

Cold surges over the Philippine Sea and tropical SST cooling

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Cold surges (CS), characterized by the southeastward expansion of continental high-pressure systems and associated cold-air outbreaks during the boreal winter Asian monsoon, are known to frequently affect the Philippine Sea. However, compared with the South China Sea, relatively few studies have focused on this region, and many aspects remain unclear, particularly from the perspective of air–sea interactions extending into the tropics and their interannual variability. This study investigates Philippine Sea cold surges and associated tropical sea surface temperature (SST) cooling over 45 boreal winters from 1980 to 2025.

Linear regression and extended empirical orthogonal function (EEOF) analyses reveal that the southeastward extension of continental high pressure first induces positive sea-level pressure anomalies over the South China Sea and the northern Philippines, followed by the development and westward propagation of a pronounced high-pressure anomaly centered south of Japan. In association with the strengthening positive sea-level pressure anomalies southeast of Japan, northeasterly wind anomalies exceeding 3 m s^{-1} emerge over the Philippine Sea.

Correspondingly, negative near-surface air temperature anomalies of approximately $-0.3 \text{ }^{\circ}\text{C}$ appear at 15° N, accompanied by SST cooling of about $-0.05 \text{ }^{\circ}\text{C}$. In addition, widespread negative SST anomalies are detected in the equatorial Southern Hemisphere, suggesting a possible large-scale cross-equatorial response.

Keywords: cold surge, Philippine Sea, air–sea interaction