Geophysical Research Abstracts, Vol. 9, 04516, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04516

Decadal Changes of the Oceanic Entrainment Temperature (Te) in the Tropical Pacific and Its Role in Modulating ENSO

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Significant decadal changes in subsurface thermal structure were observed in the tropical Pacific in the late 1970s, which are clearly manifested in the temperature of subsurface water entrained into the mixed layer (Te), a quantity that links the thermocline to sea surface temperature (SST). The relationships between the non-stationarity of Te and its decadal modulation of El Nino Southern Oscillation (ENSO) are investigated using oceanic observational/reanalysis data and coupled ocean-atmosphere models. Decadal changes in Te are first characterized from the World Ocean Database 2004 (WOD04) of the NOAA/NODC and the SODA reanalyses data of the University of Maryland. It is found that the relationships between Te and thermocline variability have undergone decadal changes in the late 1970s. Decadal changes in the sensitivity of Te to changes in the thermocline depth and other fields are further estimated by regression analyses. It is evident that the sensitivity of Te to a thermocline depth anomaly has become much stronger after the 1976-77 climate shift, with a larger Te variability both in the eastern equatorial Pacific and in the western tropical North Pacific around 10 N, indicating a bigger effect of the thermocline variability on Te and SST, and thus an enhanced thermocline feedback for ENSO. The decadal changes in the relationship between Te and thermocline variability derived directly from the SODA reanalyses are incorporated into an intermediate coupled model (ICM) to examine its modulating effects on ENSO. It is reinforced that the decadal changes in the amplitude and structure of Te play an important role in modulating ENSO properties as observed in the late 1970s.