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The Cryosphere Discussions

Interactive comment on "Thinning and slowdown of Greenland's Mittivakkat Gletscher" *by* S. H. Mernild et al.

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Interactive comment on "Thinning and slowdown of Greenland's Mittivakkat Gletscher" by S. H. Mernild et al.

Anonymous Referee #1 Received and published: 7 December 2012

This paper deals with just what is advertised in the title: thinning and slowdown of a local glacier in Greenland over the past few decades. The authors also give values for volume change and quantify the annual velocity cycle at a local on the glacier. The slowdown is explained in terms of thinning, and basal sliding is shown to be a smaller player in potential causes for slowdown. The manuscript is easy to read and understand.

I do not have many comments (see below), but some of them are very important. Most crucial may be that the results may not be all that spectacular or a big advance in our understanding. The thinning and negative mass balance of MG have been published by the first author on previous occasions and may be limiting the newsworthiness of this work. AUTHORS: The spatial distribution of winter, summer, and net mass-balances have never been published before by the first author, and neither have volume, and velocity observations from MG: a detailed screening of the literature shows this. Mean annual net mass-balance time series were used in Mernild et al. (2011) to quantify the extent to which the glacier is out of balance with present-day climate. The present study confirms what we expected from fundamental glaciology; however, there are few instances of this being clearly demonstrated from long-term observations in the literature, and we therefore consider this a useful finding to report, justifying the publication of the study in TC. REFERENCE: Mernild, S. H., N. T. Knudsen, W. H. Lipscomb, J. C. Yde, J. K. Malmros, B. H. Jakobsen, and B. Hasholt 2011. Increasing mass loss from Greenland's Mittivakkat Gletscher. The Cryosphere, 5, 341–348, doi:10.5194/tc-5-341-2011.

And the explanation of why there is a slowdown of MG is no surprise to most readers. The velocity variations could be something to put the full emphasis on, with special focus on parallels between Greenland and alpine glaciers. This would require quite some work, but could be that advance in our understanding of Greenland's peripheral glaciers that is mentioned as a driver behind this work. AUTHORS: The observed MG velocity slowdown has also been clearly demonstrated a few times elsewhere. The idea about a parallel study between alpine glacier and MG is interesting, but will require an entire new study and is outside the scope of this MG study; however, we see that MG behaves according to fundamental glaciological principles and shows similar characteristics to Alpine glaciers.

Specific comments: Fig 2: Why is the validation not shown for all stakes? AUTHORS: The validation is shown for all locations where the two-cross sections hits stake loca-

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tions, which for the 300 m a.s.l. profile was at Stake 61 and 60 and for the 400 m a.s.l. profile is Stake 80, 81, 82, 83, and 85 (as illustrated on Fig 2).

Were there no more transects of radio-echo sounding collected? What is the error at other stakes? AUTHORS: Only two radio-echo cross transects were conducted, one at 300 and the other 400 m a.s.l., as illustrated in Fig 2. Direct comparisons were not possible at other stakes since radio-echo cross were not observed there.

Line 6 & 16 page 4392: Please give root mean square difference as well. If this is mean difference then it is only helpful in detecting an offset. AUTHORS: rms-values have been added to the text.

Figure 3 is very hard to read, printed out on A4 paper. Increase font size (also in other figures). Please use the same color scales in the right panels of Fig 3 for easier comparison. Also, indicate the statistical significance of these trends and consider removing areas where the trend is insignificant. Also, repeat the period covered by these measurements in the text and mention that stakes were used. AUTHORS: The font size was increased for Figures 3 and 6, and scales are adjusted. The margins of the statistical significance trends are shown on both Fig 3 and Fig 6. The period covered is added to Fig. 3 and to the text.

Is Fig 5 mentioned in the text before Fig 4? AUTHORS: This has been fixed.

Give uncertainty in Fig 5b and make the horizontal axis (stakes?) the same as in Fig 5a. AUTHORS: Uncertainties have been added, and horizontal axes are the same in both parts of Figure 5.

Line 18&19 page 4396: You can't claim 2-decimal accuracy based on the uncertainties. AUTHORS: This has been amended accordingly.

Fig 6 is also hard to read, especially the contour line labels - like in Fig 3. Also here, indicate (in b) where trends are statistically significant. AUTHORS: The font size has been increased, and the margin for statistical trends has been added to Fig 6.

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Section 4.3 and Fig 7: Sliding only adds to velocity; thus where Vsia is larger than Vobs, all of the difference can be attributed to calculation errors. These errors seem very large in the right hand side of the figure and do not give much confidence in the result. AUTHORS: We have added uncertainty bars to both the observed and calculated velocity values in Figure 7. The uncertainty at the highest points on the profile is very large and can explain the large discrepancy between the observed and calculated velocities. In the center of the profile, however, the uncertainty is lower and the result appears to be robust.

The findings in section 4.3 are not all too remarkable. The large slowdown is interesting, but I don't think that any reader would consider another cause of this than thinning. Especially the slowdown because of changing hydrology seems far-fetched. AUTHORS: We agree that the fact that the slowdown can be explained by thinning is expected from fundamental glaciology. However, there are few instances of this being clearly demonstrated from long-term observations in the literature, and we therefore consider this a useful finding to report. We simply offer the hydrology-related explanation as a possible alternative that is supported by references in the literature, but not one that observations support.

Section 4.4 more or less sums up what is known from previous studies and provides no new insights. Besides, I find it hard to fit this section in with the rest of the manuscript. Looking into the uplift events would be interesting, and could make you come to conclusions AUTHORS: Section 4.4. has been shortened. Since this section is about seasonal velocity changes, it supports the spatial annual surface velocity analysis. The uplift part has been highlighted in the abstract.

Such as "MG behaves just (un)like alpine glaciers", which can help statements that understanding MG is crucial for understanding Greenland's peripheral glaciers. AUTHORS: The text in this section does discuss the similarity of the seasonal pattern of velocity to alpine glaciers.

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Interactive comment on The Cryosphere Discuss., 6, 4387, 2012.

Thinning and slowdown of Greenland's Mittivakkat Gletscher

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Fig. 1.

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