



## **A Study of Long-lasting Rainbands Associated with Tropical Cyclones in the Western North Pacific**

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Long-lasting rainbands might occur when tropical cyclones (TCs) interact with the environment, especially the southwest monsoon as in the cases of Typhoons Kalmeagi (2008), Morakot (2009) and Fanapi (2010) in the western North Pacific. These long-lasting rainbands are linear convective systems that have a large cold cloud shield, and last for more than six hours. They often pose great challenges to typhoon rainfall forecast when they interact with terrain to produce continuous torrential rain at remote region of TC. In this study, a total of 165 long-lasting rainbands that occurred to the south of TC centers during 1999-2009 are identified using infrared images and passive micro-wave images. Furthermore, these long-lasting rainbands are classified into two types: outer-MCS (85 cases) and enhanced-rainbands (80 cases), depending on the origin of these rainbands. A long-lasting rainband is classified as outer-MCS if it developed from a distant rainband of the TC. If the long-lasting rainband is a primary rainband, it is classified as enhanced-rainband.

Results show that 31% of all TCs in the western North Pacific produce at least one long-lasting rainband during its life period. An outer-MCS generally occurs at area 200-700 km away from the TC center and moves usually outward with respect to the moving TC center. It often develops in the downshear right quadrant of a TC. On the other hand, an enhanced-rainband usually is distributed between 100- and 300-km radii of a TC and moves cyclonically. It often develops in the downshear left quadrant of a TC. The environmental conditions favorable for the development of long-lasting rainbands are identified, including low-level south-westerly flows, mid-level dry air associated with the subtropical high, and strong vertical wind shears. Results also show that impacts of outer-MCS and that of enhanced-rainbands on TC structure changes are quite different. When an enhanced-rainband occurs, the TC usually increases its size with a faster rate and the intensification rate remains the same. However, the increasing rate of size remains the same but the intensification rate becomes slower when an outer-MCS occurs.