State of the Northeast Pacific through 2008

by William Crawford and Skip McKinnell

Anomalous winds during the winter of 2007/08 are shown by black arrows in **Figure 1a**. The center of the North Pacific High (NPH) moved westward of its normal position, bringing northerly (weaker southerly) winds near the coast. The Aleutian Low (AL) was eastward of its normal winter location so anomalously strong westerly winds persisted between the AL and the NPH. Ekman flow to the right of these prevailing anomalies could have set up cool sea surface temperatures (SST) in the mid Gulf of Alaska and upwelled cool water along the continental margin (see negative anomalies in **Figure 1b**). Positive SST anomalies formed close to the center of the NPH, likely due to Ekman divergence of surface waters under this high pressure system. The winter SST anomalies generally persisted into summer 2008 despite a change in direction of wind anomalies from winter to summer (comparing **Figures 1a and 1c**). The line of zero temperature anomaly in the mid Gulf of Alaska moved somewhat to the south, perhaps in response to anomalous westerly winds in this region. A tongue of warm water moved toward the northwest by September 2008 (**Fig. 1d**), and can be attributed to the reversal of direction of wind anomalies here from winter to summer.

The mesoscale Sitka and Haida eddies that form every winter were much weaker than normal in 2008, due to stronger westerly winds in winter, and ensuing lower sea levels along Canada and Alaska. The absence of these eddies is noted in **Figure 2**. Similar images of most previous winters reveal more closed contours of sea surface height anomalies (SSHA) in the northeast Gulf of Alaska. Also evident in **Figure 2** is the northward movement of low chlorophyll water between spring and summer in mid ocean, an April bloom in the northern Gulf and along the Canadian and Alaskan margins, and coastal plumes along the continental United States. These two images, whose SSHA are levelled to the Foreman *et al*. (2008) sea surface, are able to represent absolute sea surface height anomalies accurately, and therefore, reveal the strong tendencies for chlorophyll contours to track SSHA contours in most regions.

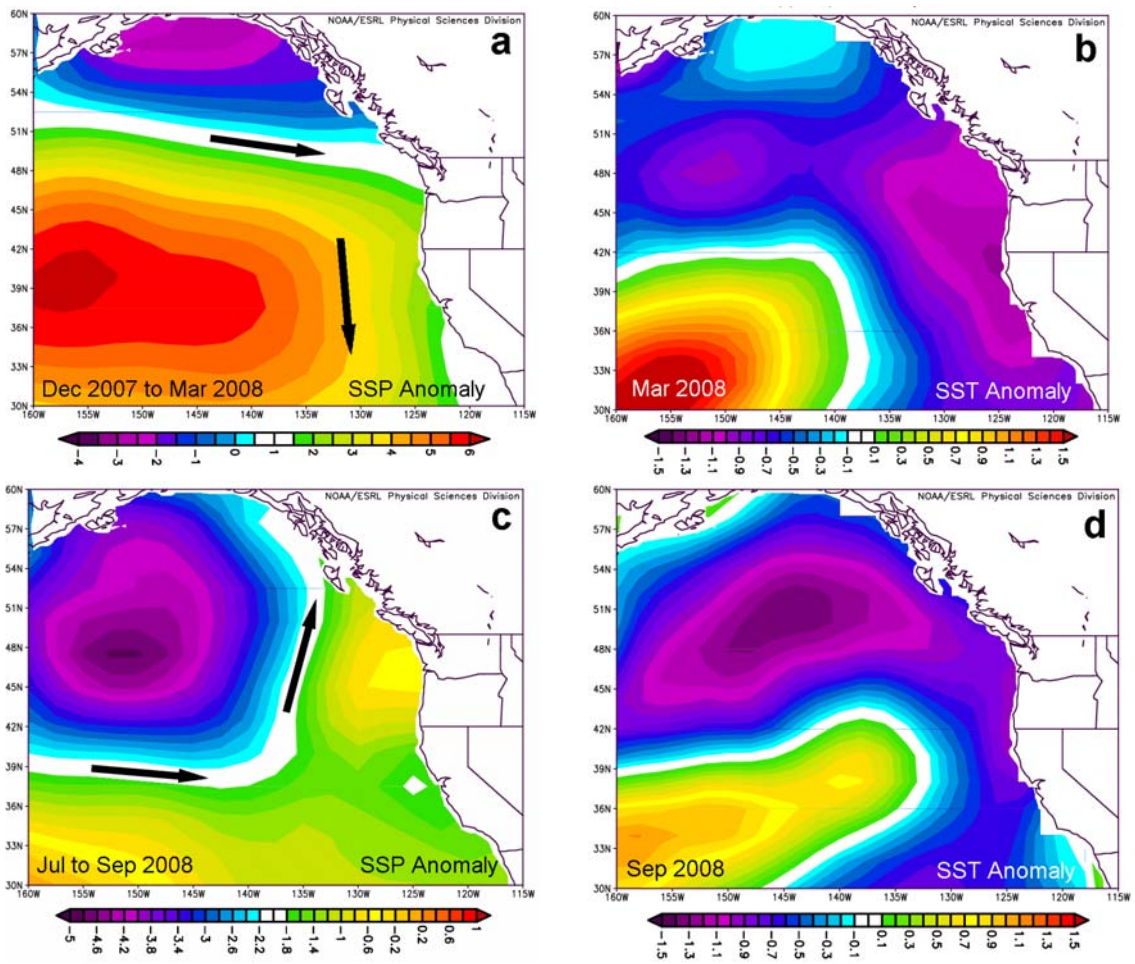

Fig. 1 Anomalies of sea surface pressure (SSP) and sea surface temperatures (SST) in winter and summer of 2008 in the Northeast Pacific Ocean. Images are from NOAA/ESRL Physical Sciences Division (http://www.cdc.noaa.gov/cgi-bin/Composites/printpage.pl).

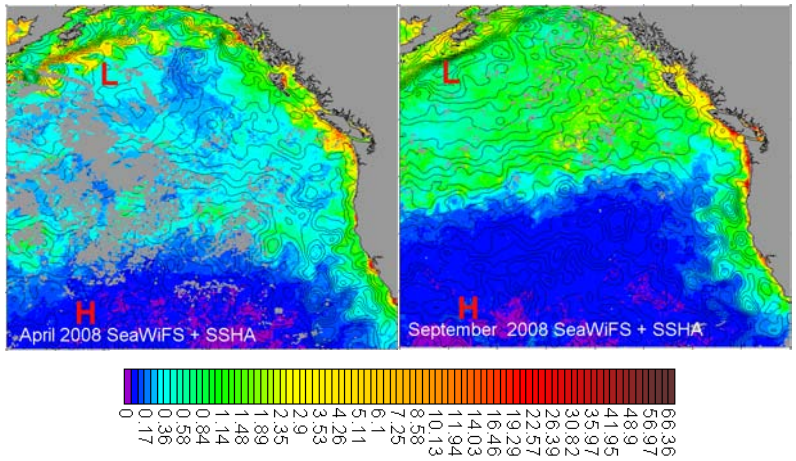

Fig. 2 Monthly composites of sea surface chlorophyll in April and September 2008, as measured by SeaWiFS, plotted over contours of sea surface height anomaly. Colour scale for chlorophyll in mg m^{-3} is at the bottom of the figure. SeaWiFS data provided by NASA. Black contours of sea surface height anomaly (SSHA) are at intervals of 5 cm. Lowest and highest sea levels are indicated by L and H. SSHA for this image is based on data provided by AVISO, and referenced to the dynamic ocean topography of Foreman et al. *(*Geophys. Res. Lett. *2008, L22606) that resolves sharp changes in sea level in the continental margin.*

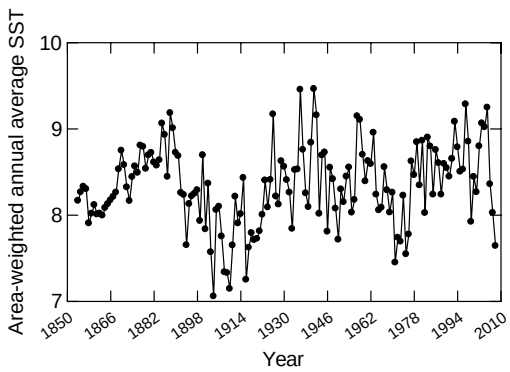

Fig. 3 Annual area-weighted average of SST in the Gulf of Alaska (1854–2008).

The surface of the Gulf of Alaska was cold in 2008. An area-weighted annual average SST, computed from the NOAA/Extended Reconstructed SST database, in the region 50–60°N, 165°W–coast, reveals that 2008 was the tenth coldest year in the Gulf of Alaska since 1854 (**Fig. 3**). The final month of 2008 had the highest value of a North Pacific Index (not shown, but calculated from NOAA/NCEP (National Center for Environmental Prediction) sea level pressure data after Trenberth and Hurrell, 1994) observed in any December since the beginning of the NCEP re-analysis period in 1948.

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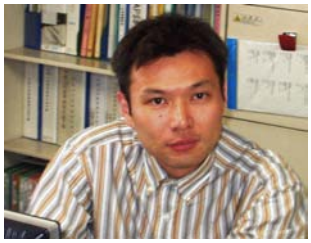
Sea ice in the Sea of Okhotsk

The extent of sea ice in the Sea of Okhotsk was below normal (30-year average values from 1971 to 2000) throughout almost the whole period from December 2007 to May 2008 (**Fig. 6**). It reached its seasonal maximum of 110.69×10^4 km^2 on February 10, exceeding the highest value for the previous season. The accumulated sea ice extent, defined as the sum of the 5-day sea ice areas from December to May, was 2058.54×10^4 km^2. This was smaller than the previous season, and its ratio to the normal value (1971–2000 average of 2574.3×10^4 km^2) was about 80%.



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