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The Cryosphere Discussions

Interactive comment on "Seasonal speed-up of two outlet glaciers of Austfonna, Svalbard, inferred from continuous GPS measurements" *by* T. Dunse et al.

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The flux of ice to the grounding line or calving front exerts an important control on an ice cap's mass balance. In this manuscript, the authors describe variations in flow speed, and hence ice flux, for two major outlet glaciers of Austfonna ice cap based on nearly-continuous two-year records of GPS observations. The results show a significant speed-up associated with the onset of summer melting, and mixed velocity responses to subsequent melt events, which the authors explain by an evolving subglacial drainage system. In addition, comparison of the GPS-derived speeds with InSAR-derived speeds shows a secular increase in flow speed (ice flux) over the last

$\sim$15 years.

Overall, the manuscript is well written and logically organized. The conclusions are generally supported by the data, and the methods and results will be of interest to a wide audience. I recommend the manuscript be accepted for publication once a few technical and editorial issues are addressed (see below). My only two (relatively minor) criticisms are that (i) there is a potential problem in extrapolating a single high-elevation melt record to all locations on the ice cap (see comment for P10 L19), and (ii) there is not much discussion of how the evolving drainage system affects ice speeds after the initial speed-up (see comment for P17 L5). It would have been useful to see the Austfonna results in the context of recent work from Greenland.

[As an aside to the EGU editorial office, the line numbering scheme in manuscripts is not conducive to making a reviewer's job any easier. Please in future use consecutive line numbering throughout the whole manuscript (and make the first page of the manuscript page 1, not page three thousand and something!). In my comments below, P1 = P3423, etc.]

P1 L15: not entirely clear what you mean by "the principle melt was of high amplitude". Do you mean the major melt event of the season?

P1 L20: "that" –> "those"

P2 L25: "strong" –> "important"

P2 L26: delete "the" in "the ice is exposed..."

P3 L24: the Greenland references could be updated to include more recent work (e.g., Bartholomew et al., 2010; Andersen et al., 2010, 2011; etc.)

P3 L28: delete comma after "occur"

P4 L5: "hamper" –> "retard"

P4 L25: it would be more useful to report calving fluxes as a mass (Gt/yr) instead of a

volume. See elsewhere as well.

P4 L27: no hyphen necessary in “GPS-observations”

P4 L28: delete “presented”

P5 L8: delete “large”

P5 L26: “...also suggests that...”

P6 L2: be careful not to confuse surface elevation change with “thickening”. Fix by deleting “with interior thickening at rates” and replace with “of up to +0.5 m/a”

P6 L6: delete “mass”

P6 L8: I think you have confused ELA with snowline. The ELA is the long-term average annual snowline position.

P6 L13: “have been” –> “were”

P6 L19: “...and the geometries along their central flowlines.”

P6 L25: “down to” –> “at”

P6 L27: delete “has”

P6 L28: ditto.

P7 L1: “since” what? Part of a sentence missing here?

P7 L2: “for” –> “of”

P7 L7: state the distance over which the elevation increase occurs.

P7 L14: in what way did Landsat imagery suggest inactivity?

P7 L23: delete “the” so, “...drains into narrow Duvefjorden”

P8 L1: awkward phrasing, change to “...ranges from $\sim$300 m to >400 m from the lower

to upper ends, with a mean of...”

P8 L3: “further” –> “farther” because you are talking about distance. Also needs changed throughout the manuscript.

P8 L4: delete “down to sea level and beyond”

P8 L10: why write “may” when a quick check of satellite imagery would tell if the supra-glacial lake forms at that location?

P8 L14: “recording units” –> “receivers”

P8 L15: rephrase, “...atop stakes drilled...”

P8 L18: “units” –> “receivers”

P8 L20: Insufficient power implies the receivers did not have solar charging capability. Is that really the case? No solar??

P8 L23: by single-frequency, do you mean L1 only?

P8 L25: unclear what you mean by allowing the system to “stabilize”

P9 L5: slightly unfocused discussion of errors in this section. You start by mentioning the accuracy of single position estimate, then discuss filtering of the data, and then describe the uncertainty estimates. It seems like this flow of ideas could be made more intuitive.

P9 L10: awkward phrasing, change to “A larger error is expected in year with higher...”

P9 L14: what do you mean by an “individual dataset entry”? Do you mean an epoch?

P9 L15: “energy” –> “power”

P9 L17: “e.g., due to riming . . . of the satellite signal” –> “multipath”

P9 L19: “measurements” –> “estimates”

P9 L27: “...are calculated trigonometrically from the averaged positions.” delete “utilizing...”

P10 L18: write out AWS on first use.

P10 L19: was the AWS on ice or rock? It was at quite a high elevation (510 m), so presumably all the GPS receivers were at lower elevations. Granted, your analysis only examined the timing of melt events and not their absolute magnitudes, but there is a strong likelihood that a single high-elevation weather station might have missed coastal temperature inversions. In other words, you infer melting occurs everywhere based on the AWS record from 510 m elevation, but there might have been instances when low-elevation GPS sites were experiencing much cooler (non-melting) temperatures during an inversion. Is there any way to address this issue? Do you have access to any weather station data from sites closer to sea level? If not, you ought to at least acknowledge the limitation of extrapolating a single melt record to all sites.

P11 L8: “...their summer maxima but maintained relatively high speeds...”

P11 L10: “above” –> “faster”

P11 L11: not clear what you mean by “not captured”. Do you mean there is missing data, or do you mean the event did not occur?

P11 L17: define what you mean by “short-lived”. Do you mean a few hours? Several weeks?

P11 L22: “unit” –> “receiver”

P12 L1: the phrase “quasi-stationary pre-summer low” is unclear.

P12 L4: “when” –> “where” since the object is a time (“the day”), not a place (“a particular location”).

P12 L4: “are in excess of” –> “exceed”

P12 L6: “between” –> “at”

P12 L10: “lowermost site”

P12 L25: “where” –> “when”

P13 L12: “provoke” –> “promote”

P13 L21: “For both flowlines...”

P13 L27: “This indicates that basal water pressures remained high and only...”

P14 L12: define “short-lived”

P14 L19: “possess” –> “impart”

P14 L21: “where” –> “when”

P14 L24: delete “initiated at the calving front.”

P15 L5: delete “negative in the case of retreat”

P15 L9: use consistent units (m or km, not both)

P15 L19: “his” –> “these”?

P16 L1: “...usually lower than the annual average.”

P16 L1: “indicate” –> “indicates”

P16 L10: no apostrophe in 1990s

P16 L20: “...factor of four...”

P16 L20: “showed also” –> “also showed”

P16 L24: put 550 m/a in parentheses.

P17 L5: in the introduction, you raised the issue of sustained meltwater inputs retarding glacier flow, as shown by the observational work of Van de Wal et al. (2008) and

Sundal et al. (2011) in Greenland, and modeling work by Schoof (2010). Maybe you can include some remarks about how your Austfonna results support (or do not) this idea. It would help put your work in a wider context.

P17 L19: “Navigation data were...”

P18 L7: “legs” –> “segments”??

Interactive comment on The Cryosphere Discuss., 5, 3423, 2011.