EGU21-14678
https://doi.org/10.5194/egusphere-egu21-14678
EGU General Assembly 2021

Characterising the effect of submarine iceberg melting on glacier-adjacent water properties

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Ocean-driven retreat of Greenland's tidewater glaciers remains a large uncertainty in predictions of sea level rise, partly due to limited constraints on glacier-adjacent water properties. Icebergs are likely important modifiers of fjord water properties, yet their effect is poorly understood. Here, we use a 3-D ocean circulation model coupled to a submarine iceberg melt module to investigate the effect of submarine iceberg melting on glacier-adjacent water properties in a range of idealised settings. Icebergs can modify glacier adjacent water properties in three principle ways: (1) substantial cooling and modest freshening in the upper ~50 m of the water column; (2) warming of Polar Water due to iceberg-induced upwelling of warm Atlantic Water, and; (3) the Atlantic Water layer warms on average when vertical temperature gradients through the Atlantic Water layer are steep (due to vertical mixing of warm water at depth), but cools on average when vertical temperature gradients are shallow. When icebergs extend to-or-below sill depth, they can cause cooling throughout the entire water column. All of these effects are more pronounced in fjords with higher iceberg concentrations and deeper iceberg keel depths. These results characterise the important role of icebergs in modifying ice sheet – ocean interaction and highlight the need to improve representations of fjord processes in ice sheet-scale models.