# Palmer LTER program: Hydrography and optics within the peninsula grid, zodiac sampling grid during the 1991-1992 field season

RAYMOND C. SMITH, KAREN S. BAKER,
PHIL HANDLEY, AND TIM NEWBERGER

*Center for Remote Sensing and Environmental Optics*

and

*Department of Geography*
*University of California at Santa Barbara*
*Santa Barbara, California 93106*

The linkages between different trophic levels is a key focus of the Palmer long-term ecological research program (LTER). We selected seabirds, Adélie penguins and south polar skuas (Fraser et al. 1991) to represent upper-tropic level predators, and our study site included the breeding areas of these birds near Palmer Station. We established a fixed set of sampling stations (Palmer grid), within the small boat range of Palmer Station, in order to provide high-resolution time-series data in the immediate area of the LTER predator field and sampling linkage with cruise observations on the larger-scale PalLTER peninsula grid (see figure Waters and Smith 1991). Our objective was to obtain higher resolution physical, optical, chemical, and biological observations, comparable with ship observations, on the Palmer grid.

A Mark V zodiac was outfitted with a platform, two davits with blocks, hand winch, gas powered generator, and consoles for electronics (figure 1). We called this zodiac, when so outfitted, the regional optical zodiac experiment (ROZE) and used it to deploy

- a SeaBird conductivity-temperature-depth recorder (CTD) with SeaTech transmissometer and fluorometer to determine temperature, conductivity, depth, beam transmittance (660 nanometers), and stimulated fluorescence (chlorophyll a);
- an optical free-fall instrument (OFFI) to determine downwelling spectral irradiance and upwelling spectral radiance (Waters et al. 1990); and
- a biosonics instrument to acoustically estimate krill school density.

We used a Trimble Pathfinder Global Positioning System (GPS) and hand-held compass for navigation, a fishfinder for depth information, and an above-water spectral irradiance sensor to complement the in-water component of the OFFI. Here we present a few preliminary hydrographic and optical results that complement the Palmer grid pigment and nutrient observations.

Sigma-t, as a function of depth and time, are shown for the Palmer stations A through E (figures 2 and 3; see map: figure 2 Waters and Smith 1991 or figure 2 Prezelin et al. 1991a). Snow-covered pack ice covered most of Arthur Harbor (and station A) until mid-December 1991. During early December stations B through E shifted between open pack ice (0.4 to 0.6 ice cover) and open water (less than 0.1 ice cover) with several large icebergs in the area. By the end of December open water conditions (with occasional icebergs) prevailed. Pack ice covered the area surrounding stations A (95 percent), B (95 percent), and C (40 percent) for a few days in late January (20 January). In spite of the nearshore environment, these stations show a high degree of coherence with fresher water stabilizing the upper layer as the season progresses. Preliminary analysis suggests that stations D and E are reasonably representative of Palmer basin, but further work is necessary to test this hypothesis.

Figure 3 shows a comparison of beam transmittance (a measure of both organic and inorganic particulate material) and stimulated fluorescence (a measure of chl-*a*) as a function of depth and time at station A. The fluorescence data are consistent with high-pressure liquid chromatography chl-*a* observations (Prezelin et al. 1991b). Beam transmittance and fluorescence show space/time coherence until late January. At that time a heavy rain, accompanied by island and glacier runoff, decreased pigment biomass and increased the non-phytoplankton component of attenuation. Energy available for photosynthesis (data not shown) was redirected to nonviable particulate material. This same event reduced surface stratification (figure 3, sigmat) and mixed particles to greater depth, further reducing energy available for photosynthesis. This is a particularly dramatic illustration of physical and bio-optical coupling.

We are further analyzing these data with respect to the coupling between physical forcing, 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. 11.

**Figure 1. Photograph of the ROZE (Mark V zodiac outfitted for the remote optical zodiac experiment) which was used to deploy a CTD (with fluorometer and transmissometer), an OFFI, and a biosonics instrument. CTD is being deployed, OFFI stored on the starboard side, biosonics fish on the port side. See text for details.**

## References


Bidigare, R. R., B. B. Prezelin, and R. C. Smith. 1992. Bio-optical models and the problems in scaling. In P. G. Falkowski (Ed.), *Primary Productivity and Biogeochemical Cycles in the Sea.* New York: Plenum Press, in press.

Fraser, W. R., W. Z. Trivelpiece, B. R. Houston, and D.R. Patterson. 1991. Palmer LTER: Seabird research undertaken during 1991-1992 at Palmer Station, Antarctic Peninsula. *Antarctic Journal of the U.S.,* this issue.

Prezelin, B. B., M. Moline, K. Seydel, and K. Scheppe. 1991a. Palmer LTER: Temporal variability in HPLC pigmentation and inorganic nutrient distribution in surface waters adjacent to Palmer Station, December 1991 - February 1992. *Antarctic Journal of the U.S.,* this issue.

Prezelin, B. B., N. P. Boucher, M. Moline, E. Stephens, K. Seydel, and K. Scheppe. 1991b. Palmer LTER: Spatial variability in phytoplankton distribution and surface photosynthetic potential with the peninsula grid, November 1991. *Antarctic Journal of the U.S.,* this issue.

Smith, R. C., R. R. Bidigare, B. B. Prezelin, K. S. Baker, and J. M. Brooks. 1987. Optical characterization of primary productivity across a coastal front. *Marine Biology,* 96:575-591.

Smith, R. C., B. B. Prezelin, R. R. Bidigare, and K. S. Baker. 1989. Bio-optical modeling of photosynthetic production in coastal waters. *Limnology Oceanography,* 34(8):1,524-1,544.

Smith, R. C., K. S. Baker, K. K. Hwang, D. Menzies, and K. J. Waters. 1991. Palmer LTER: Hydrography and optics within the Peninsula grid, November 1991 cruise. *Antarctic Journal of the U.S.,* this issue.

Waters, K. J. and R. C. Smith. 1991. Palmer LTER: A sampling grid for the Palmer LTER program, *Antarctic Journal of the U.S.,* this issue.

Waters, K. J., R. C. Smith, and M. R. Lewis. 1990. Avoiding ship-induced light-field perturbation in the determination of oceanic optical properties. *Oceanography,* 3(2):18-21.

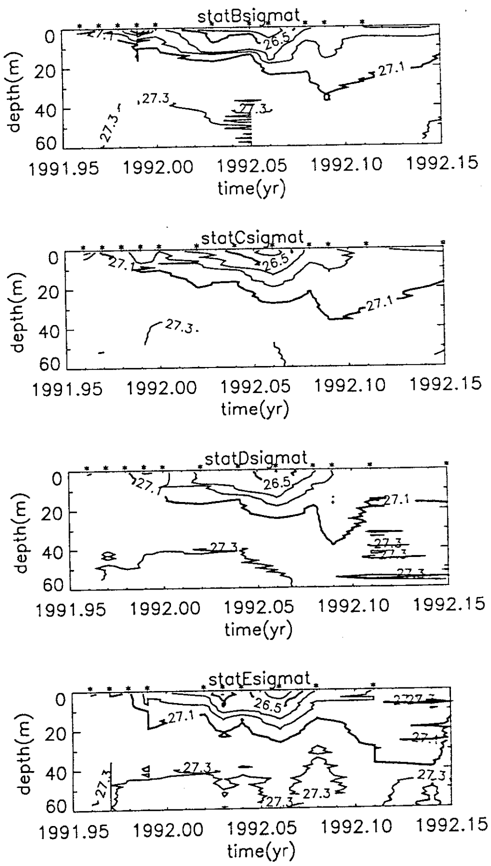


**Figure 2. Sigma-t (kilograms per cubic meter) vs. depth (meters) and time for Palmer stations B through E. (top to bottom panel)**

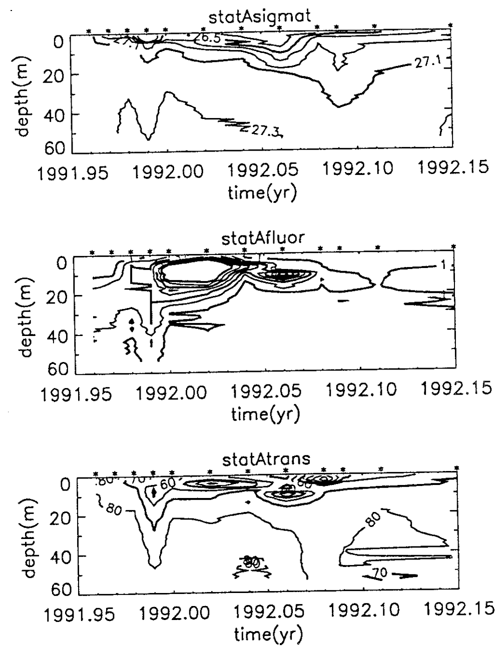


**Figure 3. Sigma-t (as in figure 2), beam transmittance (percent per meter), and stimulated fluorescence (relative) as a function of time for station A.**