

# Informing Broadcasters and the Viewing Public About Wind Farms in Weather Radar Products



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WSR-88D Radar Operations Center

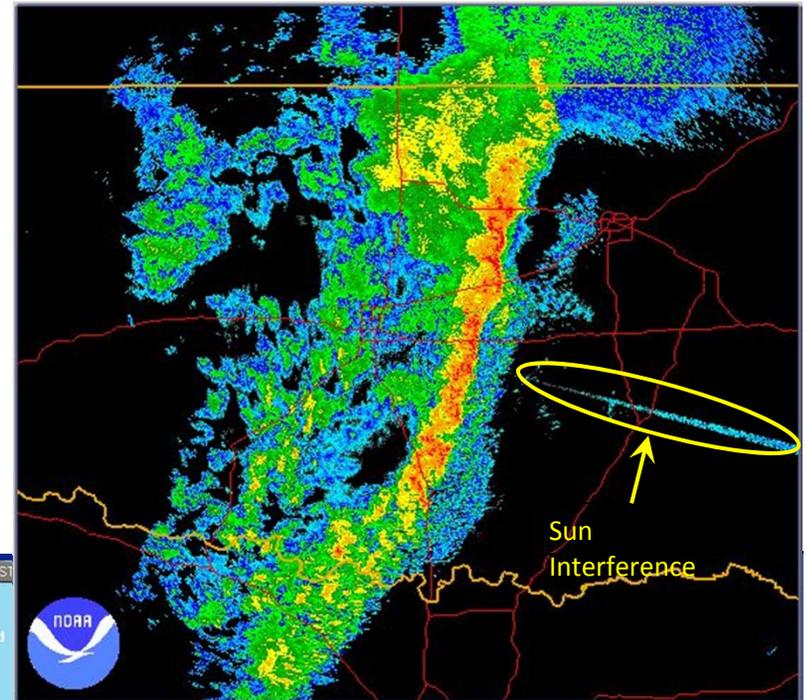
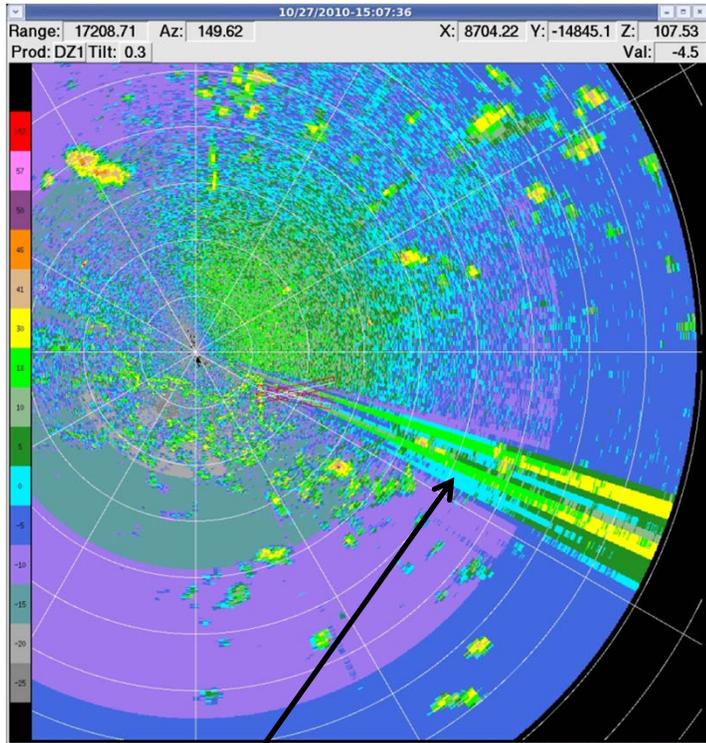
39<sup>th</sup> AMS Conference on Broadcast Meteorology  
23 June 2011



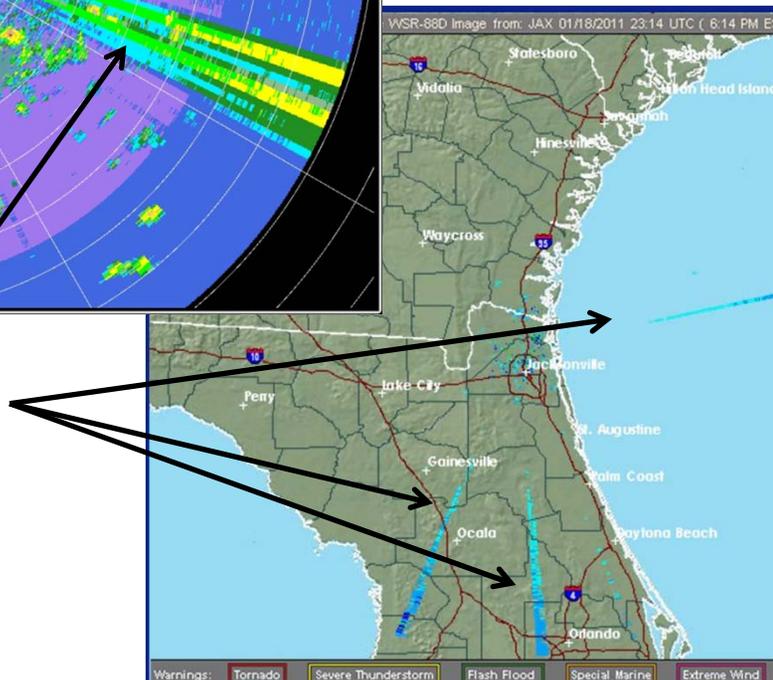
# Several Sources of Radar Interference



# Electromagnetic



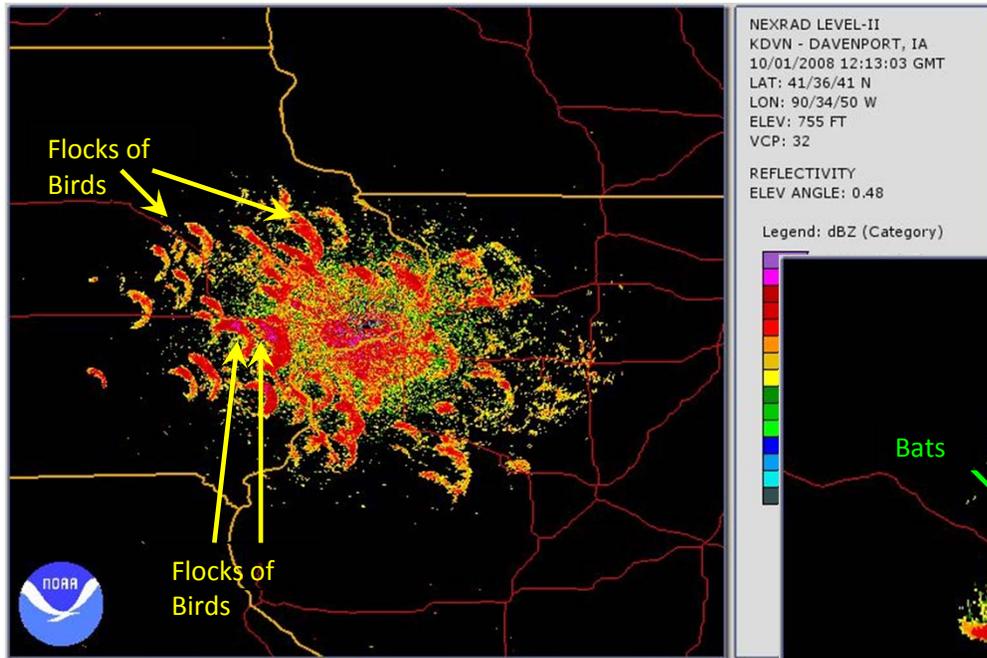
WiMax 4G  
Interference



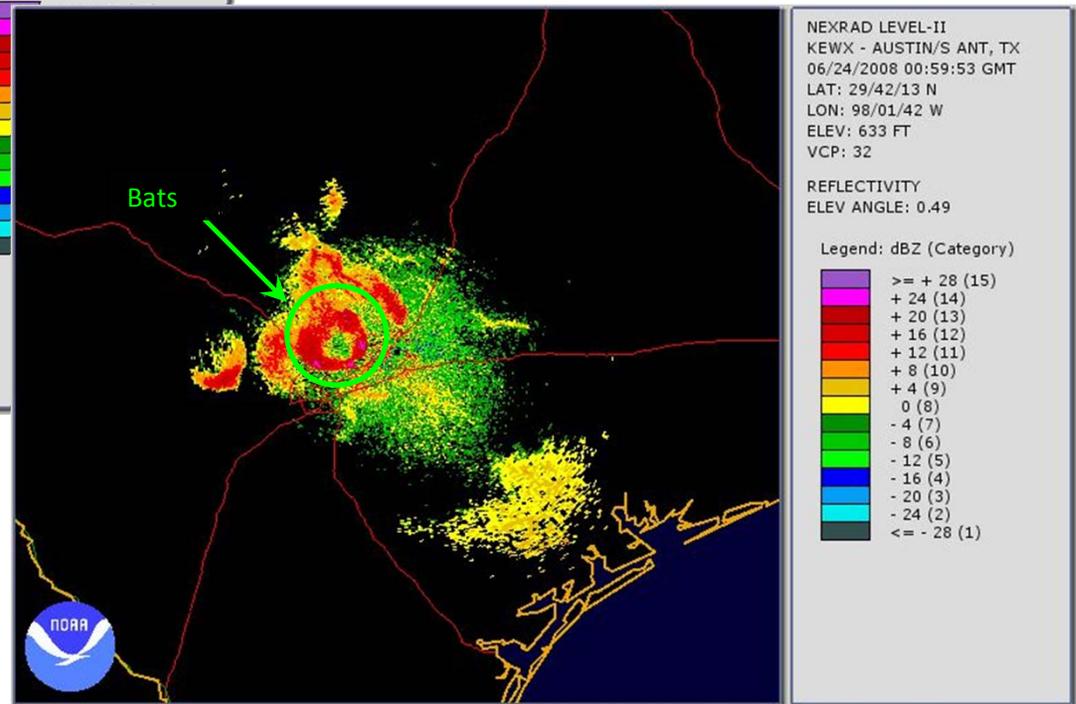


# Biological

## Bird Interference

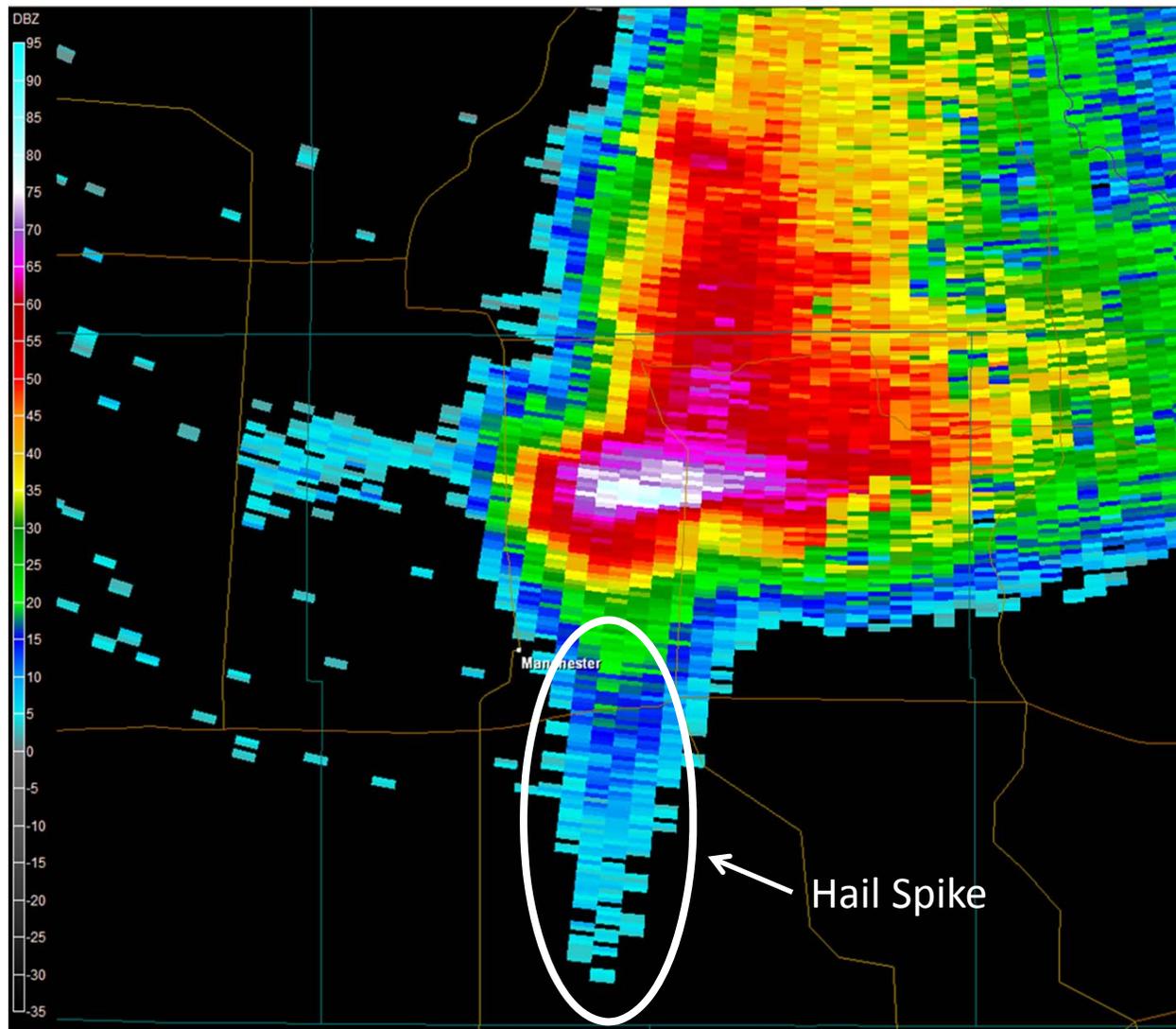


## Bat Interference





# 3-Body Scattering/Hail



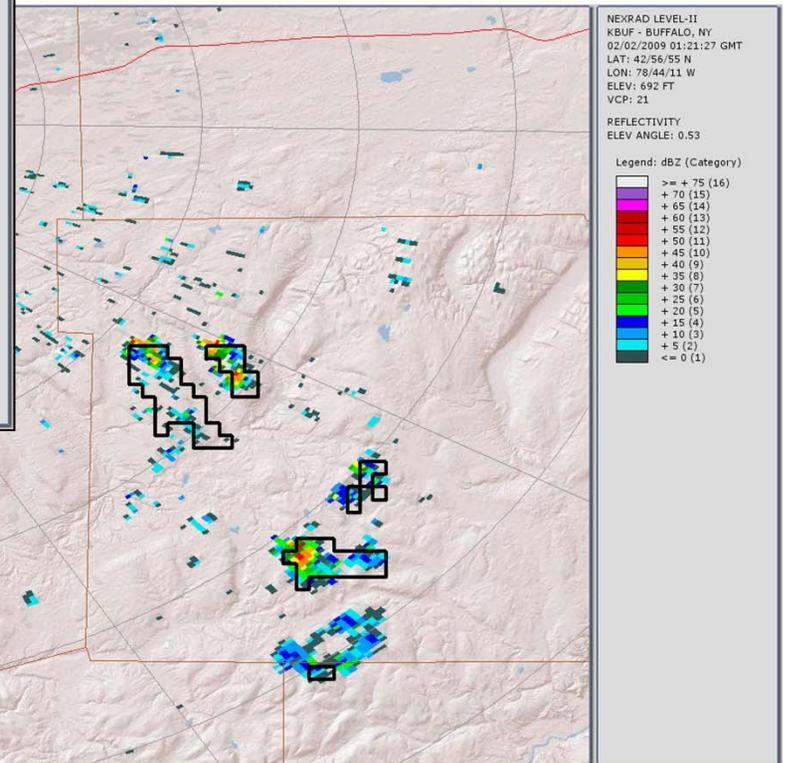
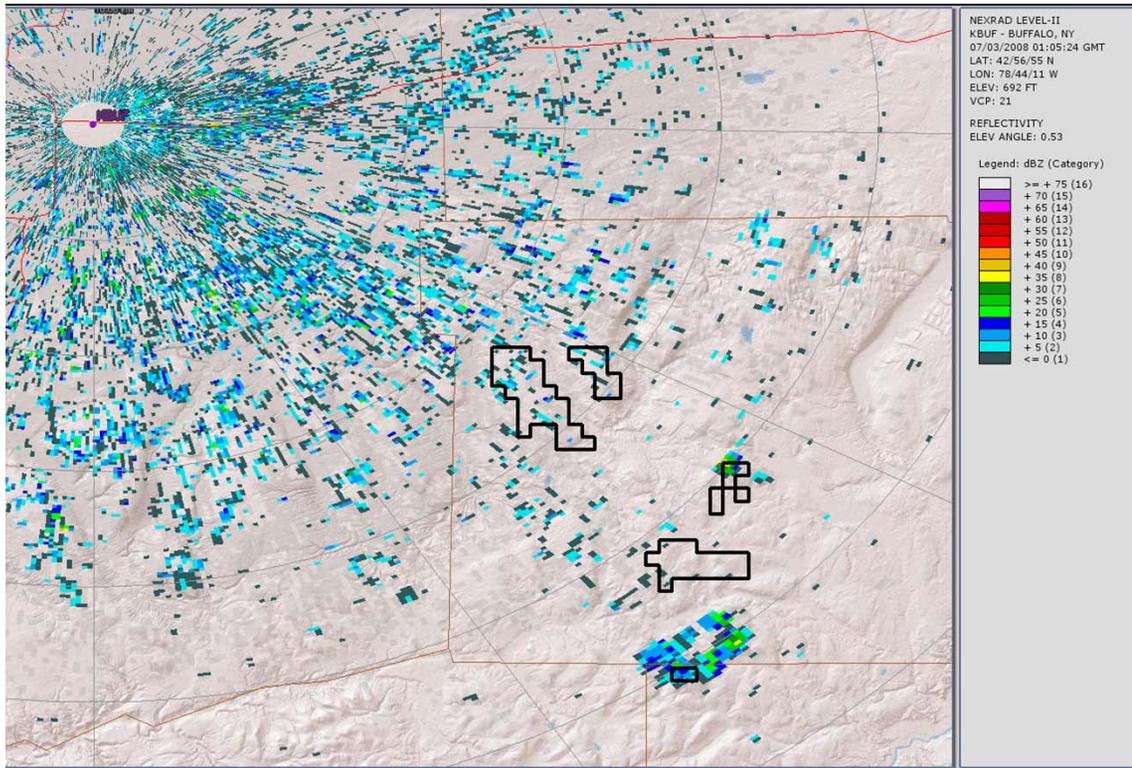


# Wind Turbine – Weather Radar Interaction

- NOAA supports wind energy generation
  - Working with DOE to improve forecasts of hub height winds
  - WSR-88D data can improve short-term wind resource forecasts
- National 2030 goal of 20% electricity by wind; ~2% now
  - Build out of wind farms in early stages
- Wind turbine clutter (WTC) can and does impact radar data
  - Radars “see” rotating turbine blades as moving targets, not stationary
    - Clutter filters designed to identify stationary targets for removal
    - Developing new filters for rotating blades not an easy task

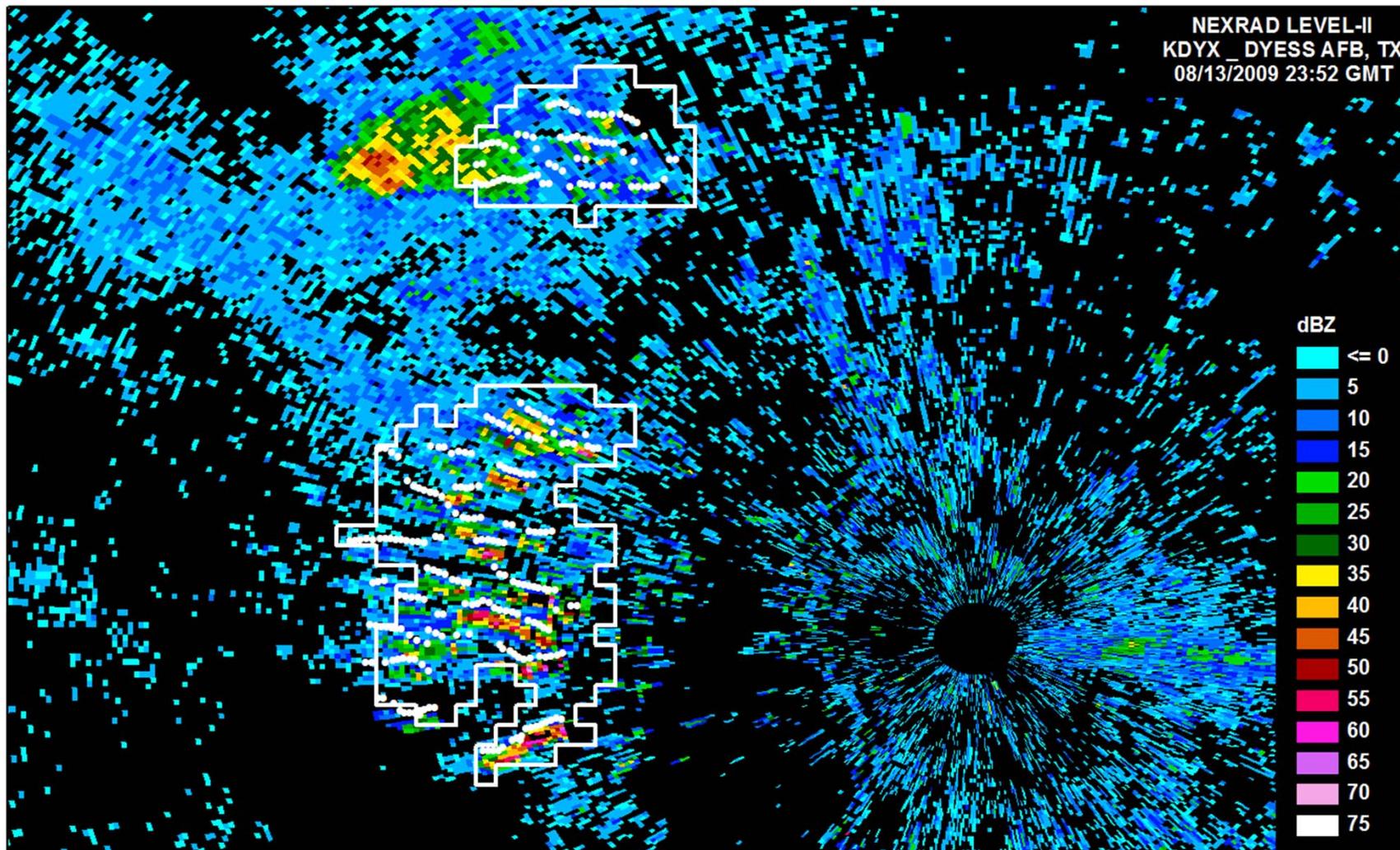


# Before and After Wind Farm Installation Reflectivity Products





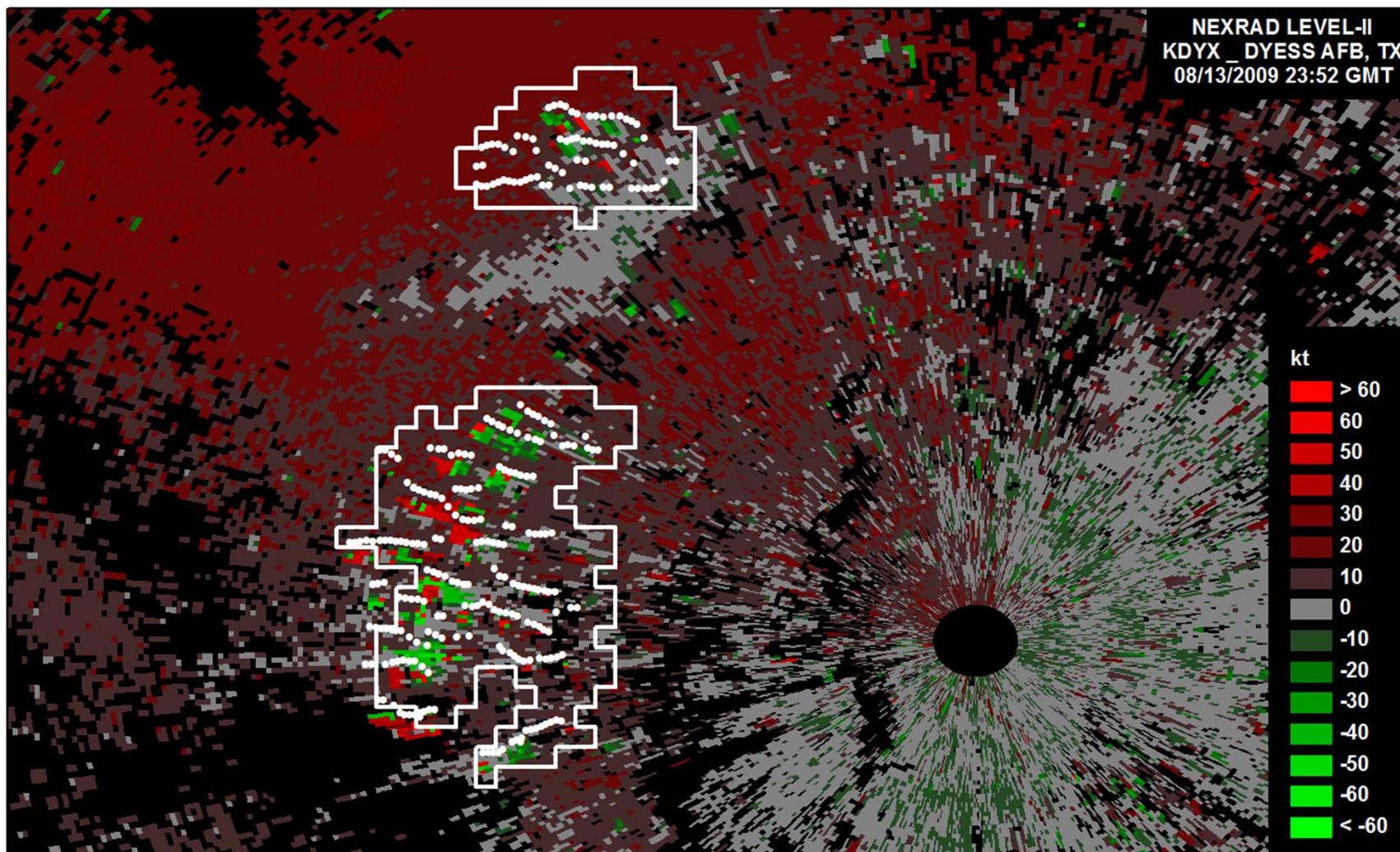
# Rotating Turbines and Weather Echoes Reflectivity





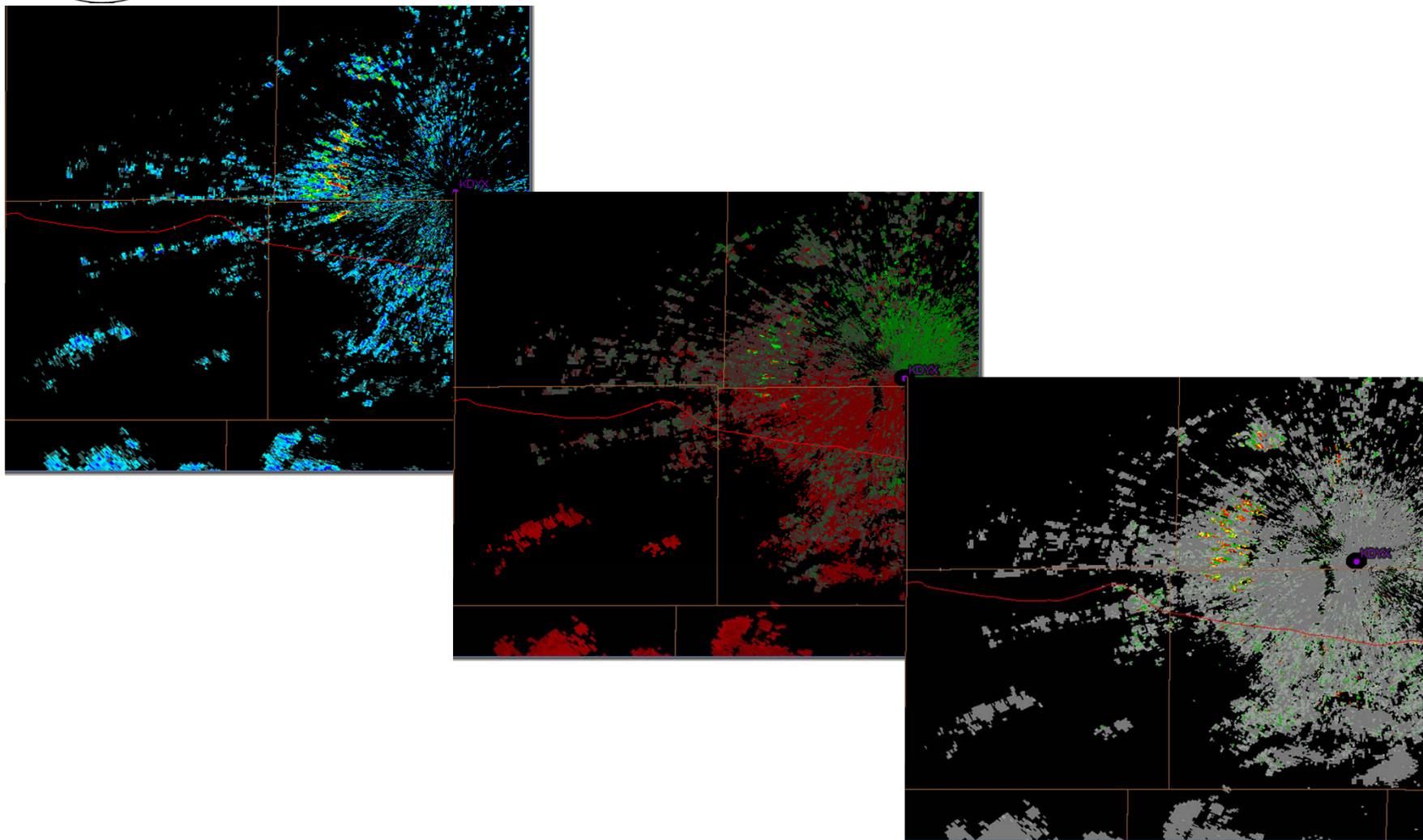
# Rotating Turbines and Weather Echoes

## Radial Velocity





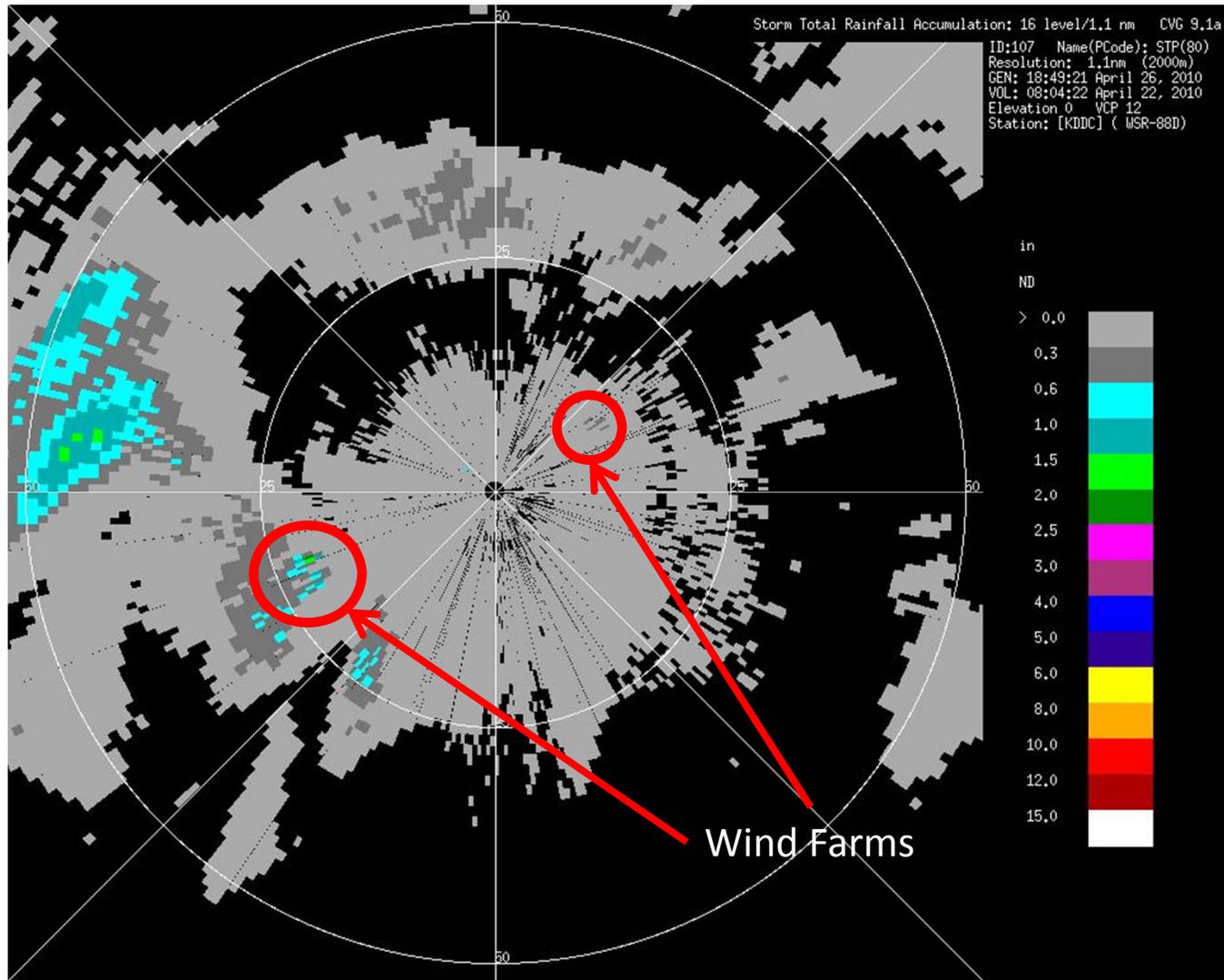
# Multi-path/Multi-Trip Echoes





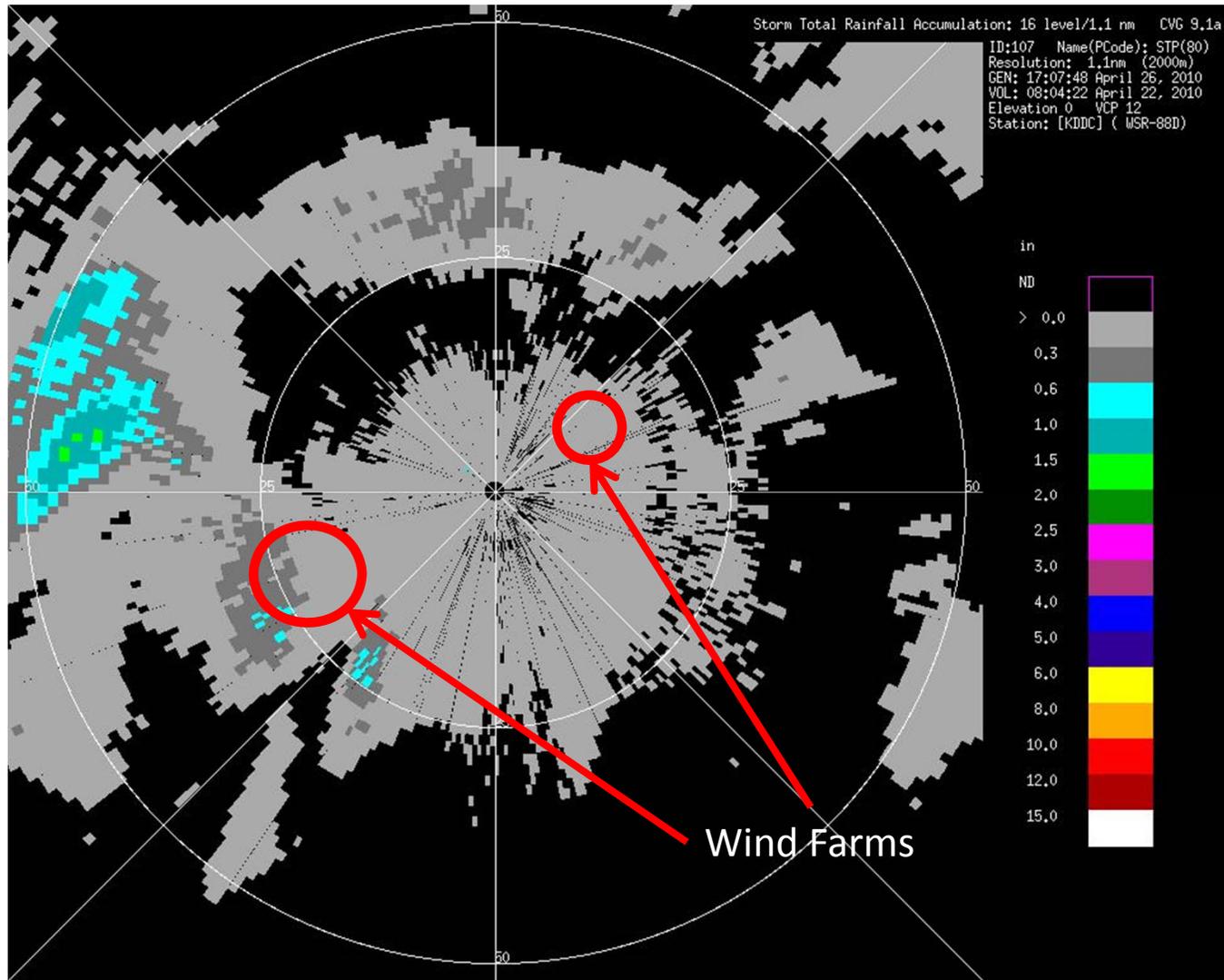
# WSR-88D Algorithms/Products Can Be Impacted

# Storm Total Precipitation 7/24/2008



- Without an exclusion zone over wind farm.

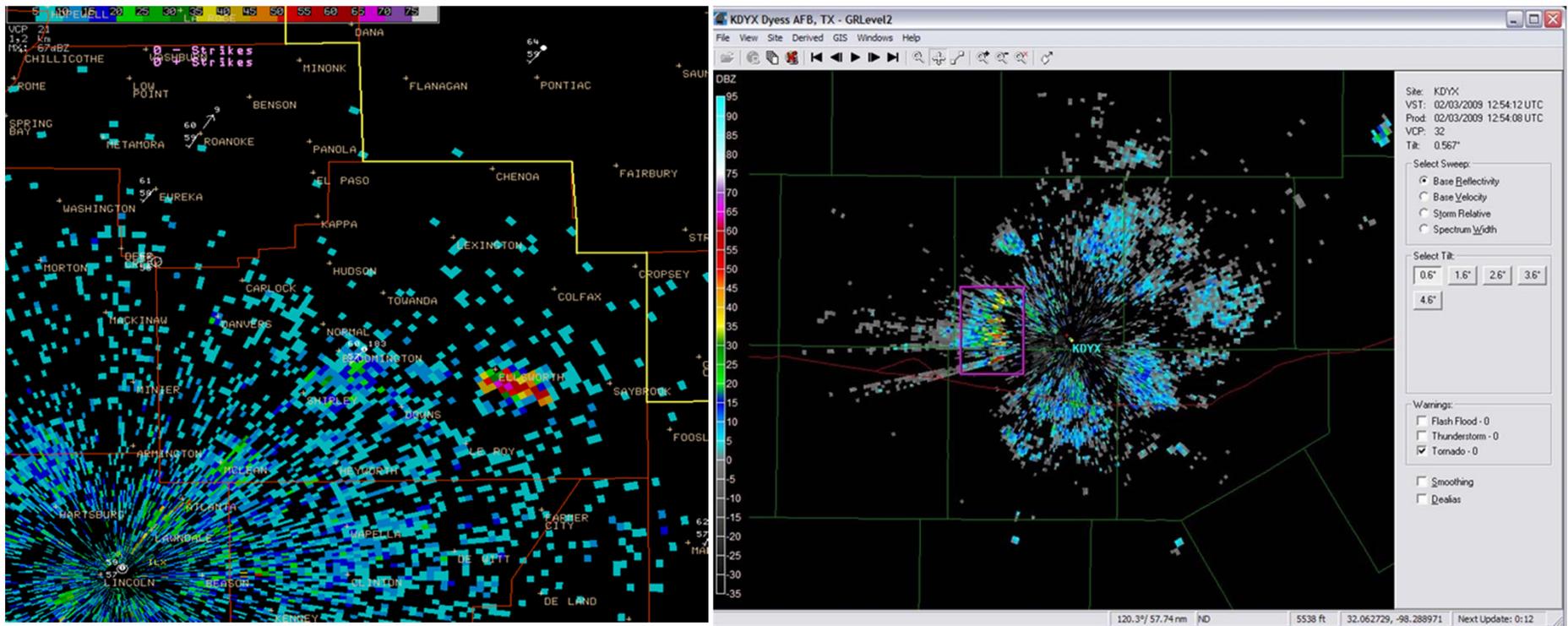
# Storm Total Precipitation 7/24/2008



- With an exclusion zone over wind farm.



# Not All Wind Farm Impacts Are the Same





# Wind Turbine – Weather Radar Interaction

- Types of Interaction
  - Wind Turbine Clutter (WTC) not visible in data
  - WTC visible in data
    - No significant impact on WFO operations
    - Could impact users not as well trained
  - WTC close enough to impact WFO severe weather warning operations
  - Turbines close enough to impact radar operation
    - Radar energy reflected back to receiver too strong
- Nearly all interactions have not impacted WFO operations
  - Impact potential increases with decreasing distance between turbines – radar



# Estimate of Wind Turbine Impacts on Warning Operations with Distance

## Impacts up to 3 km

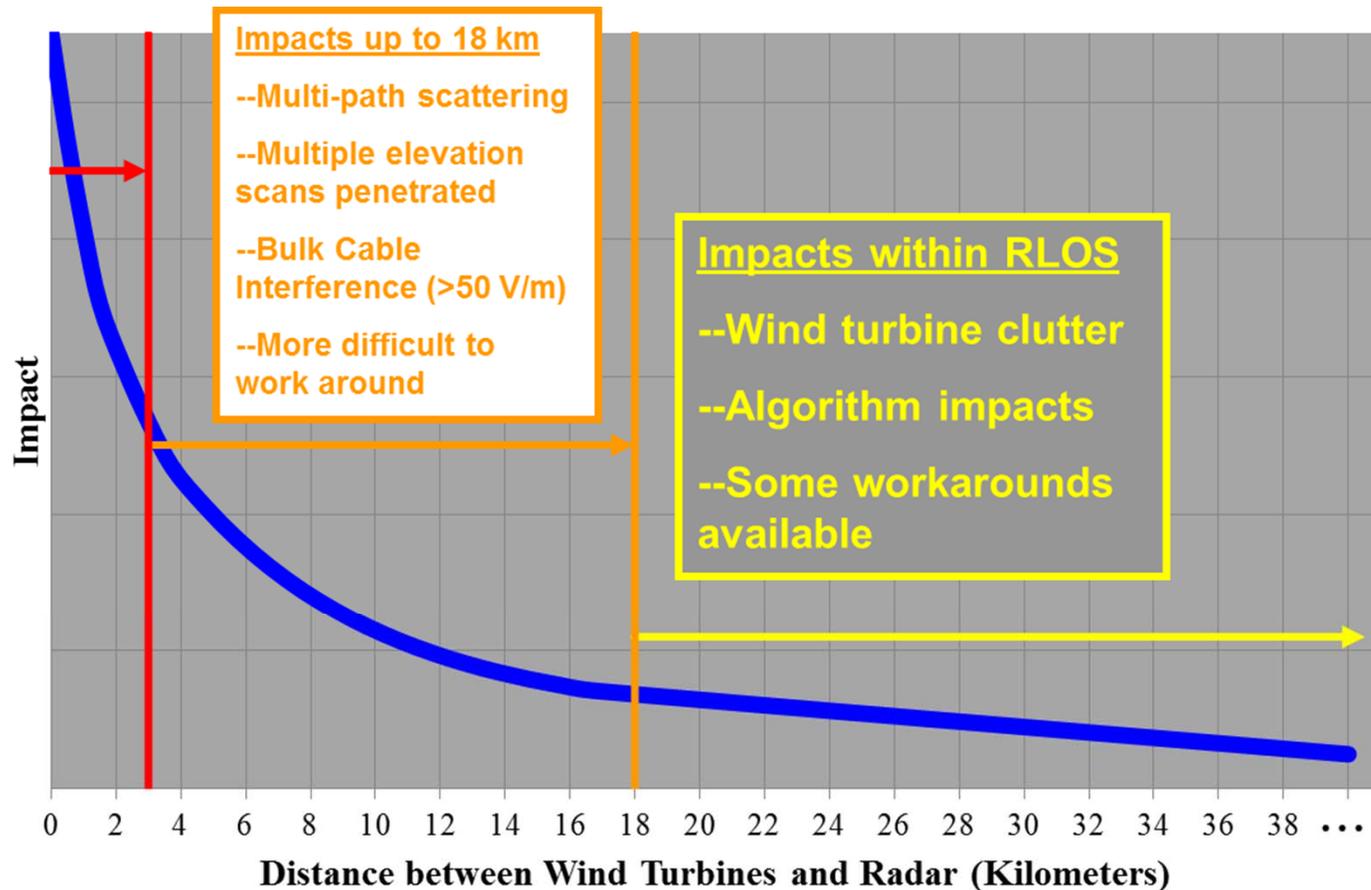
- Receiver Damage (if >53 dBm returned)
- Nacelles can block beam (within 3 km)
- Blades can block beam (within 1 km)
- Personnel Safety (within 200 meters)
- Limited or no forecaster workarounds

## Impacts up to 18 km

- Multi-path scattering
- Multiple elevation scans penetrated
- Bulk Cable Interference (>50 V/m)
- More difficult to work around

## Impacts within RLOS

- Wind turbine clutter
- Algorithm impacts
- Some workarounds available





# Wind Turbine – Weather Radar Interaction Mitigation Actions

- Outreach to wind energy industry
  - Inform of radar locations and types of interaction
  - Open dialog for voluntary consultations
  - Provide case-by-case analysis of potential impacts
- Education
  - “Work arounds” for forecasters and data users
  - “Wind Farms, the WSR-88D and Coexistence” training module: <http://www.wdtb.noaa.gov/>
  - AMS and AWEA presentations and conference papers
  - “Wind Farm Interaction section” on ROC web site: <http://www.roc.noaa.gov/WSR88D/>
- Studies
  - University of Oklahoma’s Atmospheric Radar Research Center
  - ROC continues to evaluate WTC impacts on weather radars and improve analysis tools
- Collaboration
  - Wind energy industry
  - Other federal agencies operating radars (e.g., DHS-funded Wind Turbine/Radar Modeling Tool)

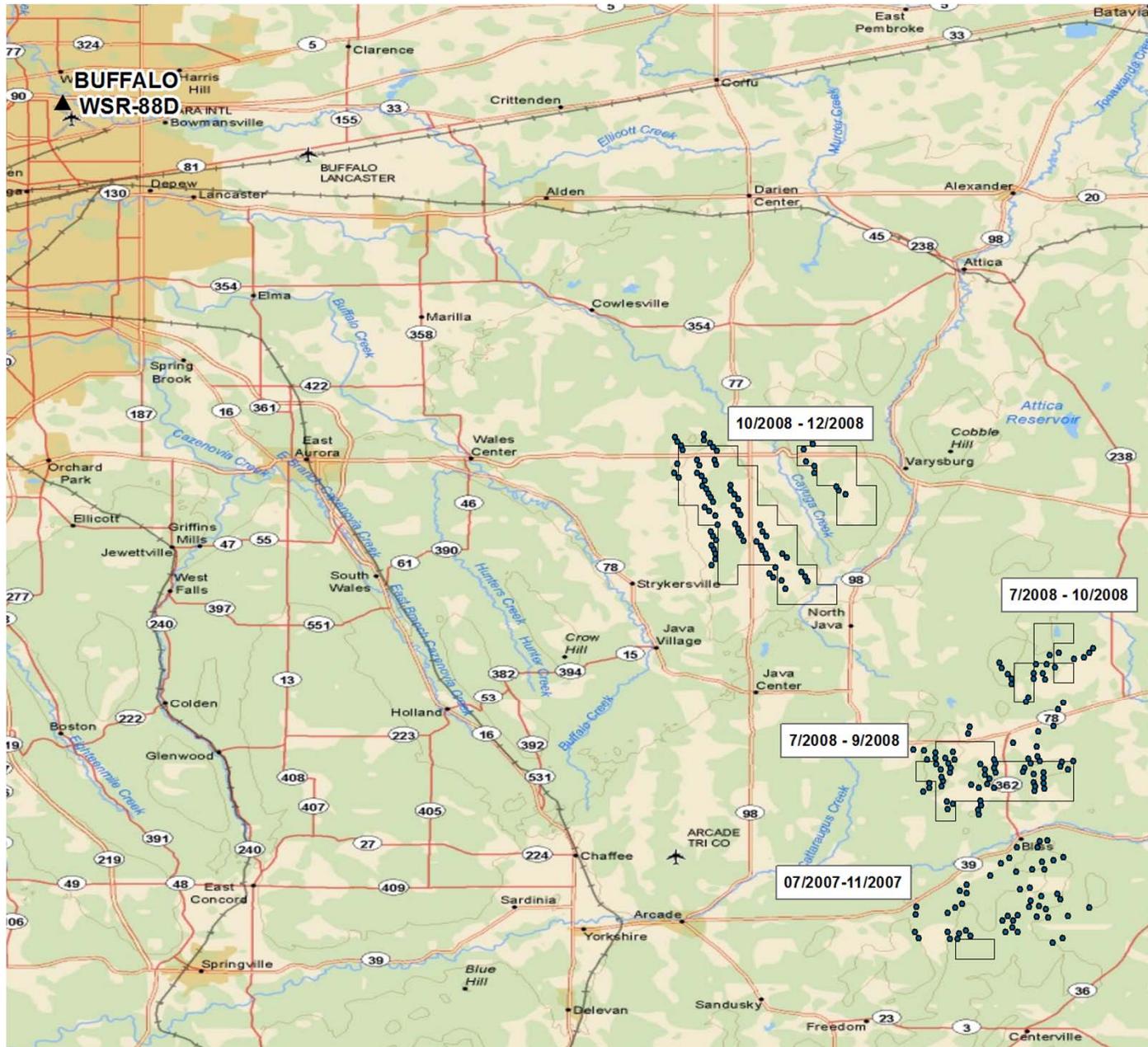


# Summary

- NWS working with wind energy industry to avoid situations where wind turbines could impact weather warning operations
- NWS working to educate wind energy industry, NEXRAD agency data users, and the public on wind turbine – radar interaction
- No known technical solution for eliminating wind turbine clutter impacts on algorithms and users
  
- Visit our website:  
<http://www.roc.noaa.gov/WSR88D/>
- Contact us at:  
[wind.energy.matters@noaa.gov](mailto:wind.energy.matters@noaa.gov)



# Backup Slides



2011 AMS Broadcasters Conference