Ground Validation Drop Size Distribution Studies: Constraints, Regimes

W. A. Petersen[1], F. L. Bliven[1], V. N. Bringi[2], L. D. Carey[3], , P. Gatlin[5], M. Thurai[2], A. Tokay[4] , M. Wingo[1,3], D. Wolff[1]

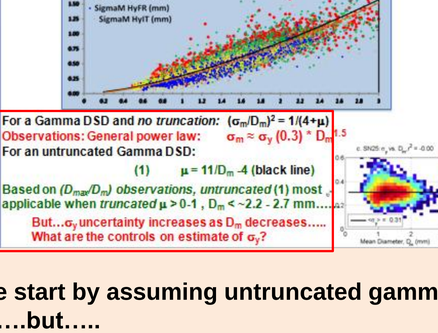
[1]NASA GSFC/Wallops Flight Facility, Wallops Island, VA, 23337; [2]Colorado State University, Fort Collins, CO; [3]ESSC, University of Alabama-Huntsville, Huntsville , AL; [4]NASA GSFC/UMBC, Greenbelt MD; [5]NASA MSFC, Huntsville, AL.

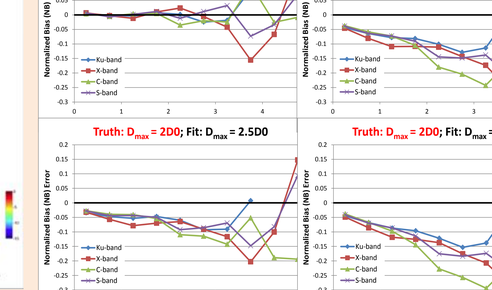
1. Science

- Multi-regime/cloud system database(s) of rain drop size distribution (DSD) character, variability, parameter correlations and constraints

2. Measurements

- Multiple field campaign and regime deployments





- Dense network deployments for investigating characteristics, variability, parametric constraints of DSD, referencing multi-parameter radar and model retrievals

3. Topic 1: Constraining upper limit of DSD Integration: D_{max}

$$p_n = N_0 \int_0^{\infty} D^{n+\mu} e^{-\Lambda D} dD$$ *vs.. reality* $$p_n = N_0 \int_0^{Dmax} D^{n+\mu} e^{-\Lambda D} dD$$

***Truncated vs. un-truncated gamma approach*: *How to constrain selection of upper integration limit* when computing moments of the DSD?**

***Can we actually sample D_{max}* on relevant scales [e.g., point vs. pulse volume]?**
Are there reasonable and persistent *relationships between D_{max} and say, D_m*?

Assumptions permeate applications!

σ_m vs. D_m regime independence
Importance of D_{max}?

We start by assuming untruncated gamma …….but…..

Truncated, D_{max} / D_m limits μ range and error in μ and σ_y if ratio is small (e.g., < 2.0)

Pol radar diagnosis of $D_0 = F(Z_{dr})$
sensitive to the D_{max}=f (D_0) assumption

Significant negative bias in D_0 for D_{max} = $3D_0$, $3.5D_0$ (*these have been used in the past!!)*

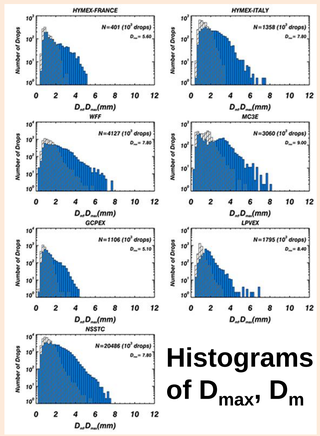
Resonance *increases D_0 error* at C-band (X-band) between 1.25 < Z_{dr} < 3.25 dB (0.75 < Z_{dr} < 1.75 dB)

Error in D_0 is large for Z_{dr} > 3.25 dB for all scenarios

What is the best D_{max}-D_m relationship if any?

Topic 1 (continued): Point/Area Observed D_{max} constraint as f(D_m)

Field-Observed D_{max} Regimes and Parameterization on D_m (D_0)



Histograms of D_{max}, D_m

2DVD GV Field Experiments sampling D_{max} and D_m;

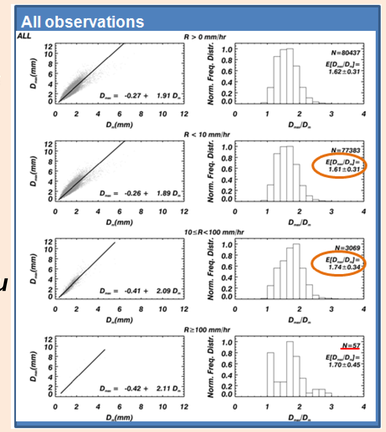
1-minute integration statistics

HyMEX (France, Italy)
WFF (Wallops Flight Facility, VA)
MC3E (Oklahoma)
GCPEX (Canada)
LPVEX(Finland)
NSSTC (Huntsville, AL)

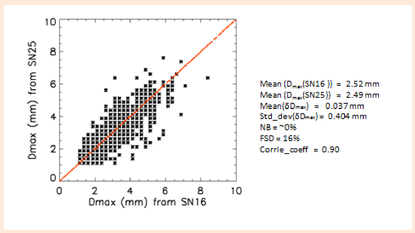
D_{max} vs. D_m: Scatter plots and Histograms of D_{max}/D_m

$E[D_{max}/D_m]$ =1.62 +/- 0.3 (~20%)

Gradual increases in $E[D_{max}/D_m]$ with *R plateau is observed*- generally ≤ 2.0



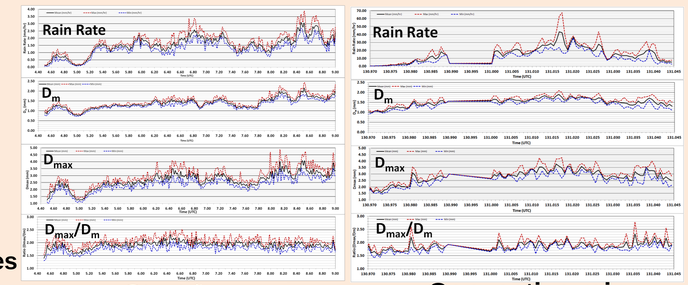
DSD Spatial Sampling and D_{max}/D_m behavior



Collocated 2DVD pair, 6300 one-minute samples

0% bias and ~16% Standard Error

Multi- 2DVD Network kilometer-scale spatial sampling (WFF)



Stratiform rain

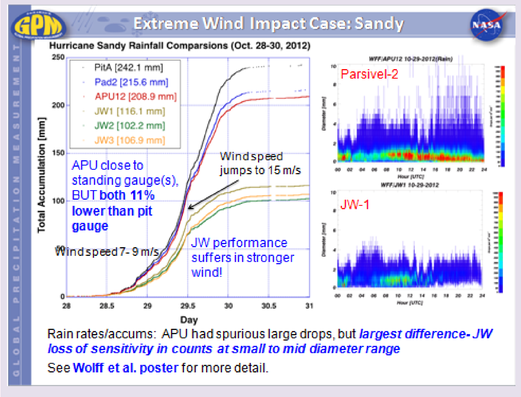
Convective rain

1-min. *max* Δ from mean:

Rain (~20%)
D_m (5%-10%)
D_{max} (15%)
D_{max}/D_m(10%)

Collective data "convergence" (point and network) suggests we are sampling a "meaningful" D_{max}
$D_{max} \approx 2*D_m$ (+/- 10%- 20%) ~ Consistent with "truth" postulated for pol radar $D_0 = f(ZDR)$

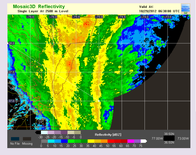
4. Topic 2: Example of Intra-Storm (Regime) DSD variability: Hurricane Sandy

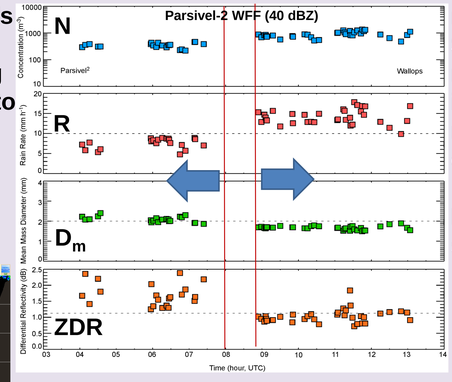


Wind impacts on rain accumulations and JW DSD measurements; less so on Parsivel

Deep outer rain bands coming from east-southeast interacting with cold front prior to 0800 UTC.

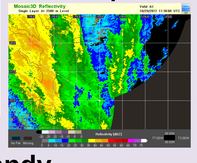
Lower concentration of larger drops





After 0900 UTC northeasterly NW-SE oriented bands rotating rapidly inland from the northeast. More oceanic in nature?

Larger number of small drops



Systematic DSD transition in Sandy rainbands during approach to shore

Summary:

D_{max} constraint: Can *practically* constrain D_{max} as a function of measured D_m. Algorithm impact?

Sandy: Intra-storm regime DSD transitions evident in ground data (wind limitations noted); consistent with dual-pol radar variables; indicates ability to identify consistent regime changes with DSD information.

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