

Palmer LTER: Hydrography in the LTER region

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Historically, the hydrography of the coastal and shelf waters of the region west of the Antarctic Peninsula has received little attention; observations were confined to a few cruises with relatively large station spacing or to a few individual stations (see, for example, Gordon and Molinelli 1982; Olbers et al. 1992). This area is believed to be a site of spawning and recruitment for antarctic krill, *Euphausia superba*. Hence, characterization of the water-mass distribution and circulation in this habitat is necessary to understand krill distribution and recruitment success. From 25 March to 15 May 1993 an extensive hydrographic survey was made of the Palmer long-term ecological research (LTER) peninsula grid (Waters and Smith 1992; Hofmann, Lascara, and Klinck 1992b) as part of a multidisciplinary cruise aboard the R/V *Nathaniel B. Palmer*. The survey covered an area that extended about 900 kilometers (km) alongshore and about 200 km offshore along the western side of the Antarctic Peninsula

(figure 1). These measurements represent the first extensive hydrographic regional coverage of the area west of the Antarctic Peninsula, an area that extends from the Bransfield Strait to the Bellingshausen Sea. This article presents preliminary results from analysis of these hydrographic data.

Vertical profiles of temperature, salinity, and oxygen were collected at about 250 stations. Measurements were made using either a Sea-Bird conductivity-temperature-depth (CTD) system or a Bio-Optical Profiling System [BOPS; see Smith, Booth, and Star (1984) for a description]. Water was taken at discrete depths with either Niskin or Go Flo bottles for nutrient and oxygen determinations, as well as for calibration of salinity sensors.

For most of the hydrographic casts, observations were made to within a few meters of the bottom. At the outermost stations on the across-shelf transects, CTD casts were made to the bottom or 3,000 m. Horizontal spacing between the

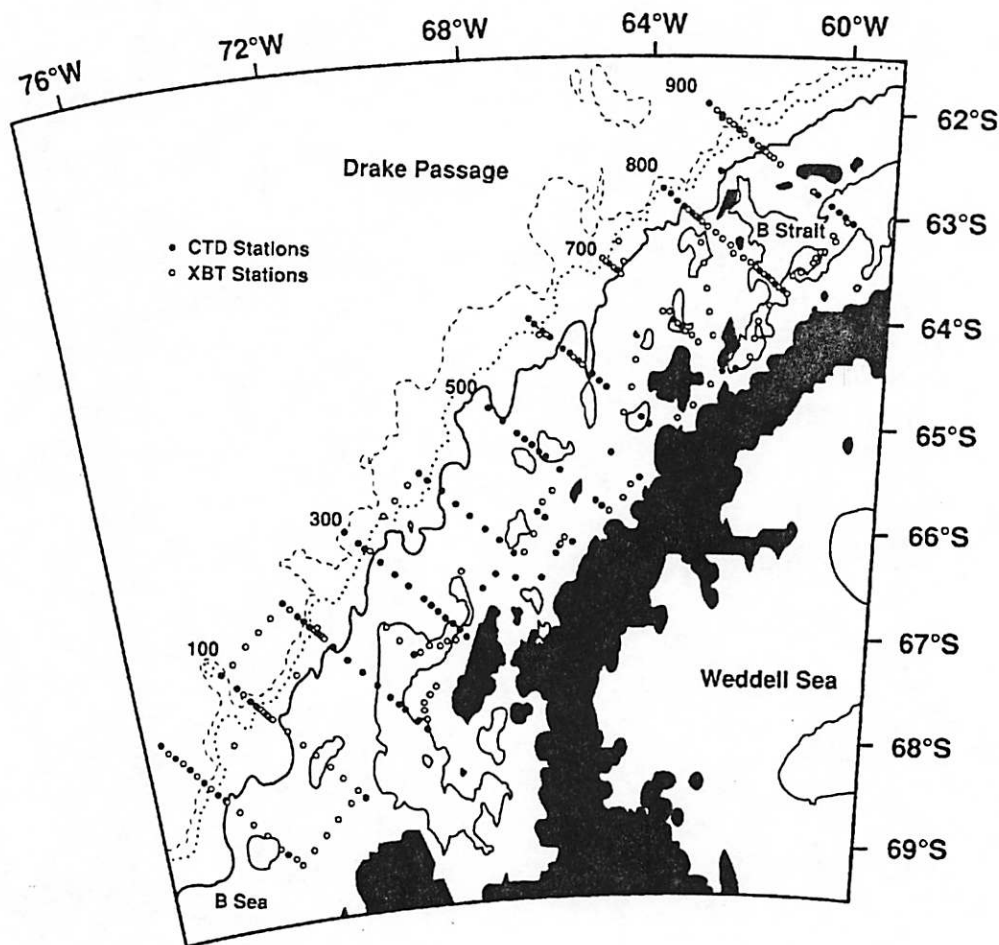


Figure 1. Distribution of CTD and XBT stations that were occupied between 25 March and 15 May 1993 (autumn 1993b cruise) as part of the Palmer LTER hydrographic survey of the waters west of the Antarctic Peninsula. Bransfield Strait and the Bellingshausen Sea are indicated by B Strait and B Sea, respectively. The 500-m, 2,000-m, and 3,000-m isobaths are shown by the solid, dotted, and dashed lines, respectively.

hydrographic stations was 10 km on most transects. Spatial resolution in the temperature field along and between transects was increased by using 151 expendable bathythermographs (XBTs). For some transects, the combined observations from the CTD, BOPS, and XBTs provide horizontal resolution of the temperature field of less than 5 km. Along-shelf spacing between hydrographic transects was 100 km. This article presents some results about the general water-mass distributions in the LTER region and the westward extent of the Polar Slope Current that were obtained from the CTD and XBT observations. Apparent gaps between CTD and XBT stations, such as on the outer part of the 700 line (figure 1), were actually filled with BOPS casts. Results from the BOPS measurements will be presented elsewhere.

The general water-mass properties in the LTER region can be seen from a potential temperature-salinity (θ -S) diagram constructed from the CTD observations (figure 2). Salinity in the LTER region ranges from about 33.0 practical salinity units (psu) to slightly greater than 34.72 psu; temperature ranges from -1.8°C to 2°C . The most prominent feature in θ -S space is Circumpolar Deep Water (CDW), characterized by a salinity maximum (salinities up to 34.729 psu) and a potential temperature maximum ($\theta > 0^{\circ}\text{C}$). CDW is the most voluminous water mass transported by the Antarctic Circumpolar Current, which flows eastward through Drake Passage. Throughout the LTER sampling region and west of 63°W , CDW fills the bottom layer of the continental shelf. In some regions, CDW warmer than 1.3°C was sampled more than 130 km inshore of the continental shelf break. This represents a large volume of warm, nutrient-rich water that is relatively near the sea surface. The presence of CDW near the sea surface along the Antarctic Peninsula has important implications for krill repro-

duction since the descent-ascent cycle of krill embryos and larvae is affected by water temperature (Hofmann et al. 1992a).

Above CDW, temperature and salinity decrease to values that are typical of Winter Water (salinity about 34.2 psu and $\theta < 0^{\circ}\text{C}$). Surface waters of the LTER region show a wide range of temperature and salinities, a finding that accounts for the large scatter in θ -S space at salinities below about 34.2 psu. The inshore stations and the inner stations on the southernmost three transects show low salinity (< 34 psu) and cold ($\theta < -1.0^{\circ}\text{C}$) water in the upper water column. These regions were influenced by newly formed sea ice.

A second region of tight correspondence between θ and salinity can be identified in figure 2, which corresponds to water of Bransfield Strait origin. This water is characterized by temperatures less than 0°C and salinities between 34.5 psu and 34.6 psu. This water was found at the inner stations on the 900 and 800 lines, which extend into the western portion of Bransfield Strait.

At the outer stations on the 800 and 900 transects, horizontal resolution in the temperature field was increased to about 2-5 km when crossing the shelf break region to define the Polar Slope Current. This current is narrow (about 10 km), is characterized by cold ($\theta < 0^{\circ}\text{C}$) antarctic shelf water, extends to depths of up to 800 m, and is believed to be trapped to the upper slope-shelf break region (Nowlin and Zenk 1988). The Polar Slope Current is apparent in the temperature field from the 900 line as a narrow cold-core ($\theta < 0^{\circ}\text{C}$) current centered at about 300 m (figure 3A). Offshore of the current is CDW. Interestingly, the inshore edge of the current is displaced off the shelf-slope region, and CDW is found between the inshore edge of the current and the shelf. Only 100 km to the south-

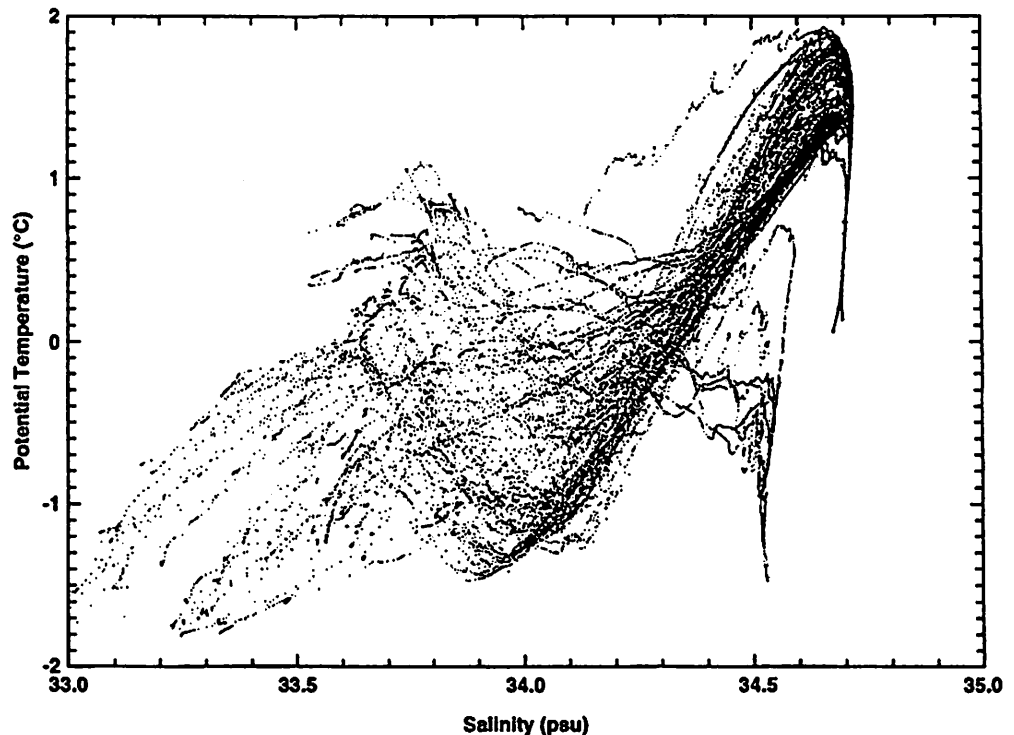


Figure 2. Potential temperature-salinity diagram constructed from CTD observations.

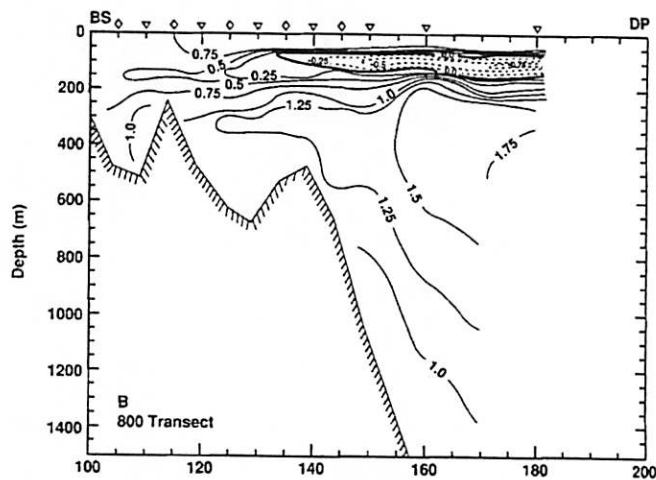
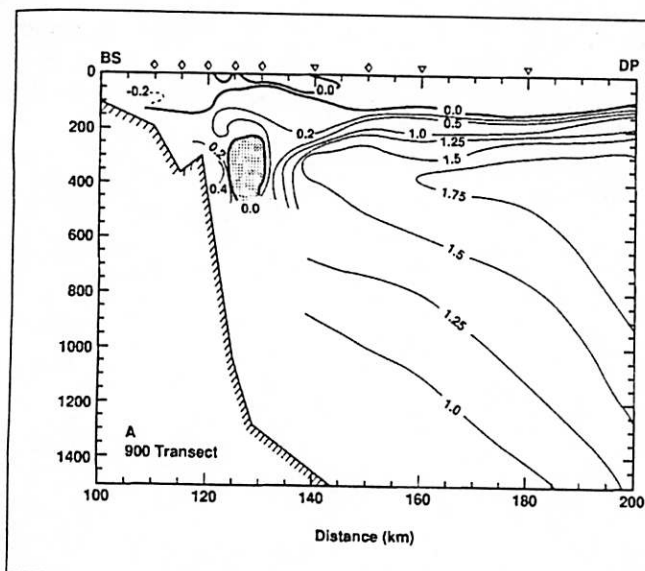


Figure 3. Vertical temperature distribution in the upper 1,400 m constructed from CTD and XBT observations made at the outer stations on the (A) 900 transect and the (B) 800 transect. Sections extend from Bransfield Strait (BS) offshore toward Drake Passage (DP). Contour interval is 0.25°C. Dashed lines represent negative temperatures; solid lines are positive temperatures. Temperature observations from the CTD are indicated by ∇ ; those from XBTs are indicated by \diamond . Station spacing is shown by these symbols. The shading in A indicates waters colder than 0°C, which correspond to the Polar Slope Current.

west of the 900 line, the temperature distribution on the outer 800 line (figure 3B) shows no evidence of antarctic shelf water on the continental slope. Similarly, temperature sections from the transects further west also show no evidence of the Polar Slope Current.

Nowlin and Zenk (1988) suggested that the Polar Slope Current may be a circumpolar feature. An analysis of historical temperature data from the South Shetland Islands–Bransfield Strait region, however, led Capella et al. (1992) to question the circumpolar nature of the Polar Slope Current. The results from the LTER hydrographic survey support the conclusions of Capella et al. (1992) and suggest that the Polar Slope Current is interrupted immediately west of the Bransfield Strait. The supply of antarctic shelf water from the Weddell Sea mixes with CDW and the Polar Slope Current loses its identity at about 63°W.

This work was supported by National Science Foundation grant OPP 90-11927. We thank Elizabeth Sharp for assistance in hydrographic data collection. Thanks are also extended to Bill Weber for his invaluable help in maintaining and operating the CTD system.

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