The Atlantic Water:

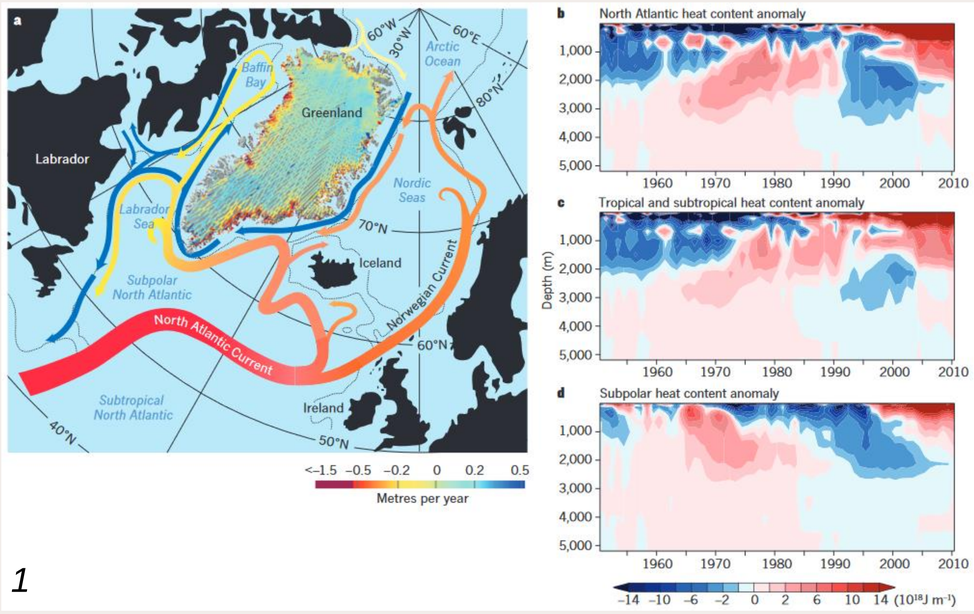
Source of heat to Greenland fjords

Linda Latuta
latuta.linda@uib.no

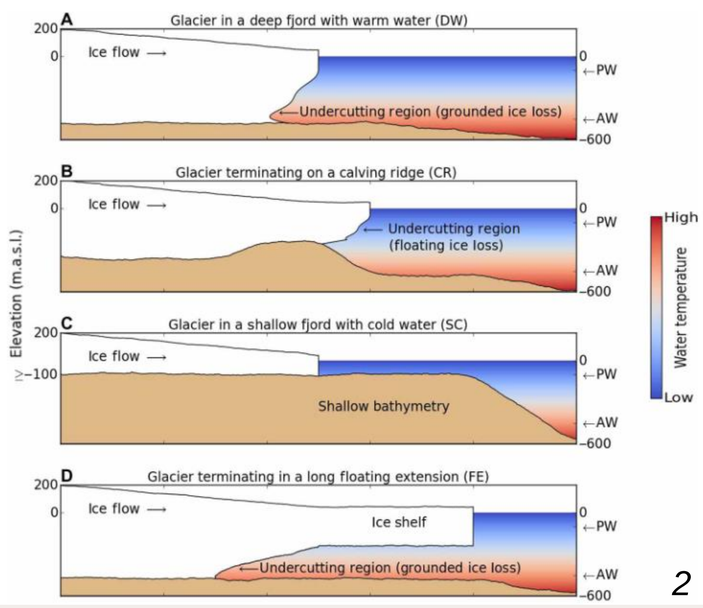
GEOF338: Polar Oceanography

ABSTRACT

The primary source of oceanic heat along the coastal margins of Greenland is the Atlantic Water (AW). Typically, in the range of 0 to 4°C, this water mass can bring enough heat to drive a substantial submarine melt. Since mid-1990s the AW has warmed and triggered a widespread mass removal at the front of marine-terminating glaciers. Prominent impact is observed in deep fjords, where AW is widely available, making such fjords responsible for 49% of the total ice sheet mass loss.



1



2

Categorisation of 135 glaciers

DW: terminating in deep warm water with AW presence (74)

CR: break into icebergs on shallow ridges (27)

SC: shallow cold fjords with PW (24)

FE: glaciers with long floating extensions (10)

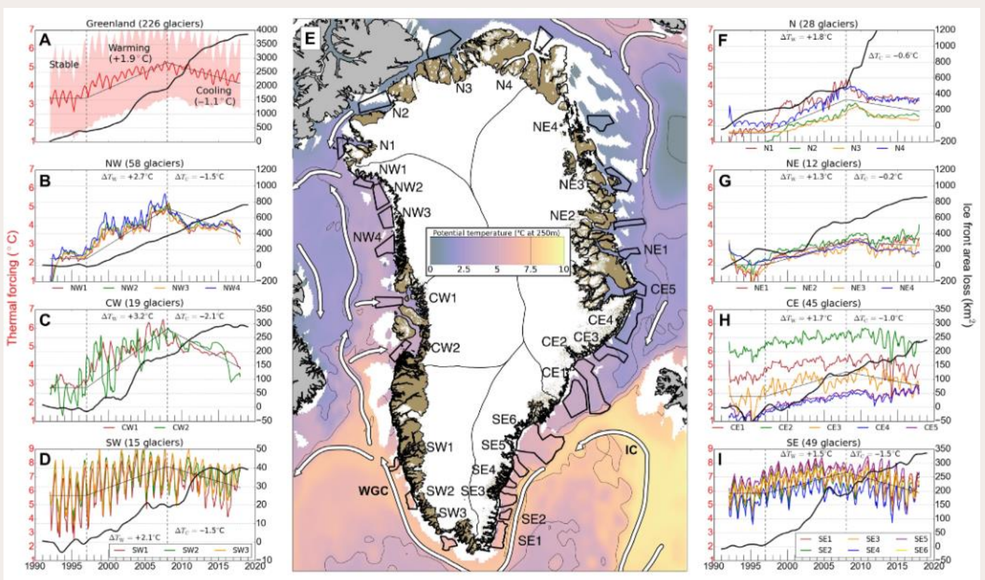
Uncategorised: 91 glaciers

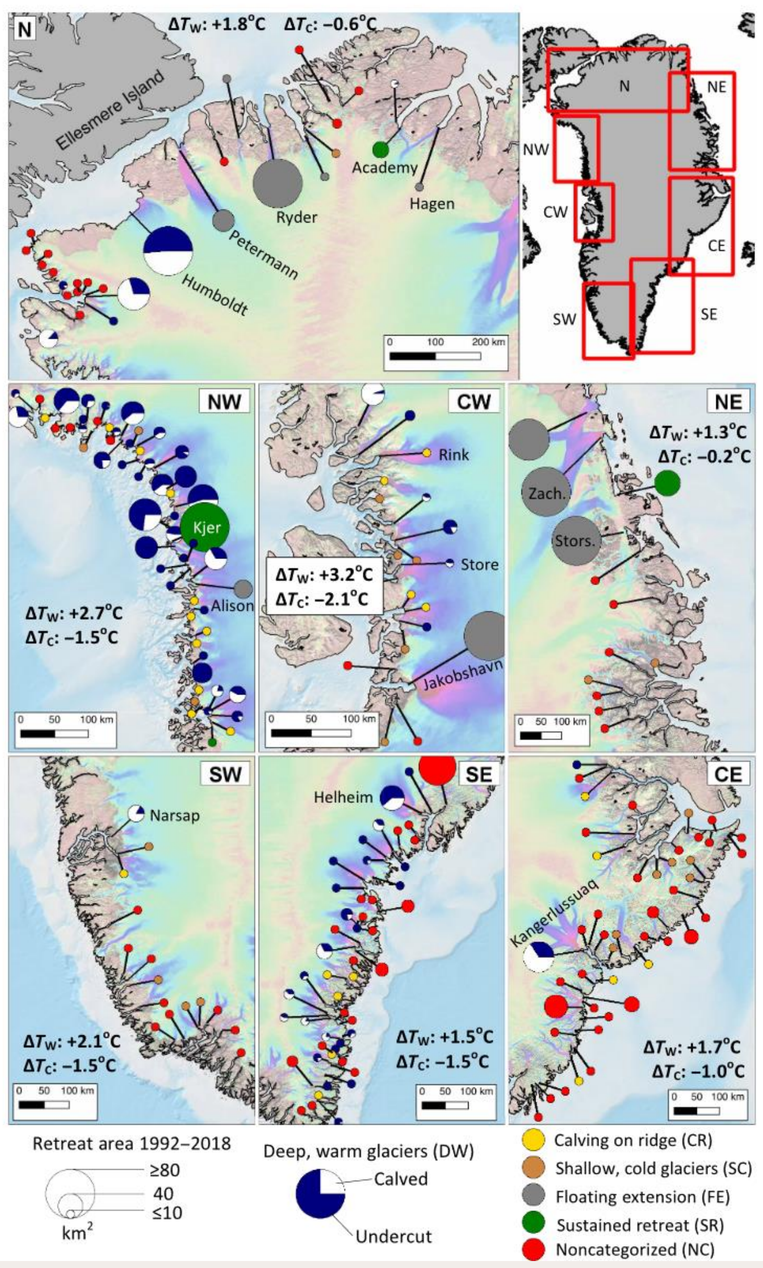
2

Warming of subsurface waters

- At the start of 21st century the North Atlantic subpolar gyre expanded, enhancing ocean heat flux through the coastal Irminger and West Greenland currents.
- Warmer subsurface waters observed on the continental shelf of all seven major basins of Greenland
- Since 2010 there is relative cooling of the subsurface waters, but ocean heat fluxes are still higher than in 1990s

1,2





2

Glaciers in deep warm fjords

DW glaciers contributed 61% of Greenland's loss from ice dynamics and **49% of the total loss.**

Mass removal in DW glaciers was predominantly driven by undercutting

2

Glacier retreat and ocean forcing

- Between 1992-2017, Greenland's marine-terminating glaciers lost 3536 Gt of mass
- Grounded ice loss tripled to 108 km²/ year
- During the cooling period 2008–2017 grounded ice continued to decline at 119 km²/ year

2

Table 1. Grounded ice retreat, ice discharge, and mean mass balance for six glacier categories and three time periods: 1992–1997, 1998–2007, and 2008–2017. The first four categories pertain to glaciers terminating in DW, on CR, in SC (<100-m depth), and with FE. The final two categories pertain to glaciers already in an SR, and NC glaciers with no ocean and bathymetry data.

Category	No. of glaciers	Ice loss (km²)			Discharge	Mass balance
		1992–1997	1998–2007	2008–2017	1992–2017 (Gt/year)	1992–2017 (Gt/year)
DW	74	13.5	601.9	612.9	225.8	−66.3
CR	27	10.0	29.3	32.0	84.0	−12.9
SC	24	3.8	34.8	34.6	20.9	−6.7
FE	10	107.2	192.5	256.7	80.9	−20.6
SR	4	26.3	37.9	57.8	3.2	−3.4
NC	87	19.0	181.8	200.1	62.1	−26.2
Total	226	179.7	1078.2	1194.2	476.9	−136.0

2

SCAN ME

References

1. Straneo, F., Heimbach, P., 2013. North Atlantic warming and the retreat of Greenland's outlet glaciers. Nature 504, 36–43.
2. Wood, M., Rignot, E., Fenty, I., An, L., Bjørk, A., Van Den Broeke, M., Cai, C., Kane, E., Menemenlis, D., Millan, R., Morlighem, M., Mouginot, J., Noël, B., Scheuchl, B., Velicogna, I., Willis, J.K., Zhang, H., 2021. Ocean forcing drives glacier retreat in Greenland. Science Advances 7

BJERKNES CENTRE for Climate Research

UNIVERSITY OF BERGEN