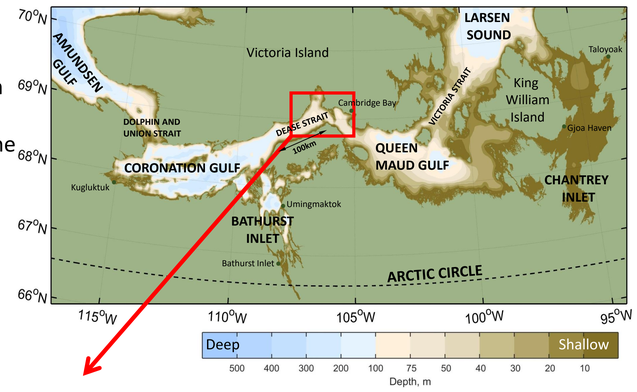
Tidal Mixing within Dease Strait in the southern Canadian Arctic Archipelago

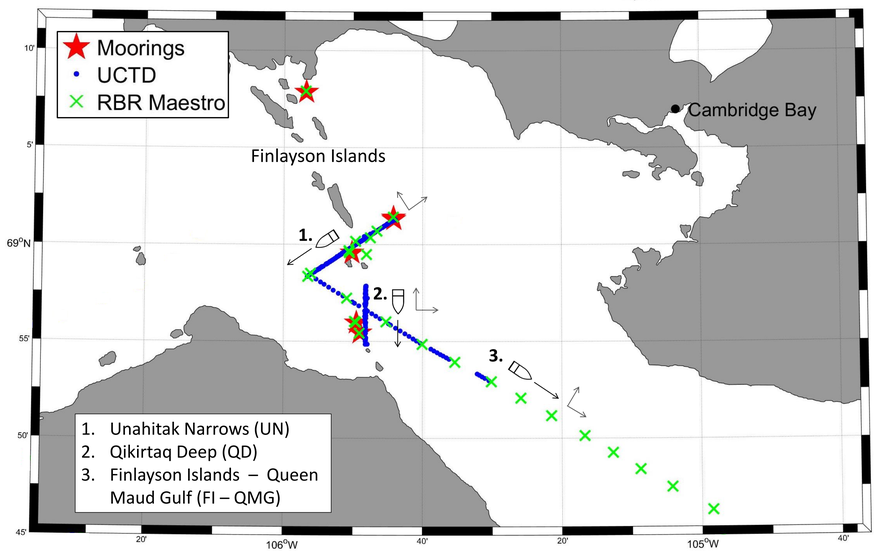
Lina M. Rotermund[1], W. J. Williams[2], K. A. Brown[2], S. L. Danielson[3], E. C. Carmack[2], B. A. Bluhm[4], J. M. Klymak[1]

1 - University of Victoria, 2 – Fisheries and Oceans Canada, 3 - University of Alaska Fairbanks, 4 - University of Tromsø

Introduction

The Kitikmeot Sea in the southern Canadian Arctic Archipelago (CAA) is the heart of the North West Passage. Dease Strait connects Coronation Gulf & Queen Maud Gulf and narrows at the Finlayson Islands near Cambridge Bay.





The Kitikmeot Sea is atypical in comparison to the surrounding CAA:

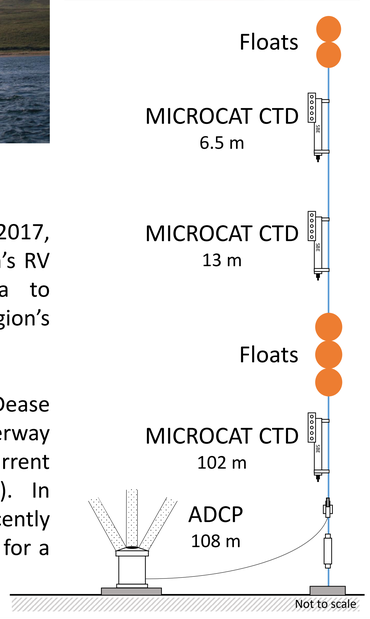
- The gulfs receive large amounts of fresh-water from mainland watersheds.
- Shallow-silled straits that connect the region to the CAA restrict inflow of salty nutrient-rich water, hence limit new primary production.
- The stratification in summer between the surface freshwater and bottom salty water suppresses upward mixing of dissolved nutrients, further limiting primary production.

Fast tidal flows in narrow straits can enhance vertical mixing, which should result in higher surface nutrient input and elevated biological productivity near the straits. Early spring ice-melt in many of these straits is evidence of enhanced vertical mixing bringing subsurface heat to the surface. So, we look to the narrow channels in the Kitikmeot Sea as possible biological hotspots within this region of low biological production.

Methods

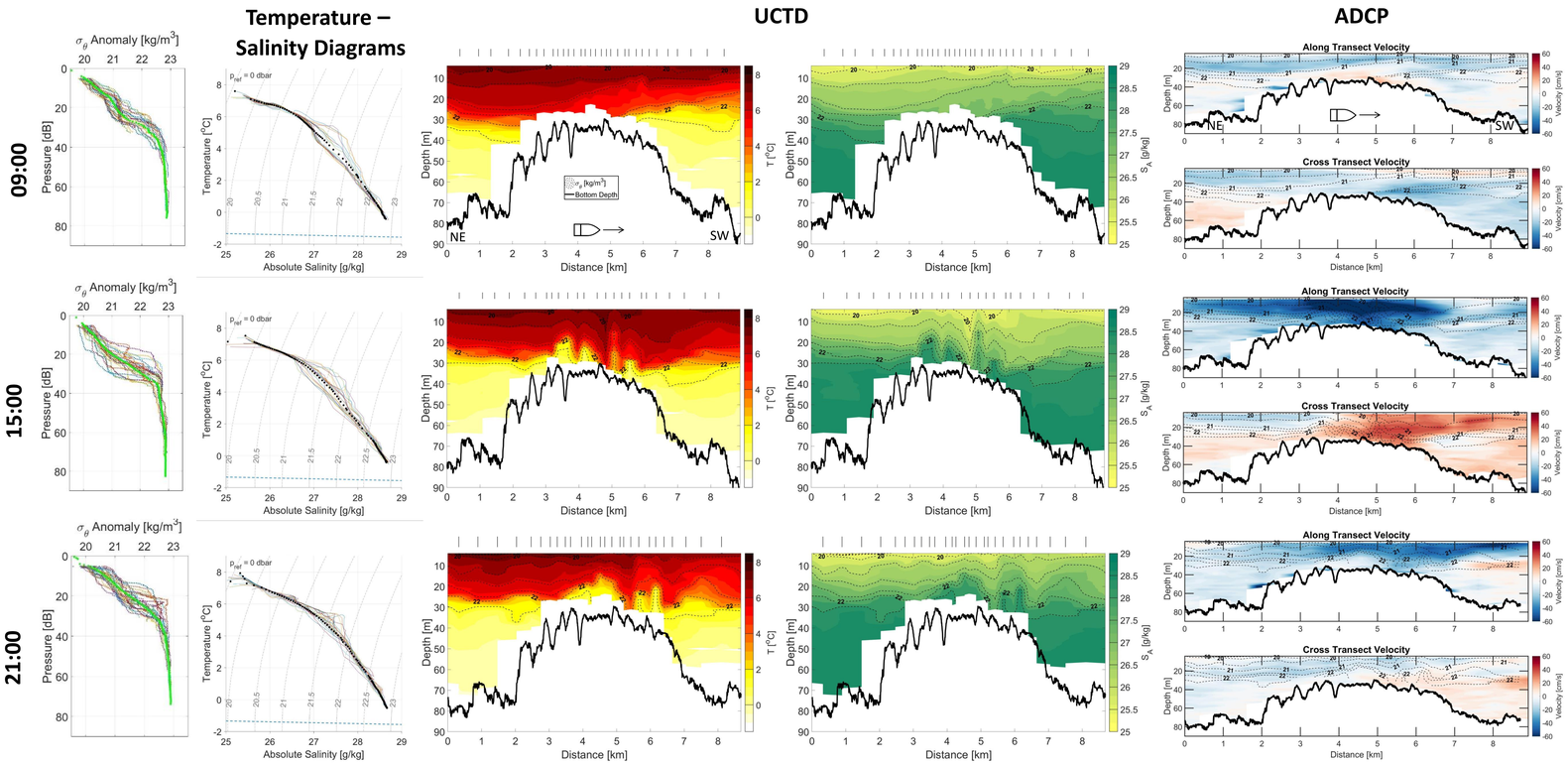
During the summers of 2015, 2016 and 2017, researchers aboard the Arctic Research Foundation's RV Martin Bergmann explored the Kitikmeot Sea to determine the ecological importance of the region's narrow straits.

To assess water column structure and mixing in Dease Strait at the Finlayson Islands, we conducted Underway CTD (UCTD) and shipboard Acoustic Doppler Current Profiler (ADCP) transects over a tidal cycle (~24 h). In addition, seasonal variation is assessed using recently recovered moored instruments, which were in-situ for a year from 2016 to 2017.

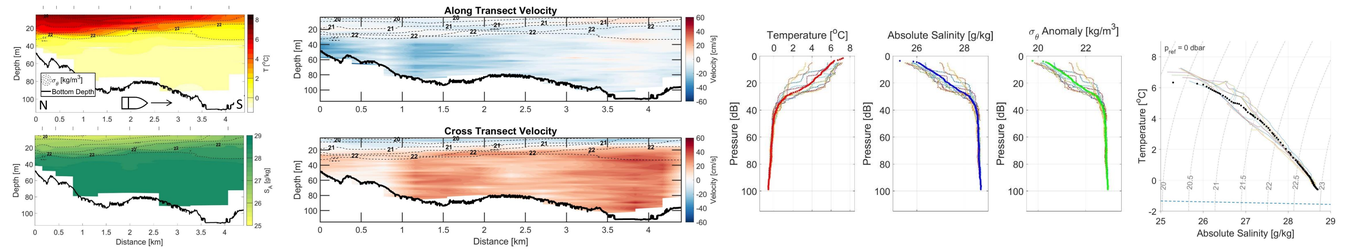


Summer tidal flow through Dease Strait at the Finlayson Islands: progression of salinity, temperature and currents.

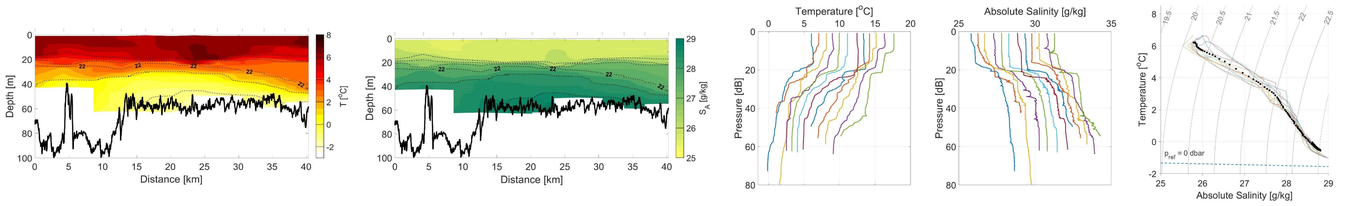
1. Unahitak Narrows Transect



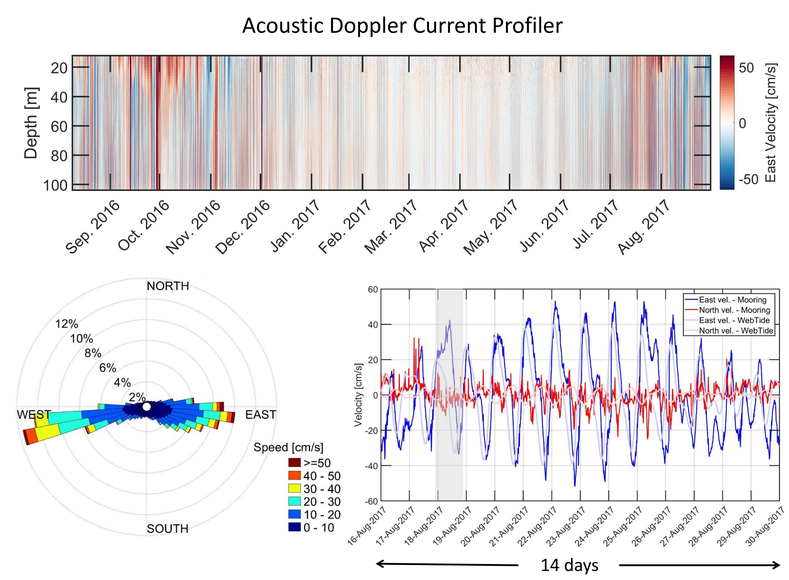
2. Qikirtaq Deep Transect

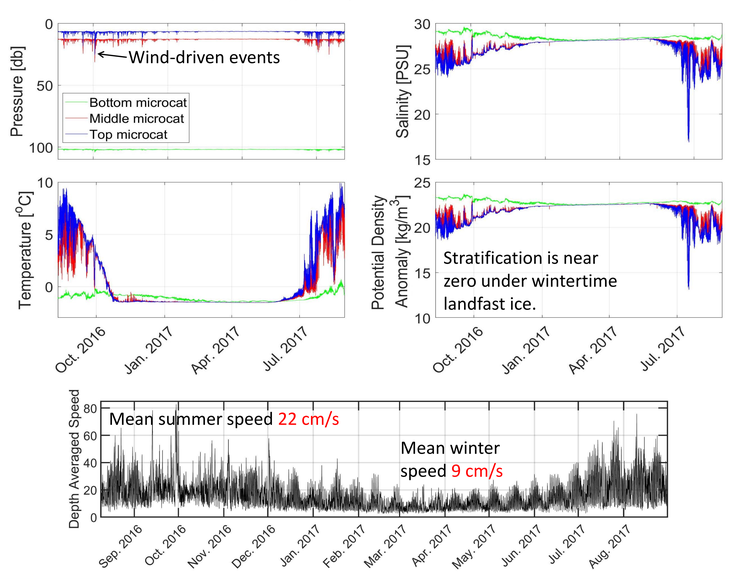


3. FI – QMG Transect



Seasonal cycle from moored instruments in Qikirtaq Deep.





Conclusions

We observed large excursions in isopycnals over the sill of Unahitak Narrows during a tidal cycle, indicative of hydraulic jumps or topographically-induced internal wave breaking. In addition, strong shear flows were measured at both Unahitak Narrows and Qikirtaq Deep, which may also result in vertical mixing and drive the late spring polynya and biological hotspot.

The year-long mooring in Qikirtaq Deep shows tidally dominated flow in east-west direction, diurnal, semidiurnal and spring/neap tides, and wind-driven events during the ice-free season. Tidal current speed decreases by half during winter months and the strong stratification of summer drops to near zero.

University of Victoria

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Polar Knowledge Canada | Savoir polaire Canada

References

- Varela, D. E., D. W. Crawford, I. A. Wrohan, S. N. Wyatt, and E. C. Carmack (2013), J. Geophys. Res. Oceans, 118.
- Dunphy, M., F. Dupont, C. G. Hannah, D. Greenberg (2005), Can. Tech. Rep. Hydrogr. Ocean Sci. 243: vi + 70 pp.
- Hannah, C.G., F. Dupont, A.K. Collins, M. Dunphy and D. Greenberg (2008), Can. Tech. Rep. Hydrogr. Ocean Sci. 259: vi + 62 pp.