TITLE: Distributed Disdrometer and Rain Gauge Measurement Infrastructure Developed for GPM Ground Validation

PRESENTATION TYPE: Assigned by Committee (Oral or Poster)

CURRENT SECTION/FOCUS GROUP: Hydrology (H)

CURRENT SESSION: H34. Global Precipitation Measurement, Validation, and Applications

AUTHORS (FIRST NAME, LAST NAME): Walter Arthur Petersen[1], V. Bringi[3], Lawrence D Carey[2], Patrick N Gatlin[2], Dustin Phillips[2], Mathew Schwaller[4], Ali Tokay[4], Mathew Wingo[2], David B Wolff[4]

INSTITUTIONS (ALL): 1. Earth Sciences Office, NASA Marshall Space Flight Center, Huntsville, AL, United States.
2. ESSC, UAH, Huntsville, AL, United States.
3. Engineering, CSU, Fort Collins, CO, United States.
4. NASA GSFC, Greenbelt, MD, United States.

Title of Team:

ABSTRACT BODY: Global Precipitation Mission (GPM)retrieval algorithm validation requires datasets characterizing the 4-D structure, variability, and correlation properties of hydrometeor particle size distributions (PSD) and accumulations over satellite fields of view (FOV;<10 km). Collection of this data provides a means to assess retrieval errors related to beam filling and algorithm PSD assumptions. Hence, GPM Ground Validation is developing a deployable network of precipitation gauges and disdrometers to provide fine-scale measurements of PSD and precipitation accumulation variability. These observations will be combined with dual-frequency, polarimetric, and profiling radar data in a bootstrapping fashion to extend validated PSD measurements to a large coverage domain.

Accordingly, a total of 24 Parsivel disdrometers(PD), 5 3rd-generation 2D Video Disdrometers (2DVD), 70 tipping bucket rain gauges (TBRG),9 weighing gauges, 7 Hot-Plate precipitation sensors (HP), and 3 Micro Rain Radars (MRR) have been procured. In liquid precipitation the suite of TBRG, PD and 2DVD instruments will quantify a broad spectrum of rain rate and PSD variability at sub-kilometer scales. In the envisioned network configuration 5 2DVDs will act as reference points for 16 collocated PD and TBRG measurements. We find that PD measurements provide similar measures of the rain PSD as observed with collocated 2DVDs (e.g., D0, Nw) for rain rates less than 15 mm/hr. For heavier rain rates we will rely on 2DVDs for PSD information.

For snowfall we will combine point-redundant observations of SWER distributed over three or more locations within a FOV. Each location will contain at least one fenced weighing gauge, one HP, two PDs, and a 2DVD. MRRs will also be located at each site to extend the measurement to the column. By collecting SWER measurements using different instrument types that employ different measurement techniques our objective is to separate measurement uncertainty from natural variability in SWER and PSD. As demonstrated using C3VP polarimetric radar, gauge, and 2DVD/PD datasets these measurements can be combined to bootstrap an area wide SWER estimate via constrained modification of density-diameter and radar reflectivity-snowfall relationships. These data will be combined with snowpack, airborne microphysics, radar, radiometer, and tropospheric sounding data to refine GPM snowfall retrievals.

The gauge and disdrometer instruments are being developed to operate autonomously when necessary using solar power and wireless communications. These systems will be deployed in numerous field campaigns through 2016. Planned deployment of these systems include field campaigns in Finland (2010), Oklahoma (2011), Canada (2012) and North Carolina (2013). GPM will also deploy 20 pairs of TBRGs within a 25 km2 region along the Virginia coast under NASA NPOL radar coverage in order to quantify errors in point-area rainfall measurements.

Title: DISTRIBUTED DISDROMETER AND RAIN GAUGE MEASUREMENT INFRASTRUCTURE DEVELOPED
FOR GPM GROUND VALIDATION

Walter A. Petersen, NASA-MSFC, Earth Sciences Office VP-61, 320 Sparkman Dr., Huntsville AL. 35805;
walt.petersen@nasa.gov
V.N. Bringi, CSU
Lawrence Carey, UAH
Patrick Gatlin, UAH
Dustin Phillips, UAH
Mathew Schwaller, NASA GSFC
Ali Tokay, UMBC/NASA GSFC
Mathew Wingo, UAH
David Wolff, SSAI/NASA GSFC

Precipitation retrieval algorithms being developed and tested for the Global Precipitation Mission (GPM) dual-frequency precipitation radar (DPR) and microwave imager (GMI) require datasets that characterize the four-dimensional (4-D) structure, variability, and correlation properties of hydrometeor particle size distributions (PSD) and associated accumulations over relatively small satellite fields of view (FOV; < 10 km). Collection of PSD and accumulation data at these scales provides a means to assess algorithm retrieval errors related to beam filling and to assumptions in algorithm physics related to the behavior of PSD parameters within a given FOV. In order to create these datasets the GPM Ground Validation (GV) program is developing a deployable network of precipitation gauge and disdrometer instrumentation to provide fine-scale measurements of both PSD and precipitation accumulation variability. These observations will be combined with dual-frequency, dual-polarimetric, and profiling radar data in a bootstrapping fashion to provide a local validation of radar PSD measurements (including point-area sampling error) that can then be extended to a much larger coverage domain.

In order to provide these measurements in both liquid and frozen precipitation regimes GPM has procured a total of 24 Parsivel disdrometers (PD), five 3rd-generation 2D Video Disdrometers (2DVD), 70 Met One tipping bucket rain gauges (TBRG), nine OTT Pluvio2 weighing gauges, seven TPS-3100 Hot-Plate precipitation sensors (HP), and three MRR-2 Micro Rain Radars (for profiling in light liquid or frozen precipitation). In liquid precipitation the suite of TBRG, PD and 2DVD instruments will provide a means to quantify a broad spectrum of rain rate and PSD variability at sub-kilometer scales within an FOV. In the envisioned network configuration five 2DVDs will act as reference points for 16 collocated PD and TBRG measurements.   When comparing collocated 2DVDs and PDs, we have noted that PD measurements appear to provide similar measures of the rain PSD (e.g., D_0, N_w) as long as the rain rate is less than 15-20 mm/hr. For heavy convective rain rates we will rely on 2DVDs for PSD information.

For measurements of snowfall the challenge is to provide accurate coincident measures of snow water equivalent rate (SWER) and PSD for several points within a typical FOV. For this effort we will combine point-redundant measures of SWER distributed over three or more reasonably-spaced locations within a FOV. Each location will contain at least one double-fenced weighing gauge, a hot-plate, two PDs, and a 2DVD. Three of the locations will also have collocated MRR-2 radars to extend measurements to the column. Collecting multiple measurements of the same quantity (SWER) using different instrument

types that employ different measurement techniques our objective is to separate and quantify measurement uncertainties and natural variability in SWER and accompanying PSD. As demonstrated using Canadian CloudSat Calipso Validation Experiment polarimetric radar, gauge, and 2DVD/PD datasets these measurements can be combined to provide a reasonable estimate of area wide SWER through constrained modification of density-diameter and radar reflectivity-snowfall relationships. When combined with surface snowpack observations, airborne microphysics, radar and radiometer data, and tropospheric soundings the resultant snowfall datasets will provide databases useful for testing and refining GPM snowfall retrieval algorithms.

The gauge and disdrometer instruments are being developed to operate autonomously when necessary using solar power and wireless communications. Near term plans for deployment of these systems include GV field campaigns in Finland (Sept.-Oct. 2010), Oklahoma (2011), Canada (2012) and North Carolina (2013). Finally, in mid-2011 through 2012, GPM-GV will deploy approximately 20 pairs of TBRGs within a 25 km^2 region along the eastern shore of Virginia under coverage of the NASA NPOL radar in order to further quantify errors in point-area rainfall measurements.