

## ***Interactive comment on “Destabilisation of an Arctic ice cap triggered by a hydro-thermodynamic feedback to summer-melt” by T. Dunse et al.***

**G.S. Hamilton (Referee)**

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This manuscript describes a recent surge-like event of the southern margin of the Austfonna ice cap, Svalbard, which the authors apparently link to a feedback mechanism involving increased surface meltwater production leading to enhanced basal motion over an ever-expanding area. The GPS observations of ice motion have been described in an earlier paper (Dunse et al., 2012) (updated here) but the velocity maps from satellite radar images are new, as is the description of the 2012-2013 surge event affecting Basin-3. There is certainly enough new information to warrant publication in The Cryosphere but, as currently written, I find much of the manuscript to be a bit too speculative and I'm not sure the conclusions are really supported by the observations. I encourage the authors to rethink a lot of the interpretation and discussion, and come

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back with a suitably revised manuscript.

One of the my main concerns is the proposed feedback mechanism. The authors don't really describe the mechanism in detail so it difficult to tell how it differs from (or is similar to) the various thermal mechanisms proposed for glacier surges, or to the cryo-hydrologic and other melt-induced mechanisms proposed for Greenland. Two missing pieces, in particular, stand out. One is the exact nature of the feedback, i.e., is it positive or negative. It seems to me that the mechanism as outlined would tend to be self-limiting (negative). Increased ice flux from the interior would gradually thin the ice column and promote refreezing of the bed (I think this type of feedback is similar to thermal mechanisms of surging). Alternatively, and this leads to the second missing piece, the subglacial drainage system gradually evolves to a more efficient state under continuing high meltwater inputs and surface velocities actually drop. This type of negative feedback has been inferred quite convincingly for the western margin of the Greenland Ice Sheet, yet the authors do not really explore the reasons why their observations are seemingly inconsistent with the Greenland story.

Some reorganization of the paper would definitely help. For example, much of the introduction strays into material that is not directly relevant to the present study (e.g., oceanic triggers for outlet glacier changes, ice shelf (in)stability in West Antarctica, or post-LGM Heinrich events). A better way to introduce the paper would be to summarize current state-of-the-art in thermal mechanisms for glacier surging and maybe meltwater-induced speed-ups of the West Greenland ice margin. Reviewing this background material would allow the authors to frame their current study in a more meaningful way, and might also help the authors refine the details of their proposed feedback mechanism in a way that builds on existing ideas and is supported by their observations.

I have a few additional comments that I hope are useful to the authors.

P2685 L3: Delete the hyphen in “summer-melt” in the title.

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P2686 L6: no hyphen in “summer-melt”

P2686 L16: change “glacier wastage” to “mass loss”

P2686 L22: change “not only the...but also the ice sheets” to “both glaciers and ice caps (Kaser et al., 2006) and ice sheets”

P2686 L26: delete the sentence “Recently, the West Antarctic...”...not sure of its relevance to a paper about Svalbard.

P2687 L4: too much disparate information in one sentence...separate the ideas about basal lubrication and oceanic forcing. As written, there is an implication that the two mechanisms are linked.

P2688 L17: start a new paragraph at “The effect of surface...”

P2689 L1: rewrite slightly “...variations in glacier flow, and is...”

P2690 L7: change “ground” to “bed”

P2690 L8: change “intersperse” to “embedded within”

P2690 L12: change “to some extent” to “partially”

P2690 L21: write out acronyms on first usage (“SAR”)

P2690 L25: “lineations” plural

P2691 L1: change “years” to “time”

P2691 L6: need a short paragraph here to set the stage for the work that follows. So far you’ve provided a general introduction, but now you need to describe the motivation for the present study.

P2691 L6: delete “GPS”

P2691 L6: the section on GPS analysis needs to be expanded a bit for clarity. I know the most of the details were written up in an earlier paper (Dunse et al., 2012) but

readers will benefit from a brief overview here. For example, you say “single-frequency code receivers (L1 band)” which could mean two things – you used the C/A code modulated on the L1 frequency, or you use the L1 phase measurements. Position qualities will be different for either approach. I suspect you used C/A code because you go on to mention “geographical positions were logged”, implying onboard processing without ephemeris information. But please clarify to reduce reader confusion.

P2692 L2: where does the ice thickness information come from???

P2692 L6: change “was” to “has”

P2692 L15: delete sentence “In spring 2008...” which is an exact repeat from section 3.1

P2692 L21: change “periods” to “events”

P2692 L25: not clear what you mean by “progressively irreversible”. Is that even possible??

P2693 L9: change “further” to “farther” because you are talking about distance.

P2693 L10: unclear what you mean by the sentence “Consequently, ...”

P2693 L12: change order of words, “also displayed”

P2693 L15: instead of inferring the lack of basal motion, you could actually estimate how much of the observed motion is due to internal deformation (using glacier geometry)

P2693 L24: re-order the sentence, “Fast flow of Basin-3 (Table 2) continued at least until the end of 2013.”

P2694 L1: calving flux estimates require information on ice thickness. Do you know that? Where do the data come from??

P2694 L10: change “as opposed to stable front position” to “compared to the stable

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configuration”

P2694 L24: rewrite slightly, “The observed dynamic changes at Basin-3 over the last two decades...”

P2694 L26: delete apostrophe in 1990s (and elsewhere in the text)

P2695 L3: change “spatial confined” to “laterally-confined”

P2695 L25: just an observation, but speeds of 114 m/yr “close to the ice divide” are quite something! How close is “close”??

P2695 L26: change “signify” to “signifies”

P2696 L1: change “drag” to “resistance”

P2696 L14: change “by the” to “at least until”

P2696 L19: change “are expected to be no longer maintained” to “will become unsustainable”

P2696 L22: “As an analogue...”

P2698 L5: this seems like an important inconsistency. Why do your results differ so much from the Greenland work??

P2702 L1: change “Analog” to “Similar”

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