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Seeking Augmented Information Content Concerning Diurnal Precipitation Achieved by Combining TRMM-PR and CloudSat-CPR Radar Data Sets

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The CloudSat satellite's Cloud Profiling Radar (CPR) is a highly sensitive 94 GHz (W-band) nadir viewing radar system flown in retrograde sun synchronous orbit useful for determining the vertical structure of cloud hydrometeors down to sensitivity of $\sim$ -30 dBZ reflectivity factor. Given this sensitivity, it is possible to unambiguously measure precipitation rates in clouds over a spectrum extending from $\sim$ 0.08 - 3.0 mm hr^{-1} down to altitudes of 0.5 km with $\sim$0.25 km vertical binning. This enables an effective means to measure a great deal of the drizzle and light rain spectrum. However, because of its near-polar sunsynchronous orbit, CloudSat cannot sample the diurnal cycle of precipitation, nor with its nadir-only CPR view can it obtain a high duty cycle in sampling precipitation at fixed local times over fixed positions. On the other hand, the TRMM satellite, which is flown in a non-sunsynchronous 35-degee inclined orbit carrying the 13.8 GHz KU-band Precipitation Radar (PR) scanning through nadir over an $\sim$225 km swath, can sample both the diurnal cycle and with a much improved duty cycle relative to CloudSat. Moreover, the PR and CPR have the same 0.25 km vertical binning capability. The PR's greatest shortcoming is its $\sim$ +17 dBZ sensitivity, which eliminates the possibility of measuring rain rates below $\sim$0.3-0.5 mm hr^{-1}, which can

involve rainfall accumulations of up to 50% of the total over some regions. This begs the question of whether by combining CPR and PR data sets, whether it is possible to obtain an augmented measurement of the diurnal precipitation cycle.

By collecting complimentary datasets during CloudSat and TRMM satellite orbit crossings within a Δt = 45-min proximity window, it is possible to demonstrate that whenever TRMM detects a precipitation signal, the correlations along the vertical axis between the reflectivities acquired from the CPR and PR are in inverse proportion to the magnitude of the Δt proximity window. By taking advantage of these underlying correlations, it is possible to develop a functional which can be used to broaden the reflectivity spectrum, concomitantly the rain rate spectrum, of the PR measurements based on the inherently broader reflectivity spectrum of the CPR at the lower reflectivity end of the spectrum, concomitantly at lighter rain rates. With the functional in place, it is then possible to produce synthetic CloudSat precipitation imagery over the PR track and thus over the diurnal time period. These augmented data are then used to study the spectral-vertical diurnal properties of precipitation over oceanic regions observed by TRMM.