USCGC *Polar Star* Arctic West Summer 2002 Cruise Summary: Shelf-Basin Interactions

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The field phase of the Shelf-Basin Interactions Experiment (SBI) began in 2002 with a series of three cruises to the Chukchi and Beaufort Seas. SBI is a multi-institutional program investigating how the western Arctic shelves communicate with the interior of the Canada Basin, from a coupled physical/biochemical perspective. The physical oceanographic (PO) component of SBI was carried out on the Coast Guard icebreaker *Polar Star*, from mid-July to mid-August. The primary aim of the PO component is to identify and understand the water masses and mechanisms by which shelf waters ventilate the western Arctic halocline.

The major goals of the 2002 Arctic West Summer cruise (AWS02) were to (1) deploy a system of moorings that will measure the outflow from the Chukchi shelf (the UW/UAF component); (2) deploy a high-resolution moored array across the Beaufort slope, downstream of the outflows, to determine how these waters are fluxed into the interior (the WHOI component); and (3) conduct a hydrographic survey encompassing locations along the Chukchi and Beaufort shelfedge. The cruise was a resounding success on all accounts.

The moored instruments will measure currents, temperature, and salinity numerous times per day until September, 2003 (at which point they will be turned around for a second year-long deployment). A combination of discrete sensors and profiling instruments were used. Nearly all hydrostations during the cruise included water sample measurements of salinity and nutrients. The conductivity/temperature/depth (CTD) package was also outfitted with a lowered Acoustic Doppler Current Profiler (ADCP) measuring absolute horizontal velocity, a turbidity sensor, and a fluorometer (attached after the second CTD section). These additional sensors provided invaluable information on the origin and magnitude of the currents in the region.

Brief Synopsis

Polar Star embarked the science party in Dutch Harbor, AK on 15 July and sailed on calm seas to the first mooring site in the central Chukchi channel (Figure 1). After completing the mooring deployment and CTD section there, we proceeded to the 166°W site, which we refer to as the Herald Valley outflow site. (Herald Valley actually lies to the west of 166°W in the Russian EEZ. We were unable to obtain clearance to work in Russian waters; however, we believe that the measurements along 166°W will capture at least a portion of the outflow of Pacific-origin water from Herald Valley.) This location contained significant ice cover, but there were enough leads to allow the deployment of two moorings and occupation of a cross-slope CTD section.

Our next scheduled site was Barrow Canyon in the eastern Chukchi Sea, but heavy ice cover prohibited us from deploying our mooring, so we continued to the Beaufort slope site. There we did a cross-slope bathymetric survey in order to choose the precise mooring sites, but our initial line proved too steep to deploy moorings effectively. Thus we moved farther west, onto a gentler

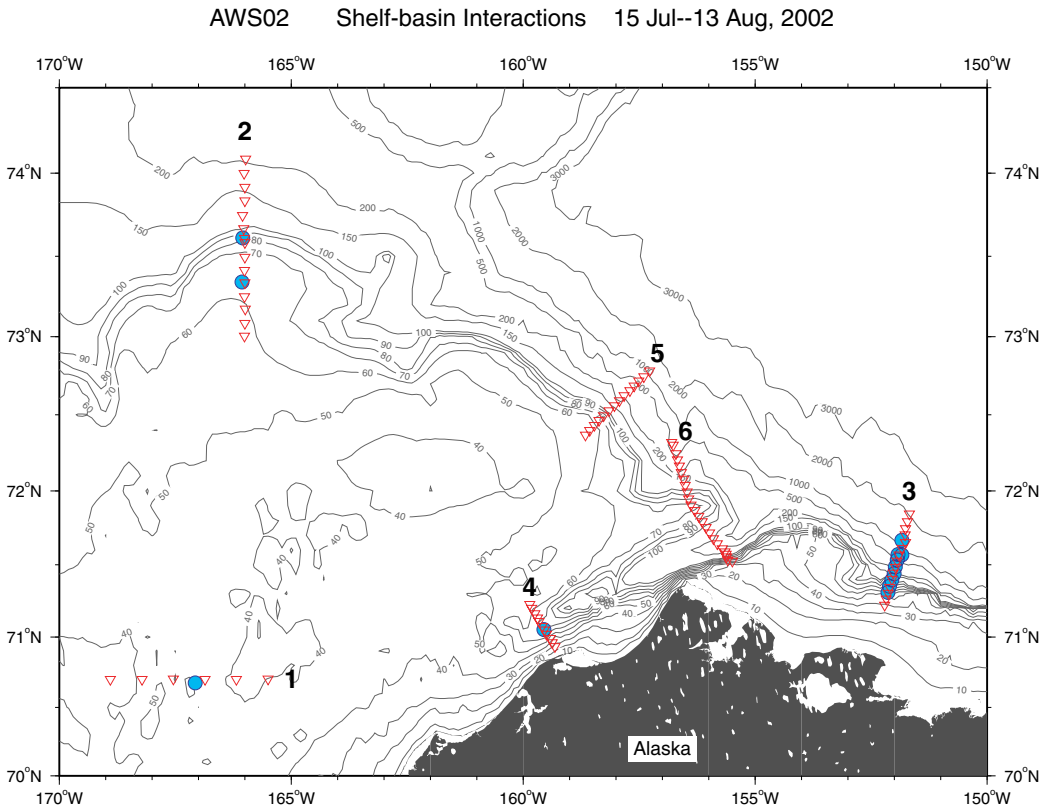

Figure 1: AWS02 CTD stations (inverted red triangles) and moorings (cyan circles).

part of the Beaufort slope (with more favorable ice-conditions as well), where we deployed the high-resolution array as desired. The array consisted of eight moorings spaced 5 km apart, with an additional "whale-listening" mooring deployed for S. Moore of the National Marine Mammal Laboratory. A cross-slope CTD/XCTD section was occupied at this site as well.

We then steamed back to Barrow Canyon, where the ice situation had improved substantially, and deployed our final mooring and occupied a short hydrographic section across the head of the Canyon. The final phase of the cruise consisted of two high-resolution hydrographic sections—one to the west of Barrow Canyon (including XCTDs), and a dogleg section spanning the mouth of the canyon. We then steamed back to Dutch Harbor, arriving on 13 August.

Some Preliminary Results

As seen in Figure 1, our hydrographic survey encompassed the three outflow branches of the Chukchi Sea: Herald Valley (Section 2), the central channel (Section 1), and Barrow Canyon (Sections 4 and 6). Additionally, we occupied sections downstream of both the Herald Valley outflow (Section 5) and Barrow Canyon outflow (Section 3). This survey represents the first systematic coverage of these outflows, as well as the first high-resolution crossings of the shelf and upper slope in this area of the western Arctic. Accordingly, our preliminary look at the data has revealed some fascinating insights on the origin and fate of the shelfedge boundary currents in this important region of the Arctic.

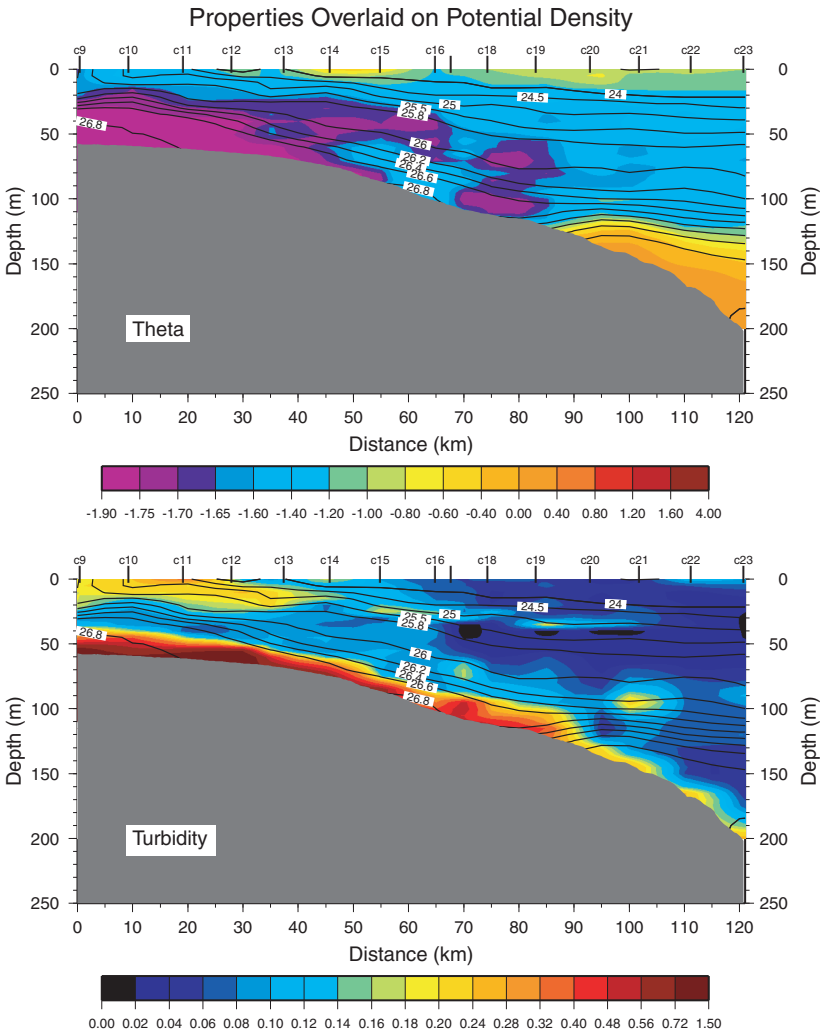

Figure 2: Vertical Sections of Potential Temperature (top panel) and Turbidity (bottom panel) along 166°W (Section 2).

Figure 2 shows the vertical sections of potential temperature and turbidity at the Herald Valley outflow site (Section 2). The outer shelf is filled with cold, dense Pacific-origin winter water as it flows eastward, forming a shelfbreak jet. Note the high turbidity in the bottom layer, likely due to sediments drawn into this water mass as it crosses the shelf. The small lenses of water at the shelfedge are likely the beginnings of eddies—a view which is supported by our downstream measurements. The second hydrographic section shown (Figure 3) is at the eastern end of the domain in the Beaufort Sea. This transect reveals the presence of a fully-developed subsurface anti-cyclonic eddy (centered near stations 28–29), comprised of cold, turbid, Pacific-origin winter water. This is the same type of eddy that has been observed repeatedly throughout the interior of the Canada Basin. Our sections suggest strongly that these features emanate from the shelf-edge boundary current. Do all of the eddies come from the Herald valley outflow, or do some originate from the Barrow Canyon outflow? How do these outflows vary in water composition and transport throughout the year? What are the physics governing the formation of the eddies? These are just a few of the questions that we hope to answer with this exciting data set. Further information on the cruise can be found at http://www.whoi.edu/arcticedge.

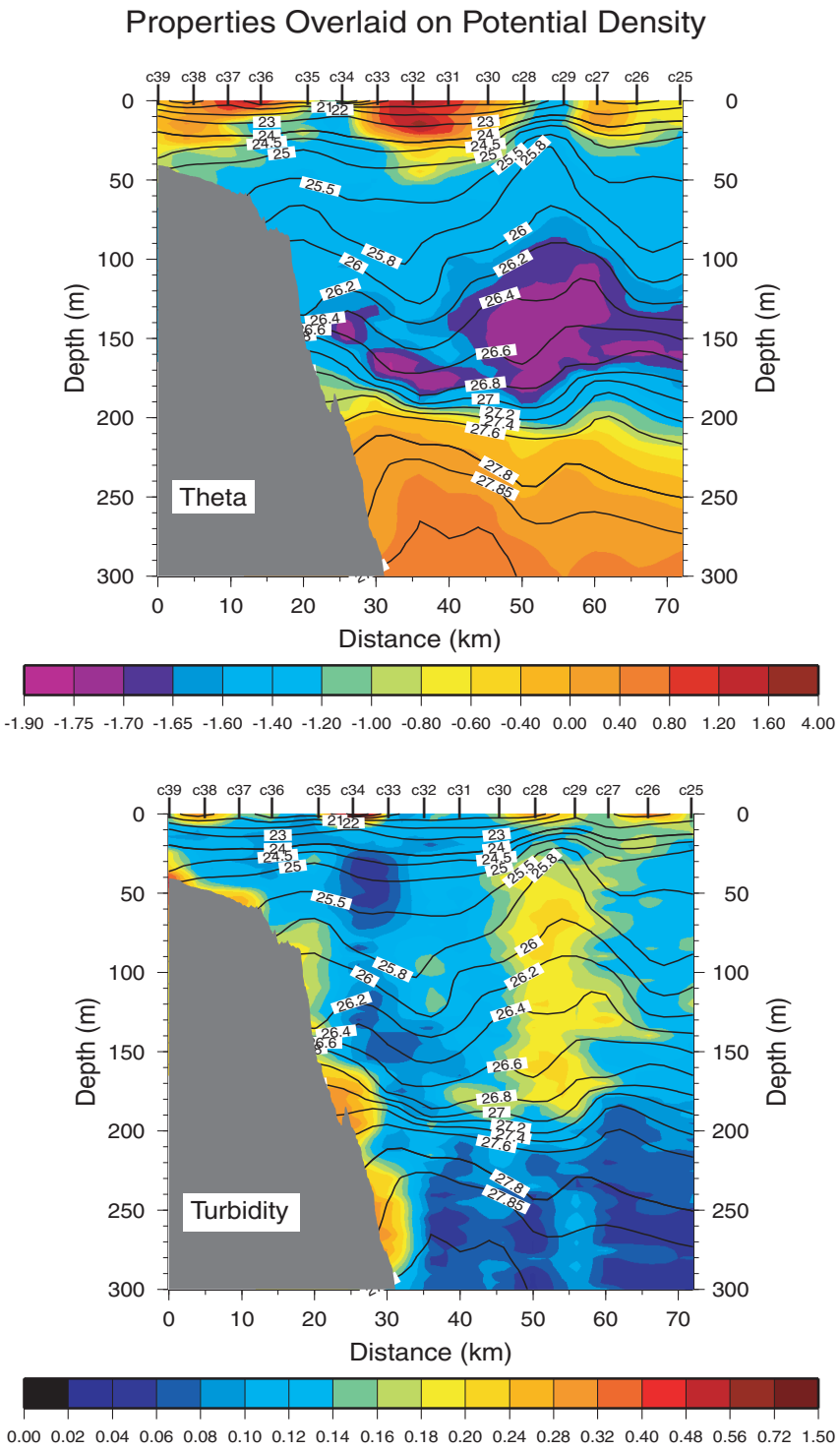

Figure 3: Vertical Sections of Potential Temperature (top panel) and Turbidity (bottom panel) across the Beaufort slope (Section 3).