

Interactive comment on “Ocean properties, ice–ocean interactions, and calving front morphology at two major west Greenland glaciers” by N. Chauché et al.

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Received and published: 26 November 2013

Comment on Chauche et al. 2013 in The Cryosphere Discuss

This paper presents new data from two outlet glacier fjords in west Greenland located in the Ummannaq Fjord region. The authors present 2 synoptic CTD surveys (summer 2009 and 2010) of the fjords close to the glacier termini of Rink Isbrae and Store Glaciers. Since the study of ice-ocean interactions is such a rapidly evolving field, it is nice to see new data presented. However, in light of the complex circulation observed in SE Greenland fjords, for example, and the suite of recent modeling work investigating fjord circulation in outlet glacier fjords, I have several major comments on this study. I

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will leave detailed comments to the referees.

1) The data are taken from two different summers over a week long period (and the surveys are somewhat limited, with at most 12 CTD casts in a survey total)—yet the discussion of the results implies that interannual variability can be inferred from these data. This is in contrast to the rapidly circulating fjord waters that are seen in Sermilik Fjord and Kangerdlugssuaq Fjord in SE Greenland (by rapid, I mean the pycnocline can vary 50-100 m in the vertical over a week time scale), the complex circulation observed in Godthabsfjord (Mortensen et al. 2011,2013), and the modeling done for Store Glacier itself (Xu et al. 2013) and Sermilik Fjord (Sciascia et al. 2013). Inferring circulation from hydrography can be difficult in these time-varying flows—and to infer 4 circulation modes from 2 summer surveys seems like a stretch.

2) The authors define new water masses before presenting their results—this leads to confusion for the reader, especially if they are familiar with other ice-ocean literature from Greenland, as all new names for the same water masses are used. That is, the source waters they identify are: sub-polar mode water is a stand in for Atlantic Water, glacier runoff water (GRW) is typically just called discharge and is sometimes assumed to be all subglacial discharge, and brine-enriched water (BEW) is speculated to be either advected in or formed locally. For the BEW, it was unclear how it would advect from western Baffin Bay to Ummannaq Fjord (the authors cite papers from the ice-ocean literature when discussing sub polar gyre circulation— what about classic studies such as Hakkinen and Rhines, 2004, Hatun et al. 2005, Thierry et al. 2008, etc.). Additionally, it was hard to see on the T-S plots whether the BEW was indeed saltier than its surroundings. At this temperature and location in the vertical, the simplest explanation would be a water mass advected along the West Greenland Current on the shelf, i.e., an extension of the EGC/EGCC system in SE Greenland. This is all based on 1 out of 4 surveys observing "BEW". The main point here being that the paper is made less clear by the discussion of all these water masses. (Note some of these same thoughts were brought up by J. Mortensen in an earlier comment).

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3) Overall the paper would benefit from clearer figures– the exact location of CTD casts in the cross and along-fjord directions would be nice, plus a better presentation of the T-S results. Labels on Fig. 6 identifying which mode is which would help the reader get through sect. 5.1 (i.e. not sure where the high discharge case comes from, given table 3 values). In addition, oceanographers typically use only the downcast data from CTD casts, and it wasn't clear if this was the case in their data collection section.

4) In section 5.2, there are sentences that do not seem backed up by actual data– for example, the discussion of kinetic energy of the deep mixed water. Also, it was unclear whether the along-fjord transect of turbidity maybe missed some cross-fjord variability in the plume front? Could it be that the plume moved laterally? Or that the subsurface turbidity maxima was caused by some other mechanism or a remnant plume?

Overall, I think this paper can be strengthened by focusing on the data at hand and limiting the conclusions reached to those that do not deal with interannual variability. The circulation modes presented seem entirely consistent with previous results– i.e., the estuarine circulation depends on the discharge magnitude. But without concurrent velocity measurements and some idea of the circulation variability in these two fjords, it seems difficult to speculate, for example, about what circulation in the winter might look like (where does wind-driven flow come into this? what about the seasonal cycle of water properties on the shelf?). But, the authors are commended on gathering this data set in a very difficult to access region– and the time lapse camera data are novel for this area. The data will be invaluable down the road as we make progress on the complex set of interactions between fjord and glacier dynamics.

Interactive comment on The Cryosphere Discuss., 7, 5579, 2013.