THE UNIVERSITY OF UTAH
Atmospheric Sciences

THESIS DEFENSE ANNOUNCEMENT

Relationships between Extreme Rain Rates and Convective Intensities from the Perspectives of TRMM and WSR-88D Radars

TRMM PR 2A25 V7 retrievals across the tropics and subtropics show that despite extreme rain rates often being associated with convectively intense systems, the precipitation features (PFs) with the tallest maximum 40 dBZ echo heights are in fact rarely the same PFs that exhibit the most extreme near-surface rainfall rates. It is also known that because TRMM PR operates at Ku-band, its signal suffers from significant attenuation in heavy precipitation.

To investigate the impacts of potential weaknesses in the 2A25 V7 retrievals, 14 years of June – August TRMM PR retrievals are compared to June – August 2014 hourly WSR-88D dual-polarimetric S-band data for 28 radars over the southeastern United States after matching their horizontal resolution and sampling as a function of geographical location. To more directly compare reflectivity estimates, TRMM-Ku band measurements are converted to S-band approximations. Rain rates for WSR-88D data are approximated using the CSU-HIDRO algorithm, which calculates rain rates from reflectivity (Z), differential reflectivity (ZDR), and specific differential phase (KDP) relationships. This research aims to not only investigate the difference between TRMM PR and WSR-88D measurements and calculations of reflectivity and rain rate, but to also investigate how apparent differences relate to TRMM path integrated attenuation (PIA), and WSR-88D KDP, ZDR and calculated hail fraction, which can indicate potential issues in TRMM 2A25 V7 attenuation correction.

Tropics-wide TRMM retrievals confirm previous findings of a low overlap fraction between extreme convective intensity and extreme near-surface rain rates. WSR-88D data also confirms that the overlap fraction is low, but shows that it is likely higher than TRMM PR retrievals indicate, approximately 30% higher in the southeastern United States for the 99th percentiles of maximum 40 dBZ heights and low-level rain rates. For maximum 40 dBZ echo heights that extend into regions likely containing ice via the presence of hail or graupel, mean WSR-88D reflectivities are approximately 2 dBZ higher than TRMM PR reflectivities. Mean low-level rain rates as a function of low-level reflectivity increase similarly across the datasets until approximately 33 dBZ, where the CSU-HIDRO algorithm increasingly relies on ZDR and KDP retrievals to calculate rain rate, causing WSR-88D rain rates to be greater than TRMM PR rain rates calculated using Z-R relationships. Higher WSR-88D rain rates for a given low-level reflectivity combine with the higher low-level reflectivities for a given maximum 40 dBZ height to produce much greater mean WSR-88D rainfall rates than TRMM PR as a function of maximum 40 dBZ height for heights that extend above 5 km into regions likely to have ice. Investigations of TRMM PR PIA, and WSR-88D KDP, ZDR, and hail fraction indicate that the TRMM PR 2A25 V7 algorithm is possibly misidentifying low-mid level hail and/or graupel as greater attenuating liquid, or vice versa. This possible misidentification, coupled with WSR-88D's use of KDP to retrieve high rain rates, results in 2A25 V7 Z-R relationships that likely produce low biased rain rates in intense convection. An exception exists for low-level reflectivities exceeding 55 dBZ, when Z-R relationships overestimate rain rate due to likely hail contamination.

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