Observations of warm water upwelling in a recurring Beaufort Shelf polynya

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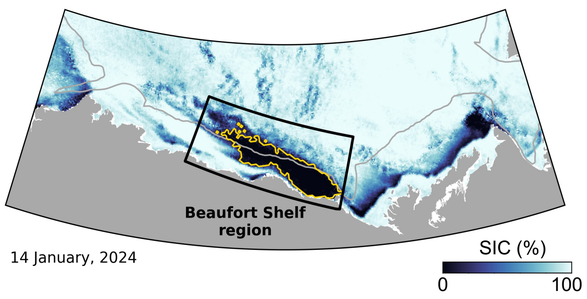
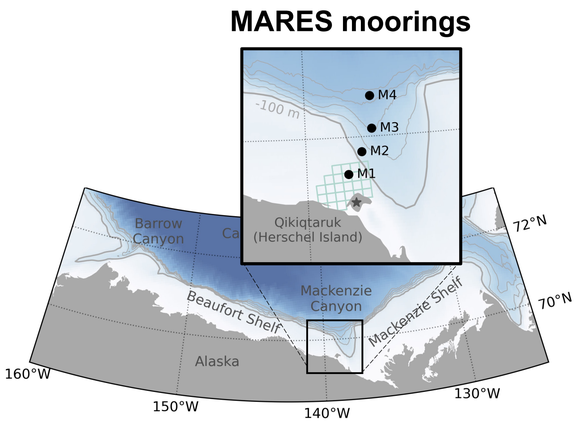
Beaufort Shelf polynyas

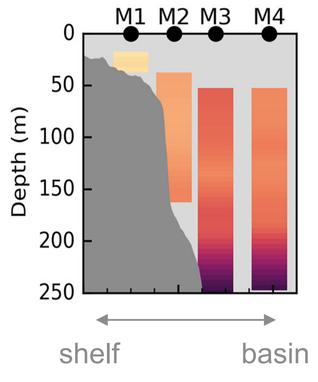
Large Beaufort Shelf polynyas are historically rare in winter [1]

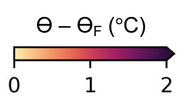
Satellite observations show large polynyas recurring in winters (Dec–Apr) 2003–2025



MARES moorings in winters 2016/17 - 2017/18 show coincident wind-driven upwelling along Mackenzie Canyon's western flank

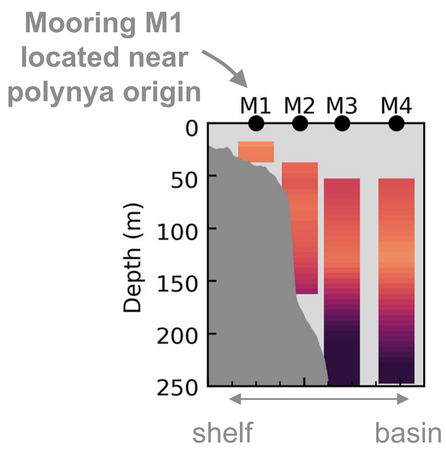


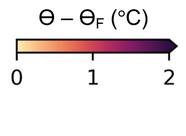




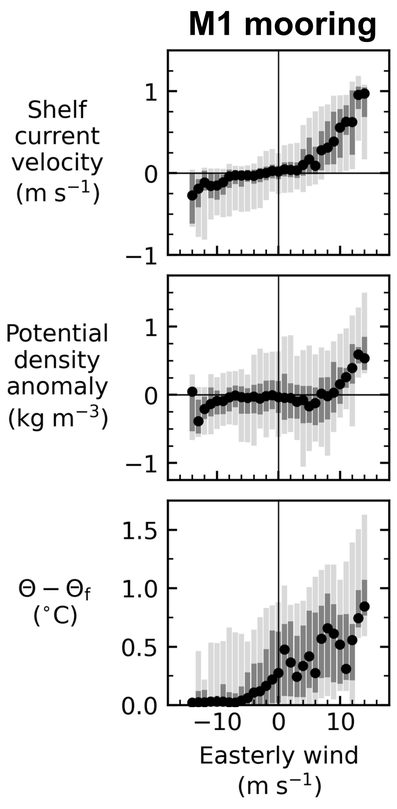
Large heat content in the canyon interior

Thermodynamics: heat transport





- Predominantly Pacific-origin waters are fluxed onto the shelf, elevating temperatures at M1 by up to 1°C above freezing (16 m below surface)

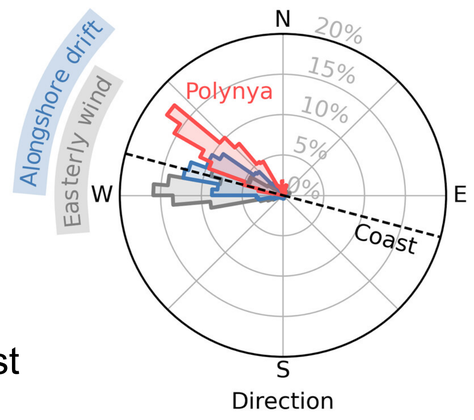


- Shelf current transports heat over the shelf (sensible heat polynya)
- Delivered heat could suppress 10 cm of daily ice growth within the polynya (distributed across 150 km of the shelf)
- Shelf current velocity and heat content both increase with easterly wind forcing

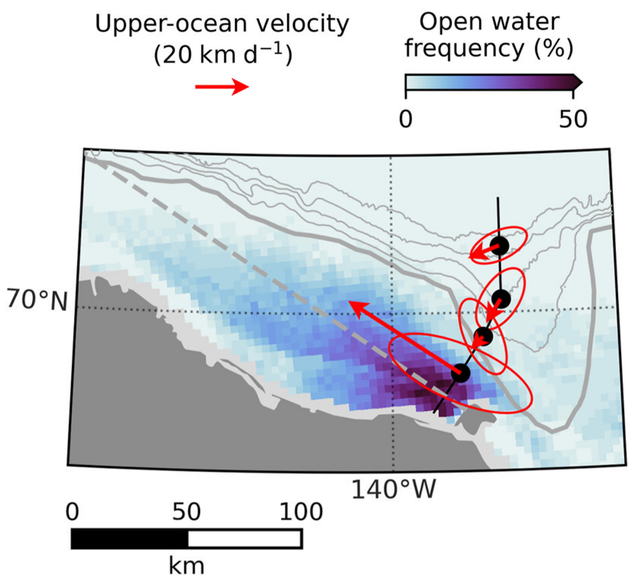
Dynamics: sea ice drift & shelf currents

Satellite observations and reanalysis 2003-2025:

- Large polynyas form under strong (> 7 m/s) easterly winds
- Rapid alongshore ice drift mechanically opens the polynyas leeward of Qikiqtaruk
- Polynyas lengthen along the shelf under persistent forcing (in contrast to purely latent heat polynyas)



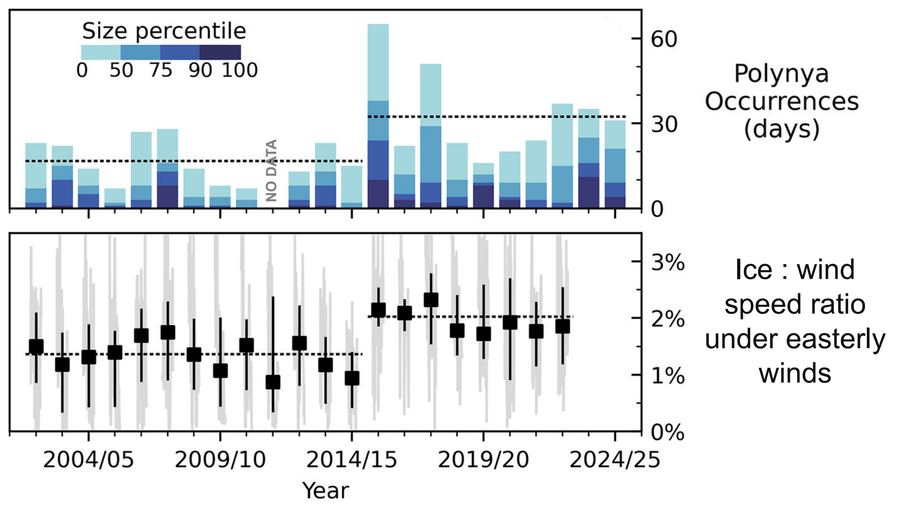
Moored ocean observations 2016-2018:



- Strong shelf current flows along axis of polynya extension
- Enhanced toward-shelf flow observed along the western flank of Mackenzie Canyon

Increasing prevalence in a more mobile sea ice cover?

- Sea ice cover modulates shelf current and upwelling [2,3]
- Increased polynya presence in the last decade (32 days yr^{-1} average compared to 17 day yr^{-1} prior to winter 2015/16)
- Coincident increase in ice mobility under easterly winds (which show no significant trends in frequency or strength)



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JGR Oceans https://doi.org/10.1029/2025JC023568
Wind Forcing and Warm Water Upwelling in a Recurring Beaufort Shelf Polynya
Jewell et al. (2026)

*All figures adapted from Jewell et al. (2026)

DATA PRODUCTS

University of Bremen ASI SIC (Spreen et al., 2008)
MARES mooring data (Weise et al., 2019)
ECMWF ERA5 Atmospheric Reanalysis (Hersbach et al., 2023)
NSIDC Polar Pathfinder Sea Ice Motion V4 (Tschudi et al., 2019)

REFERENCES

[1] Stirling & Cleator, Canadian Wildlife Service, 1981;45:73
[2] Lin et al. Progress in Oceanography, 2020;187:102396
[3] Schulze & Pickart, JGR: Oceans, 2012;117:C06022

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