Eight Years of Long-Term observations on the Southeastern Bering Sea Shelf

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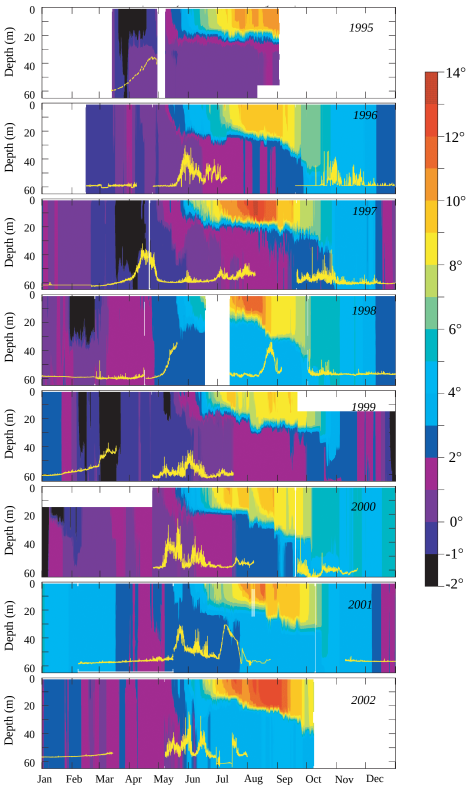
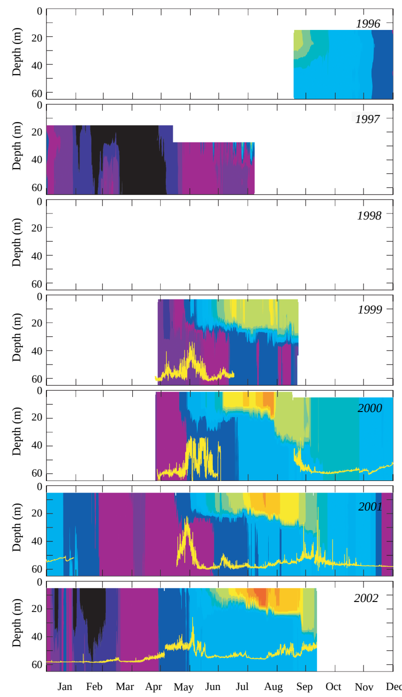
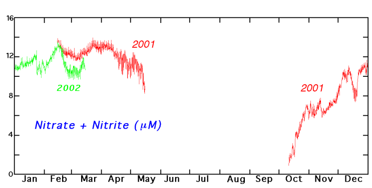
Site 2



Site 4



Contours of temperature measured at Site 2 and at Site 4 are shown in the two upper panels. The coldest temperatures (black) occurred when ice was over the moorings. The yellow line is fluorescence measured at ~11m. During the summer temperatures were recorded at 1m at Site 2 and at 8m at Site 4, and during the winter the upper most instrument was at ~10m. Temperature was extrapolated to the surface.

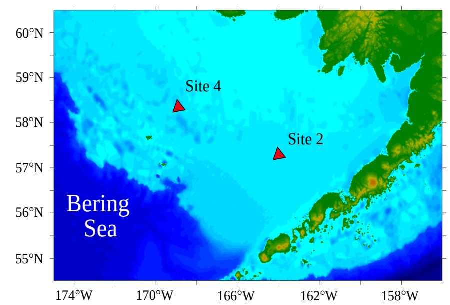


Time series of nutrients (left) measured at Site 2 reveal a seasonal cycle that contains significant annual variability depending on physical conditions and the timing of spring phytoplankton blooms. The replenishment of nutrients occurs during the winter months after the breakdown of the shelf frontal systems (October) and the decrease in nutrients in 2001 is in response to the beginning of the phytoplankton bloom (evident in fluorescence). The use of a moored nitrate meter provides critical information on the temporal scales of this replacement, the level of winter replenishment, and the physical mechanisms responsible for replenishment. The winter replenishment sets the annual level of new production in areas distant from the shelf edge.

Historically, hydrographic measurements have been made in the vicinity of Site 2 on numerous occasions, including during the PROBES experiment. Shown in the figure at right are the seasurface temperatures as measured at the mooring (lines) and the historical data (~100 data points shown as x's, ranging from 1962 to 1993). The depth integrated temperatures are shown in the lower panel. The eight years of time series obtained at Site 2 are cooler in April and May than SST measured in the late 1970s and 1980s, but warmer during July through September than all earlier measurements. SST during August and September in 1997 and 2002 were the warmest on record. Interestingly, 2002 also had the highest depth integrated temperature, even though the initial conditions at the beginning of spring were cooler than 1998 and 2001.

These warm temperatures in late summer are surprising since there was a regime shift in late 1980s to cooler conditions, and this was reinforced with a shift in the Pacific Decadal Oscillation in 1997/1998. These moorings provide important data in any attempt to monitor both decadal variablity and warming due to global climate change.

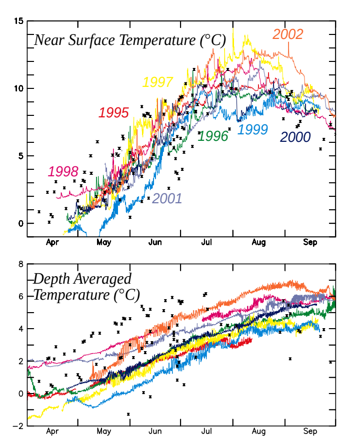
The inherent nature of an ecosystem is change. Dramatic variations in the physical and biological environment of the southeastern Bering Sea have occurred recently. The most comprehensive ecosystem characterization of these changes was made using observations collected at, and in the vicinity of, biophysical moorings at Sites 2 and 4 (see map). Both moorings are on the middle shelf in approximately 73m of water. Site 2 has been maintained almost continually since 1995, providing the longest near continuous time-series of biophysical variables on the Bering Sea shelf. In addition, a series of moorings have been deployed at Site 4, providing almost five years of more sporadic data.



Eight years of temperature records from the moorings at Site 2 reveal a large seasonal cycle. In January, the water column is well mixed. This condition persists until buoyancy is introduced to the water column either through ice melt or solar heating. The very cold temperatures (indicated by black) that occurred in 1995, 1997 and 1998 resulted from the *in situ* melting of ice. Generally, stratification develops during April. The water column exhibits a well-defined two-layer structure throughout the summer consisting of a 15-25 m wind mixed layer and a 35-45 m tidally mixed bottom layer. Deepening of the upper mixed layer by strong winds and heat loss begins as early as mid August, and by early November the water column is again well mixed. During any given year, marked variations are superimposed on the mean springtime warming trend observed at Site 2 .

While the record at Site 4 is less complete, several things are clear. The moorings are close enough that the such broad scale variables as mixed layer depth are similiar between the sites. The temperatures tend to be cooler at the more northern site, and the presense of ice more common.

In addition to currents, temperature and salinity, chlorophyll fluorescence and nutrients are measured on the biophysical platforms. A phytoplankton bloom at Site 2 (yellow lines) occurred in March/April during 1995 and 1997, associated with the arrival and melting of sea ice. In both years, the bloom began even though the water column was not yet stratified. In 1996 and 1998, when ice was present early in the year (February) and then retreated, the earliest bloom occurred during May after the water column became thermally stratified. It is likely that during 1996 and 1998, the ice was present too early in the year when insufficient sunlight was available to initiate an ice edge bloom. The timing of the blooms is important to the Bering Sea's sea food webs (e.g. the Oscillating Control Hypothesis; Hunt et al., 2002, Hunt and Stabeno, 2002). Conventional wisdom is that ice-edge blooms, being little-grazed, are especially important sources of food to the benthos. In addition, the cold-water temperatures associated with years in which ice penetrates far into the southeastern Bering Sea result in low plankton production (Coyle and Pinchuk, 2002). Shipboard measurements show that both the ice-associated bloom and the more typical spring bloom strip the upper water column of nutrients. In November, when the strong summer thermocline breaks down, a fall bloom is signaled by an increase in fluorescence.



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