# Evolution of a "Poleward Undercurrent" over the Continental Slope of Arctic Alaska

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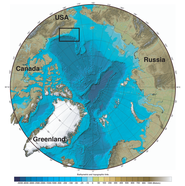



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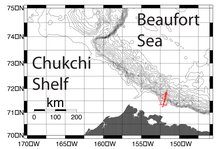
## Study Area and Methods:



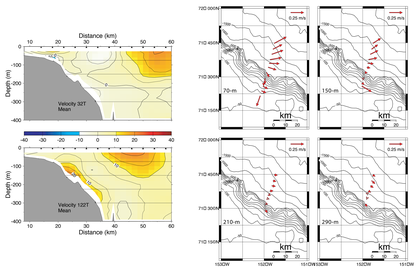

The USCGC Healy contains a hull-mounted 75 kHz Ocean Surveyor (OS75) acoustic Doppler current profiler manufactured by RD Instruments, Inc. The phased-array is mounted in its own well and is separated from the water by an acoustically transparent window. Trimble Inc. Centurio P-code and Ashtech Inc. attitude global positioning systems provide U.S. military-grade navigational and heading information to transform single ping data from beam to averaged earth referenced velocity estimates.

## USCGC Healy, summer 2003:


*We greatfully acknowledge professional, cheerful, and most dedicated support from officers and crew of the USCGC Healy commanded by CAPT. Daniel Oliver.*

## Introduction:

Our perception of the Arctic Ocean circulation presently undergoes major revisions as traditional water mass analyses become augmented with direct velocity observations fro moored current meters (Woodgate et al., 2001), drifting buoys (Plueddemann et al., 1997), and ship-mounted ADCP surveys (Gawarkiewicz and Plueddemann, 1995; Münchow et al., 2000).




Two-Week Mean Flow Sept./Oct.-2003 from 75-kHz ADCP surveys

We surveyed a single section across the outer Beaufort Sea from the 40-m to the 2000-m isobath repeatedly for about 16 days from Sept. 24. (Hour-294) through Oct.-09 (Hour-672). with ~20 ADCP and 5 hydrographic CTD sections. A typical ADCP-only section with <1-km horizontal resolution took generally less than 3 hours,

## Winds Oct.-2003: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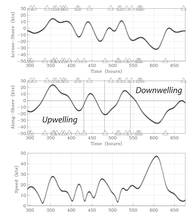
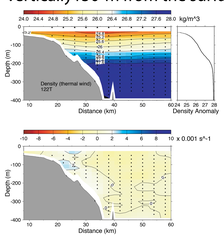



Two flow features emerge that advect mass in the downstream, that is, south-eastward direction (Kelvin wave propagation); their combined volume flux is ~0.76 Sv (10^6 m^3/s). We find

(a) a subsurface slope current between the 100-m and 300-m isobath (0.13 Sv), and
(b) a surface intensified jet (0.63 Sv) in the same direction seaward of the 500-m isobath.

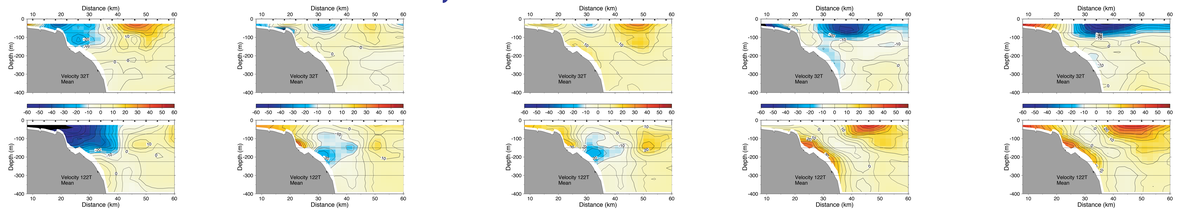
The subsurface current is ~10-km wide and extends vertically 75-m from the bottom. The surface jet is ~20-km wide and extends vertically150-m from the surface.



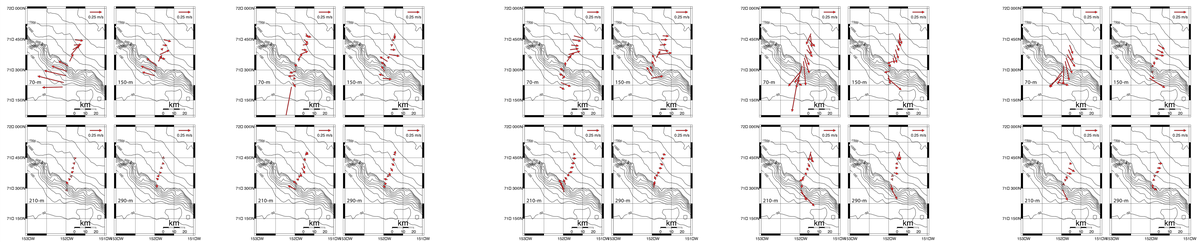

If these flows are in geostrophic thermal wind balance, then they require a density field

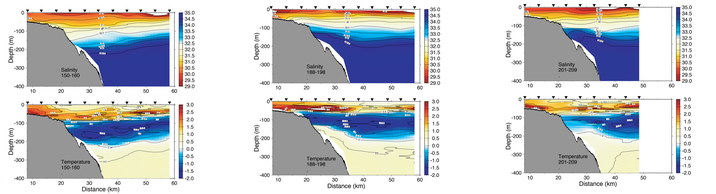
$$\rho(x,z) = \rho(x_0,z)\cdot\exp\left(\frac{f}{g}\int_{x_m}^{x}\frac{\partial v}{\partial z}dx\right)$$

calculated from an integral of the vertical current shear relative to an offshore vertical density profile.




Two Aleutian low-pressure systems resulted in sustained upwelling favorable (easterly) winds reaching 50 kts. The shelf circulation responded within an inertial period to this forcing with a barotropic current exceeding 0.5 m/s. Most dramatic, however, was the slower evolution of a bottom-intensified 0.3 m/s strong, 15-km wide, eastward flow along the slope that opposed the local winds. Its seaward extent coincided with the inshore edge of a surface-intensified jet. Substantial across-slope flows also occured; but, it is difficult to define an across-slope direction in the presence of a rugged bottom.




## Conclusions:

Volume fluxes of 10-km wide bottom intensified slope current (Beaufort Undercurrent?) are ~0.1-0.3 Sv while those of a 20-km wide surface jet (Beaufort Gyre?) reach ~1.0 Sv.

Rossby numbers of both bottom- and surface intensified flows were ~0.4 suggesting that nonlinear inertial terms contribute to the dynamics in addition to topographic beta-effects.

*This study was funded by the National Science Foundation and the Office of Naval Research in support of the Shelf-Basin Interaction (SBI) initiative.*