South China Sea Interannual Variability

Chiung-wen June Chang , Chau-Ron Wu and Huang-Hsiung Hsu
National Taiwan University

Abstract

Situated at the pathway of East Asian monsoon system, the South China Sea (SCS) circulation is largely influenced by the seasonal reversal of the monsoonal winds, northeasterly in winter and southwesterly in summer. On a seasonal time scale, the surface oceanic circulation is cyclonic in winter and anti-cyclonic in summer. Beyond the seasonal time scale, the oceanic circulation of the SCS demonstrates an interannual variation related to El Niño /Southern Oscillation (ENSO) [e.g., Wu et al., 1998; Shaw et al., 1999]. A number of recent studies reveal that the ocean dynamics and horizontal advection in particular play a key part in the interannual variability in the SCS [Metzger and Hurlburt, 2001; Qu et al., 2004; Liu et al., 2004]. To understand the influence from the ocean dynamics on the interannual variability of sea surface temperature, sea surface height (SSH) variation, which is a proxy for the upper oceanic thermodynamics, in the South China Sea (SCS) are examined using results from an altimetric data assimilation model. After the SSH data have had the seasonal mean removed, principal component analysis illustrates two distinct anomaly patterns. The first mode shows an east-west sea-saw pattern which would affect the basin-wide gyre intensity in winter. The second mode consists of a meridional dipole feature with a nodal line around 12°N and is related to the development of the eastward jet and upwelling off Vietnam in summer. Both EOF modes have significant interannual variations and are highly correlated to the ENSO events. This study demonstrates that SST variations in the SCS are largely accounted for by the upper oceanic dynamics. El Nino's influence would persist into the next summer through the existence of an anomalous atmospheric low-level anticyclone over the tropical North Pacific (Wang et al. 2000a). The persistent atmospheric anticyclone modulates wind fields in the summer SCS, thereby induces marked interannual variability in ocean circulation and SST (Xie et al., 2003). Effect combined of these two modes may explain the prolonged SCS warming from 1997 winter to 1998 summer.

The second mode shows that before and after ENSO, summer SCS circulations are all enhanced but in opposite directions. Prior to the peak central-eastern Pacific warming, SCS circulation is anti-cyclonic in the south and cyclonic in the north. This structure 1) generates divergence off the Vietnam coast such increases the cold-water upwelling, 2) enhances an eastward offshore flow which carries the cold water into the central SCS. The Cold SST in SCS prior to El Nino is in agreement with findings in earlier literature (Yamagata and Masumoto, 1991). During our 10 years data analysis (1993-2002), year 1994 and 1997 are both ENSO developing years and IOD (Indian Ocean Dipole, Saji et al. 1999) event years; yet in 1994 there were colder SSTs in the SCS. Possible processes such as IOD and the internal variation of west northern Pacific Monsoon are accounted for the SCS summer variation will thereby be examined in the presentation.

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