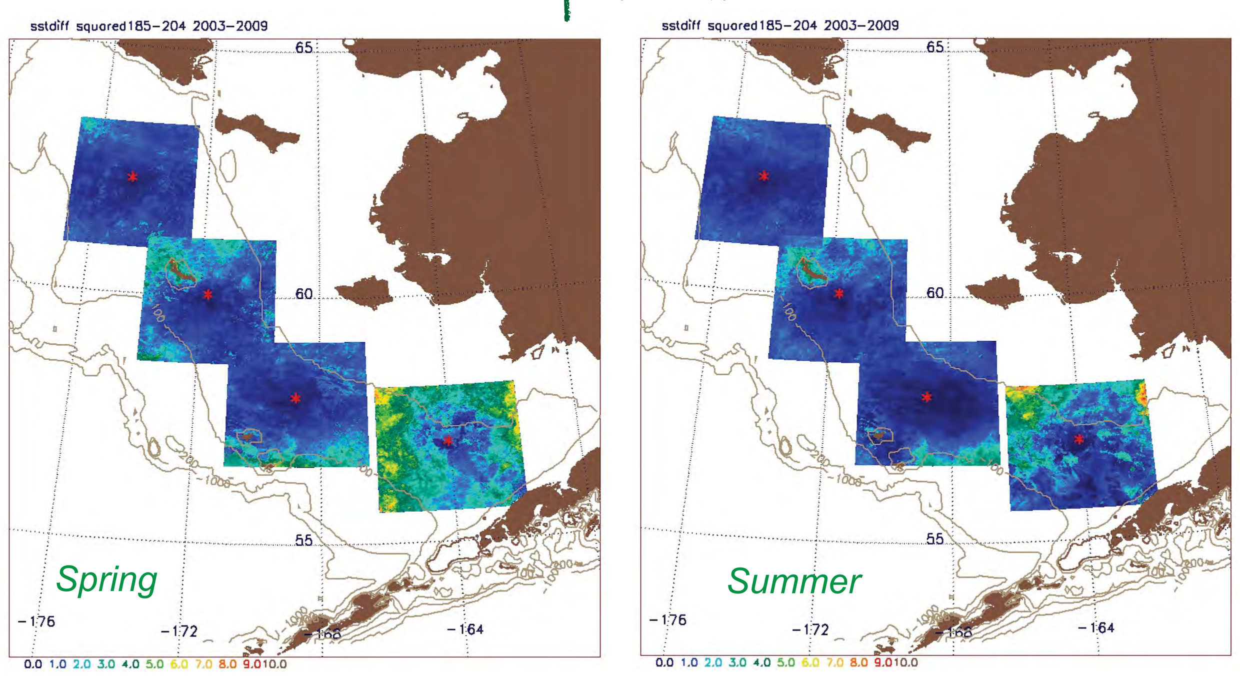
Spatial Patterns of Correlation around FOCI Moorings on the Bering Middle Shelf

Authors: Sigrid Salo & Phyllis J. Stabeno
NOAA, PMEL, 7600 Sand Point Way NE, Seattle, WA 98115

Introduction

FOCI/PMEL maintains four moorings on the middle shelf of the eastern Bering Sea. The southernmost has been in place since 1995, while the northernmost was established in 2004. In this poster, we examine the spatial and temporal variability of Modis satellite SST and chlorophyll data in the regions surrounding the four moorings in order to infer the size and shape of the area that is described by measurements at the mooring.

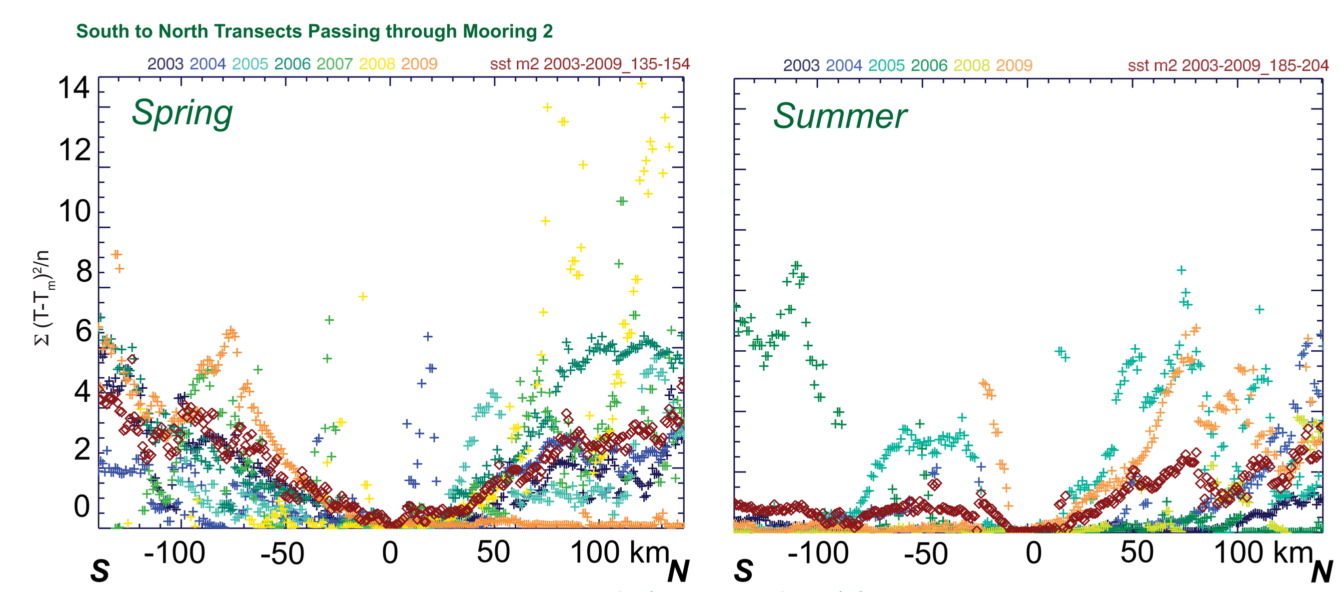
Temperature



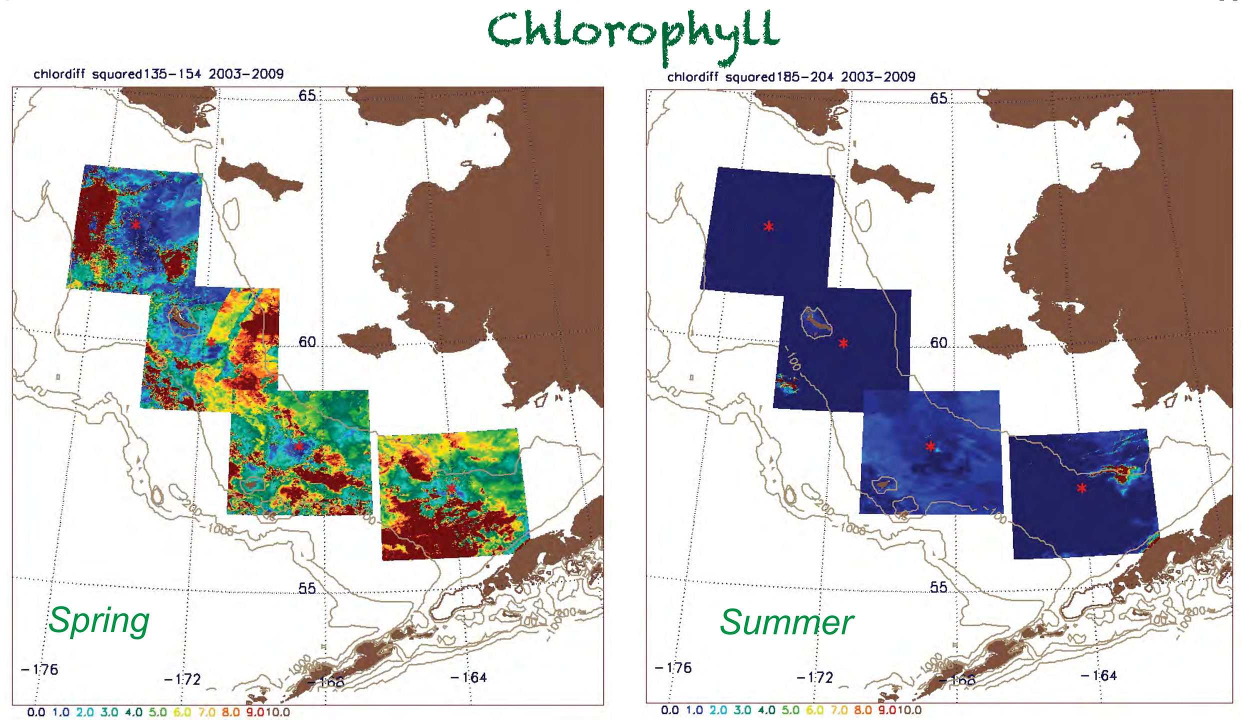
Temperature

- Patterns are organized and depth-related
- Length-scales longer along-shelf than across-shelf; vary regionally and seasonally
- Cross-shelf temperature length-scales are commonly greater than 50-75 km.

Variance due to cold inner-front water and warm water advected along the 100 m isobath is evident in the images.



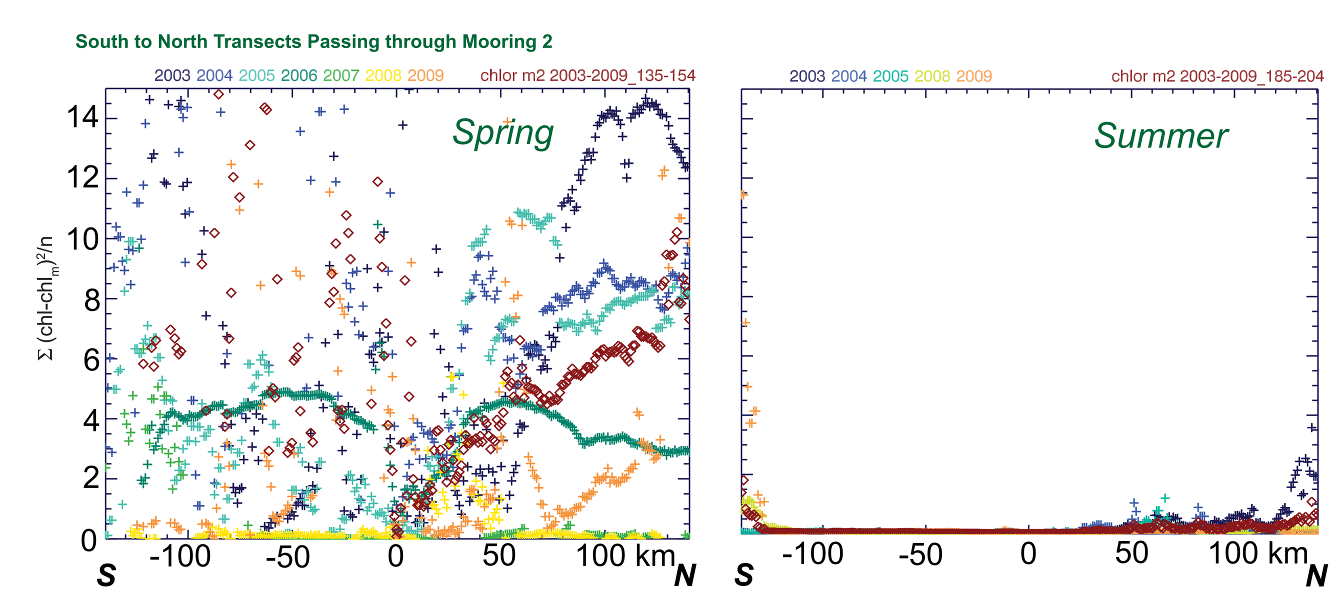
Chlorophyll



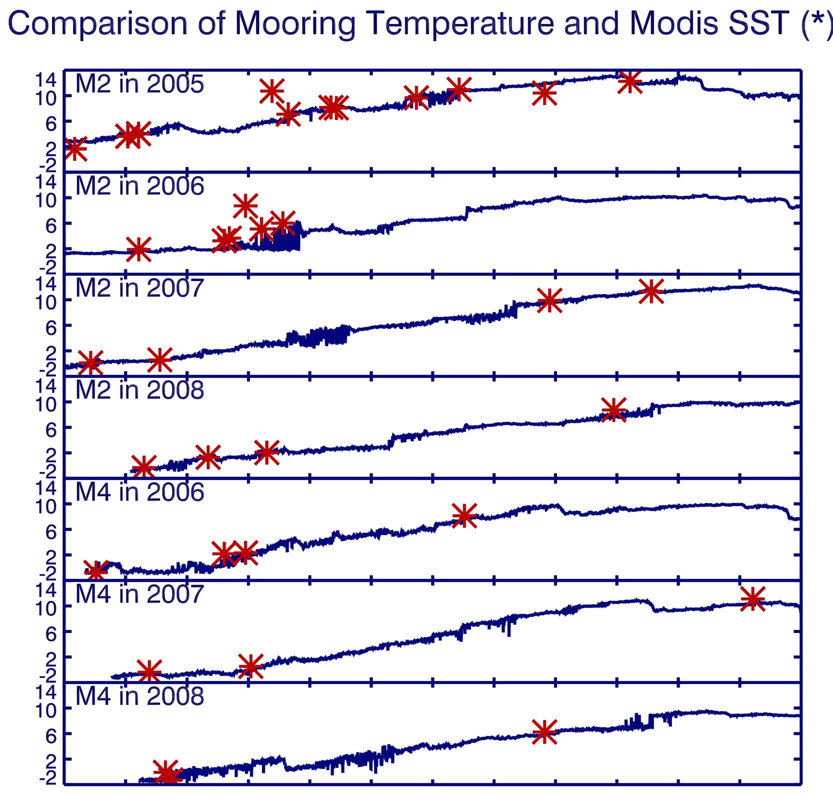
Chlorophyll

- Patterns are patchy and highly variable both spatially and temporally
- Patches occur on scales from ~1km to 100s km, and concentration varies within the patches

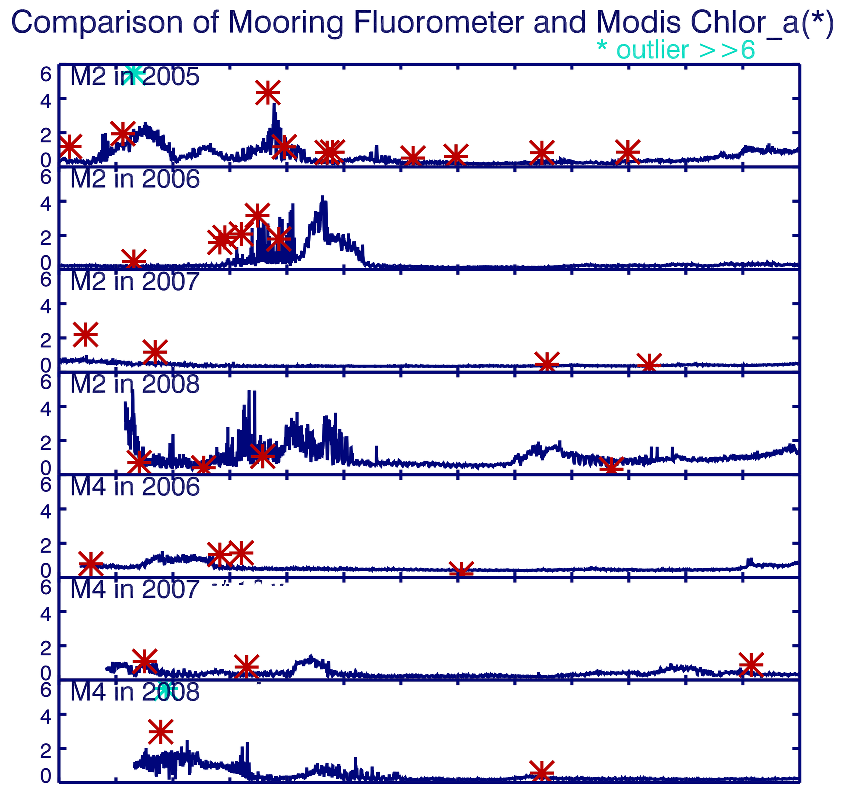
Blooms generally occur near or offshore of the moorings, so that the correlation in the transect inshore of M2 and M4 is more organized than it is offshore of the moorings.



Comparison of Mooring Temperature and Modis SST (*)

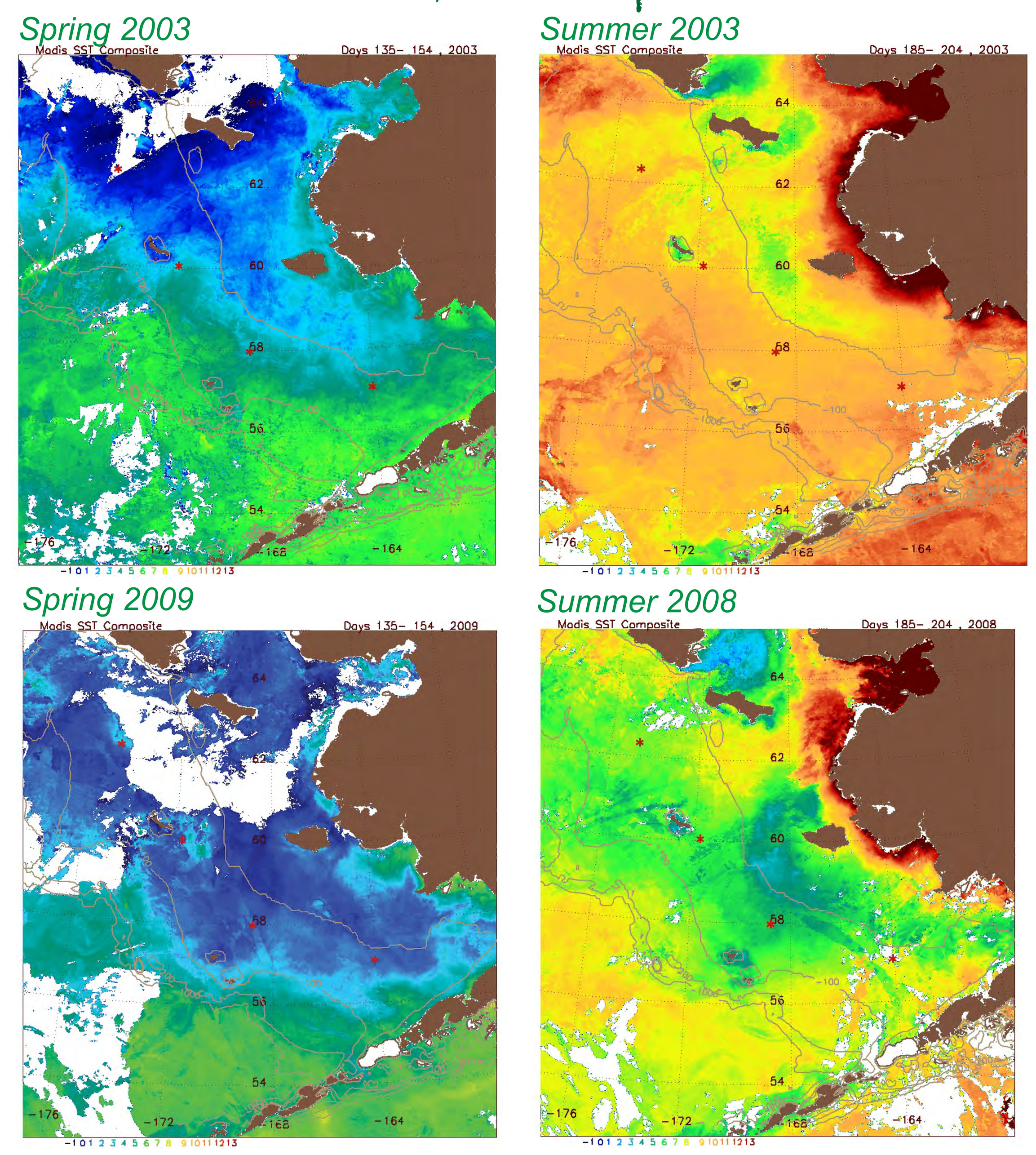


Comparison of Mooring Fluorometer and Modis Chlor_a(*)



Although we don't have enough matchup points for a rigorous comparison, satellite data and mooring data generally agree well.

Sea Surface Temperature



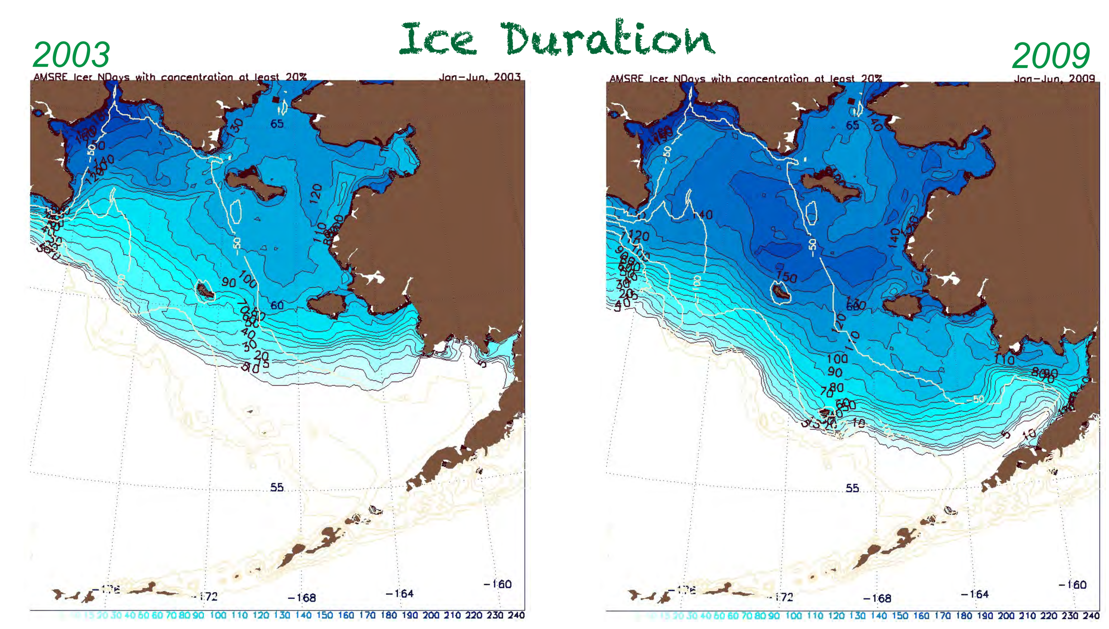
Temperature features are depth-dependent and large-scale. In general, there are similar sea-surface temperatures over water at the same depth, although there are local exceptions like the feature near M5 in the spring 2003. Therefore, the length scales are longer in the along-shelf direction.

Length scales in the cross-shelf direction are constrained by the shape of the shelf. At M2, the 70-m isobath is close to the inner front, while the other 3 moorings are farther from the 50-m isobath. Although none of the moorings is in a region where there are strong currents, M2 is closer to the flow along the peninsula and along the shelf break. M4 can be affected by onshore flow north of the Pribilof Islands. The length scales at M5 are affected by its proximity to St. Matthew Island.

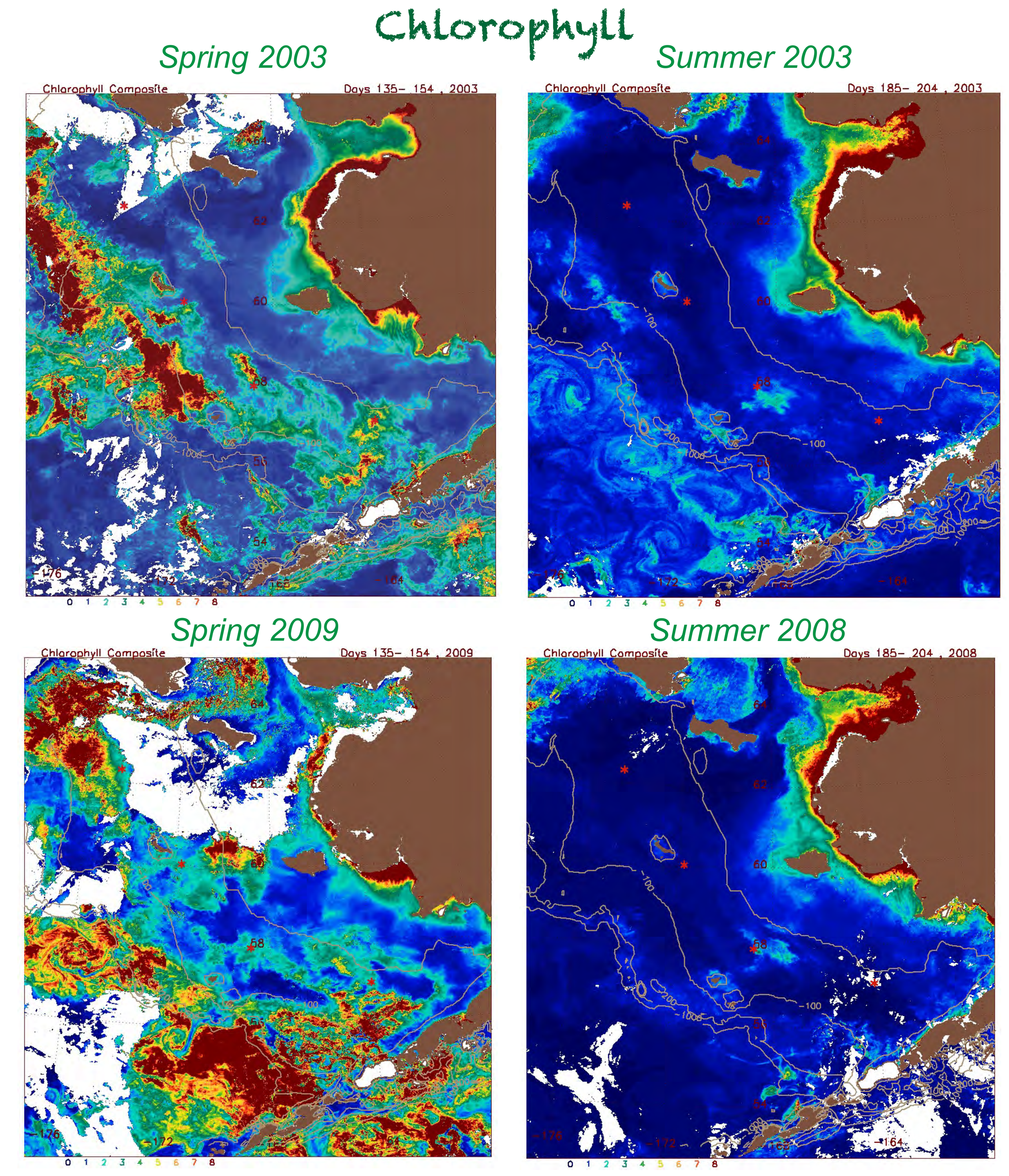
The severity of the preceding winter/spring largely determines the water temperature in spring. M8 always spends ~6 months under the ice. The other moorings see more variability. In the winter of 2003, the ice didn't reach M2, and only covered M4 and M5 for about 20 and 60 days. In 2008 and 2009, ice covered M2, M4, and M5 for ~50 days, ~80-90 days, and ~120 days, respectively. In spring, the SST at M2 was correlated with temperature to the south in a warm year like 2003, but with temperatures to the north in 2009 when the mooring was included in the winter-cooled water.

Summer SST depends on the spring temperature and summer winds and air temperatures. Summer winds are generally low, which allows the formation of a warm surface layer at the mooring sites, but both summer SST images show the persistent colder temperatures that occur where water is well-mixed inshore of the inner front and near islands. As in the spring, the length scales for the moorings depend on their proximity to well-mixed regimes and to regions where advection is stronger. These dependencies exist in both cold and warm summers; although temperatures change, the temperature patterns by and large do not. For example, although summer SST was colder in 2008 than 2003, the tongue of cold water in the inner stopped near the latitude of M4.

Ice Duration



Chlorophyll



Like SST, chlorophyll patterns depend on water depth; the largest blooms occur near 100m. However, unlike SST, chlorophyll distribution is extremely patchy. SST at a given depth is similar over a large expanse of the shelf, but high chlorophyll concentrations occur in narrow filaments, and in small, medium and large convoluted patches from 1-several hundred km across. The length-scales we calculated for chlorophyll therefore depend highly on whether the mooring (and each individual point in the array) finds itself in a filament, patch, or low-concentration area. For this reason, the offshore sections of the spring chlorophyll transects have no distinguishable pattern. The onshore part of the transects are more organized because there are fewer blooms shoreward of the moorings.

In the summer, there are low concentrations throughout the shelf except for small isolated patches.

In short, we cannot calculate a length-scale for chlorophyll during the spring bloom because of the transient patches-within-patches nature of chlorophyll distribution. In the summer, the concentration of chlorophyll at the moorings does correspond to chlorophyll over most of the shelf; but only because the concentrations are extremely low.

Methods

All satellite images in this poster are from data downloaded from the Ocean Color website (oceancolor.gsfc.nasa.gov) as level 1 files, and processed with SeaDAS5.4. We used IDL programs to create and plot composites of Modis chlorophyll_a concentration and sea surface temperature over the region of the southern Bering Sea shelf. For the composites, we chose two 20-day intervals which had enough clear days to show the region for many of the years when satellite data are available. The first interval, days 135 to 154 (mid May to early June) generally falls within the period of the spring bloom, while the second interval (days 185 to 204) is in July. We should note that although we are using 20-day intervals, no points in our arrays ever had 20 days of clear-sky data; a more typical value is 3 patchy days of coverage.
We also created images similar to semivariograms. We formed daily composite arrays of SST and of chlorophyll, each 280 by 280 points, centered on the moorings. Each day, if the mooring position was clear we calculated the squared difference between the SST or chlorophyll at each point in the array and its value at the mooring position. These daily difference arrays were averaged to form a 20-day semivariogram. In addition, in order to display length-scales of this "variance" we extracted transects that ran west-east, south-north, and across the diagonals of the array for the daily difference values and final image.

Modis satellite data were obtained from the oceancolor website http://oceancolor.gsfc.nasa.gov and processed with SeaDAS, the suite of ocean color programs written and maintained at the Goddard Space Flight Center (GSFC). The FOCI moorings are funded by the National Pacific Research Board (NPRB)>