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Regional extreme rainfalls observed globally with 17 years of the Tropical Precipitation Measurement Mission

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While extreme rainfall has a huge impact upon human society, the characteristics of the extreme precipitation vary from region to region. Seventeen years of three dimensional precipitation measurements from the space-borne precipitation radar equipped with the Tropical Precipitation Measurement Mission satellite enabled us to describe the characteristics of regional extreme precipitation globally.

Extreme rainfall statistics are based on rainfall events defined as a set of contiguous PR rainy pixels. Regional extreme rainfall events are defined as those in which maximum near-surface rainfall rates are higher than the corresponding 99.9th percentile in each 2.5degree x2.5degree horizontal resolution grid.

First, regional extreme rainfall is characterized in terms of its intensity and event size. Regions of “intense and extensive” extreme rainfall are found mainly over oceans near coastal areas and are likely associated with tropical cyclones and convective systems associated with the establishment of monsoons. Regions of “intense but less extensive” extreme rainfall are distributed widely over land and maritime continents, probably related to afternoon showers and mesoscale convective systems. Regions of “extensive but less intense” extreme rainfall are found almost exclusively over oceans, likely associated with well-organized mesoscale convective systems and extratropical cyclones.

Secondly, regional extremes in terms of surface rainfall intensity and those in terms of convection height are compared. Conventionally, extremely tall convection is considered to contribute the largest to the intense rainfall. Comparing probability density functions (PDFs) of 99th percentiles in terms of the near surface rainfall intensity in each regional grid and those in terms of the 40dBZ echo top heights, it is found that heaviest precipitation in the region is not associated with tallest systems, but rather with systems with moderate heights. Interestingly, this separation of extremely heavy precipitation from extremely tall convection is found to be quite universal, irrespective of regions. Rainfall characteristics and environmental conditions both indicate the importance of warm-rain processes in producing extreme rainfall rates. Thus it is demonstrated that, even in regions where severe convective storms are representative extreme weather events, the heaviest rainfall events are mostly associated with less intense convection.

Third, the size effect of rainfall events on the precipitation intensity is investigated. Comparisons of normalized PDFs of foot-print size rainfall intensity for different sizes of rainfall events show that footprint-scale extreme rainfall becomes stronger as the rainfall events get larger. At the same time, stratiform ratio in area as well as in rainfall amount increases with the size, confirming larger sized features are more organized systems. After all, it is statistically shown that organization of precipitation not only brings about an increase in extreme volumetric rainfall but also an increase in probability of the satellite footprint scale extreme rainfall.