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Ground Validation Assessments of GPM Core Observatory Science Requirements

Walt Petersen (1), George Huffman (2), Chris Kidd (3), and Gail Skofronick-Jackson (2)

(1) NASA Marshall Space Flight Center, Earth Sciences, Huntsville, Alabama, United States (walt.petersen@nasa.gov), (2) Goddard Space Flight Center, Greenbelt, Maryland, United States, (3) University of Maryland/GSFC, Greenbelt, Maryland, United States

NASA Global Precipitation Measurement (GPM) Mission science requirements define specific measurement error standards for retrieved precipitation parameters such as rain rate, raindrop size distribution, and falling snow detection on instantaneous temporal scales and spatial resolutions ranging from effective instrument fields of view [FOV], to grid scales of 50 km x 50 km. Quantitative evaluation of these requirements intrinsically relies on GPM precipitation retrieval algorithm performance in myriad precipitation regimes (and hence, assumptions related to physics) and on the quality of ground-validation (GV) data being used to assess the satellite products. We will review GPM GV products, their quality, and their application to assessing GPM science requirements, interleaving measurement and precipitation physical considerations applicable to the approaches used.

Core GV data products used to assess GPM satellite products include 1) two minute and 30-minute rain gauge bias-adjusted radar rain rate products and precipitation types (rain/snow) adapted/modified from the NOAA/OU multi-radar multi-sensor (MRMS) product over the continental U.S.; 2) Polarimetric radar estimates of rain rate over the ocean collected using the K-Pol radar at Kwajalein Atoll in the Marshall Islands and the Middleton Island WSR-88D radar located in the Gulf of Alaska; and 3) Multi-regime, field campaign and site-specific disdrometer-measured rain/snow size distribution (DSD), phase and fallspeed information used to derive polarimetric radar-based DSD retrievals and snow water equivalent rates (SWER) for comparison to coincident GPM-estimated DSD and precipitation rates/types, respectively.

Within the limits of GV-product uncertainty we demonstrate that the GPM Core satellite meets its basic mission science requirements for a variety of precipitation regimes. For the liquid phase, we find that GPM radar-based products are particularly successful in meeting bias and random error requirements associated with retrievals of rain rate and required +/- 0.5 millimeter error bounds for mass-weighted mean drop diameter. Version-04 (V4) GMI GPROF radiometer-based rain rate products exhibit reasonable agreement with GV, but do not completely meet mission science requirements over the continental U.S. for lighter rain rates (e.g., 1 mm/hr) due to excessive random error ($\sim$75%). Importantly, substantial corrections were made to the V4 GPROF algorithm and preliminary analysis of Version 5 (V5) rain products indicates more robust performance relative to GV.

For the frozen phase and a modest GPM requirement to “demonstrate detection of snowfall”, DPR products do successfully identify snowfall within the sensitivity and beam sampling limits of the DPR instrument ($\sim$12 dBZ lower limit; lowest clutter-free bins). Similarly, the GPROF algorithm successfully “detects” falling snow and delineates it from liquid precipitation. However, the GV approach to computing falling-snow “detection” statistics is intrinsically tied to GPROF Bayesian algorithm-based thresholds of precipitation “detection” and model analysis temperature, and is not sufficiently tied to SWER. Hence we will also discuss ongoing work to establish the lower threshold SWER for “detection” using combined GV radar, gauge and disdrometer-based case studies.