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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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We would like to thank anonymous referee #1 for their constructive comments on this paper for which we are grateful. We have read the reviewer's recommendations with interest and will take them fully into account in a revised manuscript, given an opportunity.

One interesting matter we wish to raise regards our suggestion that no submarine melting occurs as the ocean temperature nears 0°C.

Referee #1 suggests that seawater can melt glacier ice (with a freezing/melting point of ∼0°C) as long as the ocean is not frozen (hence, when its temperature is >∼ -1.8°C).

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We agree with this point and will adjust our thinking accordingly. However, when trying to assess the respective melt-rates in the two contrasting cases of seawater above and below glacier ice melting point, we are slightly confused and can find no relevant reference.

From our understanding, when the seawater has a temperature below the glacier ice freezing point ($\sim$0°C), no heat transfer from the ocean into the ice is possible. To provide the thermal energy to melt this ice, it is necessary for salt to transfer from the ocean into the ice, which hence, lowers the freezing point of the glacier ice and which subsequently enables energy transfer from the ocean into the ice, which will melt it. This is analogous to what happens when salt is spread on frozen roads in winter. Hence, melting of ice in seawater therefore occurs at temperature below 0°C but does require a transfer of salt across the interface to take place.

We stand corrected, but in water the molecular diffusion of salt is about 100 times slower than thermal diffusivity (Bukreev, 2007). Thermal diffusion in ice is $\sim$6 time greater than in water (James, 1968). Unfortunately, we cannot find any reference regarding the coefficient of diffusion of salt into ice, but we suspect it will be yet even slower than salt diffusion in water, hence much slower than thermal diffusion.

Following this line of reasoning, given seawater at temperatures below the melting point of ice (<0°C), salt diffusivity becomes the limiting factor of any melting. We may then assume that the melt rate driven by thermal diffusion alone (for seawater temperature above 0°C) will be slowed by $\sim$2 orders of magnitude in the case of salt diffusion. If melt rates, in this particular case of seawater at temperatures below 0°C, are negligible, is it reasonable to assume that seawater with temperatures <0°C will provide a "thermal/melting insulation" barrier to the ice front?

As said, we cannot find any reference regarding diffusion of salt in ice, which could verify or disprove the above assumption. Hence, any insight or reference on this particular process would be welcome.

TCD

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Reference:

Bukreev, V. I.: Double diffusion during ice thawing in salt water, Izv. Atmos. Ocean. Phys., 43(6), 762–765, doi:10.1134/S0001433807060102, 2007.

James, D. W.: The thermal diffusivity of ice and water between -40 and + 60° C, J Mater Sci, 3(5), 540–543, doi:10.1007/BF00549738, 1968.

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