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The Role of Tropical Waves in Tropical Cyclogenesis over the Western North Pacific

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The present study investigates the relationship between the tropical waves and the tropical cyclone (TC) genesis over the western North Pacific (WNP) for the period 1979-2011. Five wave types are considered in this study. It is shown that the TC genesis is strongly related to enhanced low-level vorticity and convection of tropical waves in all wave types but with significant difference in the TC modulation between wave dynamic and thermodynamic components. More TCs tend to form in regions of each wave with overlapping cyclonic vorticity and active convection. About 83.2% of TCs form within active phase of tropical waves, mainly in either one or two wave types. Each wave type is accounts for about 30% of all TC geneses except for the Kelvin waves that account for only 25.2% of TC geneses. The number of each wave type-related TC genesis consistently varies seasonally with peak in the TC season (July-November), which is attributed to the combined effect of both active wave probability and intensity change. The interannual variation of the TC genesis is well reproduced by the tropical wave-related TC genesis, especially in the region to east of 150°E. An eastward extension of the enhanced monsoon trough (MT) coincides with increased tropical wave activity by accelerated wave-mean flow interaction.
Furthermore, this study investigates the possible linkage between the MT and the interannual variability of the activity of westward-propagating tropical waves (WTW) over the WNP during July–November. It is shown that the interannual variability of WTW activity is closely related to the location of the MT. During the years when the enhanced (weakened) MT extends eastward (retreats westward), the lower-tropospheric WTW activity is above (below) normal within the southeastern quadrant of the WNP. The barotropic conversion associated with the MT is the most important mechanism for the growth of eddy energy in both TD–MRG and ER waves. The large rotational flows help to maintain the rapid growth and tilted horizontal structure of the lower-tropospheric waves through a positive feedback between the wave growth and horizontal structure. The baroclinic conversion process associated with the MT contributes a smaller part for TD–MRG waves, but is of importance comparable to barotropic conversion for ER waves as it can produce the tilted vertical structure. The growth rates of the waves are much larger during strong MT years than during weak MT years. Numerical experiments confirm that the mean flow of the MT provides a favorable background condition for the development of the waves and acts as a key energy source. Differences in the location of the MT may lead to an east–west contrast in the tropical waves, which provide an important source for TC genesis.