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Cross Validation of TRMM Precipitation Radar and Ground Radar Reflectivities

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Given the decade long and highly successful Tropical Rainfall Measuring Mission (TRMM), it is now possible to cross validate ground-based radars (GRs) and the space-borne TRMM precipitation radar (PR) with greater certainty over longer time scales in various tropical climatological regions. Researchers have shown that the PR is consistently able to measure reflectivity with absolute calibration accuracy better than ± 1 dB. Thus, the PR can serve as a consistent reference to calibrate GRs, and to detect inconsistencies between adjacent GRs. On the other hand, the PR has a low sensitivity threshold of 18 dBZ, and operates at an attenuating frequency of 13.8 GHz; whereas the GRs have a higher sensitivity and operate at less-attenuating frequencies (such as 2.8 GHz). Hence, GRs can be used to check the PR rain detection ability and attenuation correction algorithm performance.

This study develops an automated methodology to match and compare simultaneous TRMM PR and GR reflectivities at four primary TRMM Ground Validation (GV) sites: Houston, Texas (HSTN); Melbourne, Florida (MELB); Kwajalein, Republic of the Marshall Islands (KWAJ); and Darwin, Australia (DARW). Data from each instrument are resampled into a three-dimensional Cartesian coordinate system. The horizontal displacement during the PR data resampling is corrected. Comparisons suggest that the PR suffers significant attenuation at lower levels especially in convective rain. The attenuation correction performs quite well for convective rain but appears to slightly over-correct in stratiform rain. The PR and GR observations at HSTN, MELB and KWAJ agree to about ± 1 dB on average with a few exceptions, while the GR at DARW requires +1 to -5 dB calibration corrections. One of the important findings of this study is that the GR calibration offset is dependent on the reflectivity magnitude. Hence, we propose that the calibration should be carried out using a regression correction, rather than simply adding an offset value to all GR reflectivities.

This methodology is developed towards TRMM GV efforts to improve the accuracy of tropical rain estimates, and can also be applied to the proposed Global Precipitation Measurement and other related activities over the globe.