

Impacts of Wind Farms on WSR-88D and Forecast Operations



Interim Report to the TAC

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CIMMS/NSSL/ROC
March 27, 2007

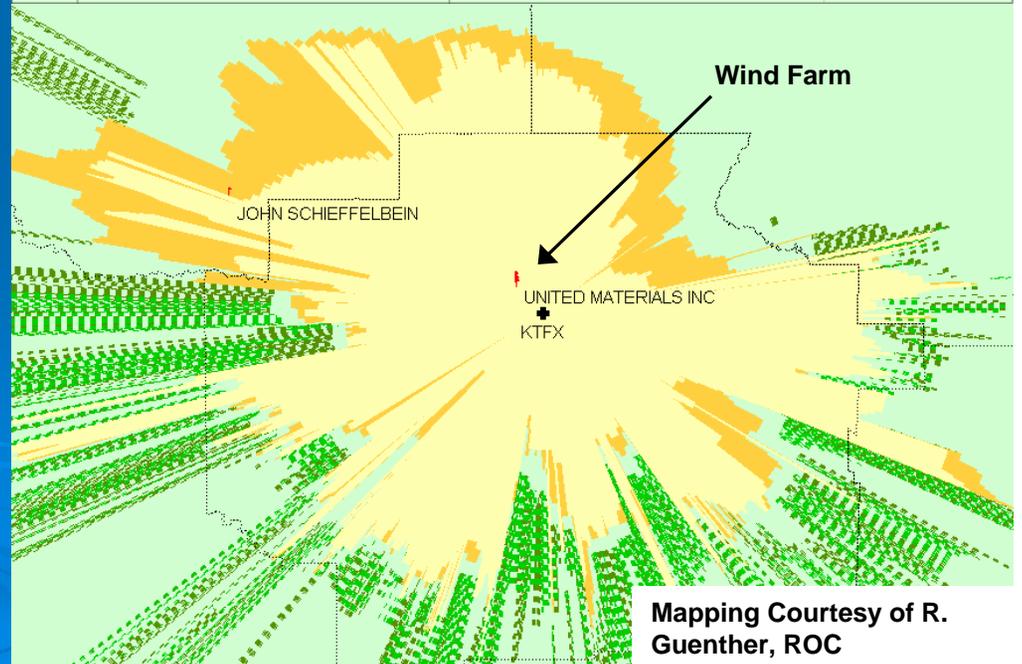
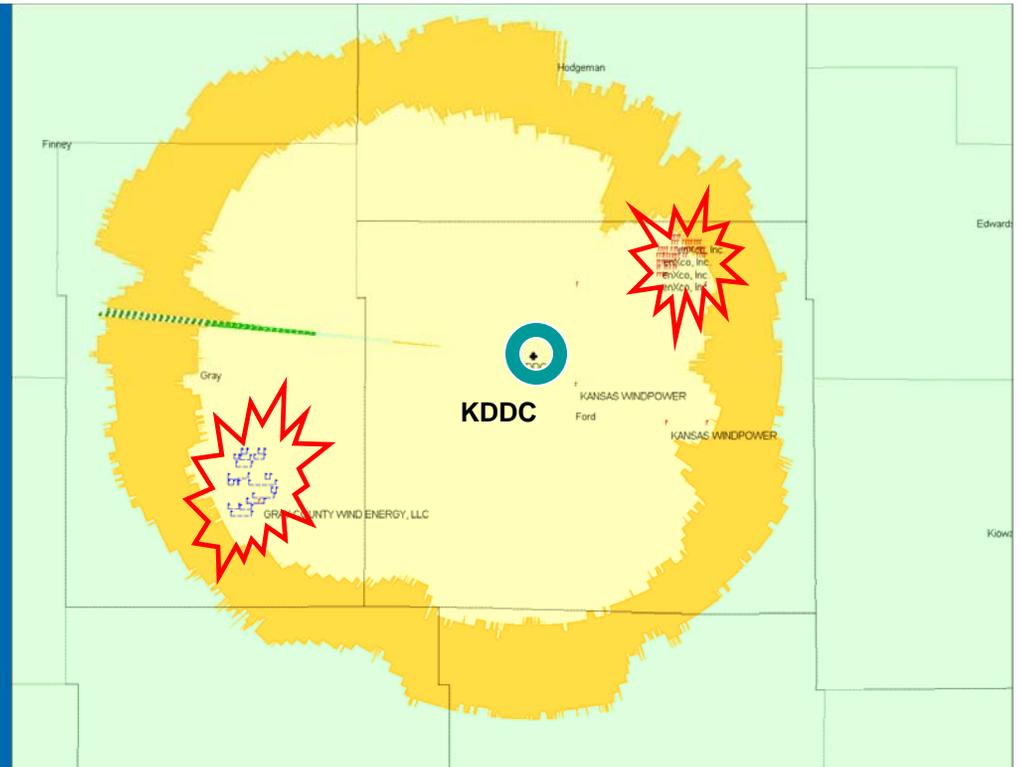
Study Goals

➤ 1st Priority: Dodge City WSR-88D (KDDC)

- Two Wind Farms
 - Large Farm ~40 km Southwest of Radar
 - Smaller Farm ~22 km Northeast of Radar
- Climatology of Echoes
- Impacts/Potential Impacts on Operations

➤ 2nd Priority: Great Falls WSR-88D (KTFX)

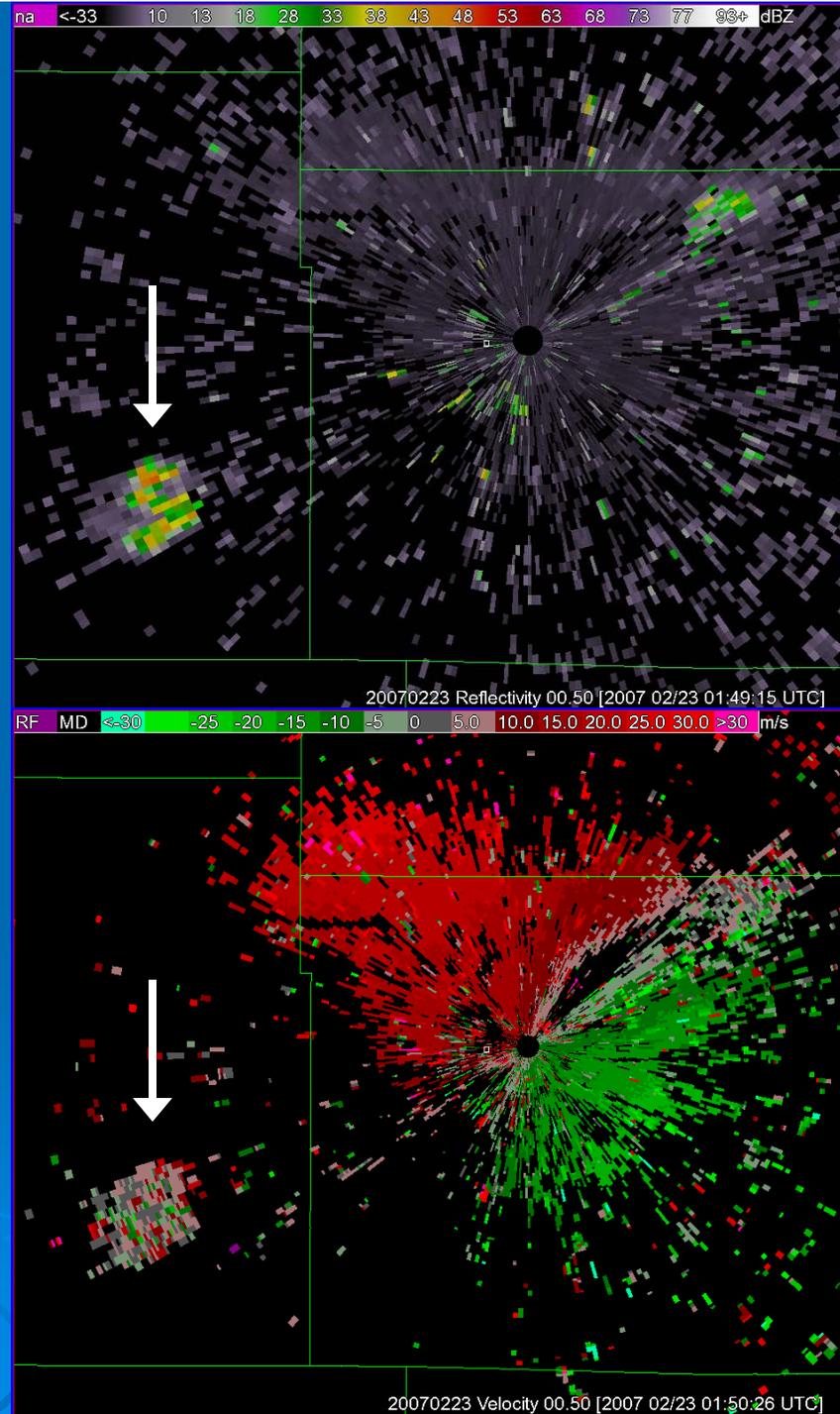
- One Wind Farm: Close to Radar (~6 km), 6 Turbines
- Spot Observations
- Impacts/Potential Impacts on Operations



Mapping Courtesy of R. Guenther, ROC

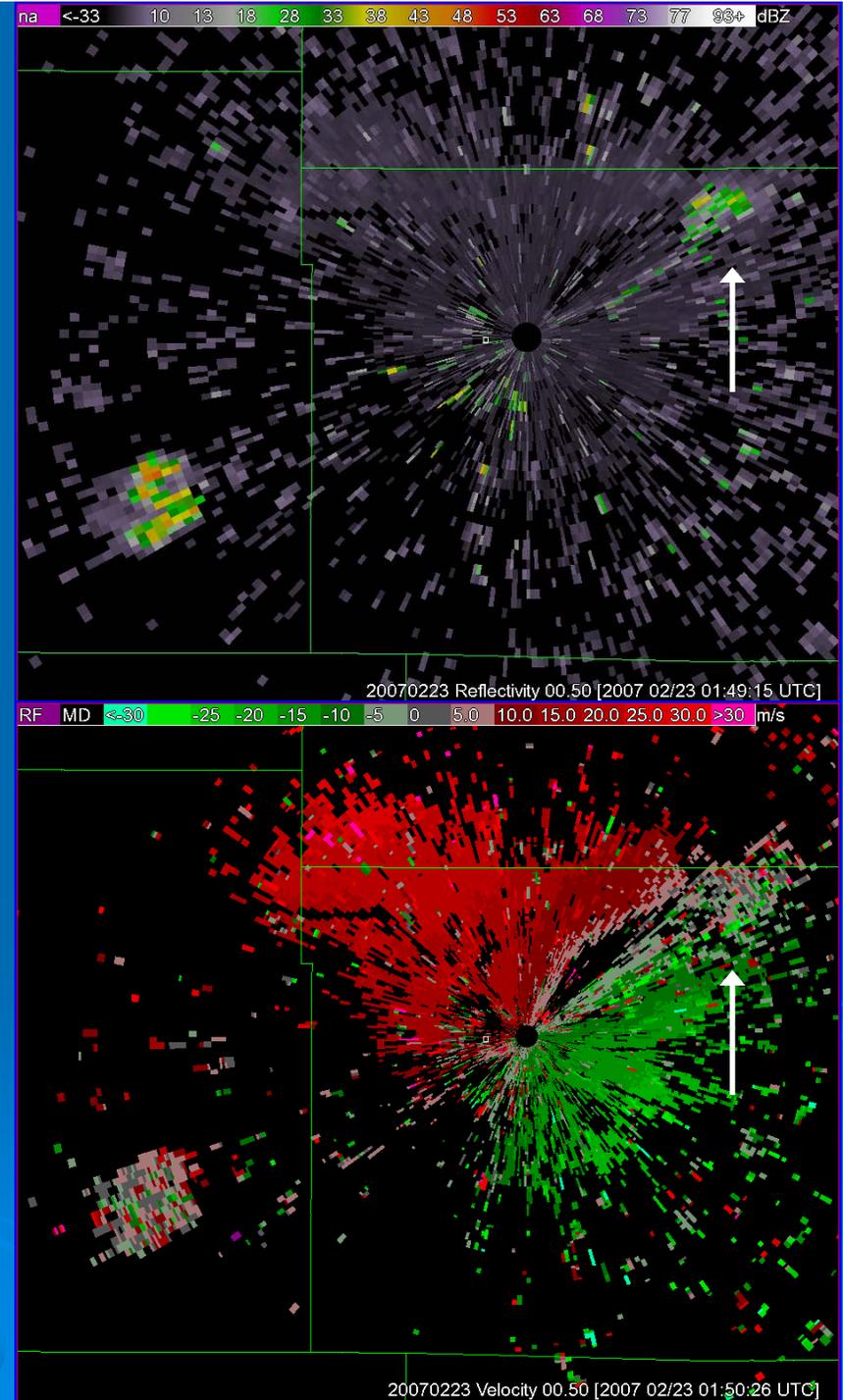
DDC Southwest (SW) Wind Farm

- Montezuma Wind Farm
- 170 Turbines
- Turbine Tops ~120 m AGL
- Azimuth Extent ~12° (240°-252°)
- Range Extent ~7 km (37-44 km)
- Center AzRan ~245°/40 km
- 0.5° Beam Height at Center ~400 m
- Max Reflectivity ~40-50 dBZ
- 0.9°, 1.3°, 1.5° Reflectivity Much Weaker/Rare



DDC Northeast (NE) Wind Farm

- Spearville Wind Farm
- 72 Turbines
- Turbine Tops ~120 m AGL
- Azimuth Extent ~10° (051°-061°)
- Range Extent ~8 km (18-26 km)
- Center AzRan ~ 056°/22 km
- 0.5° Beam Height at Center ~220 m
- 0.5° Max Reflectivity ~30-40 dBZ
- 0.9°, 1.3°, 1.5° Reflectivity Much Weaker/Rare

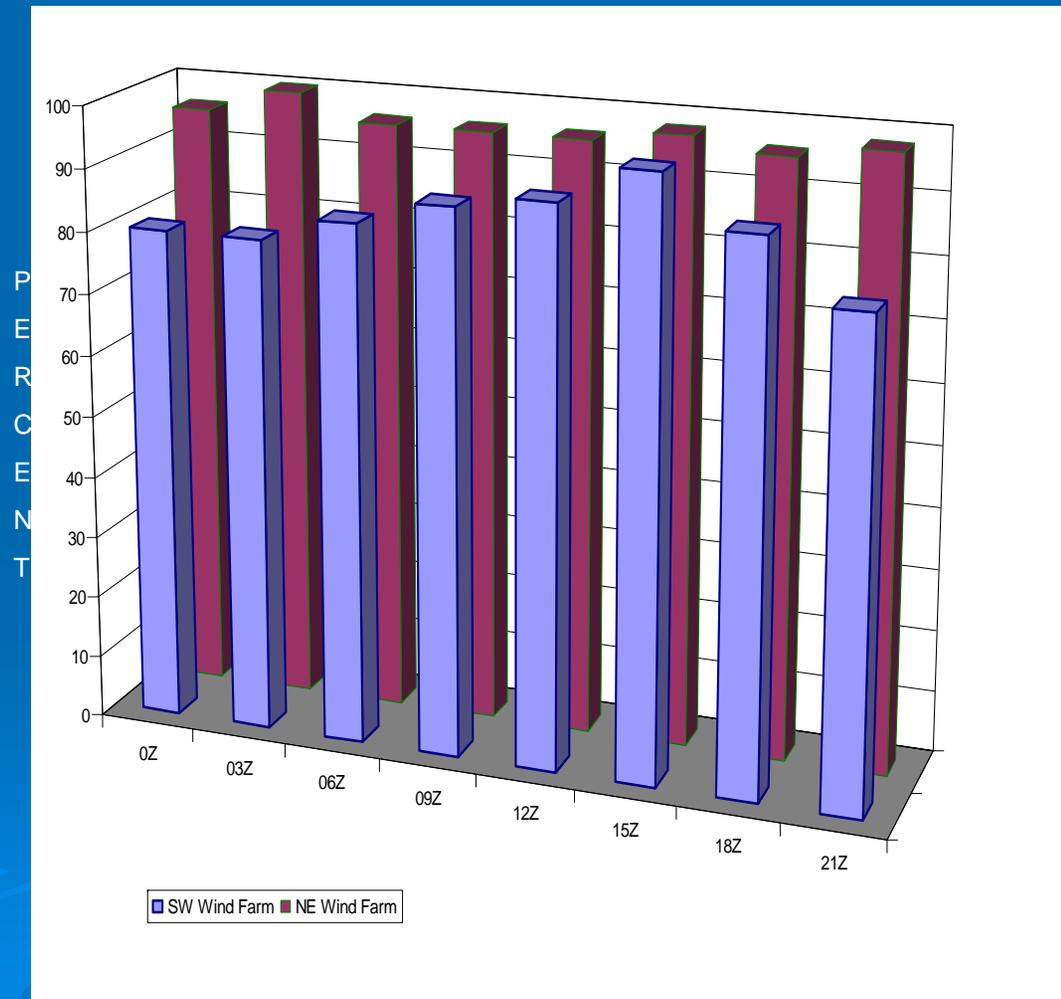


SW & NE Echo Climatologies

- ~ 60 days: 20 Jan – 20 Mar
- 8 observations per day
- 480 observations: Clear Air & Precip Mode
- Loops of all data
- DDC surface observations
- DDC soundings 12Z & 00Z

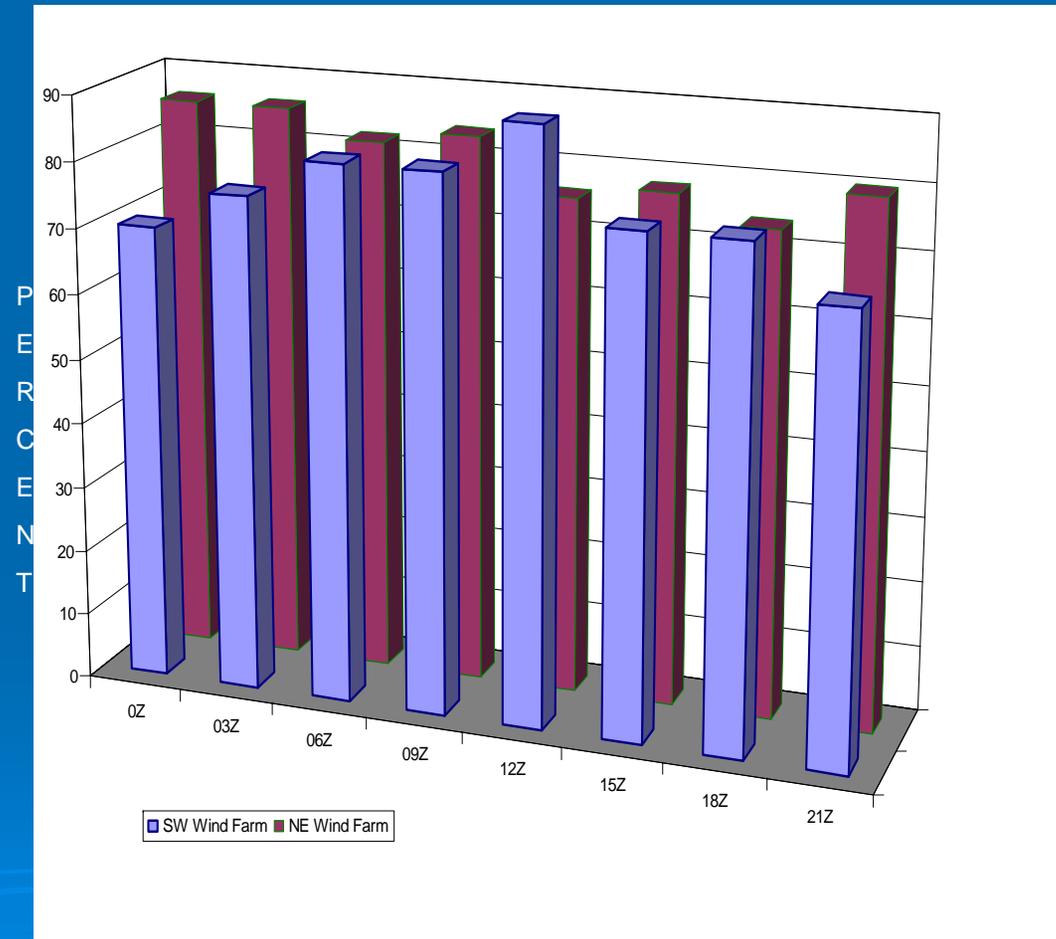
- SW > 5 dBZ ~86%
- NE > 5 dBZ ~97%

- SW has Diurnal Trend
- NE has no Trend

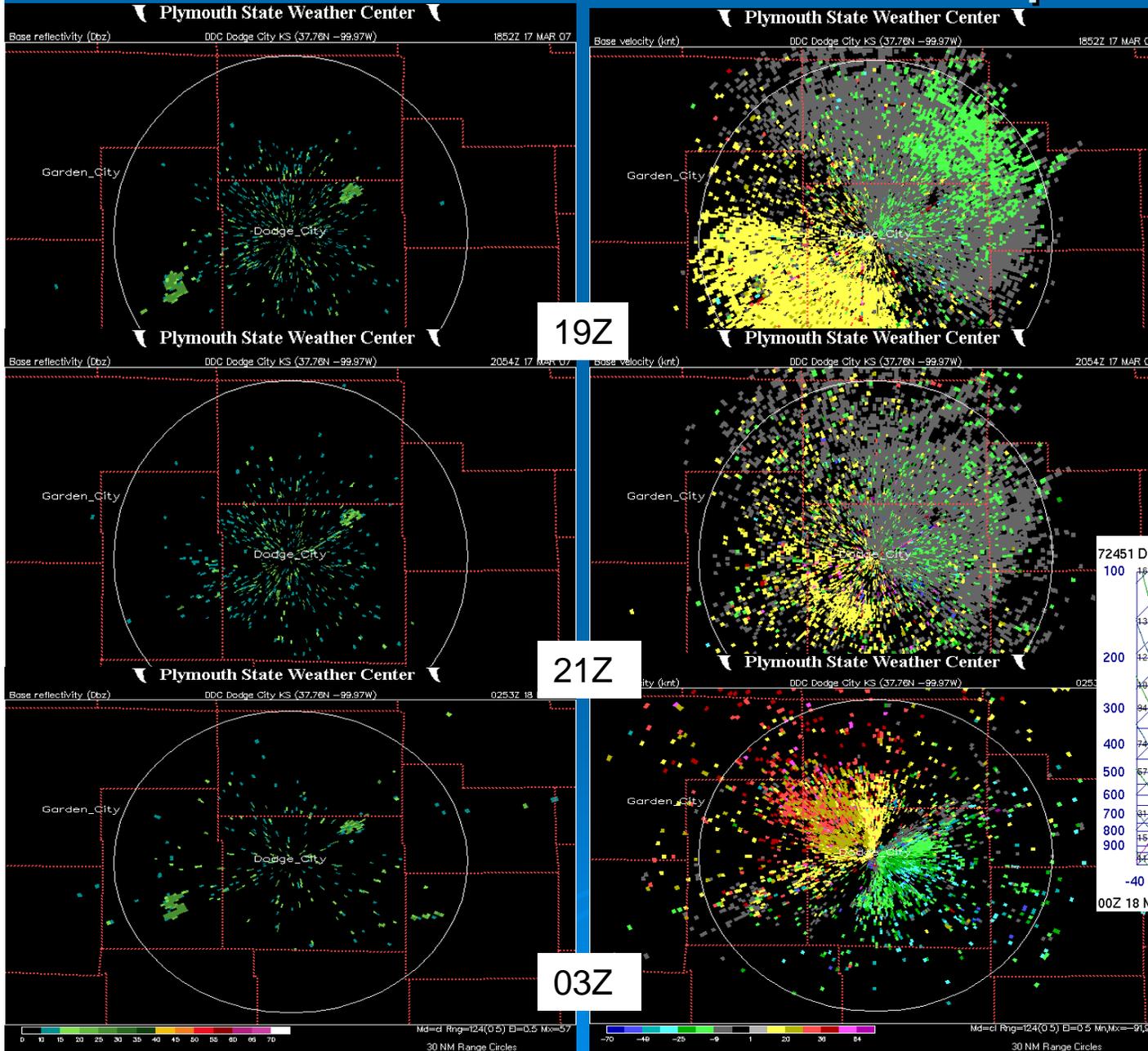


SW & NE Echo Climatologies -2

- SW > 20 dBZ ~77%
- NE > 20 dBZ ~81%
- SW has Diurnal Trend: Morning Best
- NE has Diurnal Trend: Night Best
- Considerations:
 - Beam Propagation
 - Super-refraction: Night?
 - Sub-refraction: Day
 - Wind Speed
 - Returns disappear during winds near calm (< 5 kt)



Sub-Refraction Example



DDC Obs:

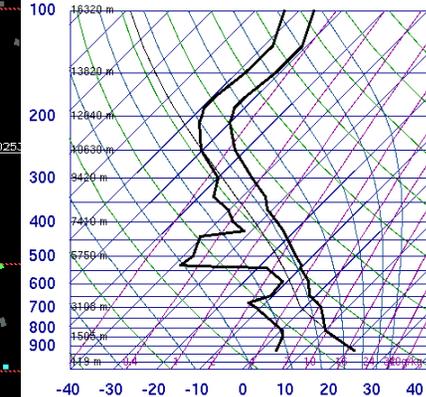
19Z 68/38/03@13

21Z 73/39/07@08

00Z 67/42/08@10

03Z 60/40/16@10

72451 DDC Dodge City(Awos)

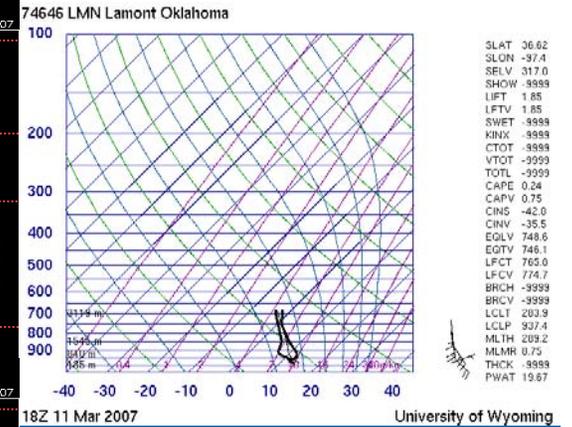
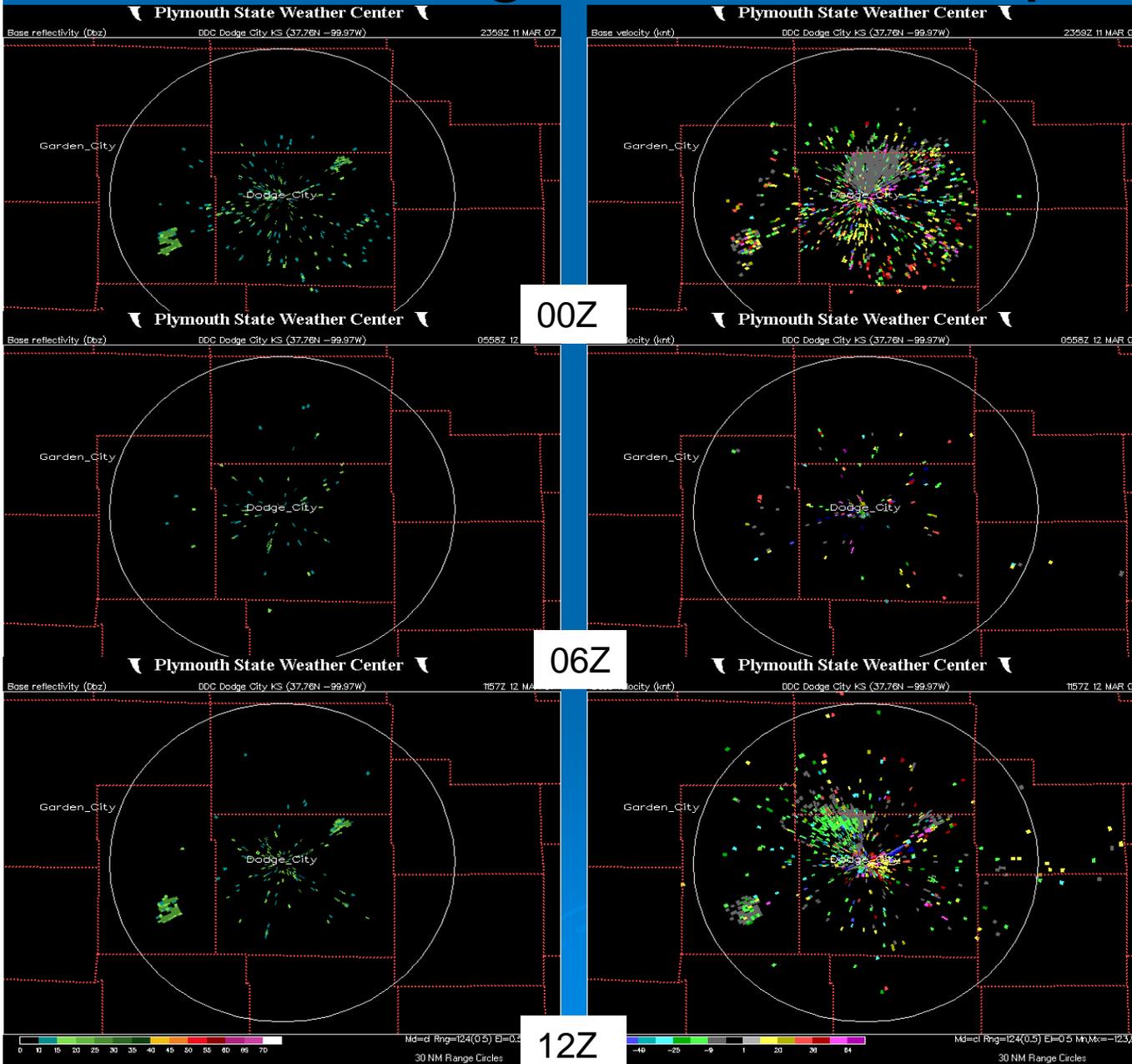


SLAT 37.75
 SLON -99.9
 SELV 790.0
 SHOW 4.87
 LIFT 4.45
 LFTV 4.21
 SWET 83.59
 KINX 14.30
 CTOT 15.50
 VTOT 27.50
 TOTL 43.00
 CAPC 0.00
 CAPV 0.00
 CINS 0.00
 CINV 0.00
 EGLV -9999
 EGTV -9999
 LFCT -9999
 LFCV -9999
 BRCH 0.00
 BRCV 0.00
 LCLT 272.6
 LCLP 707.5
 MLTH 300.9
 MLMR 5.25
 THCK 5631
 PWAT 14.86

00Z 18 Mar 2007

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Light Wind Example



DDC Obs:

00Z Fog/49/47/35@07

06Z Fog/48/47/CALM

12Z Fog/46/44/30@09

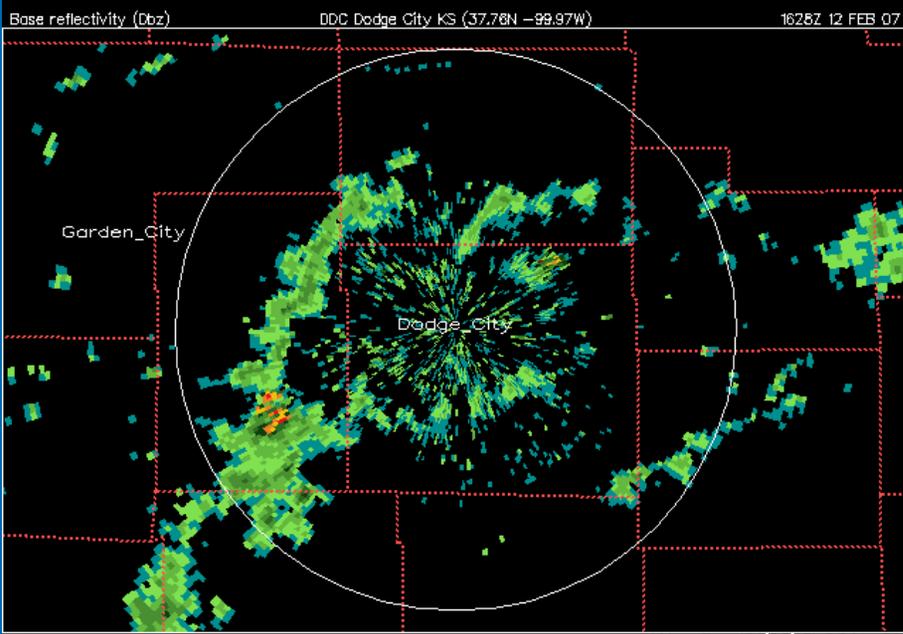
Impacts/Potential Impacts to Dodge City WFO Operations

- False Storm Identification: Some Impact
 - Velocity Dealiasing Errors: Some Impact
 - False VAD Wind Profile: Almost No Impact
 - Clear-Air Boundary Detection: Small Impact
 - Severe Storm Detection: Small Impact
 - Precipitation Estimation: Big Impact
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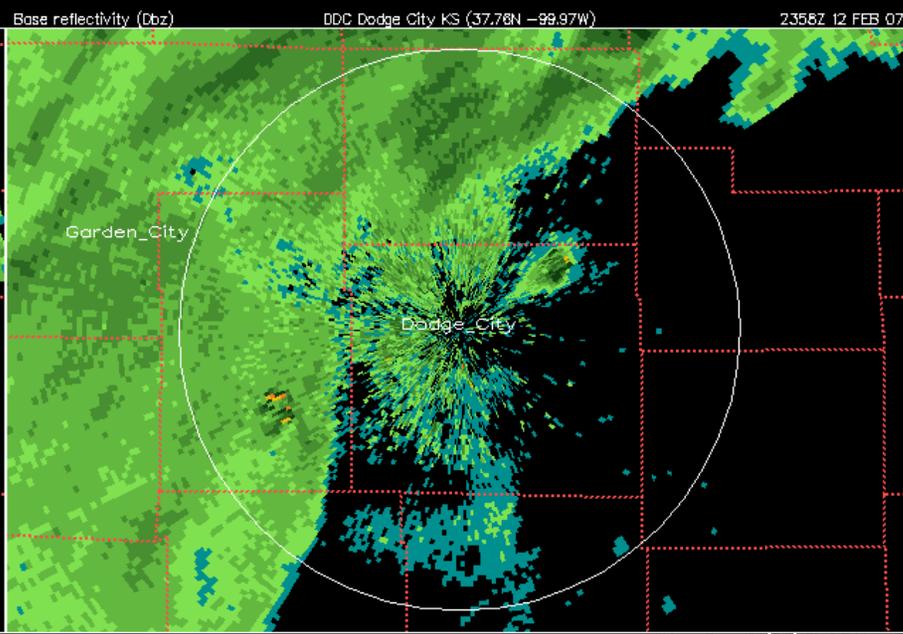
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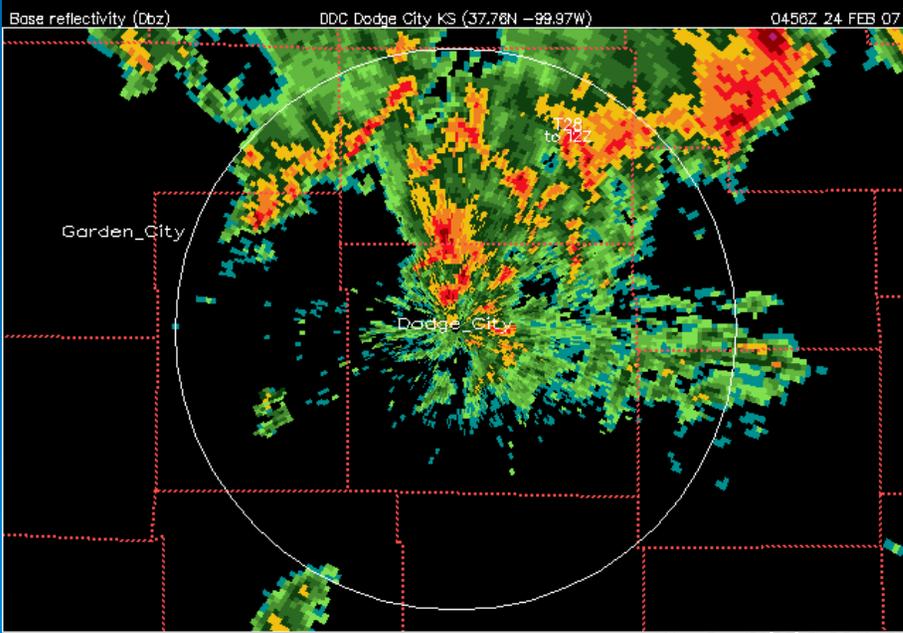
Plymouth State Weather Center



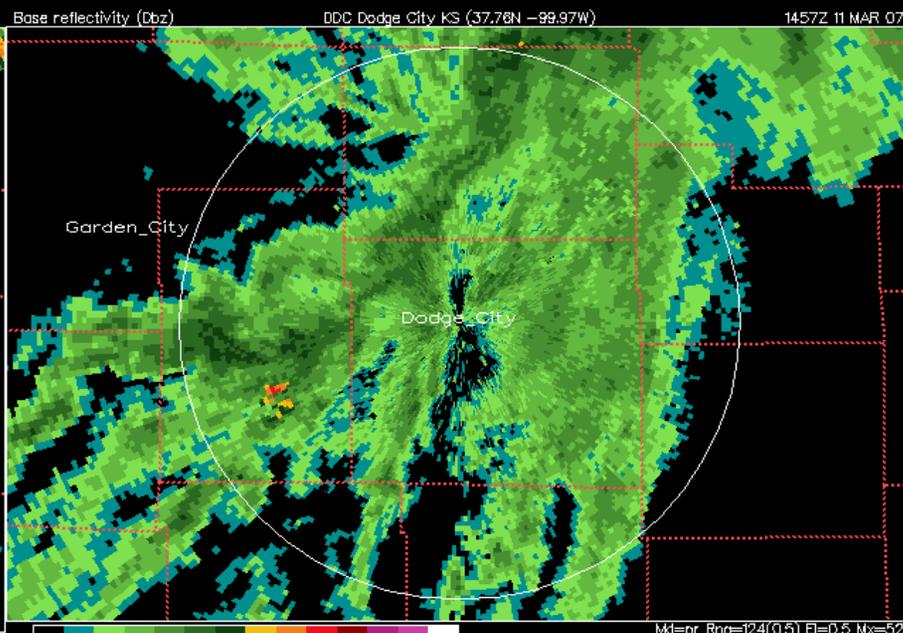
Plymouth State Weather Center



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Plymouth State Weather Center



Base reflectivity (Dbz) DDC Dodge City KS (37.78N -99.97W) 1626Z 12 FEB 07 Md=pr Rng=124(0.5) EI=0.5 Mx=56

Base reflectivity (Dbz) DDC Dodge City KS (37.78N -99.97W) 2358Z 12 FEB 07 Md=pr Rng=124(0.5) EI=0.5 Mx=47

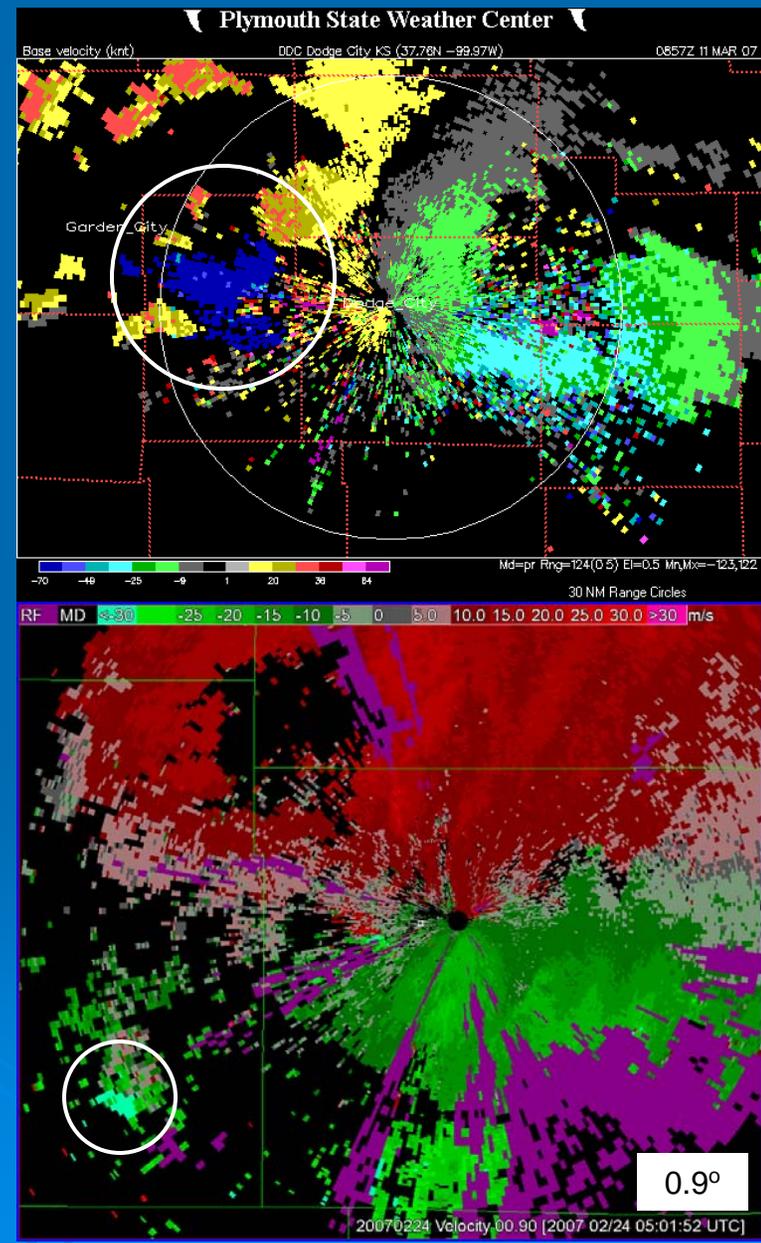
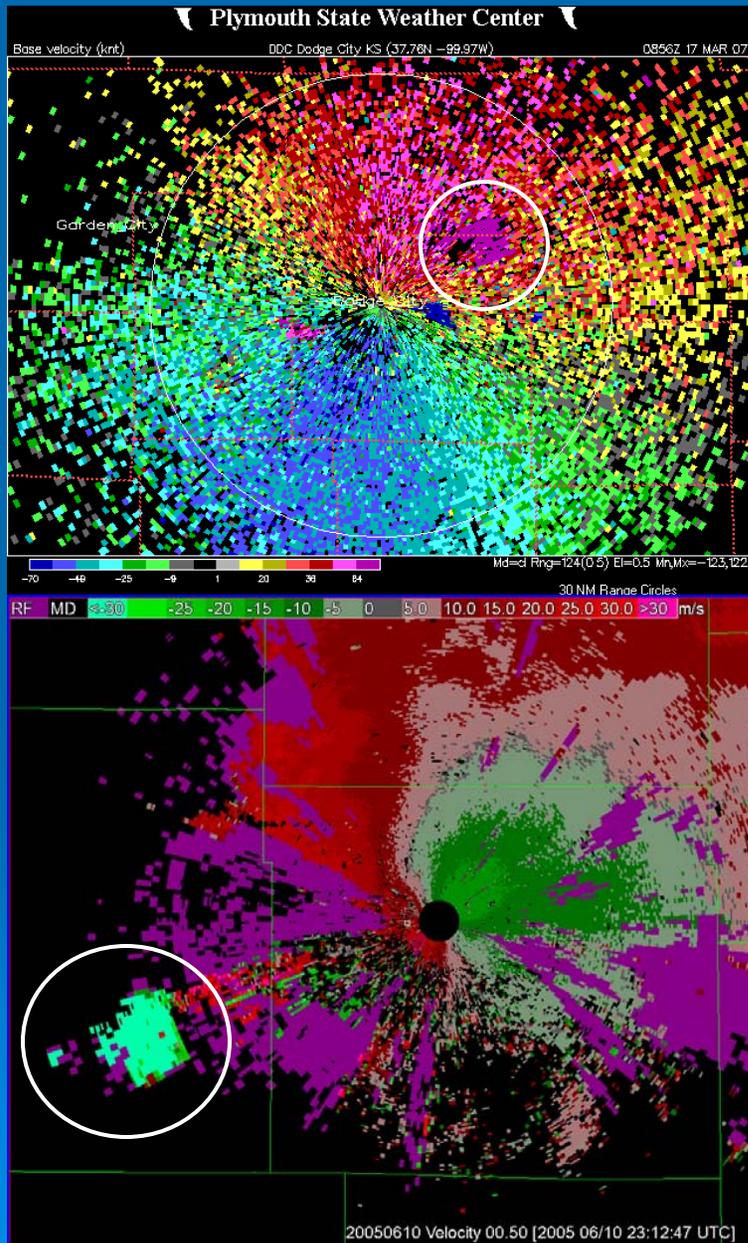
Base reflectivity (Dbz) DDC Dodge City KS (37.78N -99.97W) 0458Z 24 FEB 07 Md=pr Rng=124(0.5) EI=0.5 Mx=61

Base reflectivity (Dbz) DDC Dodge City KS (37.78N -99.97W) 1457Z 11 MAR 07 Md=pr Rng=124(0.5) EI=0.5 Mx=52

30 NM Range Circles

30 NM Range Circles

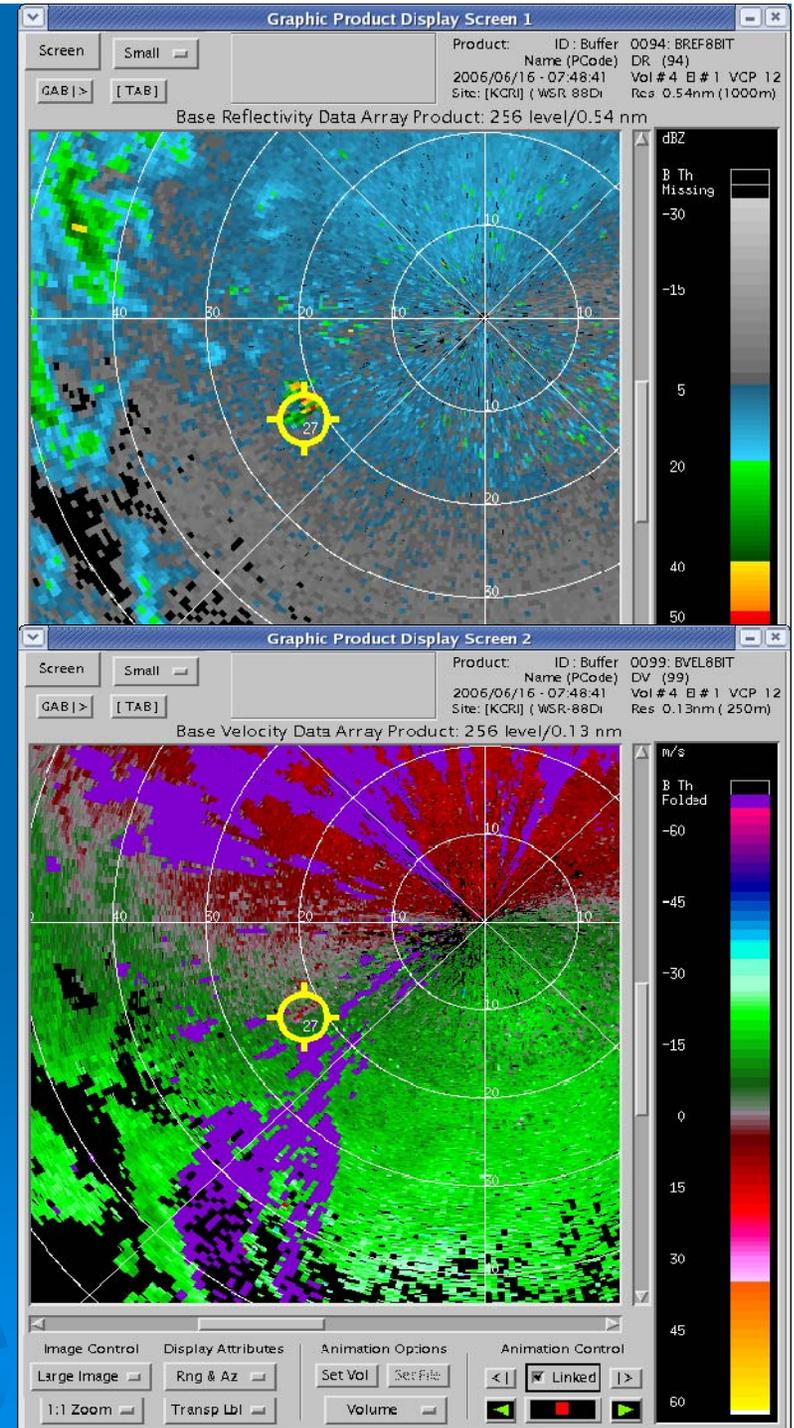
KDDC Velocity Dealiasing Errors



KDDC False Mesocyclone Detection

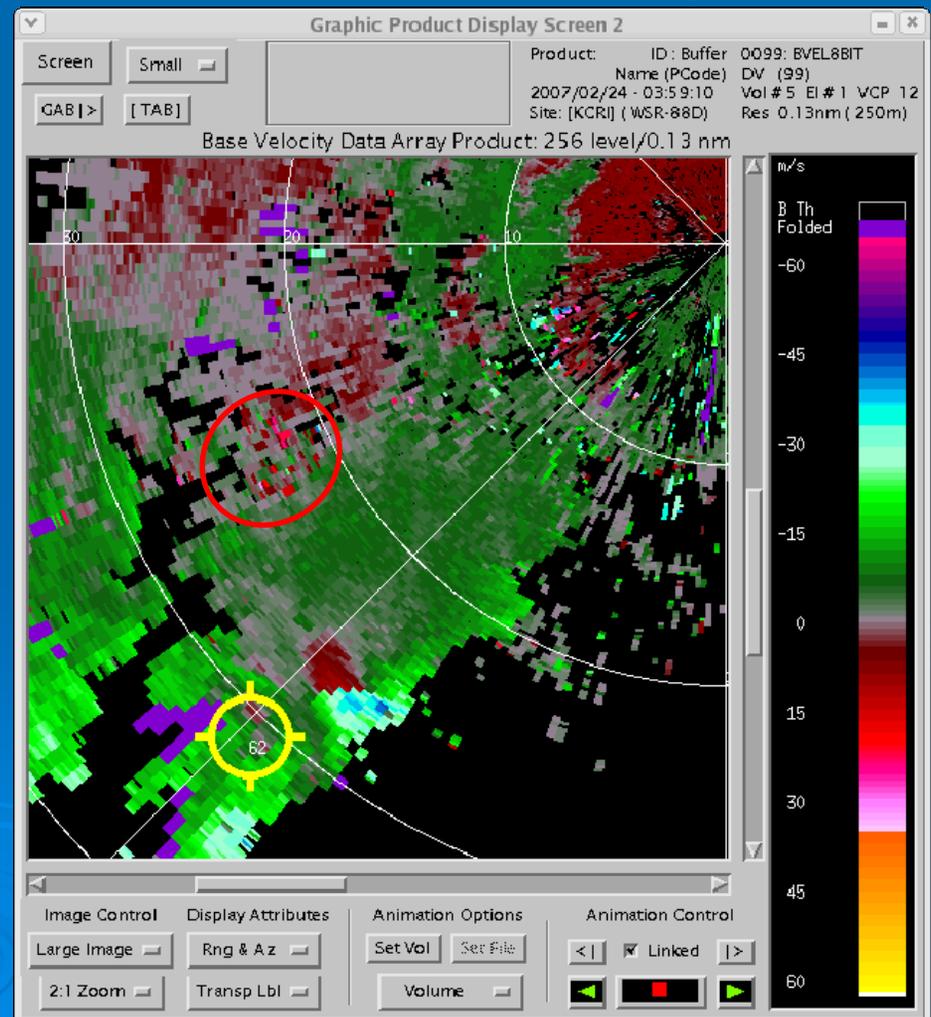
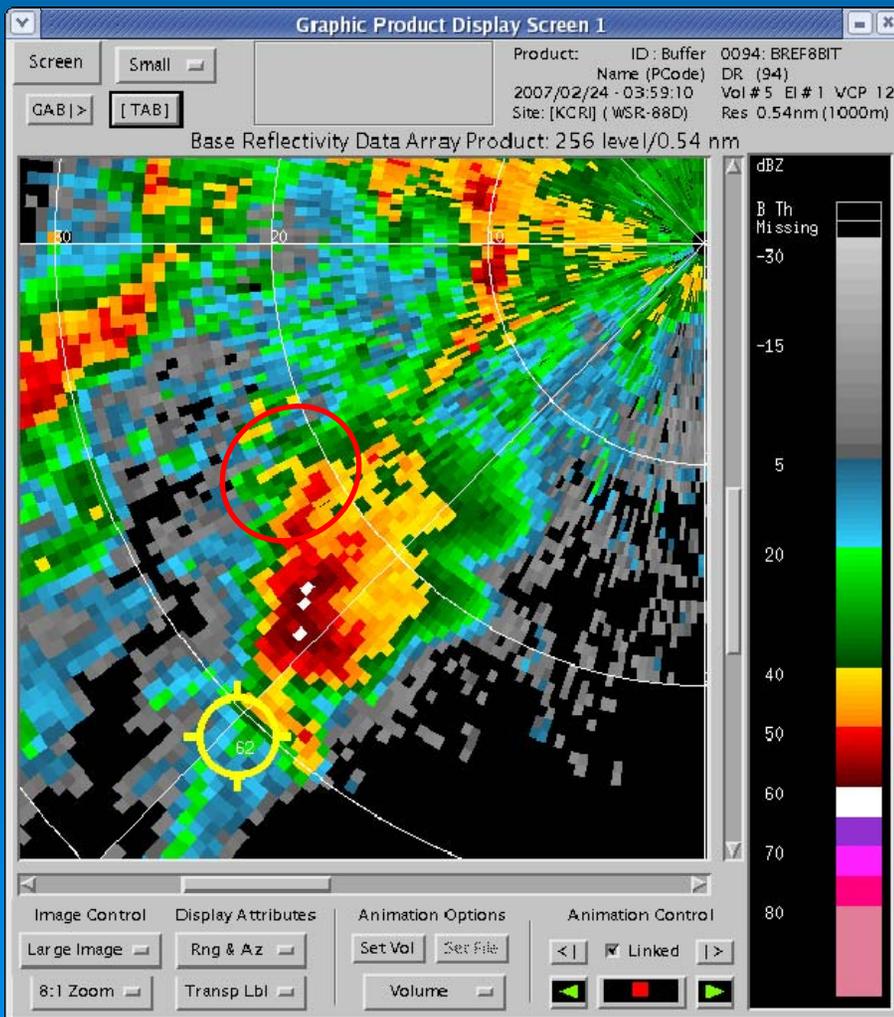
- 16 June 06, 0749Z
- ORPG Replay – Default Adaptable Parameters*
- Severe Storms to Southwest and Northwest
- VCP 12: 0.5° and 0.9°
- No Known Negative Impact from this Event on DDC Staff or Products

* Thanks to ROC/APPs (Dave Zittel, Bob Lee, and Melissa Pitchin) for ORPG Replay Assistance

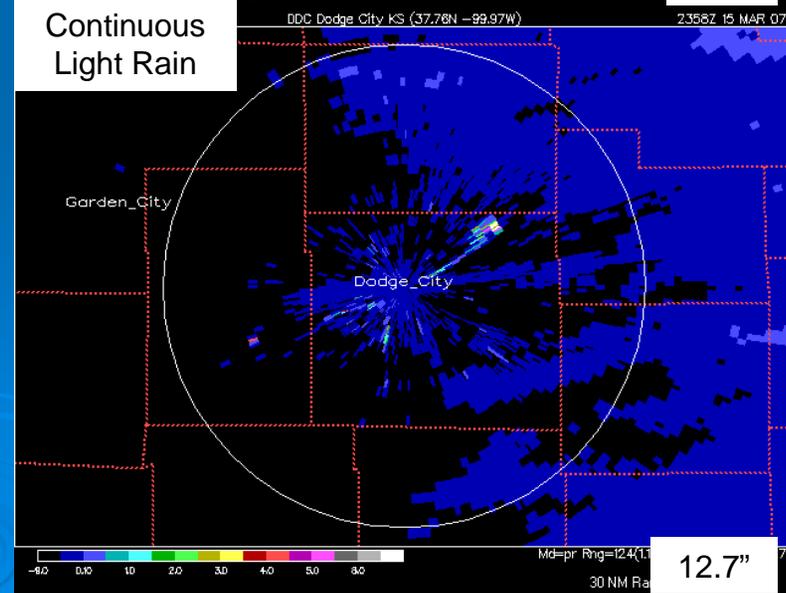
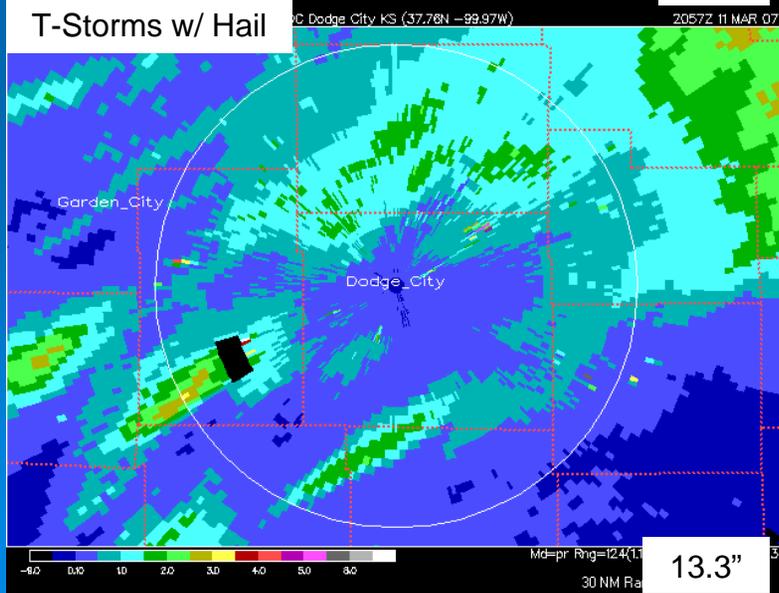
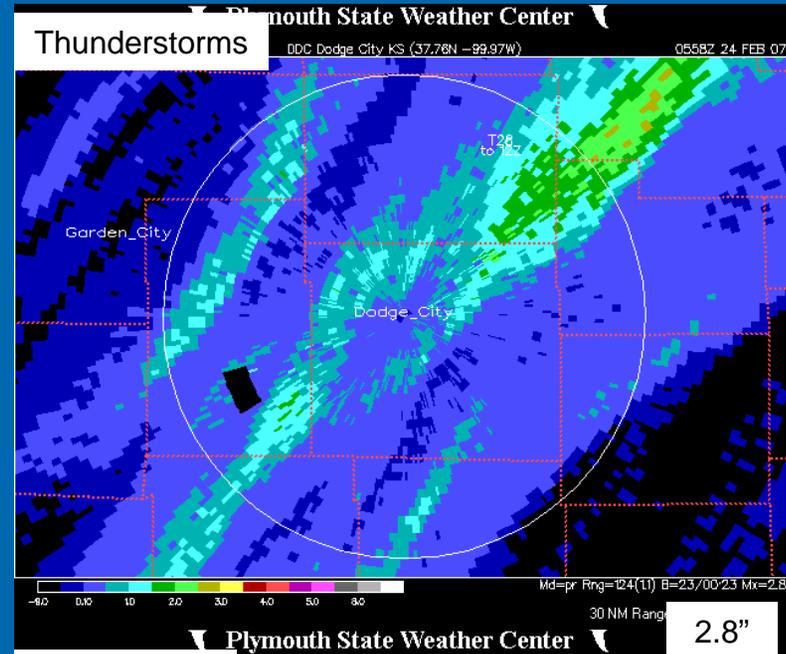
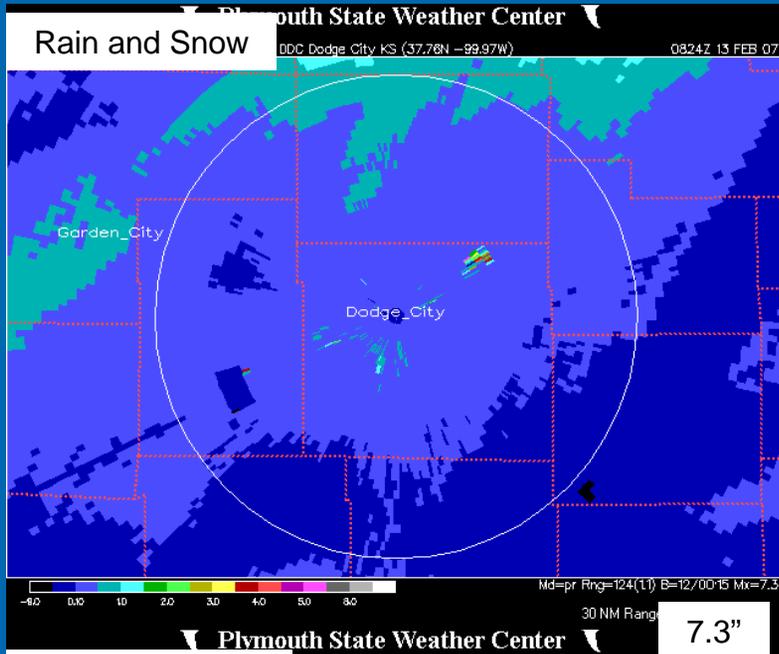


KDDC Tornadic Supercell Near SW Wind Farm

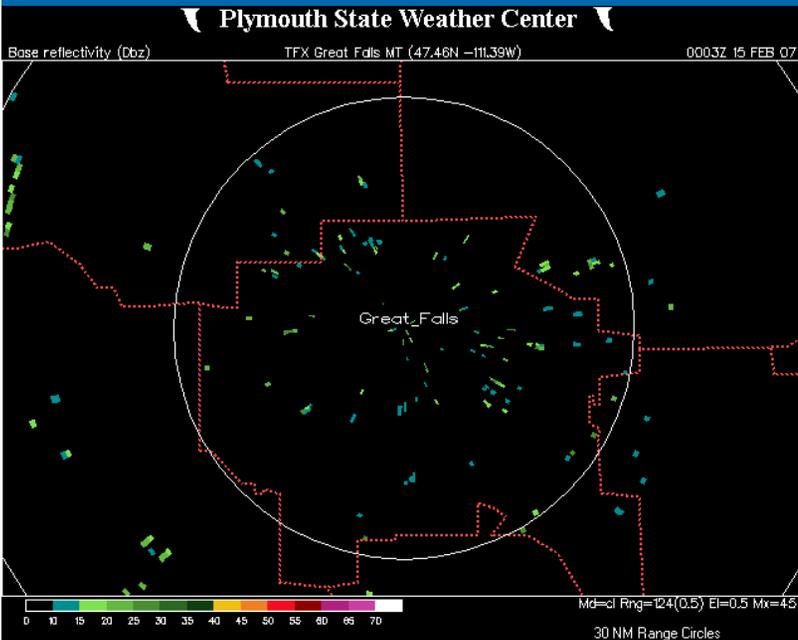
- 24 Feb 07, 04Z
- EF2 Tornado, 27 km Track
- VCP 12
- No Known MDA Detection Failures or False Detections
- No Known DDC Warning Problems



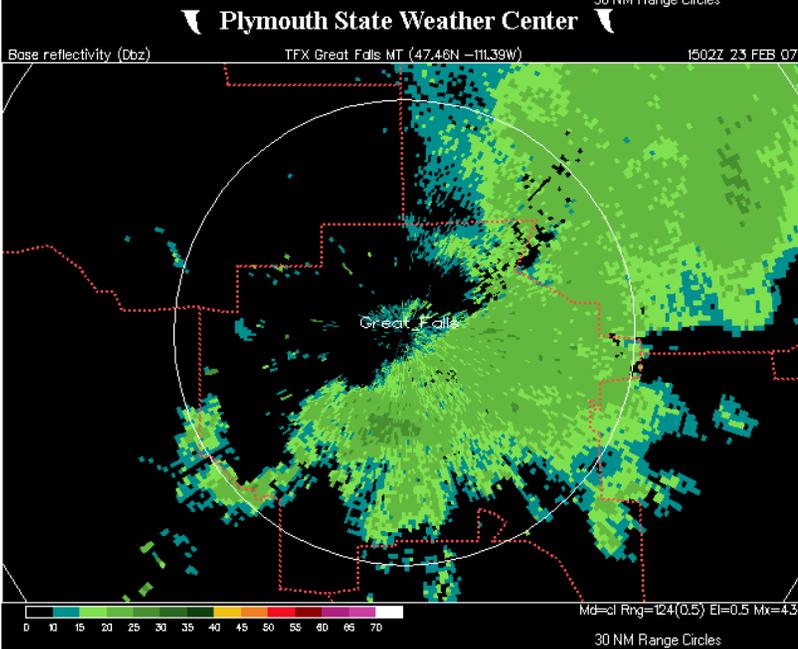
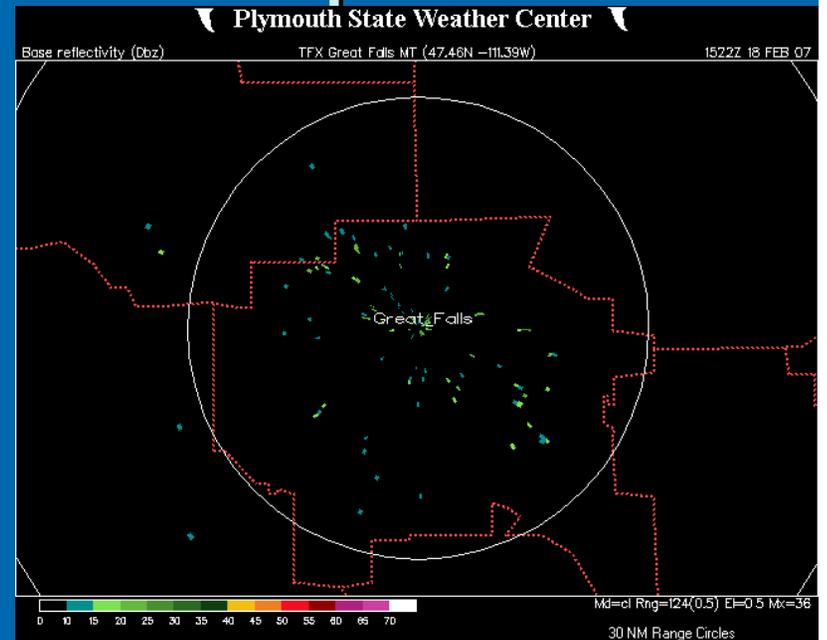
DDC Examples of Precipitation Estimation Errors



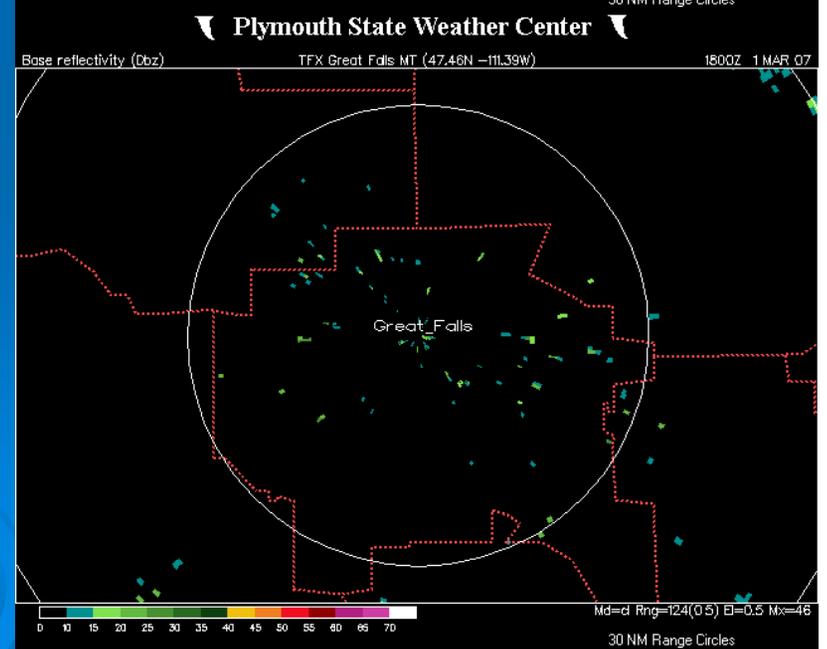
KTFX Reflectivity Examples



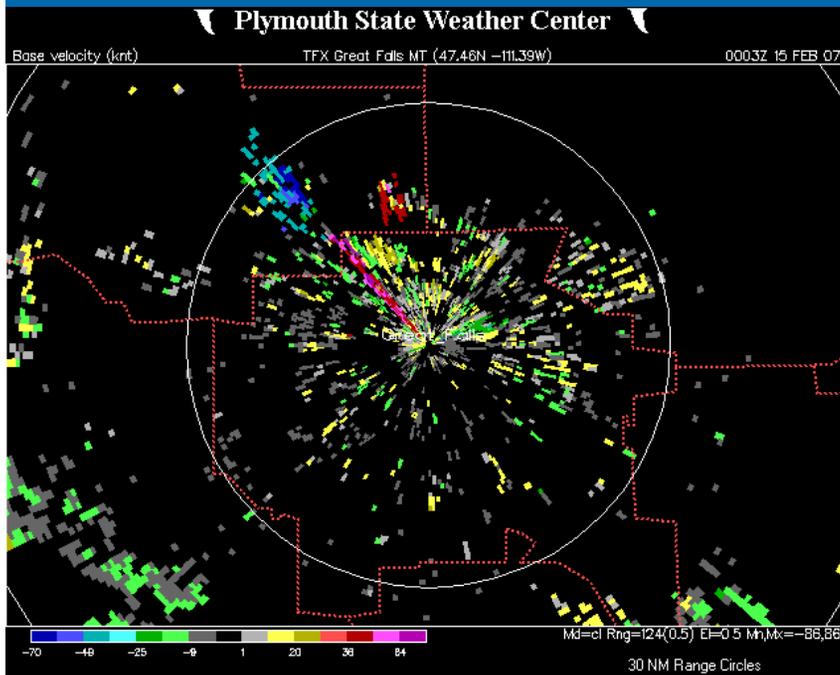
Clear Air



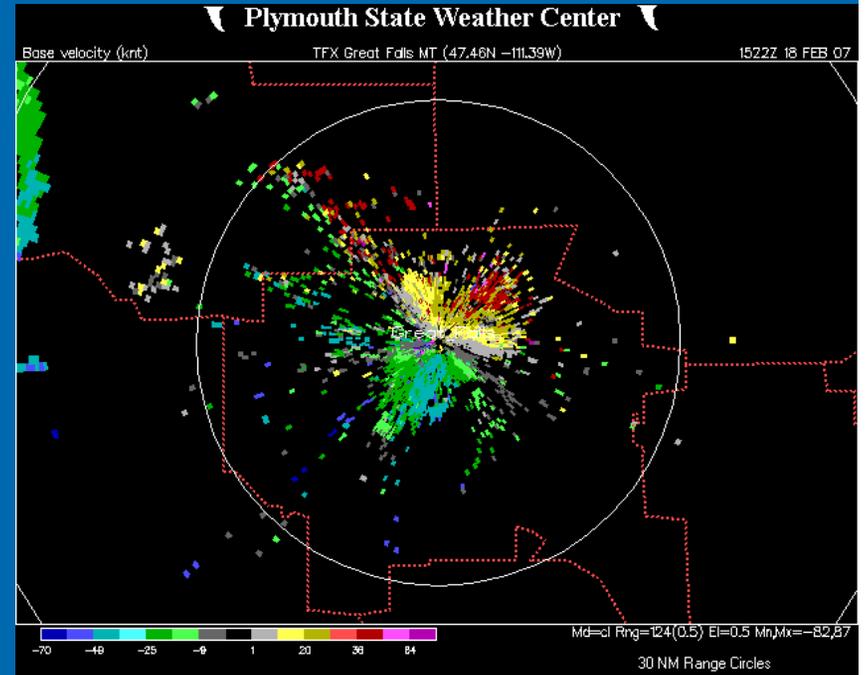
Precipitation



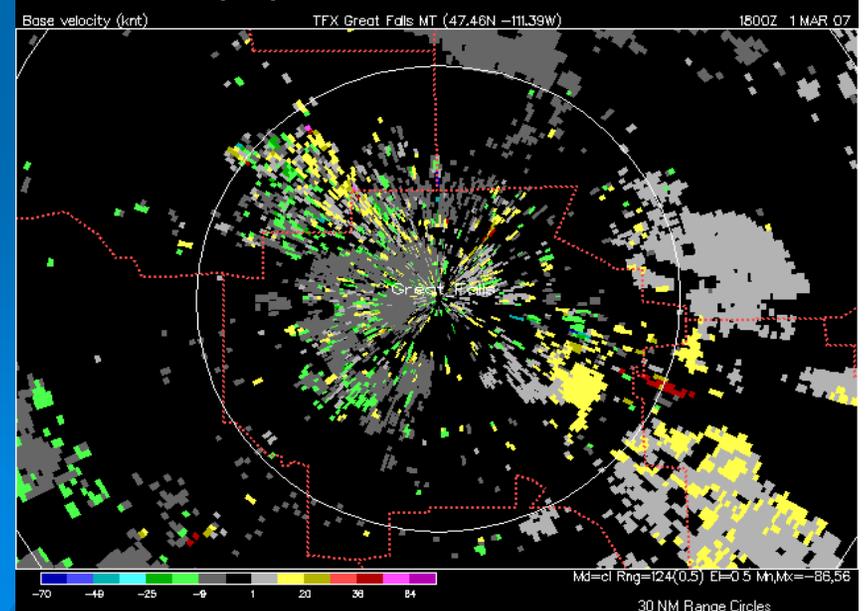
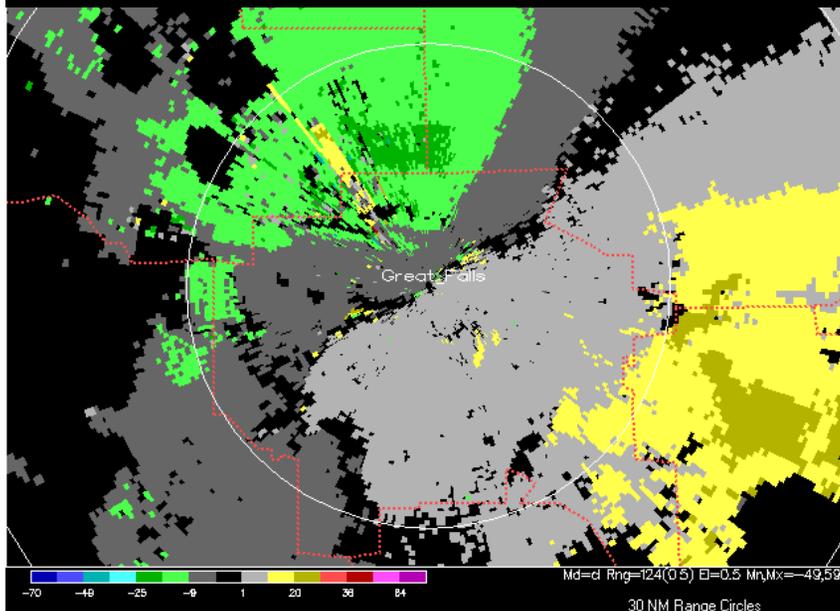
KTFX Velocity Examples



Clear Air



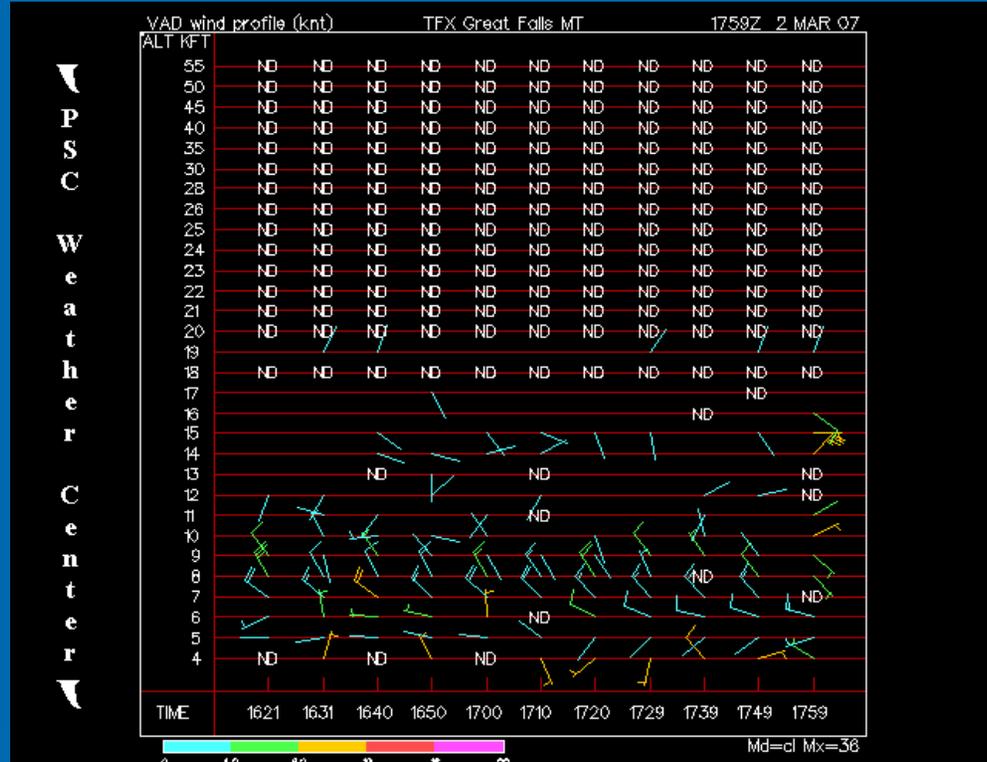
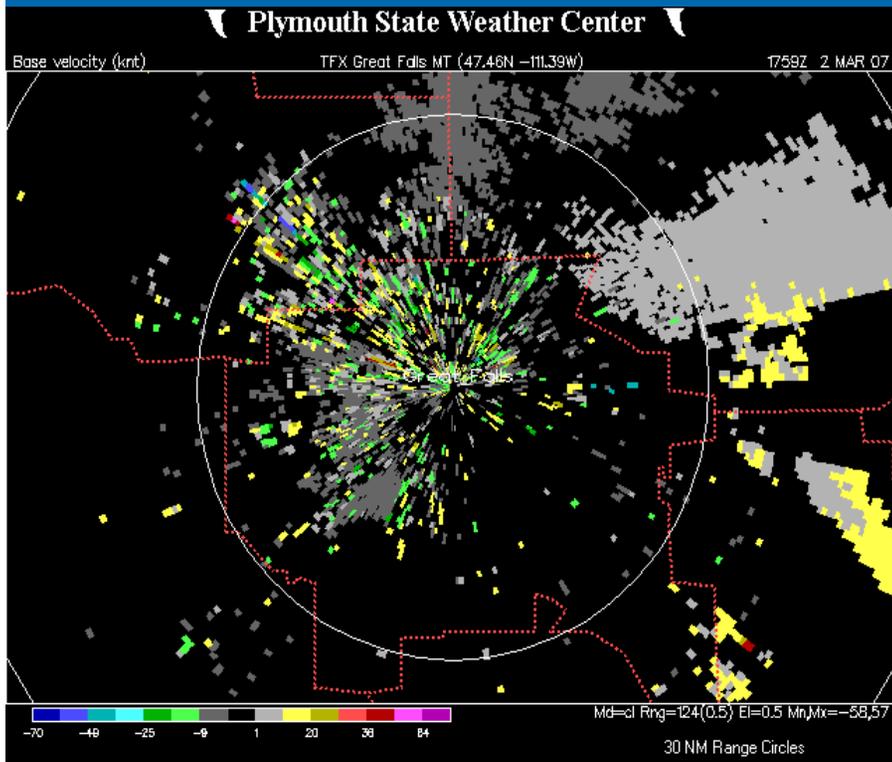
Precipitation



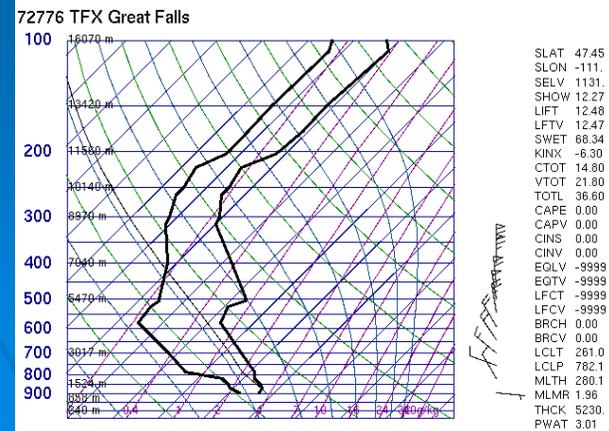
Impacts/Potential Impacts to Great Falls WFO Operations

- False Storm Identification: ?
 - Velocity Dealiasing Errors: Some Impact
 - False VAD Wind Profile: Some Impact
 - Clear-Air Boundary Detection: Some Impact
 - Severe Storm Detection: Some Impact
 - Precipitation Impact: ?
- 

KTFX VWP Example



- 2 Mar 07, 18Z
- VCP 32, Light Snow Case
- Disturbed Velocity in Several Elevation Angles
- No good Range for VAD Computation



00Z 03 Mar 2007

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Interim Summary

- Draft Report Due April 1; Final Report Due June 1
- Extend KDDC Climatology into Spring
- Examine KTFX Warm Season Cases
- Results Not Likely to Change
 - Wind Farms at Ranges <50 km (25 nm) Impact WFO Operations; Bigger Impact for Near-Range Farms; Bigger Impact for Bigger Farms
 - Biggest Impact at Dodge City WFO is Precipitation Estimation
 - Biggest Impact at Great Falls WFO is Bad Velocity Data and Poor VWP Outputs

Backup Slides



Question for the Learned Group

