North and South Pacific Decadal Oscillations: Tropical Pacific Forcing versus Internal Variability

*Yu Zhang[1,2], Shang-Ping Xie[3], Yu Kosaka[4], Jun-Chao Yang[1,2]

1. Physical Oceanography Laboratory, Ocean University of China, 2. Qingdao National Laboratory for Marine Science and Technology, 3. Scripps Institution of Oceanography, University of California San Diego, 4. Research Center for Advanced Science and Technology, The University of Tokyo

The Pacific decadal oscillation (PDO) is the leading mode of sea surface temperature (SST) variability over the North Pacific (north of 20˚N). Its South Pacific counterpart (south of 20˚S) is the South Pacific decadal oscillation (SPDO). The effects of tropical eastern Pacific (TEP) SST forcing and internal atmospheric variability are investigated for both the PDO and SPDO using a 10-member ensemble tropical Pacific pacemaker experiment. Each member is forced by the historical radiative forcing and observed SST anomalies in the TEP region. Outside the TEP region, the ocean and atmosphere are fully coupled and freely evolve. The TEP-forced PDO (54% variance) and SPDO (46% variance) are correlated in time and exhibit a symmetric structure about the equator, driven by the Pacific–North American (PNA) and Pacific–South American teleconnections, respectively. The internal PDO resembles the TEP-forced component but is related to internal Aleutian low (AL) variability associated with the Northern Hemisphere annular mode and PNA pattern. The internal variability is locally enhanced by barotropic energy conversion in the westerly jet exit region around the Aleutians. By contrast, barotropic energy conversion is weak associated with the internal SPDO, resulting in weak geographical preference of sea level pressure variability. Therefore, the internal SPDO differs from the TEP-forced counterpart and features SST anomalies along ~60˚S in association with the Southern Hemisphere annular mode. Isolating the internal component from observations is limited, partly due to the small degrees of freedom in the instrumental record. Nevertheless, internal PDO variability appears to contribute significantly to the North Pacific regime shift in the 1940s. Our study demonstrates that the PDO differs from the so-called Interdecadal Pacific Oscillation (IPO), the latter of which is manifested as the TEP-forced covariation of the PDO and SPDO. We highly recommend not to mix up to use the terminologies between the PDO and IPO in future climate research.

Keywords: Pacific decadal oscillation, South Pacific decadal oscillation, tropical Pacific forcing, internal variability, barotropic energy conversion

