Feedback on ARcticGO 2022

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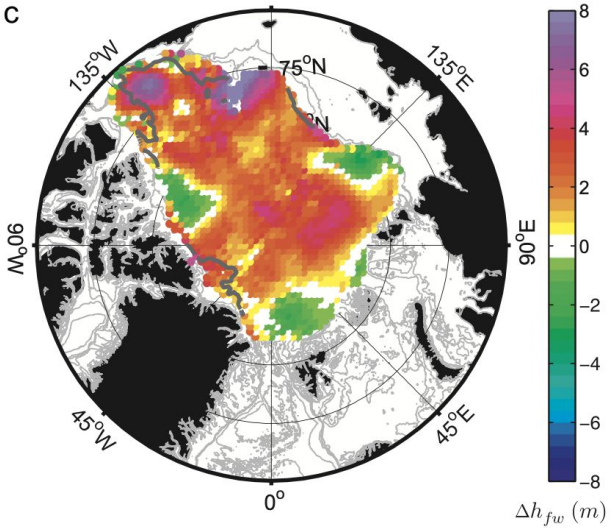
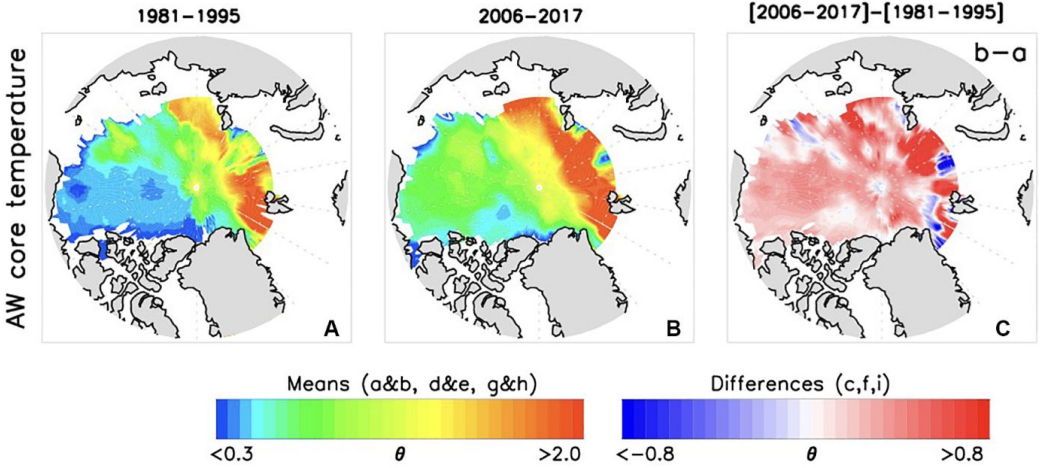
The Arctic is experiencing the most rapid changes on Earth

- The Arctic climate and ocean are experiencing rapid changes in response to climate change global warming
- As sea ice retreats, the ocean is getting warmer, fresher, more energetic…
- … but the changes are not uniform in space!

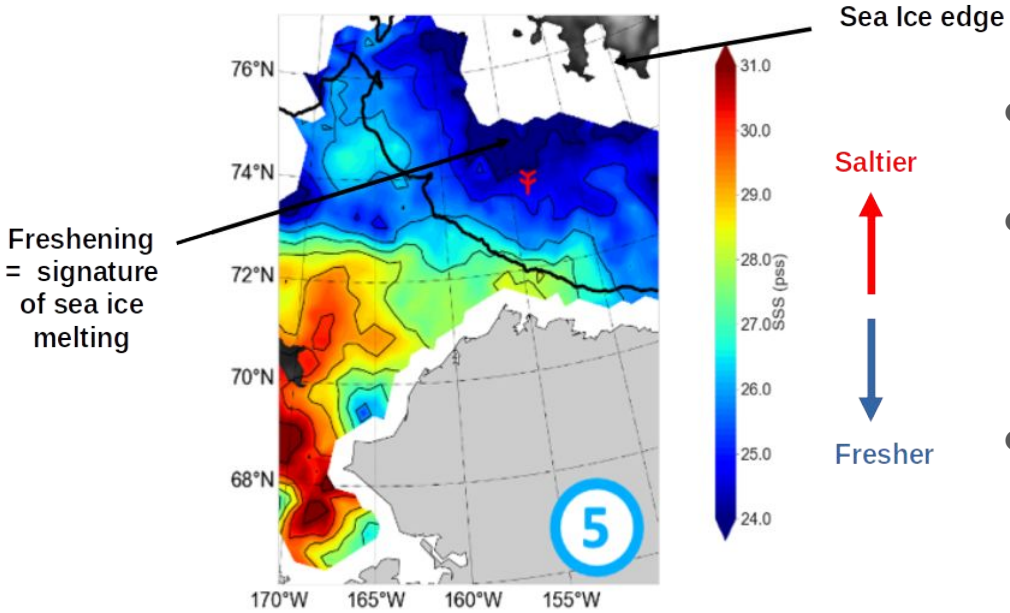


FW content anomaly of 2006–2008 relative to 1992–1999 (Rabe et al., 2010)



AW core temperature anomalies (Polyakov et al., 2020)

Enhancing understanding of MIZ variability



- Arctic entering «seasonal regime» (Haine and Martin, 2017)
- Observing the seasonal sea ice melting and its interaction with ocean dynamics is still challenging
- Example of sea ice melting signature in Beaufort Sea observed from satellite (Supply et al., 2022)
- L-Band SSS qual/val

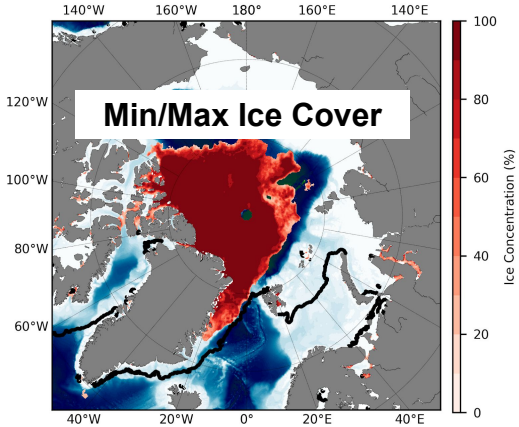
(Supply et al., 2022)

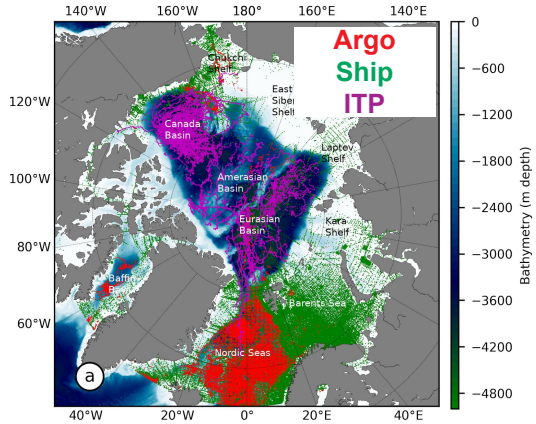
The Arctic Ocean is under sampled

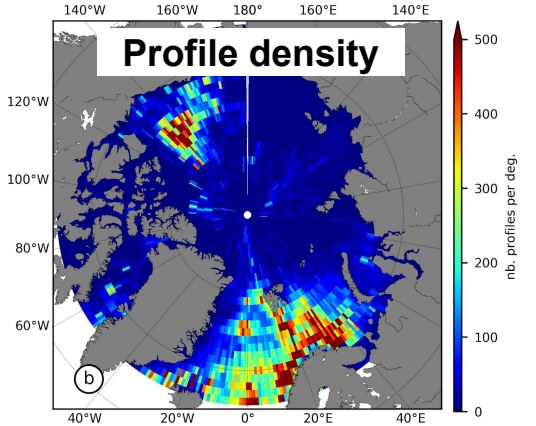
- Arctic Basin dramatically under-sampled for monitoring these changes
- Seasonal sea ice cover/harsh winter conditions

However

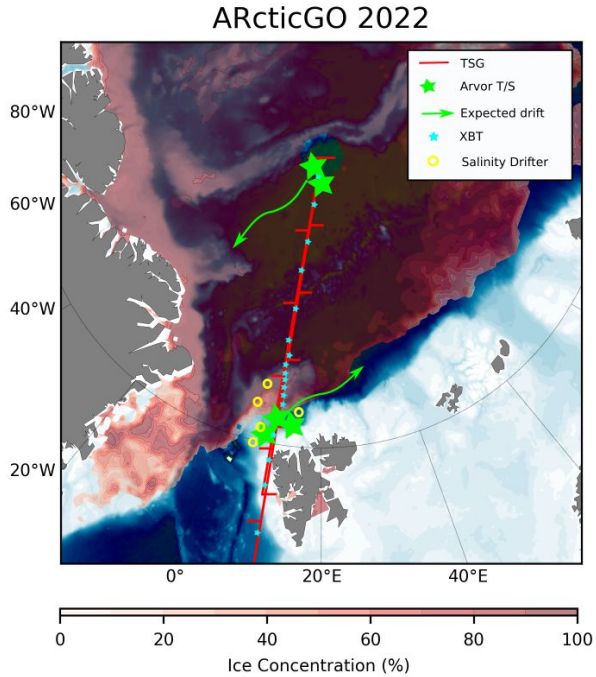
- Historical sampling strategy based on ITP in ice pack and ship CTD
- Fleet of 140 matured ISA-equipped Argo floats deployed in the Southern Ocean as part of SOCOM, allowed a reconstruction of realistic trajectory (*Chamberlain et al., 2018*)
- Data assimilation of Argo float data in the Arctic, with no position info, improves model results (*Nguyen et al., 2020*)
- Since 2006, 230 Argo floats have profiled in the Arctic Basin, but mainly in the Seasonal Ice Zone and Marginal seas

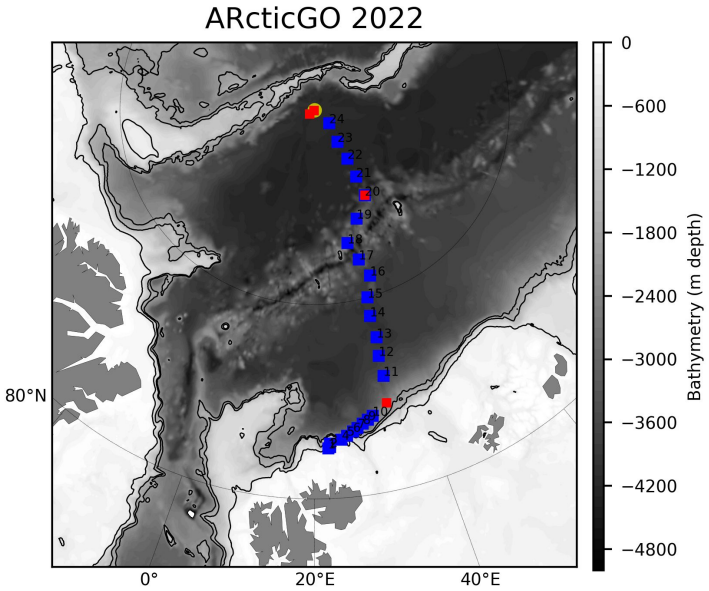


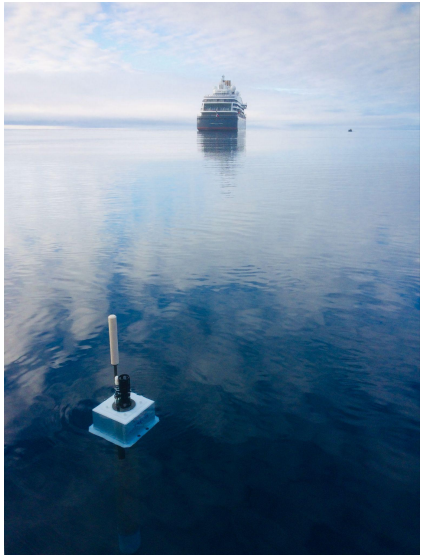




ARcticGO 2022 program



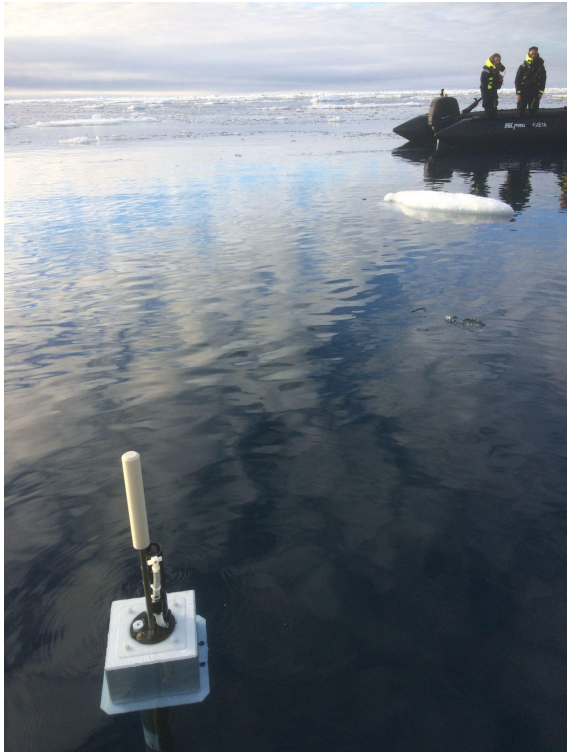




- Ice Breaker of opportunity “Le Commandant Charcot” (Le Ponant)
- Argo deployment, XBT/XCTD launch, CTD stations, SVP drifter deployment (SSS), …

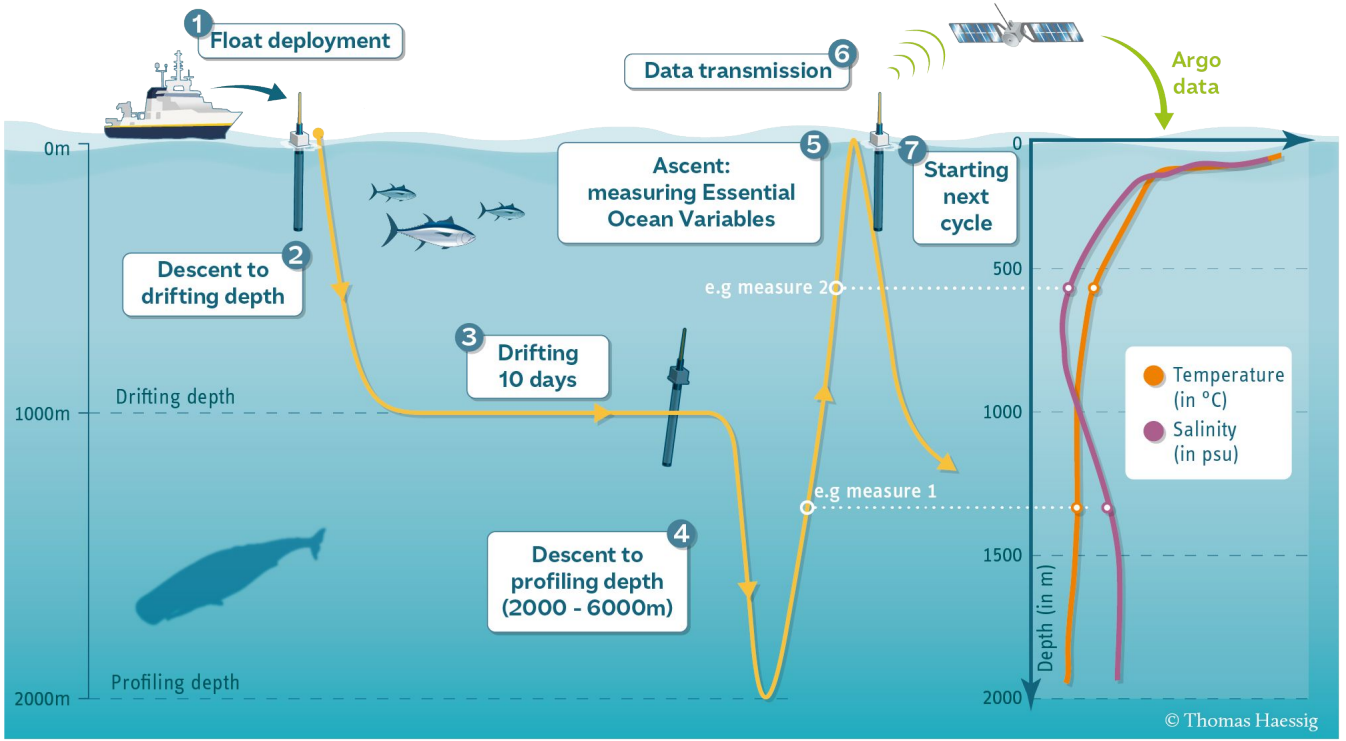
Argo Deployments

Argo deployment at the North Pole (July 2022)



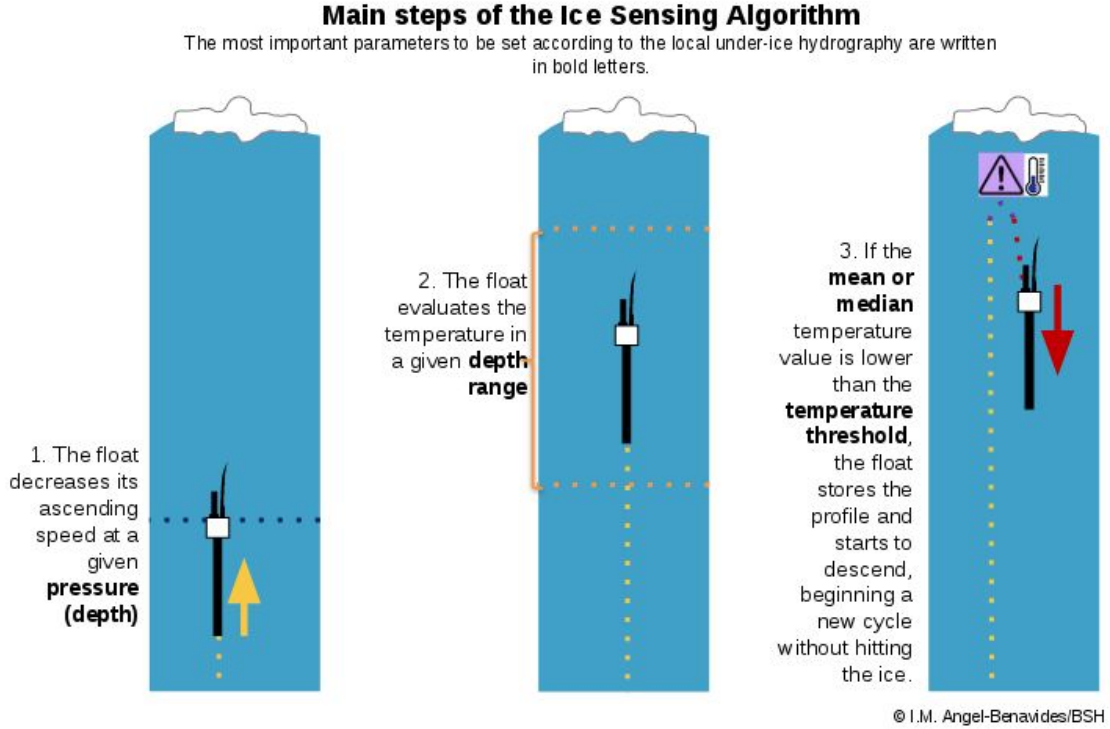
Argo deployment in the MIZ (~83°N)

Issue #1: Cycling in Sea Ice region



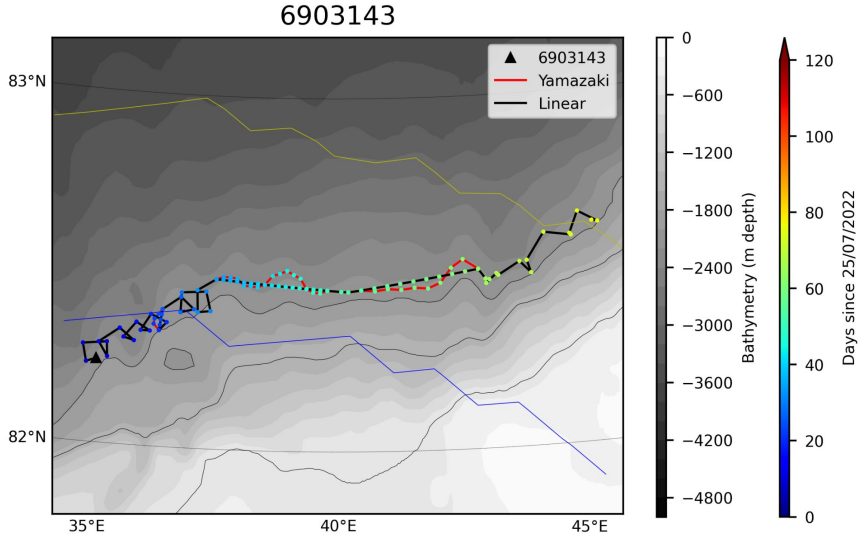
- Argo float standard cycle (no ice)

Issue #1: Cycling in Sea Ice covered region



- Sea Ice -> no surfacing -> no GPS fix/no data transmission
- Ice Sensing Algorithm (ISA; Klatt et al., 2007)

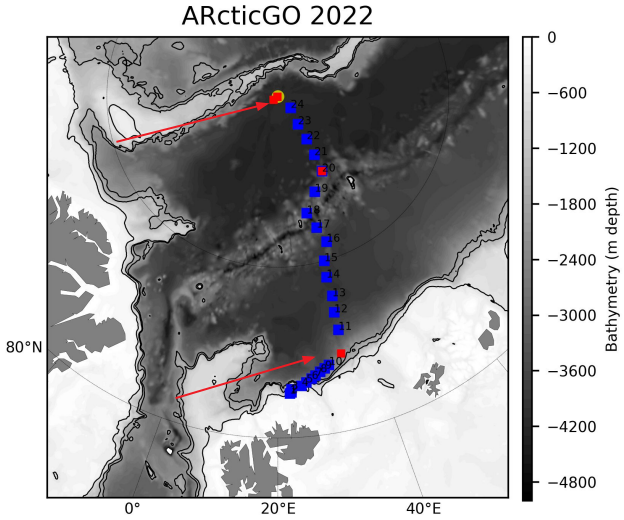
Issue #2: Under ice position estimates

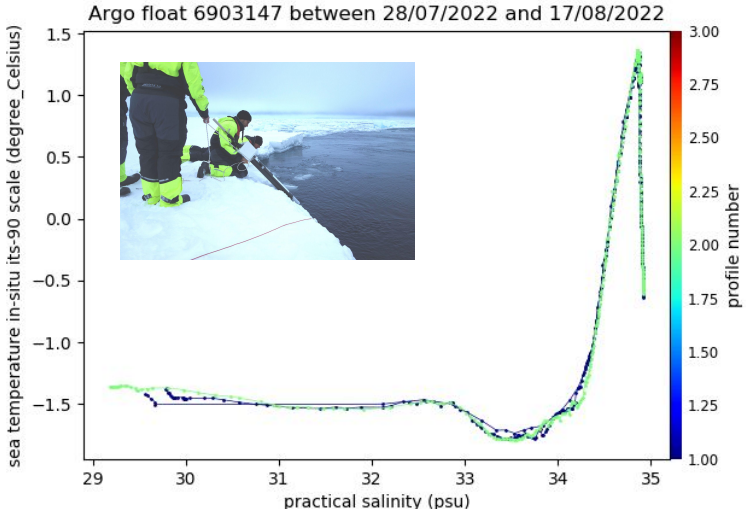


- Estimating Argo Float trajectory under ice (**Yamasaki et al., 2020**; Oke et al., 2022)
- Combining isopycnal/vorticity/MSL constraints to estimate trajectory
- Provide more realistic estimates
- Reduce uncertainty due to missing GPS position

Argo deployments at North Pole

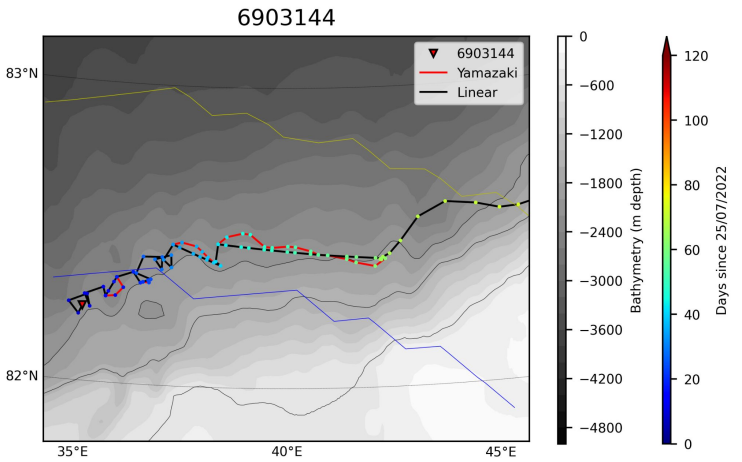
- In September 2021, 2 floats at the North Pole (500 dbar)
- In July 2022, 2 floats at the North Pole (100 dbar)
- Ice condition were looser in 2022
- 3 surfacing in leads occured
- Waiting for the next summers for potential surfacing in leads/out of ice pack
- So far : 3 profiles/4 deployments

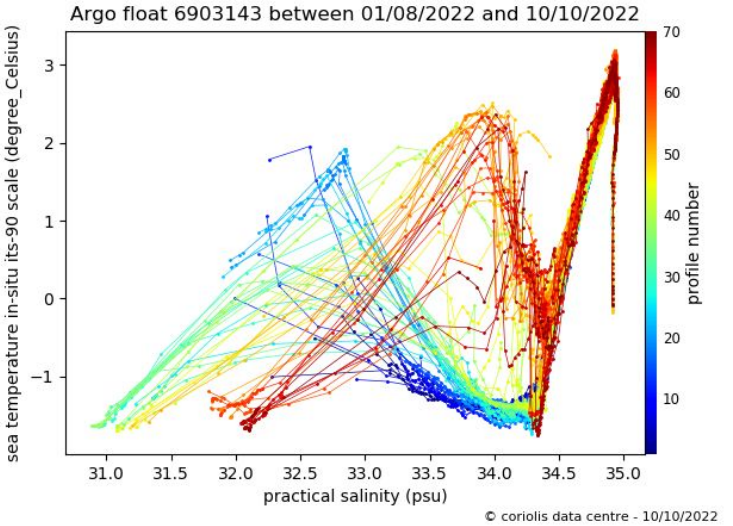




Argo deployments in the MIZ

- Deployment of 3 Argo floats in the MIZ during summer 2022
- Daily sampling at 200 m depth
- 10-day sampling at 2000 m depth (Argo cycle)
- ISA optimal set up (-1.5°C)
- >70 cycles both under sea ice and in free ice regions
- Currently under winter sea ice



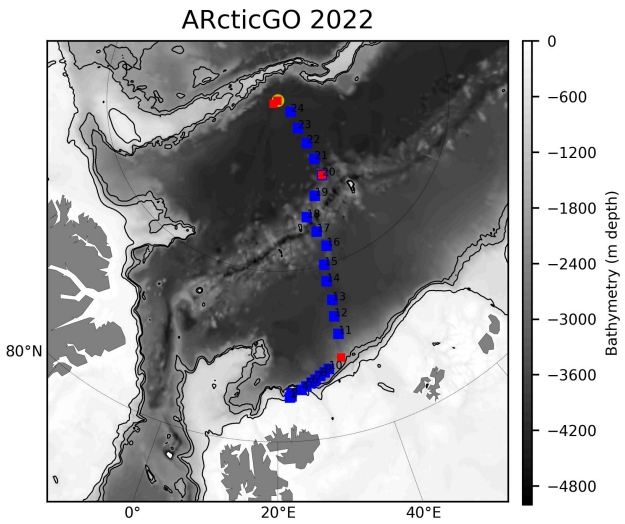


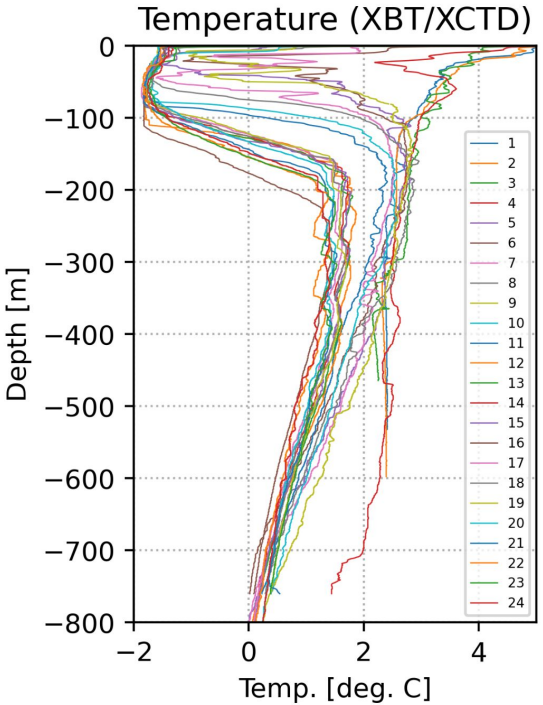
XBT/CTD profiles

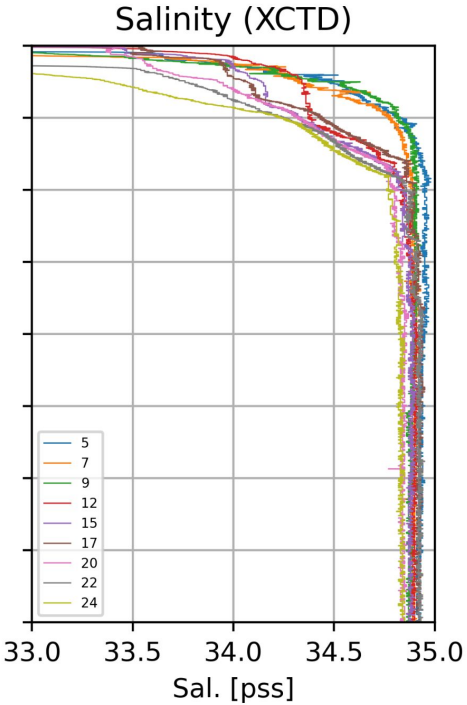
RBR CTD cast in the ice pack in 2021

XBT launch from the ice edge in the ice pack

XBT/CTD profiles

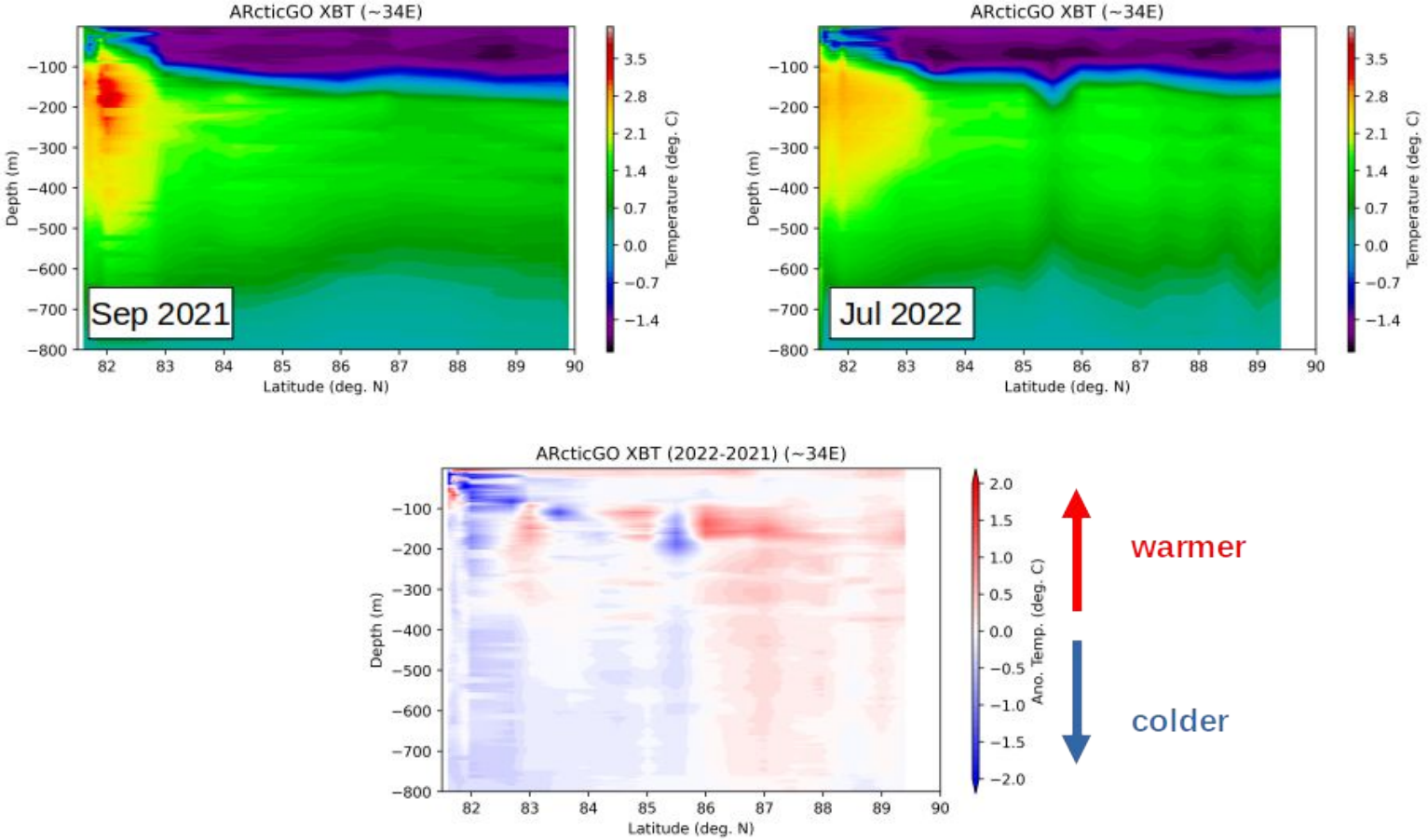






- 24 XBT/XCTD profiles
- 7 CTD profiles for Ago calibration
- Svalbard/North Pole radial

2022 vs 2021

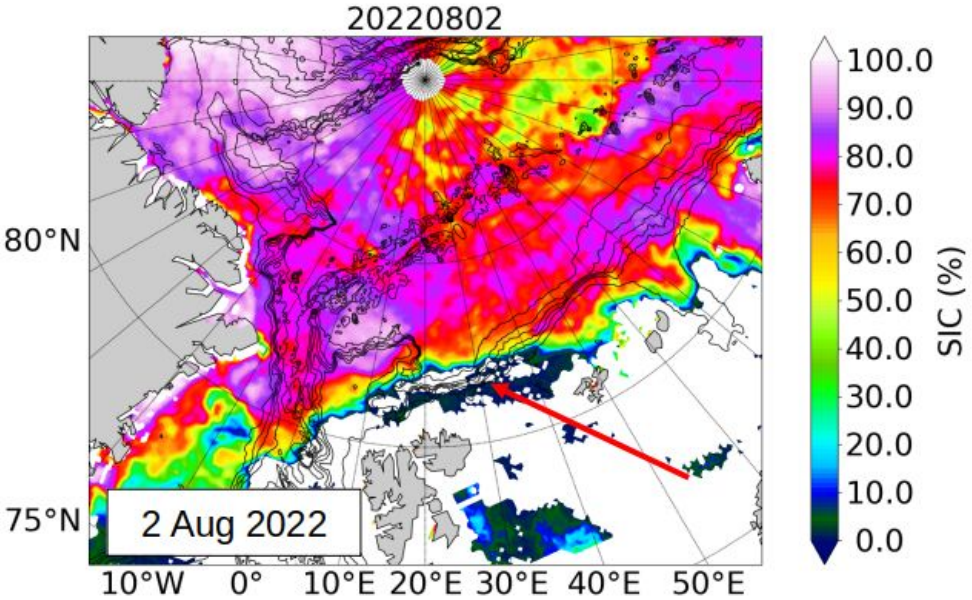

ARcticGO XBT (~34E)
Sep 2021
Depth (m)
Latitude (deg. N)
Temperature (deg. C)
ARcticGO XBT (~34E)
Jul 2022
Depth (m)
Latitude (deg. N)
Temperature (deg. C)
ARcticGO XBT (2022-2021) (~34E)
Depth (m)
Latitude (deg. N)
Ano. Temp. (deg. C)
warmer
colder

Drifter Deployment in the MIZ

SVP BSC drifter in the MIZ

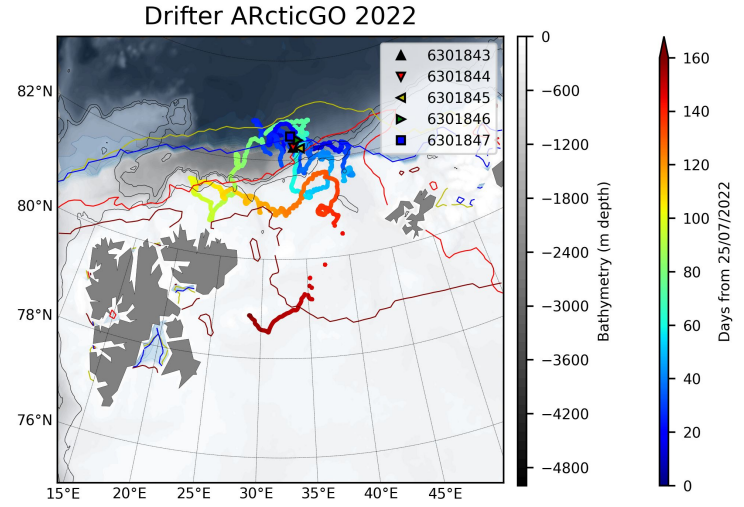
SVP BSC drifter in the MIZ

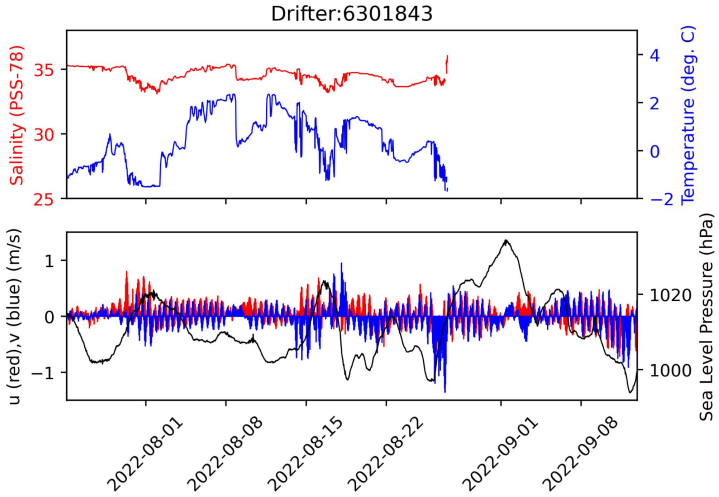
Deployments in the MIZ



SVP Drifter data

- Deployment of 5 SVP SSS drifters in the MIZ
- Hourly sampling
- Life expectancy : few weeks to 6 months
- Sensor issues with ice conditions
- Drifters have remained in the same region during the late summer



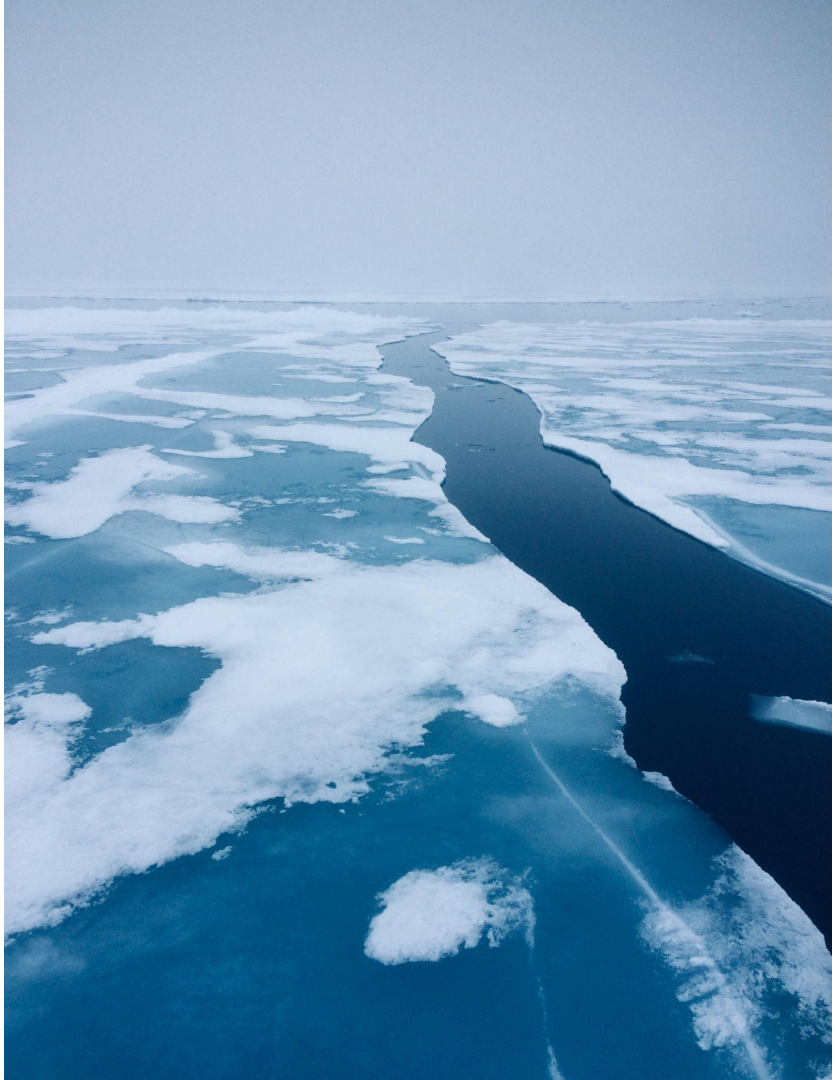


Conclusion

- **In the SIZ and MIZ:**
  - Drifter + Argo profiles will help to picture the 3D hydrological variability of the ocean MIZ (work in progress)

- **Under the permanent ice pack:**
  - Repeated XBT/XCTD radial will help to monitor the interannual variability (work in progress)

- **ARcticGO 2023 in next July and next …?**



Questions ?

Conclusion

- **In the SIZ and MIZ:**
  - We and other groups (US, Germany, Norway Poland, …) have successfully demonstrated the Argo+ISA capability in Seasonal Ice Zone
  - Suitable for ocean state monitoring and process-oriented measurements
  - Using trajectory estimates algorithm help to reduce positioning error
  - Need technological improvement for under ice positioning (work in progress)
  - Shorter lifetime than in ice free region (less cost effective)
  - Drifter + Argo profiles will help to picture the 3D hydrological variability of the ocean MIZ (work in progress)
- **Under the permanent ice pack:**
  - On going evaluation of % profiles recovery (leads, drifting out of the ice pack, …)
  - Probability of surfacing drops dramatically (4 floats -> 3 profiles in 2 years)
  - Surfacing and positioning issues still pending (technological development for positioning and data recovering)
  - Complementarity with ITPs and/or POPs (designed for ice pack) should be considered
  - Repeated XBT/XCTD radial will help to monitor the interannual variability (work in progress)
- **ARcticGO 2023 in next July and next …?**