

Interactive comment on “Changes in the marine-terminating glaciers of central east Greenland and potential connections to ocean circulation, 2000–2010” by K. M. Walsh et al.

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Received and published: 5 January 2012

Author's Final Comments

Reviewer Paulo:

Although the manuscript did not directly deal with changes in mass balance (or the direct effect of climatic impacts on glacier change), it is a valid argument that some mention of potential changes in mass balance must be mentioned. Mention of this (along with the proper citations) has been added to the beginning of the discussion.

Reviewer Christofferson:

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Throughout the manuscript, changes were made to reflect changing ocean patterns/circulation in the Irminger Sea and Denmark Strait regions, not the entire North Atlantic Ocean. Additionally, we were careful to exclude “warming of the (insert region here)” and instead included the potential of increased transport of subtropical ocean waters. Every effort was made to adjust all oceanographic geography statements to reflect this smaller area and the correct mechanisms for potential changes in ocean characteristics.

1) 2866,6-8: “Thermodynamic” changed to “oceanographic”, geographic description of Denmark Strait region was corrected to “. . . between the Irminger and Greenland seas . . .”, and syntax describing the Denmark Strait as an area that only spans 3 degrees of latitude was removed. 2) 2866, Introduction: Arrangement of first two sentences was reversed. 3) 2866, 22: Ambiguity was resolved by stating that the most pronounced glacier change has been observed in southeast and northeast Greenland. 4) 2866, 25: “Atmospheric circulation” (including appropriate references) was added to the statement. 5) 2867, 5: “Correlates” was changed to “has been linked to”. 6) 2867, 9: Statement adjusted to read “It is possible that warming of the ocean surrounding the Greenland Ice Sheet is increasing melt and retreat of the ice sheet’s outlet glaciers, with a potential link to atmospheric warming (Box, 2009; Christofferson et al., 2011).” 7) 2867, 21: “Ultimately” was added between “there is” and “no proof”. 8) 2867, 24: See comments above. 9) 2868, 2: See comment/correction above. 10) 2868, 4: See comment/correction above. 11) 2868, 12: Statement corrected to reflect reviewer’s suggestion/correction. 12) 2869, 1-19: Tenses were changed to be in the past tense. 13) 2871, 11: “Found” removed. 14) 2872, 7: “Thinning” replaced with “surface elevation change”. 15) 2875, 11: Changes were made to the discussion to suggest Svalbard-type surging as the predominant surging mechanism of marine-terminating glaciers in east Greenland, although the literature suggests that Sortebrae displays qualities similar to Alaskan-type surging glaciers. Both types of surging were discussed with an emphasis made on Svalbard-type surging glaciers (since most glaciers in east Greenland exhibit similar qualities). Jiskoot et al. (2001) and Jiskoot and Juhlin (2009)

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were added as references. 16) 2876, 10: See comment above. 17) 2876, 25: See comment above regarding surging and discussion. 18) 2877, 1: See comment above regarding surging and discussion. 19) 2878, 26: This figure was revisited and it was determined that the temperature increase was gradual instead of instantaneous. 20) 2879, 14: This number is from this study, and the statement was adjusted to read 'A sudden increase in the temperature (measured in this MODIS SST dataset) of the fjord water could explain the roughly 80 m yr⁻¹ of thinning that occurred between 1997 and 2001, and the disintegration of the glacier's floating tongue soon after (Motyka et al., 2011; Holland et al., 2008). 21) 2879, 17: "Have been correlated" was replaced with "coincided". 22) 2879,17 – 2890, 9: We believe that an SST comparison including 5 points along the east Greenland coast allows for a more complete qualitative analysis of the surface oceanographic conditions in the region. While points A and E illustrate the stark differences in surface ocean temperatures between the northern-most and southern-most points of the study area, points B-D illustrate the gradation in change. 23) 2880, 13: Wording adjusted. 24) 2880, 17: Wording adjusted, and comments regarding warming in the North Atlantic changed (see above comments).

Reviewer Yde:

1) 2871, 15: Gasegletscher has been removed from the manuscript. 2) 2876, 25 – 2877, 1: Changes were made to the discussion to suggest Svalbard-type surging as the predominant surging mechanism of marine-terminating glaciers in east Greenland, although the literature suggests that Sortebrae displays qualities similar to Alaskan-type surging glaciers. Both types of surging were discussed with an emphasis made on Svalbard-type surging glaciers (since most glaciers in east Greenland exhibit similar qualities). Jiskoot et al. (2001) and Jiskoot and Juhlin (2009) were added as references. 3) 2877, 16: See above comment. 4) Table: The authors feel that the figures provided show a sufficient overview of glacier change in east Greenland, so a table was not included.

Reviewer Jiskoot:

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With respect to the comments regarding land-terminating glaciers in east Greenland: the focus of this paper was on the marine-terminating glacier dynamics of this region, and an analysis of all glaciers (including peripheral glaciers and ice caps) is beyond the scope of this paper.

Regarding estimating volume loss: thickness data is not available for a majority of the glaciers observed in this study, so it is impossible to generate an "average" thickness for all glaciers in the study (and thus, impossible to generate an estimate for volume loss for glaciers in east Greenland).

Regarding the location of SST measurement points: all five of these points are within the boundary of relevant ocean currents, and moving these points closer to the shore includes a greater probability that the SST data will be skewed by the presence of sea ice.

Changes were made to the discussion to suggest Svalbard-type surging as the predominant surging mechanism of marine-terminating glaciers in east Greenland, although the literature suggests that Sortebrae displays qualities similar to Alaskan-type surging glaciers. Both types of surging were discussed with an emphasis made on Svalbard-type surging glaciers (since most glaciers in east Greenland exhibit similar qualities). Jiskoot et al. (2001) and Jiskoot and Juhlin (2009) were added as references.

1) Title: The title was changed to "Changes in the marine-terminating glaciers of east Greenland . . ." to reflect this larger region discussed in the manuscript. 2) Regarding spaces in between number and degrees symbols – I believe that is a formatting mechanism used by Copernicus, as our original document does not have this spacing. 3) Glacier names were corrected throughout the manuscript to account for proper glacier names. 4) 2866, 17: "Unpredicted" removed. 5) 2867, 27-29: The location description was cleaned up to exclude "Sermilik Fjord" and "Scoresby Sound" references. 6) 2867, 10: Box et al. (2009) was added as a reference. 7) 2868, 7:

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Wording adjusted. 8) 2869, 1-19: Data sources adjusted to include more information about each data source (Landsat-7 ETM+, ASTER and MODIS). 9) 2870, 3: "Arbitrary" deleted. 10) 2870, 7: Measurement error included (0.1 km). 11) 2870, 15: Including information about tidal range in Greenland is beyond the scope of this paper, and thus was not included in the analysis. 12) 2870, 19-27: Time periods used to calculate surface speed were included. 13) 2870, 23: Wording adjusted. 14) 2870, 24: "Near the front" was replaced with "a point approximately 10 km from the most retreated front position". 15) 2871, 7-9: Geographic description clarified and reference to figure 1 made. 16) 2871, 11: Wording rewritten to be "glaciers along Scoresby Sound". 17) 2871, 16: The description of Gasegletscher was removed from the manuscript. 18) 2871, 18-19: Wording adjusted. 19) 2872, 4: Wording adjusted. 20) 2873, 6-10: Statement adjusted to include the fact that all glaciers in this region are outlets of the GrIS. 21) 2874, 1: Title adjusted to read "Blosseville Coast". 22) 2874, 18: Both Howat et al. references remain included. 23) 2874, 7: Wording adjusted. 24) 2875, 8-9: The authors agree that there are in fact numerous glaciers in this study region that exhibit qualities of surging, but to discuss each of these in detail is beyond the scope of this study. 25) 2875, 9-12: Sentence removed. 26) 2875, 9-13: Jiskoot et al. (2001) added to references. 27) 2875, 20: Header changed. 28) 2875, 26: Glacier name corrected. 29) 2876, 25: Comments regarding surging adjusted. Changes were made to the discussion to suggest Svalbard-type surging as the predominant surging mechanism of marine-terminating glaciers in east Greenland, although the literature suggests that Sortebrae displays qualities similar to Alaskan-type surging glaciers. Both types of surging were discussed with an emphasis made on Svalbard-type surging glaciers (since most glaciers in east Greenland exhibit similar qualities). Jiskoot et al. (2001) and Jiskoot and Juhlin (2009) were added as references. 30) 2877, 1-4: See above comments. 31) 2877, 10-15: Section cleaned up and mostly removed to avoid redundant information. 32) 2877, 16: See comment for 2875, 8-9. 33) 2877, 20-28: Paragraph removed. 34) 2878, 1: Title changed to "Glacier thinning". 35) 2878, 18: Figure referred to. 36) 2878, 20: Statement adjusted to read "smaller outlet glaciers".

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37) 2879, 7-16: The authors feel that including the background information regarding the rapid retreat of Jakobshavn Isbrae is important for context and for supporting the argument of potential oceanographic forcing on marine-terminating glacier dynamics. 38) 2879, 16-20: Straneo et al. (2010) added as a reference. 39) 2879, 20-30 and 2880, 1: See comment for 2875, 8-9. 40) 2881, 1-16: Since the prospects of studying glacier change in this region are not terribly concrete and require more brainstorming and planning, we feel that this paragraph is appropriate. 41) 2881, 20: Mass loss measurement, while important to mention with regard to changing glacier dynamics in Greenland, was beyond the scope of this project and thus was not including in the analysis. 42) 2881, 28-30: Sentence adjusted. 43) 2886, 7: Reference corrected. 44) Figure 1: Location map was made to the best of the authors' abilities with the given computer software and imagery. 45) Figure 2: Changed to "Terminus Position". 46) Figure 3: Figure caption changed to read 'Change in surface elevation (all values negative) (2000-2010) for all marine-terminating outlet glaciers in this analysis. Thinning measured at 15 km from most retreated front position. Circles indicate the location of each glacier and colors indicate magnitude of thinning.' 47) Figure 4: It is assumed that the DEM error would have been noted in the "Data Sources and Methods" section. 48) Figure 5: Heading changed to "Average Sfc. Speed". 49) Figures 6 and 7: Not adjusted. 50) Figure 8: Figure caption adjusted to read "See Fig 1 for SST point locations".

Please also note the supplement to this comment:

<http://www.the-cryosphere-discuss.net/5/C1670/2012/tcd-5-C1670-2012-supplement.pdf>

Interactive comment on The Cryosphere Discuss., 5, 2865, 2011.

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