North Pacific Current

The North Pacific Currents (NPC), is a slow warm ocean current that forms part of the large scale North Pacific Subtropical and Subpolar Gyres. The NPC is sometimes referred as the North Pacific Drift. It flows from west to east between the 40°N and 50°N latitude (Pickard and Emery, 1982) and has a width of about 2000km (Tomczak and Godfrey, 1994).

The NPC is formed by the collision of the cold Oyashio current, flowing south, and the warm Kuroshio currents flowing north, east of Japan. After flowing across the Pacific Ocean, the NPC split into the southward flowing California, and the northward flowing Alaska current just off the coast of Vancouver Island, Canada. Doe (1955) was the first person who published the issue that the latitude of NPC bifurcation differed from year to year in the west of North America. The latitude where the NPC splits varies with seasons, 45°N in winter and 50°N in summer (Pickard and Emery (1982), demonstrated by using satellite tracked drogue buoys released on the NPC. More recently, Batten and Freeland (2007) analyzed dynamic height data from Project Argo floats to show the likely position of the bifurcation during 2002 and 2003. It was relatively far north at 53°N during 2002 then it moved southwards to a more normal position at 45°N during early 2003.

The eastward flowing NPC supplies water sources for both sub-polar and sub-tropical gyres. Douglass et al (2006) examined the connections between North pacific circulation and these two gyres based on observational data and output from a global ocean circulation model using ocean observations from 1992 to 2002. They found that in the upper 800 meters, 25 Sv flow eastward between 30°N and 50°N, and that this broadband current bifurcate just west of the North American continent. About 8 Sv flow northward into the Alaska current and the remaining 17 Sv flow southward into the California current.

Currently, many researchers have been studied on the bifurcation of the NPC with related to the strength of NPC and fluctuations in the transport of the sub-polar and subtropical gyres. The bifurcation of the NPC is conceptualized into two modes; breathing and bifurcation
modes. The breathing mode involves in-phase fluctuations in the transport of the sub-polar and subtropical gyres associated with changes in the strength of the NPC. Conversely, for the bifurcation mode, the strength of the NPC is invariant, and fluctuations in the transport of the sub-polar and sub-tropical gyres are anti-correlated. For example, Chelton and Davis (1982) examined 30 years of sea level anomalies using a network of coastal tide gauge. They found a low frequency in-phase coastal sea level variations extending from Mexico to the Aleutian Island that is associated with the intensity of the sub-polar and subtropical branches of the NPC (this mode of variability is called bifurcation mode). More recently, Cummins et al (2007) showed the occurrence of both correlated and anti-correlated variation in the transport of the sub-polar and sub-tropical gyres from their numerical simulations of wind-driven variability extending for over 50 years duration. Furthermore, they showed that two-thirds of the variance resides in the breathing mode. These results are in good agreement with a similar analysis of the relatively short-time series of dynamic heights from the Argo data and also with the results of Freeland (2006) who claimed that the bifurcation mode itself accounted for only 18% of the total variance. Using four years of hydrographic data from Project Argo floats, Cummins and Freeland (2006) also showed that although the location of bifurcation is highly variable, but it does not create a large variability in the fraction of transport that goes into the Alaska and California currents. Until now, it has been known that a long-term increase in the NPC strengthens the subtropical gyre transport (Douglass et al. 2006; Cummins et al. 2007). Bifurcation could also have some biological impacts Wickett (1966). Recently, Dorner et al (2007) addressed the bifurcation index and proved that it provided a useful predictor for salmon survival in the California Current.

To quantify the large-scale changes in the midlatitude subtropical and sub-polar currents in North Pacific, Qiu (2002) analyzed Altimetry data from 8-yr TOPEX/Poseidon (T/P) mission and concluded that NPC intensified steadily annually (over the T/P period from 1992 to 1998) due to the persistent sea surface height (SSH) drop on the northern side of the NPC. But there is no clear modulation on the annual timescale. It has been known that the fluctuations in the strength of NPC are driven by changes in wind forcing. In addition, the variability of NPC is associated with large-scale differential Ekman pumping rather than Rossby wave propagation or
changes in the Sverdrup-balanced transport (Lagerloef, 1995; Cummins and Lagerloef, 2004; Cummins et al. 2007).

There are several eddy energy studies for the North Pacific current. For instance, contrast in mesoscale eddy energy levels between the eastern and western North Pacific current was studied by Bernstern (1976). It was found that there is a sharp change from high to low amplitude in eddy energy from west to east, this transition occurred at about 175°W. East of the 170°W to 140°W, the NPC appears to be a near void for mesoscale eddies (Bernstern, 1976). Reid et al (1963) and Bernstern (1976) found that the eddy activity was located further to the east on the California current, they believe that these eddies are formed on the more intense Kuroshio-Oyashio extension and in the California current, and that these eddies somehow cannot reach the eastern part of the NPC.

Furthermore, models and observations were used to study the dynamics and thermodynamics that caused a shift in the ocean SST from a warm to a cool state in the North Pacific during the mid 70s to mid 80s (Miller et al. 1994a; Miller et al. 1994b; Cayan et al. 1995). Miller et al (1998) also found that during the previously mentioned decade, the cooling of the thermocline was part of a basin-scale pattern of adjusting to wind stress curl forcing, caused by a series of deepening Aleutian lows during the winters of the 70s and 80s. Anomalous Sverdrup circulation associated with stronger wind speed during the 70s was studied by Trenberth (1991). The subpolar and subtropical gyres were strengthened by 10% during that period (Miller et al. 1998), strengthening the NPC.

References


Dorner, B., R. M. Peterman, C. Bessey and F. J. Mueter: North-south location of the North Pacific Current and its influence on temporal variation in recruits per spawner in northeastern Pacific salmon (Oncorhynchus) populations. From PICES 16th Annual Meeting.


