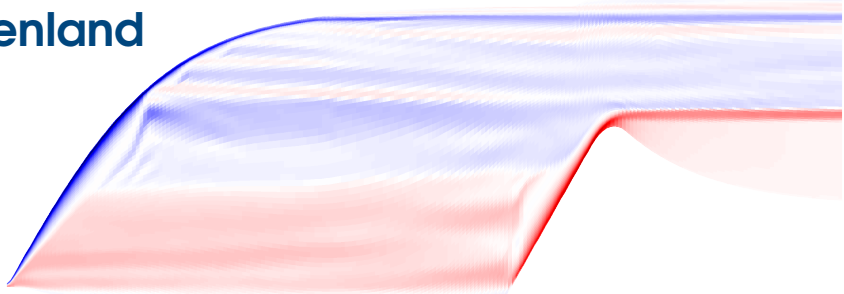
EGU General Assembly 2022, Session CR4.3

GROCE Greenland Ice sheet Ocean Interaction

Understanding the melting of the largest ice tongue in Greenland



This presentation participates in OSPP

EGU

Outstanding Student & PhD candidate Presentation contest

with high-resolution modelling and adaptive coordinates

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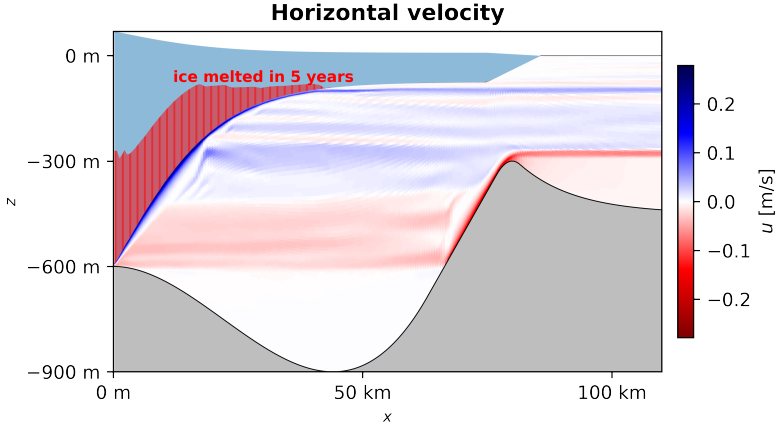
Idealized model of the 79°N Glacier fjord

Our 2D model shows the circulation in the sub-glacial cavity, which consists of:

- a dense plume flowing over the sill, bringing *Atlantic Intermediate Water* into the fjord,
- a buoyant plume of sub-glacial discharge and melt water at the ice–ocean interface.

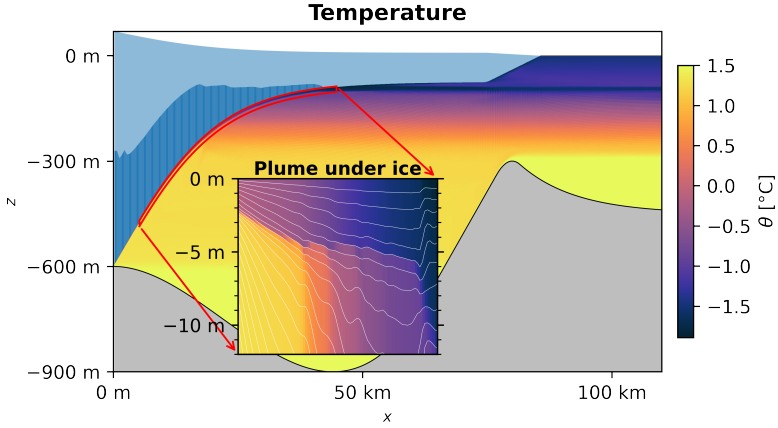


The melt water plume detaches from the ice at the level of its neutral buoyancy and transports modified water out of the fjord. The melt rate is highest at the grounding line with about 60 m/yr. The average melt rate is 12 m/yr, consistent with measurements by Schaffer et al. (2020). There is almost no melting after the plume detachment.

Idealized model of the 79°N Glacier fjord

The melt water in the sub-glacial plume is at the freezing point of saline water (−1.5 °C to −2 °C).

The white lines are the coordinate levels.
They adapt to the plume and follow it, to some extent even after the detachment of the plume from the ice.



Within the sub-glacial plume, we achieve a high vertical resolution of 1 m and less, so that we resolve melting, plume, and entrainment with several layers.
This high resolution is necessary according to Burchard et al. (2022).

Conclusions

- **Vertical resolution < 1 m in the melt water plume** with only 100 levels over 800 m made possible by **adaptive vertical coordinates** implemented in GETM. (Hofmeister, Burchard, and Beckers 2010)
- Adaptive coordinates **follow the melt water plume** also after its detachment.
- Glacial tongue melts where the **plume is at the ice–ocean interface.**

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https://meetingorganizer.copernicus.org/EGU22/EGU22-2903.html

References

- Burchard, Hans et al. (2022). "The Vertical Structure and Entrainment of Subglacial Melt Water Plumes". In: *Journal of Advances in Modeling Earth Systems* 14.3. DOI: 10.1029/2021MS002925.
- Hofmeister, Richard, Hans Burchard, and Jean-Marie Beckers (2010). "Non-uniform adaptive vertical grids for 3D numerical ocean models". In: *Ocean Modelling* 33.1. DOI: 10.1016/j.ocemod.2009.12.003.
- Schaffer, Janin et al. (2020). "Bathymetry constrains ocean heat supply to Greenland's largest glacier tongue". In: *Nature Geoscience* 13.3. DOI: 10.1038/s41561-019-0529-x.

Websites

- GETM: A general estuarine transport model: `https://getm.eu/`
- GROCE project: Greenland Ice Sheet–Ocean Interaction: `https://groce.de/en/`