The status of the Bering Sea: January – July, 1999

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Dr. Phyllis J. Stabeno, a physical oceanographer at the Pacific Marine Environmental Laboratory (PMEL) of NOAA, conducts research focussed 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 focusses on building sustainable fishery resources in the Gulf of Alaska and Bering Sea while maintaining a healthy ecosystem. Phyllis is also a 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.

Observations of the eastern Bering Sea shelf continue to depict an ecosystem undergoing significant physical and biological change. Most of the observations of conditions over the southeastern Bering Sea and basin were collected as part of two funded programs: Southeast Bering Sea Carrying Capacity (a NOAA Coastal Ocean Program) and the Inner Front Program (NSF funded research). A single mooring site at the 70m isobath (56.9°N, 164°W), which has been occupied for five years, provides insight into the changes that have occurred during these years. Conditions at this site are representative of conditions over the southern middle shelf of the Bering Sea.

During the last three years, great interannual variability has occurred in the physical environment over the Bering Sea shelf. In 1997, sea surface temperatures were above normal, primarily as a result of weaker than normal winds in the spring and the summer (Fig. 1). Sea surface temperatures were cooler in 1998 than in 1997, and were associated with strong winds in the spring and weak winds in summer. The depth-integrated temperature in 1997 was typical of temperatures observed in the last decade. In 1998, despite the decrease in surface temperature compared to the previous year, the depth-averaged temperature was greater and closer to temperatures observed in the early 1980s. The higher than normal heat content over the southern shelf resulted from warmer initial conditions which in turn were caused by a reduction in sea ice. Although ice was present in February 1998, it retreated early and did not cool the water column to the same extent as occurred in 1997.

In contrast to these years, 1999 was markedly different. Although sea ice was not as extensive as was observed in 1995 or 1997, it arrived early over the southeastern shelf, and persisted into May. Because the ice retreated slowly, compared to the last 20 years, the water column remained cold (approximately -1°C in mid-May; Fig. 1). Once the ice was gone, however, the water column began to warm at a similar rate to that observed in recent years. Because of the colder initial conditions, sea surface temperatures were unusually cool in late July and August, when the warmest sea surface temperatures are typically observed. Although conditions were cold in 1999, both sea surface temperatures and depth-averaged temperatures were still warmer than observed during the cold years before 1976.

Transport in the Bering Slope Current, which flows to the northwest along the Bering Sea shelf break, undergoes long-term variability. In 1997, transport was greater than normal (>6 x 10^6 m^3 s^{-1}). In 1998, transport weakened (~2 x 10^6 m^3 s^{-1}) and these conditions continued through the first 6 months of 1999. Mechanisms causing this shift in transport are not known. Satellite-tracked drifters also displayed a sluggish current along the eastern Bering Sea slope, with weak on-shelf transport in spring and summer.

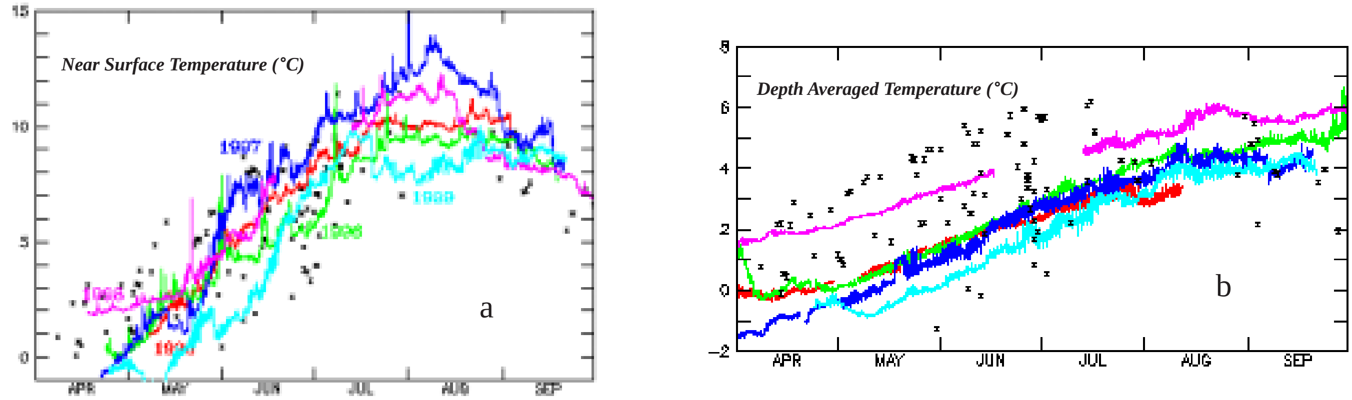

Fig. 1 (a) The seasonal sign of near surface temperature at Site 2. Data from each year when moorings were located at this location are indicated by colored lines. Data from 138 separate occupations of hydrographic stations between 1966 and 1994, in the vicinity of Site 2, are shown as Xs. (b) The depth-averaged temperature for the same data shown in panel a.

The North Pacific Ocean and the Bering Sea are influenced by large-scale atmospheric variability known as the Pacific Decadal Oscillation (PDO). It is generally recognized that a regime shift occurred in 1977, when the PDO shifted from strongly positive to negative. Speculation of a possible regime shift opposite to that which occurred in 1977 continues, but it still remains too early to be sure. ENSO events influence the PDO. The La Niña of 1998 persisted into the winter and spring of 1999, so the changes in the PDO may be a result of persistent La Niña conditions rather than a shift in the decadal patterns to pre-1977 conditions.

A coccolithophore bloom continued for an unprecedented third year over the eastern Bering Sea shelf. Coccolithophores are small, photosynthetic cells covered by calcareous plates (liths), from which light reflects giving the water its distinctive milky white color . The bloom first appeared over much of the southern Bering Sea shelf in 1997, and was observed both from space (SeaWiFS, and the space shuttle) and aboard ships. In 1998, it extended further north, and was advected into the Arctic Ocean through the Bering Strait. The earliest SeaWiFS true color image from 1999 revealed the milky white water over the shelf (Fig. 2), seaward of the ice edge. Satellite imagery does not differentiate between the live cells and free liths, which are detached from cells but remain in the water column. During early February, 1999, scientists collected samples that contained both live cells and large numbers of liths in the water column; satellite imagery from the same time revealed the distinctive color associated with coccolithophores near the ice edge (Fig. 2). Large blooms of coccolithophores in the Bering Sea do not appear until July or perhaps August. The extent of this year's bloom, and the impact of the cooler sea surface temperatures on it, will not be known until later in the year.

Significant changes in this ecosystem are of particular concern since the eastern Bering Sea provides approximately half the fish and shellfish caught in the United States and supports a large number of sea mammals. In 1997 and 1998, unexpectedly low returns of sockeye salmon occurred in the Bristol Bay fishery. This year the trend was reversed and sockeye salmon returned in large numbers. Whales continue to be seen over the middle Bering Sea shelf, which is an apparent shift from historical concentrations along the slope. The Bering Sea fur seal population on the Pribilof Islands (which accounts for ~90% of the fur seal population) has remained stable during the last few years, although this year there is some evidence of a decrease. Three to four years of observations are required to determine if a decline has occurred. The Stellar sea lion population continues its 20-year decline. Long-term changes in atmospheric forcing will undoubtedly continue to change this ecosystem.

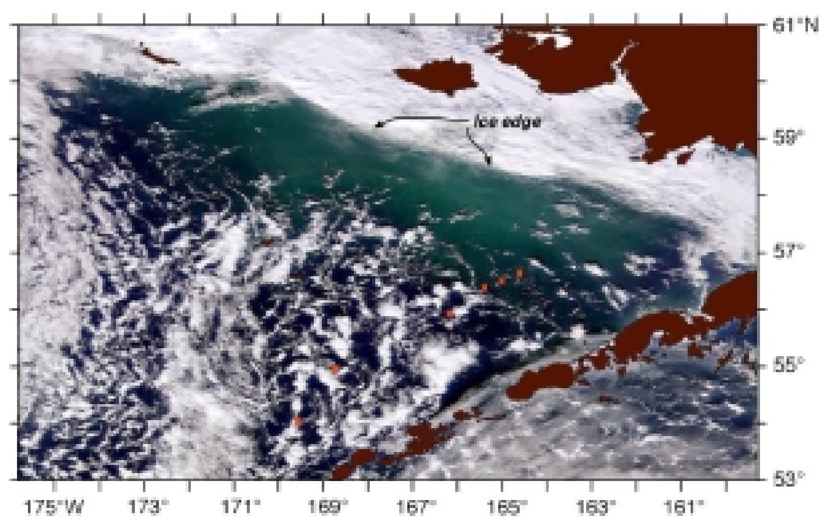

Fig. 2 SeaWiFS true color image from February 23, 1999, showing the presence of milky water near the ice edge. Both Nunivak and St. Matthew Islands (at the upper edge of the image) are in the ice field. The orange dots are where samples were taken to test for presence of coccolithophores.