

Interactive  
Comment

## ***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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This paper presents results from remote sensing of marine terminating glaciers in southeast and central East Greenland. The analysis includes changes in front position, surface elevation and speed of 38 tidewater glaciers.

The data are new and show detailed extent of recent glacier changes, with an emphasis on the transition between glaciers affected by prolonged retreat and those farther north which have remained largely unchanged. Although the boundary of this transition has been discussed previously, this paper adds spatial constraints to it.

The methods and results are clearly communicated and the paper is overall well writ-

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ten. I recommend it be published in TC on the basis of minor revisions.

My main criticism is the description of oceanographic forcing, which needs to be more clearly communicated. In various places, glacier change is explained by 'warming of the North Atlantic' or 'changes in circulation in the North Atlantic', which is both vague and imprecise.

First, 'The North Atlantic' is a huge region extending well beyond East Greenland. The authors need to explain only the conditions in the Irminger Sea, which is a central part of the sub-polar North Atlantic, or the sub-polar North Atlantic gyre to be more specific. When the Irminger Sea receives more subtropical waters, other part of the North Atlantic may well receive less. Warming of the North Atlantic implies warming everywhere.

Second, it is the transport of subtropical waters, i.e. volume flux, that is key here; not exclusively the warming of the source water itself. Although waters have been shown to be warmer, the magnitude of this warming is orders of magnitudes less than the variability of subsurface temperatures in fjords. This indicates that glaciers are affected by variability of transport, primarily, and that warming of the source waters is a secondary, independent and more gradual effect.

A detailed account of the variability of subtropical waters entering the East Greenland shelf seas is given in Christoffersen et al. (TC, 2011). I suggest using this study as a key reference to explain the conditions under which warm subtropical waters flows onto the East Greenland continental shelf south of DK Strait. The key driver is wind, which also affects the circulation of water inside fjords (Straneo et al., 2010).

Minor points:

2866, 6-8: Problematic sentence. 1. Remove 'thermodynamic'.

2866, 6-8: Problematic sentence (cont.). 2. Denmark Strait is a boundary between the Irminger Sea and the Greenland Sea or the North Atlantic vs. the Nordic seas. The

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Arctic Ocean is much farther north. Correct.

2866, 6-8: Problematic sentence (cont.). 3. It sounds like the North Atlantic Ocean spans only 3 degrees latitude. Correct.

2866, Introduction: The very first sentence is more specific than the second. Change order or remove?

2866, 22: 'especially' is ambiguous. Does it refer to surface melting or discharge or both? Clarify.

2866, 25: 'Previous ... linked recent increases in mass loss to changes in ocean circulation'. Actually, there are far more studies relating recent changes in mass loss to changes in air temperature! Sentence needs to describe both atmospheric and oceanic effects.

2867, 5: Correlates should be coincides, although strictly speaking it doesn't really coincide since glacier change occurred several years later. Perhaps better to simply say that Jakobshavn retreated abruptly subsequent to warming of coastal waters.

2867, 9: '... either independently of, or in addition to...'. Odd sentence. How is independent warming of the ocean different to oceanic warming in addition to the atmospheric warming? Perhaps the point is that ocean warming can be either linked to atmospheric warming (i.e. at the surface) or be independent (i.e. deeper effects). If so, consider citing Christoffersen et al. (TC, 2011) who show that both effects are important in East Greenland.

2867, 21: Consider adding 'ultimately' between 'there is' and 'no proof'.

2867, 24: 'warming of the North Atlantic'. See comment above.

2868, 2: Arctic Ocean is much farther north. See comment above related to the geographic boundary at DK Strait.

2868, 4: 'North Atlantic' is a huge region. See comment above related to the geo-

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graphic boundaries.

2868, 12: ‘... directly associated with change in North Atlantic circulation’. This should be ‘... directly associated with variable inflow of subtropical waters from the Atlantic Ocean’. See main comment above on circulation.

2869, 1-19: There is a combination of past and present tense in these paragraphs. Is this intentional?

2871, 11: Remove ‘found’.

2872, 7: Replace ‘thinning rates’ with ‘surface elevation change’.

2875, 11: Linked cavity system. I am not convinced this inference is needed or even warranted. This particular aspect of surging comes from the study of Variegated glacier, which is temperate and located in North America. Since surges in Svalbard are frequent, but very different, and since Svalbard is closer to East Greenland than western North America, I am somewhat skeptical about this inference. Although I am not a specialist on surging glaciers, there is at least one article with the title “Surge of a small East Greenland glacier, 2001-2007, suggests Svalbard-type surge mechanism” (Jiskoot and Juhlin, JGlac, 2009) which argues that the Svalbard surge mechanism may be the most relevant in East Greenland. See also related comments below.

2876, 10: ‘warming of the North Atlantic’. See comment above,

2876, 25: ‘Glacial surges are short-term events (days to weeks)’. Again taken from North American surge type. Svalbard surges are longer and there is at least one paper suggesting the surges in East Greenland are similar to these.

2877, 1: ‘... release of trapped subglacial water, which.. ’ . Again related to North American surges. Svalbard surges are also influenced by thermal conditions at the bed.

2878, 26: ‘...reveal a spike in temperatures.. ’ Is this accurate? Was it a spike or simply

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a gradual increase?

2879, 14: +1.1 degrees C. Which study is this number from? Both those cited?

2879, 17: Replace 'have been correlated' with 'coincided'

2879, 17-2890,9: Does the SST comparison need five points? On the figure, only A and E stand out. Perhaps skip B-D, or at least B and D, so difference between North and South stands out. I also suggest plotting 12-month-moving averages on top of the monthly means so that the interannual variability is more clearly shown.

2880, 13: Add 'in southeast Greenland up to' before 'Denmark Strait' and remove 'through' to clearly explain the extent of change.

2880, 17: Replace 'glaciers though the Denmark Strait' with 'glaciers in the Denmark Strait region'.

2880, 17: '...glaciers terminating in the Denmark Strait'. No glaciers really terminate in the DK Strait. Suggest stating 'glaciers terminating in fjords near the DK Strait'.

2880, 17: Warming. See comment above on circulation.

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

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