Continuing Cool in the Northeast Pacific Ocean

by William Crawford and Skip McKinnell

The past few years have brought high temperatures to many regions of the globe, including record highs across the contiguous United States in 2011 to 2012, and extreme warm temperature in March 2012 in Canada and the USA. In contrast, the Northeast Pacific Ocean surface temperature has remained relatively cool for the past seven years or so. Cooler temperatures have dominated in all four seasons, and were interrupted only briefly in the winter of 2010 when an El Niño warmed the region for one season.

The negative (cool) temperature anomaly (Fig. 1a) extends along the west coast from southern Alaska to Baja California, and then sweeps southward to spread along the central Pacific Equator. Positive (warm) anomalies are found in the central North Pacific Ocean. This pattern is typical for La Niña events and the negative phase of the Pacific Decadal Oscillation. The relative cooling is most intense in the central and eastern Gulf of Alaska.

The spatial pattern of the sea surface temperature anomalies (Fig. 1a) is consistent with the sea level pressure anomalies over the same period (Fig. 1b). The positive (high pressure) anomaly is south of the Aleutian Islands and relatively low pressure lies over western Canada. The thick arrow (Fig. 1b) shows the direction of the average wind anomaly through these years.

For comparison, the average sea surface temperature and sea level pressure for 1981–2010 are shown in Figures 1c and 1d, respectively. The north–south temperature gradient of Figure 1c is much stronger in the western Pacific near 40°N than in the eastern Pacific. The Aleutian Low Pressure system lies near 55°N and 180°W in Figure 1d, with the North Pacific High situated to the southeast at 30°N, 140°W. Average geostrophic winds generally blow along isobars with high air pressure to their right side. Average winds of 1981–2010 between 40°N and 50°N were generally blowing from the west southwest, with the Aleutian Low to their left and North Pacific High on the right. The effect of the persistent pressure anomaly from 2006 to 2012 was to shift the average wind direction to blow more from the west, or even west northwest, bringing cooler air to the eastern Gulf of Alaska. A second effect of this change in wind direction is toward stronger upwelling along the west coast of Alaska to Baja California, which also contributes to cooler sea surface temperature.

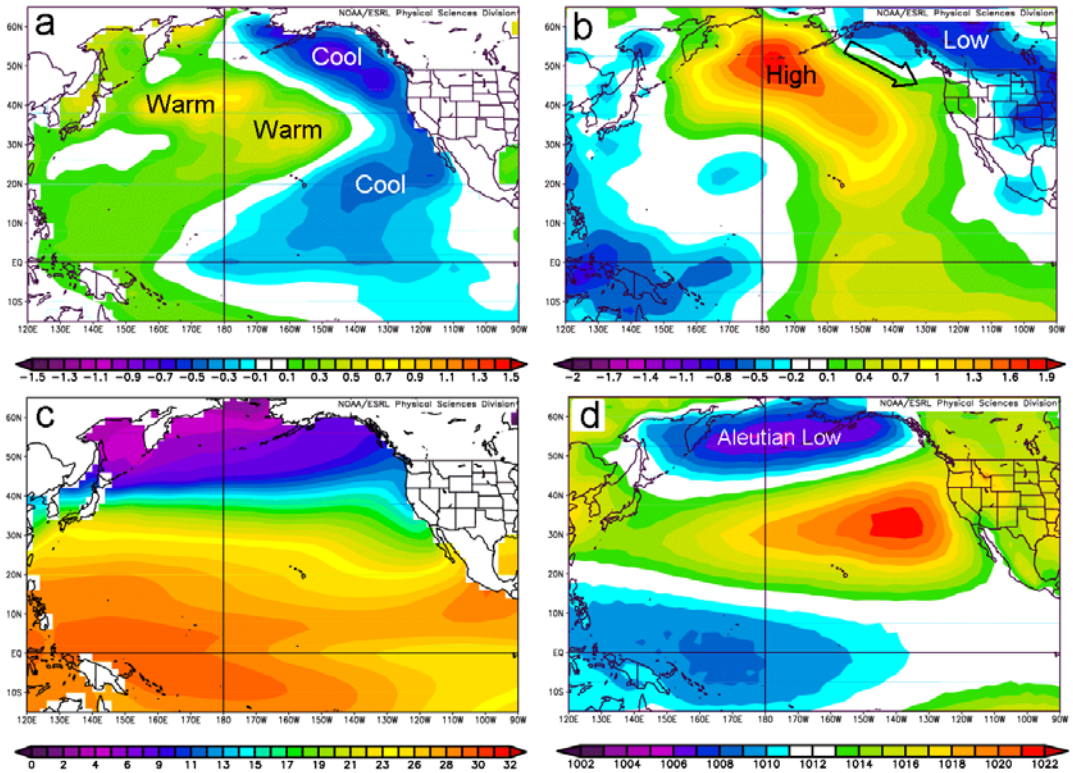

Fig. 1 December 2005 to November 2012 averages (lower panels) and anomalies (upper panels) from the 1981–2010 mean temperature and sea level pressure in the North Pacific Ocean. (a) sea surface temperature anomaly (SSTA, °C); (b) sea level pressure anomaly (SLPA, mbar); (c) sea surface temperature (SST, °C); (d) sea level pressure (SLP, mbar). Images provided by NOAA Earth System Research Laboratory, Physical Sciences Division.

Fisheries and Oceans Canada maintains an observation program along Line P that extends 1400 km west from Juan de Fuca Strait. Since 2006, temperature anomalies along Line P have been cool, with 2008 being the second coolest in a time series that extends to the 1950s (Fig. 2). One must look back to the early 1970s to find a similar period of persistent cool ocean temperature.

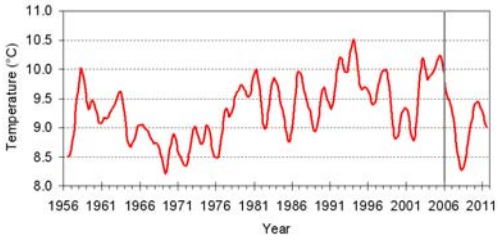

Fig. 2 Average temperature from 10 and 50 m depth along Line P. A 12-month running-mean filter has been applied. A grey vertical bar marks the beginning on the year 2006.

Marine ecosystems along the North American west coast have been affected by the drop in temperature from highs in 2002 to 2005. Many of the warm-water species that extended their range northward along the coast in 2005 have retreated to more southern waters. Cold water species off the British Columbia coast have increased in numbers. As shown in Figure 1a, the pattern of warm and cold anomalies extends across the North Pacific Ocean.

Most boreal regions have ecosystem changes that are associated with shifts in temperature. Forecasting these persistent changes in temperature provides an opportunity for economic advantage should the predictions of temperature changes be accurate. Unfortunately, there has been little success in predicting shifts in the Pacific Decadal Oscillation and other climate patterns. The exceptions are the ENSO events, which provide some predictability in North Pacific ocean temperature for six months or so, but accurate multi-year predictions remain elusive.

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