Physical Validation of GPM Retrieval Algorithms Over Land: An Overview of the Mid-Latitude Continental Convective Clouds Experiment (MC3E)

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The joint NASA GPM – DOE ARM Midlatitude Continental Convective Clouds Experiment (MC3E) was conducted from April 22–June 6, 2011, centered on the DOE-ARM Southern Great Plains Central Facility site in northern Oklahoma. GPM field campaign objectives focused on the collection of airborne and ground-based measurements of warm-season continental precipitation processes to support refinement of GPM retrieval algorithm physics over land, and to improve the fidelity of coupled cloud resolving and land-surface satellite simulator models. DOE ARM objectives were synergistically focused on relating observations of cloud microphysics and the surrounding environment to feedbacks on convective system dynamics, an effort driven by the need to better represent those interactions in numerical modeling frameworks. More specific topics addressed by MC3E include ice processes and ice characteristics as coupled to precipitation at the surface and radiometer signals measured in space, the correlation properties of rainfall and drop size distributions and impacts on dual-frequency radar retrieval algorithms, the transition of cloud water to rain water (e.g., autoconversion processes) and the vertical distribution of cloud water in precipitating clouds, and vertical draft structure statistics in cumulus convection.

The MC3E observational strategy relied on NASA ER-2 high-altitude airborne multi-frequency radar (HIWRAP Ka-Ku band) and radiometer (AMPR, CoSMIR; 10-183 GHz) sampling (a GPM “proxy”) over an atmospheric column being simultaneously profiled in situ by the University of North Dakota Citation microphysics aircraft, an array of ground-based multi-frequency scanning polarimetric radars (DOE Ka-W, X and C-band; NASA D3R Ka-Ku and NPOL S-bands) and wind-profilers (S/UHF bands), supported by a dense network of over 20 disdrometers and rain gauges, all nested in the coverage of a six-station mesoscale rawinsonde network. As an exploratory effort to examine land-surface emissivity impacts on retrieval algorithms, and to demonstrate airborne soil moisture retrieval capabilities, the University of Tennessee Space Institute Piper aircraft carrying the MAPIR L-band radiometer was also flown during the latter half of the experiment in coordination with the ER-2. The observational strategy provided a means to sample the atmospheric column in a redundant framework that enables inter-calibration and constraint of measured and retrieved precipitation characteristics such as particle size distributions, or water contents- all within the umbrella of “proxy” satellite measurements (i.e., the ER-2). Complimenting the precipitation sampling framework, frequent and coincident launches of atmospheric soundings (e.g., 4-8/day) then provided a much larger mesoscale view of the thermodynamic and winds environment, a data set useful for initializing cloud models.

The datasets collected represent a variety cloud and precipitation types including isolated cumulus clouds, severe thunderstorms, mesoscale convective systems, and widespread regions of light to moderate stratiform precipitation. We will present the MC3E experiment design, an overview of operations, and a summary of preliminary results.