

Ocean warming and Greenland ice loss: The case for expanding Argo to Greenland's continental shelf

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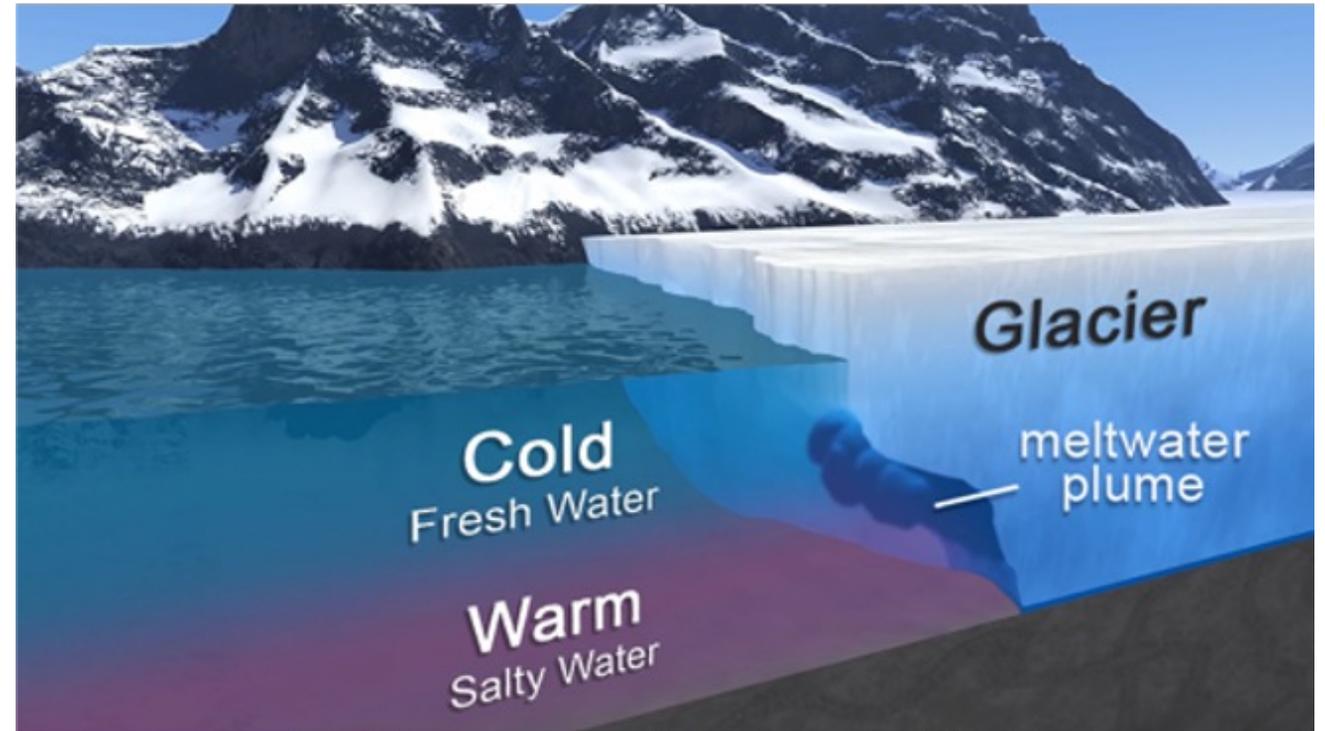
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Greenland's 200+ glaciers are the largest contributor to sea level rise since 2000¹

Glaciers melt from below by warm subsurface Atlantic water and glacier runoff²



¹Frederikse, Thomas, et al. (2020) "The causes of sea-level rise since 1900." *Nature*

²Straneo, Fiammetta, and Patrick Heimbach. (2013) "North Atlantic warming and the retreat of Greenland's outlet glaciers." *Nature*

OMG: NASA's Oceans Melting Greenland Mission

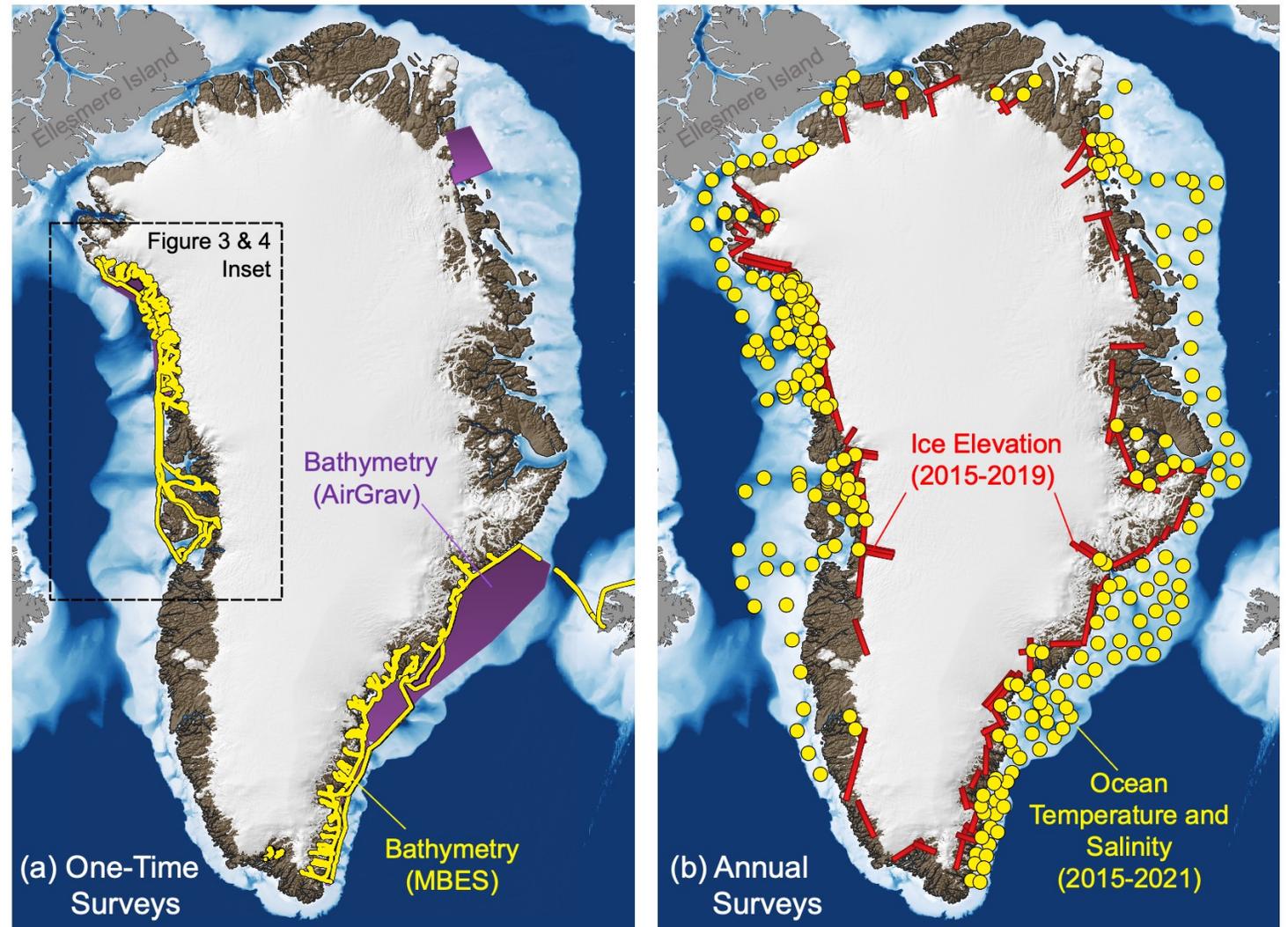
6-year airborne mission 2015-2021³

Overarching Question:

To what extent are Greenland's glaciers melted from below by the ocean?

Idea:

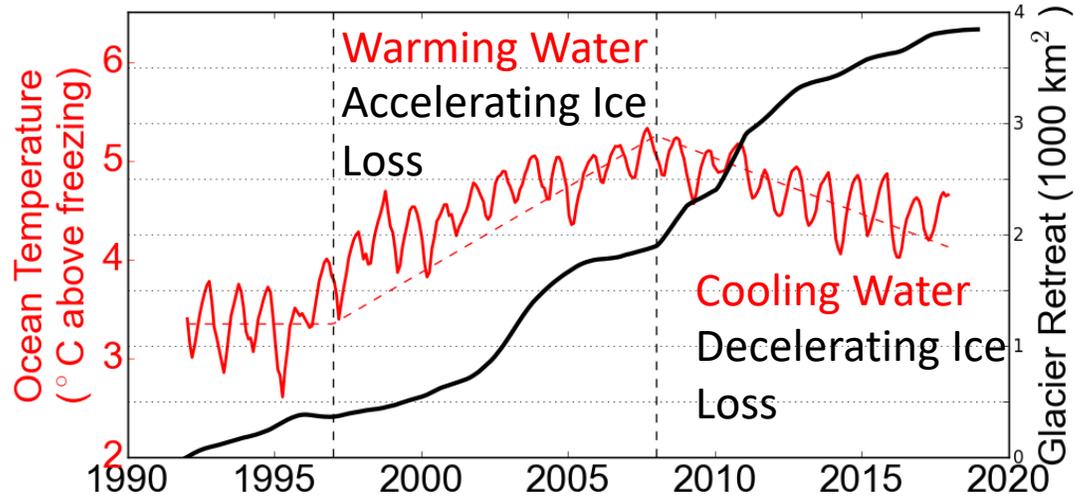
Measure the ice and ocean simultaneously to observe how they change



Summary of Measurements from NASA's OMG Mission

³Fenty, Ian, et al. (2016) "Oceans Melting Greenland: Early results from NASA's ocean-ice mission in Greenland." *Oceanography*

Ocean Warming and Greenland Ice Loss

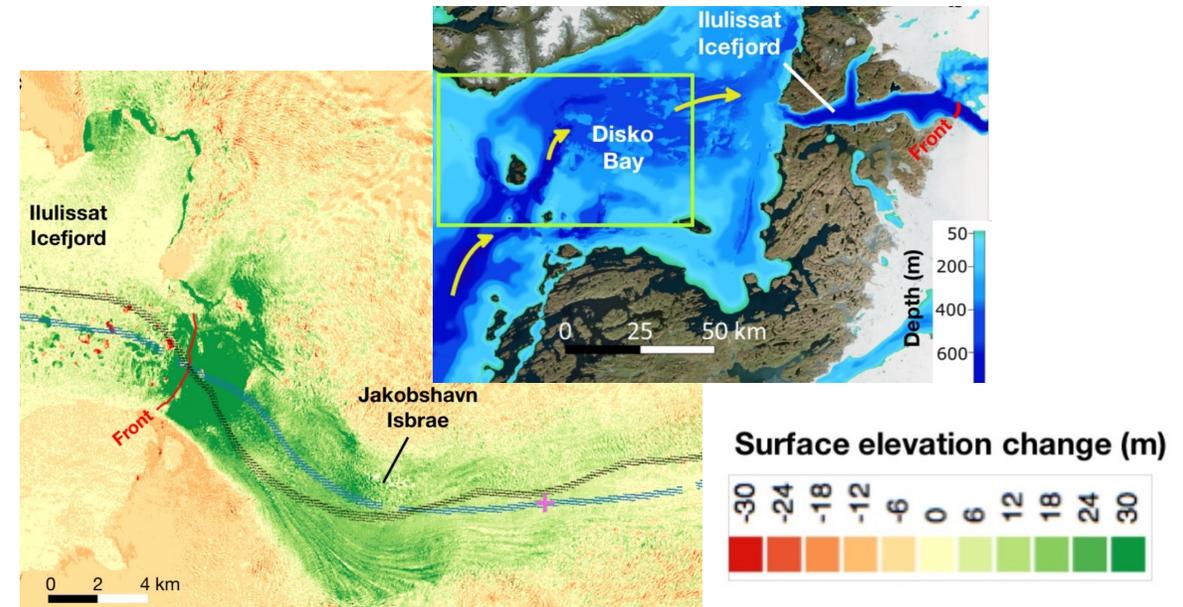


As subsurface waters have warmed over the past 3 decades, glacier ice fronts have retreated⁴

Ice front retreat causes glaciers to accelerate, contributing to sea level rise

Conversely, cooling waters may decrease ice loss, allowing glaciers to grow

This phenomenon occurred at Ilulissat Glacier, which gained mass during 2016-2019 as colder waters flooded its fjord⁵



Wood, Michael, et al. (2021) "Ocean forcing drives glacier retreat in Greenland." *Science Advances*

⁵A. Khazendar et al. (2019) "Two decades of Jakobshavn Isbrae Acceleration and Thinning Interrupted as Ocean Cools", *Nature Geoscience*

Autonomous Float Deployment during OMG

Two types of floats were tested during OMG

MRV Alamo

- Purchased: 17
- Deployed: 17
- Returned Data: 11



Teledyne APEX

- Purchased: 6
- Deployed: 6
- Returned Data: 5



APEX Floats were deployed from the airplane door during the OMG campaign
Photo: Kenn Borek Air Flight Engineer Gerald Cirtwell

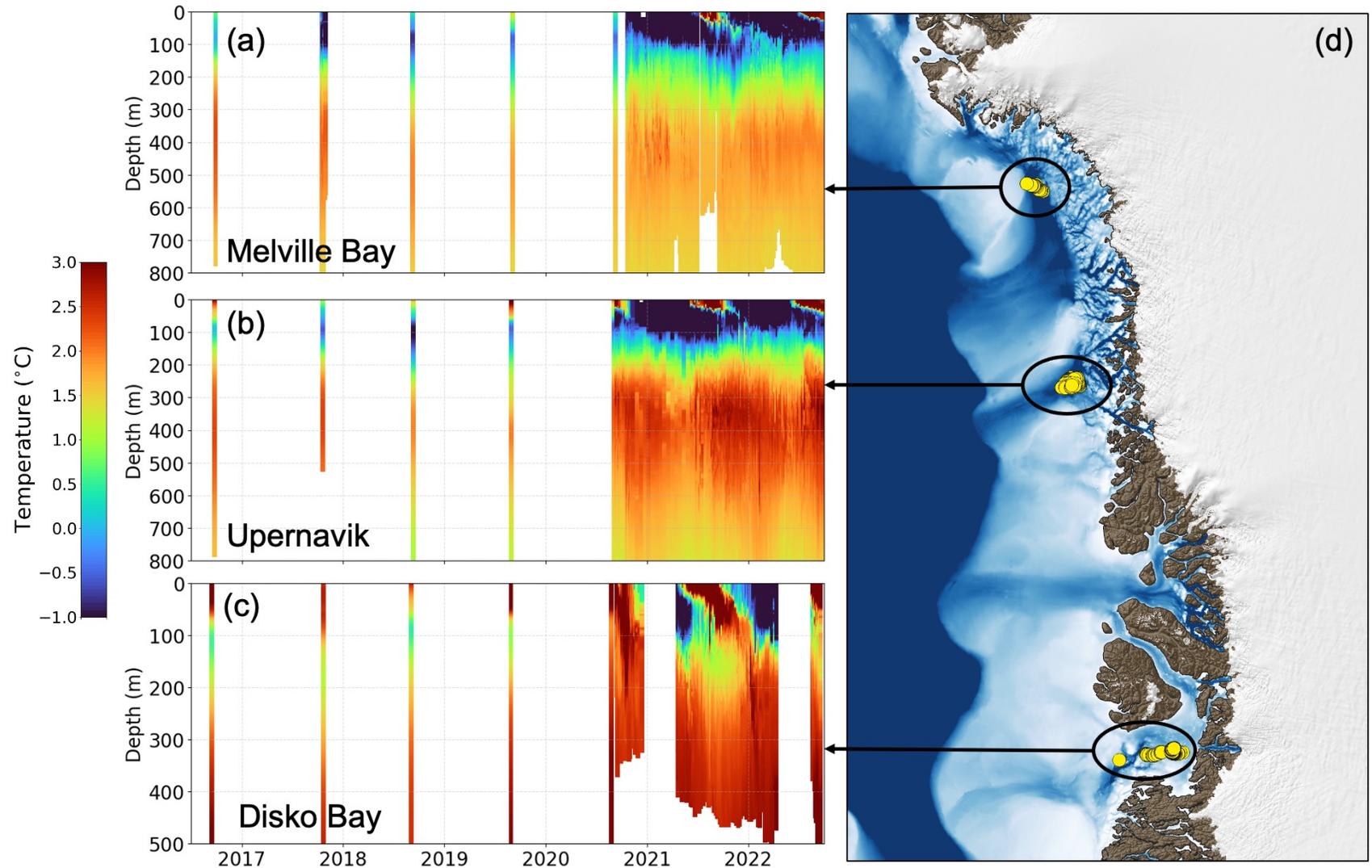
Temperature Records from OMG Floats

Autonomous floats can ...

...be "parked" on the bottom so they continuously sample localized areas

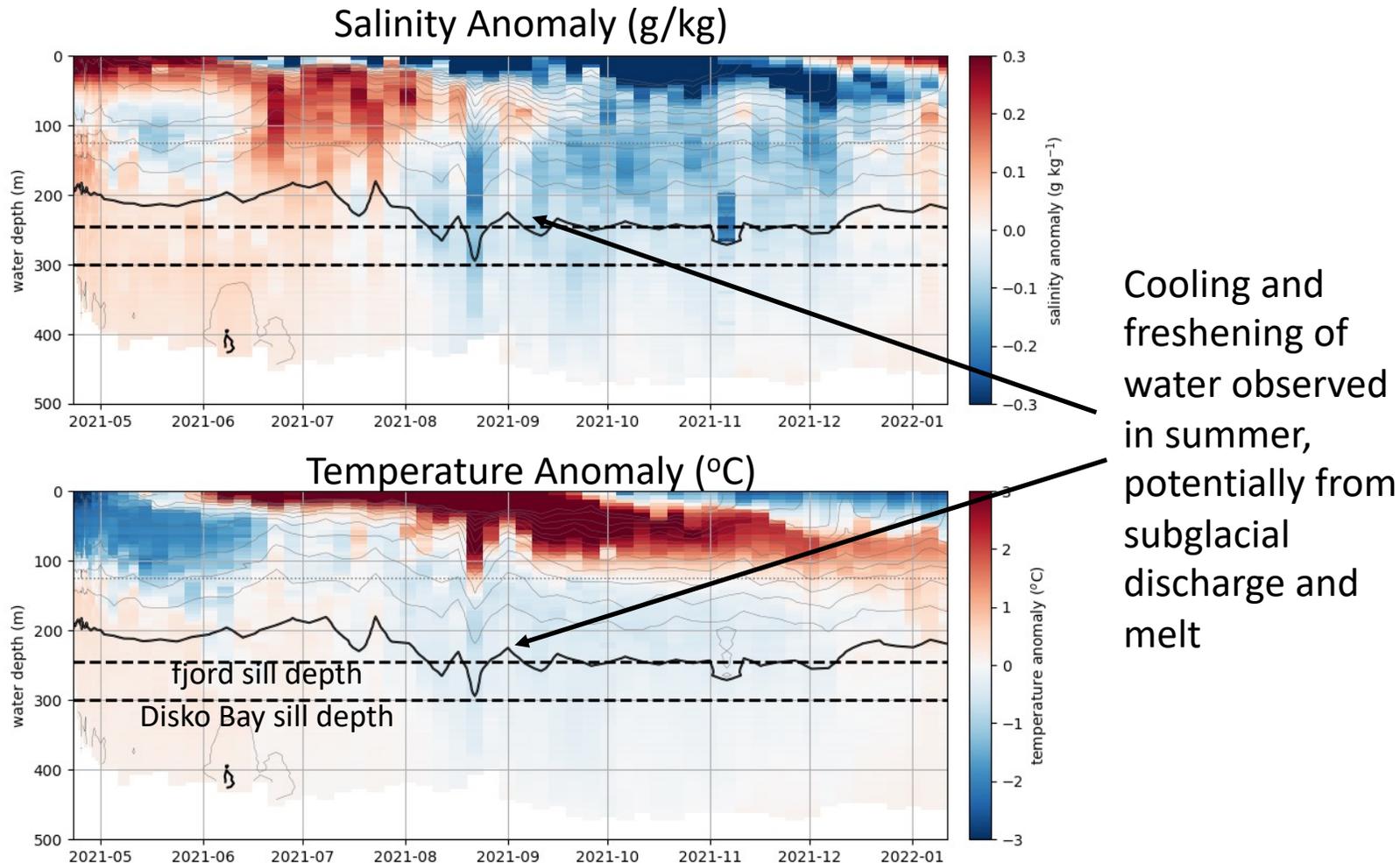
... collect data under sea ice and send back data when the sea ice clears

... provide a viable way to monitor Greenland's shelf waters over several years



Preliminary Results and Conclusions

Seasonal Variation in Salinity and Temperature in Disko Bay



Cooling and freshening of water observed in summer, potentially from subglacial discharge and melt

Conclusions

- Autonomous floats are a useful tool for sampling Greenland's subsurface waters and inferring glacier melt
- Expansion of the Argo array to Greenland's shelf would provide critical measurements for inferring glacier melt and contributions to sea level rise