Comparing WRF Modeled Fields to Observations for the 9-10 June 2003 MCS Observed During BAMEX

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Motivation

- Modeled and observed mesoscale convective systems (MCSs) account for a substantial amount of summertime precipitation
- Many methods of evaluating simulated MCSs exist (rainfall rate, vertical velocity, maximum reflectivity, etc.) but these cannot account for horizontal and vertical variability of these quantities within the MCS
- Here, methods of comparing the bulk statistical properties of an MCS sampled during the Bow Echo and Mesoscale Convective Vortex Experiment (BAMEX) are presented

Example from June 9-10, 2003

- Observations obtained from two radars on board NOAA and NRL P-3 aircraft flying ahead of and behind the convective line
- This provides a unique high-resolution dataset including dual- and quad-Doppler data

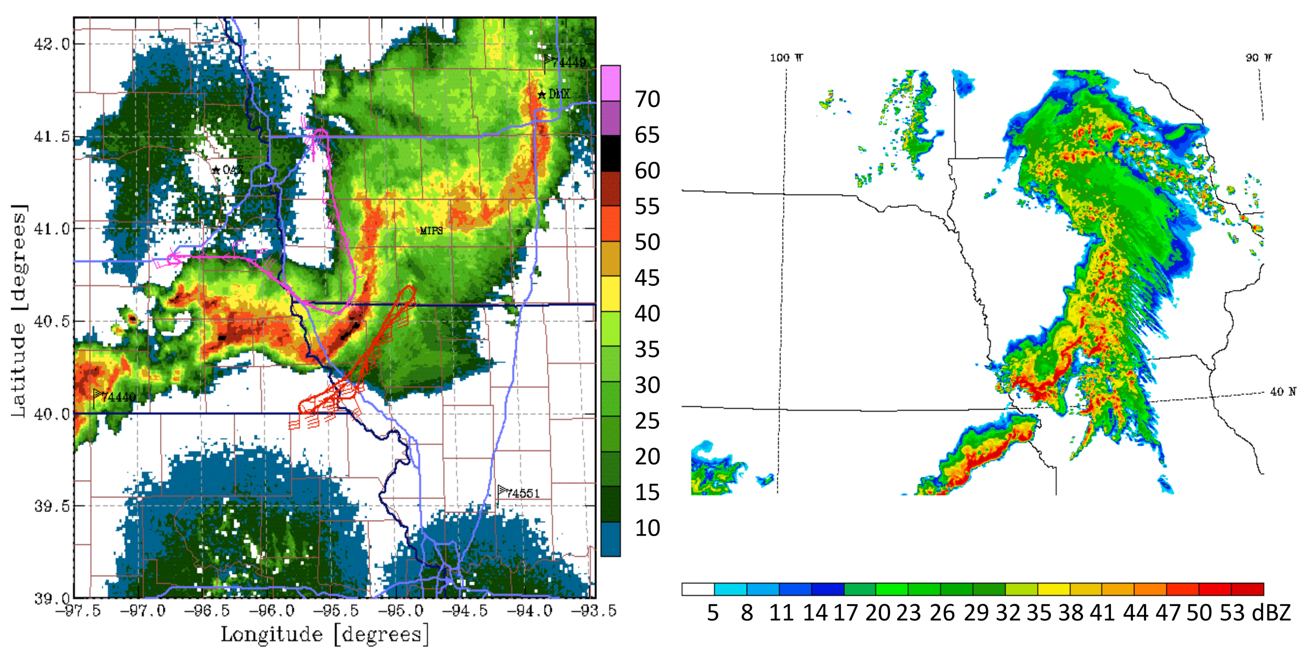


Figure 1: Radar reflectivity at 0540Z from NOAA P-3 (left) and simulated reflectivity from a corresponding stage of evolution at 0445Z (right).

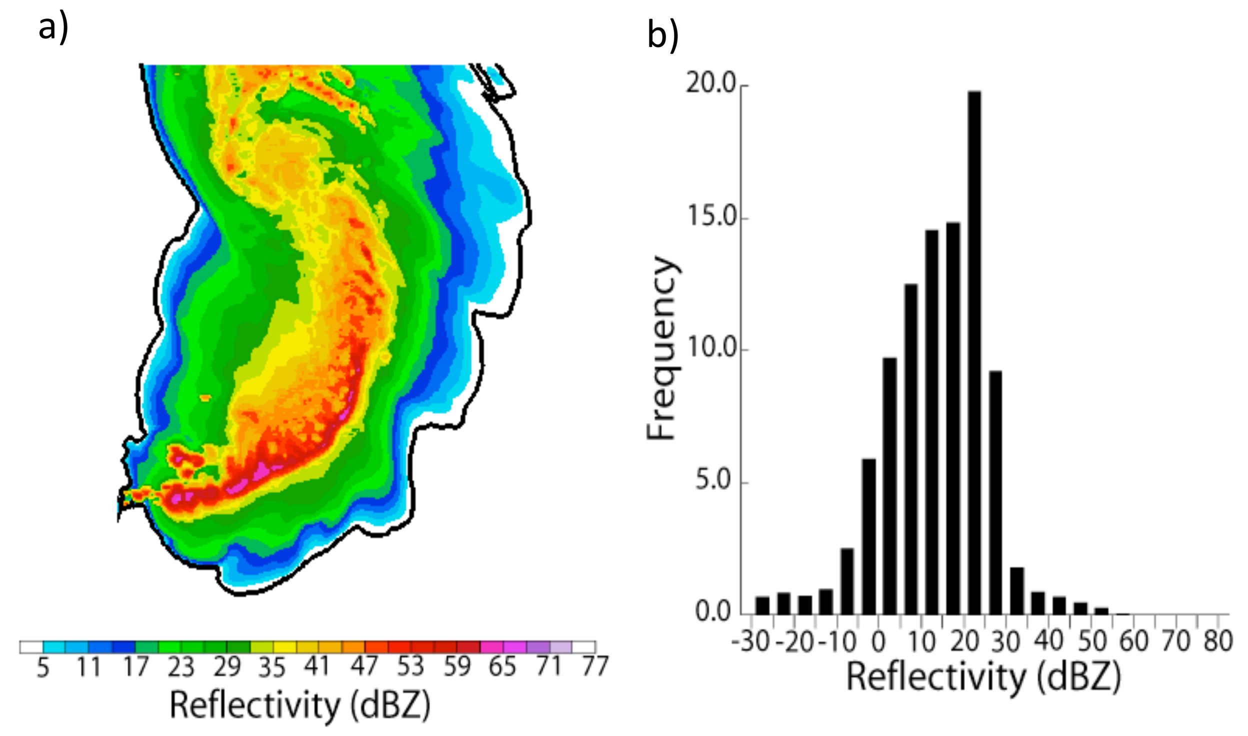
Model Details

- 36 hour simulation using WRF v3.3.1
- Initial and boundary conditions set with NAM data
- 27 km, 9 km, 3 km, 1 km grids
- Thompson microphysics
- RRTMG SW and LW radiation
- Monin-Obukhov surface-layer physics
- RUC land surface model
- Mellor-Yamada-Janjic PBL
- BMJ cumulus (27 and 9 km grids only)

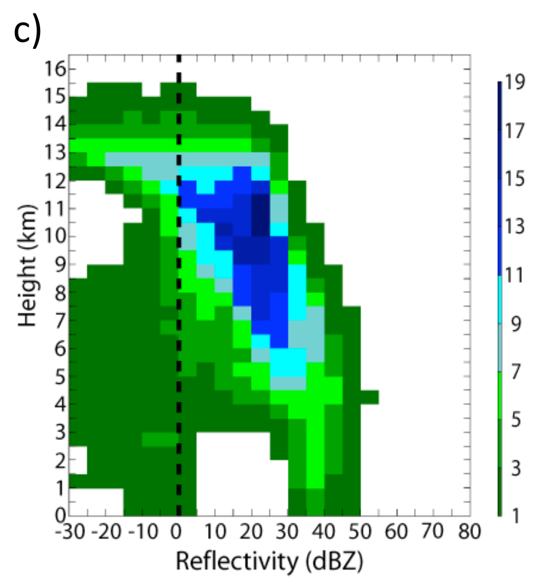
Contoured Frequency by Altitude Diagrams (CFADs)

Developed by Yuter and Houze (1995) to examine statistical properties using the frequency of occurrence of variables as a function of altitude

How to Develop CFADs



(a) Mask area of storm (black line) using points with maximum column reflectivity > 0 dBZ
(b) Create histogram for each x-y slab
(c) Develop CFAD from histograms



Contoured Frequency by Distance Diagrams (CFDDs)

- Like CFADs, but frequencies plotted as function of distance behind leading anvil edge rather than altitude
- Y-axis oriented parallel to rear inflow jet (RIJ), x-axis perpendicular to y-axis, z-axis vertical

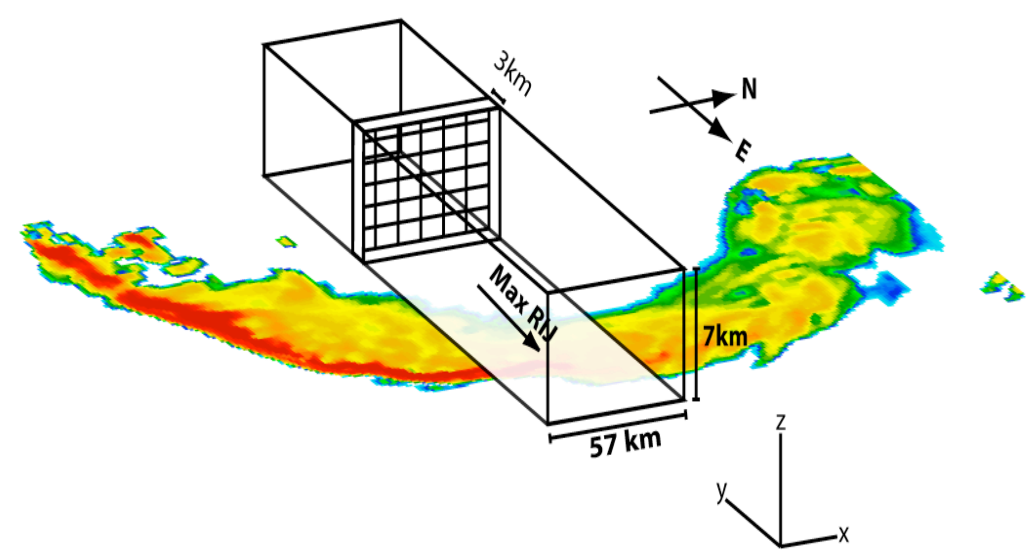


Figure 2: Schematic of a CFDD. The domain used to construct the CFDD can be visualized as a stick of butter, with each vertical slab being one histogram. Each x-z slab is 57 km wide by 3 km deep by 7 km tall.

Model vs. Observations CFADs

Highest frequencies occur at similar Z, but very different distribution with respect to altitude

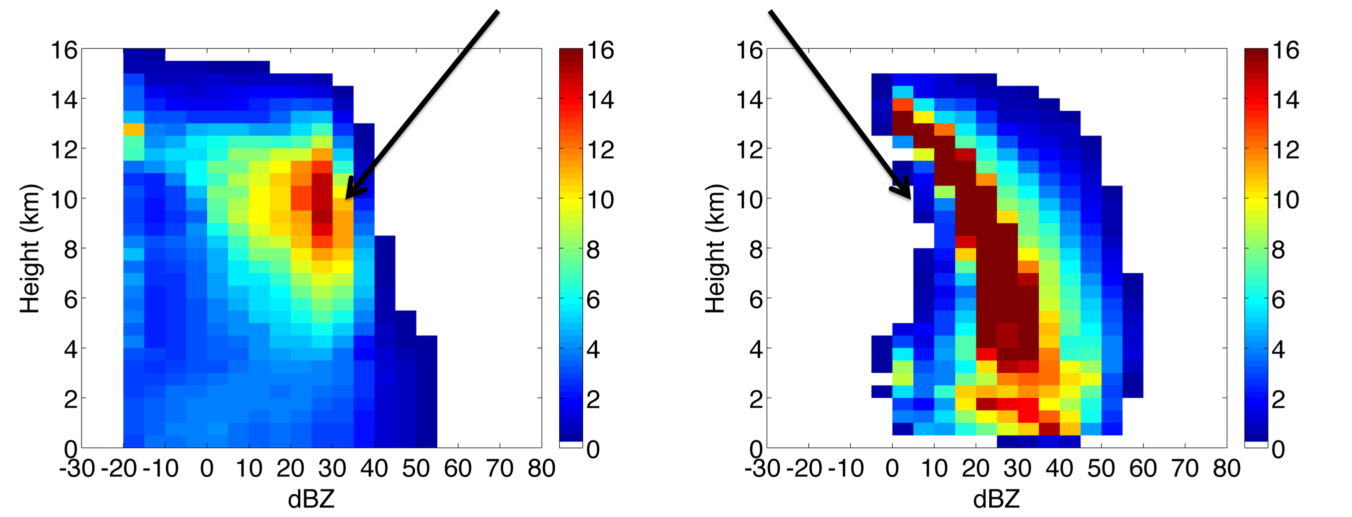


Figure 3: CFADs of simulated (left) vs. observed (right) radar reflectivity

Model vs. Observations CFDDs

- Variable bins along x-axis
- Distance front to rear on y-axis
- Colors represent frequency of occurrence

Difference in location of leading convective line between simulation and observations

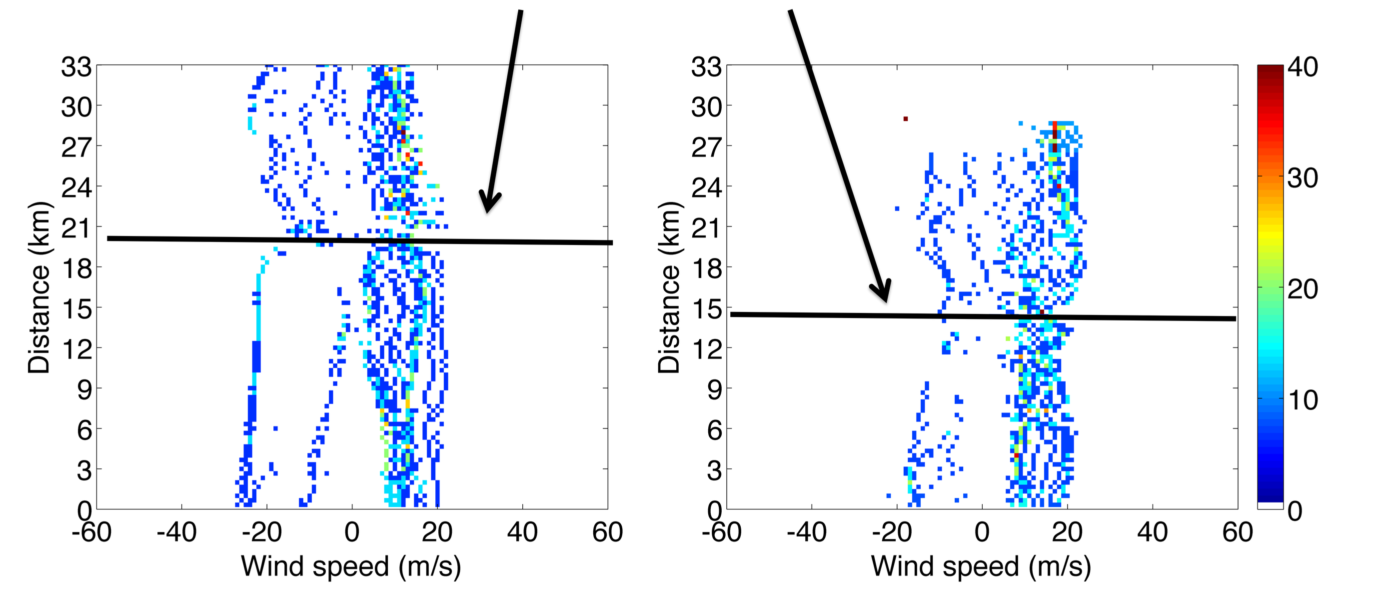


Figure 4: Left: CFDD of simulated line-relative velocity. Right: CFDD of model observed line-relative wind velocity.

Average Altitude per Bin Diagrams (ABDs)

- CFDDs do not have information about vertical distribution
- ABDs constructed in the same manner as CFDDs, but colors represent altitude rather than frequency

Front-to-rear flow predominant in lower altitudes, strongest ahead of convective line

Rear-to-front flow predominant in higher altitudes

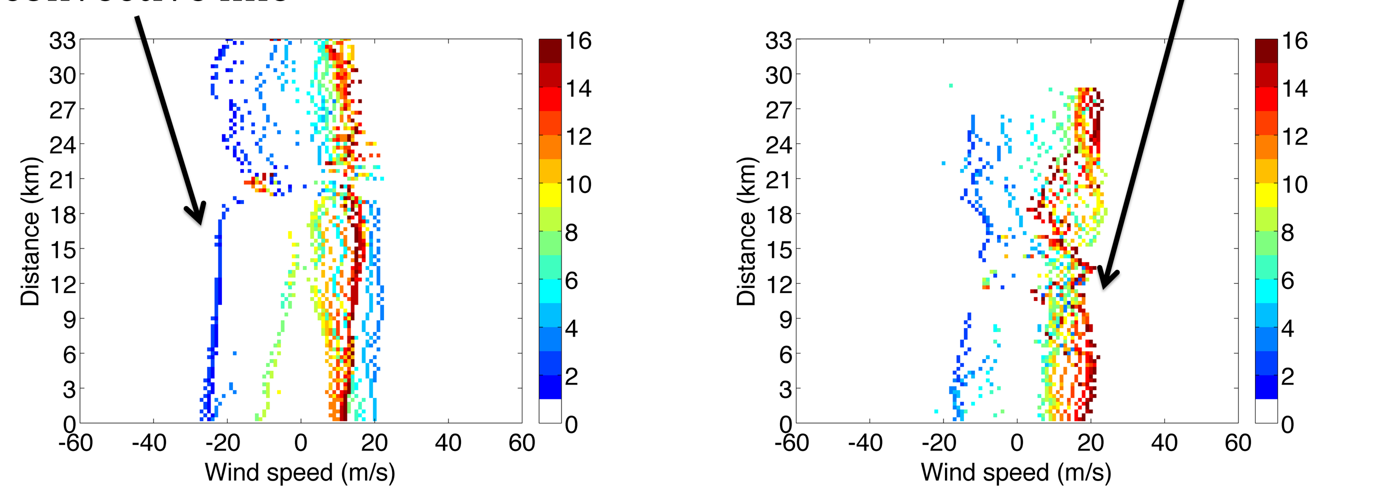


Figure 5: Simulated (left) and observed (right) ABD diagrams corresponding with the above CFDDs.

Conclusions

- CFDDs and ABDs are new methods for comparing modeled MCSs to observations
- Allow for examination of statistical distribution of quantities rather than specific values

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