Drop Size Distribution – Based Separation of Stratiform and Convective Rain

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0. INTRODUCTION: Williams et al. (2014) have examined the correlation between two of the drop-size distribution parameters (viz. the mass-weighted mean diameter and the standard deviation of the mass spectrum) using 2D video disdrometer datasets from various locations. These correlations will be important for the development of retrieval algorithms for the dual-frequency precipitation radar on-board the GPM satellite. The next step is to separate the same datasets into stratiform and convective rain types and repeat the same analysis. To this end, we have developed an automated scheme to partition the datasets based on the characteristics of the DSD. Here, we present the method and the testing of the technique with data from Ontario, Canada, and Huntsville, Alabama.

1. DARWIN OBSERVATIONS: Bringi et al. (2009) had used duual frequency profiler and dual polarization radar (C-Pol) in Darwin for DSD retrievals, and found that stratiform and convective rain could be separated in the N_W versus D_0 domain. Later, Thurai et al (2010) confirmed that both the dual-frequency profiler data based separation and the C-Pol based separation were consistent with each other.

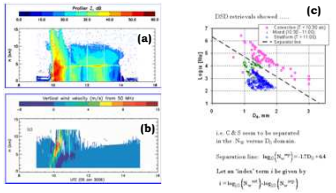


Fig. 1.1: (a): Time–height color-filled contours of Z from the 920-MHz profiler for the 5 Jan 2006 buildup regime. **(b)** :the mean Doppler wind velocity from the 50-MHz profiler, where positive (negative) values indicate updraft (downdraft). **(c):** DSD retrieved from the profiler data, and the separator line

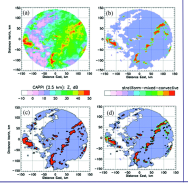


Fig. 1.2: (a) Constructed CAPPI dBZ from CPOL volume scans taken on 22 Jan 2006 (at around 1500 UTC), (b) rain-type classification using the indexing scheme, (c) rain-type classification using the Steiner et al. (1995) method (SHY), and (d) the indexing scheme (color) with the SHY method overplotted as black contours for convective rain type.

2. ONTARIO DATA: A 2D video disdrometer was installed at the CARE site belonging to Environment Canada in Ontario, collocated with a vertically-pointing X-band Doppler radar and a Precipitation Sensor Occurrence Sensor System. Testing was carried out for three events.

Fig. 2.1: CARE site in Ontario & the various instruments used

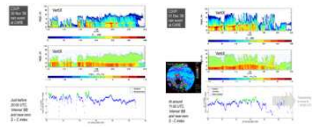


Fig. 2.2: Z and Doppler mean from VertiX for two events on consecutive days and the rain_index

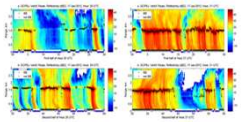


Fig. 2.3: Bright-band detection from the time series of Z and the bright-band height (if present) and the maximum intensity, for the cold-rain event on 17 Jan 2012.

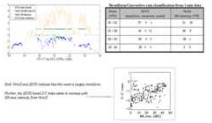


Fig. 2.3: 2DVD-data-based rain index, and its correlation with the bright-band intensity

3. HUNTSVILLE (AL) DATA: 2D video disdrometers were installed at the University of Huntsville, Alabama, collocated with a UHF profiler (Doppler) and a vertically pointing X-band Doppler radar (X_VPR). Testing was carried out for several events. We show a few cases below.

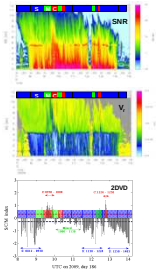


Fig. 3.1: Z and Doppler mean as time series from the UHF profiler and the 2DVD data based rain-index for the event on 05 July 2009

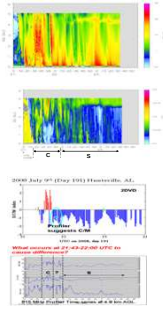


Fig. 3.2: Same as Fig. 3.2, for the event on 9 July 2008

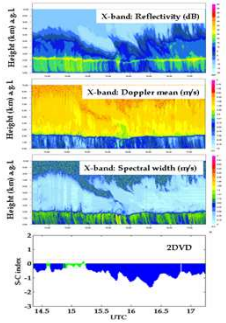


Fig. 3.3: X_VPR data (top three panels) and the 2DVD data based rain-index for the event on 11 March 2013 (largely stratiform)

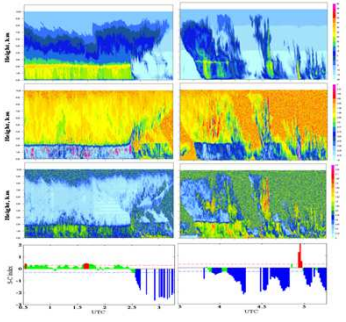


Fig. 3.4: X_VPR data (top three panels) and the 2DVD data based rain-index for the event on 26 Dec 2012. Thick bright band until 02:30 UTC results in a 'mixed' rain categorization whilst highly convective rain is indicated just prior to 05:00 UTC, both in agreement with X_VPR observations.

4. SUMMARY

The stratiform-convective rain separation method uses the DSD characteristics. The method was initially developed based on dual-frequency observations and dual-polarization data in Darwin. Testing was carried out in two other sites, namely, Ontario, Canada, and Huntsville, Alabama.

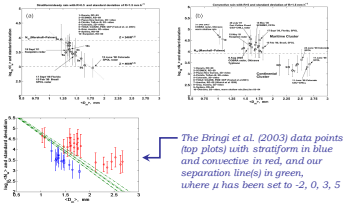
For the Ontario case, three cold-rain events were examined. A bright-band detection algorithm was developed which also outputs the bright-band maximum intensity and the corresponding height. Our index scheme seems to increase with the bright-band maximum intensity, i.e. the more intense the bright-band, the closer the N_W - D_0 gets to the separation line.

For the Huntsville case, our method does very well a vast majority of the time when compared with UHF Profiler and X-band VPR observations. During transitions from Mixed to Convective and vice versa, the S/M/C rain indexing method can fail, Reasons: (i) Definition of C/S/M (i.e., subjective interpretation of profiler data); (ii) Precipitation streamers (raindrops being advected).

Testing is ongoing; the bright-band detection algorithm output will be used in a more 'quantitative' manner in the future to compare against the 2DVD based rain classification.

APPENDIX

Our separator line also seems to separate the N_W versus D_M data published by Bringi et al. (2003) for stratiform and convective rain for many different locations and climatologies.



The Bringi et al. (2003) data points (top plots) with stratiform in blue and convective in red, and our separation line(s) in green, where μ has been set to -2, 0, 3, 5

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