Large–Scale Air–Sea Interactions in the Tropical Western Pacific on Interannual and Intraseasonal Time Scales*

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ABSTRACT

It has recently been recognized that the air–sea coupling in the warm water region of the western Pacific must be better understood since it is identified with triggering the El Nino/Southern Oscillation (ENSO) phenomenon. However, it is still considerably uncertain what air–sea coupled system is essential or prominent for each time and spatial scale. This paper addresses the question of large–scale air–sea coupling in the warm water region of the western Pacific on two time scales; *i.e.*, the interannual and intraseasonal time scales. The following results were obtained:

(1) The interannual variability of the main thermocline in the tropical western Pacific along the 137°E longitude line is reflected primarily in the quasi–biennial oscillation (QBO) time scale. Each dominant eastward–propagating QBO mode is extracted by applying a complex EOF analysis to the sea surface temperature (SST) and 700 mb zonal wind anomaly fields over the tropical Indian and Pacific Oceans. The QBO mode of the SST does not propagate with a uniform phase speed and a marked phase difference is found in the area around 150–160°E, where the eastward–propagating QBO mode of 700 mb zonal wind exhibits uniform phase speed and has the largest amplitudes. It is concluded that the QBO of the upper ocean temperature in the warm water region results from the dynamic response of the ocean to the wind stress having a QBO time scale.

(2) Two air–sea coupled modes; *i.e.*, intraseasonal and interannual modes, are statistically extracted using the complex EOF analysis. There exist remarkable differences in the air–sea coupling of the intraseasonal time scale compared with the interannual time scale. It is found that in the intraseasonal mode, the SST is approximately out of phase with the high–cloud cover (HCC) and 850 mb zonal wind (u). For this mode the region of maximum SST anomaly lies to the east of the center of active convection, which favors the eastward propagation of the large–scale disturbance as well as the evaporation–wind feedback effect. On the other hand, for the interannual mode the SST is almost in phase with the HCC, but the phase relation of the 850 mb u is different in each region of the tropical western Pacific. The predominant growth of this mode defined in the key region (0°–10°N, 130°–160°E) coincides with the life cycle of the ENSO: the occurrence, development and decay.

(3) The growth of the atmospheric 30–60 day oscillation over the equatorial western Pacific is even affected by high SST above a threshold value of 28°–28.5℃. The intraseasonal variations, especially with 40–60 day scales are predominant when the mean SST over the warm water region

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is in the range of 29°–29.5℃. There exists strong air–sea coupling on the intraseasonal time scale in the warm water region. Once the tropical western Pacific SST is above the upper threshold value of about 29.5℃, it is clearly seen that the 30–60 day oscillation is damped in this region, although tropical large–scale convection is still rather active. As a result, high frequency fluctuations (*e.g.*, 15–25 day period) become relatively dominant under high SST conditions. The air–sea coupling for the 30–60 day time scale is very weak in this region and disturbances organized on the scale of the super cluster are infrequently observed. Notable eastward–moving air–sea interactive systems on the intraseasonal time scale are not observed.