

Use of dual-polarization radars for validation of spaceborne precipitation measurements: Rationale and opportunities.

Author list: Dr. V. Chandrasekar, chandra@engr.colostate.edu
Dr. Arthur Hou, Arthur.y.Hou@nasa.gov
Dr. Eric Smith, Eric.a.Smith@nasa.gov
Prof. V. N. Bringi, bringi@engr@colostate.edu
Prof. Steven A. Rutledge, Rutledge@atmos.colostate.edu
Dr. Eugenio Gorgucci, e.gorgucci@isac.cnr.it
Dr. Walter A. Petersen, walt.petersen@msfc.nasa.gov

Popular Summary:

Space-based precipitation estimates, and techniques for making those estimates, must be evaluated using complex Ground Validation (GV) methods. GV activities perform quality control and improve space-based precipitation measurements via the collection of detailed scientific observations which describe the way precipitation forms in clouds, including the evolution of precipitation size, shape and composition (what the satellite “sees”) as precipitation falls to the surface as rain or snow. The observational requirements for GV necessitate the use of versatile and well calibrated instruments that can “see” and measure precipitation both in and outside of clouds. We believe that one such platform particularly well suited to this task is dual-polarization radar.

Based on 20 years of scientific and technological advancements we make a strong case for the use of dual-polarimetric radar measurements in satellite precipitation measurement ground-validation. Using straight forward radar theory and published observations of precipitation properties, we demonstrate that dual-polarimetric radar measurements can accurately distinguish precipitation size, shape, concentration, type (e.g., ice vs. rain) and rate characteristics in virtually any environment. Moreover, because of the specific variables measured by dual-polarimetric radar it is possible to maintain a well calibrated radar system using only the radar system itself, thus providing both the high accuracy and small error required for GV precipitation measurements. We conclude that future networks of dual-polarization radars will provide a robust, necessary, and unique validation tool for programs associated with spaceborne precipitation measurement.

Abstract:

Dual-polarization weather radars evolved significantly in the last three decades culminating in the operational deployment by the National Weather Service. In addition to operational applications in the weather service, dual-polarization radars have shown significant potential in contributing to the ground based remote sensing of rainfall microphysics. Furthermore the dual-polarization radars have also raised the awareness of radar system aspects such as calibration. Microphysical characterization of precipitation and quantitative precipitation estimation are

important applications that are critical in the validation of satellite borne precipitation measurements and also serves as a valuable tool in algorithm development. This paper presents the critical role played by dual-polarization radar in validating space borne precipitation measurements. Starting from a historical evolution, the various configurations of dual-polarization radar are presented. Examples of raindrop size distribution retrievals and hydrometeor type classification are discussed. Quantitative precipitation estimation capability, especially in the presence of ice contamination is highlighted. The quantitative precipitation estimation is a product of direct relevance to space borne observations. During the TRMM program substantial advancement was made with ground based polarization radars specially collecting unique observations in the tropics which are noted. The scientific accomplishments of relevance to space borne measurements of precipitation are summarized. The potential of dual-polarization radars and opportunities in the era of global measurement of precipitation are discussed