

A photograph of a researcher wearing a blue hard hat, safety glasses, and a blue life vest over a dark long-sleeved shirt. The researcher is leaning over the side of a boat, working with a yellow glider. The glider is a long, cylindrical device with a yellow body and a white sensor pod at the front. It is mounted on a metal frame. The background shows the calm surface of the ocean under a clear sky.

# Glider Observations in the Arctic Ocean - Opportunities, Challenges, and Next Steps

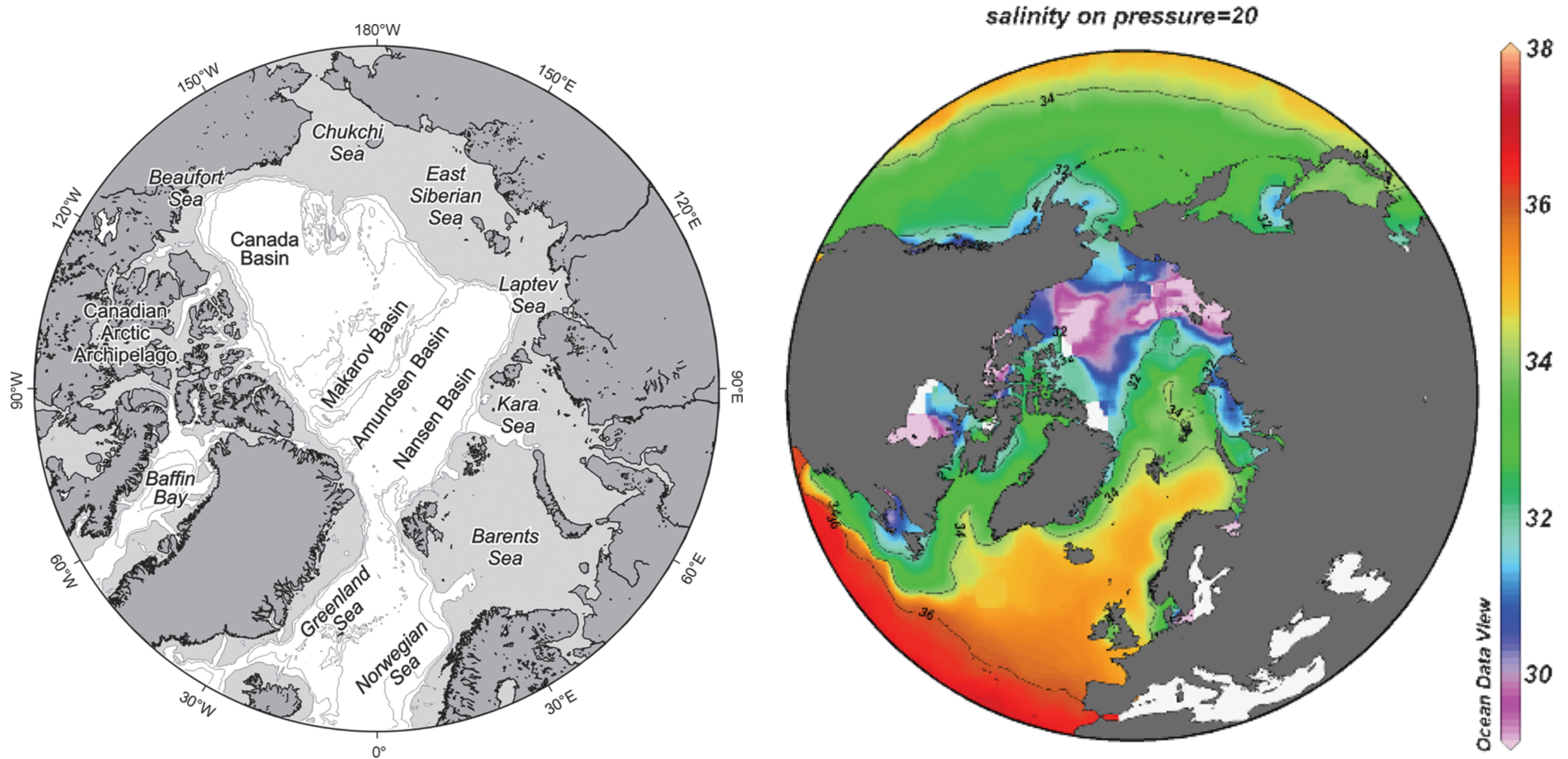
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Virginia Institute of Marine Science - William & Mary

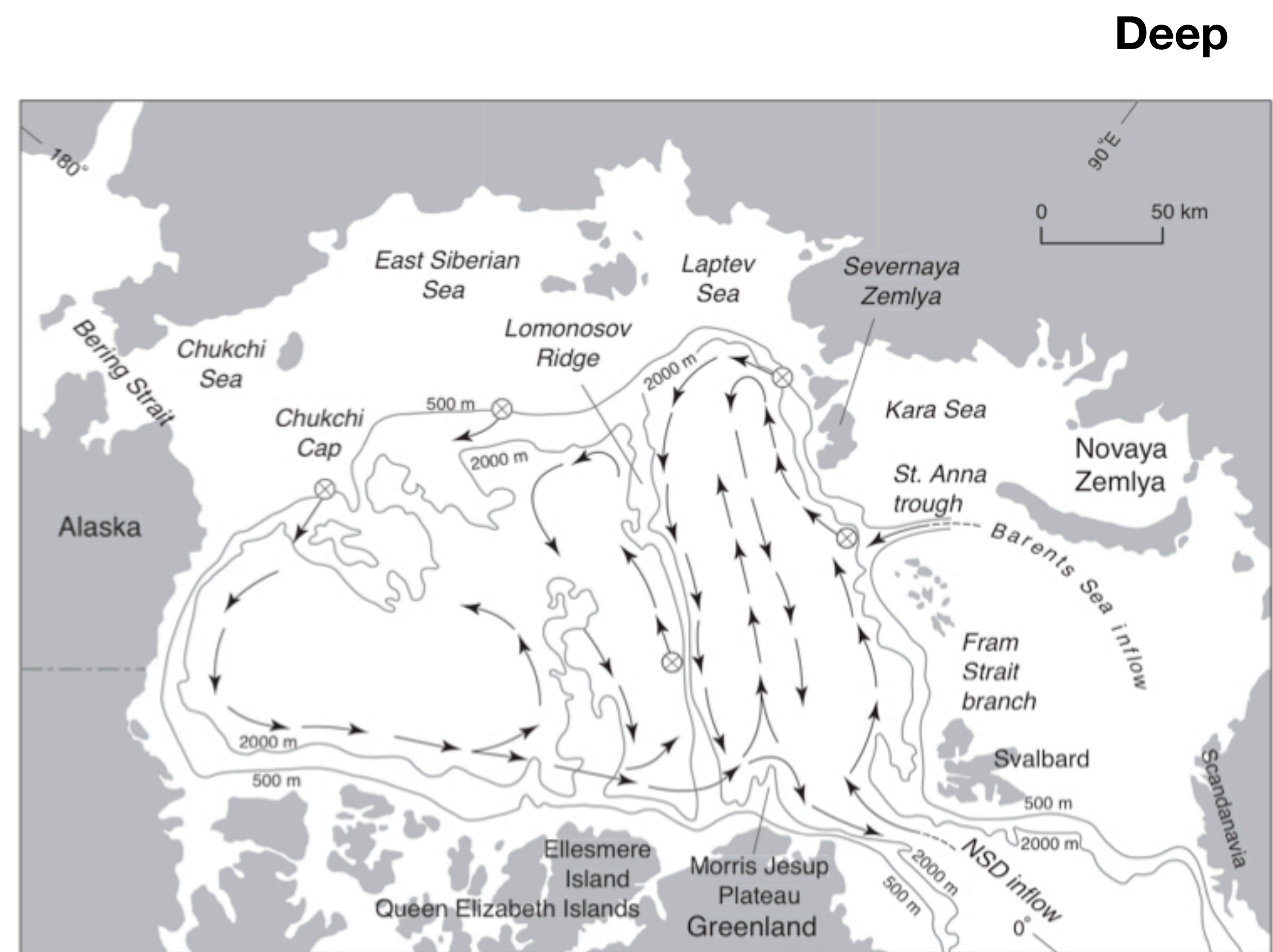
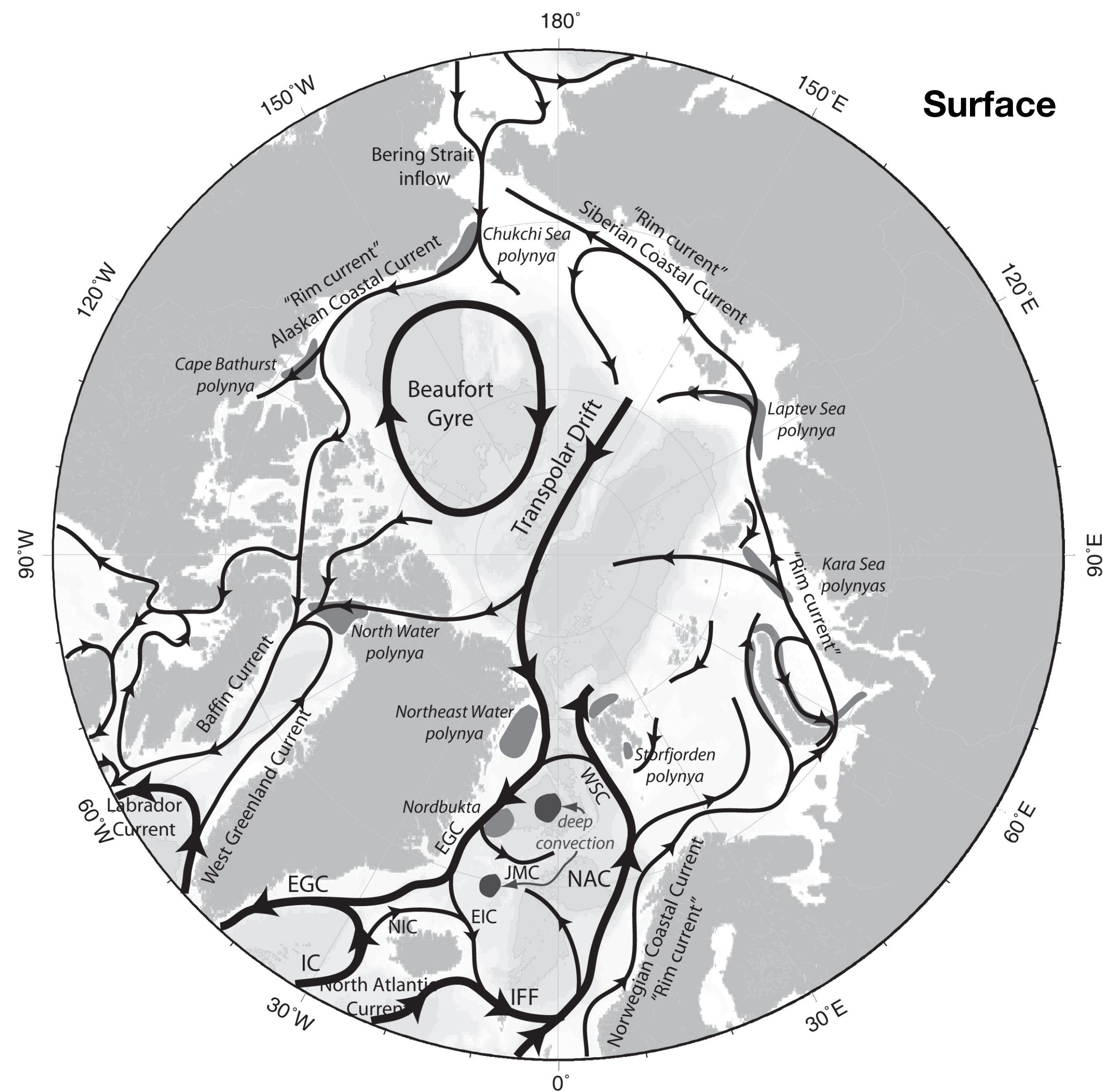


# The Arctic Ocean: Brief Introduction

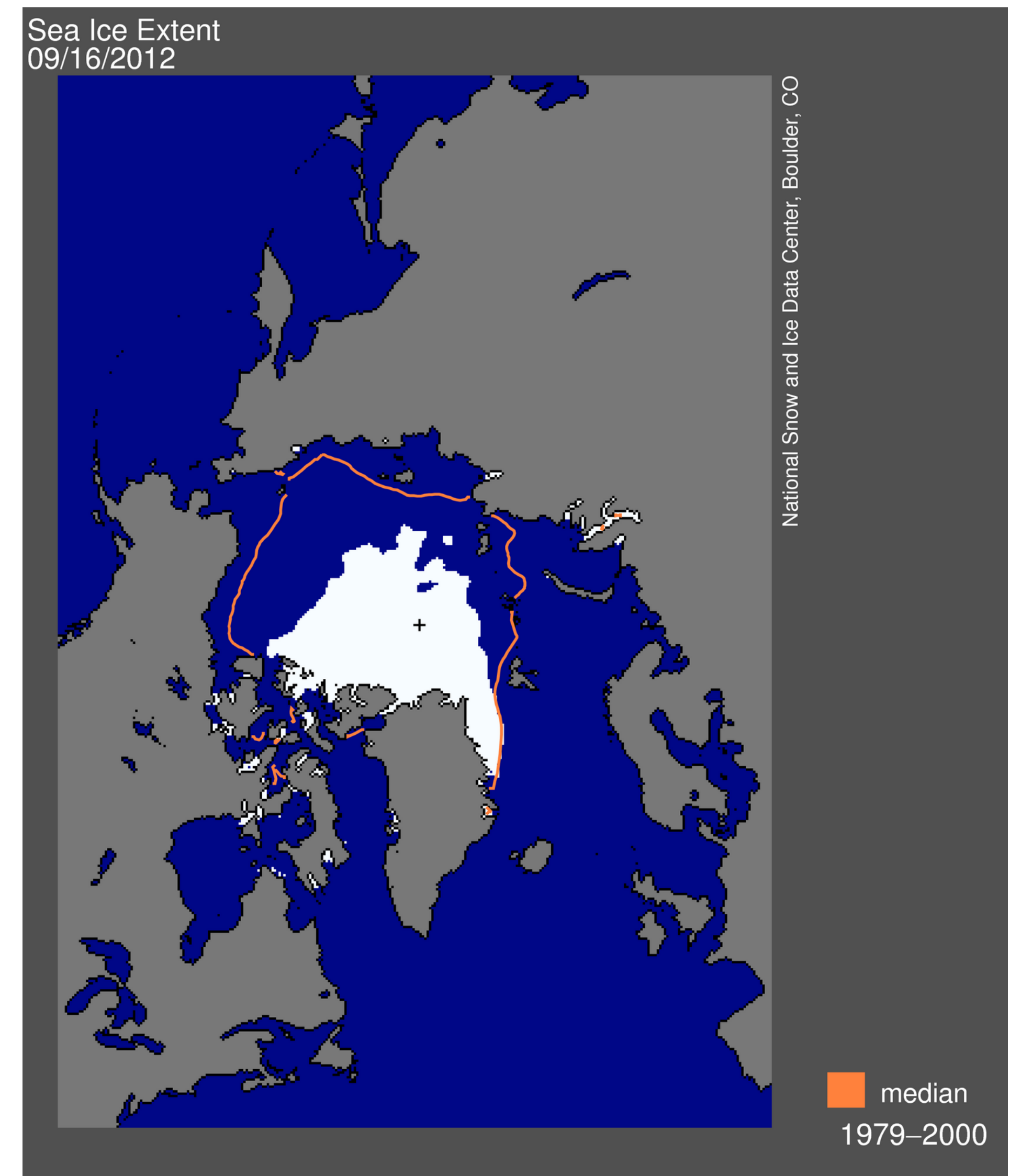
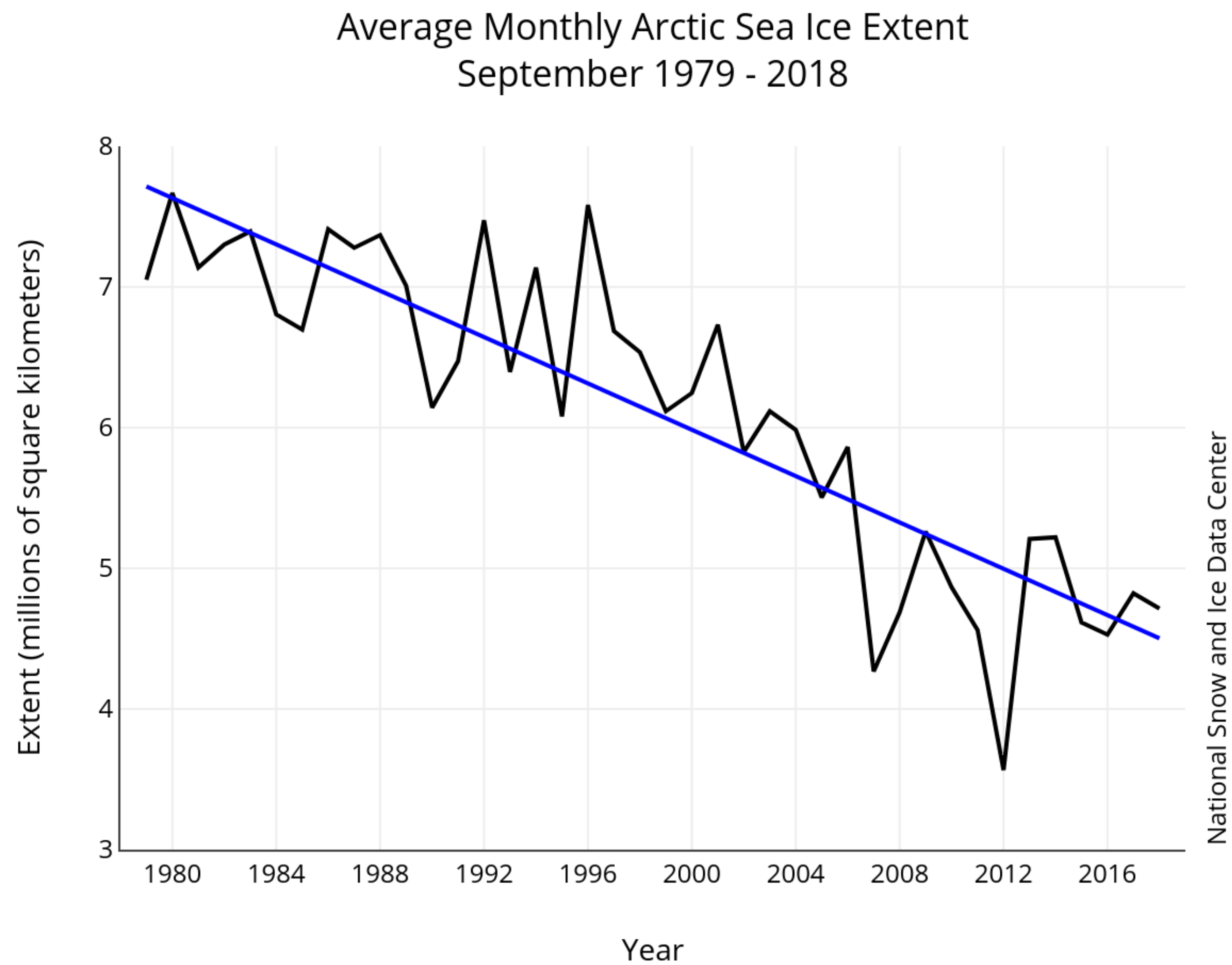




# Arctic Ocean: Circulation





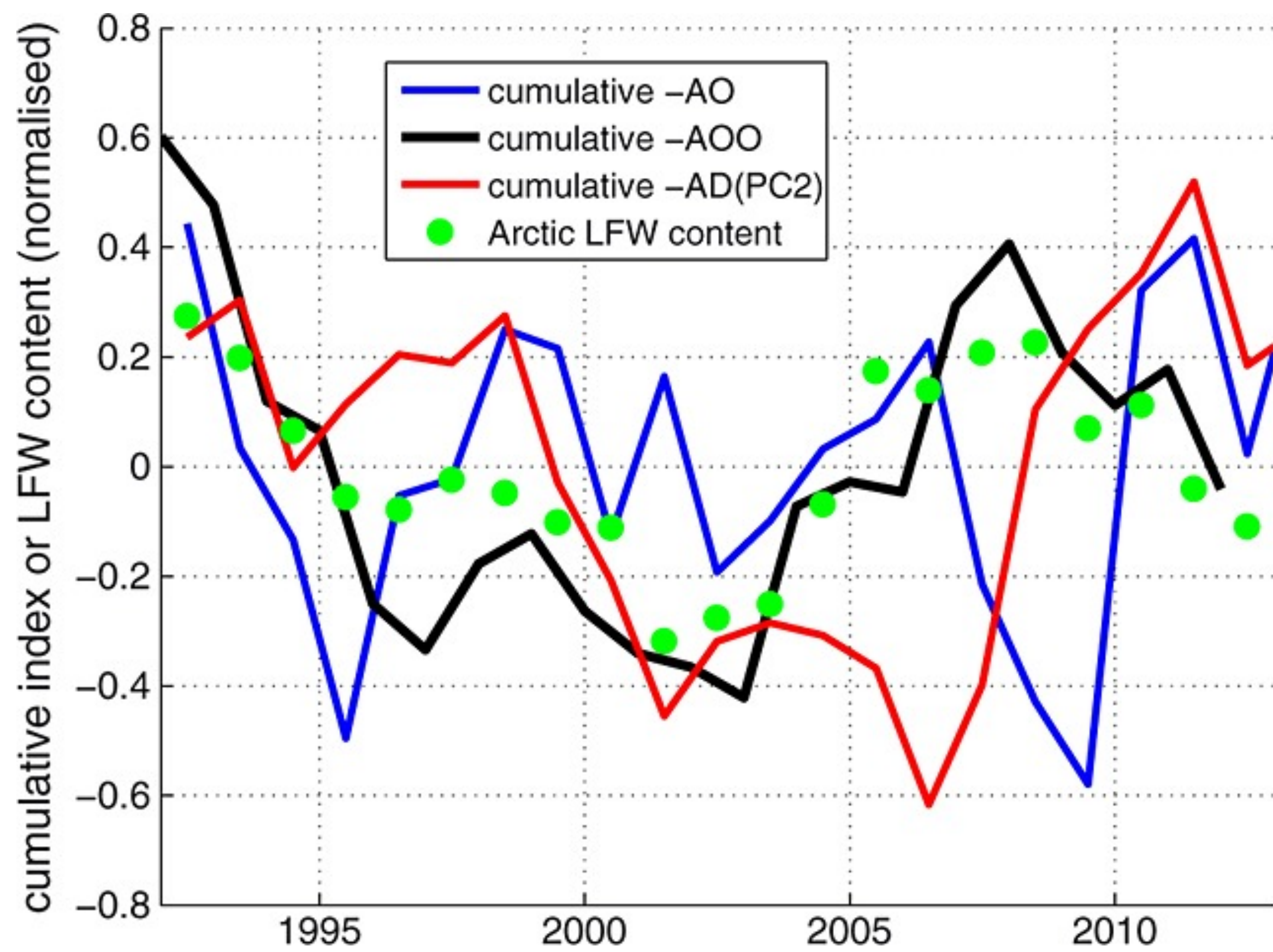
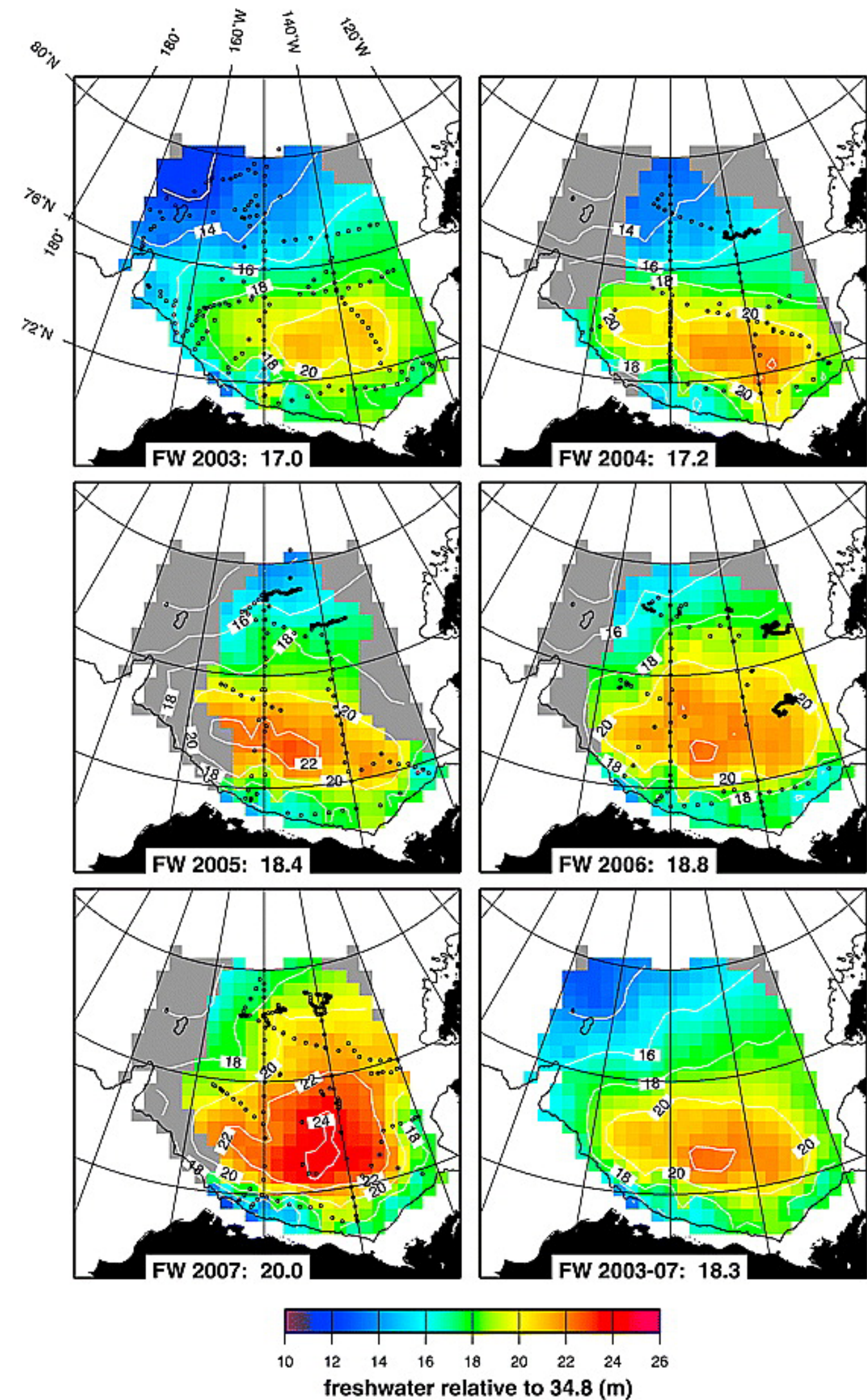


## Changing Arctic Sea Ice Extent

Summer 1979 - 2018



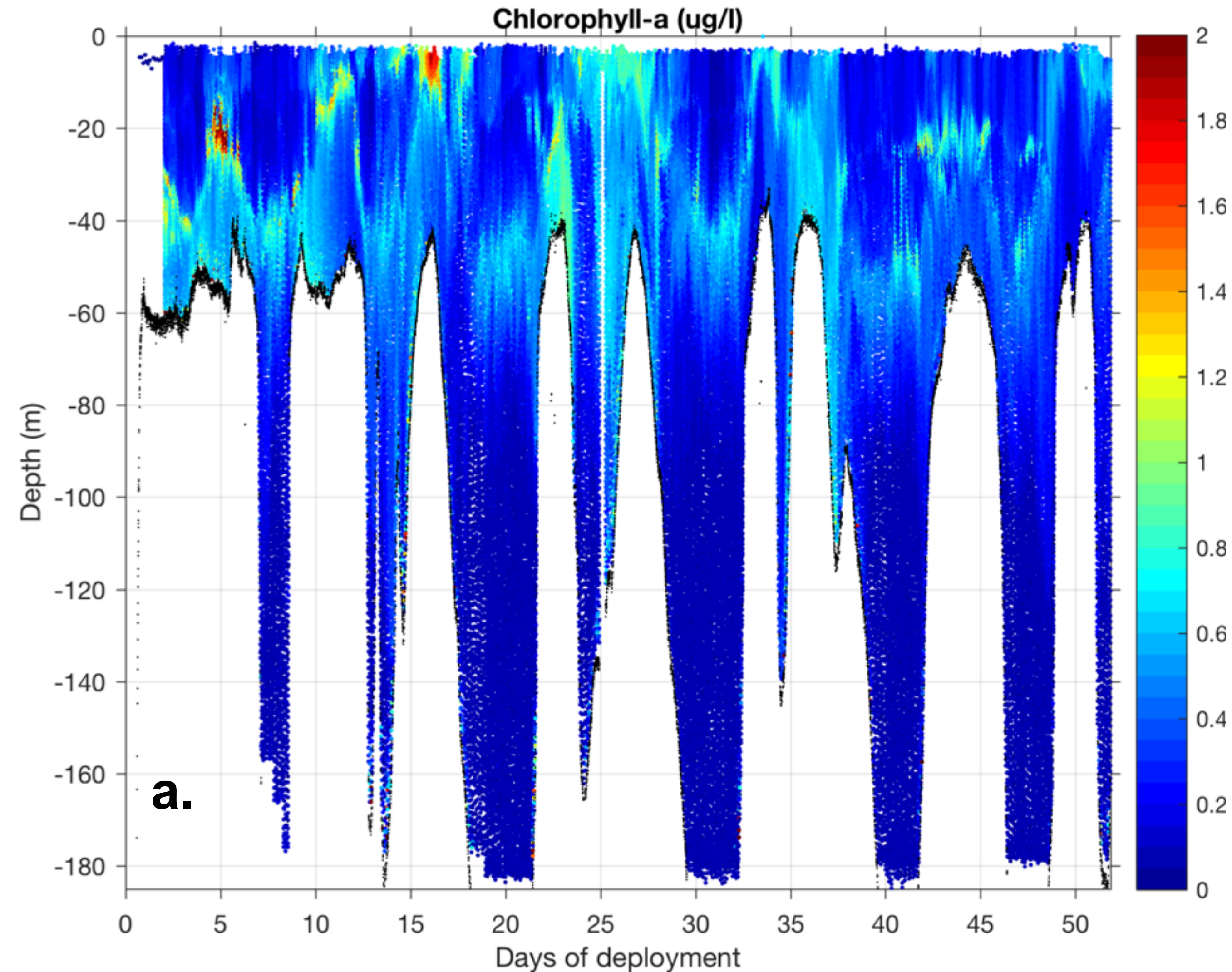
# Continuous Shifting baseline of Arctic Oceanography





# Opportunities for Arctic Ocean Science using gliders

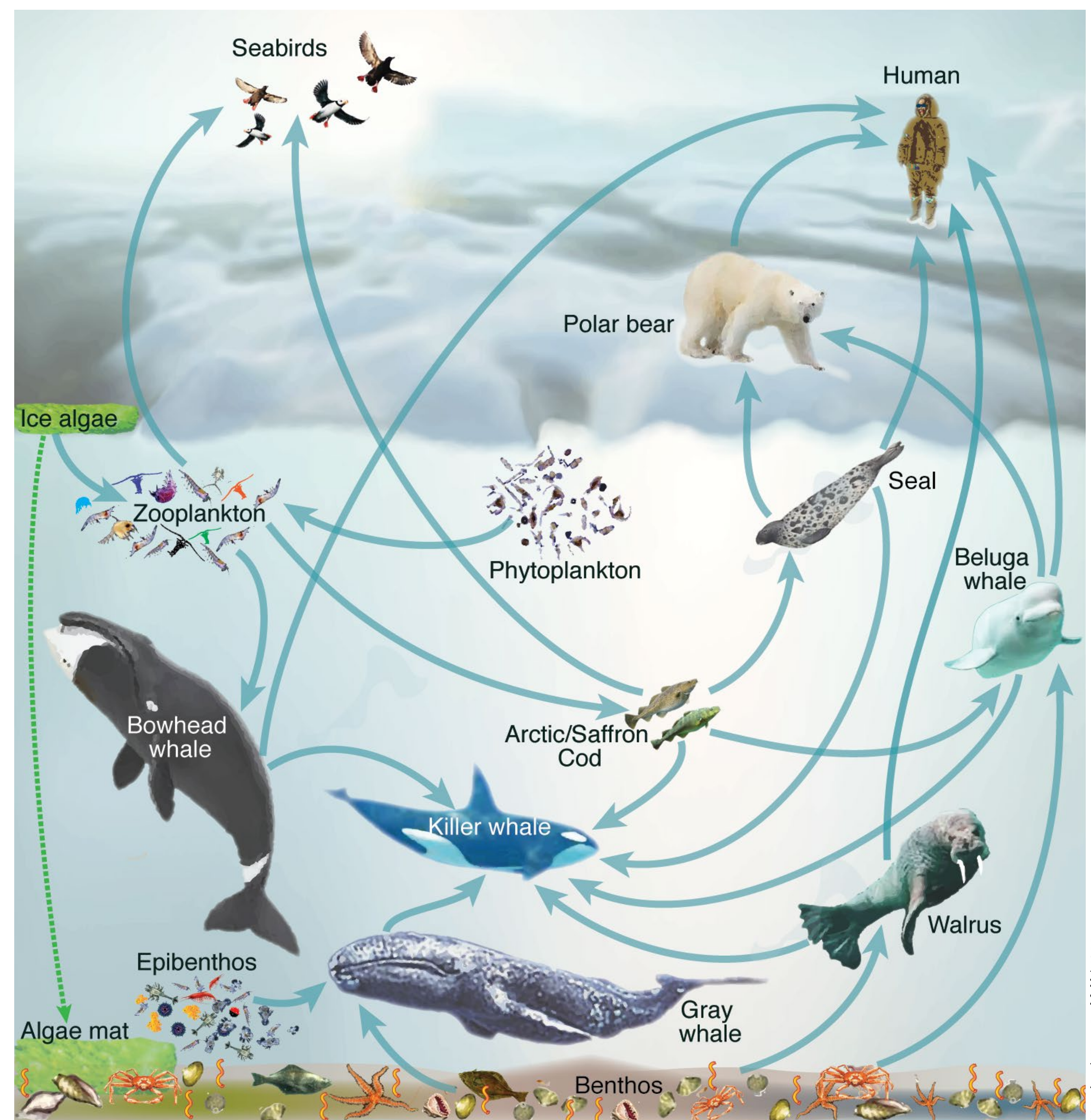
- ◆ Under-sampled ocean, especially when ice covered
- ◆ Rapid environmental and ecosystem changes - constantly shifting baseline
- ◆ Geopolitical focus in the region
- ◆ Environmental monitoring & assessment
- ◆ Serving science needs of indigenous people
- ◆ Education & Outreach opportunity with students & general public
- ◆ Interesting Science & Exciting engineering challenges





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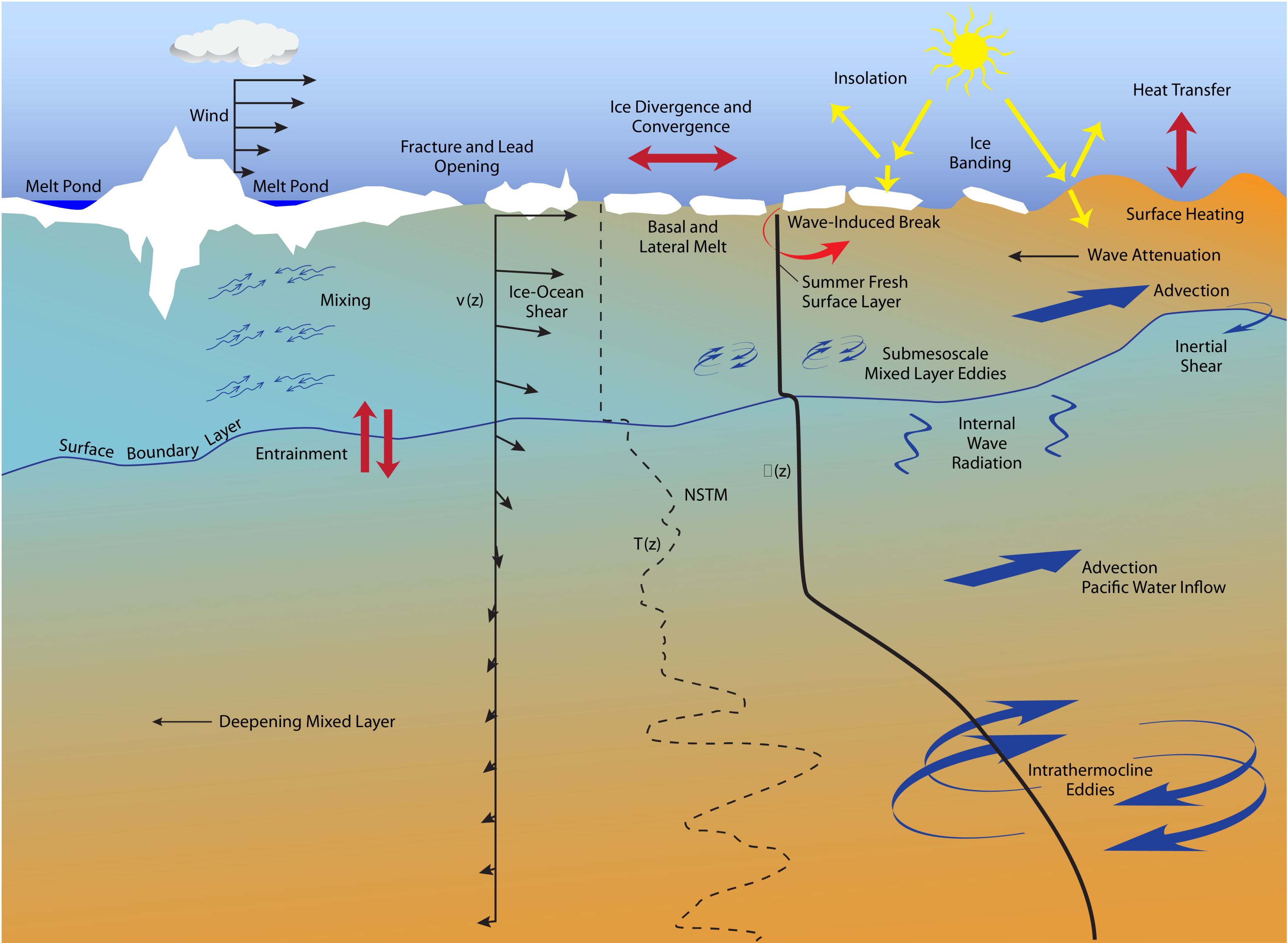
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The dynamic food web of the Pacific Arctic, illustrating complex interactions between trophic levels, from primary productivity to apex predator.

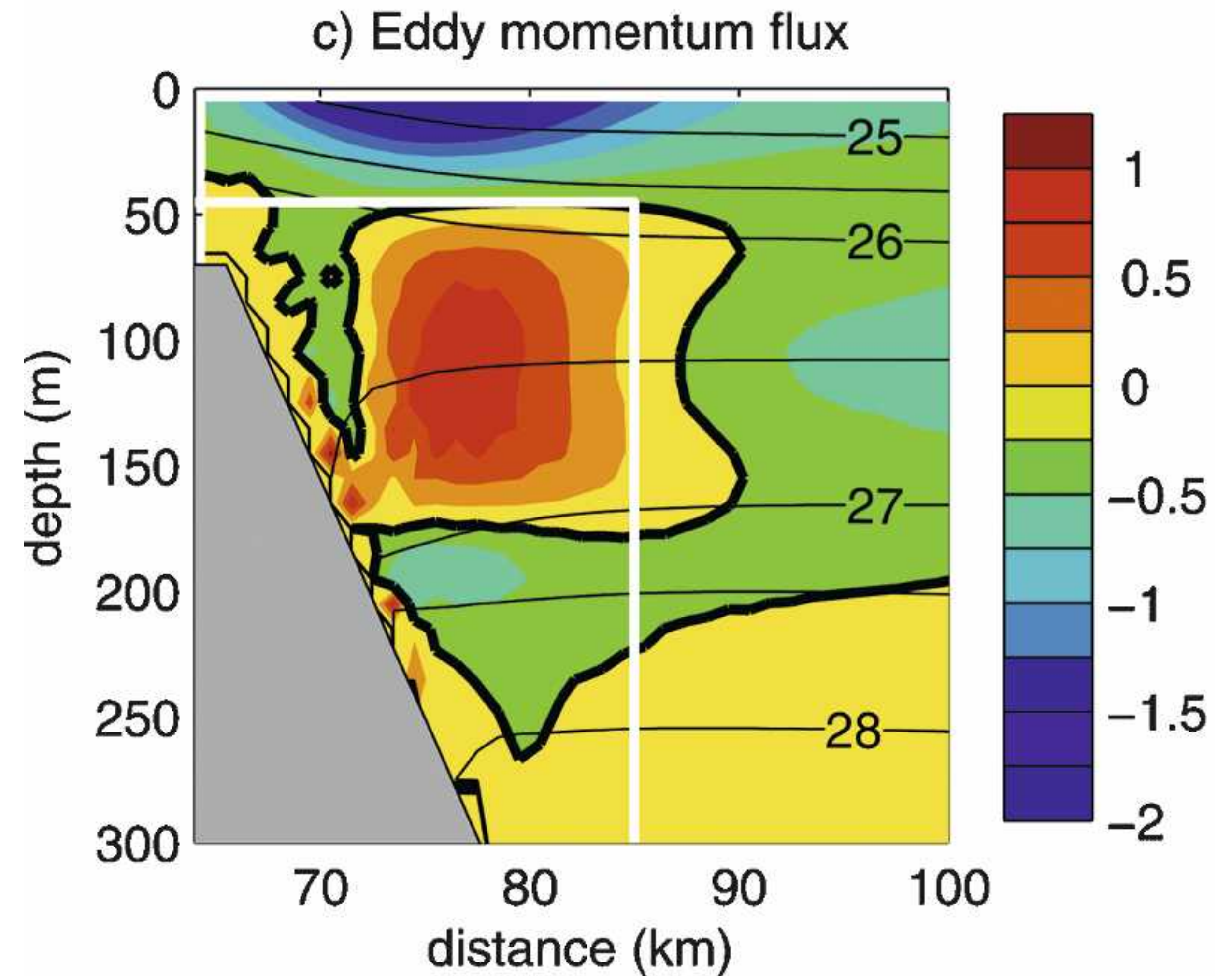
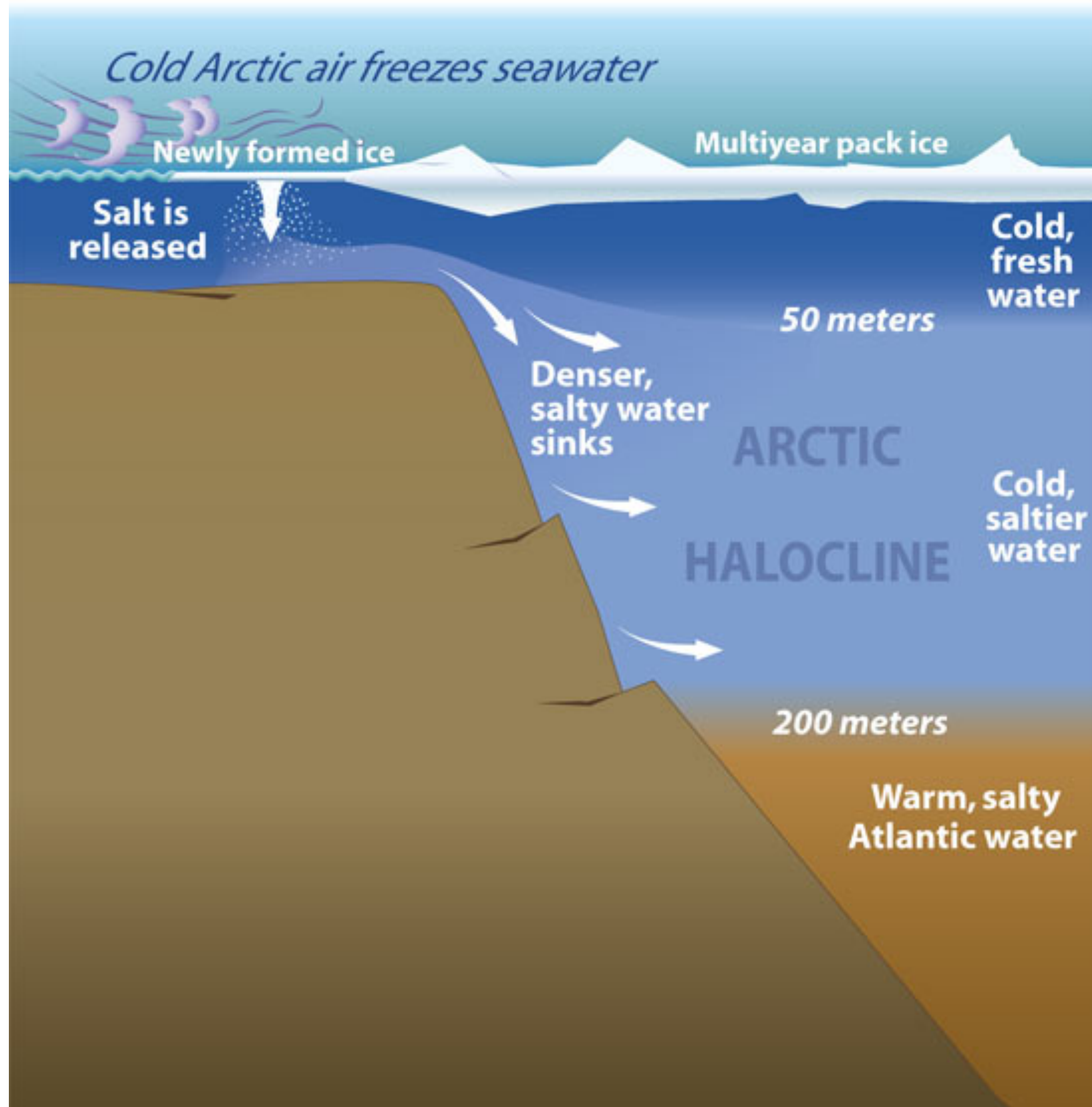


# Relevant Physical Processes in the Arctic Ocean



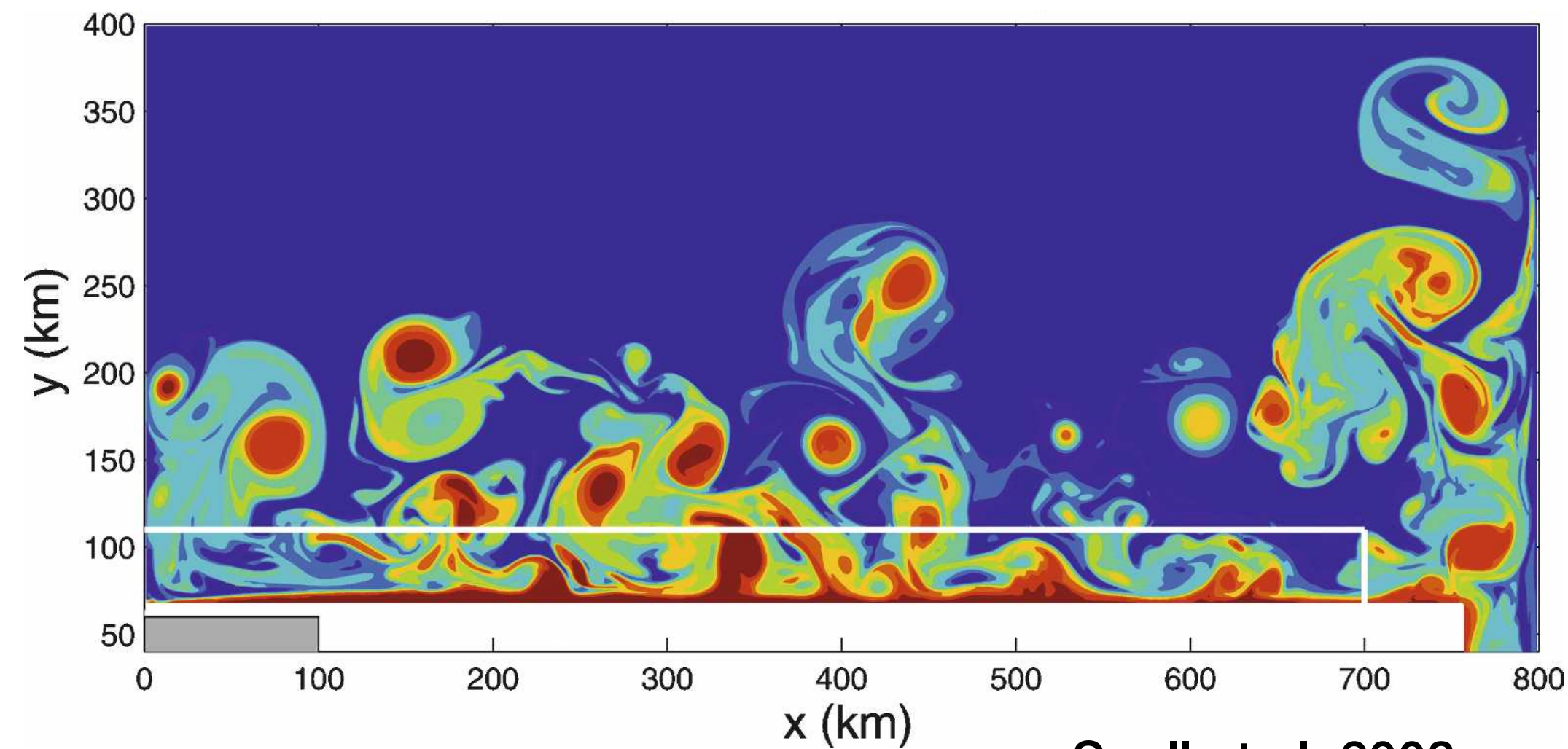


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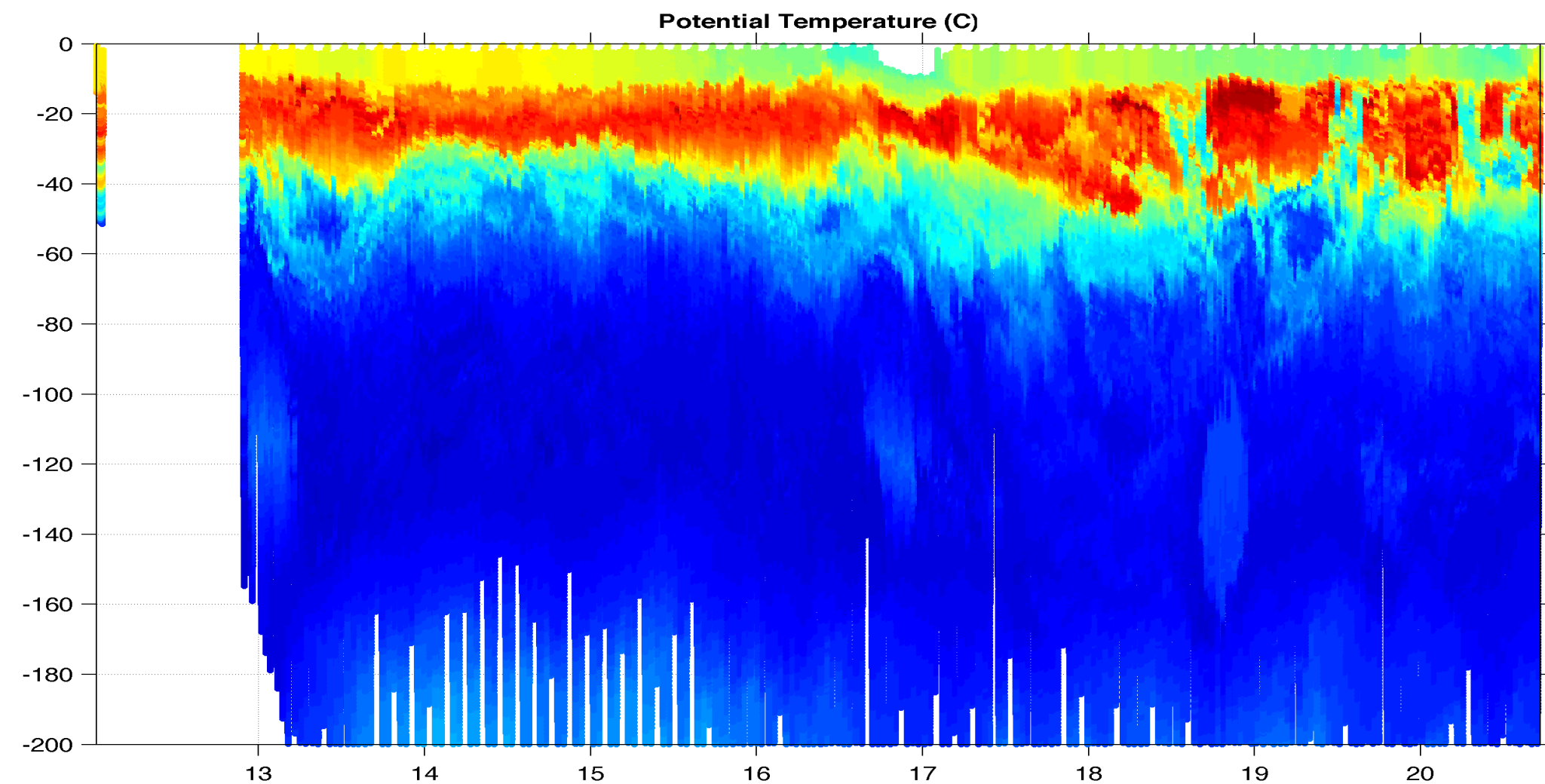




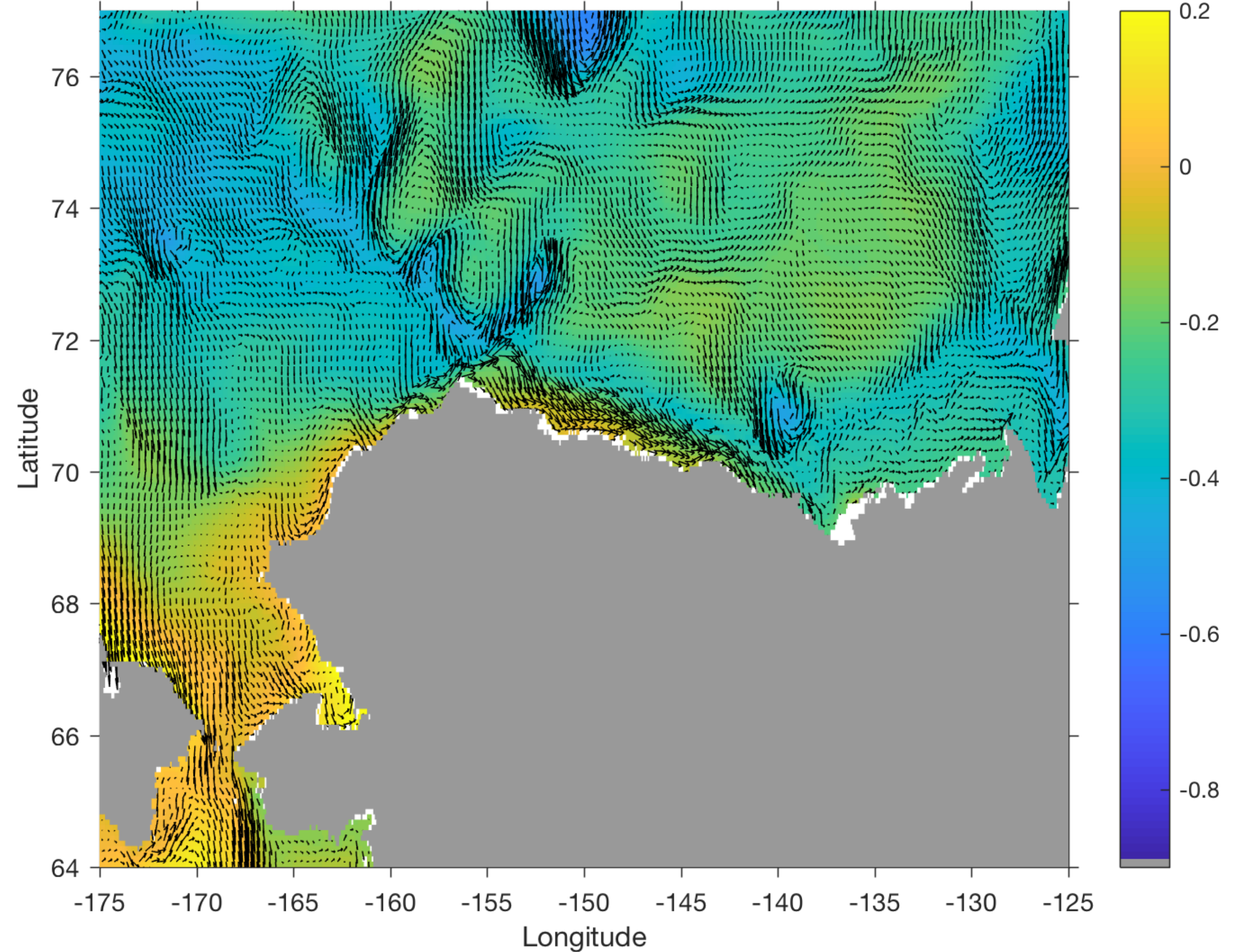
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Spall et al. 2008



**HYCOM SSH & Surf Vel. 2016-08-15 to 2016-08-21**

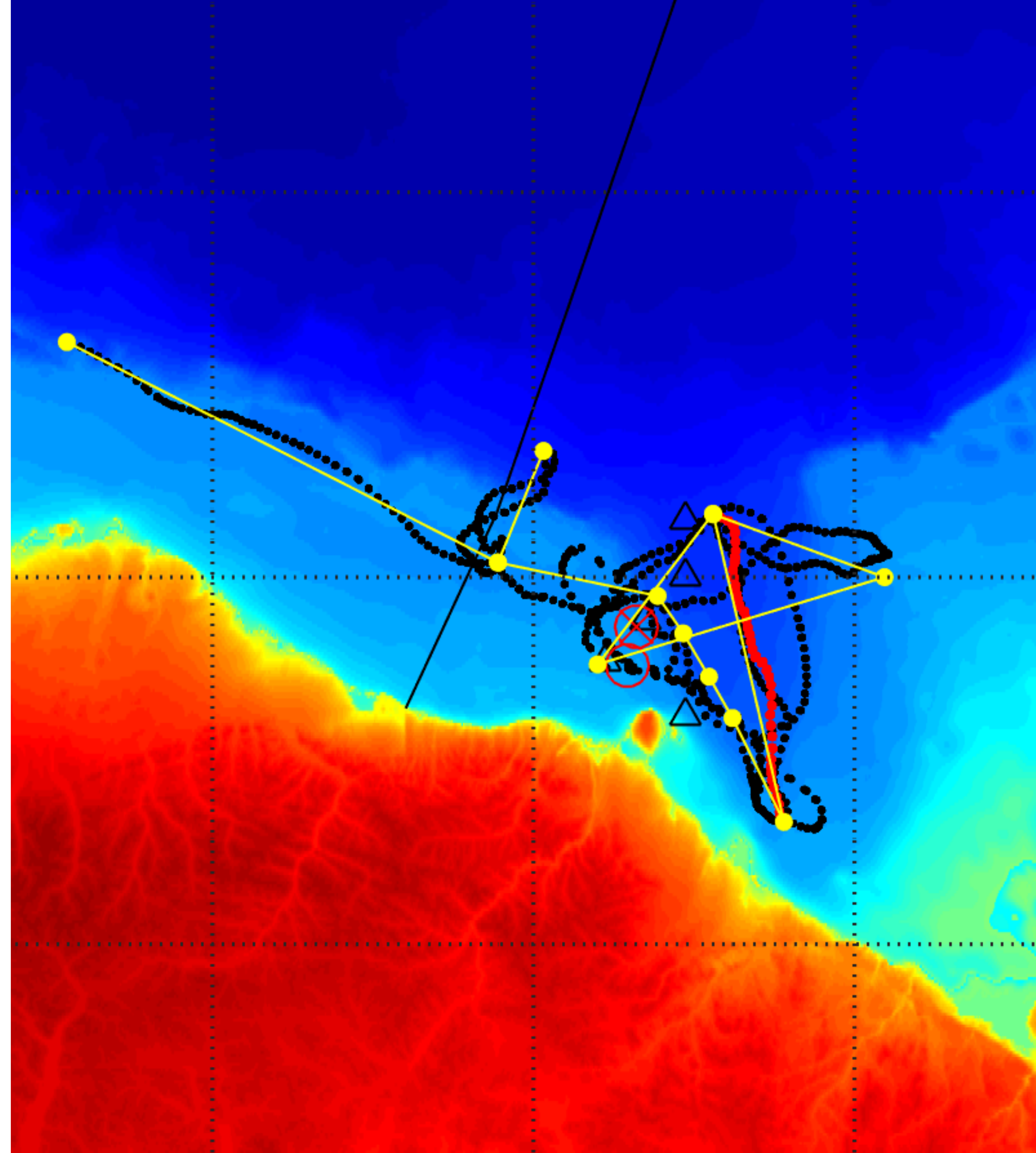




# Major Arctic field campaigns (potentially) involving gliders:

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- **NSF:**
  - Arctic Observing Network
  - Navigating the New Arctic
- **ONR:**
  - Marginal Ice Zone
  - Stratified Ocean Dynamics in the Arctic
  - Autonomous Mobile Observing System
- **BOEM:**
  - Marine Arctic Ecosystem Study
  - Autonomous Carbon Glider
- **NOAA:**
  - Arctic Wave Glider

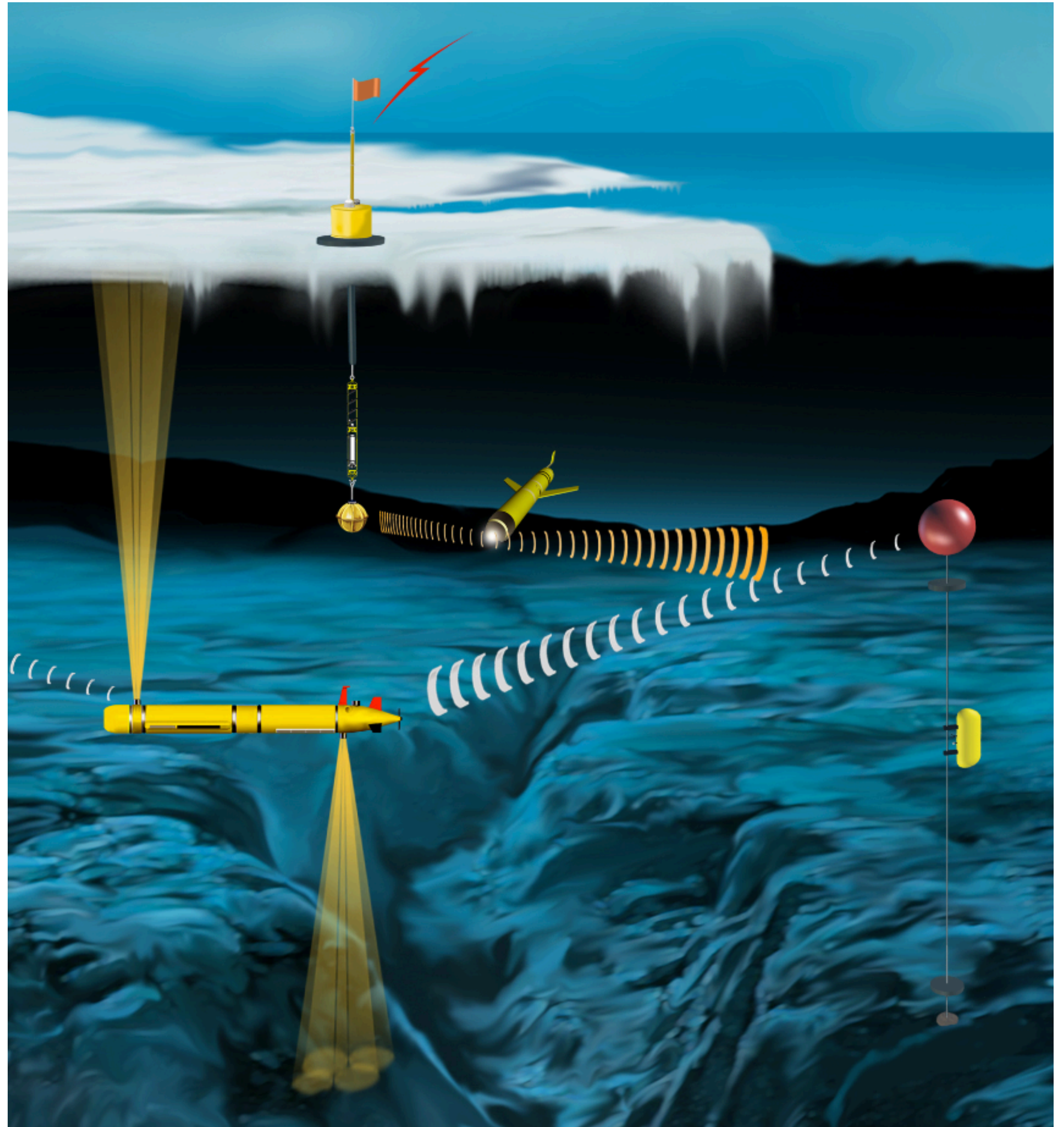




# Operational challenges for operating gliders in the Arctic

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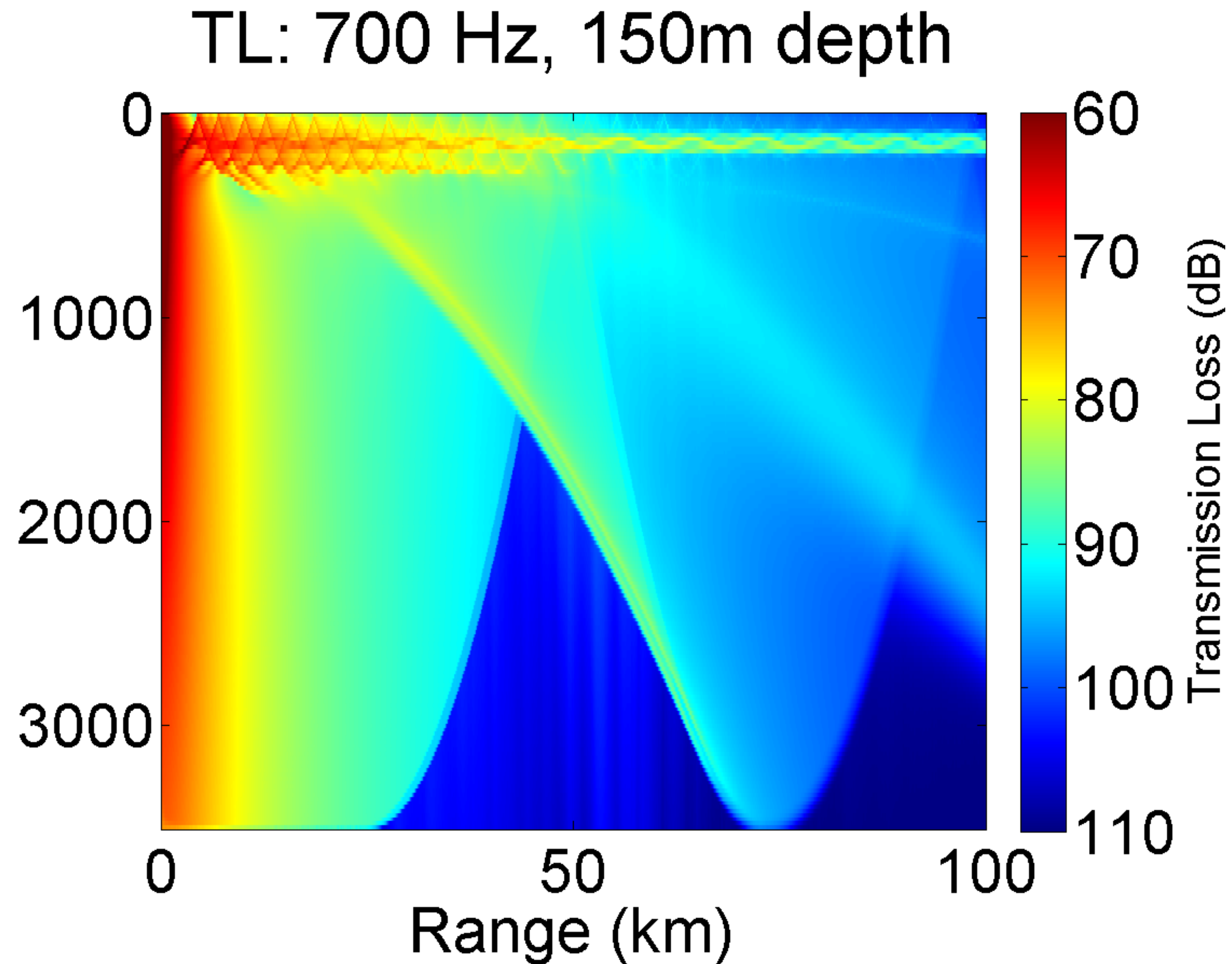
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- ◉ **Under ice navigation & communication**
- ◉ Extreme Stratification
- ◉ Strong boundary/coastal currents
- ◉ Deployment/Recovery Logistics
- ◉ Indigenous Whaling





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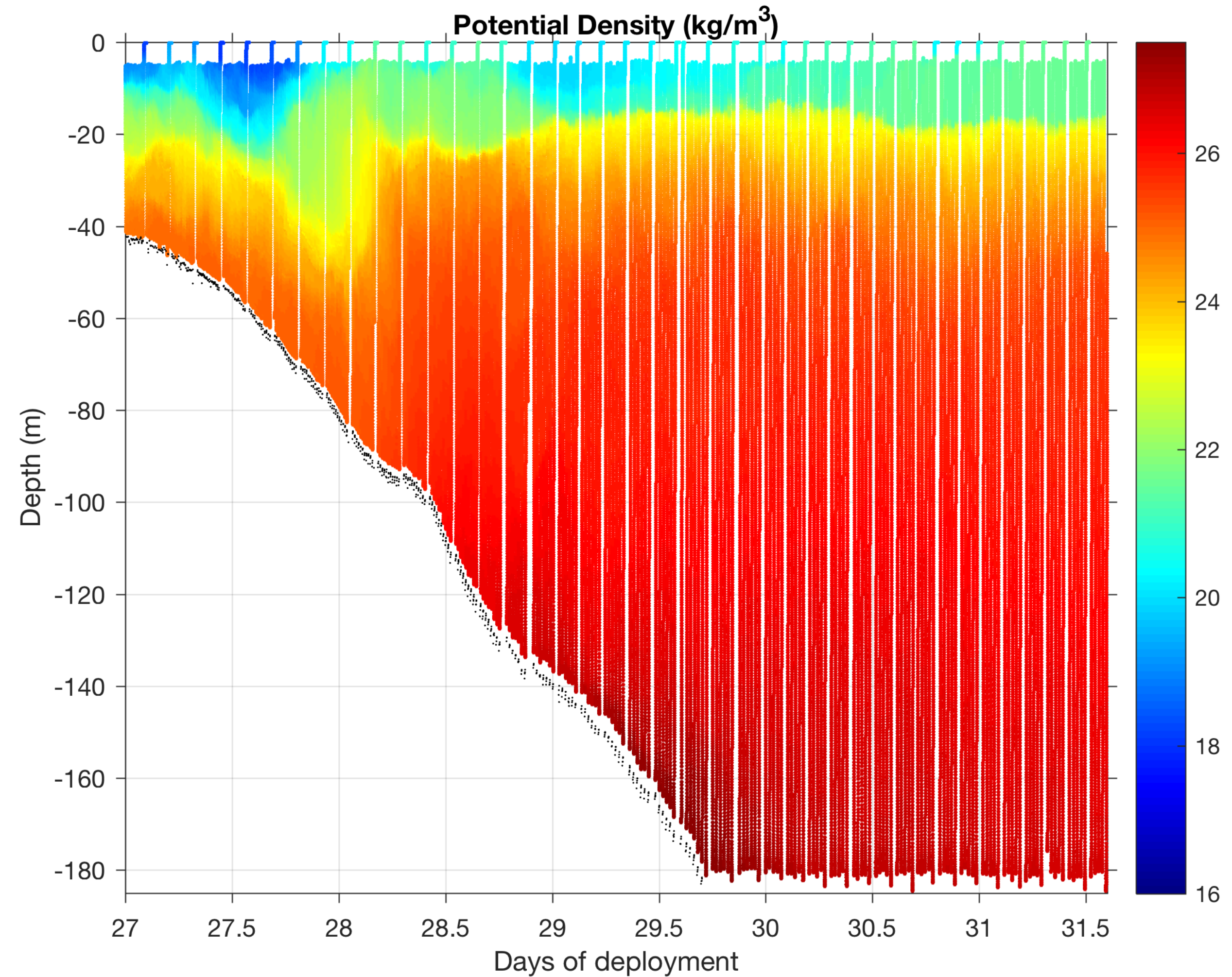
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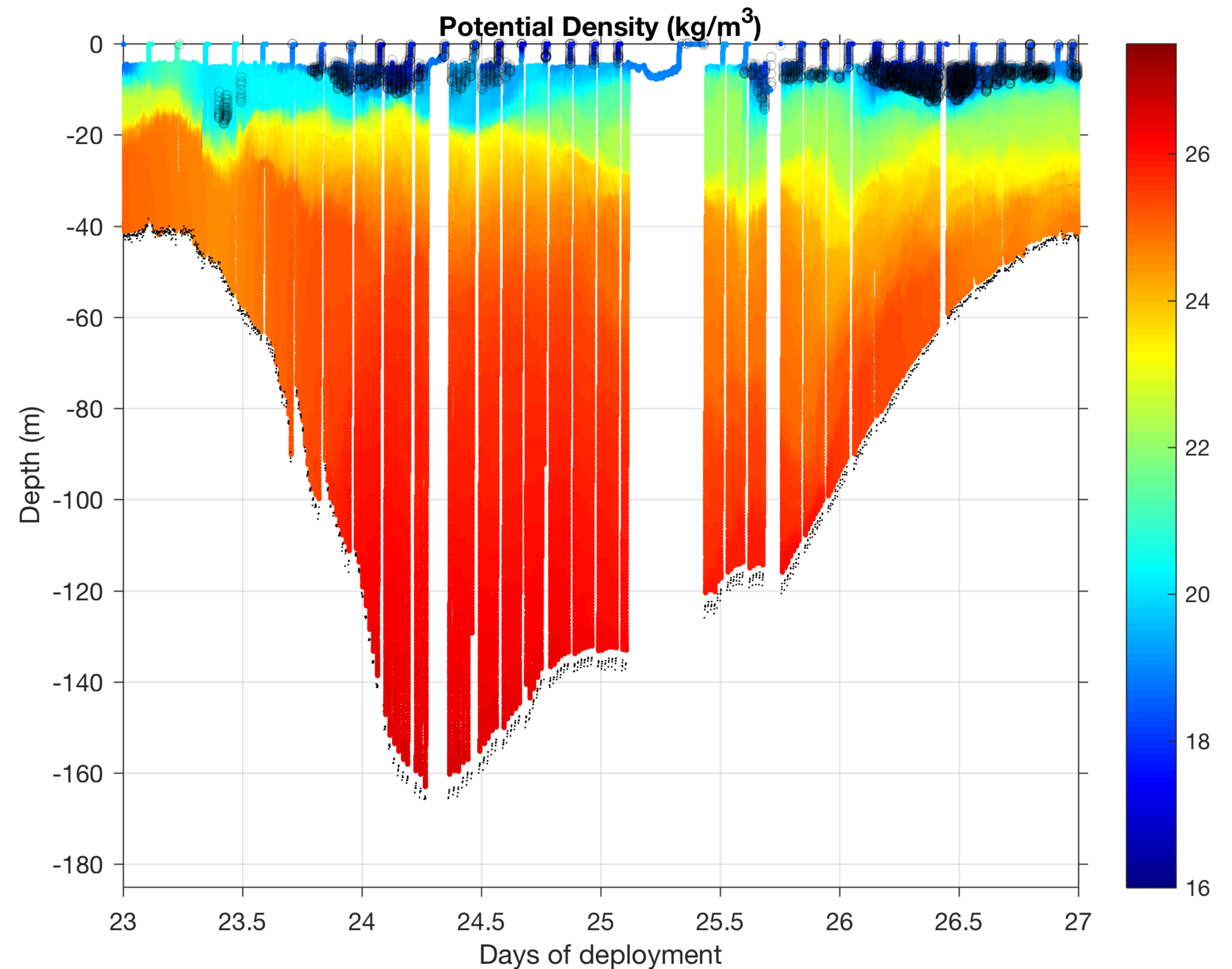
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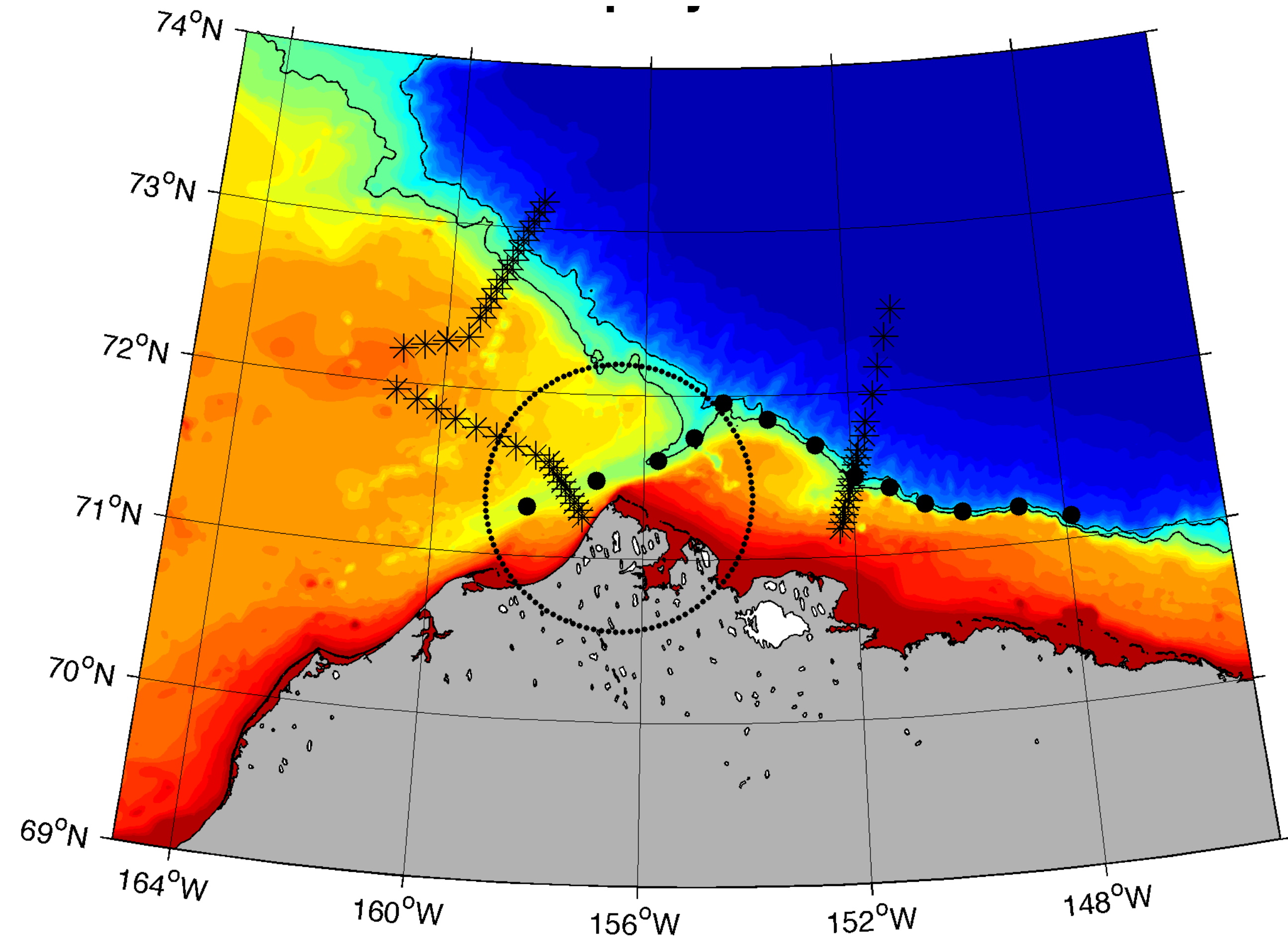
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## Next steps toward improving glider science & operations in the Arctic:

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- More robust platforms that can be deployed and recovered by non-specialized personnel without special equipment.
- Under-ice navigation & communication network for all to use.
- Improve engagement and build trust with local indigenous communities with regards to glider-based science.
- Develop technologies & techniques for year round sampling of shelf-basin exchange in the presence of strong boundary currents & river plumes.