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Seasonal and diurnal spatial patterns of precipitation frequency from the TRMM Precipitation Radar

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The detailed spatial distribution of rainfall is currently poorly understood over the oceans and for land regions without routine precipitation observation infrastructure. Many of these poorly observed areas are in the tropics where most of the global precipitation occurs. NASA's Tropical Rainfall Measuring Mission (TRMM) satellite was launched in 1997 and continues to operate. TRMM carries the first space-borne Precipitation Radar (PR) which provides high spatial resolution data of the vertical structure of precipitation. We utilize TRMM PR orbit data to construct 5 km x 5 km grids of precipitation statistics over several tropical regions. We focus on several statistics derived from over 10 years of TRMM PR data –the frequency of precipitation above a threshold corresponding to $\sim$0.4 mm/hr, the conditional rain rate near the surface, and conditional radar reflectivities at 3 km and 6 km altitude. Maps of seasonal precipitation frequency reveal the expected large-scale latitudinal variations of the ITCZ and monsoon as well as smaller scale regional precipitation patterns related to sea and land breezes and mountain upslope and downslope flow. In comparison, maps of conditional rain rates and reflectivities indicate less regional variation and primarily illustrate differences between continental and oceanic precipitation. Use of a single satellite-based precipitation instrument over the global tropics facilitates intercomparison among geographic regions.

In Asia and the Maritime Continent, there are very high frequencies of precipitation off the coast of Myanmar north toward Bangladesh and off the west coast of Sumatra. The precipitation frequencies off the coast of Myanmar are likely associated with a land breeze but are comparable in magnitude to those for orographic precipitation. The Central Range of the island of New Guinea exhibits a strong diurnal cycle with the precipitation near the crest during day associated with upslope flow and similar magnitude precipitation frequencies along the lower flanks of the range during the night. Concavities in the New Guinea and New Britain coastlines also yield high frequencies of precipitation associated with diurnal land breezes. The frequency of orographic precipitation associated with the Western Ghats mountain range on the Indian subcontinent is comparable to that for the Himalayas but the Himalayas have higher conditional rain rates. In comparison to Asia and the Maritime Continent, Africa has lower frequencies of precipitation in the mountains and near the coast associated with sea/land breezes. Precipitation frequency over the African continent is highest near -12 deg S latitude corresponding to Angola, Zambia and the Democratic Republic of the Congo. In the Americas, the concave southern coastline of Panama and western coastline of Columbia yields very high precipitation frequencies. The Andes do not exhibit the strong local enhancement of conditional rain rate and reflectivities aloft associated with the Himalayas. Areas with high yearly rainfall accumulations but lower rainfall frequencies, such as Darwin, Australia, indicate regions with a few intense storms. Regions where a small number of storms are responsible for the majority of local fresh water resources are potentially at higher risk for variations in fresh water availability in a changing climate.