Using radar data to evaluate CRM simulations of TWP-ICE monsoonal convection

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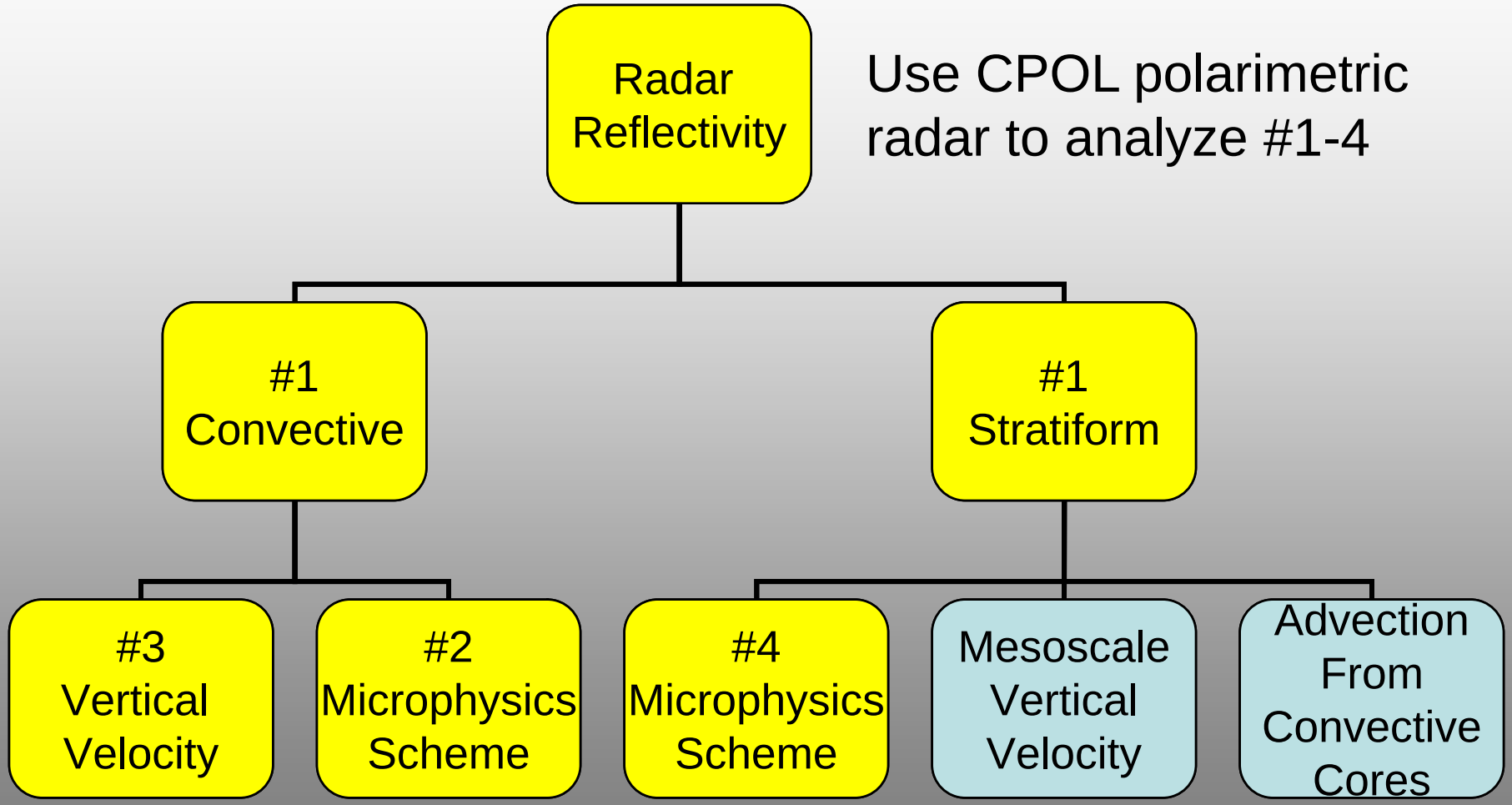
Analysis Flowchart



Use CPOL polarimetric radar to analyze #1-4

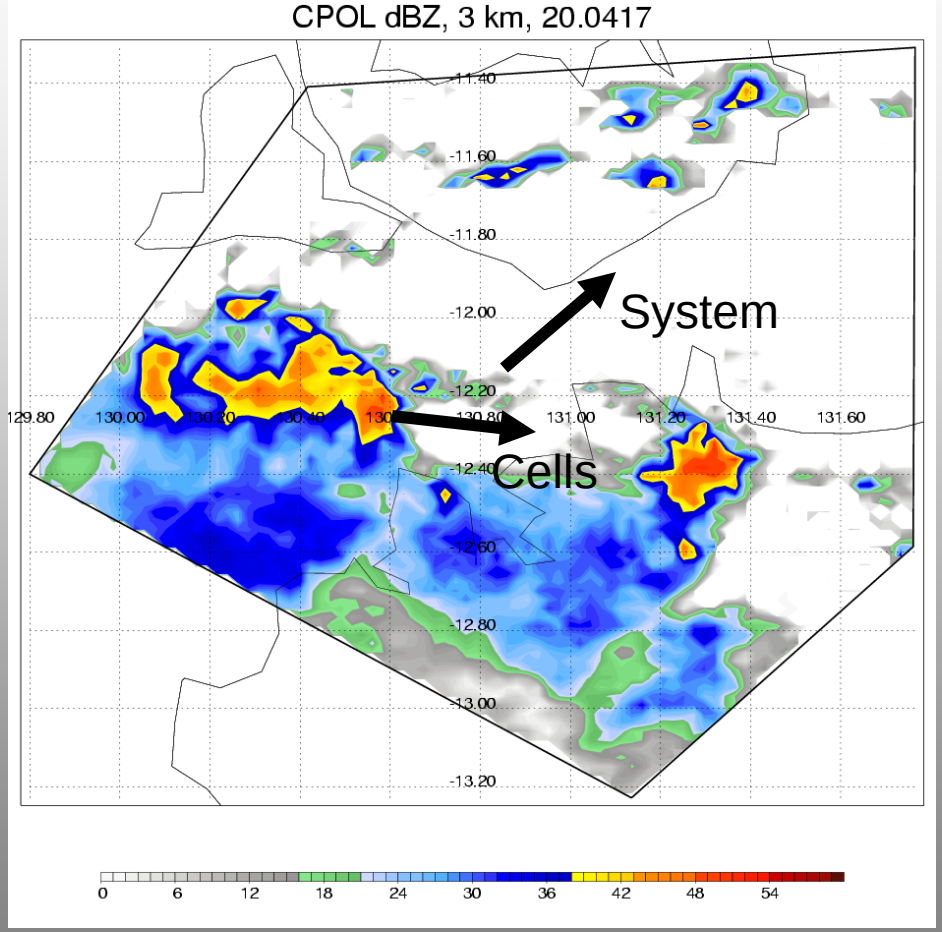
*CPOL data provided by Peter May, Australian BMRC

Model Description

- DHARMA run by Ann Fridlind and Andy Ackerman at NASA GISS
  - Oceanic lower boundary (T=29C)
  - 176 km by 176 km by 24 km domain
    - Horizontal resolution of ~0.9 km
    - Periodic boundary conditions
  - Grabowski (1999) one-moment 2-ice microphysics
  - Xie forcing enforced below 15 km
  - 3 ~day long events (A, B, and C) with 10 minute 3D fields

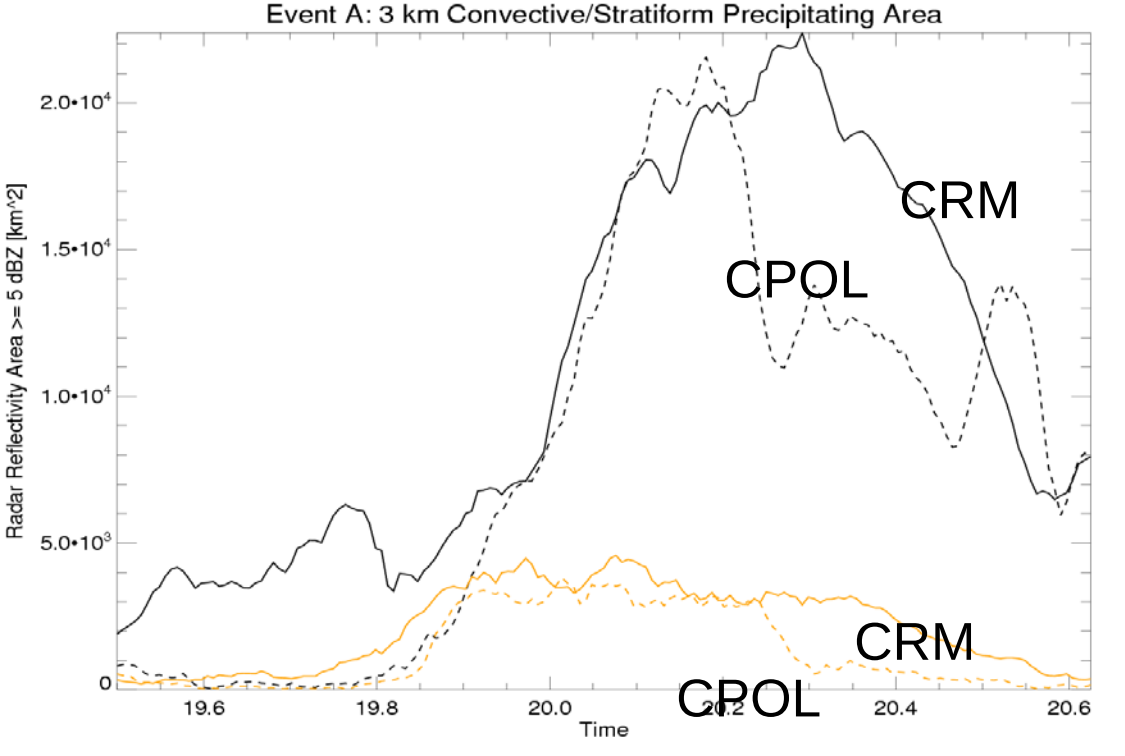
Focus on Event A

- 12Z 19 January – 15Z 20 January
- Oceanic in origin within normal active monsoonal westerlies
- Fits within the forcing domain
- Other events are larger and more complicated



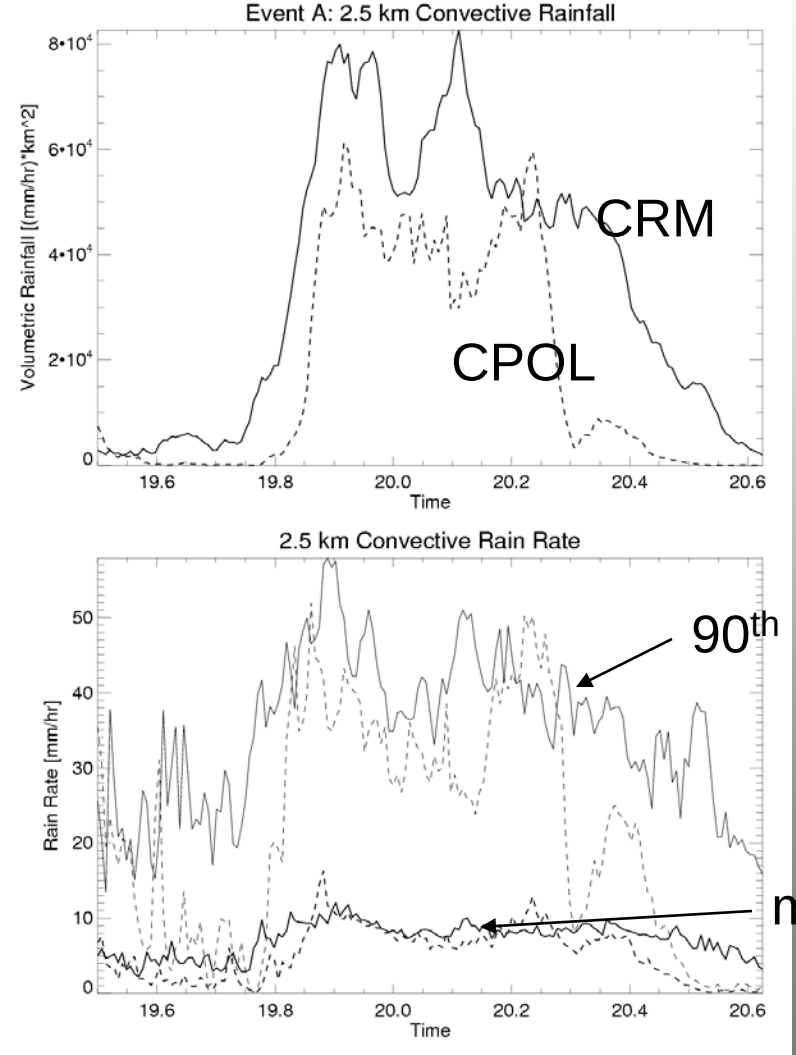
Convective/Stratiform Area

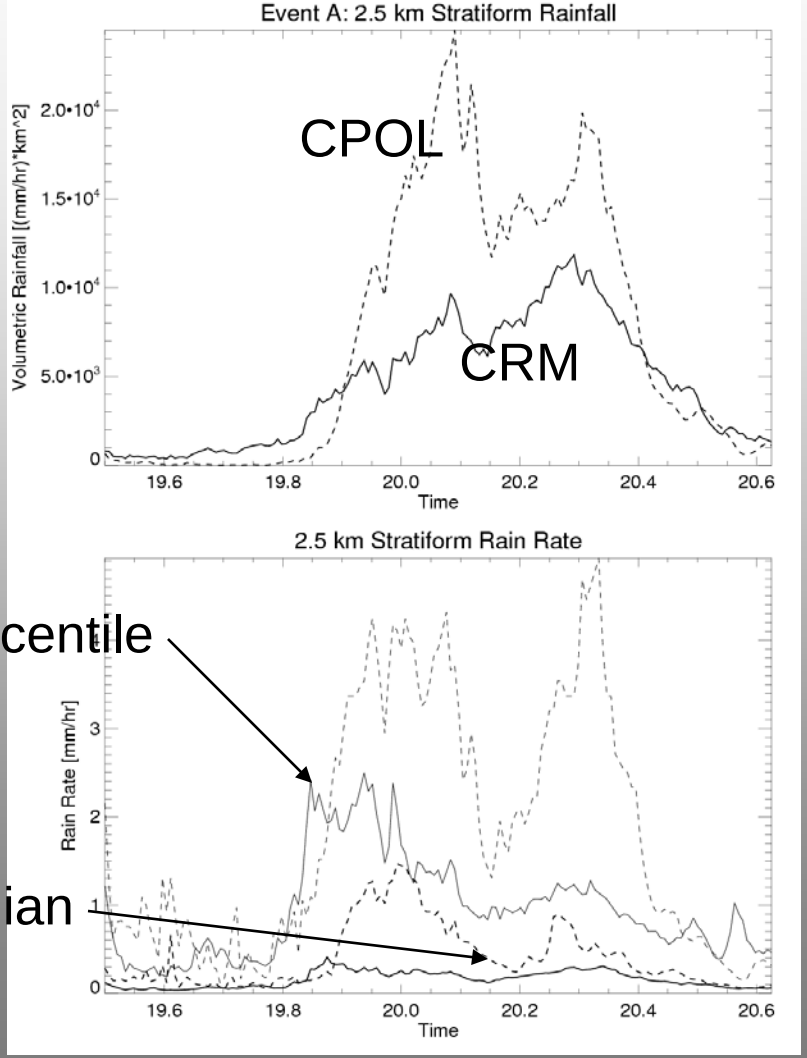
- Steiner et al (1995) Separation
- Convective and stratiform area represented fairly well
- Both tend to be a bit higher in the CRM, especially before and after system maturity



Rainfall (top) and Rain Rates (bottom)

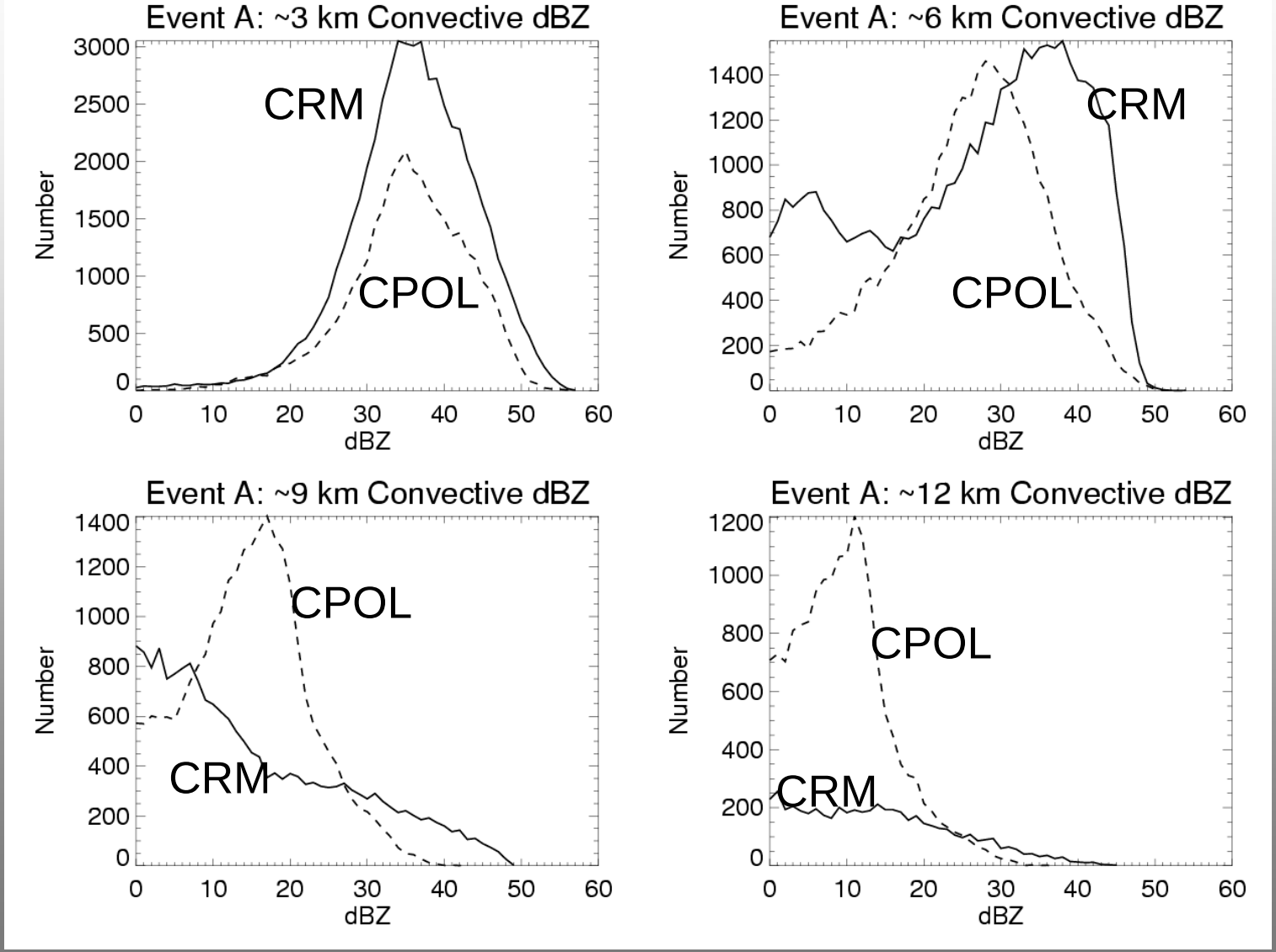
Convective



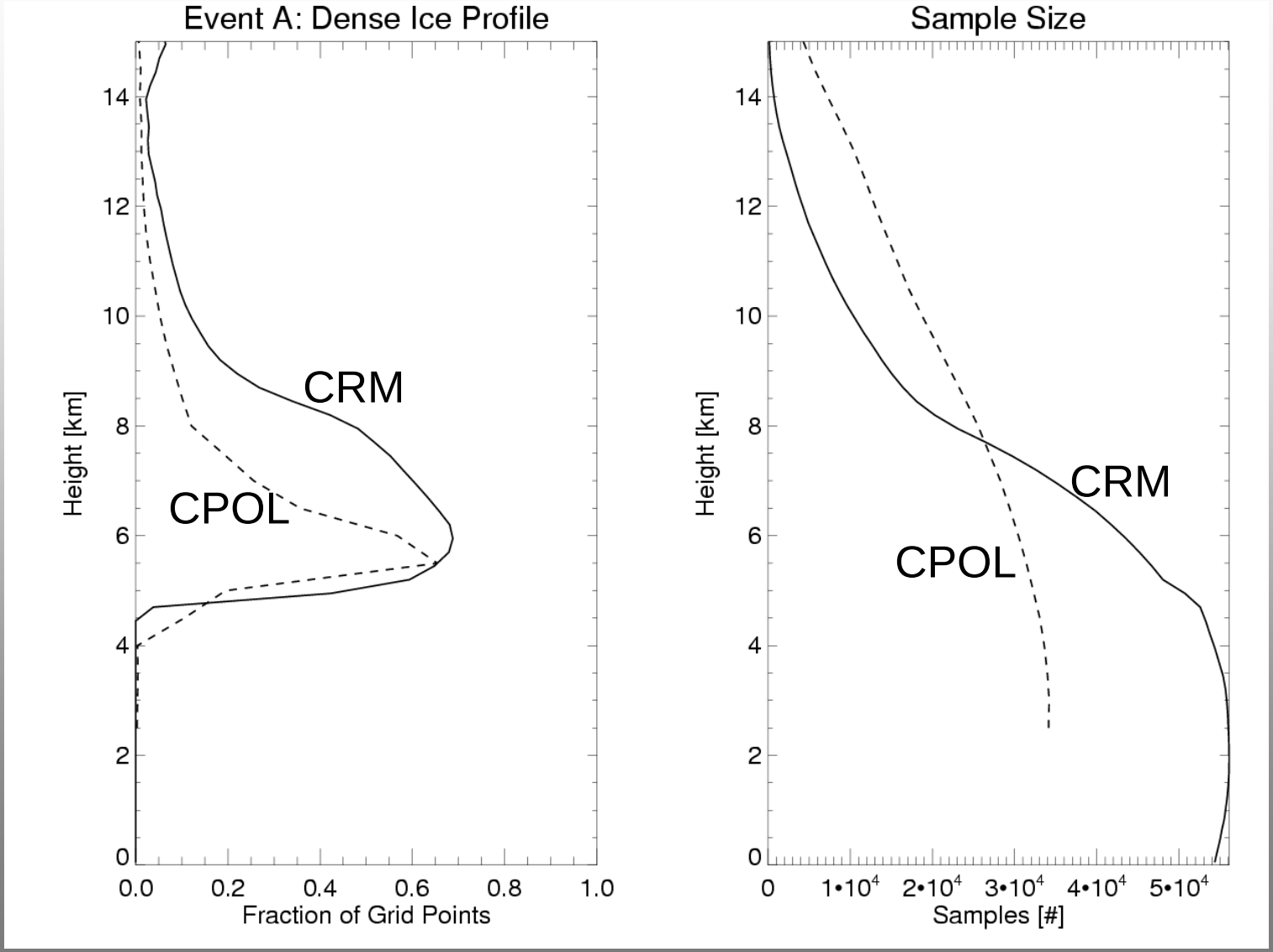


Stratiform

Convective dBZ

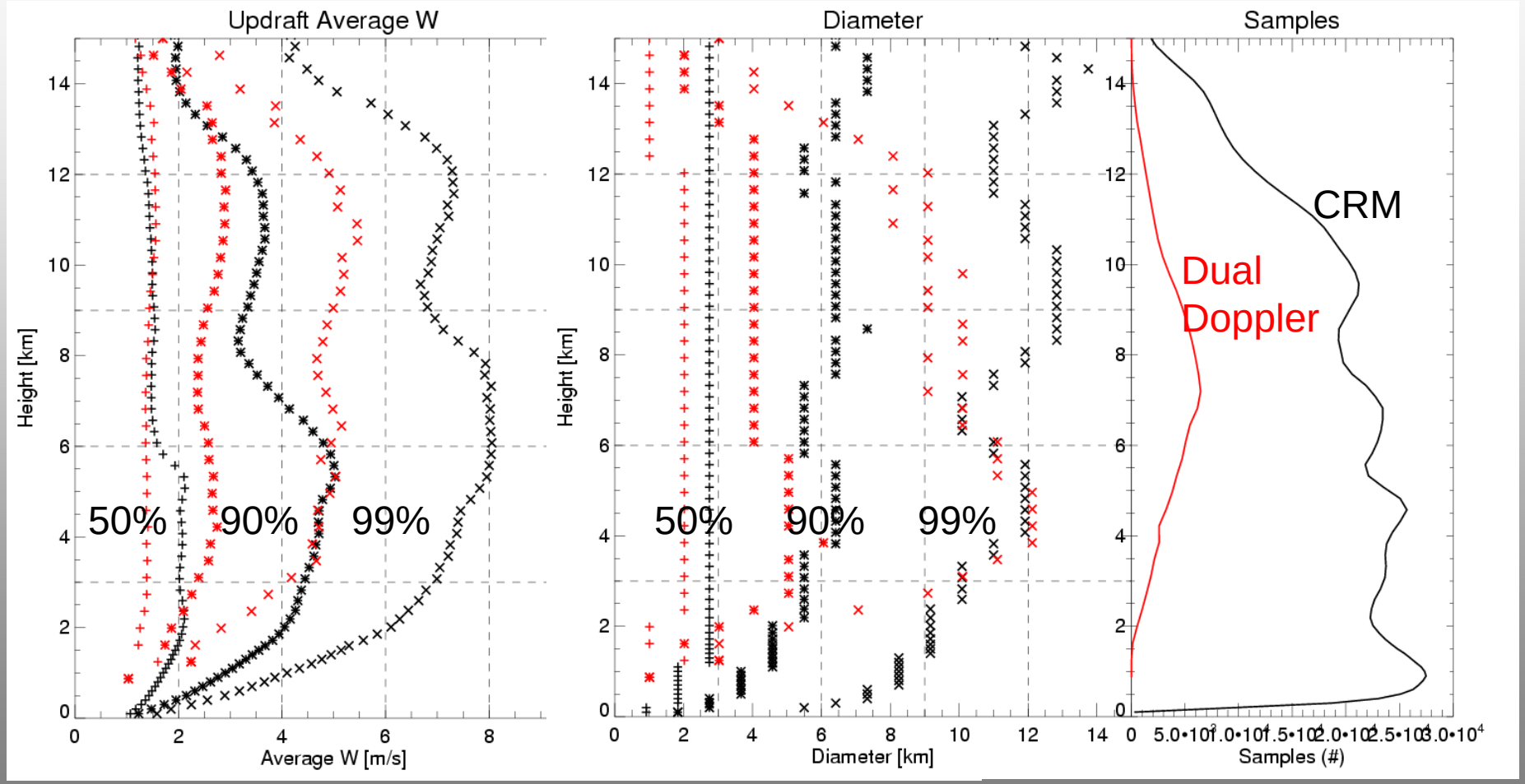


Convective Dense Ice



*See May and Keenan (2004) for CPOL microphysical retrieval

Convective Updrafts

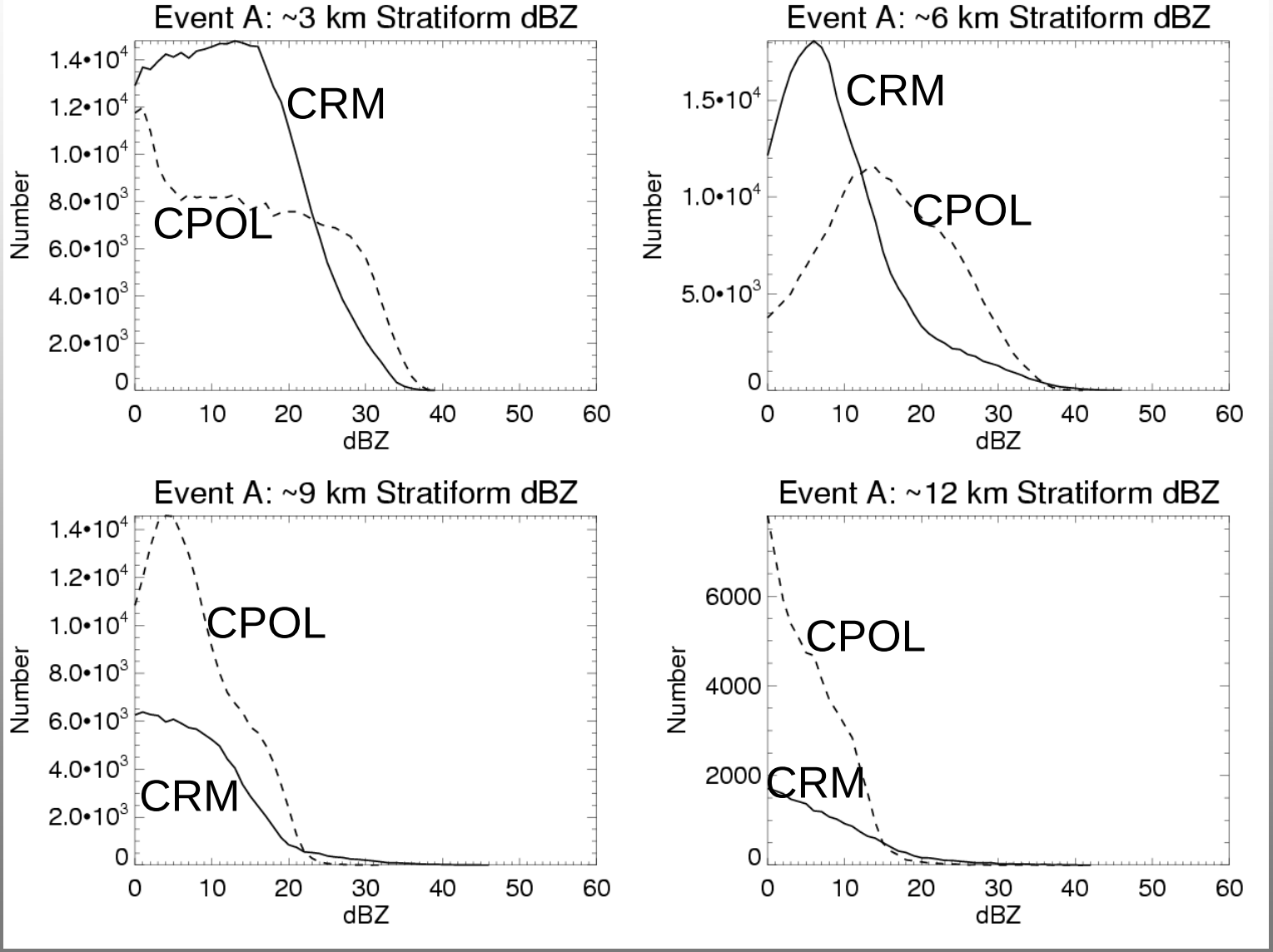


*Dual Doppler analysis performed by Scott Collis

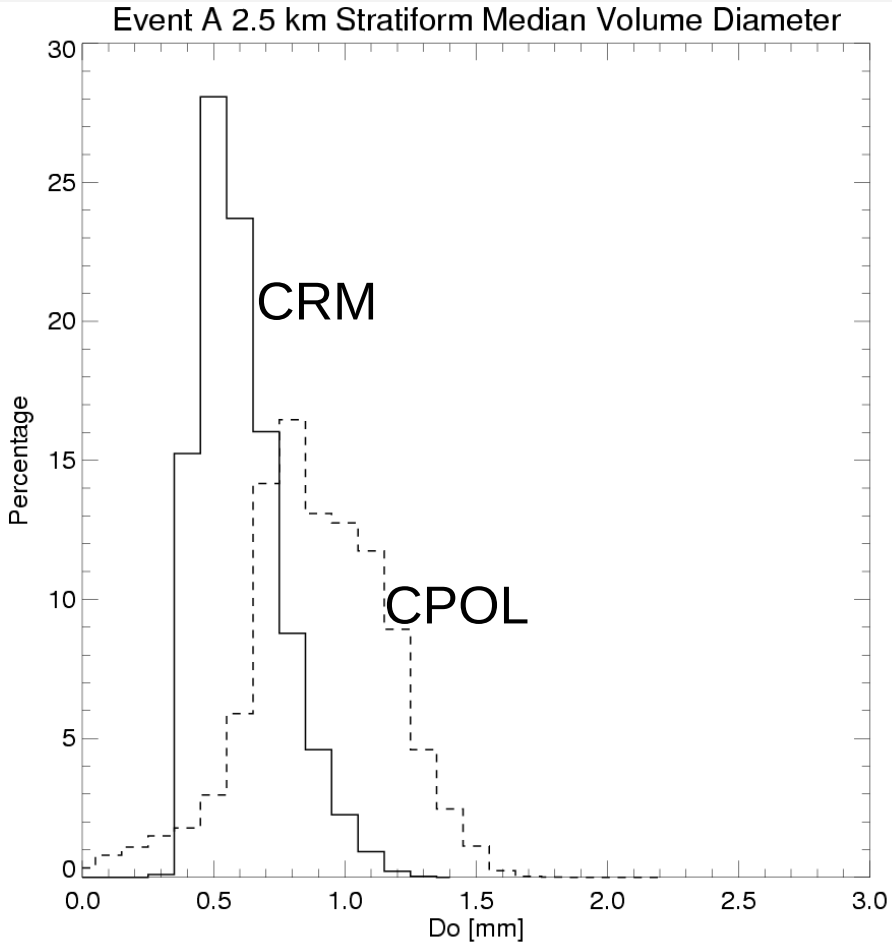
Convective Summary

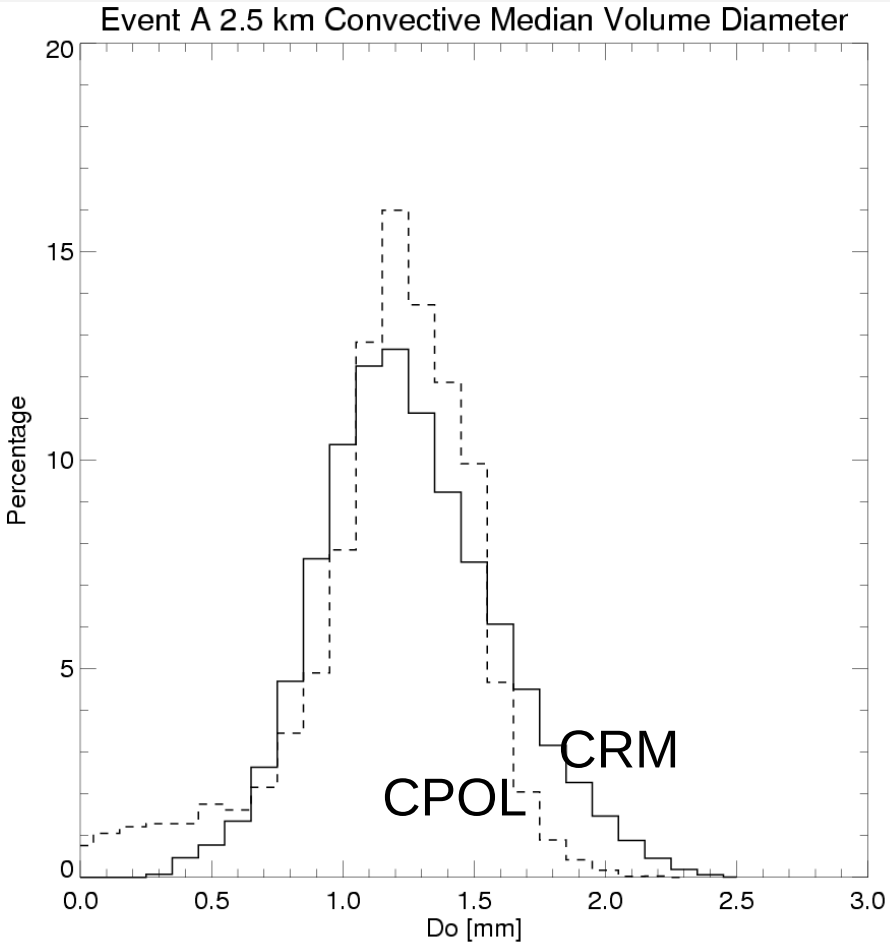
- Excessive dBZ aloft in CRM convective cores is a result of excessive dense ice
- 90th and 99th percentiles of updraft values at 6 km and below are about 3 m/s greater than those given by dual Doppler
  - Aircraft data from GATE, EMEX, TAMEX, KWAJEX, and TRMM LBA show 90th percentile values of ~5-6 m/s between 3 and 6 km, similar to the model although aircraft data is higher resolution
  - Darwin profiler data with horizontal resolution of 0.6 to 1.1 km shows updraft diameters of 5-6 km and average w values of 4-6 m/s below 6 km similar to the model (May and Rajopadhyaya, 1998)
- CRM downdraft stats are similar to dual Doppler

Stratiform dBZ



Stratiform DSDs





*See Bringi et al (2009) for CPOL-derived DSDs

Stratiform Summary

- While stratiform area may be comparable between the CRM and CPOL, CPOL dBZ values are higher reflecting differences in the DSDs
  - This is caused by lower than realistic dBZ values aloft (not enough ice)
- Issues in CRM dBZ aloft are yet to be investigated, but can be explored with more complex model microphysics runs and satellite data

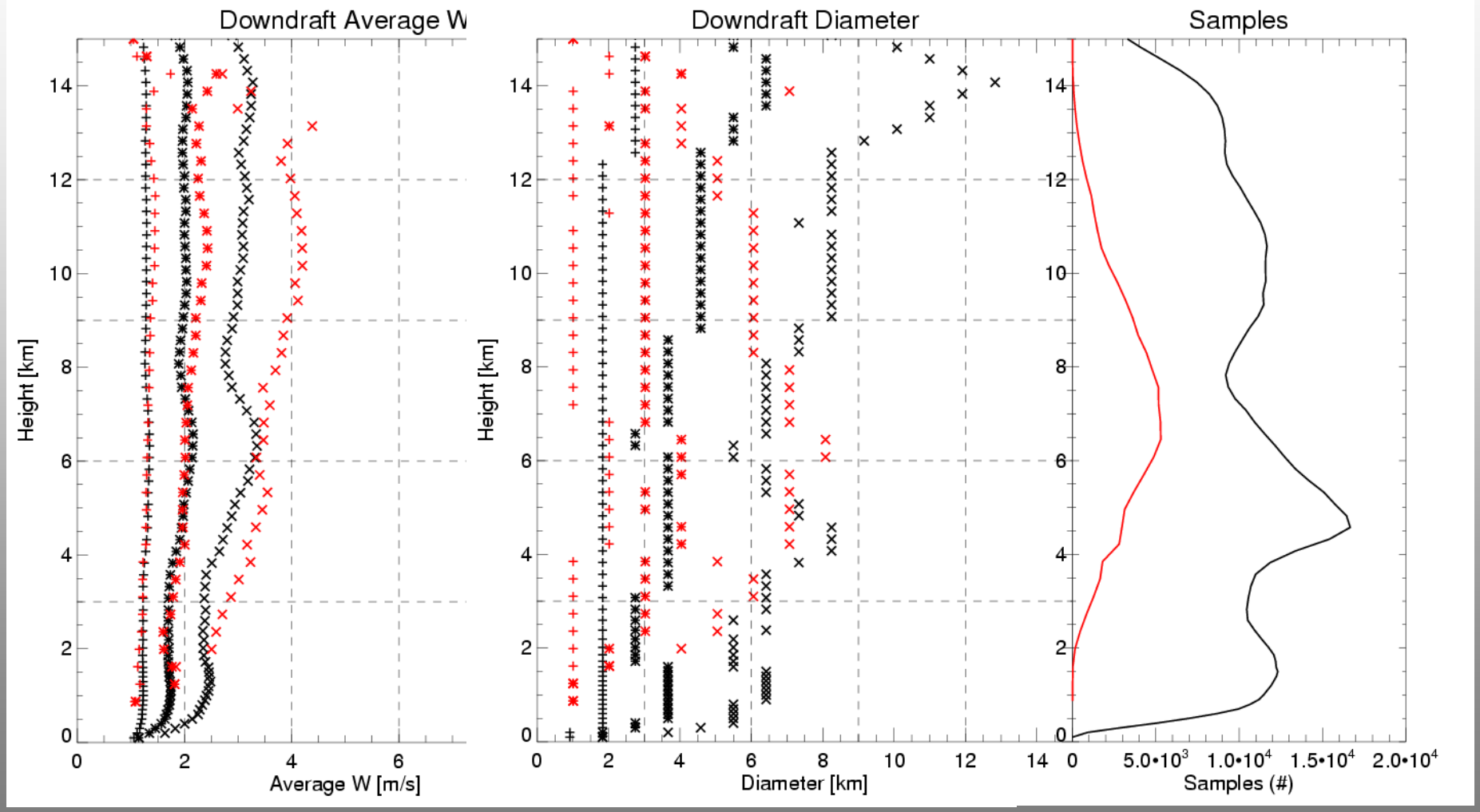
Conclusions Thus Far

- A far higher percentage of rainfall in the model is produced in convective regions as compared to reality
- Simulated radar reflectivity is too high aloft in convective regions due to excessive dense ice, likely not entirely due to intense updrafts
  - Graupel intercept parameter?
- Simulated radar reflectivity is too low throughout the troposphere and is too limited in extent in stratiform regions
  - At low levels, the median volume diameters are significantly smaller than those derived using CPOL
  - At upper levels, related to convective core issues?

Going Forward

- Use more observational data and 2-moment and bin schemes to examine the microphysical-dynamical interactions in more detail
  - What leads to the **high concentrations of dense ice aloft**? Improper entrainment/detrainment, growth processes, size distribution?
  - What leads to the **insufficient stratiform regions aloft**? Problems in ice advection from convective cores, insufficient mesoscale ascent, growth processes, size distributions?
  - How are the **convective scale and mesoscale downdrafts** maintained? How does this affect **cold pool and gust front** formation, maintenance, and structure?

Acknowledgments

- ARM
- Steve Krueger
- Andy Ackerman
- Scott Collis and Peter May
- Christopher Williams

Downdraft Stats