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Freshwater contribution of Greenland icebergs to the North Atlantic

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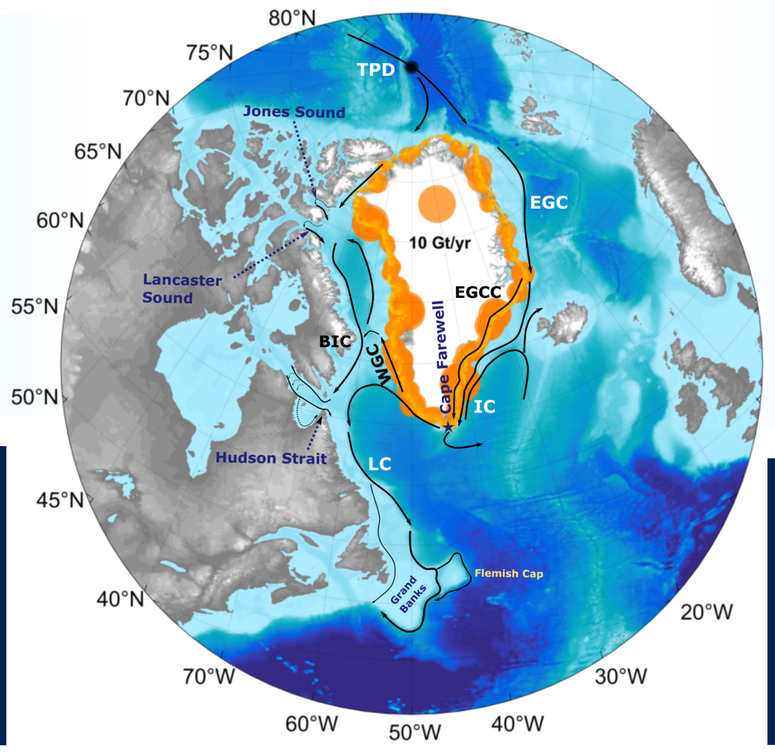
While most model studies parameterize Greenland discharge as a liquid runoff from the coast, in reality about half of this discharge is attributed to calving. What are the errors these models assume when ignoring the explicit representation of icebergs? In other words, how differently do Greenland icebergs impact the North Atlantic compared to liquid discharge?



Key Points

- Differences in ocean properties between all-liquid and iceberg runs are small in general
- Larger differences are related to the role of icebergs:
  - storing part of the discharged freshwater
  - distributing it to regions where liquid discharge would not normally reach
  - taking up heat from the ocean

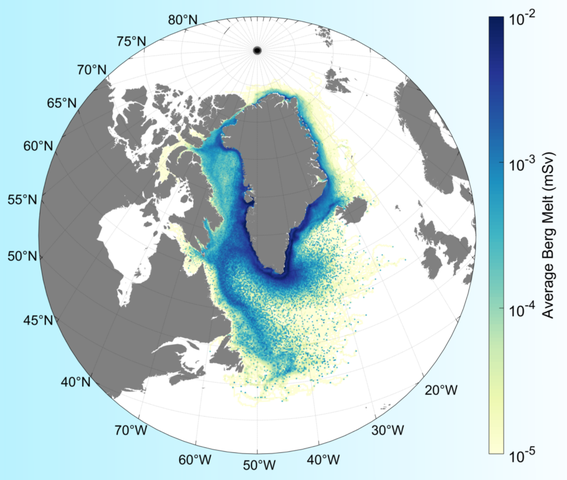
Model details

- NEMO 3.4 (1/4°)
- LIM2
- Merino *et al.* (2016) Marson *et al.* (2018)
- CGRF (2002-2016)
- IC & OBC: GLORYS 2v3

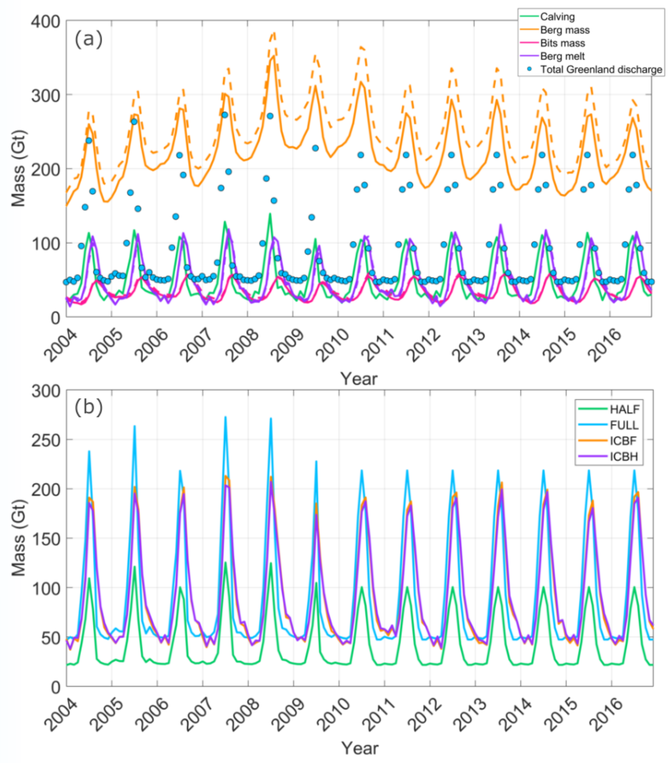
Experiments

HALF	No icebergs; only liquid discharge (46% from total)
FULL	No icebergs; liquid (46%) + solid discharge (54%) converted
ICBF	Liquid (46%) + solid (54%) discharge explicitly represented as icebergs; only iceberg freshwater flux is included
ICBH	Same as ICBF but also includes iceberg latent heat flux

Mass of freshwater entering the ocean

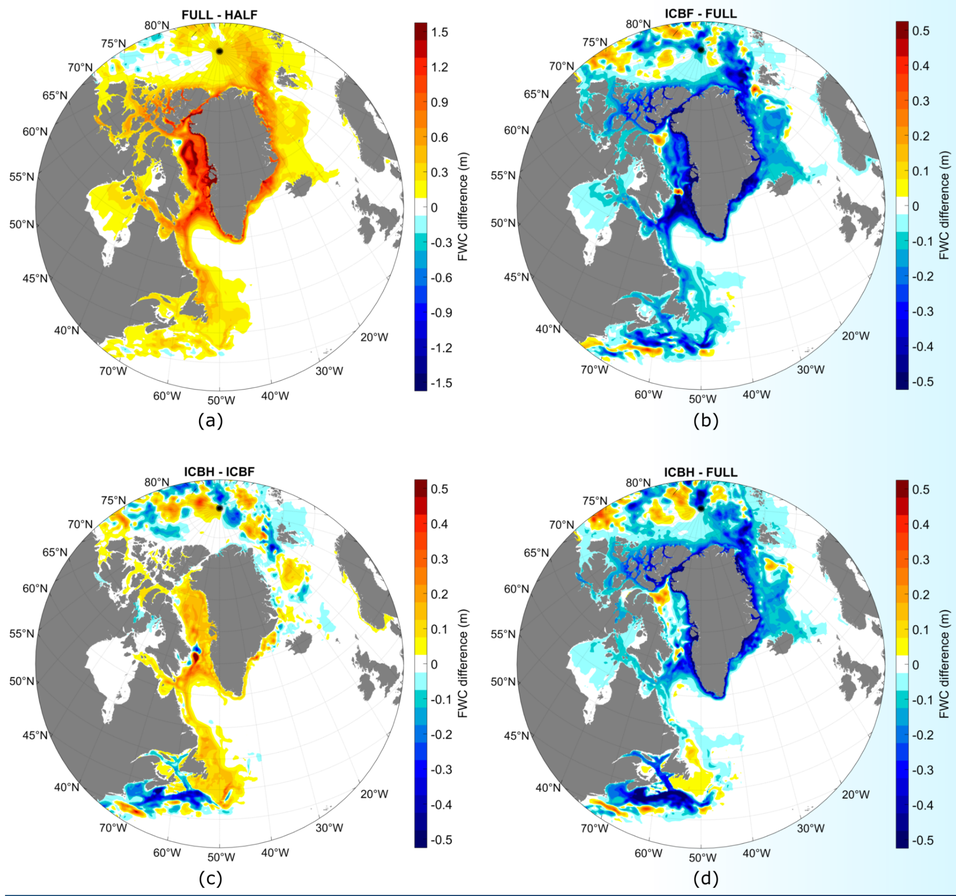


- Icebergs → freshwater reservoirs
- Iceberg melt lags calving by one month, on average
- Some icebergs take years to melt completely so, by the end of the simulation, part of Greenland discharge does not enter the ocean



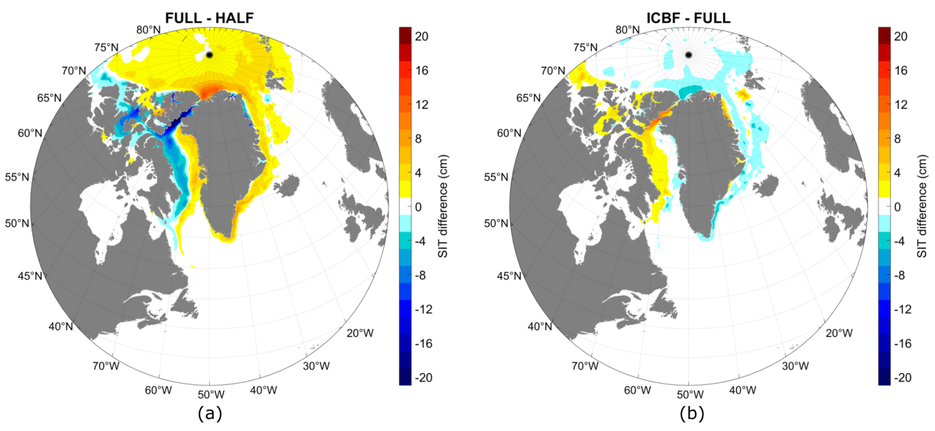
(a) Mass of Greenland freshwater entering the ocean divided into its components, liquid or solid. While the solid lines show values for ICBF, dashed ones represent ICBH. (b) ***Liquid*** *freshwater entering the ocean.*

Freshwater content

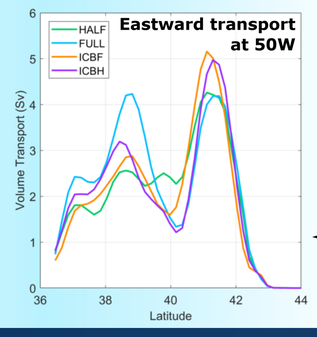


- Additional liquid discharge accumulates in Baffin Bay and boundary currents
- ICBH take up of latent heat → thicker sea ice → reduced evaporation → more freshwater

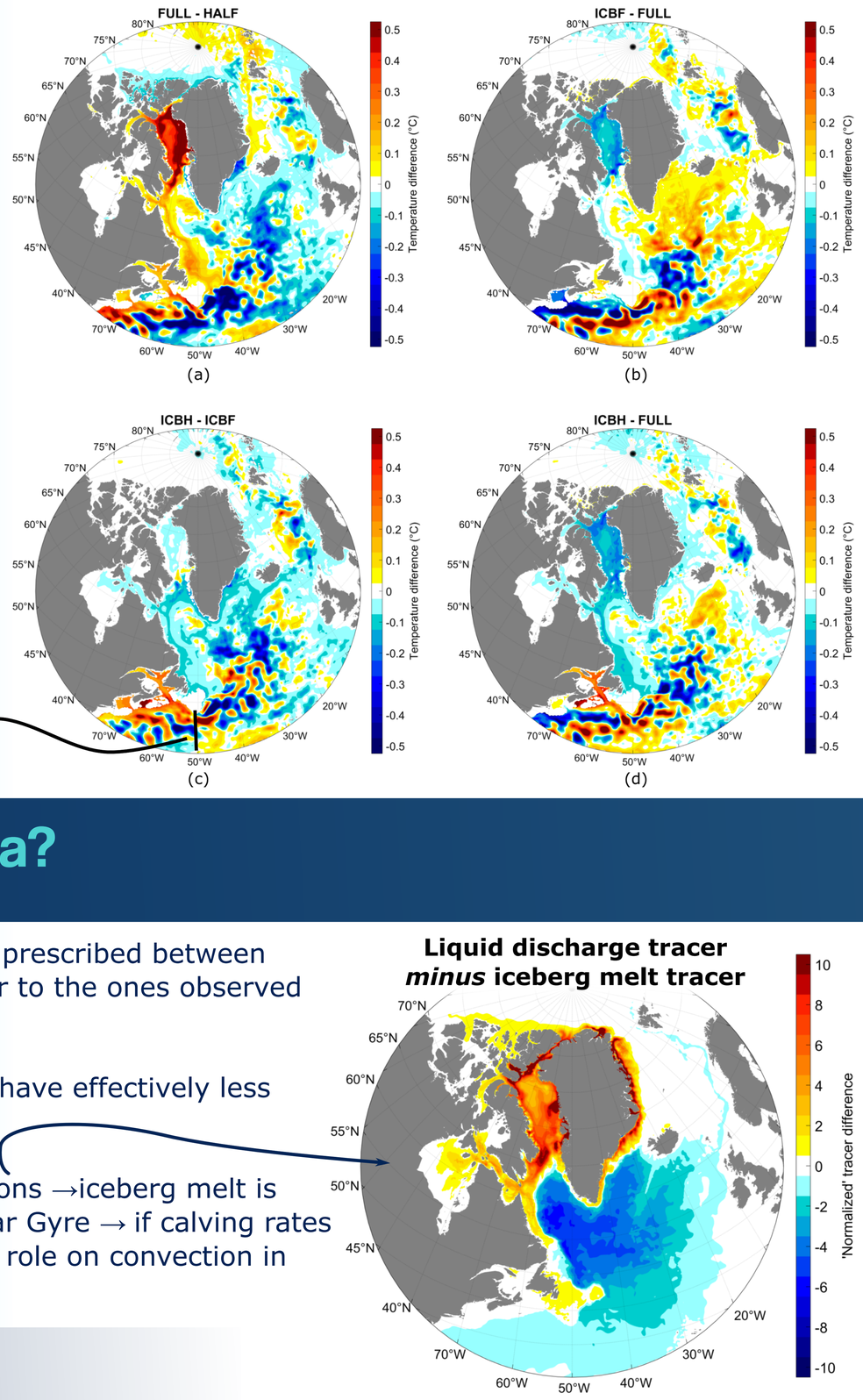
Sea ice thickness



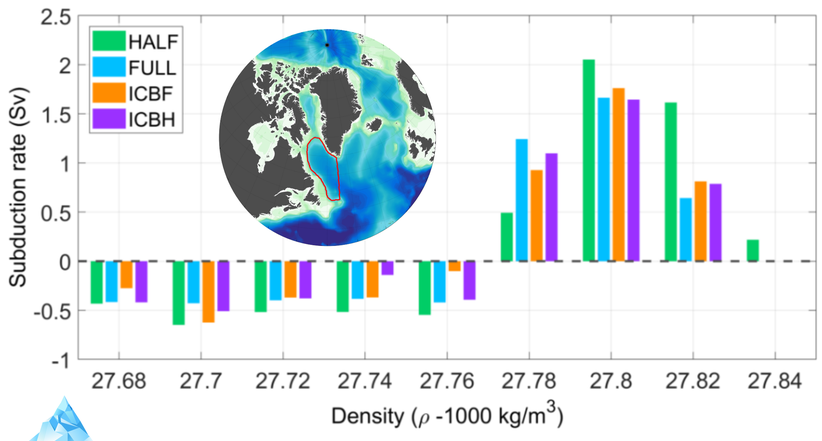
- Greenland liquid discharge increase → reduction of cold Arctic water export to Baffin Bay and intensification of Baffin Bay circulation (Castro de la Guardia *et al.*, 2015)
  - Reduced sea ice cover in west Baffin Bay
  - Lifting of isopycnals → subsurface warming
- Iceberg runs usually reduce the differences between FULL and HALF
- Warming of Gulf of St. Lawrence → position and intensity of Gulf Stream core?



Temperature (100-500 m)



How icebergs affect subduction in the Labrador Sea?



- When both freshwater and heat fluxes are prescribed between iceberg-ocean, subduction rates are similar to the ones observed at FULL simulation
- But we have to consider that iceberg runs have effectively less freshwater entering the ocean than FULL
- If we normalize their freshwater contributions →iceberg melt is more likely to reach the interior of Subpolar Gyre → if calving rates increase, icebergs could play an important role on convection in the Labrador Sea

Castro de la Guardia et al., 2015. Geophysical Research Letters, 42(12):4922–4930
Merino et al, 2016. Ocean Modelling, 104:99 – 110.
Marson et al., 2018. Geophysical Research Letters, 45(9):4208–4217.