Joint modulation of coastal rainfall in Northeast Australia by local and large-scale forcings: Observations versus AUS2200 simulations

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This study investigates the interaction between large-scale and local-scale forcings in regulating precipitation and its diurnal variation over coastal areas in Northeast (NE) Australia using the convection-permitting UK Met-Office Unified Model simulations with a horizontal grid-spacing of 2.2 km (AUS2200). The AUS2200 simulates well the spatial distribution of rainfall and its variation with large-scale variabilities such as El Niño-Southern Oscillation (ENSO) and the Madden Julian Oscillation (MJO) over Northeast Australia during a total 180 simulations days. Over the coastal areas, inhomogeneous rainfall patterns are evident in both radar observations and model simulations. By classifying the characteristics of offshore and onshore rainfall propagation, we found that the rainfall propagation modulates the average rainfall patterns. Modelling results suggest that the large-scale background wind and local-scale land-sea breeze circulations are two important factors driving rainfall propagation. For offshore rainfall propagation, a dominant propagation type over NE Australia, rainfall is triggered during the afternoon by strong sea breezes, and then propagates offshore during the nighttime with the strong upper-level westerly wind. In contrast, onshore rainfall propagation occurs during days with strong background easterlies from the surface to the upper levels. Rainfall tends to occur and stay over the land during days with strong sea breezes and weak background upper-level westerlies. On days with strong low-level easterly winds and strong upper-level westerly winds, rainfall is mainly concentrated over the ocean. We test the hypothesis that the background wind regimes associated with different phases of the MJO modulate the direction and strength of rainfall propagation, leading to different coastal rainfall patterns. In some cases, this may dominate the thermodynamic influence of the convective phases of the MJO. Normal text style should be used for all body text of the document.