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The Synoptically-Influenced Extreme Precipitation Systems over Asian-Australian Monsoon Region observed by TRMM Precipitation Radar

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This study investigates the synoptic-scale flows associated with extreme rainfall systems over the Asian–Australian monsoon region (90°E–160°E and 12°S–27°N). On the basis of the statistics of the 17-year Precipitation Radar observations from Tropical Rainfall Measurement Mission, a total of 916 extreme systems, with both the horizontal size and maximum rainfall intensity exceeding the 99.9th percentiles of the tropical rainfall systems, are identified over this region. The synoptic wind pattern and rainfall distribution surrounding each system are classified into four major types: vortex, coastal, coastal with vortex, and none of above, with each accounting for 44%, 29%, 7%, and 20%, respectively. The vortex type occurs mainly over the off-equatorial areas in boreal summer. The coast-related types show significant seasonal variations in their occurrence, with high frequency in the Bay of Bengal in boreal summer and on the west side of Borneo and Sumatra in boreal winter. The none-of-the-above type occurs mostly over the open ocean, and in boreal winter, these events are mainly associated with the cold surge events. The environment analysis shows that coast-related extremes in the warm season are found within the areas where high total water vapor and low-level vertical wind shear occur frequently. Despite the different synoptic environments, these extremes show a similar internal structure, with broad stratiform and wide convective core (WCC) rain. Furthermore, the maximum rain rate is located mostly over the convective area, near the convective–stratiform boundary in the system. Our results highlight the critical role of the strength and direction of synoptic flows in the generation of extreme rainfall systems near coastal areas. With the enhancement of the low-level vertical wind shear and moisture by the synoptic flow, the coastal convection triggered diurnally has a higher chance to organize into mesoscale convective systems and hence a higher probability to produce extreme rainfall.