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Variability and Mechanisms of Summer Heat Wave in Korea

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This study investigates the variability of heat waves in South Korea in terms of frequency, duration, and intensity over the past 40 years (1973-2012). Daily maximum temperatures were used to define the indices of extreme months based on the number of days that crossed the thresholds. Empirical orthogonal function (EOF) analysis was applied to the monthly indices. Correlation between the EOF principal components and the time series of other fields allows for plotting of maps that highlight the anomalies in the large scale circulation and in SST that are associated with the occurrence of Korean heat waves.

A noteworthy feature exhibited in the results is the north-south dipole mode that dominates the variability of the South China Sea, with opposite signs at the East Asian sector. The positive correlation of the vorticity at 150hPa in the East China Sea induces more convection and diabatic heating, which in turn becomes a source of a Rossby wave-train along the southerly wind that generates positive geo-potential height anomalies around Korea. It can be concluded that Rossby waves are generated by the heat source, with positive correlation to vorticity over South China during July-August. To investigate the mechanisms behind the circulation changes, we calculated the heat budget correlation map for July-August using thermodynamic equations. Over Korea, the adiabatic atmospheric warming due to the anomalous downward motion of air is dominant. On the other hand, we found a positive correlation between the cyclonic circulation and the Korean heat wave from the Tropical Western Pacific to the southern part of China.

This circulation change facilitates the convective activity in the region but it weakens the moist transport from the South China Sea to the eastern part of Korea. Anomalous meridional circulation associated with the Korean heat wave links with the anomalous downward motion over the tropical ocean and the anomalous ascent of air at about 20°N. This leads to extreme (hot and dry) conditions over Korea.