The status of the Bering Sea: January – August 2001

Phyllis J. Stabeno
Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE,
Seattle, WA, 98115 U.S.A.
E–mail: stabeno@pmel.noaa.gov

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 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.

During the latter part of 2000, air-sea interaction in the Bering Sea was dominated by effects associated with an unusually strong, and northward-displaced, Aleutian low. As a consequence, anomalous northward winds of 2-3 m s^{-1} occurred over the eastern shelf, and anomalous southward winds occurred off the Kamchatka Peninsula. The anomalous winds in the northern Bering Sea blew from the east, and were substantially warmer than normal. This resulted in unusually warm conditions in December over the northern Bering Sea. These conditions persisted well into February, when the pattern changed to the more typical frigid winds out of the north.

The unusual atmospheric conditions in the fall of 2000 directly impacted the formation of sea ice over the shelf. Usually, cold winds out of the northeast freeze the seawater and advect the resulting ice southwestward over the shelf. Usually by December, much of the northern shelf is ice covered. At the beginning of January 2001, however, the northern Bering Sea shelf was largely ice-free. Maximum ice extent occurred in mid to late March, which is typical, but the coverage over the eastern shelf was far less than was common during the previous decade (Fig. 1). Except for the shallow areas next to the coast, the southeastern shelf was ice-free.

Observations collected at a mooring site (Site 2: 56.9°N, 164°W) over the middle shelf showed an anomalously warm, well-mixed water column during most of the winter.

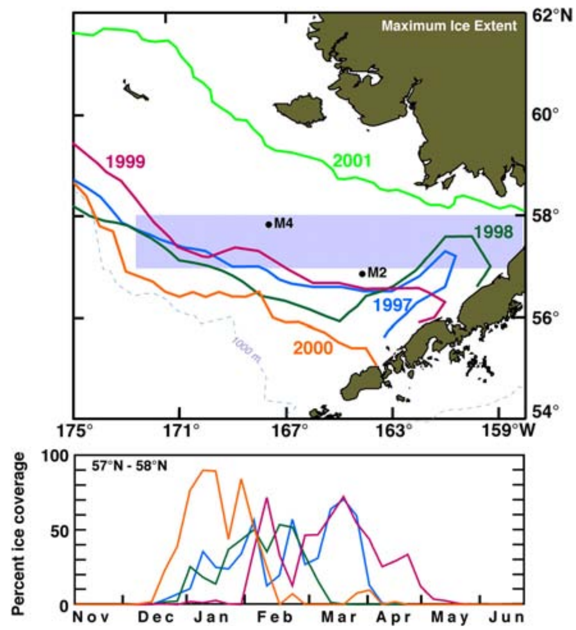

Fig. 1 *Maximum ice extent over the eastern Bering Sea from 1997 through 2001 (top). A time series of percent of ice cover in a one-degree band of latitude (shaded area in top panel) shows the great variability in ice cover over the southern shelf. The light green line from 2001 does not appear in the lower panel, because there was no significant amount of ice south of 58°N during that year.*

Temperatures were >4°C until the end of January, and >3°C until mid-March. At the beginning of April, both the surface temperatures and the depth-integrated temperatures were similar to those observed in the warm period of the late 1970s and early 1980s (Fig. 2). Cool atmospheric conditions, resulted in little heating of the water column until May. Thus the sea surface temperatures during the summer were nearly normal compared to observations since 1995 (solid black lines, Fig. 2). The depth-averaged temperatures of the spring and summer, however, were among the warmest of the last decade.

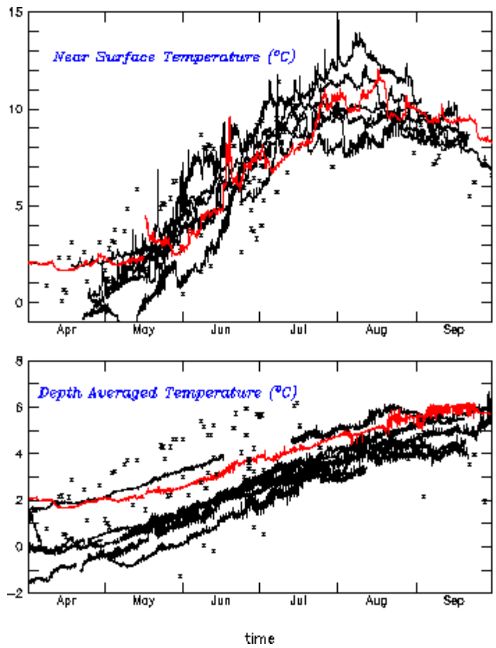

Fig. 2 (top) The seasonal signal of near-surface temperature at Site 2. Data (1995-2000) from the moorings at Site 2 are shown by solid black lines and 2001 as a red line. Data from hydrographic surveys between 1966 and 1994 are shown as Xs. (bottom) The depth averaged temperature for the same data shown in the top panel.

During the summers since 1997, large coccolithophore blooms have appeared 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. During each of the previous four years, the bloom had appeared by late July, and typically reached its maximum extent in the early fall. Its distinctive, milky-white color had been easily visible in satellite images. While active coccolithophore cells were observed over the middle shelf in August 2001, their numbers were lower than observed in previous years, resulting in a less noticeable bloom. A greatly altered zooplankton community was also observed by scientists in August 2001, with a conspicuous absence of calanoid copepods over the southeastern middle shelf (J. Napp, per. comm.).

For several days in early June, much of the eastern and northern Bering Sea was free from clouds, making it visible to satellites. A composite of SeaWiFS images from the first half of June (Fig. 3) shows several regions of high production over the middle shelf and along the outer shelf north of the Pribilof Islands. The high concentrations of chlorophyll over the southeastern shelf are unusual this late in spring, since the spring bloom usually occurs in May, or earlier if there is ice. Mesoscale features, including eddies, are evident in the image. Some eddies, such as the one seaward of the 1000 m isobath near the center of the image, are regions of elevated chlorophyll, while other eddies, such as the one south of the Pribilof Islands, appear to have lower concentrations of chlorophyll. The mechanisms that cause this variability are under investigation.

The large interannual variability of the Bering Sea is evident in both the time series from Site 2 (Fig. 2) and in the plots of ice extent (Fig. 1). While the maximum extent of ice did not vary greatly from 1997-2000, the timing of ice arrival or retreat differed greatly among years. For instance, the greatest ice coverage occurred in 2000, but this occurred early in the year and the shelf was largely ice free after mid-February. Alternately, during 1999, the ice arrived in February and persisted into May. The presence of ice over the southeastern shelf is closely related to the timing of the spring bloom. The historical time series at Site 2 (1995 – 2001) has supported the hypothesis that the absence of sea ice after mid-March results in an open water phytoplankton bloom in May. Alternately, when ice is present after mid-March, an ice-associated bloom occurs. The lack of ice over much of southeastern shelf in 2001 contributed to a late bloom over the southeastern shelf.

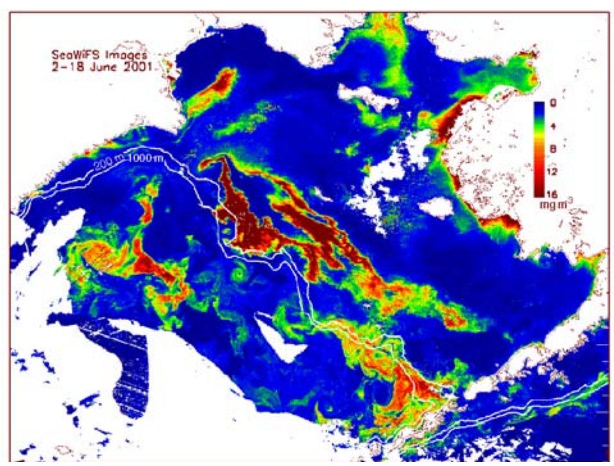

Fig. 3 SeaWiFs composite chlorophyll image (June 2-18, 2001). The image was provided by the SeaWiFs Project, and the Distributed Active Archive Center at the Goddard Space Flight Center, Greenbelt, MD. NASA's "Mission to Planet Earth Program" sponsors these activities.