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Optimization of TRMM 2A25 Extreme Rainfall Rate and Probability

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With the launch of the Global Precipitation Measurement (GPM) mission imminent, the Tropical Rainfall Measurement Mission (TRMM) Precipitation Radar (TPR) still represents one of the most accurate satellite-based on-land rainfall measurements. However, as a low-orbital satellite (swath width 247km) with a comparatively low temporal sampling frequency, there is a high likelihood that TPR does not observe individual storm events, most notably localized tropical convective storms. Furthermore, the TPR product 2A25 standard radar reflectivity-rainfall rate (Z-R) relationship is optimized for moderate precipitation rates, given their more frequent occurrence, which affects estimation of high-intensity events.

In this study two methods are presented for optimization of extreme rainfall intensity and probability in TRMM 2A25. Firstly, the TPR reflectivity-rainfall relationship (Z-R relationship) was re-calibrated for 143 gauge locations across Peru based on hourly gauge measurements from 2005-2013. Various rainfall thresholds were defined to focus Z-R optimization on extreme precipitation rates. In each case the updated set of parameters were applied to the remaining TPR observations using an interpolation approach to obtain a spatially-continuous improved dataset for Peru. Secondly, the extreme precipitation probability statistics of both the original and updated 2A25 datasets were assessed. For this purpose General Pareto Distributions (GPD) were fitted to Partial Duration Series (Peaks-over-Threshold) of the original and updated 2A25 product at the 143 gauge locations as well as to the gauge records themselves. The 2A25 statistics were perturbed to match the GPD parameters and distributions of the gauges. The correction factors were applied to the entire 2A25 dataset to obtain distributions across the region.

Performance of the Z-R re-calibration and extreme precipitation probability optimization was evaluated using a split-sample cross-validation whereby 90% of the gauges were used for optimization and 10% for validation. Lastly, the impact of gauge density within a TPR gridcell (5km x 5km) and topography on the optimization results was assessed using linear regression. The results indicate that both the estimation of rainfall intensities as well as the precipitation probability estimation can be improved by using gauge-based updating of TPR.