Stuck in Neutral in the Northeast Pacific Ocean

by Skip McKinnell

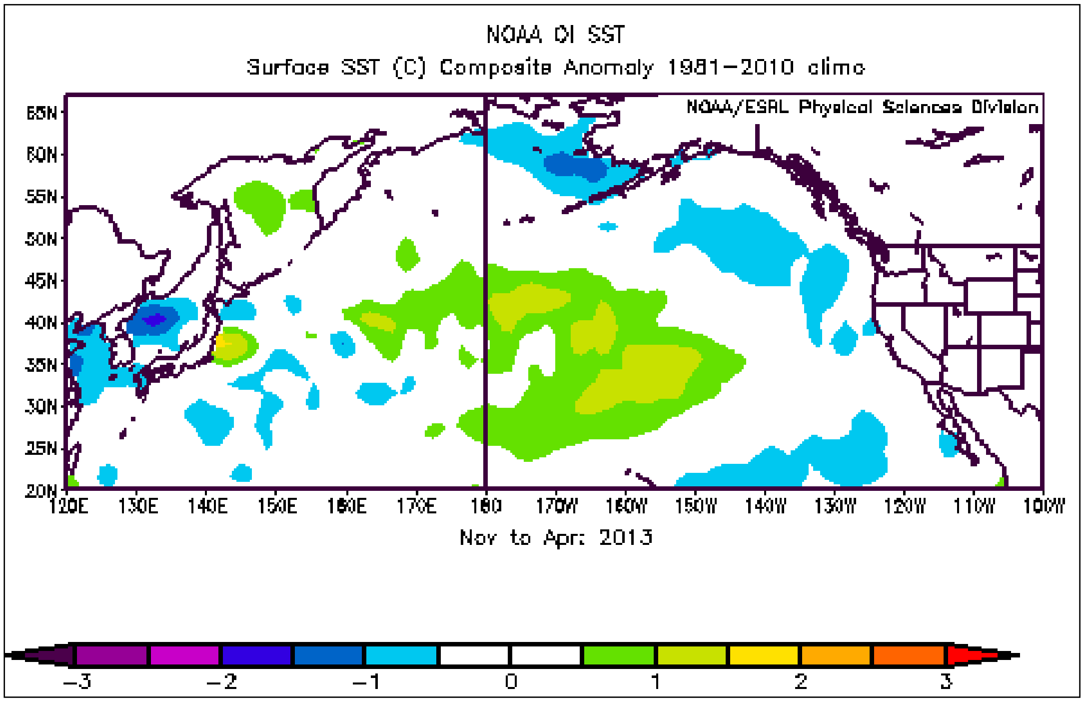

Fig. 1 Winter sea surface temperature anomalies (°C) in the North Pacific in 2013. The colour legend indicates the magnitude of the anomalies.

The surface temperature of the Northeast Pacific Ocean has remained relatively cool since 2006, interrupted briefly during the winter of 2010 by an El Niño that warmed the coastal region for a few months. The perimeter of the North Pacific was cooler than average during the winter of 2013, while the central part was warmer than average, but the anomalies were generally less than |0.5|°C (Fig. 1). This pattern reflects a negative/neutral PDO (Pacific Decadal Oscillation) phase that has been relatively persistent since early 1998 (Fig. 2).

Teleconnections between the tropics and the Northeast Pacific imply that aspects of the state of the Northeast Pacific can be found in the state of the tropical Pacific Ocean and atmosphere. The El Niño–Southern Oscillation (ENSO) has been relatively neutral since the middle of 2012. This can also be seen in the dominant EOF (empirical orthogonal function) of weekly equatorial sea surface temperature from 5°S to 5°N (Fig. 1). Climate models suggest a persistence of ENSO-neutral conditions through the boreal summer.

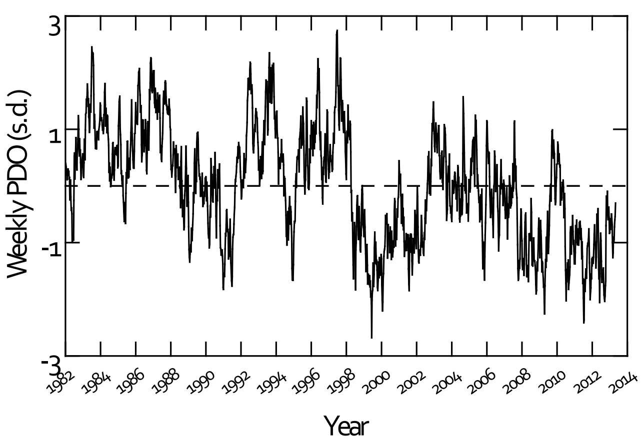

Fig. 2 Temporal index of the dominant EOF of sea surface temperature in the PDO region calculated from weekly NOAA/OIv2SST data from 1982–2013.

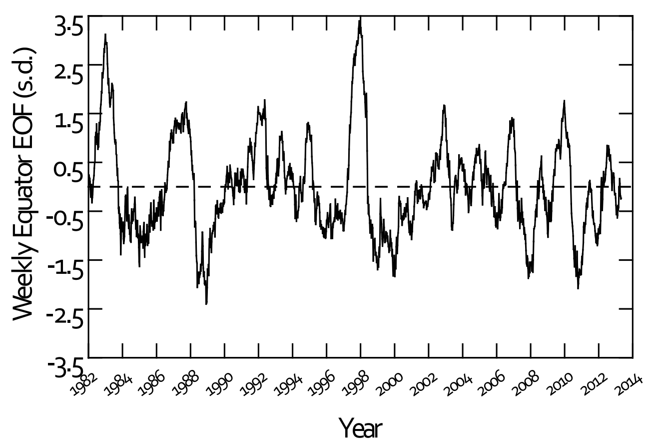

Fig. 3 Temporal index of the dominant EOF of sea surface temperature at the equator calculated from weekly NOAA/OIv2SST data from 1982–2013.

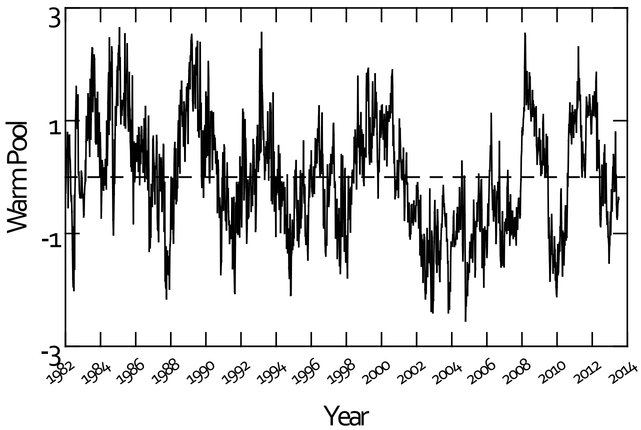

Fig. 4 An index of the weekly extent of the Western Tropical Warm Pool from 1982–2013 (May), measured as the number of 1° x 1° grid points exceeding 29°C at the ocean surface. OIv2SST data provided by NOAA Earth System Research Laboratory, Physical Sciences Division.

Low frequency variation is a characteristic of the spatial extent of the western tropical Pacific warm pool (region with surface temperatures greater than 29°C). The extent of the warm pool during the winter of 2013 was about average (Fig. 4), which reflects other climate indices for the region.

Winter storms are responsible for the decay of the summer seasonal pycnocline. The number and intensity of the storms is a factor that determines the depth of the winter mixed layer and the extent to which nutrients are resupplied to the surface waters. An index of winter (DJF) sea level atmospheric pressure in the Northeast Pacific Ocean indicates that the winter of 2013 was near the long-term average (Fig. 5).

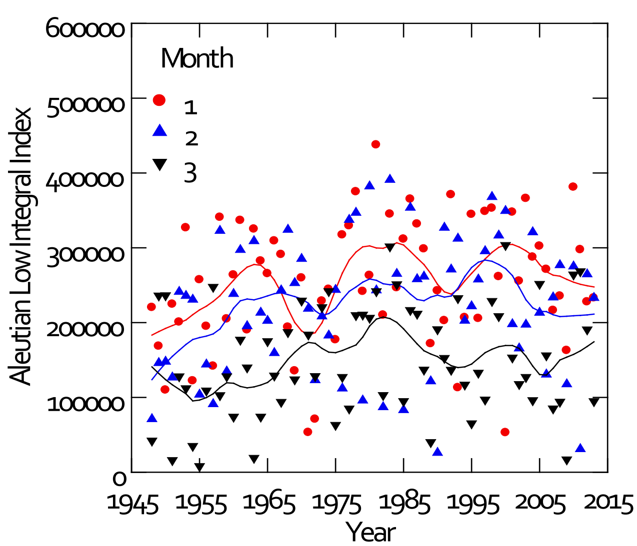

Fig. 5 The Aleutian Low Integral Index is a monthly integral of sea level pressure less than 1008.5 hPa in the North Pacific. Loess smoothers are applied to each month to show the trends. SLP data are taken from the NCEP Reanalysis and are served by NOAA Earth System Research Laboratory, Physical Sciences Division.

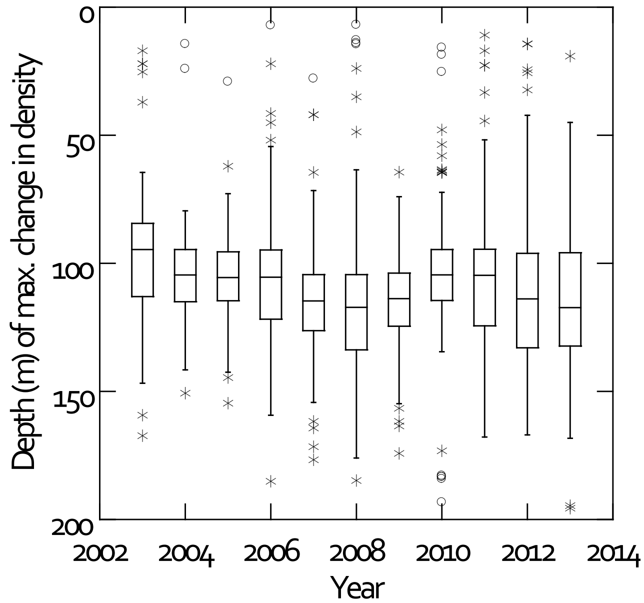

Fig. 6 Box and whisker plot indicating median, quartiles, and outlier depths of the maximum rate of change in vertical density (an index of mixed layer depth) in the months of March and April in the subarctic Gulf of Alaska east of 170°W. The 4051 hydrographic profiles used to create this figure are due to Project Argo.

Vertical profiles of water density in the Gulf of Alaska typically exhibit a sharp increase in density at about 25 m depth in the summer and about 100 m depth in the winter. After applying a smoother to the raw data, the depth of the maximum rate of change in density can be used as an index of mixed layer depth. The average winter mixed layer in the Gulf of Alaska (maximum in March/April) has been about 8 m deeper since 2007 than the four years prior to that, although there is considerable inter-annual variability (Fig. 6). A linear model fit to the individual profiles from 2003 to 2013 has the Gulf of Alaska winter mixed layer deepening over this period at 0.8 m y^{-1} ($P<0.01$). Deeper mixing in the Gulf of Alaska should entrain more nutrients into the surface layer that will foster increased productivity in the spring.

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