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South Pacific Ocean controls the phase reversal and periodicity of the decadal and bi-decadal ENSO-like variabilities

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Phase reversal mechanism of the Pacific decadal and bi-decadal ENSO-like variabilities and origins of oceanic signals for the phase reversal are investigated based on a pair of the climate model experiments using MIROC3m and consisting of the control run (CTRL) and the partial blocking run (PB) where model temperature and salinity are restored to their climatological values along 10°S in the South Pacific. In CTRL, the pattern of the Pacific Decadal Oscillations (PDO) with positive anomalies in the tropics and negative anomalies in the North Pacific mid-latitudes is found in the leading mode of the sea surface temperature. On the other hand, in PB, the former tropical signals are not appeared and only the mid-latitude signals are seen. It is robustly demonstrated that oceanic signals of the South Pacific origin are keys in controlling the Pacific ENSO-like variabilities on decadal timescales. By separating oceanic signals in CTRL into decadal and bi-decadal components, we try to identify oceanic physical processes and to explain how the periodicity is determined. Based on statistical analysis and a tracer experiment using an off-line ocean model, it is shown that relatively faster oceanic wave adjustments triggered by changes of wind-stress curl in the South Pacific extra-tropics and slower mean isopycnal advection of subsurface temperature anomalies associated with modification of South Pacific eastern subtropical mode water are essential in the phase reversals of a decadal and bi-decadal variabilities, respectively. The periodicity and frequencies of the variabilities are determined mainly by the transient times of the oceanic subsurface signals from the extra-tropics and mid-latitudes to the tropics. In the last several years, decadal climate predictions are in progress using state-of-the-art climate models at research institutes and centers world-wide towards contributing to the IPCC-AR5. Although predictability of the PDO within several years has been reported, this is not the case for the tropical predictability on a decadal scale. The present study implies that observational data accumulated by ARGO floats which cover the South Pacific Ocean will contribute to further improvement of decadal climate predictions by using the data in initializing climate models.