Earth Syst. Sci. Data Discuss., 6, C19–C24, 2013
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Earth System Science Data Discussions

Interactive comment on "Seasonal velocities of eight major marine-terminating outlet glaciers of the Greenland ice sheet from continuous in situ GPS instruments" *by* A. P. Ahlstrøm et al.

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This is the final response on behalf of the authors.

Below, we address the remarks of reviewers and commentators one by one, including the remarks in citations " " before addressing them to facilitate the editorial process.

Reply to Reviewer 1: "My main concern is that the authors present all their errors in terms of percentages. I do not see how errors in GPS or in InSAR can scale with velocity and hence this is a strange, and possibly misleading, presentation of the velocity uncertainties. I strongly recommend they express them in terms of m/yr." Answer: It is true that errors in the GPS-derived velocities do not scale with velocity. However, we

are interested in the difference between GPS-derived velocities and satellite-derived velocities assuming that the former can be regarded as ground-truth. The satellite-derived velocities do scale with velocity as we assume surface parallel flow, which essentially reduces the 3-d problem by assuming the vector lies in the local plane tangent to the surface. So errors in this plane, which are slope dependent, scale with velocity (typically a few percent, as demonstrated in the comparison). The errors also depend on correlation, which can be affected by speed. This however, is included in the error statistics. In conclusion, we argue that it is most sensible to state the errors in percent. If one is interested also in the absolute errors in m/s, it is easy to consult the tables included in the manuscript which contains all the derived velocity estimates. We will include a sentence clarifying our choice of percent to express the error based on the above.

"Further, the actual data at the doi require some header records to explain the units and all the columns in full." Answer: Agreed. We will add header records to explain units and columns in full.

Minor points from Reviewer 1: "P29L7: swap radar and satellite": Done.

"P30L15-17: can the mass budget approach yield this improvement or does it rather rely on it?": Will rephrase to clarify this.

"L18: change application to increased accuracy?": Agreed.

"L24: give at the end of the sentence a typical range of X-Y weeks" Will be included.

"P32L9: King et al 2002 is not peer reviewed and a better replacement should be found" Will find replacement reference.

"L13: multi-path is conventionally multipath in GPS" OK, will change.

"L18: do you mean every one-third?" We mean once every third hour, will clarify in text.

"P33L2: I wasn't clear why gaps would increase the s.d. given this is before any

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temporal averaging" The gaps do not increase the standard deviation, but relaxing the requirement ensures that at least some data is available for the subsequent steps in the procedure. Note that the data availability threshold was also relaxed in a following step, where only 50% of the data had to be present within a time window in the case of Upernavik in contrast to a 95% requirement for the other sites. The higher threshold for the standard deviation at Upernavik simply means that we accept more noise, in order to have at least a basic idea of the ice velocity that would otherwise have been lost.

"L5: I wasn't clear if the Press reference referred to the original method or the modified one. If the original, then information is lacking on what the modification does" OK. We will include more detailed information on the exact nature of the modified Welch window. A more general discussion is also available in the Den Ouden et al. (2010).

"L9: both "is" should be "are" Corrected.

"L24: use of "waves" is unclear at this point Will clarify.

"P34L21: move derived to before GPS Done.

"P35 data set 3: I wasn't clear how frequent these were available, typically." OK. Will insert text on frequency of availability, generalizing the specific information in Table 4.

"P36L5 onwards - you say you refer to the datasets as GEUS and APL but then do not in this section" Corrected.

"L23: again, I don't think SAR velocity errors scale with speed so not to be expressed as %" Addressed in the reply at the top.

"P37L5: this examination is not shown anywhere I could see." It is indeed not shown. We will specify that it is not in the text.

"L21: "shorter or longer time span."" Agreed, will insert this rephrasing.

"P38L7: make it clear you are talking about SAR when discussing resolution and time span" OK, will do.

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"Table 1: please add coordinates for all sites Figure 1: scale bars and fonts are too small" OK, will do.

"Figure 3: state if the date is the mid-point or something else" OK, we will address this point in the caption of all velocity plots.

"Figure 11 caption: slope depending effects are not discussed in the main text and need something there to explain them." Text addressing slope-depending effects will be included in the main text, and relates to the question of whether errors should be given in percent or m/s.

"Figure 11 caption: The green point is a massive outlier at 200m/yr so this needs a little bit of discussion in the main text." We will address this particular point in the data set and determine, if at all possible, why this is an outlier.

"Figure 11 caption: The comment on the black point belongs in the main text." OK, will move text on outliers to main text.

Reply to Reviewer 2: Review 2 did not require any changes or answers from the authors.

Reply to comments by M. Pelto:

"There is one substantial issue that deserves further attention. There is a pattern of mid-summer deceleration that is as marked as the early summer acceleration. The early summer acceleration has been evident in a number of data sets to date, the mid-summer deceleration has not been as well quantified in other data sets as here." Answer: This is a good point and we will include it in abstract and main text as suggested.

Specific Comments: "A pattern of equal importance and often greater magnitude to the early ablation season speedup is the late ablation season deceleration. This should be noted in abstract." Agreed. Will do.

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"“too far apart” is too vague give the range of dates used." Agreed. Will be addressed.

"The series of maps showing seasonal velocity change have what temporal period, 3-6 months I think? How does the temporal resolution compare to that of Howat et al (2010)?" Will include comparison/mention of Howat et al. (2010) in text.

"It is evident in the graphs that the mid-summer deceleration is comparable in significance to the speedup and warrants focus. This is a more unique observation that this data set can make, that has been missing from most other data sets. Howat et al (2010) should be referenced; they observed that except for Rinks Isbrae the other outlet glaciers undergo a mid-summer deceleration indicative of subglacial drainage system evolution. Sermilik Brae has a similar deceleration after early June as before that. Kangiata Sermia indicates a late July maximum that is more significant than the early melt season speedup; May 1 to June 1 +200 m/s, June 1 to Aug. 1 -400 m/s. Sermeq Avanerleq indicates same thing; May 1-June 1 +100 m/a, June 1 to Aug 1 -250 m/a. Store Glacier has a -550 m/s slow down at the ARGOS station from July 1 to Aug. 1 Upernavik GPS 3's most significant trend is the decline at the end of the melt season in 2011. Rinks Isbrae also shows a late summer deceleration of at least equal magnitude to the speed up." Answer: Indeed an interesting aspect of the dataset presented. We will include these points in a general form, but refrain from a more thorough analysis as this is outside the scope of ESSD and will be addressed in a later publication.

"A notable aspect of many of the velocity plots is the double or single velocity cycle per month. Petermann, Humboldt and Sermeq in particular indicate this. Attribution at this point is not possible, but how statistically significant are these cycles, is this signal or noise?" Answer: Small amplitude variations may be a result of natural factors impacting the GPS-signal such as the lunar cycle (c. 15 day cycle) or the averaging procedure as previously mentioned and addressed in Den Ouden et al. (2010) and Dunse et al. (2012). Thus, we do not address any variations smaller than 30 m/s.

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