Palmer LTER program: Hydrography and optics within the peninsula grid, November 1991 cruise

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The Palmer long-term ecological research (LTER) program focuses on marine ecosystem processes that link physical forcing, especially the annual advance and retreat of pack ice, to biological factors at different levels of the food web. The abundance and distribution of phytoplankton biomass and primary production include contributions from open water, the marginal ice zone, and ice algae. Controls on phytoplankton production reflect the space/time variability in ice cover, turbulent mixing, nutrient availability, and solar irradiance. We selected the LTER sampling strategy to elucidate the relative importance of these mechanisms, and our hydrographic and bio-optical observations provide data necessary to quantify linkages between the physical and biological components of the system. During the Palmer LTER cruise on the R/V *Polar Duke* in mid-November 1991, we used the bio-optical profiling system (BOPS II) (Smith et al. 1984; Smith et al.) to sample and define the physical, optical, chemical, and biological characteristics of the marginal ice zone in the large-scale area surrouding Palmer Station. We carried out transects along the Renaud (500), Palmer basin (600), and Dallmann Bay (700) lines of the PalLTER Peninsula grid (Waters and Smith 1991). Here we present preliminary hydrographic and optical results which complement the LTER phytoplankton (Prezelin et al. 1991) and krill work (Quetin et al. 1991).

Figure 1 is a defense meterological satellite program (DMSP), optical line scanner image showing ice cover in LTER cruise area at the start of the cruise. The ice edge was compacted, the pack ice snow covered, and the concentration of large icebergs relatively high. The image shows open water in portions of the Gerlache and Bismarck Straits.

Temperature, conductivity, and sigma-t as a function of depth are shown for each transect line in figure 2. Also shown is the approximate location of the ice edge. Ship observations are consistent with the satellite image. On the Renaud I (500) line the compacted ice edge was near and seaward of station 500.100, which was snow-covered and rafted pack ice. Open and ice-free water was to the northwest, with many large icebergs to the southeast toward the Peninsula. On the Palmer basin line there was open water to the southeast near the Bismarck Strait, snow-covered and rafted pack ice (within which the R/V *Polar Duke* was held fast for four days) between stations 600.040 and 600.060, and

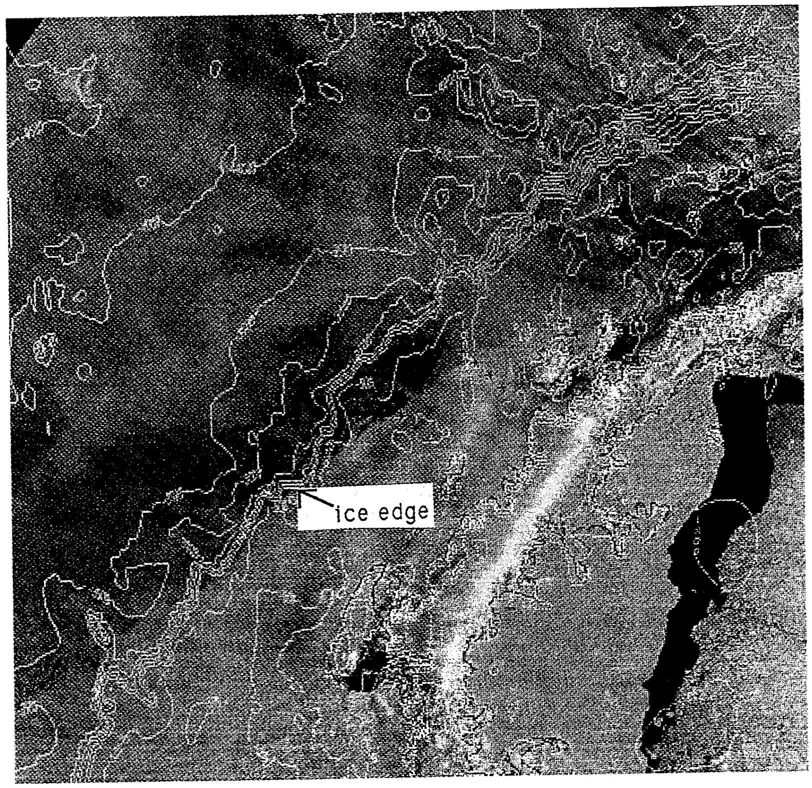

Figure 1. Defense Meterological Satellite Program, Optical Line Scanner (DMSP/OLS) image from 7 November 1991 (1023z) of the Antarctic Peninsula (coast simplified and outlines in black) and the Palmer area during the LTER cruise on the R/V *Polar Duke*. Small arrow points to the compacted ice edge to the west of the Antarctic Peninsula. Station points are shown as black asterisks and bottom topography as white lines with depth in meters.

ice-free water northwest of stations 600.080. The Dallmann Bay line had snow-covered and heavily rafted pack ice and icebergs near station 700.020, with open water in Schollaert Channel and ice-free water at all stations farther northwest.

The beam attenuation coefficient (660 nanometers), stimulated fluorescence, and downwelling irradiance at 488 nanometers as a function of depth are shown in figure 3. Beam c, often characteristic of biogenic particulate matter (Bishop et al. 1992), and fluorescence, an indicator of chl-*a*, show spatial coherence and are consistent with HPLC chl-*a* observations (Prezelin et al. 1991). Elevated values of pigment biomass appear to be associated with the marginal ice zone along the Renaud and Dallmann lines. The Palmer basin line, with open water at each end and a wind-compacted ice edge, had relatively low pigment biomass.

We are analyzing these data further with respect to the coupling between ice-edge dynamics, circulation, optical properties, nutrient distribution, and biological variability. Our goal is to define and model this coupling, using full spectral bio-optical models (Smith et al. 1987; Smith et al. 1989; Bidigare et al. 1992).

This work was supported by National Science Foundation grant DPP 90-11927 (RCS) and is Palmer LTER Publication No. 10. Bob Whritner, Manager of the Arctic and Antarctic Research Center, Scripps Institution of Oceanography, kindly provided the satellite image.

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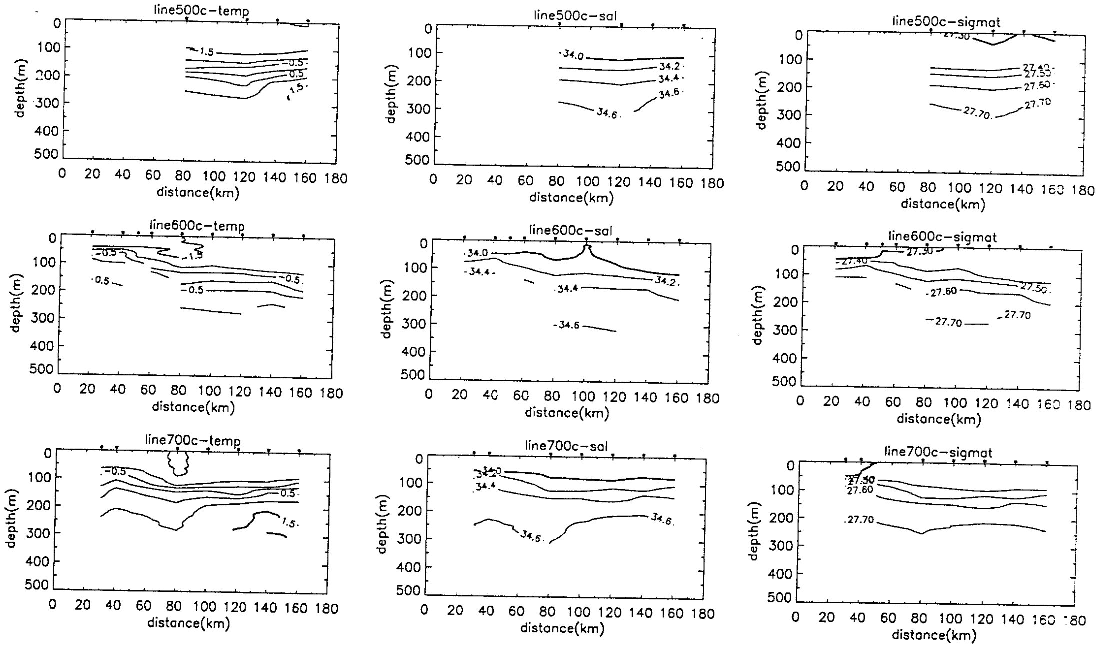

Figure 2. Temperature (degrees Celsius), salinity (percent), sigma-t (kilogram per cubic meter) vs. depth (meters) for transects along the Renaud I (500), Palmer basin (600) and Dallmann Bay (700) lines. Along these lines the approximate location of the ice edge was at grid locations 500.100, 600, 080, 700.025.

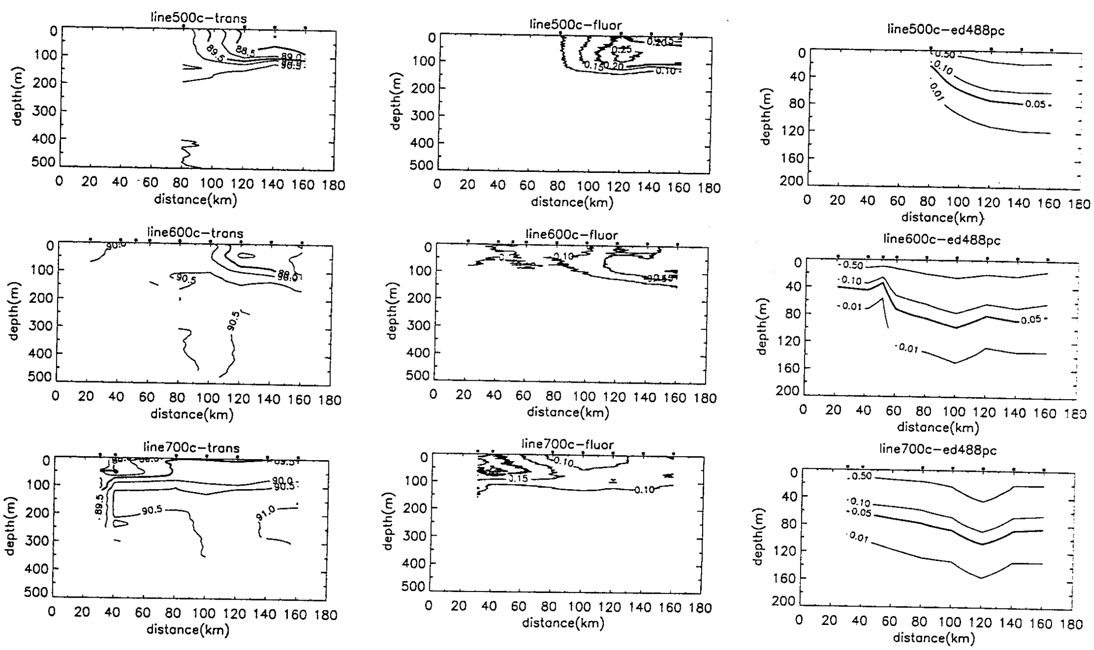

Figure 3. Beam transmittance (percent per meter), stimulated fluorescence (relative), and downwelling irradiance at 488 nanometers (per square meter per nanometer) vs. depth (meters) for transects along the Renaud, Palmer, and Dallmann lines. Scale as for figure 2.

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