



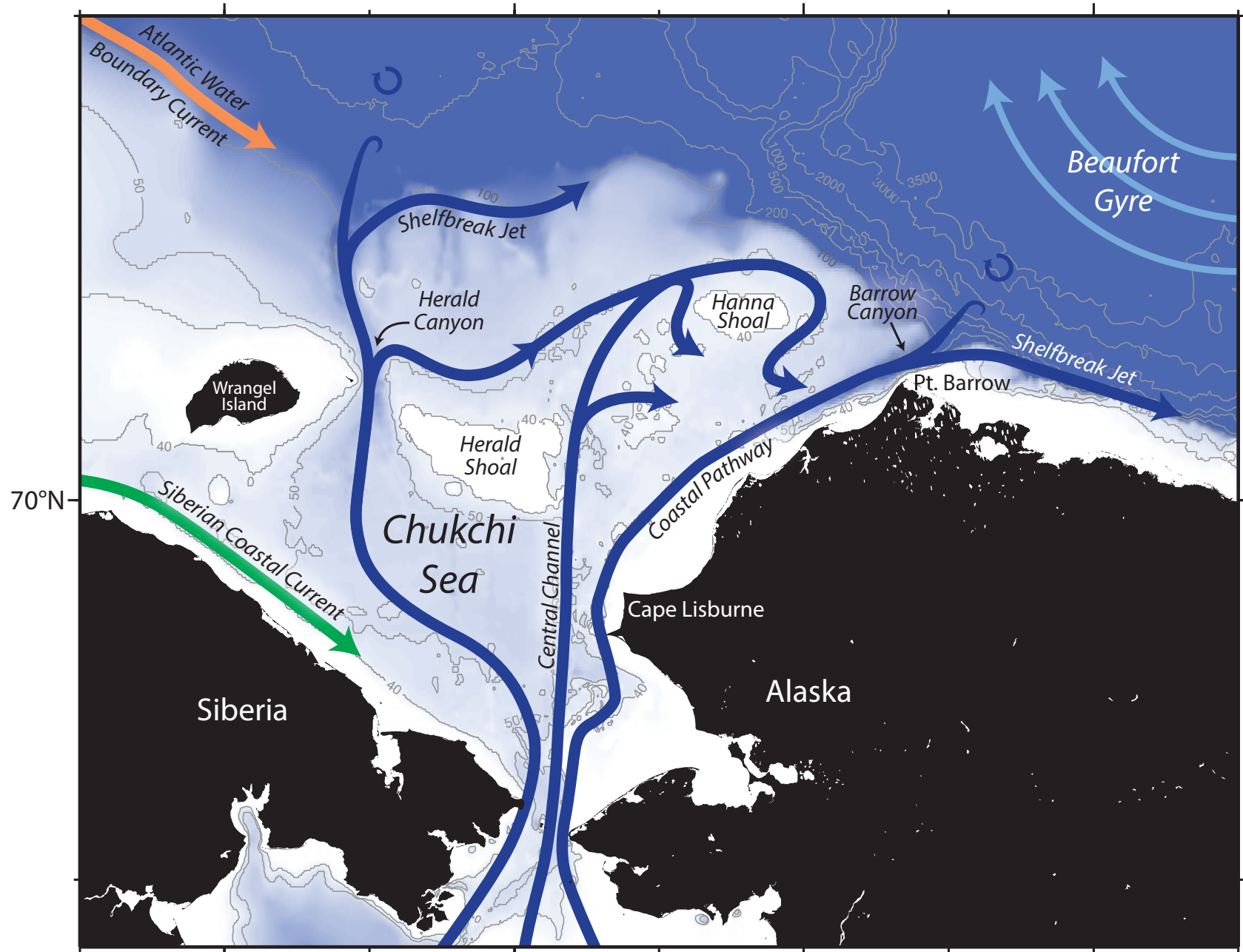
# Closing the Mass Budget between Bering Strait and the Arctic Basin: The Chukchi Slope Current

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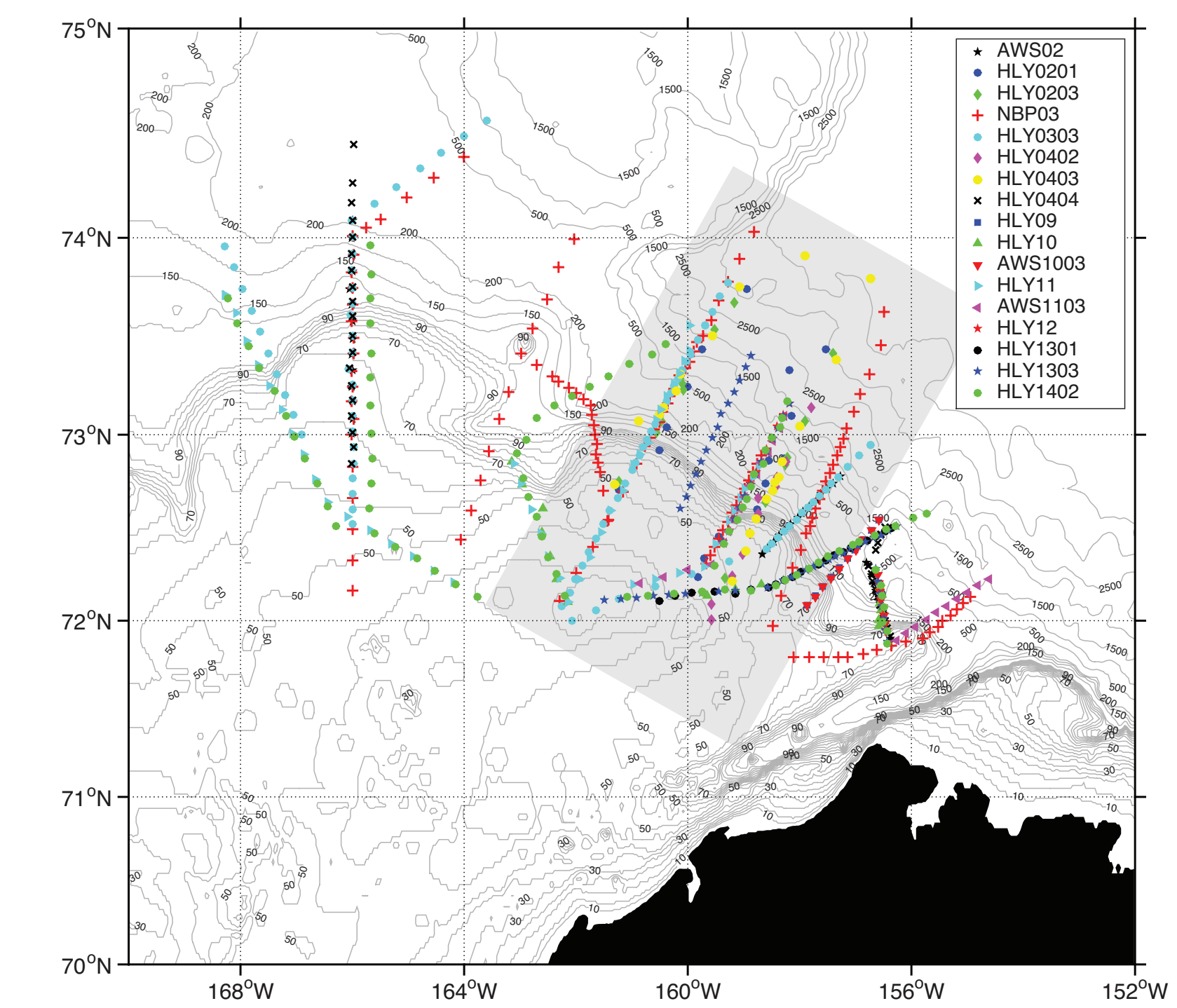
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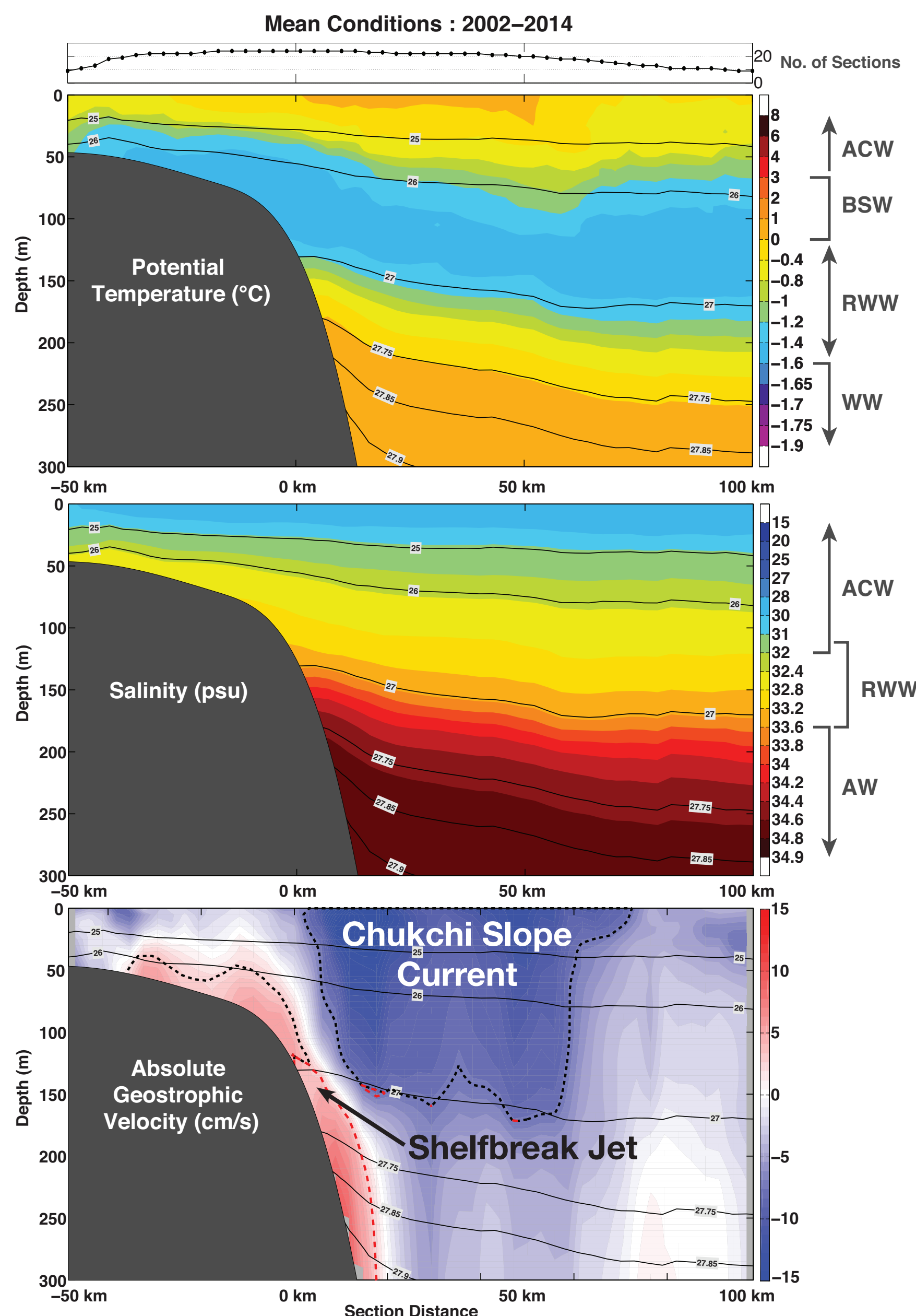
## 1. Mean Conditions near the Chukchi Shelfbreak



**Figure 1:** Presently accepted circulation of the Chukchi Sea, adapted from Brugler *et al.* (2014).



**Figure 2:** Compiled hydrographic transects, color-coded by cruise; the shaded region illustrates the region of well-behaved bathymetry used to create the mean across-shelfbreak sections.



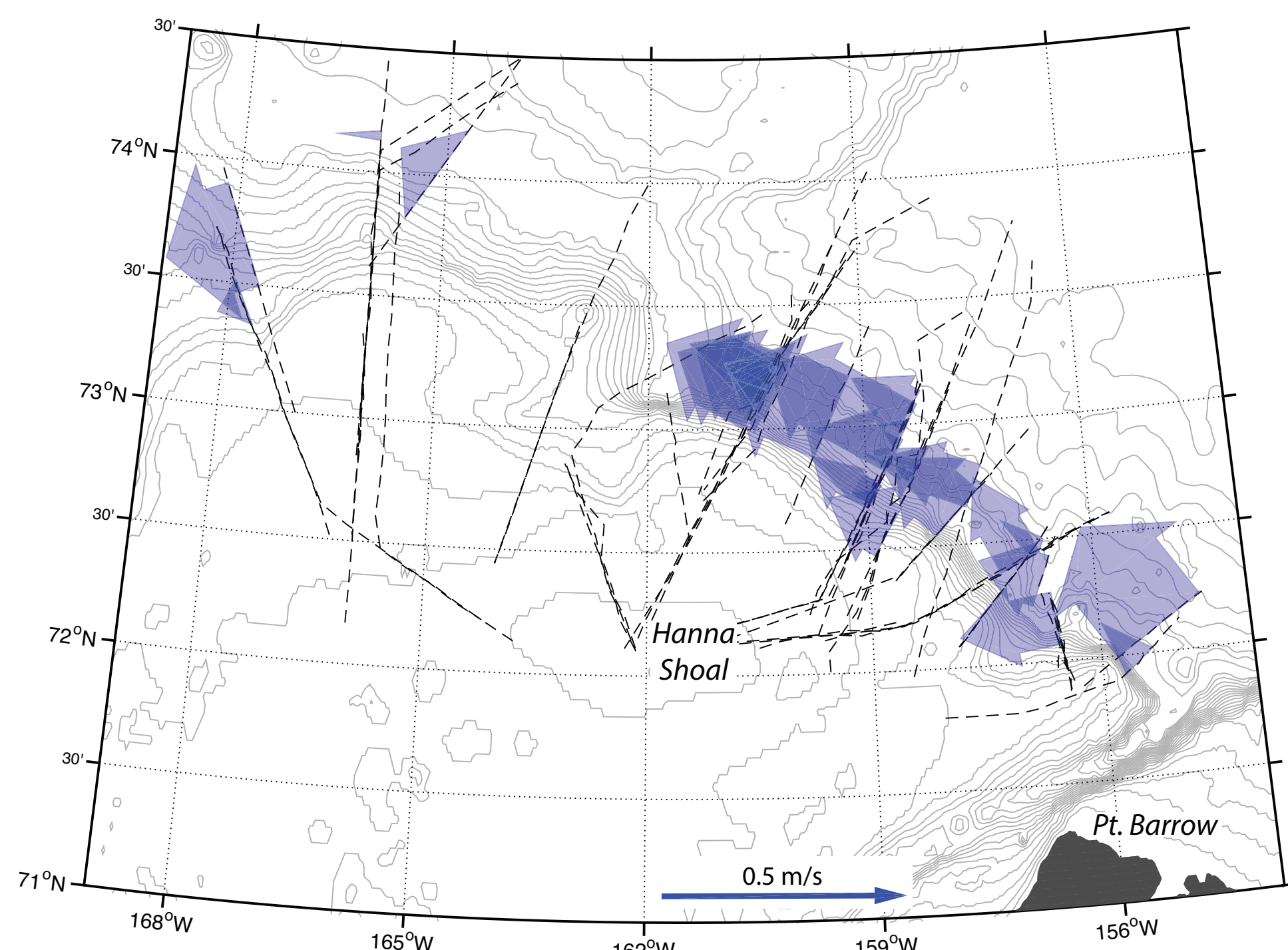
**Figure 3:** Mean potential temperature, salinity, and absolute geostrophic velocity sections within the region of well-behaved bathymetry. Black (red) dashes delimit the Pacific (Atlantic) portion of the eastward-flowing, bottom-intensified shelfbreak jet and the westward-flowing, surface-intensified slope current.

To date, the circulation in the vicinity of the Chukchi Sea shelfbreak has remained unclear, including the flow of the different Pacific-origin water masses as well as the Atlantic water (Fig 1). To examine this, we compiled all available hydrographic sections crossing the Chukchi shelfbreak and slope that include direct velocity measurements (shipboard or lowered ADCP). The resulting 46 sections span from 154° to 170° West, representing conditions observed from May through October from 2002 through 2014.

Using a subset of the transects within a region of well-behaved bathymetry (Fig2) we calculated mean sections of hydrographic properties and absolute geostrophic velocity. This revealed two distinct jets (Fig 3): the bottom-intensified eastward current is the Chukchi shelfbreak jet, and the surface-intensified westward current is a previously-undescribed feature that we call the Chukchi slope current.

The mean potential temperature section reveals a layer of Atlantic water from ~150 to 300 m depth, bounded above by a layer of Pacific-origin Remnant Winter Water (RWW) from 50 to 150 m depth. The surface layer consists of a mix of warmer water masses, including Pacific-origin water (Bering Sea Water and Alaskan Coastal Water) and melt water. To compute the transport of the slope current, we consider the individual synoptic sections.

## 2. The Chukchi Slope Current



**Figure 4:** Realizations of the Chukchi slope current. Each vector represents the mean absolute geostrophic velocity and width of the current within a single section.

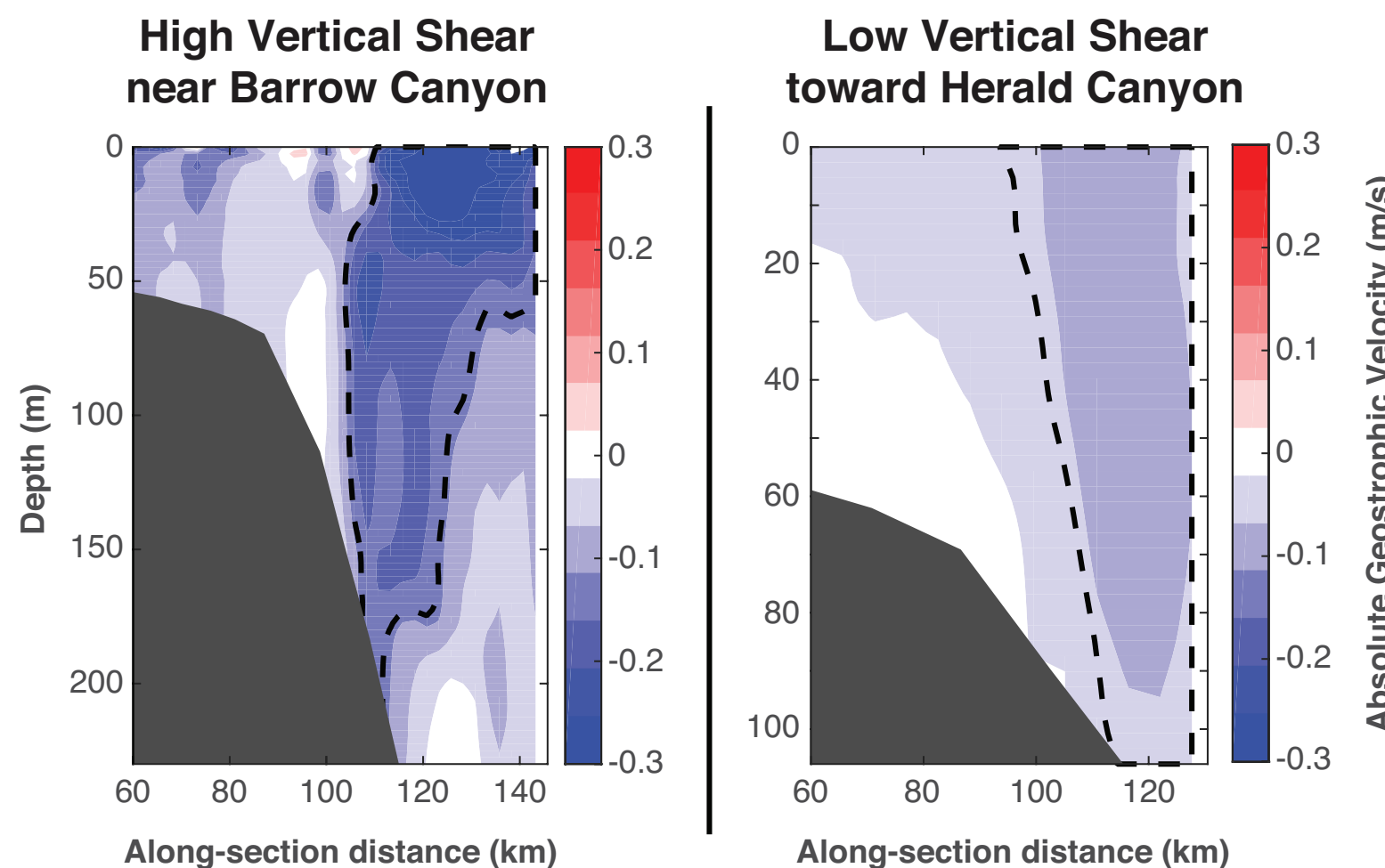
### Mean Transport

|            |                        |
|------------|------------------------|
| Volume     | $-0.65 \pm 0.11$ Sv    |
| Heat       | $-3.03 \pm 0.60$ TW    |
| Freshwater | $-0.058 \pm 0.0085$ Sv |

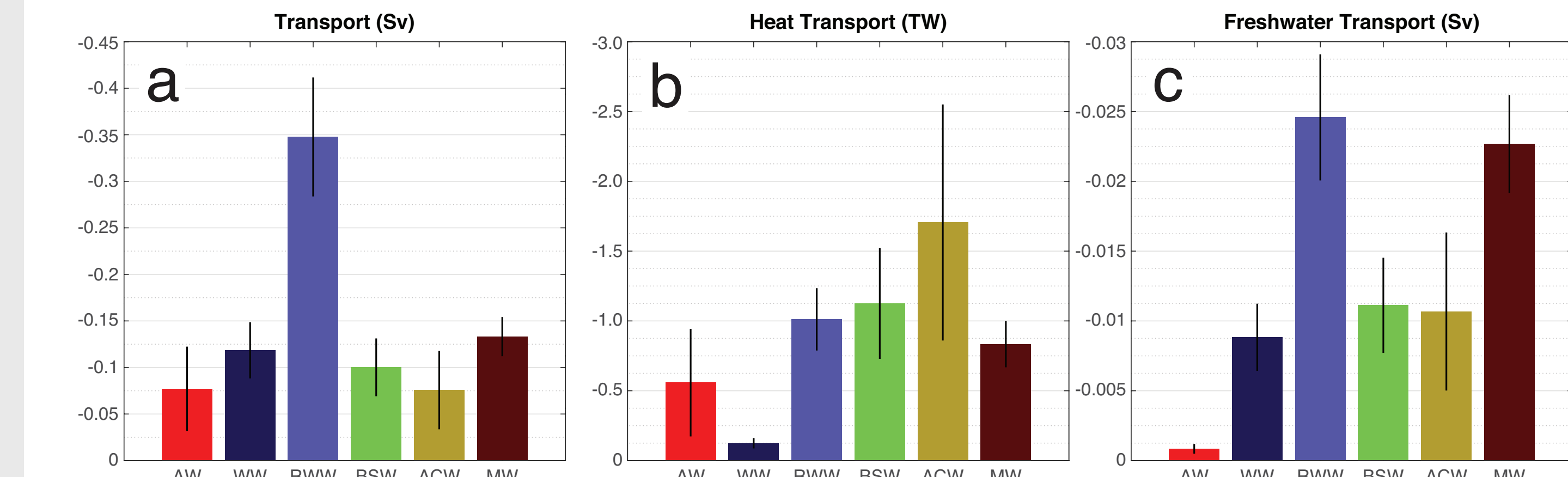
Mean Velocity:  $-14.3 \pm 1.26$  cm/s

### Mean Pacific Water Transport

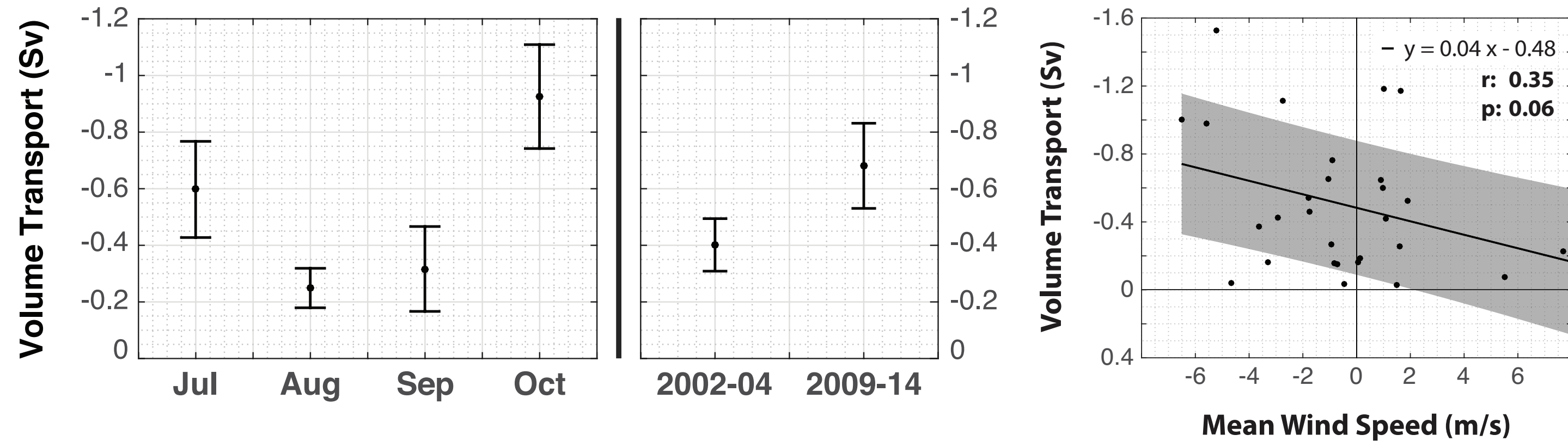
|            |                        |
|------------|------------------------|
| Volume     | $-0.50 \pm 0.077$ Sv   |
| Heat       | $-2.00 \pm 0.45$ TW    |
| Freshwater | $-0.037 \pm 0.0058$ Sv |



**Figure 5:** Representative absolute geostrophic sections of the slope current, demonstrating the decrease in vertical shear of the flow with distance from Barrow Canyon.



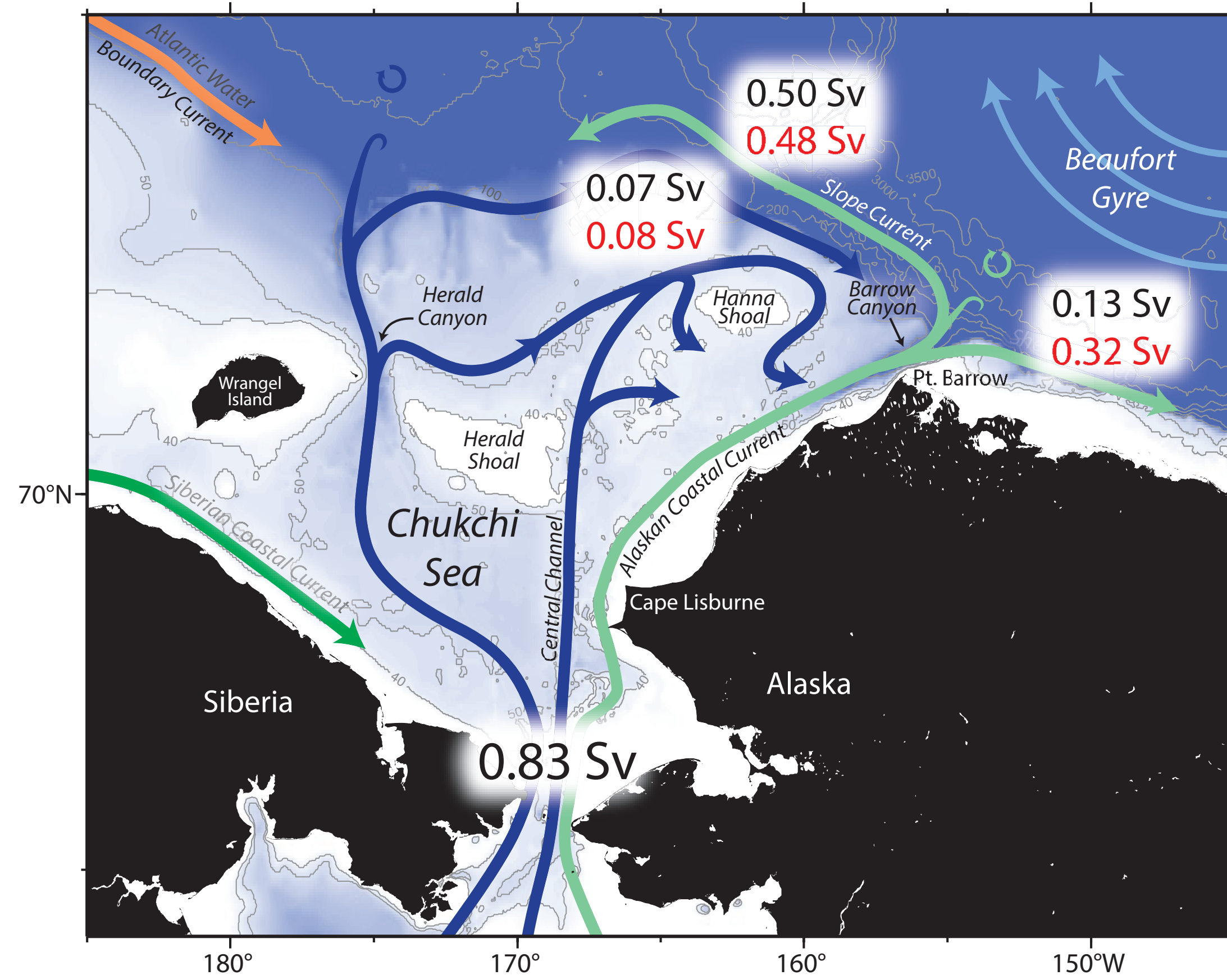
**Figure 6:** Mean (a) volume transport (b) heat transport and (c) freshwater transport of the slope current by water mass: Atlantic Water (AW), Winter Water (WW), Remnant Winter Water (RWW), Bering Sea Water (BSW), Alaskan Coastal Water (ACW), and Melt water (MW). Error bars are standard errors.



**Figure 7:** Slope Current Pacific-origin volume transport on seasonal and interannual timescales.

## 3. Pacific Water Mass Budget of the Chukchi Sea

The mean mass budget for the Chukchi Sea is presented in Fig 9 (black numbers), where the transport of the Beaufort shelfbreak jet (plus errors) was calculated by Nikolopoulos *et al.* (2009), the transport through the Bering Strait was estimated by Roach *et al.* (1995), and the Bering strait transport errors were estimated by Woodgate *et al.* (2012). The mass budget balances within the error bars, although there is likely some net outflow – on the order of 0.2 Sv – from the shelf via Long Strait into the East Siberian Sea, and through Herald Canyon into the Canada Basin. The no-wind transport values are shown in red.



**Figure 9:** Mean (in black) and no-wind (in red) transports within the Beaufort Shelfbreak Jet, Chukchi Slope Current, and Chukchi Shelfbreak Jet. The schematic now includes the Chukchi Slope Current and eastward extension of the Chukchi Shelfbreak Jet.

### Mean Mass Budget

$$\begin{aligned} 0 &= [\text{Bering Strait Inflow}] - [\text{Barrow Canyon Outflow}] \\ &\quad - [\text{Herald Canyon Outflow}] \\ \text{Barrow Canyon Outflow} &= [\text{Beaufort Shelfbreak Jet}] + [\text{Chukchi Slope Current}] \\ &\quad + [\text{Loss to Arctic}] - [\text{Chukchi Shelfbreak Jet}] \\ \text{Herald Canyon Outflow} &= [\text{Chukchi Shelfbreak Jet}] + [\text{Loss to Arctic}] \end{aligned}$$

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$$\begin{aligned} 0 &= [0.83 \pm 0.1] - [(0.13 \pm 0.08) + (0.50 \pm 0.08) - (0.07 \pm 0.03)] \\ &\quad - [(0.07 \pm 0.03) + (\text{Loss to Arctic})] \end{aligned}$$

where (Loss to Arctic) =  $0.20 \pm 0.26$  Sv

## 4. Conclusions

- Data from a collection of shipboard transects have revealed the presence of a heretofore unknown westward flowing current along the Chukchi Sea continental slope, which we call the Chukchi Slope Current. It transports  $0.50 \pm 0.08$  Sv of Pacific-origin water westward from Barrow Canyon.
- The Slope Current exhibits significant seasonal (+0.5 Sv) and interannual (+0.3 Sv) variability, which is likely wind-driven.
- The discovery of the Chukchi Slope Current brings us closer to closing the Pacific water mass budget of the Chukchi Sea.

**Works Cited:**  
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