BEST BSIERP Bering Sea Project

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Poleward Thermohaline Circulation on the Southeast Bering Sea Shelf

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Figure 1. Rugged RDI Citadel CTD attached to trawl net headrope

Introduction

- Instrumented NOAA Fisheries Bottom Trawl Survey fishing nets with CTDs on trawl headropes
- Over 300 stations each summer of 2008-2010 covering southeastern Bering Sea shelf
- First 3D measurements of temperature, salinity and water density on a large-scale, closely spaced (37 km) grid in this region
- Density measurements enable dynamic height calculation and computation of the thermohaline circulation
- Gridded observations are valuable for model comparisons

Figure 2. Over the upper 50 m, the dynamic height difference reveals the geostrophic, thermohaline circulation on the continental shelf. These contours are streamlines, and the black arrows show the geostrophic velocity at the surface. White arrows show the net poleward transport across sections S1-S4. There is strong poleward flow just seaward of the 100-m isobath north of the Pribilof Islands, strong clockwise circulation west of St. Matthew Island in 2008, and recirculation north of the island in 2010.

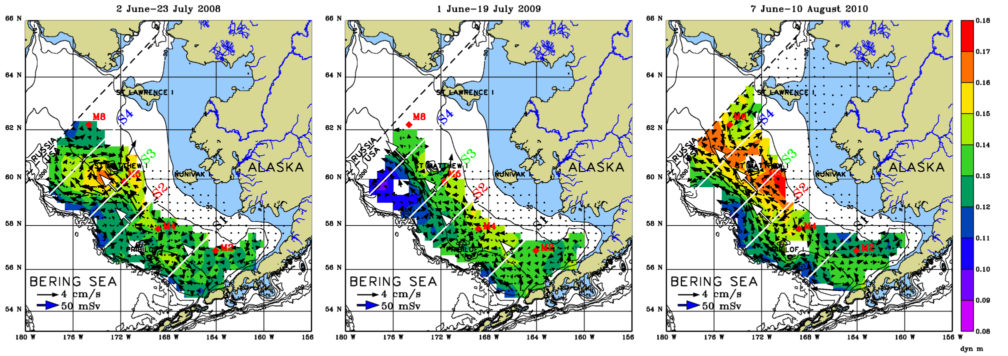


Figure 3. Salinity dominates temperature in their relative contributions to the vertical density gradient over much of the region, as shown by the negative Turner Angle, T_u. The strong clockwise circulation west of St. Matthew I. in 2008 owes its existence to a pool of fresher water there, probably due to sea-ice melt. Recirculation north of St. Matthew I. in 2010 is due to warmer water there. The Turner Angle, T_u, is a measure of the relative contributions of temperature and salinity to the vertical density gradient. For $90° \geq T_u \geq 0°$, temperature dominates salinity. For $0° \geq T_u \geq -90°$ salinity dominates temperature.

$$T_u = \tan^{-1}\left(-\alpha \frac{dT}{dz} \Big/ \beta \frac{dS}{dz}\right) - 45° \text{ where } \frac{d\rho}{dz} = \rho\left(\beta \frac{dS}{dz} - \alpha \frac{dT}{dz}\right),$$

ρ = density, S = salinity, T = temperature, β = haline contraction coefficient, α = thermal expansion coefficient.

Advantage: $-90° \leq T_u \leq 90°$ whereas $-\infty \leq \left(-\alpha \frac{dT}{dz} \Big/ \beta \frac{dS}{dz}\right) \leq \infty$

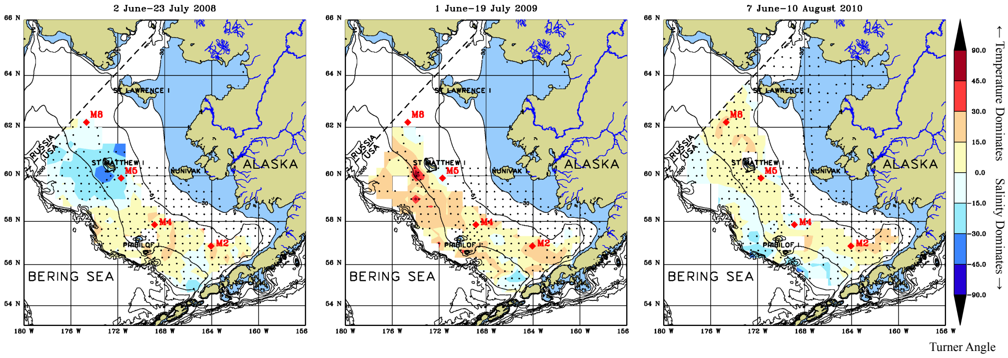
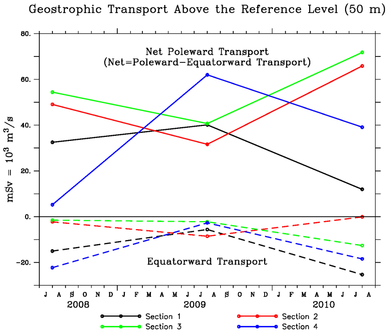


Figure 4. The net poleward, thermohaline transport in the upper 50 m varies between 12 and 72 mSv depending upon year and section. Transport is conserved between streamlines, i.e. dynamic height contours, but they enter and leave the sections; therefore transport between sections is not conserved.



Conclusions

- Organized thermohaline flow exists all 3 years
- Strong poleward flow is present just seaward of the 100-m isobath, north of the Pribilof Islands
- $12 \leq$ Poleward transport ≤ 72 mSv over 0-50 m
- Cross-shelf flow
  - Bending 100-m isobath produces a cross-shelf component
  - Fresher water pool produces clockwise circulation west of St. Matthew Island in 2008
  - Warmer water produces recirculation north of St. Matthew Island in 2010
- For the strongest flows, salinity dominates temperature stratification in 2008 & 2010, but in 2009 the roles are more equal

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