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Intraseasonal to interdecadal variations of South China Sea Summer Monsoon

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South China is dominated by a sub-tropical monsoon climate which is characterized by significant multi-timescale variations (intraseasonal - interdecadal).

On intraseasonal timescale: Two major components of intraseasonal oscillation (ISO) (10–20-day and 30–60-day modes) are identified. The coupling of these two intraseasonal modes during the pre-monsoon period of the South China Sea Summer monsoon (SCSSM) are investigated by examining the filtered outgoing longwave radiation (OLR), low-level circulation, apparent heat source and apparent moisture sink from October of a previous calendar year to September of a calendar year. The zonal and meridional propagations of the 10–20-day and 30–60-day modes are found to be different, which reflects their different roles in the establishment and development of the SCSSM. The northwestward propagation of the 10–20-day mode is associated with the weakening of the subtropical high over the western Pacific, while the northeastward propagation of the 30–60-day mode originates from convection over the equatorial Indian Ocean. A hypothesis is then proposed to explain the observed variability in the SCSSM onset. When the equatorial Indian Ocean exhibits a 30–60-day mode oscillation, an initially weak convection develops into a large convection band (or monsoon trough). Meanwhile, a convective disturbance of the 10–20-day mode is induced when this monsoon trough extends to the western Pacific. These two processes then collaborate to cause a weakening of the subtropical anticyclone over the South China Sea. Because the monsoon trough associated with the 30–60-day mode subsequently propagates northward into the Bay of Bengal, the induced vortex together with the 10–20-day westward-migrating convection from the equatorial western Pacific will substantially increase the effect of horizontal advection of moisture and heat, thus destabilizing the atmosphere and weakening the subtropical ridge there. Westerlies can then penetrate and prevail over the South China Sea region, and the SCSSM onset occurs.
On interannual timescale: It is found that, in years associated with a warm (cold) ENSO (El Nino/Southern Oscillation) event or the year after, the monsoon tends to have a late (an early) onset and the intensity of the SCSSM also tends to be weaker (stronger). During a 2-year period prior to the onset, anomalies of ocean heat content have an obvious eastward propagation. The 850-hPa flow east of the Philippines, specifically the strength of the subtropical high, is also found to be critical in determining the monsoon onset date. The link between these two results appears to be the propagation of cold (warm) subsurface water into the western North Pacific, which strengthens (weakens) the subtropical high, and hence a late (an early) SCSSM onset.

Further, interdecadal variations in the early (May–June) summer monsoon rainfall over South China (SCMR) are found to be related to the ENSO and the PDO (Pacific Decadal Oscillation). An interdecadal variation in SCMR can be identified, with more dry (wet) monsoon years during the periods of high (low) PDO index. Such variations are also related to ENSO in association with PDO. When ENSO and PDO are in phase, i.e. high PDO phase/El Nino events, or low PDO phase/La Nin˜a events, the SCMR tends to be below or above normal respectively more often. But when the ENSO and PDO are out-of-phase, the SCMR has no wet or dry preference. Such relationships appear to be related to the intensity of the subtropical high determined by the superposition of the effects of ENSO and PDO.