A Comparison of X-band Polarization Parameters with In-Situ Cloud & W-band Radar Measurements in the Comma Head of A Winter Cyclone

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1. Objectives

- Analyze the vertical change of dual-polarization parameters (from ground-based radar) within the 22 February 2010 cyclone during the Profiling of Winter Storms (PLOWS) field campaign.
- Relate these findings to coincident in-situ cloud microphysical measurements.

2. Data

Both the Mobile Alabama X-band (MAX) Doppler Radar and the W-band Wyoming Cloud Radar (WCR) profiled the comma head region of a cyclone as the NSF/NCAR C-130 aircraft made vertically stacked passes along the same azimuthal angle as the MAX RHI radar scans.

Fig. 1 The MAX radar measured reflectivity (Z) and radial velocity, as well as the correlation coefficient (ρ_{hv}) and differential reflectivity (Z_{dr}).

Fig. 2 The two-dimensional cloud (2D-C, above) and precipitation (2D-P) probes captured particle size and shape along with other variables.

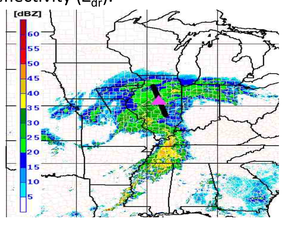

Fig. 3 WSR-88D regional radar for 0045 UTC 22 February 2010. The MAX radar location (pink triangle) is shown, with the black line outlining the scanning direction and flight path of the MAX and C-130, respectively.

3. Methodology

- Reflectivity and dual-polarization variables from the MAX were averaged at specific C-130 altitudes during times when the aircraft was close to the X-band radar.
- 2D-C images, as well as size distributions and corresponding bulk parameters determined from 2DC/2DP probes, were used when the C-130 was in the view sampled by the MAX RHI scans.

4. Dual-Polarization Measurements

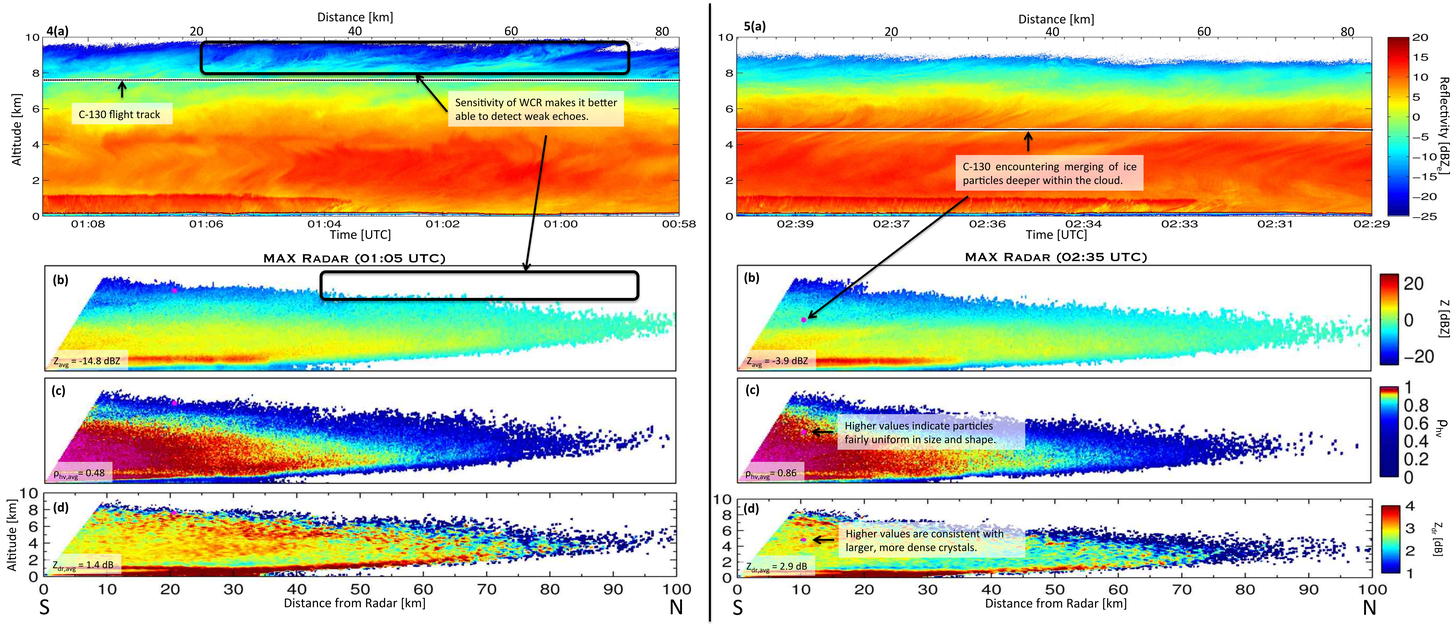

Fig. 4 (a) WCR reflectivity cross section for the same path as (b-d) MAX RHI variables. Pink dot in RHI scans denote the location of the C-130 aircraft, with average values of Z, ρ_{hv}, and Z_{dr} as the aircraft flew toward/away from the MAX radar. Same as in Fig. 5 but at a different aircraft altitude.

5. Microphysical Measurements

Fig. 6 2D-C particle images taken at four specified altitudes, with a notable shift in crystal size and composition at lower altitudes.

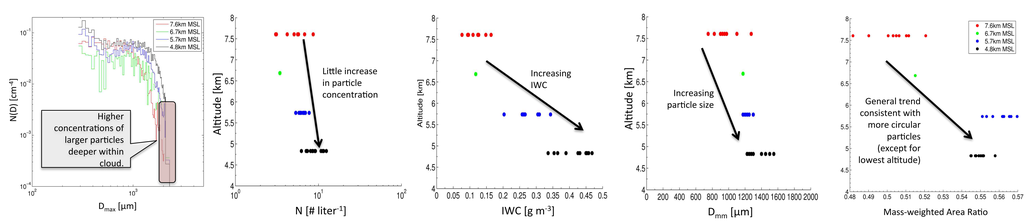

Fig. 7 Plots of (a) size distributions, (b) concentration, (c) IWC, (d) median mass diameter, and (e) mass-weighted area ratio for four different altitudes within the cyclone. Increasing particle size deeper within the cloud support particle growth by aggregation as in Fig. 6. Current work is examining linkage between area ratio and Z_{dr} data on a point-by-point basis.

6. Conclusions

- Dual-pol measurements of ρ_{hv} and Z_{dr} are consistent with more uniformity in particle shape and larger particle size deeper within the cloud, respectively.
- Corresponding probe data suggests that growth by aggregation is occurring during the particle's descent (no liquid water is present at these levels for riming to occur).
- Uniqueness of coincident ground- and air-based measurements of the same cyclone region give further insight into the MAX radar's dual-pol values.

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