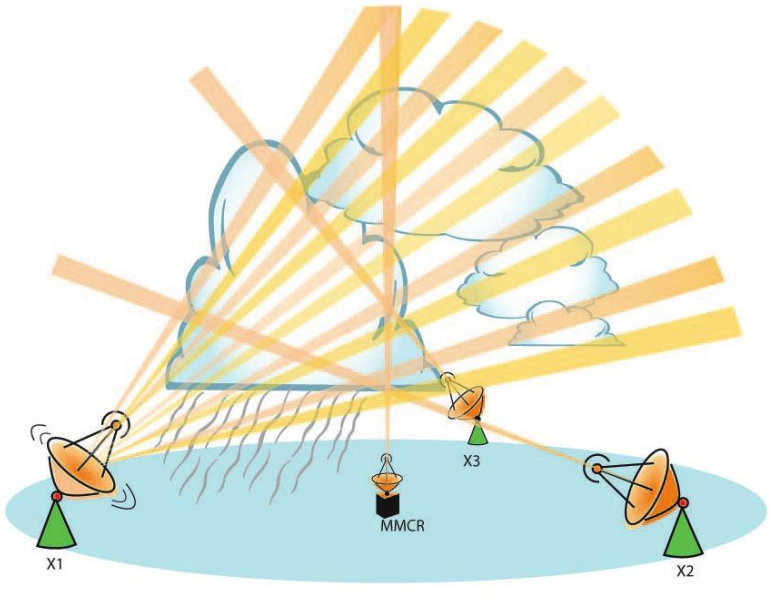
Uncertainties and Recommendations for Multi-Doppler Radar Vertical Velocity Retrievals



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Application of Radar Forward Simulator to Evaluation of Multi-Dop Retrieval

Input
WRF simulated **u, v, w, Q, N**
This study:
MC3E, dx=500,
20-sec outputs

Forward Model (CR-SIM)

Zhh, DV, SW, Zvv, Zdr, Kdp, Ah, Av, and LDRh for each hydrometeor type at each gridbox. Account for radar elevation angles.

Instrument Model (Convert to CFRadial)

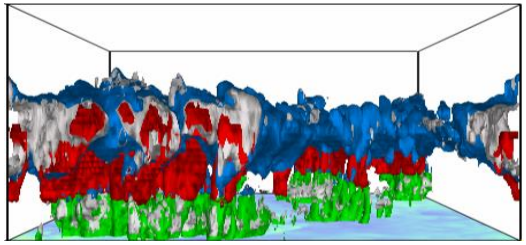
Sampling geometry, sampling volume, attenuation, and sensitivity.

Retrieval Model

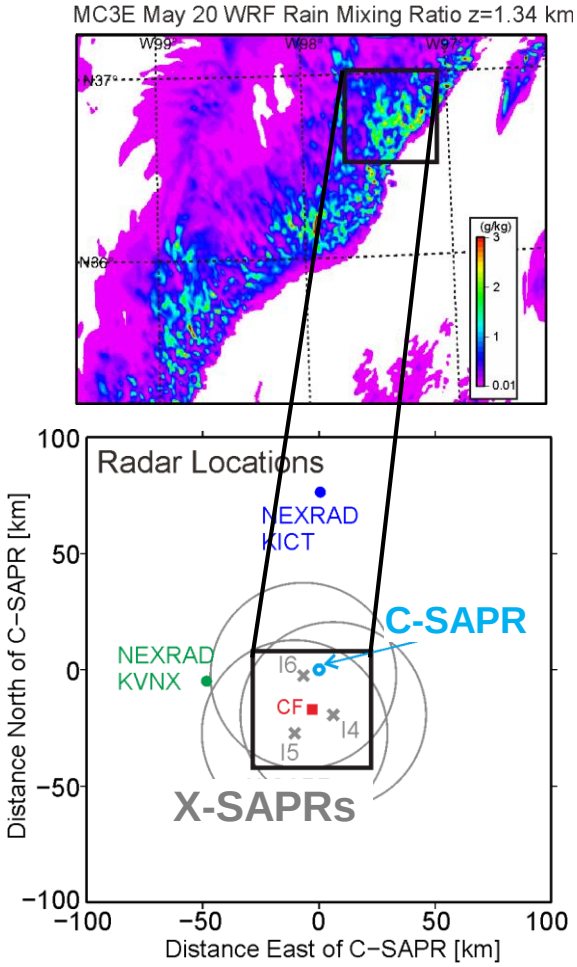
Gridding using smoothing factor.
3DVAR multi-Doppler radar wind retrieval.

Output
Simulated retrieval parameters
This study:
multi-Doppler radar retrieved **w**

Compare and investigate uncertainties from error sources separately

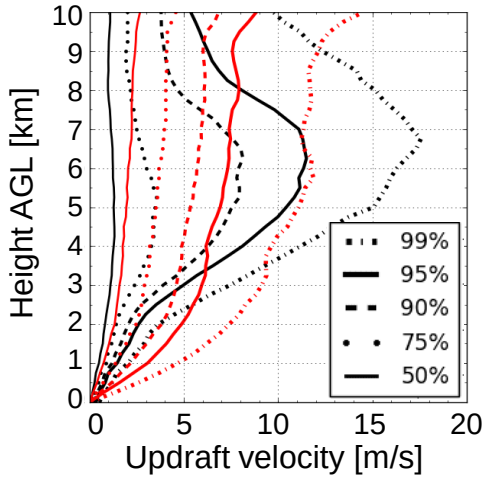


Multi-Dop Retrievals for Mesoscale Convection



WRF simulation:
MC3E of 2011/05/20 12:18:00,
DX=DY=0.5 km, 50 km x 50 km domain,
20-sec outputs

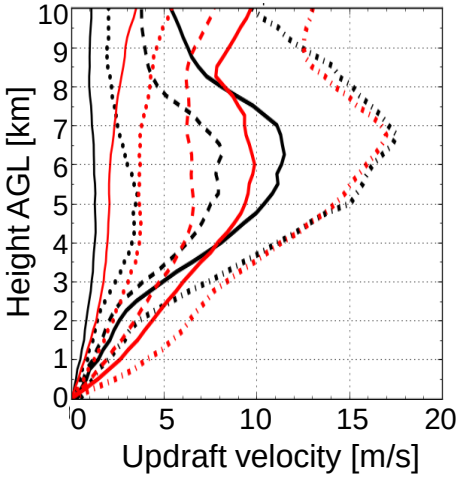
3 X-SAPRs (current settings)



Sources of errors include:

- Time differences amongst PPI scans
- Gridding (e.g. smoothing factor)
- Radar characteristics (e.g. beam width)
- VCP (e.g., elevations, locations)
- Particle fall speed estimate

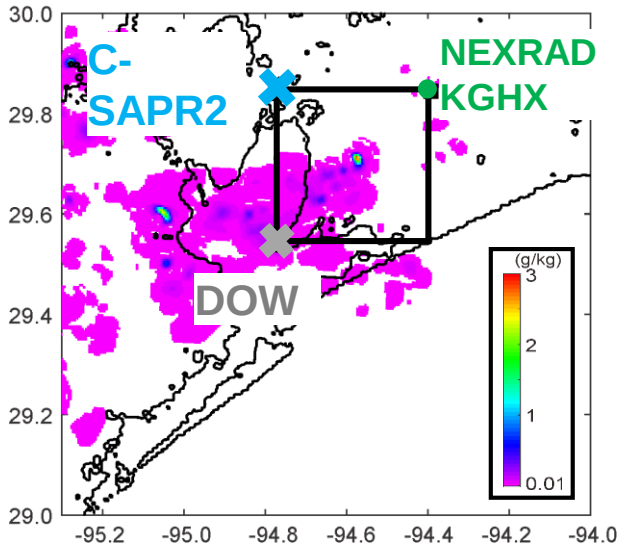
Doppler measurements from 4 radars



- Fast volume scans (< 1 min) by 3-4 radars (e.g., sector scans, phased array radars) at high spatial resolution can provide best performance.
- Non-attenuation reflectivity (e.g., NEXRAD) should be used to estimate particle fall speed.

Multi-Dop Retrievals for Isolated Convection

WRF Rain Mixing Ratio z=1.6 km

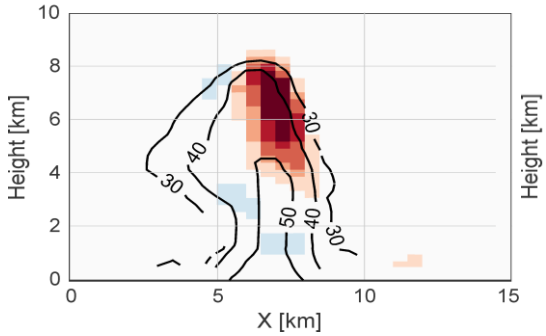


WRF simulation:

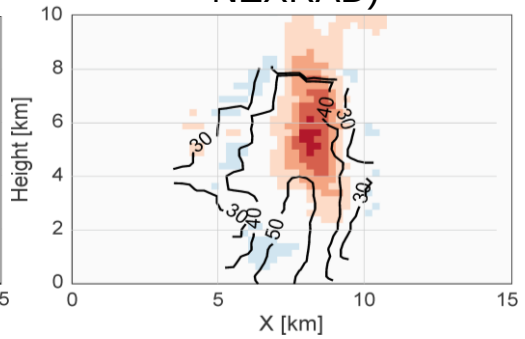
Houston 2013/06/08 17:25-17:30,
DX=DY=0.5 km, 30 km x 30 km domain,
20-sec outputs

Distance between cloud and radar is ~25-30 km.

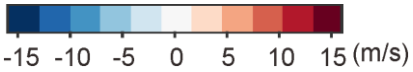
WRF vertical velocity



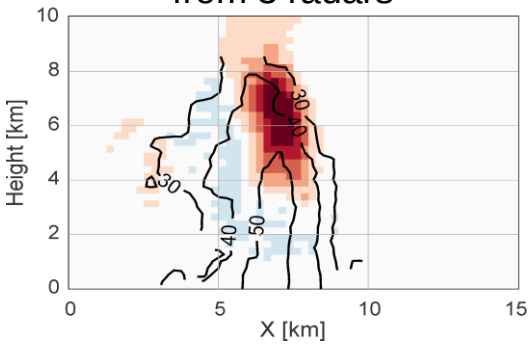
5-min volume scan by 2 radars (C-SAPR and NEXRAD)



Contour: S-band reflectivity (dBZ)



Doppler measurements from 3 radars



- Time delay in PPI scans can cause underestimation of updrafts and tilted vertical structures of radar observables.
- Use of 2 radars may not enough to quantitatively capture the updraft core.
- Fast volume scans (< 1 min) by 3 radars can provide best performance.