be very similar, but why should they ‘agree’ with each other?

p. 5173, line 11: 5.6 kg is very little of course, however, is the water also readily available for the entire ice column below  $1 \text{ m}^2$ ? How does this compare with the 0.31 K per century heating rate on p. 5174, line 3, for strain heating?

p. 5175, line 18: “refined to a coarseness” sounds a bit contradictory, would “resolution” not be more adequate than coarseness? What is the resolution elsewhere?

Figure 1: please connect the points in the upper panel with lines (as you do in all other figures and panels). This makes it easier to read the figure.

Figures 5-7, upper label of lower panels: “supply” indicates a heat flux rate, but you give a heat “content” (density)?

comments on the heat flow model:

p. 5174, lines 12-19: do I understand correctly that you solve the transient equation within a block of ice moving along the flow profile. Is the solution for the flow line profile as a whole a stationary solution? How do you handle the upstream and downstream boundaries of the block of ice?

p. 5175, lines 3-4 and lines 21-24: Don’t you change the advective heat flow with neglecting vertical shearing? Are the analytical solutions of Vorkauf (2014) one-dimensional solutions? If yes, do they really test the omission of the vertical shearing?

C2170

Acknowledgements: do not acknowledge an author (M. Funk)

---

Interactive comment on The Cryosphere Discuss., 8, 5169, 2014.

C2171