The status of the Bering Sea: July-December 2001

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Dr. Phyllis J. Stabeno, a physical oceanographer at the Pacific Marine Environmental Laboratory (PMEL) of NOAA, conducts research focused on understanding the dynamics of circulation of the North Pacific, Bering Sea and their adjoining shelves. She is the PMEL Director of NOAA Fishery Oceanography Coordinated Investigations (FOCI), and by applying her knowledge of physical processes to fisheries oceanography, she plays a vital role in its success. FOCI research focuses on building sustainable fishery resources in the Gulf of Alaska and Bering Sea while maintaining a healthy ecosystem. Phyllis is also the Principal Investigator on several research elements for other programs, including: Southeast Bering Sea Carrying Capacity (Coastal Ocean Program), the Bering Sea Green Belt: Processes and ecosystem production (Arctic Research Initiative) and Prolonged Production and Trophic Transfer to Predators: Processes at the inner front of the southeast Bering Sea (National Science Foundation). This research seeks to improve our understanding of ecosystems through the integration of physical and biological phenomena.

The Bering Sea varies on a continuum of temporal scales. On scales longer than seasonal, most of the energy is found in the year-to-year variability, although the Bering Sea is also influenced by both the Arctic Oscillation (AO) and the Pacific Decadal Oscillation (PDO). Both of these decadal patterns have undergone changes since the mid-1990s. During 2001, the AO was strongly negatively, which resulted in weaker zonal flow and more north-south excursions in the atmosphere (Fig. 1).

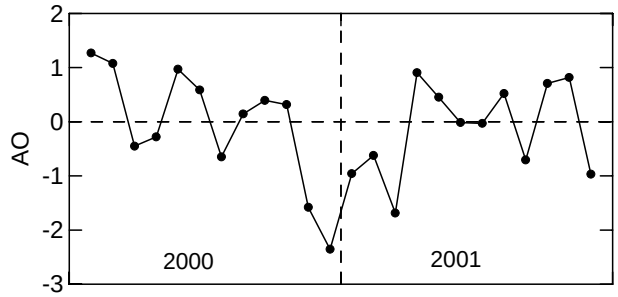

Fig. 1 Monthly values of the Arctic Oscillation Index in 2000 and 2001, showing the strongly negative trend during the winter of 2000/2001.

The PDO, which is the first mode of variability in sea surface temperature, changed from negative to positive in 1977 (Fig. 2). This regime shift in 1977 resulted in a reorganization of the Bering Sea ecosystem. During the La Niña of 1998, the PDO changed sign again. Historically, changes in the PDO have altered marine ecosystems around Alaska, especially salmon populations. It is too early to tell what impact on the Bering Sea ecosystem the change that occurred in 1998 will have. It should be noted that an El Niño is predicted for 2002. How the El Niño will interact with PDO in a negative state is not known.

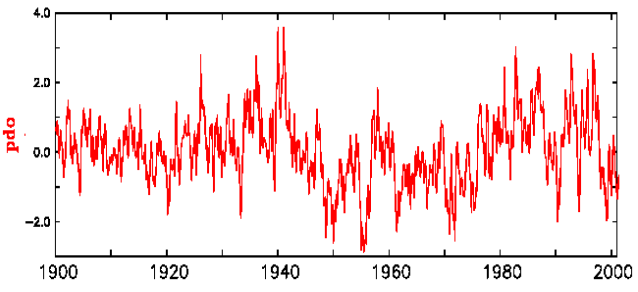

Fig. 2 The Pacific Decadal Oscillation from 1900 to 2001.

With the completion of two major research programs (Coastal Ocean Program's Southeast Bering Sea Carrying Capacity and NSF's Inner Front Programs) in 2000, there

are limited oceanographic data available for the Bering Sea. In 1995, a biophysical mooring was deployed at 56.9ºN, 164ºW over the southeastern Bering Sea shelf (Fig. 3). This mooring site is located near the center (70 m isobath) of the middle shelf. Instruments measuring temperature, salinity, fluorescence, nitrate and currents are deployed year around. The mooring was maintained through 2001, providing seven years of almost continuous data at that site.

Shown in Figure 4 are near surface and depth average temperature data from spring and summer of 1995-2001 at Site 2. The pattern of sea surface temperature is fairly consistent. Coldest temperatures occur after the retreat of the ice. The upper layer typically begins warming in late March or early April, and temperature continues to increase through late July or early August, when maximum sea surface temperature typically occurs.

During the summer of 2001, both the sea surface temperature and the depth averaged temperature at Site 2 were similar to those observed in 1998. The temperature in early spring, 2001, was relatively warm at Site 2, because of the lack of sea ice the previous winter. While 1997 had

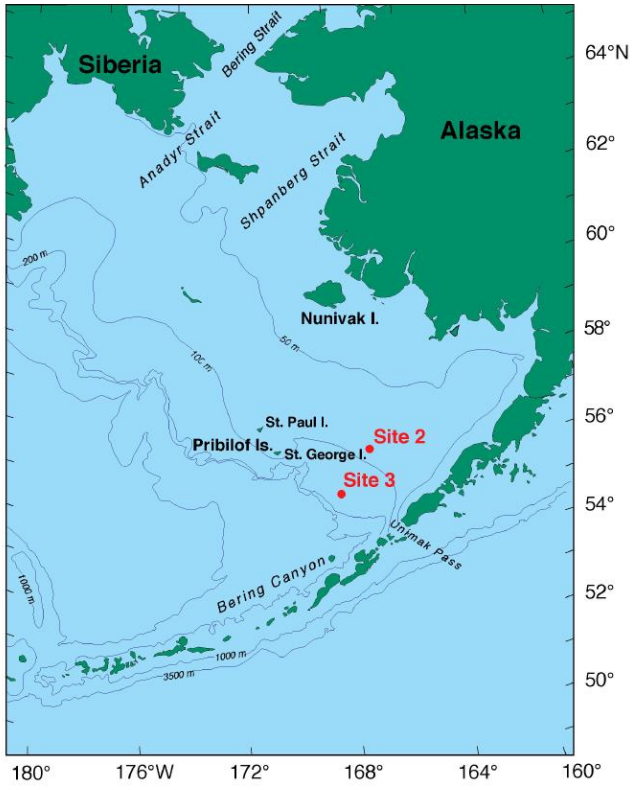

Fig. 1 Geography and place names in the eastern Bering Sea. The location of the two monitoring lists is indicated by bold numerals. Depth contours are in meters.

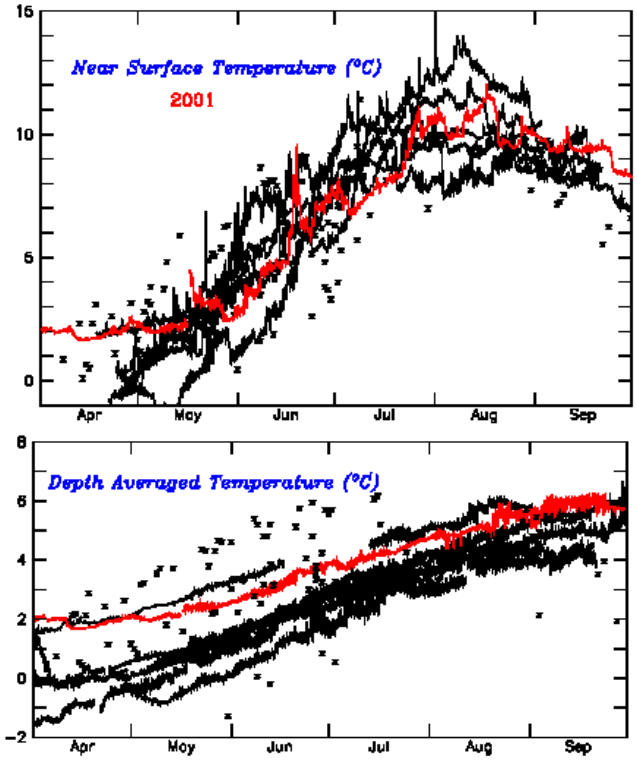

Fig. 4 The seasonal sign of near surface temperature measured (top panel) and the depth averaged temperature (bottom panel) at Site 2. Historical data from 1995-2000 are shown by solid black lines, and 2001 data as a red. Data from hydrographic surveys between 1966 and 1994 are shown as Xs.

the warmest sea surface temperatures, it was during 1998 that warmest depth average temperatures were observed (lower panel, Fig. 4). The water column became well mixed in late October and continued to cool through December to about 1.5°C. Flow was well defined along the 50 m isobath, which forms the boundary between the well-mixed coastal domain and the two-layered middle shelf.

Since 1997, a coccolithophore bloom has occurred over the eastern Bering Sea shelf each summer. Coccolithophores are small, photosynthetic cells. They are covered by calcareous plates, which reflect light and give the water a distinctive milky color. The bloom during the warm, calm summer of 1997 was clearly visible from ships and satellite images. While the bloom was evident in satellite images during 2001, shipboard measurements indicated that concentrations of cells were lower than had been observed in earlier years. It is not known whether this decrease was due to the timing of the measurements or if the bloom was weaker than in previous years.