farther offshore than in 1993. As a result, the 33.7 and 33.8 isohalines were farther offshore (20–50 km) in 1994. The strongest salinity gradients occurred along the inner shelf region in 1993 and in the region near Anvers Island in 1994. In both years, a region of higher salinity water was found near Anvers Island but was more pronounced in 1994.

The decreased offshore temperature and decreased salinity in 1994 suggest that this year may have been characterized by a larger influx of fresh water from the regions to south or inner shelf or by increased local ice melt. For example, it is possible that the wind patterns and inner shelf circulation in 1994 were such that more of the fresh water near the coast was allowed to spread out onto the shelf. The LTER data, however, are not adequate to evaluate the influx of fresh water from the south or inner shelf. The contribution from local ice melt may be estimated by considering the duration and extent of the ice cover in the preceding austral winter. During the 1992 austral winter, the sea-ice duration around Palmer Station was about 18 weeks and the maximum sea-ice extent in September was to 60°50'S. These values compare to a sea-ice duration around Palmer Station of 15 weeks and a maximum September extent of 62°20'S during austral winter 1993. Thus, in 1993, the sea ice was of greater extent and disappeared faster than in 1992. It may be that more rapid melting of more sea ice in 1993–1994 introduced fresh water faster than it was mixed or advected away.

The source of the high-salinity water around Anvers Island is unknown, but this water may derive from outflow from the Bransfield Strait through the Gerlache Strait. It is, however, more likely that this may be a region of upwelling of the saltier and warmer Circumpolar Deep Water that is found throughout the continental shelf west of the Antarctic Peninsula (Hofmann et al. in press; Smith et al. 1995), which would then mix with the Antarctic Surface Water. Irrespective of the source of this water, however, the near-surface temperature and salinity distributions indicate that the region near Anvers Island differs from the rest of the west Antarctic Peninsula shelf region.

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Palmer LTER: Temporal variability in the location of the Antarctic Circumpolar Current along the west Antarctic Peninsula continental shelf

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As part of the Palmer Long-Term Ecological Research (LTER) program, a series of cruises was completed during which physical and biological properties of the continental shelf west of the Antarctic Peninsula were measured. In particular, between January 1993 and January 1994, four cruises, covering the same region, provide observations adequate to describe seasonal variability of hydrographic properties. These cruises occurred in January 1993 (Lascara et al. 1993), March to May 1993 (Hofmann et al. 1993), August to September 1993 (Klinck, Smith, and Smith 1995), and January 1994 (Hofmann et al. 1996).

The Antarctic Circumpolar Current (ACC) flows northeastward through Drake Passage; its southern boundary is near the continental shelf break west of the Antarctic Peninsula (Orsi, Whitworth, and Nowlin 1995). Associated with the southern boundary of the ACC is a distinctive water mass, Upper Circumpolar Deep Water (UCDW), which is characterized by relatively warm temperatures (above 1.5°C) and high salinity (34.7) (Orsi et al. 1995). Because of the elevated temperatures, the location of the ACC is easy to identify along this shelf. Thus, the objective of this article is to use the Palmer LTER hydrographic observations to describe changes in hydrography that occurred between January 1993 and January 1994 at the outer continental shelf.

The area covered by the four LTER cruises is shown in figure 1, where locations are determined by the LTER grid system (Waters and Smith 1992). This system is based on distances in kilometers along the shelf and across the shelf from a base point on the peninsula far to the southwest (on Alexander Island).

The repeated hydrographic measurements near the shelf break, coupled with the easily identified core of the southern ACC, allow a determination of the time variability in its position. The location of the 1.8°C isotherm at a depth of 300 meters relative to the LTER baseline (figure 1) was determined for each transect on each cruise (table). Two points are clear immediately. First, the 1.8°C isotherm is never observed in the middle portion of the sampling region because the sampling did not extend far enough offshore to capture the southern boundary of the ACC. Second, the location of the ACC is variable everywhere except at the north and south ends of the sampling region.

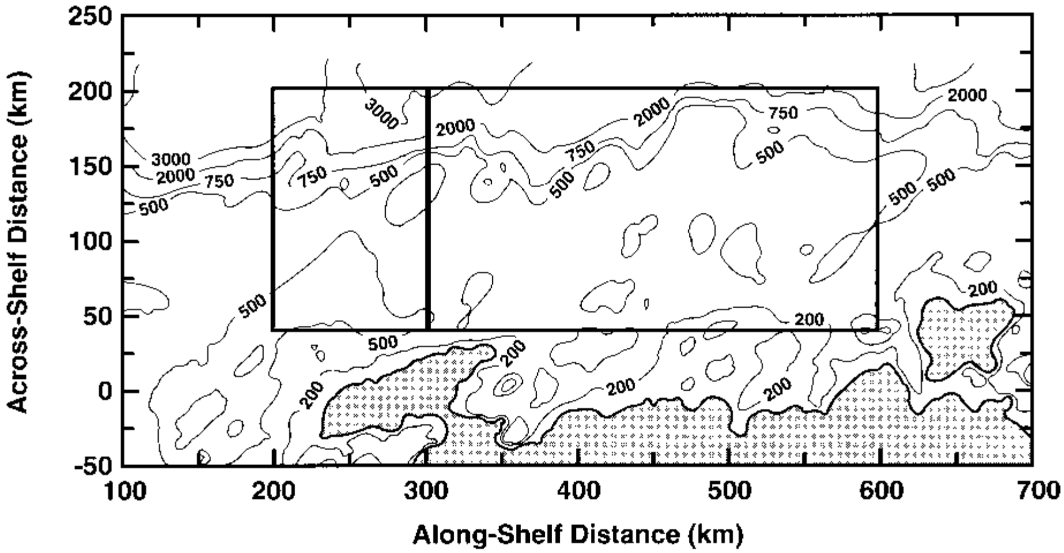

Figure 1. Bathymetry of the Palmer LTER study region. Locations are in distance (km) alongshore and across shore from a base point southwest of the study area (Waters and Smith 1992). The area of LTER sampling is enclosed in the heavy box. A heavy dashed line shows the location of the transects in figure 2. Shaded areas are land. Solid lines are isobaths at depths of 200, 500, 750, 2,000, and 3,000 m. The shelf break typically occurs near the 500-m isobath.

No clear pattern is evident to the location of the 1.8°C isotherm along the shelf break. In particular, the ACC location at one section does not indicate the location at any other section, which means that the across-shelf movement of this current does not occur as a large-scale shift in position but rather as local meanders with scales smaller than the resolution of the hydrographic observations [100 kilometers (km)]. Dynamical considerations indicate that the meander length scale should be 30 to 50 km.

The nature of the shelf break variability is illustrated by the vertical temperature distribution from the four cruises from a transect in the southern portion of the sampling region (figure 2). The pool of water just cooler than 1.8°C, seen in January 1993 (figure 2*A*), indicates a recent intrusion of UCDW. This temperature structure is reminiscent of that seen at the outer edge of the southeastern U.S. shelf where the Gulf Stream meanders are associated with exchange of water across the shelf break (Lee and Atkinson 1983). Two months later, the ACC is firmly against the shelf break (figure 2*B*). Five months later, the warm core of the ACC has retreated more than 20 km offshore (figure 2*C*). A pool of water with temperatures above 1.6°C remains on the middle shelf and the 1.4°C isotherm has moved closer to the coast. After an additional 4 months, the warmest waters are still offshore and the 1.4°C isotherm on the shelf has lifted offshore almost to the shelf break (figure 2*D*).

The implication of these measurements is that the oceanic flow along the outer shelf break west of the Antarctic Peninsula is dynamically active, likely due to baroclinic instability and the interaction of this current with the rugged topography of the shelf break. The time and space scales of this variability are typical of other meandering coastal currents (timescales of 1–2 months and space scales of 30–50 km). This variability is smaller and faster than can be measured by the current sampling scheme, leaving the possibility that changes between cruises will be a mixture of real interannual variability and higher frequency changes. It appears that this variability is largely confined to the outer half of the continental shelf, but these details remain to be determined.

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Location of the 1.8°C isotherm at a depth of 300 m at the outer edge of five across-shelf transects occupied during four cruises between January 1993 and January 1994

Location	93a	93b	93c	94a	Shelf break
200	150	150	160	NO	140
300	OFF	160	180	185	160
400	180	OFF	OFF	180	160
500	OFF	OFF	OFF	OFF	190
600	190	190	OFF	195	170

NOTE: Each section is identified by its distance alongshore from a base point (Waters and Smith, 1992). The location of the isotherm is in kilometers offshore of a base line along the Antarctic Peninsula. The location of the shelf break along each of these lines is included. The absence of observations along a transect is indicated by NO. The notation OFF indicates that the isotherm was not observed.

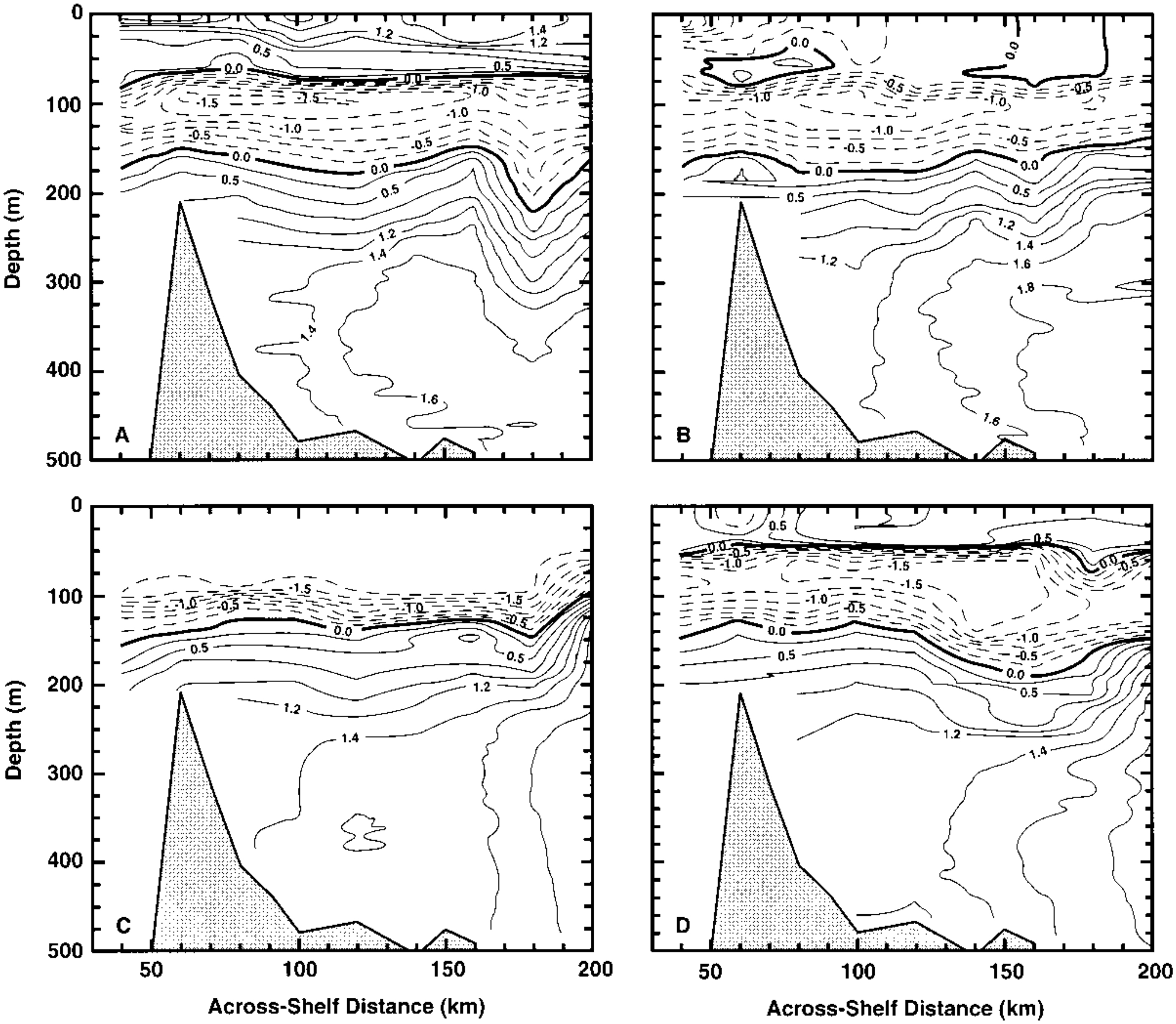

Figure 2. *In situ* temperature from across-shelf transects from four cruises in the southern part of the sampling region (figure 1). Dashed contours indicate temperatures below 0°C. The contour interval is 0.25°C from –2.0 to 1.0°C. The contour interval above 1.0°C is 0.2°C. The ocean bottom, determined by soundings during the March to May cruise, is indicated by shading. (*A*) January and February 1993 cruise. (*B*) March to May 1993 cruise. (*C*) August to September 1993 cruise. (*D*) January and February 1994 cruise.

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