NEXRAD Correction of Vertically Integrated Liquid in Areas of Partial Beam Blockage

Kenta T. Hood, Evelyn N. Mann, Betty J. Bennett, David J. Smalley
Massachusetts Institute of Technology, Lincoln Laboratory

Pengfei Zhang
CIMMS, University of Oklahoma and NOAA/OAR
National Severe Storms Laboratory

Background

Objective: Automatically correct Vertically Integrated Liquid (VIL) for partial beam blockage effects using differential phase, which is immune to partial blockage and miscalibration

- Safe and efficient routing of air traffic relies on the quality of VIL
- Partial beam blockage negatively biases reflectivity and decreases VIL
- Blockage maps do not account for unexpected blockage sources due to anomalous propagation
- NEXRAD dual polarization upgrade introduces a new variable, differential phase, to correct partial beam blockage without the need for blockage maps

Algorithm

VIL is the integration of Liquid Water Content (LWC) M over a column of space

\[ VIL = \int M(z)dz \]

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\[ A_h = \frac{2^{b}(r) + \left\{ 0.10^{1.95b \phi^2} - 1 \right\}}{I(r, r_0) + \left\{ 0.10^{1.95b \phi^2} - 1 \right\} / I(r, r_0)} \]

\[ I(r, r_0) = 0.46b \int_{r_0}^{r} 2^{b} \left( s \right) ds \]

\[ a(t) = 70.8 + 2.04t + 0.21t^2 \]

\[ M = 3.44 \times 10^{-3}Z^4 \]

\[ M = a(t)A_h^{0.93} \]

- Specific attenuation \( A_h \) is obtained from the radial profiles of reflectivity and differential phase (Testud et al., 2000)
- LWC is estimated directly from \( A_h \)
- Vertical profiles of temperature are required as a temperature dependent factor, \( a(t) \), is used in the estimation algorithm
- Highlighted areas reveal a difference in LWC estimates

Results

Data from 318/2012 1615 Z, 0.5° tilt, Tucson, AZ (KEMX)

- Recovery of VIL in partially blocked areas is possible using specific attenuation
- Application of algorithm will benefit the entire NEXRAD network with more accurate estimates of VIL

Conclusions

Future Work

- Integrate gridded model temperature data
- Resolve underestimation of LWC in affected radials
- Compensate for possible discontinuities at the dual polarization range limit of 300 km
- Blend LWC estimation methods where necessary to take advantage of the strengths of each relation