Recent trends in waters of the subarctic NE Pacific

by William Crawford and William Peterson

The winter of 2006/07 was characterized by a drop in temperatures in the eastern Gulf of Alaska accompanied by unusually large snowfalls on the inland mountains. We attribute these conditions to the persistent anomalies that were observed in the atmosphere. The Aleutian Low was located far to the east of its normal winter position, as indicated by the location of the anomalous low pressure region labelled **L** in **Figure 1a**. The resulting winter winds blew more strongly from the west, bringing cooler surface waters to the eastern Gulf, as shown in **Figure 2a**. These conditions share many features with the winters of 1999 to 2002 when the Victoria pattern was strongly positive. From April to September 2007, the North Pacific High (labelled by **H** in **Fig. 1b**) was located far to the south, and a region of anomalously low pressure occupied the Gulf of Alaska creating anomalous winds from the south (**Fig. 1b**) and warmer coastal waters (**Fig. 2b**). Lower sea surface temperature anomalies developed closer to the center of the low pressure anomaly (**Fig. 2b**).

Based on local sea levels, the spring transition arrived early off central Oregon (March 12), although it featured weakly upwelling winds that prevailed through the summer. The date of the biological spring transition (the first date when the copepod community had changed from a winter (warm-water) downwelling community to a spring upwelling (cold-water) community) was March 21.

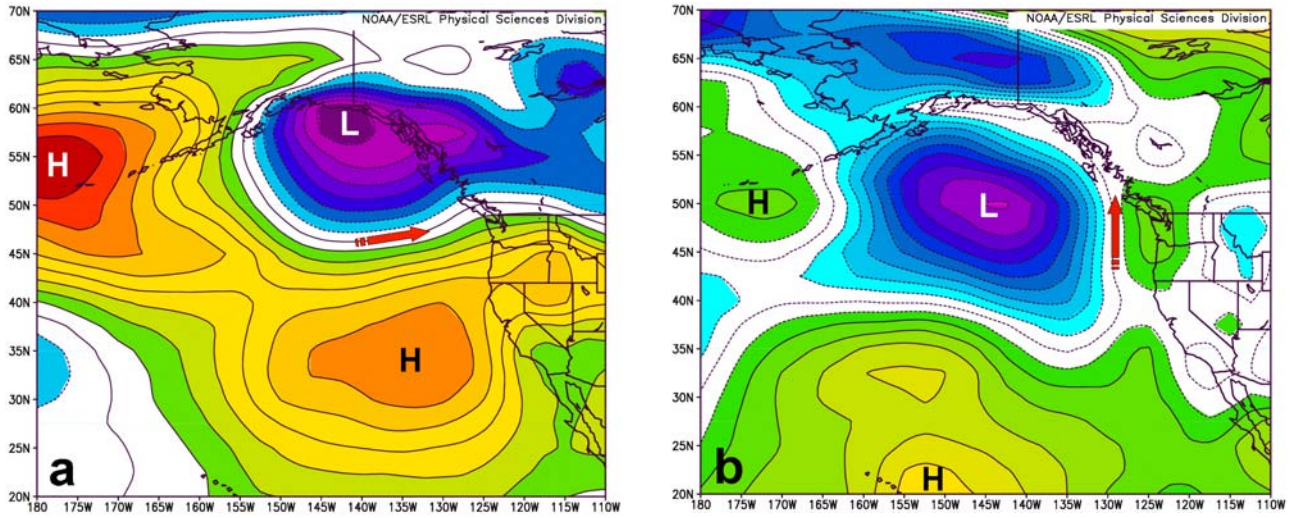


Fig. 1 Contours of sea level pressure anomalies from the average for each period for the years 1968 to 1996. Red arrows indicate the direction of anomalous winds. (a) November 2006 to March 2007, contour interval is 0.25 millibars; (b) April to September 2007, contour interval is 0.5 millibars. (Source: NOAA Earth System Laboratory, Physical Sciences Division.)

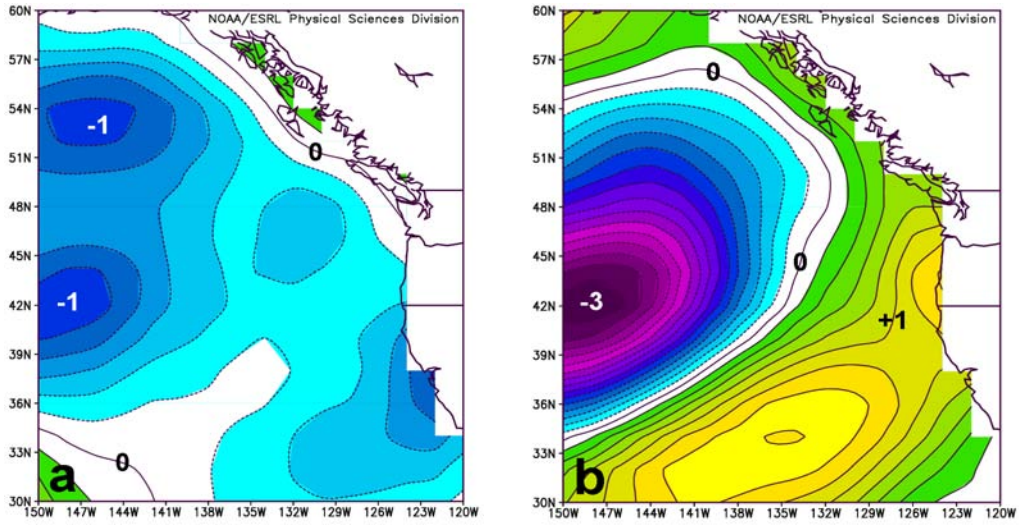


Fig. 2 SST anomalies in (a) January 2007 and (b) July 2007. (Source: NOAA Earth System Laboratory, Physical Sciences Division.)

Despite warmer surface temperatures (**Fig. 3, bottom**) due to weaker upwelling winds of Oregon, the shelf bottom waters that could have upwelled (*i.e.*, the source waters) were very cold, as cold as the well-described *sub-Arctic intrusion* of the summer of 2002, and equally as cold as what was observed during the 1999 La Niña (**Fig. 4**). This past summer, however, the water was much saltier than all summers observed since recent measurements began in 1997. We attribute the presence of cold sub-surface water (which has Gulf of Alaska origins) on the shelf to the cool temperatures generated in the Gulf of Alaska during the winter of 2006/07. The warm surface waters in summer are likely due to the dominance of southwesterly winds in summer (**Fig. 1b**). Thus, the Oregon upwelling zone in 2006/07 had the best sub-arctic conditions in the deeper water but the worst of times at the surface in the summer.

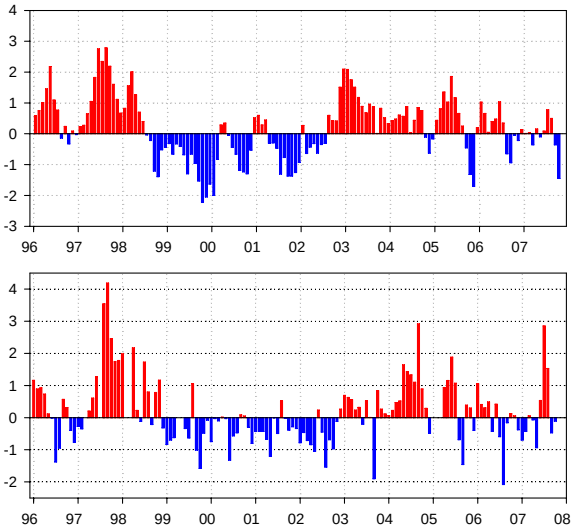


Fig. 3 (Top) Time series of the monthly PDO index since 1996. Note that the PDO was very weak from fall 2006 through summer 2007. The Victoria pattern appears to have dominated through this winter. The PDO turned negative in September 2007 and strongly negative in October 2007. (Bottom) SST anomalies (from 1992–2005 mean) at the NOAA buoy off Newport, OR The months of June through August 2007 were warmer than average, with a difference of nearly 3°C in July.

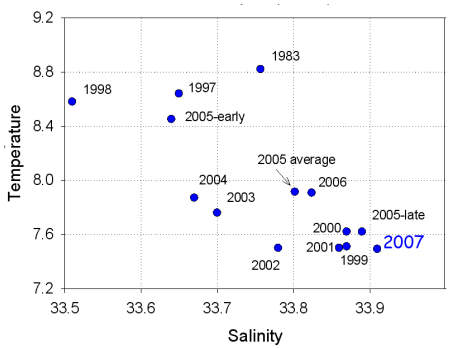


Fig. 4 Temperature and salinity averaged over the months of May through September at a baseline station located 5 miles off Newport (NH05). Water depth at this station is 62 m. In 2007, the deeper water was the saltiest observed since measurements began in 1997; temperatures were similar to those seen from 1999–2002. For each year the number of visits to NH05 varied from 12 to 20.

As for the zooplankton, copepod species richness anomalies were negative or neutral during all months of 2007, indicating that the community composition was chiefly northern cold water species. This shift to northern copepods is plotted in **Figure 5**.

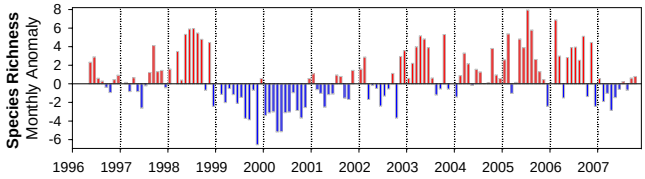
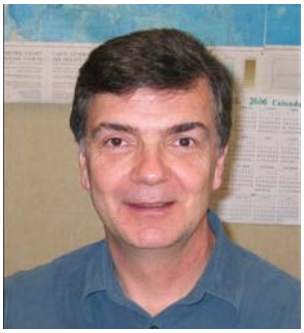


Fig. 5 Copepod species richness anomalies were negative throughout 2007 indicating a cold water community. This matches with the cold water that was off the coast during the winter and the cold, salty deep water during summer 2007.

The question is, of course, will the "cold water" conditions prevail into next year? So far, all indications are that this will be the case, especially since the PDO is strongly negative. However, note in **Figure 3** that the PDO has turned negative during late autumn in each of the past four years (2004-2007), but then returned to the positive phase by late winter or spring.



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