Jakobshavn Glacier and Disko Bay

Class: Arctic Seminar

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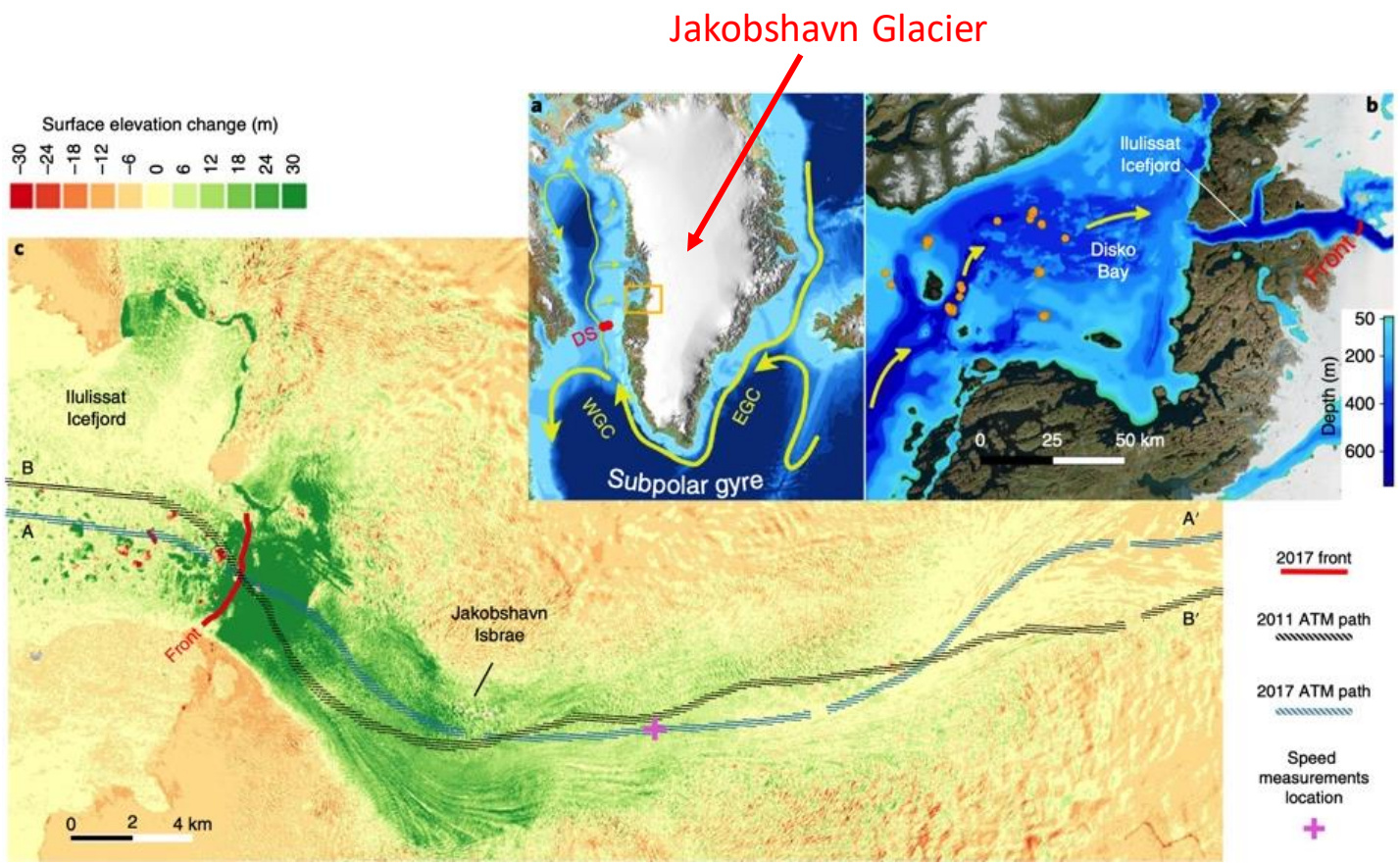
Motivation/Introduction

Jakobshavn Glacier

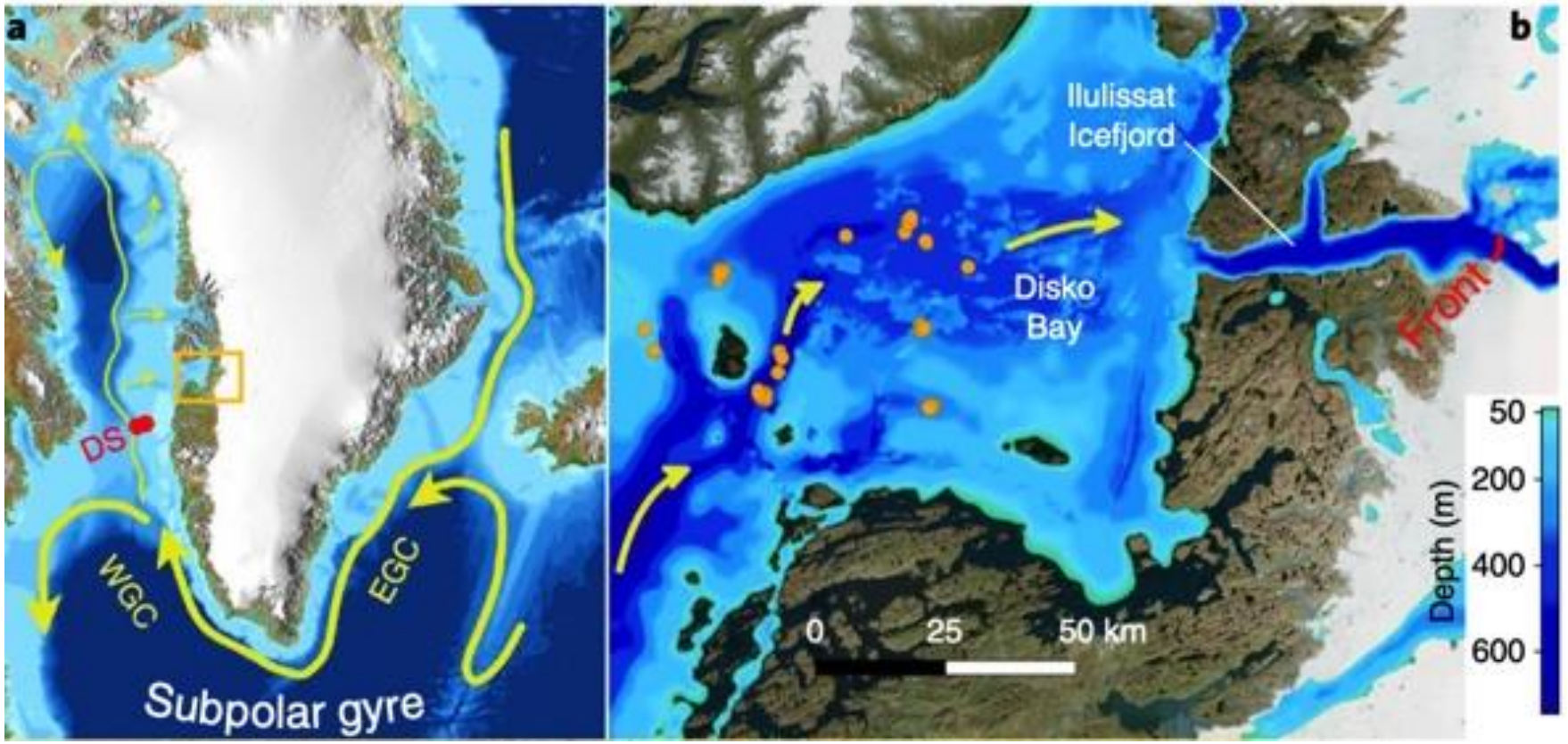


- Located in central west Greenland
- Terminates into Icefjord, which is connected to Disko Bay
- Greenlands fastest glacier with largest volume discharge

-> Jakobshavn Glacier contributes essentially to the global mean sea level rise.

Motivation/Introduction

Atlantic Water reaches Disko Bay via a boundary current that circulates along the shelf



Leading question of this talk:

How does Jakobshavn Glacier respond to warming or cooling of the regional ocean?

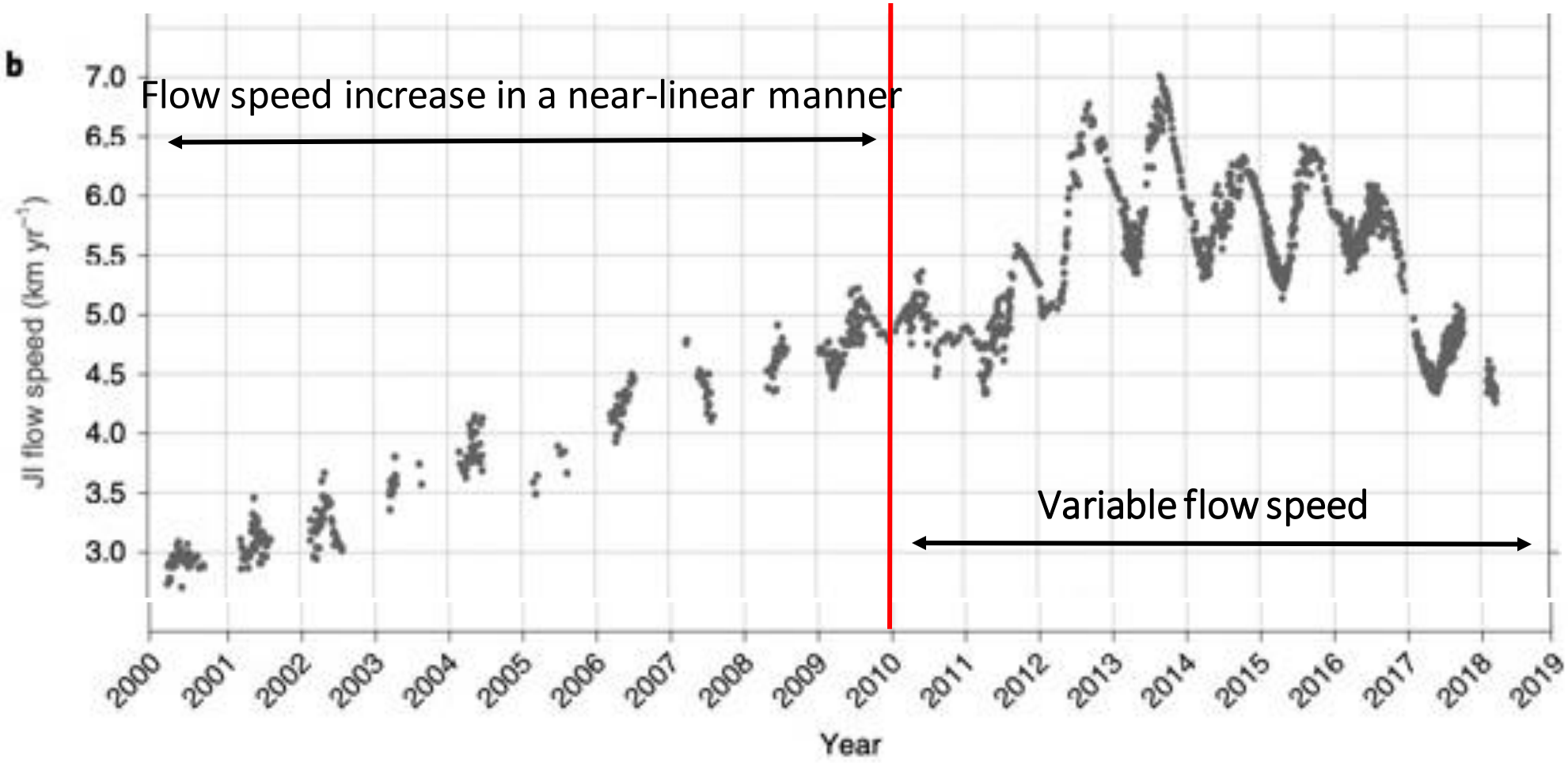
To answer this question:

1) Review the paper by Khazendar et al. 2019: Interruption of two decades of Jakobshavn Isbrae acceleration and thinning as regional ocean cools

2) Own analysis from the workshop -> What are future implications?

Jakobshavn Glacier: Flow speed

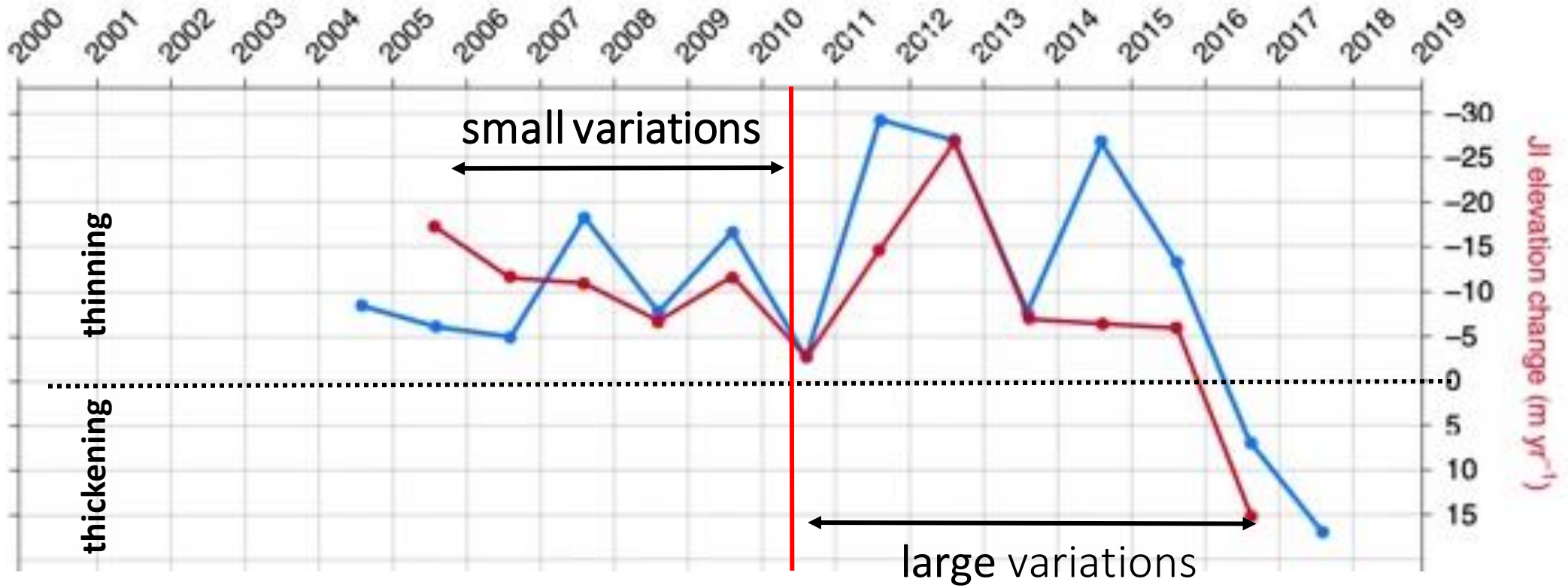
Measurements: feature tracking of repeat optical imagery



-> Flow speed increases between 1998 and 2013

Jakobshavn Glacier: Surface elevation changes (I)

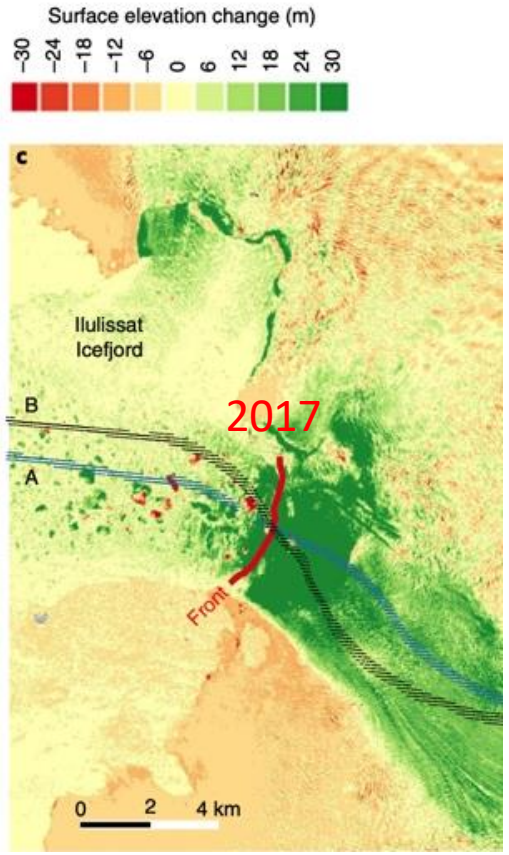
Measurements: Laser and radar altimetry

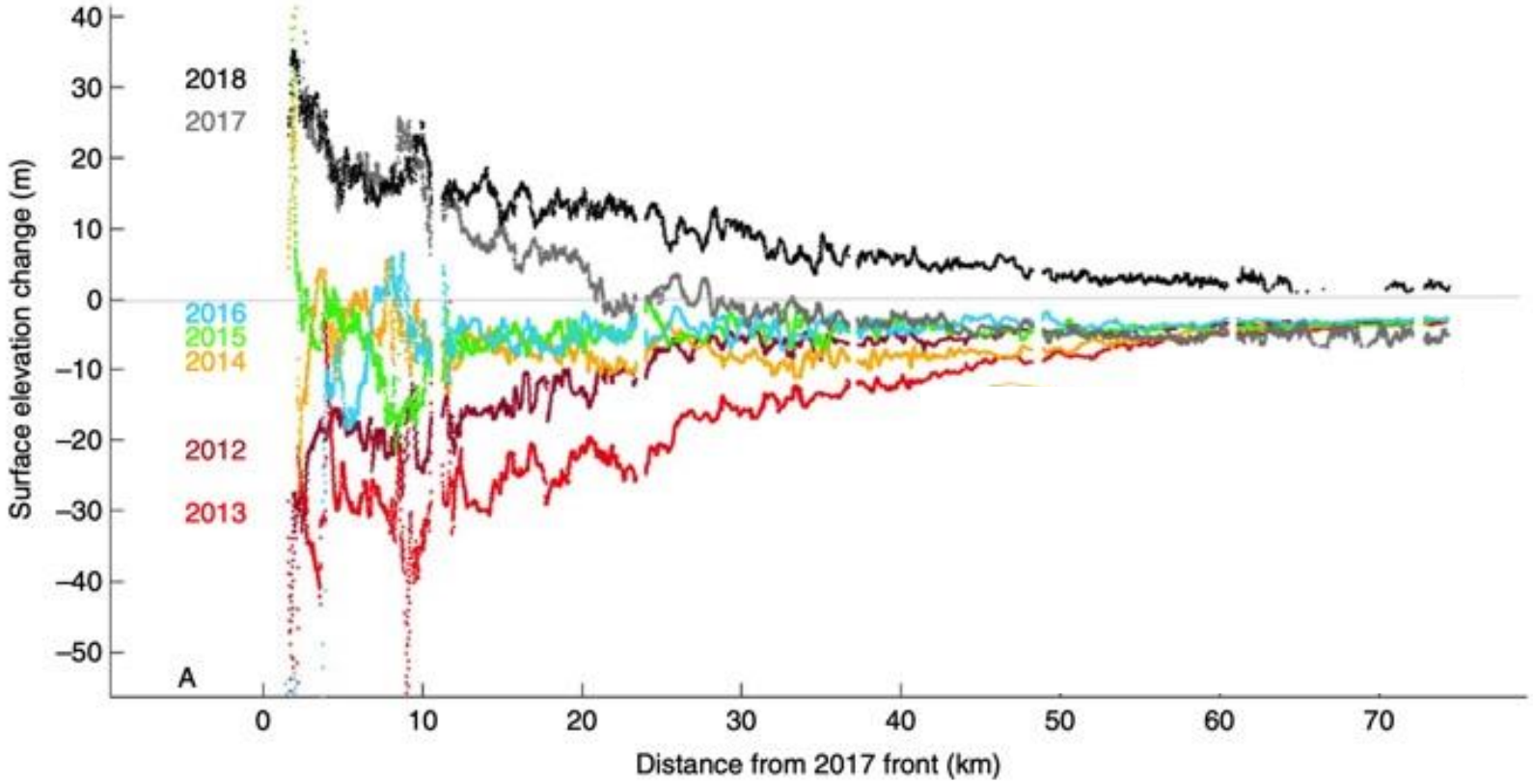


-> Glacier thinning rates slow down since 2014

-> Glacier thickened since 2016

Jakobshavn Isbrae: Surface elevation changes (II)





- Between 2016 and 2017, ice thickening of 20 to 30 m in the vicinity of the front is observed.

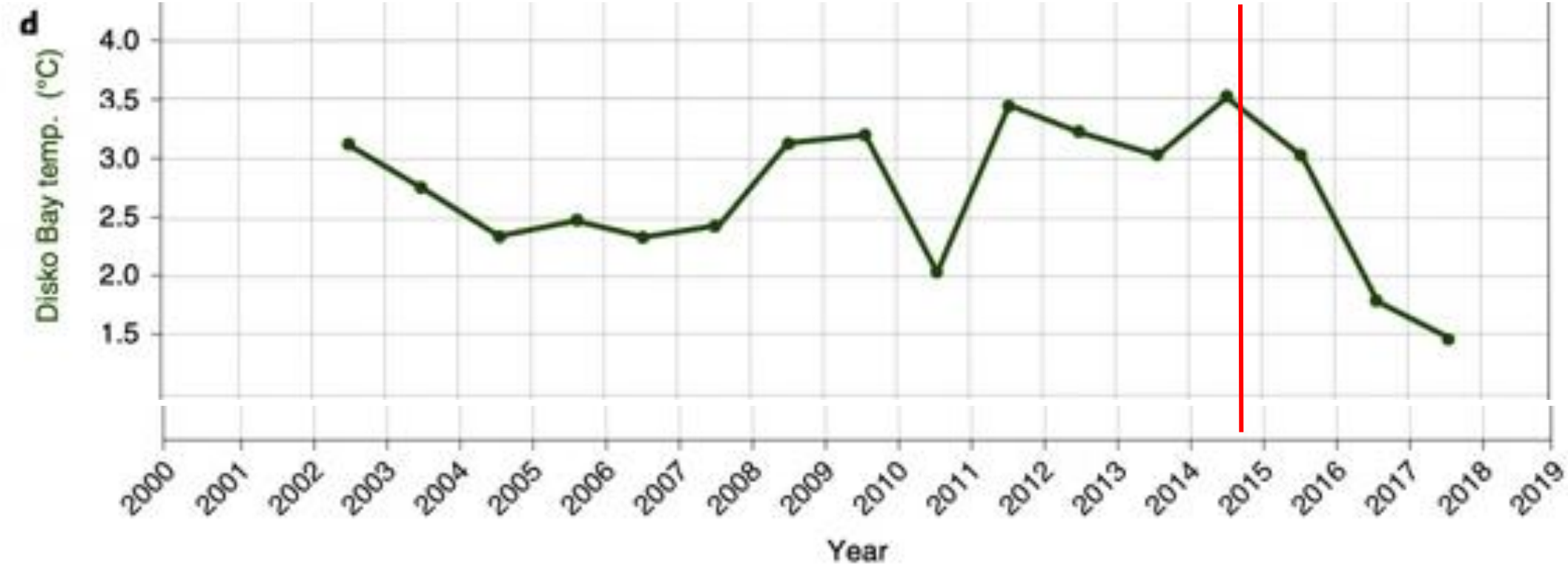
Summary: Jakobshavn Glacier

- After two decades of thinning, thinning rates of Jakobshavn Glacier slowdown since 2014.

- Significant slowing in 2017.

Is there a connection between the slowing and thickening of Jakobshavn Glacier and regional ocean waters?

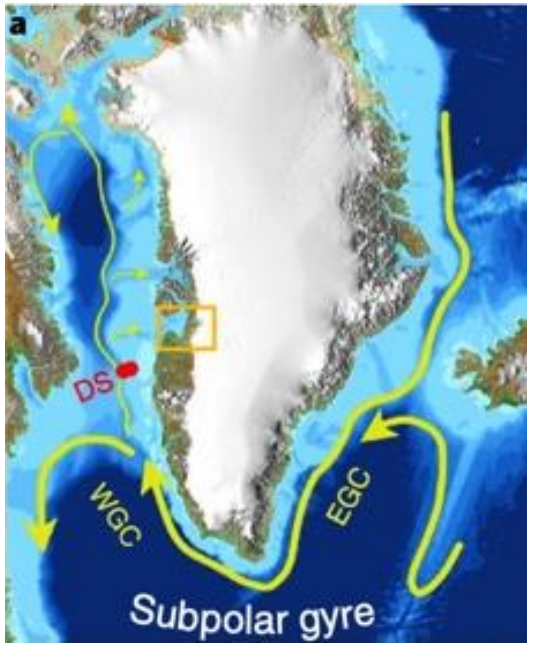
Disko Bay:
Observed summer ocean temperatures at 250 m depth

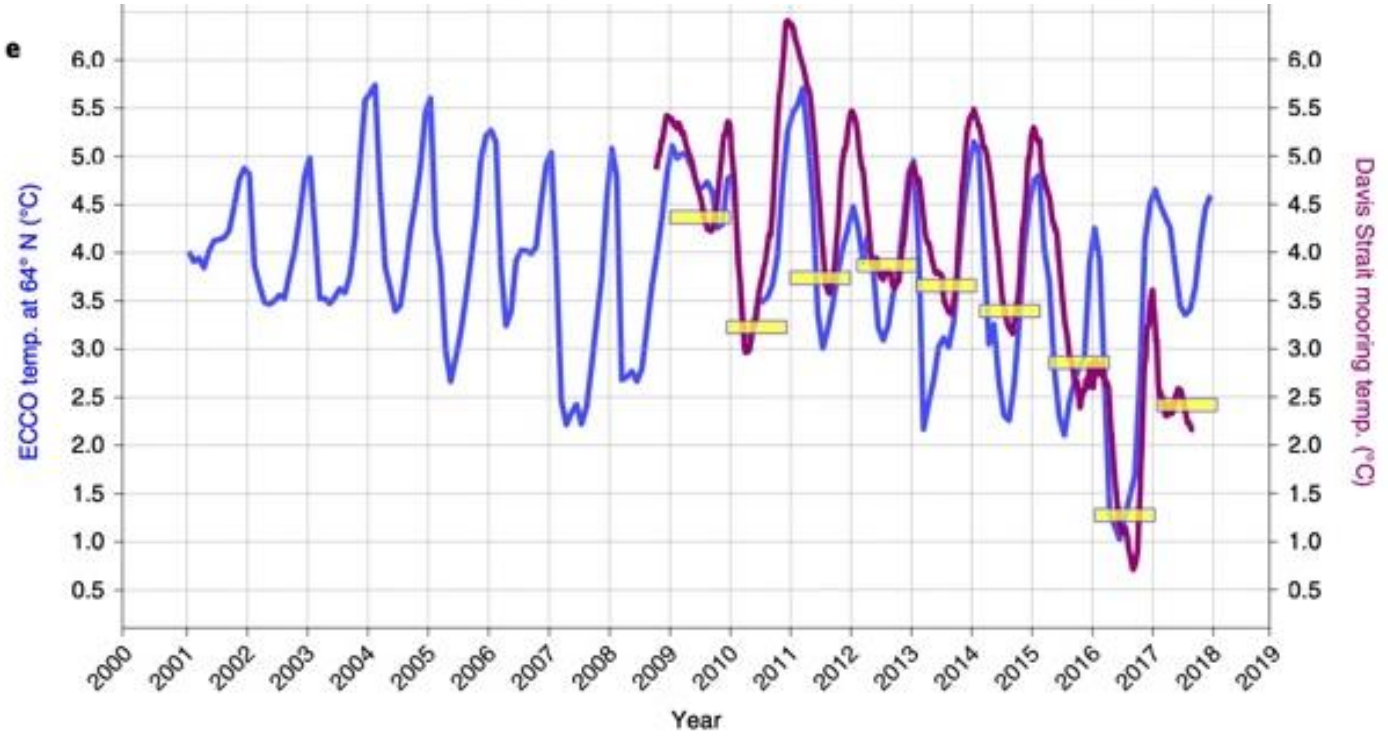


- Ocean temperatures in Disko Bay have cooled by nearly 2 deg. C between 2014 and 2016

Cold water persist in Davis Strait throughout the second half of 2015

Similar timing and magnitude of the observed Davis Strait cooling is seen in the Estimating the Circulation and Climate of the Ocean (ECCO) ocean state estimate.

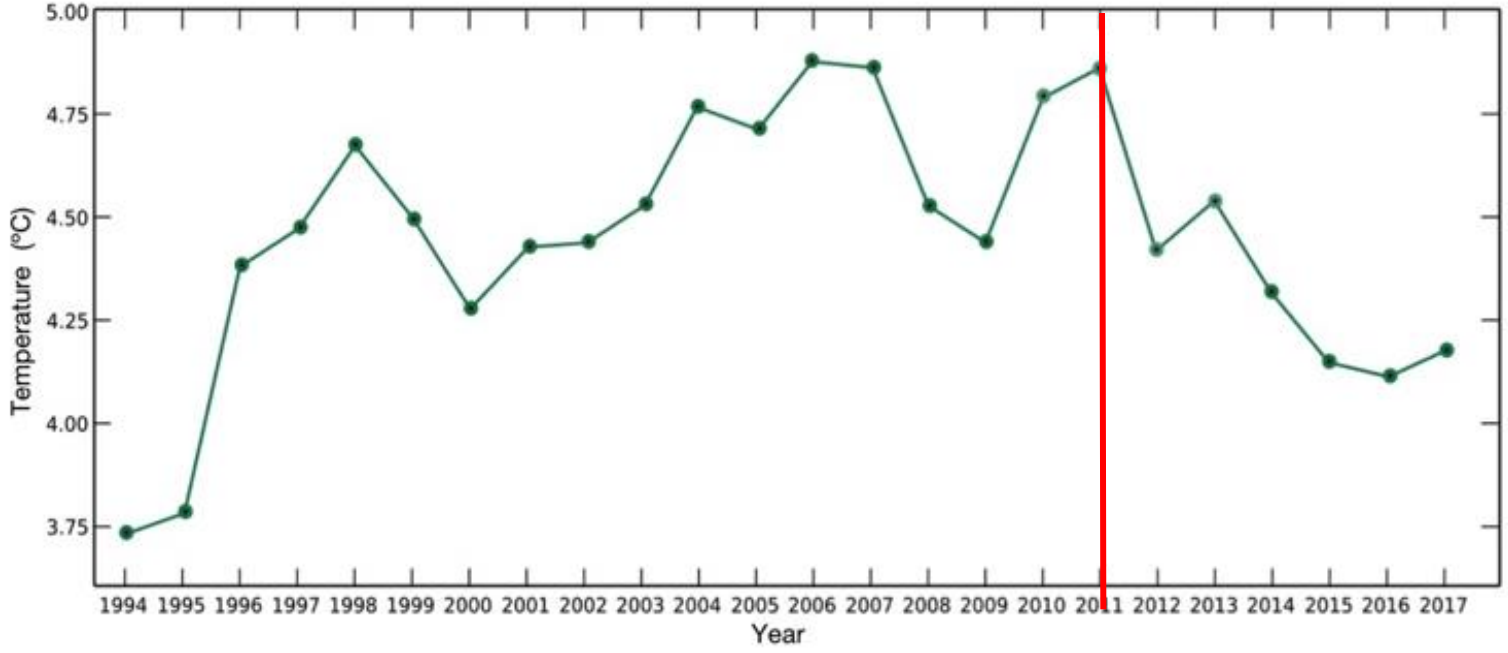




-> Cooler Atlantic Waters entering Davis Strait from the south contributed to the cooling of Disko Bay

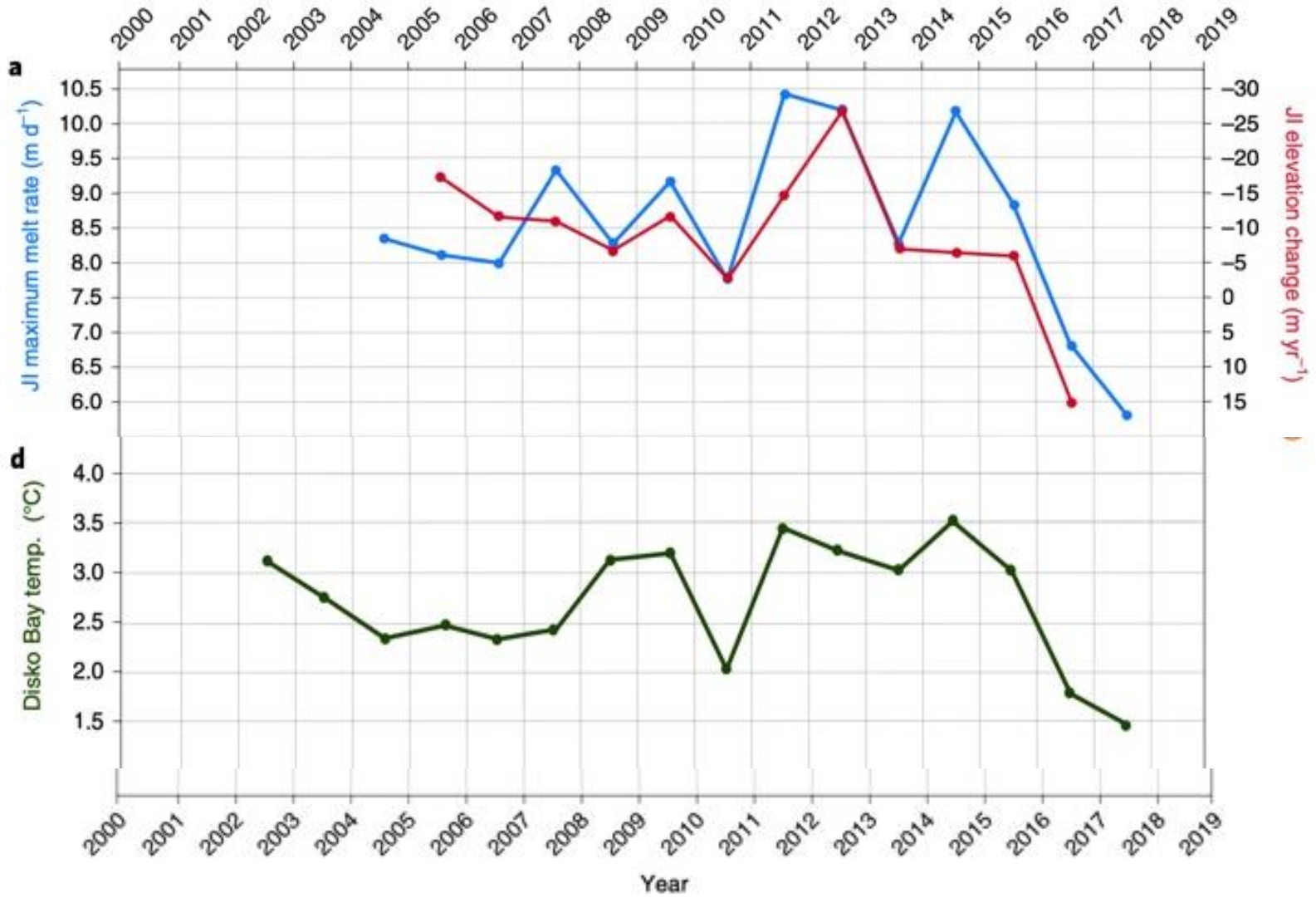
How can the observed cooling in Davis Strait and Disko Bay in 2015 and 2016 be explained?

Wintertime heat loss lowered ocean temperatures across the entire North Atlantic subpolar gyre since 2011



Supplementary Figure 13 | Subpolar Gyre temperatures. Depth-averaged (0-300 m) upper ocean temperatures estimated from the ECCO model and Argo observations for the period 2015 to 2017 (ref. [9]) within the Subpolar Gyre.

The high (modelled) melting rates are the result of higher ocean temperatures



Summary:
Disko Bay, Recent cooling of ocean waters

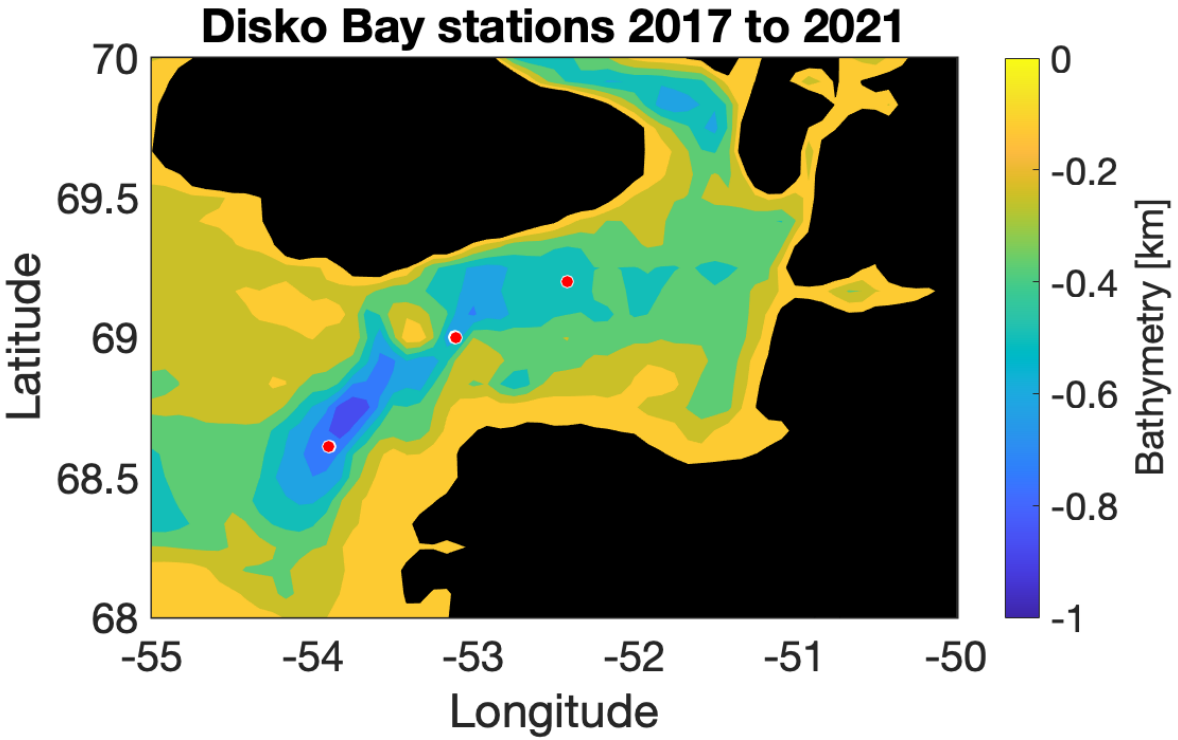
The origin of the unusually cold Atlantic Water in Disko Bay in 2016 can be explained by a combination of factors:

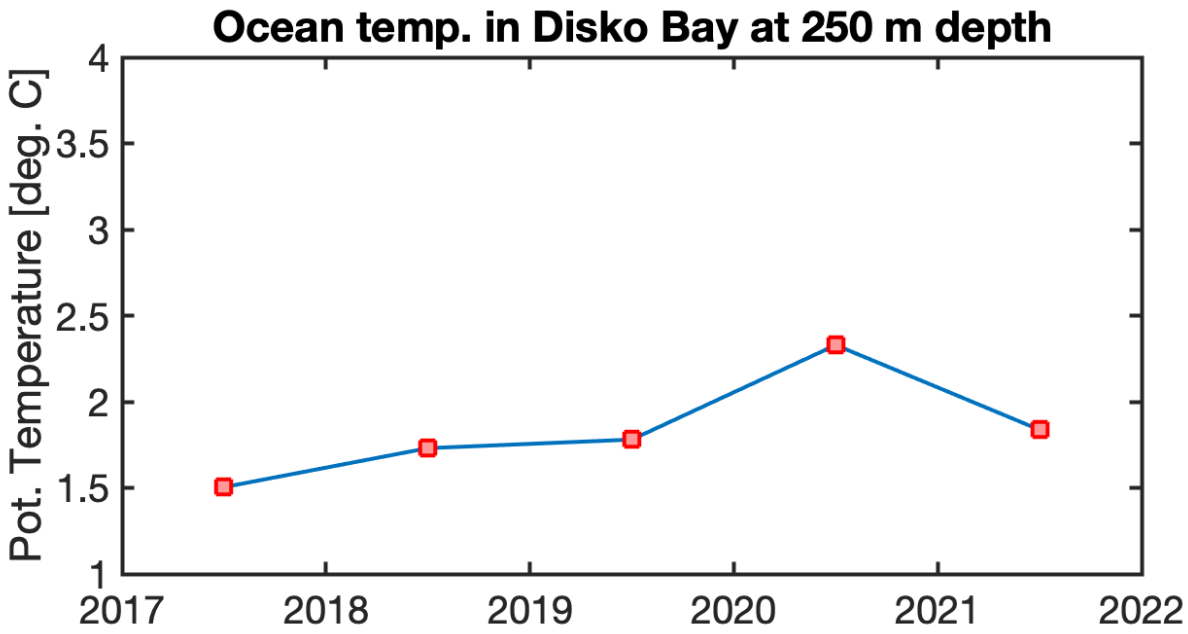
- Exceptional cooling of the subpolar gyre

- Followed by a weak temperatures along the boundary current (observed at Davis Strait mooring)

- Transition to colder ocean temperatures in the vicinity of Jakobshavn Glacier interrupts the period of warmer conditions that lasted for nearly 20 years.

Does the cooling of Disko Bay continue until 2021?





- Ocean temperature in Disko Bay increases until summer 2020 and decreases again in 2021!

Take-Home Message

Initial question:

How does Jakobshavn Glacier respond to warming or cooling of the regional ocean?

- Greenland's Jakobshavn Glacier reactc to changing ocean temperature.
- Colder ocean temperatures in the vicinity of Jakobshavn Glacier interrupt the period of warmer conditions that have lasted for nearly 20 years.
- Glacier experienced thickening and decrease of flow speed (recently).
- The ocean play a key role in Greenlands melt!

Questions?

https://www.youtube.com/watch?v=ZHcB5EFDylc

Literature

Khazendar, A., Fenty, I.G., Carroll, D. *et al.* Interruption of two decades of Jakobshavn Isbrae acceleration and thinning as regional ocean cools. *Nat. Geosci.* **12,** 277–283 (2019). https://doi.org/10.1038/s41561-019-0329-3