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Generation mechanism of the South Pacific subtropical dipole

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Interannual variability of sea surface temperature (SST) in the South Pacific plays an important role in regulating regional climate through modulation of synoptic rainfall. Although the SST variability is greatly affected by the tropical climate mode as El Niño/Southern Oscillation (ENSO), it frequently represents a northeast-southwest oriented dipole of the positive and negative SST anomalies in the central basin, which is not associated with ENSO. The second empirical orthogonal function mode of the SST anomalies captures this dipole structure and it is called South Pacific subtropical dipole (SPSD) after similar phenomena in the southern Indian and South Atlantic Oceans.

The positive and negative SST anomaly poles associated with the SPSD start to develop during austral spring, reach their peak during austral summer and gradually decay afterward. Previous studies suggested that the latent heat flux anomalies associated with the sea level pressure (SLP) anomalies are responsible for generating the dipole SST anomalies. However, the importance of the seasonal and interannual variations in the mixed-layer thickness on the dipole SST anomalies, which are significantly large in the subtropical region, has also been suggested for the Indian and Altantic subtropical dipoles.

This study investigates the generation mechanism of the dipole SST anomalies related to the SPSD by considering the effect of the mixed-layer variations. A close examination of mixed-layer heat balance reveals that the SST anomaly pole develops mainly because warming of the mixed layer by shortwave radiation is modulated by the mixed-layer thickness change. Over the positive (negative) pole, the mixed layer becomes thinner (thicker) than normal and enhances (reduces) the warming of the mixed layer by climatological shortwave radiation. This thinner (thicker) mixed layer may be related to the suppressed (enhanced) evaporation associated with the overlying SLP anomalies. Weaker-than-normal surface wind also contributes to the thinner mixed layer in the case of the positive pole. Furthermore, the SLP anomalies have a link with the geopotential height anomalies in the upper troposphere, which are associated with a stationary Rossby wave pattern extended from a region south of Australia. This suggests that the SLP anomalies that generate the SPSD are not locally excited, but remotely induced signals.