Accurate Characterization of Rain DSDs for GPM-GV Applications

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0. SYNOPSIS: DSD analyses measured by collocated Meteorological Particle Spectrometer (MPS) and a 2D-video disdrometer (2DVD) are presented. Two events from two different regions (Greeley, CO, and Huntsville, AL) are analyzed. Whilst the MPS, with its 50 μm resolution, enabled measurements of small drops, typically for D < 1.1 mm, the 2DVD provided accurate measurements for D > 0.7 mm. Drop concentrations in the 0.7 to 1.1 mm overlap region were found to be in excellent agreement between the two instruments. Examination of the combined spectra clearly reveals a drizzle mode for small drops and a precipitation mode for larger diameters. The combined spectra were analyzed in terms of the DSD parameters (N_W, D_m, σ_M). The inclusion of small drops from the MPS significantly affected all three parameters. For the Huntsville event, a GPM overpass enabled comparison of satellite-based dual-frequency radar retrievals of D_m with ground based DSD measurements.

1. GREELEY EVENT *(10 Aug 2015, Moderately convective)*

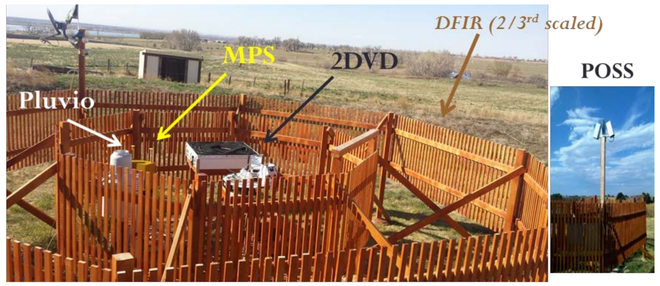


Fig. 1.1: The MPS, 2DVD and Pluvio inside the DFIR double wind fence, as well as POSS installed at the site near Greeley. A similar set-up was installed in Huntsville.

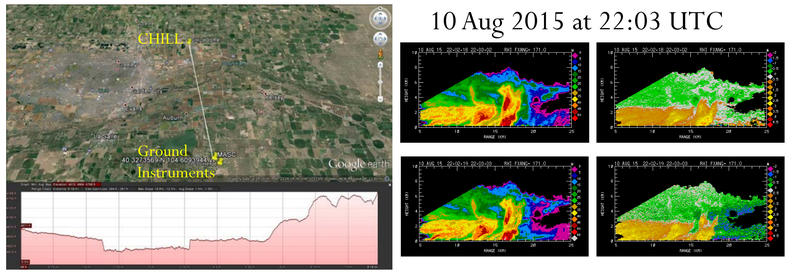


Fig. 1.2: CHILL radar site (left) and a set of RHI scans showing (a) S-band Z_h, (b) X-band Z_h, (c) S-band Z_{dr}, (d) X-band Z_{dr}, along the azimuth over the ground instrument site (13 km range).

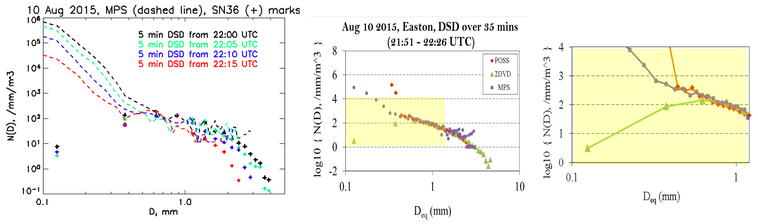


Fig. 1.3: 5 min DSDs from MPS and 2DVD (left plot) and 35-minute DSDs from MPS, 2DVD and POSS measurements for the on 10 Aug 2015 event; for 0.1 to 10 mm drop diameter (middle); and enlarged version from 0.1 to 2 mm (highlighted in yellow) (right plot)

2. THE HUNTSVILLE EVENT *(11 April 2016, Stratiform event with embedded convection, GPM overpass at 23:31 UTC)*

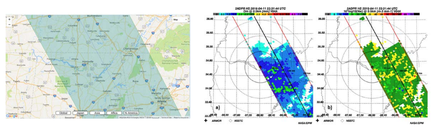


Fig. 2.1: GPM DPR swath across northern Alabama during the 11April 2016 event (left), and D_m [mm] (middle) and $10.\log_{10}(N_W)$ [$m^{-3}mm^{-1}$] (right), both at 500m AGL from the 2ADPR product.

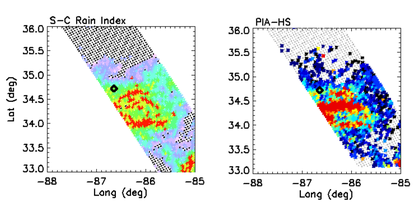
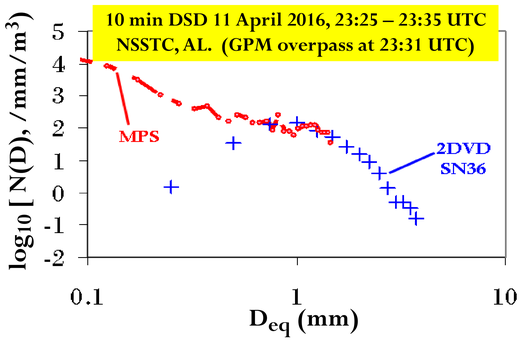


Fig. 2.2: Convective rain likelihood index (left) and HS-PIA (right). ◊ Represents the MPS, 2DVD location



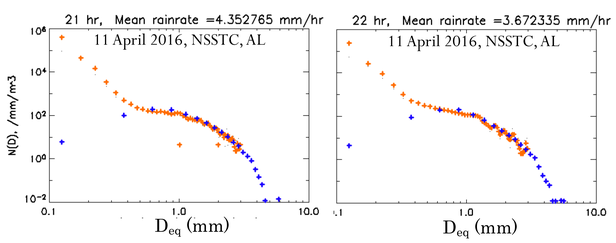


Fig. 2.3: ***Top plot***: 10 min DSD during the GPM overpass. ***Bottom plot*** – Two examples of hourly DSD comparisons

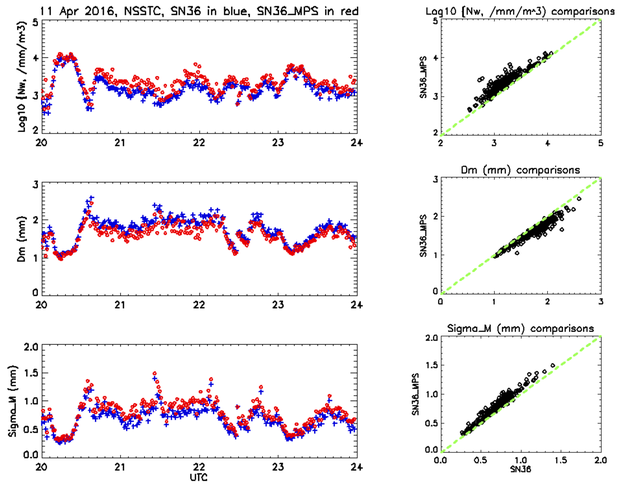


FIG. 2.4: ***Left plots*** – log10 (N_W), D_m and σ_M derived from 1 minute DSDs (after smoothing over 3 minutes) using 2DVD data alone (blue), and the combined MPS-2DVD data (red).
Right plots - Scatterplot of their comparisons

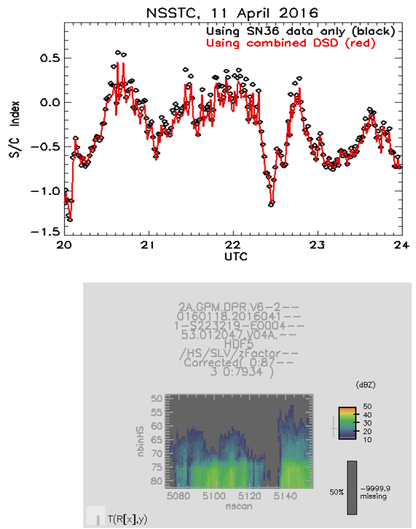


Fig. 2.5: ***Top plot*** – Stratiform-Convective Rain Index using the 1 –min DSDs. At the time of the GPM overpass (23:31 UTC), stratiform rain is indicated. ***Bottom plot*** – Confirmed by 2A.GPM.DPR.V6 - 2

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