Geophysical Research Abstracts
Vol. 17, EGU2015-7573, 2015
EGU General Assembly 2015

Construction of Polarimetric Radar-Based Reference Rain Maps for the Iowa Flood Studies Campaign

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The Global Precipitation Measurement (GPM) Mission Iowa Flood Studies (IFloodS) campaign was conducted in central and northeastern Iowa during the months of April-June, 2013. Specific science objectives for IFloodS included quantification of uncertainties in satellite and ground-based estimates of precipitation, 4-D characterization of precipitation physical processes and associated parameters (e.g., size distributions, water contents, types, structure etc.), assessment of the impact of precipitation estimation uncertainty and physical processes on hydrologic predictive skill, and refinement of field observations and data analysis approaches as they pertain to future GPM integrated hydrologic validation and related field studies. In addition to field campaign archival of raw and processed satellite data (including precipitation products), key ground-based platforms such as the NASA NPOL S-band and D3R Ka/Ku-band dual-polarimetric radars, University of Iowa X-band dual-polarimetric radars, a large network of paired rain gauge platforms, and a large network of 2D Video and Parsivel disdrometers were deployed. In something of a canonical approach, the radar (NPOL in particular), gauge and disdrometer observational assets were deployed to create a consistent high-quality distributed (time and space sampling) radar-based ground "reference" rainfall dataset, with known uncertainties, that could be used for assessing the satellite-based precipitation products at a range of space/time scales. Subsequently, the impact of uncertainties in the satellite products could be evaluated relative to the ground-benchmark in coupled weather, land-surface and distributed hydrologic modeling frameworks as related to flood prediction.

Relative to establishing the ground-based "benchmark", numerous avenues were pursued in the making and verification of IFloodS "reference" dual-polarimetric radar-based rain maps, and this study documents the process and results as they pertain specifically to efforts using the NPOL radar dataset. The initial portions of the "process" involved dual-polarimetric quality control procedures which employed standard phase and correlation-based approaches to removal of clutter and non-meteorological echo. Calculation of a scale-adaptive KDP was accomplished using the method of Wang and Chandrasekar (2009; J. Atmos. Oceanic Tech.). A dual-polarimetric blockage algorithm based on Lang et al. (2009; J. Atmos. Oceanic Tech.) was then implemented to correct radar reflectivity and differential reflectivity at low elevation angles. Next, hydrometeor identification algorithms were run to identify liquid and ice hydrometeors. After the quality control and data preparation steps were completed several different dual-polarimetric rain estimation algorithms were employed to estimate rainfall rates using rainfall scans collected approximately every two to three minutes throughout the campaign. These algorithms included a polarimetrically-tuned Z-R algorithm that adjusts for drop oscillations (via Bringi et al., 2004, J. Atmos. Oceanic Tech.), and several different hybrid polarimetric variable approaches, including one that made use of parameters tuned to IFloodS 2D Video Disdrometer measurements. Finally, a hybrid scan algorithm was designed to merge the rain rate estimates from multiple low level elevation angle scans (where blockages could not be appropriately corrected) in order to create individual low-level rain maps. Individual rain maps at each time step were subsequently accumulated over multiple time scales for comparison to gauge network data. The comparison results and overall error character depended strongly on rain event type, polarimetric estimator applied, and range from the radar. We will present the outcome of these comparisons and their impact on constructing composited "reference" rainfall maps at select time and space scales.