

Interactive comment on “Warming of waters in an East Greenland fjord prior to glacier retreat: mechanisms and connection to large-scale atmospheric conditions” by P. Christoffersen et al.

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I preface my (very brief) review by stating that I am a glaciologist with a naive understanding of oceanography. I am therefore focusing primarily on the glaciological implications of this paper. I assume that the other reviewer(s) will be more qualified to comment on the oceanographic analysis.

This paper uses a combination of two oceanographic profiles (collected in 1993 and 2004) and ocean reanalysis to investigate changes in ocean heat flux off the coast of East Greenland. The authors conclude that (1) both the small retreat of Kangerdlugssuaq Glacier (KG) in the 1990s and large retreat in in the early 2000s were pre-

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ceded by an increase an ocean heat flux toward the glacier and (2) ocean heat flux in this region is strongly tied to geostrophic winds. If the oceanographic analysis is robust (which it appears to be from an “outsiders” perspective), then this paper will significantly contribute to our growing understanding of atmosphere-ocean-glacier interactions and deserves to be published.

My only suggestion for the paper is, in order to make this paper more appealing to glaciologists (this is submitted to the Cryosphere, after all), to more emphatically highlight the time scales that it takes a glacier to respond to oceanic forcing – particularly in the introduction and conclusions. We’ve learned over the past few years that outlet glaciers can respond very rapidly to changes in oceanic conditions, but what is still lacking is a good understanding of the time scales involved (what is meant by ‘rapidly’?). By using a long time series from ocean reanalysis, this paper can help to fill that gap. See especially Figure 6. For example, the increase in ocean heat flux in 1996 corresponds almost 1-to-1 with a terminus retreat of 2 km, whereas the larger-scale retreat in 2004 did not occur until after about a decade of warming. Even though heat flux toward the terminus has since decreased, the glacier does not appear capable of re-advancing. I assume that this is because ocean temperatures remain high? Or maybe the glacier is unable to advance for geometric (i.e., ice flow) reasons? What I interpret from this study (maybe erroneously?) is that warm water was flushed into Kangerdlugssuaq fjord, and that warm water initiated the retreat. The warm water has not yet been flushed out of the region, and so the glacier is unable to advance...

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