# Palmer LTER: Hydrography in the inner shelf region

DAVID A. SMITH, CATHY M. LASCARA, JOHN M. KLINCK, *and* EILEEN E. HOFMANN, *Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, Virginia 23529*
RAYMOND C. SMITH, *Institute for Computational Earth System Science, University of California, Santa Barbara, California 93106*

As part of sampling the Palmer Long-Term Ecological Research (LTER) program's offshore peninsula grid (Waters and Smith 1992), several stations were occupied along the inner shelf (figure 1). At these locations, hydrographic measurements were made during LTER cruises in January and February 1993 and March through May 1993. The inner shelf region west of the Antarctic Peninsula is poorly represented in southern ocean historical databases (Gordon and Molinelli 1982: Olbers et al. 1992). Thus, the LTER measurements are some of the first from which the hydrographic structure of these waters can be described.

Vertical profiles of temperature and salinity were obtained at 20 stations [7 conductivity-temperature-depth (CTD), 13 expendable bathythermograph (XBT)] during the

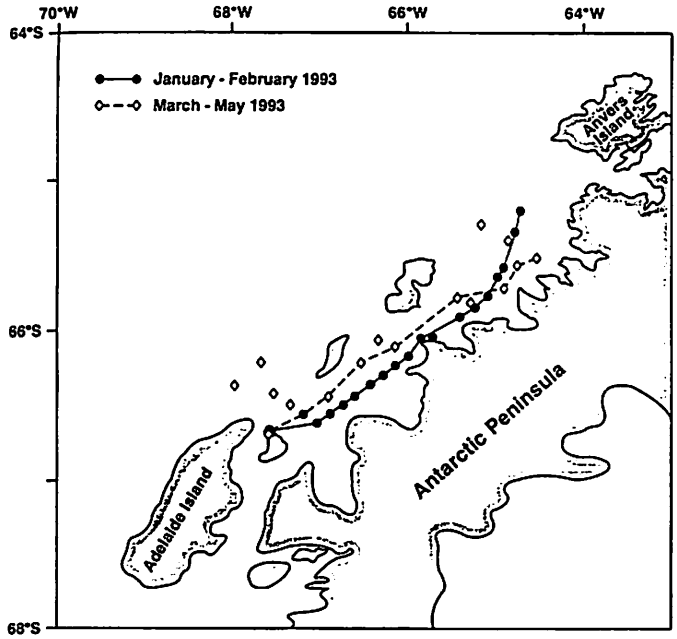


Figure 1. Distribution of CTD and XBT stations occupied in January and February 1993 (●) and March through May 1993 (◇).

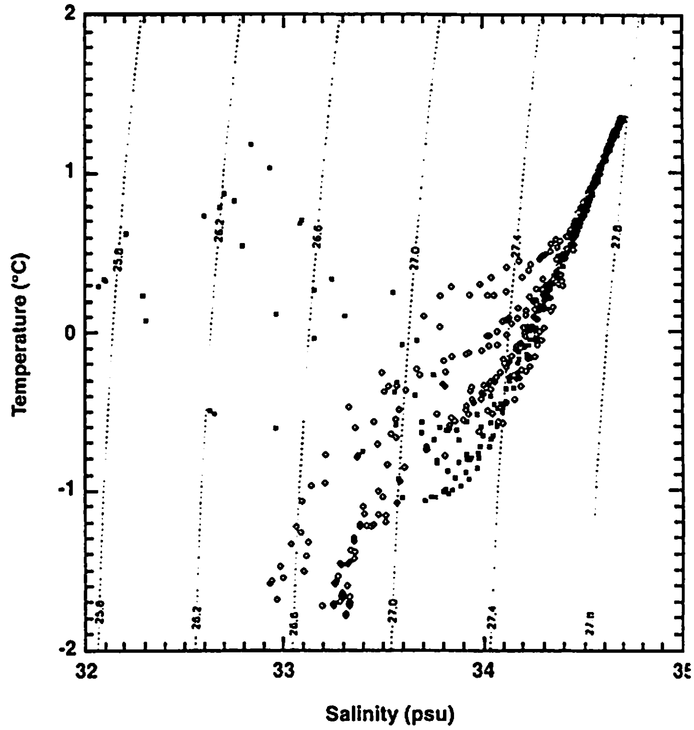


Figure 2. Potential temperature-salinity diagram constructed from CTD observations. Observations from the January and February 1993 cruise are indicated by *; those from the March through May 1993 cruise are indicated by ◇. Contours are lines of constant $\sigma_t$. (psu denotes practical salinity units.)

austral summer and 19 stations (15 CTD, 4 XBT) during the austral fall (figure 1) using a Sea-Bird CTD system. Water was taken at discrete depths using either Nisken or Go Flo bottles for nutrient and oxygen determinations, as well as for calibration of the CTD salinity sensors. On all casts, observations were made to within a few meters of the bottom. Horizontal spacing between the hydrographic stations was about 10 kilometers (km) although some stations from the austral fall were farther apart (figure 1). Details of the processing of the CTD and XBT measurements for the austral summer cruise are given in Lascara, Smith, and Menzies (1993) and Lascara et al. (1993) and for the austral fall cruise in Smith, Smith, and Menzies (1993) and Smith et al. (1993).

The general water mass properties in the inner shelf region can be seen from a potential temperature-salinity ($\theta$-S) diagram constructed from the CTD observations (figure 2). Salinity ranges from 32.0 to 34.7; temperature ranges from −1.8°C to 1.3°C. The salinity maximum (34.7) and temperature maximum (1.3°C) seen in $\theta$-S space is characteristic of Circumpolar Deep Water (CDW). This water mass is transported by the Antarctic Circumpolar Current and is found at depths of 200 to 700 m at the shelf break west of the Antarctic Peninsula. This water mass is found throughout the shelf region west of the Peninsula (Hofmann et al. in press) and, as shown by the inner shelf hydrographic measurements, it essentially covers the entire shelf.

Temperature and salinity values less than 0°C and 33.8–34.0, respectively, are characteristic of Winter Water, which forms the lower portion of Antarctic Surface Water (AASW). The temperature-salinity structure of the upper portion of AASW is modified by solar heating and meltwater addition during the austral summer, which produces scatter in the $\theta$-S diagram (figure 2). The lack of a dense (low temperature, high salinity) water mass on the inner shelf indicates that this is not a region of water formation.

Vertical profiles of temperature (figure 3) show clearly the presence of CDW below 200 m in the austral summer and fall. Variability in the vertical structure of this water mass is likely the result of different bathymetry encountered along the two cruise tracks (figure 1). At mid-depths (100–150 m), a permanent pycnocline separates CDW from AASW. During the austral summer, heating of the surface produces a seasonal pycnocline at about 50 m, which isolates AASW, thereby, producing the temperature minimum at depth that is referred to as Winter Water (figure 3*A*). By the austral fall, wind mixing has eroded the Winter Water core (figure 3*B*).

Variability in the structure of the inner shelf waters is confined to the portion of the water column that is influenced by changes in surface fluxes in heat, salt, and momentum. The water column structure shown in figure 3 is consistent with what has been described for the outer continental shelf west of the Antarctic Peninsula (Hofmann et al. in press), suggesting coherent across-shelf circulation. Moreover, the inner shelf has retained the water mass structure that is characteristic of oceanic waters. This differs from midlatitude continental shelves where the inner shelf water structure is largely determined by freshwater inputs.

This work was supported by National Science Foundation grant OPP 90-11927. Computer facilities and support were provided by the Center for Coastal Physical Oceanography at Old Dominion University.

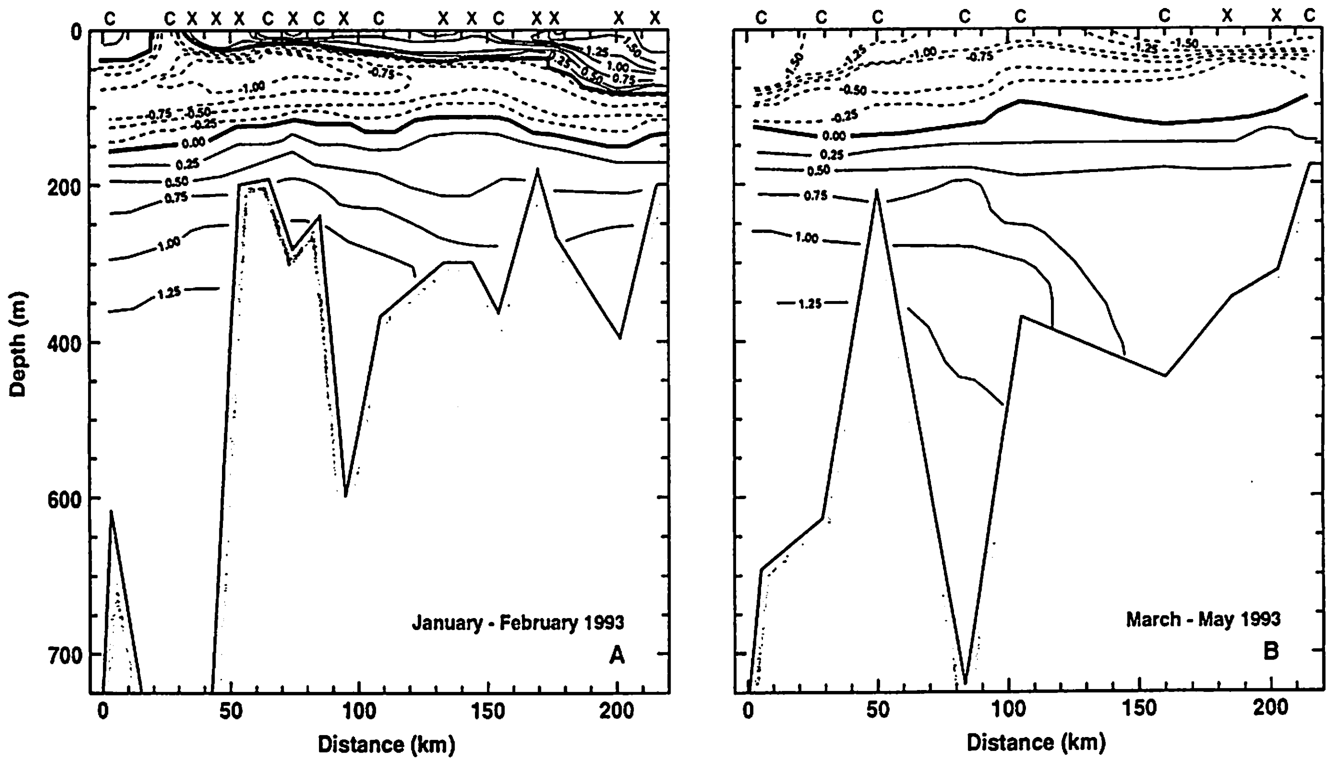


Figure 3. Inner shelf vertical temperature (°C) distribution constructed from CTD and XBT observations made in (*A*) January and February 1993 and (*B*) March through May 1993. Contour intervals are variable. Dashed lines represent negative temperatures; solid lines are positive temperatures. The location of CTD stations is indicated by C; XBT stations are indicated by X.

## References


Gordon, A.L., and E.J. Molinelli. 1982. *Southern ocean atlas.* New York: Columbia University Press.

Hofmann, E.E., J.M. Klinck, C.M. Lascara, and D.A. Smith. In press. Water mass distribution and circulation west of the Antarctic Peninsula and including Bransfield Strait. In R.M. Ross, E.E. Hofmann, and L.B. Quetin, (Eds.), *Foundations for ecological research west of the Antarctic Peninsula* (Antarctic Research Series). Washington, D.C.: American Geophysical Union.

Lascara, C.M., R.C. Smith, and D. Menzies. 1993. *XBT data collected aboard the R/V Polar Duke January–February 1993* (CCPO Technical Report No. 93-03, Center for Coastal Physical Oceanography). Norfolk: Old Dominion University.

Lascara, C.M., R.C. Smith, D. Menzies, and K.S. Baker. 1993. *Oceanographic data collected aboard the R/V Polar Duke January–February 1993* (CCPO Technical Report No. 93-02, Center for Coastal Physical Oceanography). Norfolk: Old Dominion University.

Olbers, D., V. Gouretski, G. Seiss, and J. Schröter. 1992. *Hydrographic atlas of the southern ocean.* Bremerhaven, Germany: Alfred-Wegener-Institute.

Smith, D.A., R.A. Locarnini, B.L. Lipphardt, Jr., and E.E. Hofmann. 1993. *XBT data collected aboard the R/V Nathaniel B. Palmer March–May 1993* (CCPO Technical Report No. 93-06, Center for Coastal Physical Oceanography). Norfolk: Old Dominion University.

Smith, D.A., R.C. Smith, and D. Menzies. 1993. *Oceanographic data collected aboard the R/V Nathaniel B. Palmer March–May 1993* (CCPO Technical Report No. 93-05, Center for Coastal Physical Oceanography). Norfolk: Old Dominion University.

Waters, K.J., and R.C. Smith. 1992. Palmer LTER: A sampling grid for the Palmer LTER program. *Antarctic Journal of the U.S.*, 27(5), 236–238.