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Multi-scale interactions during the Indonesian monsoon

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The multi-scale interactions between El Niño Southern Oscillation (ENSO) and Indonesian monsoonal rainfall are analyzed using various datasets including daily rain gauges, high resolution satellites estimates of rainfall, atmospheric data taken from the National Center for Environmental Prediction (NCEP)/NCAR reanalysis and regional climate model version 3 (RegCM3) simulations with an horizontal resolution of 25 km from 1979 to 2006. We analyze interactions between large-scale ENSO-induced seasonal anomalies, synoptic scale of weather regimes defined through a k-means clustering of daily 850 hPa NCEP/NCAR winds and local scale and diurnal cycle of rainfall. The impact of ENSO is found to be largely spatially-uniform across the most of Indonesia during the spring-to-summer transition when the monsoon advances southeastward with a large delay (small advance) observed during warm (cold) ENSO events. The ENSO signal becomes more fragmented during the rainy season, from December. In particular, the large-scale seasonal easterly anomaly observed in low tropospheric levels (i.e. weakening of the austral summer monsoon) across Indonesia during warm ENSO events is found to be related to an increased frequency of a weather regime characterized by "quiescent" winds. RegCM3 outputs suggest that these weak winds tend to enhance the diurnal cycle and this leads to locally increased rainfall over mountains and the southern/western faces of the islands, such as Java. The ENSO signal is thus temporally and spatially coherent over the seas (i.e. anomalously dry during warm ENSO events), but more complex over the islands, with the spatially-uniform signal across Indonesia restricted to onset phase of the monsoon.