The Community Active Sensor Module (CASM)

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CASM Purpose:

(1) Simulate active sensor platforms within the CRTM environment

(2) Provide a physical basis for 1-D variational retrievals via MIIDAPS

(3) Enhance data assimilation capabilities by providing increased access to active sensor dataset

(4) Foundation for observational Data Fusion activities

Status and Scope:

(1) Presently covers satellite-based radar simulations with path-integrated attenuation

(2) Work on complete integration into CRTM and MIIDAPS is ongoing

(3) Expected to eventually provide forward modeling capability for all space-based active microwave and lidar sensing platforms (scatterometer, altimeter, radar, lidar)

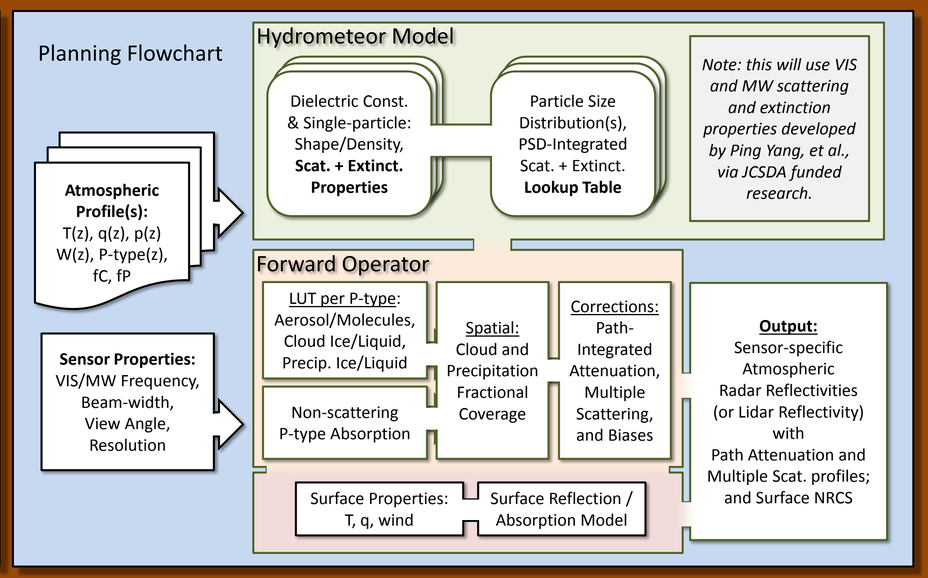
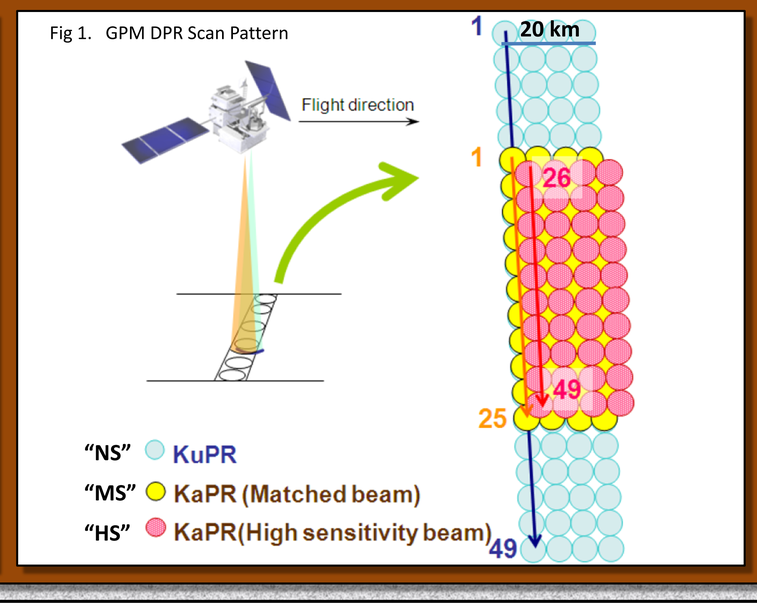


Fig 1. GPM DPR Scan Pattern



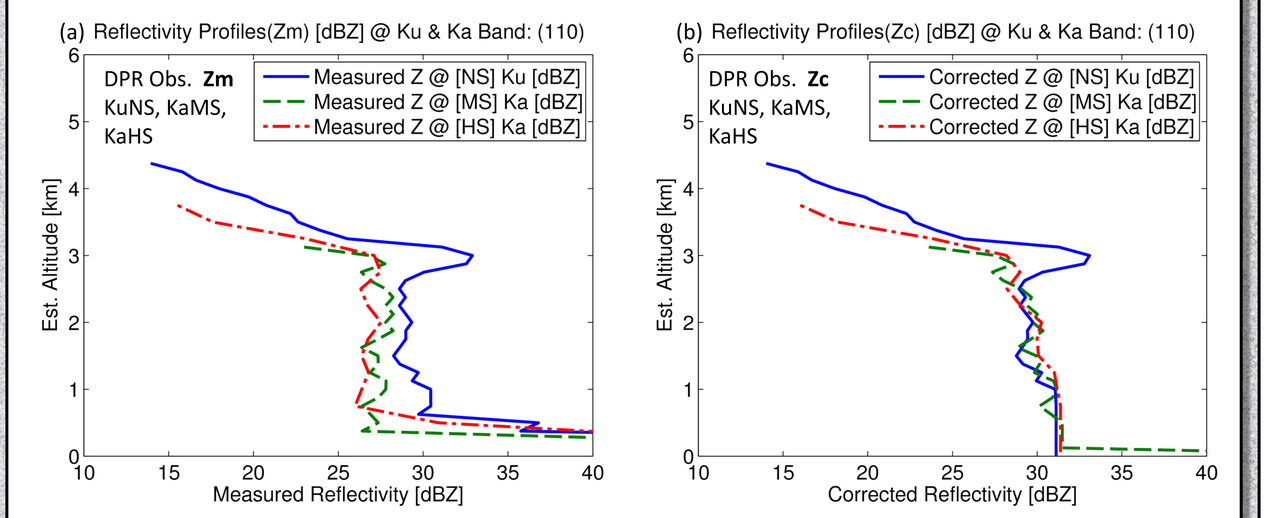


Figure 3. The purple line in Fig. 5b indicates the approximate location of this vertical profile of radar reflectivities. Panel (a) shows the measured radar reflectivity, at Ku and Ka bands. Panel (b) shows the corrected reflectivities,.

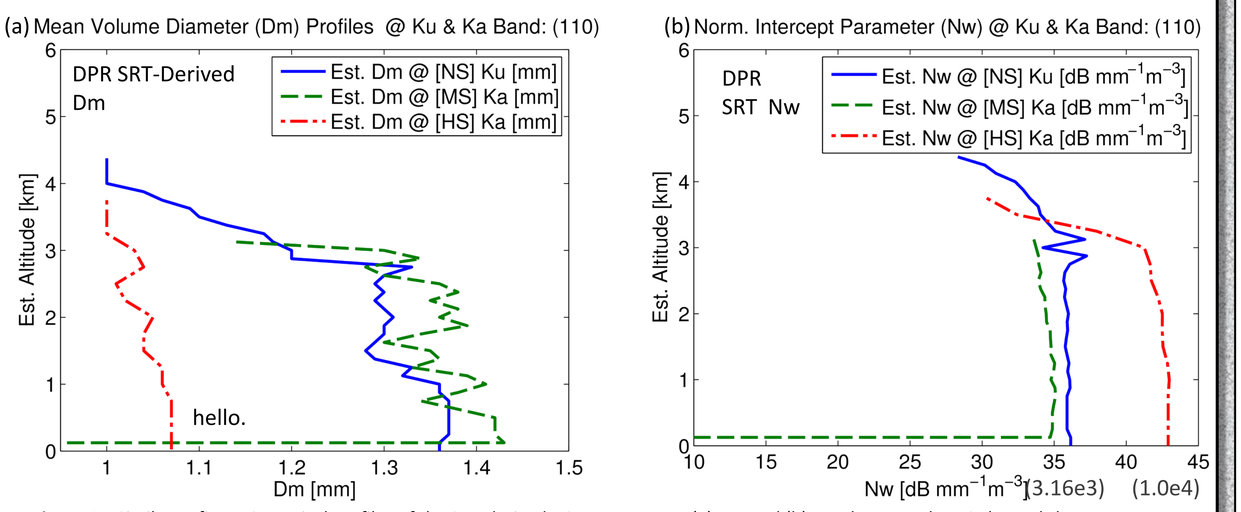


Figure 4. Similar to figure 3, vertical profiles of the SRT-derived DSD parameters (a) Dm and (b) are shown . The HS channel shows a significantly different Dm and Nw combination compared to the NS and MS profiles. In the remaining figures, only the NS profiles are used.

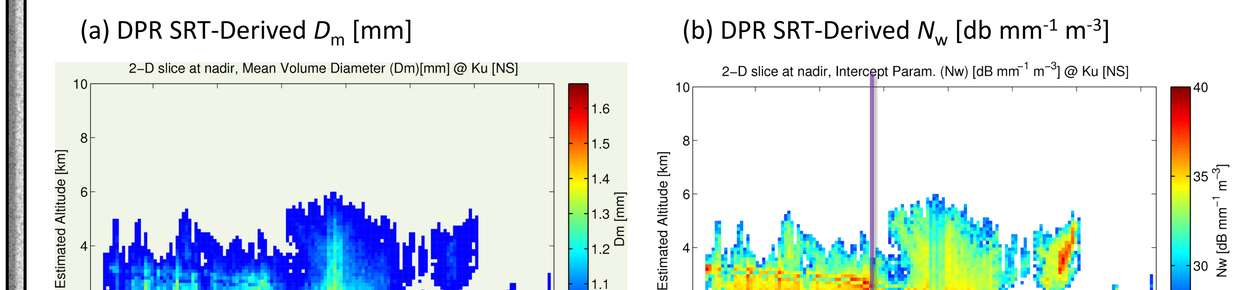


Figure 5. A 2-D vertical slice of SRT-derived DSD parameters. Panel (a) shows the median volume diameter (Dm), and (b) shows the normalized intercept parameter (Nw). Both quantities are derived from the Ku-band observations, after correcting for path-integrated attenuation, and removal of surface clutter.

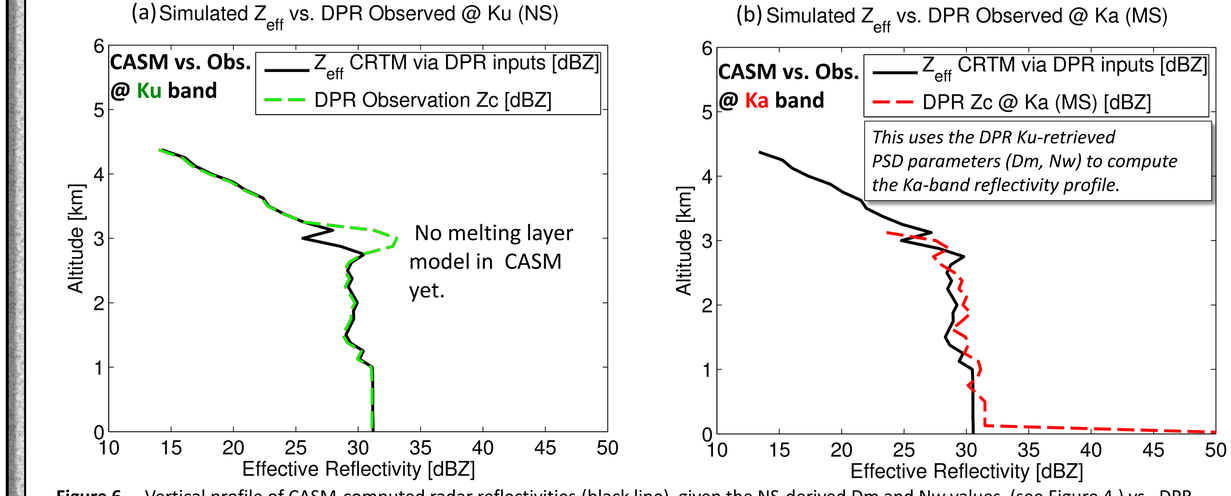


Figure 6. Vertical profile of CASM-computed radar reflectivities (black line) given the NS-derived Dm and Nw values (see Figure 4.) vs. DPR observed reflectivity profiles (dashed lines). Panel (a) is Ku-band, panel (b) is Ka-band. Of note is the melting layer behavior.: A melting layer model will be implemented in CASM to address deficiencies in this region.

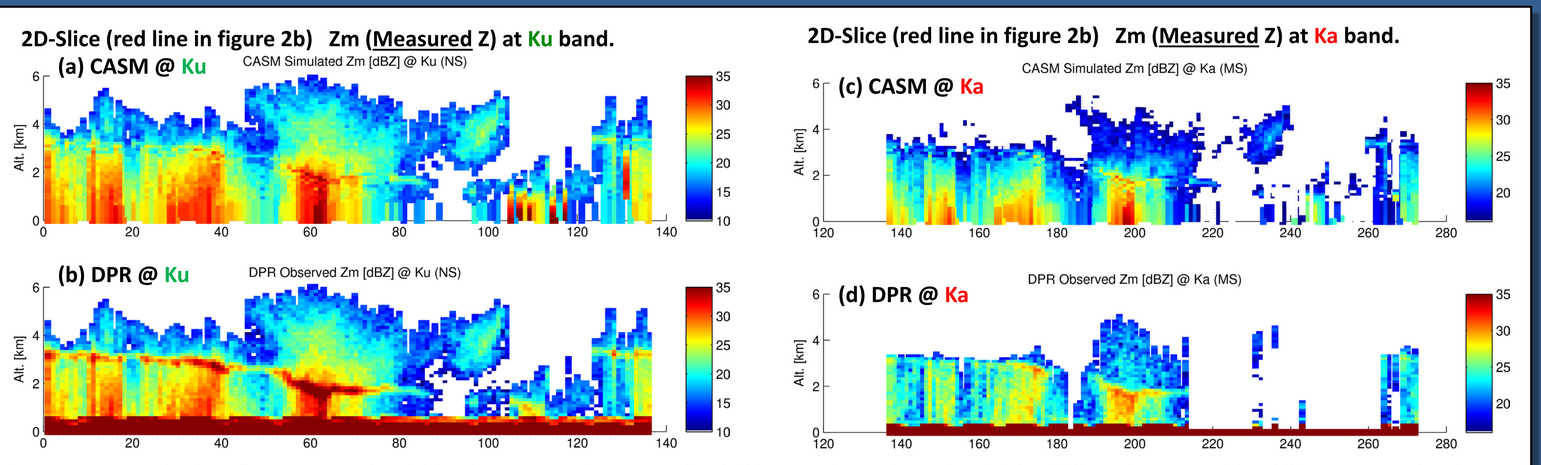


Figure 7. Measured radar reflectivities at Ku band, (a) is the CASM simulation at Ku-band, (b) is DPR observed at Ku-band. (c) and (d) are the same as (a) and (b), except at Ka-band. The path-integrated attenuation in CASM has no special tuning, and corrects attenuation from gaseous absorption and hydrometeor extinction. No water vapor information was provided in the L2A files, so I had to assume a nominal in-cloud water vapor profile.

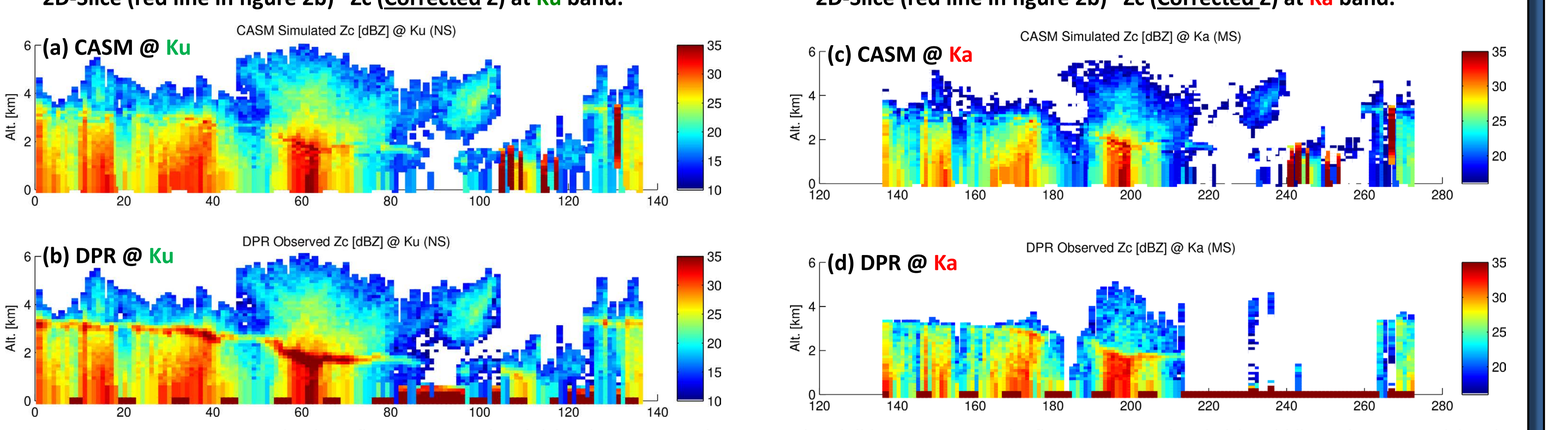


Figure 8. Attenuation-corrected radar reflectivities at Ku band: (a) is the CASM simulation at Ku-band, (b) is DPR corrected reflectivities at Ku-band. (c) and (d) are the same as (a) and (b), except at Ka-band. Note the significant attenuation corrections at Ka-band, compared with Fig. 7c. and 7d.

One year of GPM DPR level 2A (V6) data was downloaded and processed. Following the previous approach, the N_w, D_m, temperature, and reflectivity information was obtained from each DPR file -- only the nadir beam was selected. Processing these variables using CASM, the figure below shows CFADs of attenuation-corrected reflectivity (Zc) for GPM DPR observed Ku- and Ka-band reflectivities in panels (a) and (b), respectively; and for the CASM simulations at Ku- and Ka-band in panels (c) and (d), respectively.

Altitudes were normalized to be height above the land surface. Range bin height was estimated using the number of range gates in the Ku-band (NS) products and the Ka-band (MS) products. Radar echoes are over-sampled at twice the rate of the corresponding resolution, i.e.,125 m for the matched beams. CASM simulated reflectivities were computed at the same range gates as the DPR observations, so there's a one-to-one correspondence between observation and simulation on a profile-by profile basis. The CFAD vertical bin resolution was set to 250 meters to provide smoother sampling. The horizontal bins are set to 1 dBZ width.

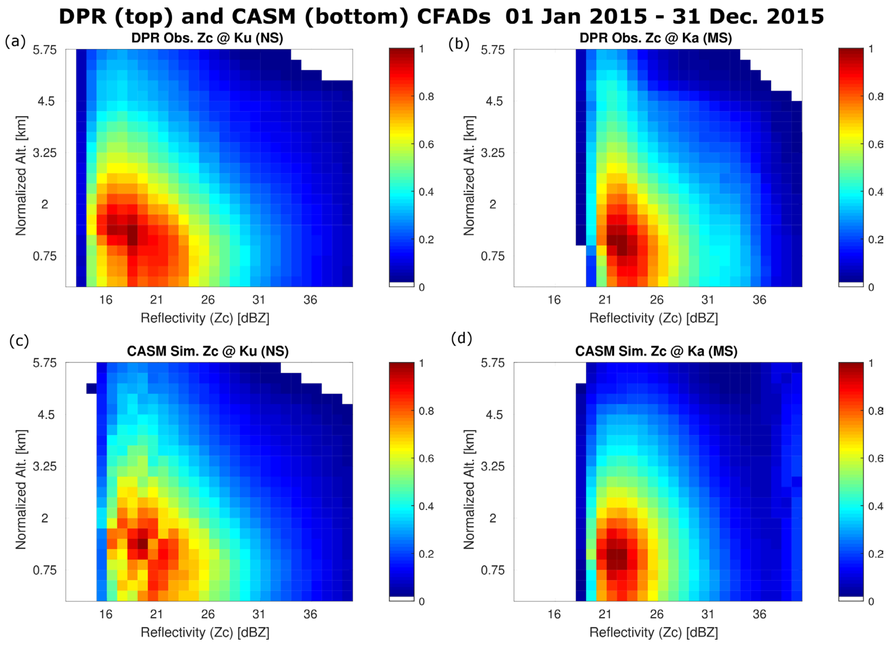


Figure 9. CFADs of GPM DPR observations (top row) and CASM simulations (bottom row) for Ku band and Ka band (beam matched). One year of data was used for the analysis, nadir beam only, from 01 January 2015 to 31 December 2015.

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