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Monitoring All Weather Precipitation Using PIP and MRR

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The objective of this study is to demonstrate the science benefit of monitoring all weather precipitation for the Global Precipitation Measurement (GPM) Mission Ground Validation Program using a combination of two instruments: the Precipitation Imaging Package (PIP) and a Microwave Rain Radar-II (MRR). The PIP is a new ground based precipitation imaging instrument that uses a high speed camera and advanced processing software to image individual hydrometeors, measure hydrometeor size distributions, track individual hydrometeors and compute fall velocities. PIP hydrometeor data are also processed using algorithms to compute precipitation rates in one-minute time increments, and to discriminate liquid, mixed and frozen (e.g., snow) precipitation. The MRR, a vertically-pointing 24 GHz radar, is well documented in the literature and monitors hydrometeor vertical profile characteristics such as Doppler fall-speed spectra, radar reflectivity, size distribution and precipitation rate. Of interest to GPM direct and physical ground validation are collections of robust, satellite overpass-coincident, long-duration datasets consisting of observations of the aforementioned hydrometeor characteristics for falling snow and mixes of falling-snow and rain, as there are relatively few instruments that provide continuous observations of coincident hydrometeor image, size, and fall velocity in cold regions due to harsh environmental conditions.

During extended periods of 2013 and 2014, concurrent PIP and MRR data sets were obtained at the National Weather Service station in Marquette, Michigan (2014), and at the NASA Wallops Flight Facility in Wallops Island, Virginia (2013,14). Herein we present examples of those data sets for a variety of weather conditions (rain, snow, frontal passages, lake effect snow events etc.). The results demonstrate 1) that the PIP and MRR are well-suited to long term operation in cold regions; 2) PIP and MRR data products are useful for characterizing a wide variety of precipitation types and conditions; 3) systematic variability in bulk snow characteristics such as fall speed and size distributions can be observed between event types, but also within individual event types (e.g., within a given synoptic or lake effect storm). The observed behavior suggests that added information on environmental or cloud parameters may be necessary to further define snowfall types/regimes or to estimate snow water equivalent rates using satellite or ground-based active or passive remote sensing tools.