Eastern Bering Sea Climate – FOCI

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Summary. The year 2009 was a fourth sequential year with cold temperatures and extensive springtime sea ice cover. The Bering Sea again contrasted with much of the larger Arctic which had extreme summer minimum sea ice extents in 2007 through 2009 (39 % below climatology) and positive autumn surface temperature anomalies north of Bering Strait of greater than 4 C. These four recent cold years in the eastern Bering Sea followed a sequence of warm years earlier in the century. A major lesson is that Bering Sea climate conditions are primarily controlled by local or North Pacific processes through winter, spring and summer, and tend to be decoupled from the continued major sea ice loss and warming taking place throughout the greater Arctic regions. Over the next year we should see a modest shift back toward more normal temperatures and less sea ice, ending the run of cold years, as weak to moderate El Nino conditions have developed and are projected to influence Alaska through fall and winter (see North Pacific review).

Surface temperatures are easily measured and provide an available long term measure of the state of the climate. Winter (December-March (DJFM)) average surface air temperatures on St. Paul Island continued cold in 2009 (Figure 13 top). On long time scales (Figure 13 bottom), cold anomalies had their first major appearance in 2006 and 2006-2009 is now the coldest period since pre-1978 conditions.

As in 2008, winter and spring during 2009 was anomalously cold in the southeast Bering Sea (Figure 14). The Bering Sea was part of a region of cold temperatures extending eastward across Alaska and western Canada. In contrast to 2008 the western Pacific Ocean to the southwest switched to warmer temperatures in 2009, while the Arctic remains warmer than normal. The proximate cause of the cold winter and spring in 2009 is similar to 2008 and is shown by the sea level pressure (SLP) anomaly field in Figure 15. The Aleutian low pressure region had much higher than normal SLP indicating weaker or fewer storm systems entering the Bering Sea and east-west trending SLP contours suggest the presence of cold Arctic air masses over the central Bering Sea. What also stands out for 2007 through 2009 is that the warm temperatures of 2000-2005 continue in Chukchi Sea, but not in the southeast Bering Sea.

The four year major cold period in the Bering Sea will probably come to an end with more average conditions prevailing through winter and spring 2009-2010. Modest El Nino conditions are now established and forecasts project these conditions will persist in the North Pacific (See North Pacific climate section). El Ninos can have a direct impact in warming the Bering Sea, called Nino North, but if the northern atmospheric jet stream is also strong, the El Nino impact is less. While we cannot be certain of a warm Bering Sea, we generally can say that the Bering will most likely shift to more average temperatures and sea ice extent in 2010.

Seasonal sea ice is a defining characteristic of the Bering Sea shelf. The presence of sea ice influences the timing of the spring bloom and bottom temperatures throughout the year. Sea ice extent in 2009, as well as 2007 and 2008, (Figure 16) was close to record extents, not seen since the early 1970s, and contrast to the warm years of 2000-2005 (except 2002). With regard to sea ice, the southeast Bering Sea is again showing different conditions than north of Alaska. September 2007, 2008 and 2009 all showed extreme sea ice loss in the summer Arctic. But in fall 2007 and 2008 sea ice extent moved rapidly southward in the northern Bering Sea by December. This supports that the southeastern Bering Sea climate system is mostly decoupled from the continuing warming trend of the greater Arctic.

Along with cold air temperatures and extensive sea ice, ocean temperatures at the M2 mooring site continued to be sharply lower in winter 2006 through winter 2009 compared with 2000-2005 (Figure 17), while 2005 was the warmest year on record. The cold pool (Figure 18), defined by bottom temperatures < 2°C, influences not only near-bottom biological habitat, but also the overall thermal stratification and ultimately the mixing of nutrient-rich water from depth into the euphotic zone during summer. The extent of the cold pool for summer 2009 is the most prominent since 1999, and is even more extensive than 2007 or 2008.

Further information from the M2 mooring, the vertical distribution of temperature for different years (Figure 19) relates to biological productivity. Prior to 2000, ice was observed in the location of M2 on the southeast Bering Sea shelf almost every winter (black shading of temperatures, Figure 19). This was followed by the warm, sea ice-free years. Water column conditions in the winter of 2008 and 2009 were cold for much longer than even 2006 and 2007. As noted in the cold pool figure (Figure 18), the southeastern Bering Sea is now a reservoir of cold sea temperatures.

The most important aspects of the physical environmental in the eastern Bering Sea during 2009 was the multi-year sequential continuation of cold air temperatures, more extensive sea ice, and cold ocean temperatures relative to the previous decade and the apparent decoupling of this cold climate response from the larger scale warming trend of the Arctic. These conditions may moderate in winter 2009-2010.

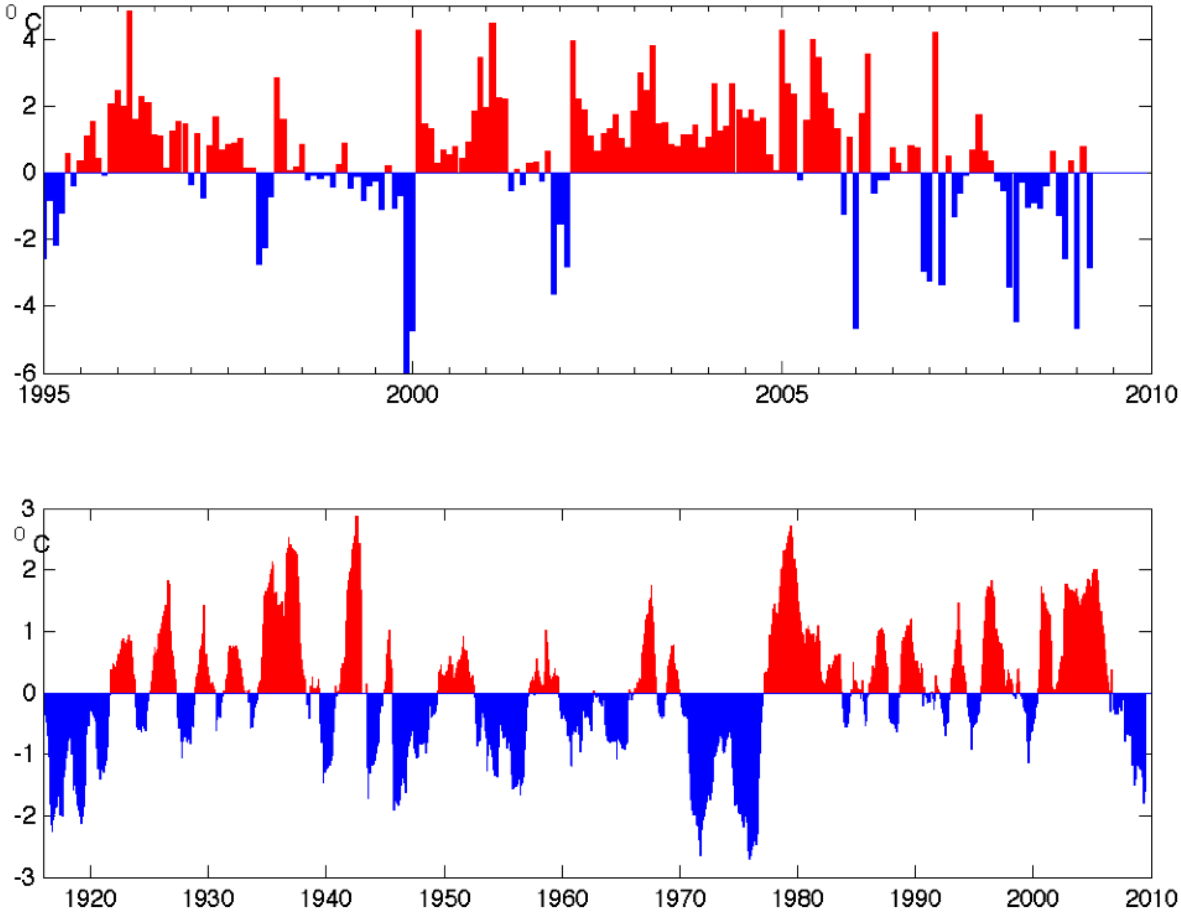

Figure 13. Mean monthly surface air temperatures anomalies in St. Paul, Pribilof Islands, a) unsmoothed, January 1995 through April 2009, and b) smoothed by 13-month running averages, January 1916 through April 2009. The base period for calculating anomalies is 1961-2000.

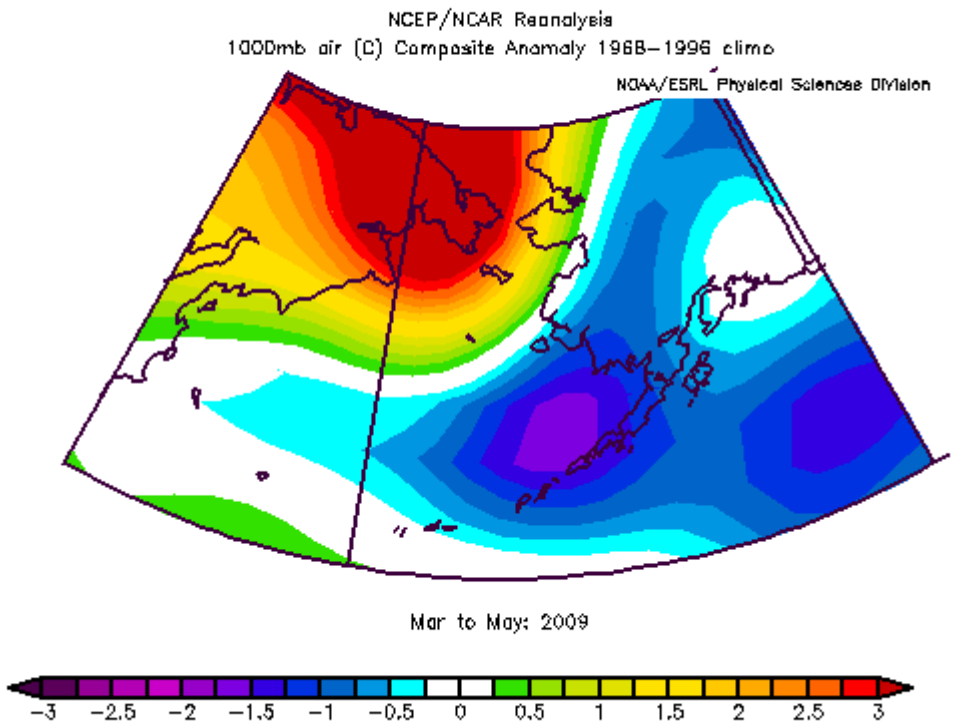

Figure 14. Surface air temperature anomaly over the greater Bering Sea region for spring 2009. Cold surface air temperature anomalies were present in the southeastern Bering Sea (blue shading). Note the contrast to the warm anomalies in northern Siberia.

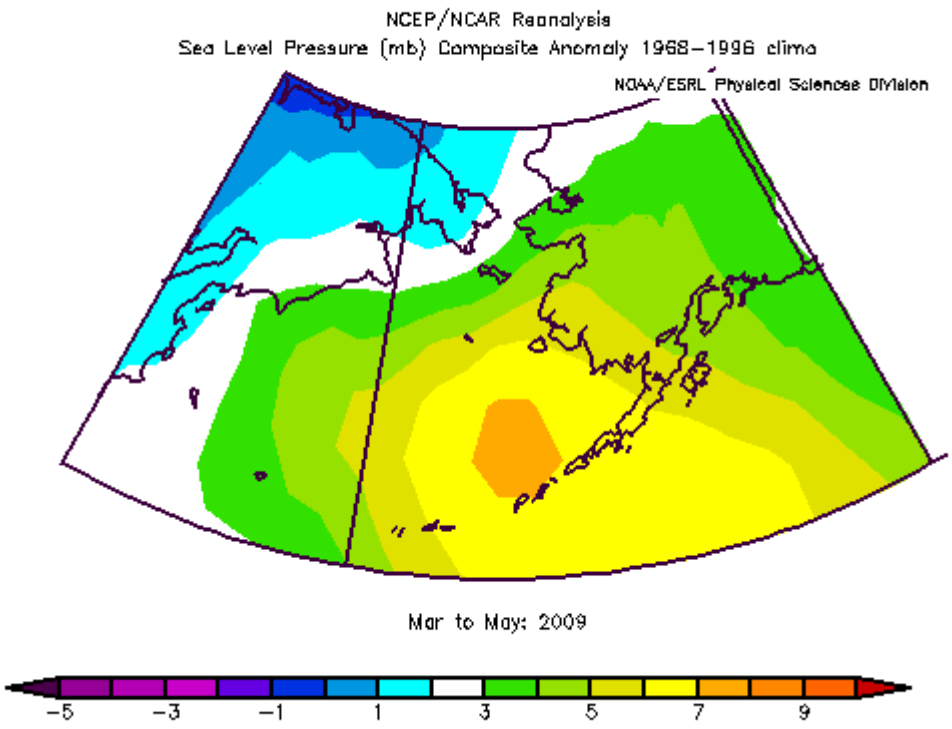

Figure 15. Sea level pressure (SLP) anomaly field for spring 2009. Much higher than normal SLP was present throughout the region. The maximum in the southeast Bering Sea supports weak or west winds anomalies supporting cold air over the SE Bering Sea.

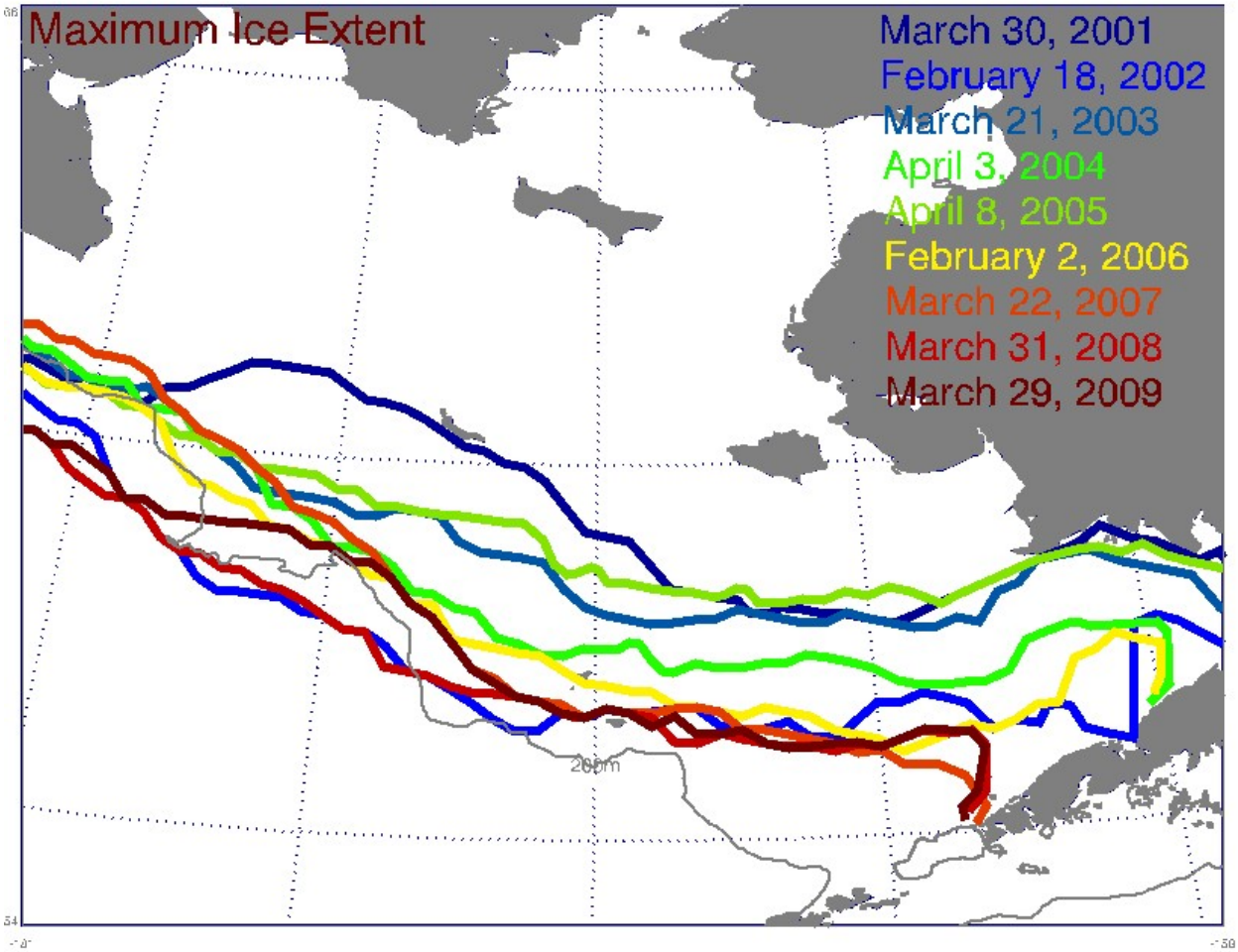

Figure 16. Recent springtime ice extents in the Bering Sea. Ice extent in 2006 through 2009 exceed the minimums of the early 2000s.

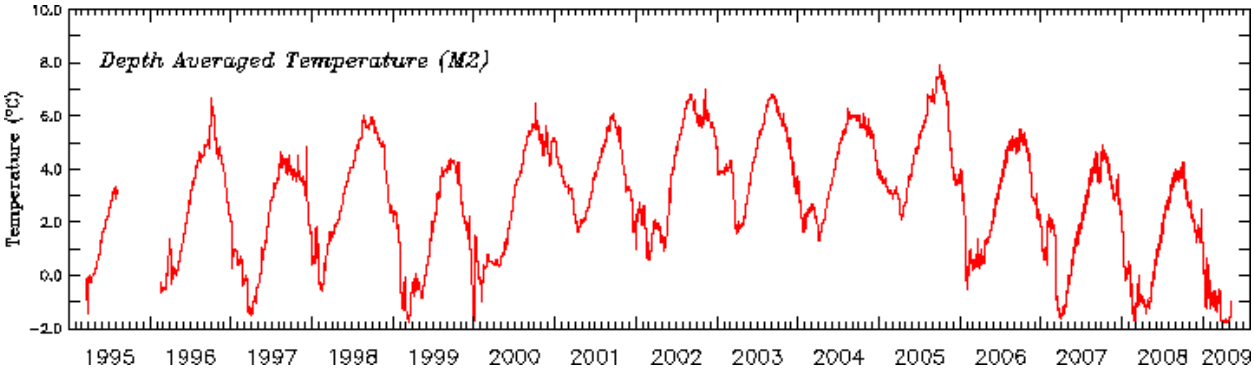

Figure 17. Depth averaged temperature measured at Mooring 2, 1995-2009 in the southeast Bering Sea (°C).

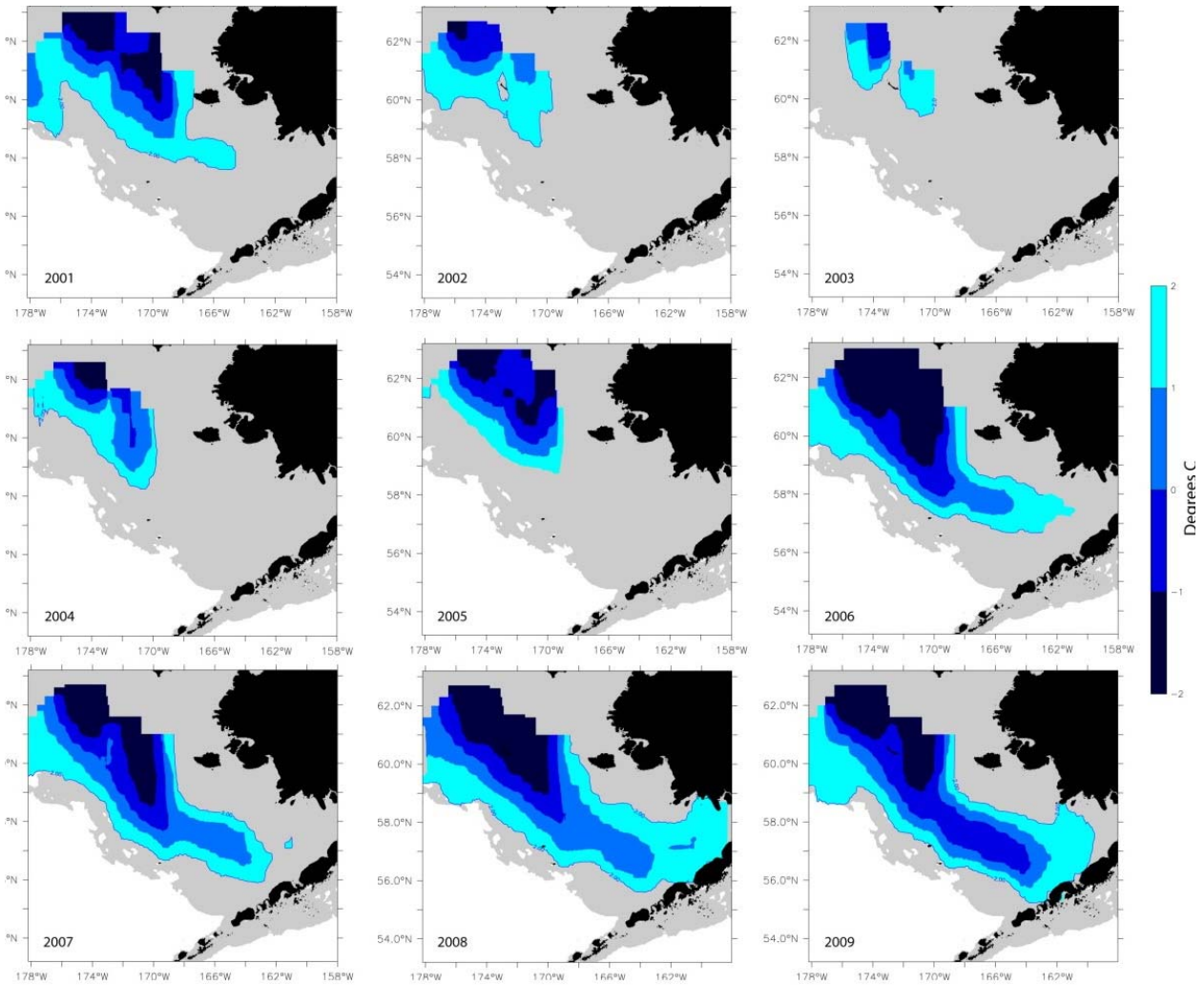

Figure 18. Cold Pool locations in southeast Bering Sea from 2001 to 2009. 2009 represents the maximum southeastward extent of the cold pool of the decade.

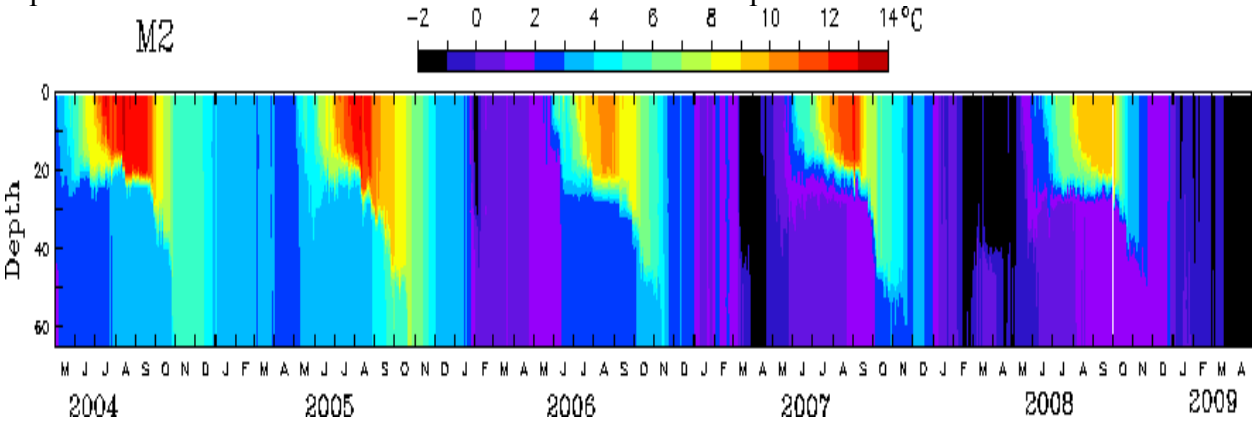

Figure 19. Temperature versus depth and time of year measured at the Mooring 2, 2004-2009 in the southeastern Bering Sea. Temperatures < 1°C (black) occurred when ice was over the mooring. Note the contrast of the warm years of 2004 and 2005 versus 2007-2009.