

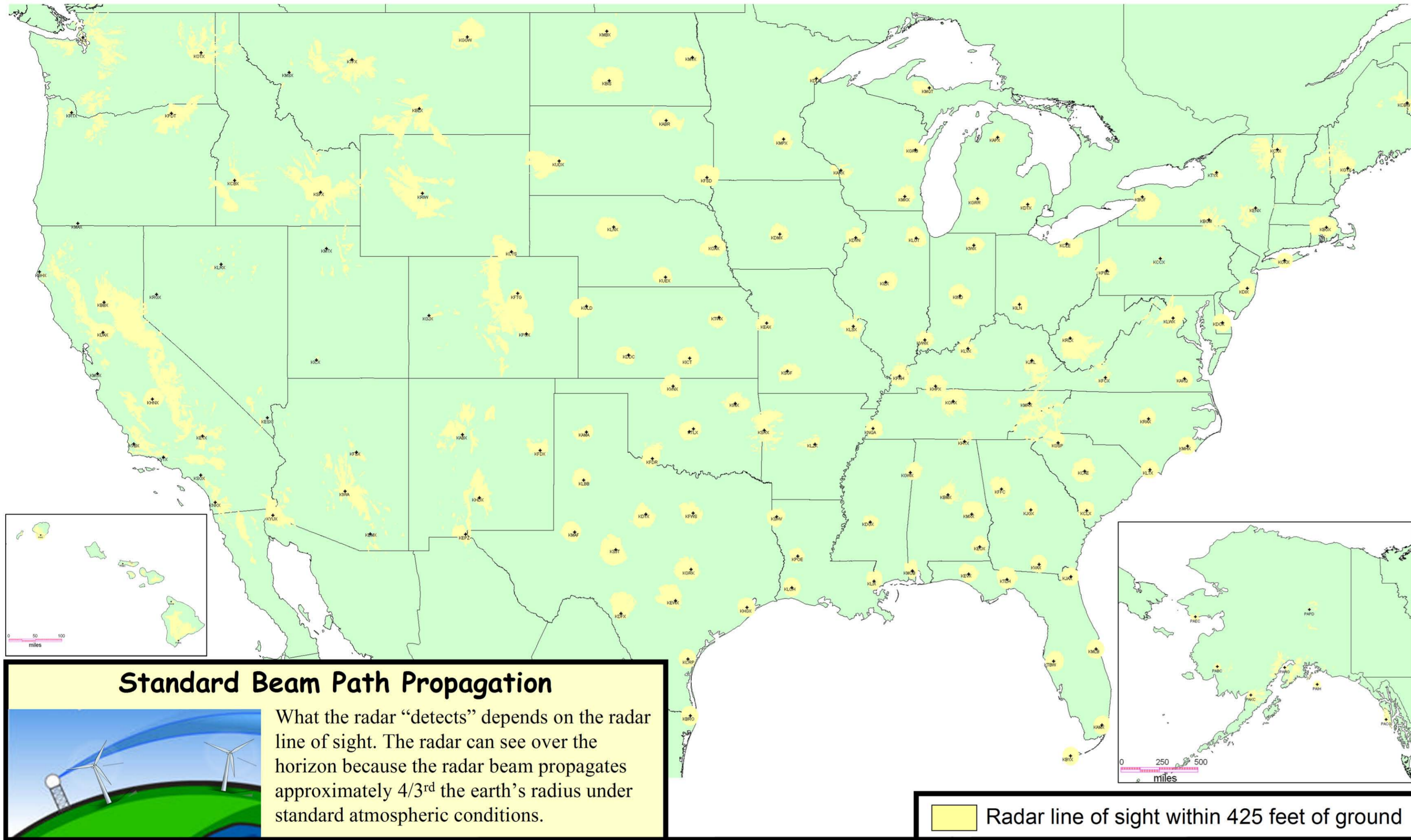


# WEATHER RADARS AND WIND FARMS WORKING TOGETHER FOR MUTUAL BENEFIT

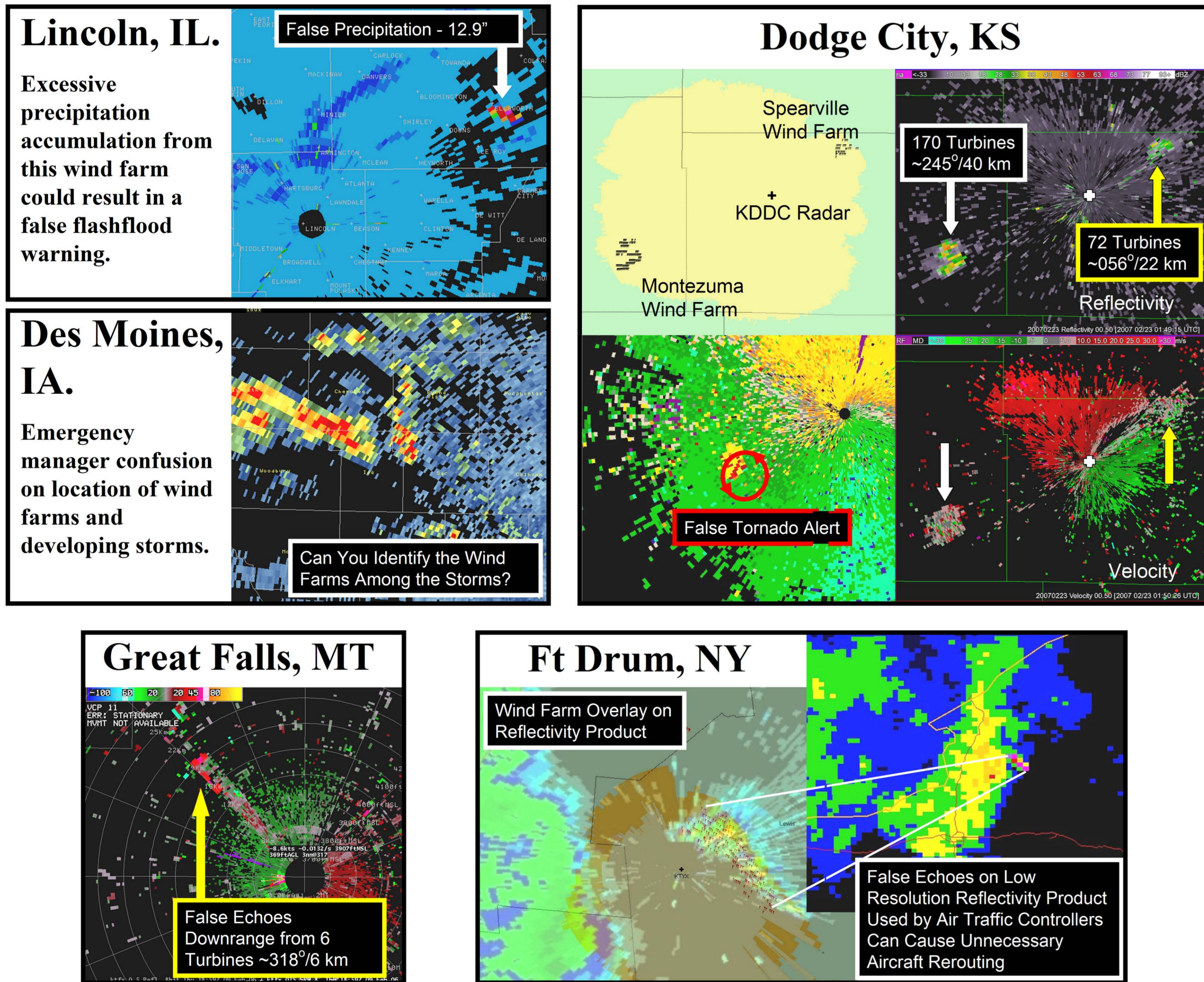


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## NEXRAD WEATHER RADAR LOCATIONS



## EXAMPLES OF WIND FARM IMPACTS ON WEATHER RADARS AND USERS



## HOW WIND FARMS CAN IMPACT WEATHER RADARS

- **Potential Impacts on NEXRAD Data**
  - Spinning turbine blades inhibit radar's ability to filter turbine echoes and turbine clutter
  - Turbines can look like storms or severe weather on radar
  - Turbines can cause partial beam blockage, shadow effects, false echoes downrange
- **Effects on NEXRAD Products Near Wind Farms**
  - False and anomalously large precipitation estimates
  - Incorrect wind speed estimates
  - Missed/delayed tornado and thunderstorm detections or false alarms
  - False and anomalously large reflectivity estimates
  - False storm identification and incorrect storm track forecasts
- **Potential Impacts on Weather Forecasts and Warnings for**
  - Tornadoes
  - Flash Floods
  - Winter Storms
  - Air Traffic Control and Routing

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<http://arrc.ou.edu/turbine>

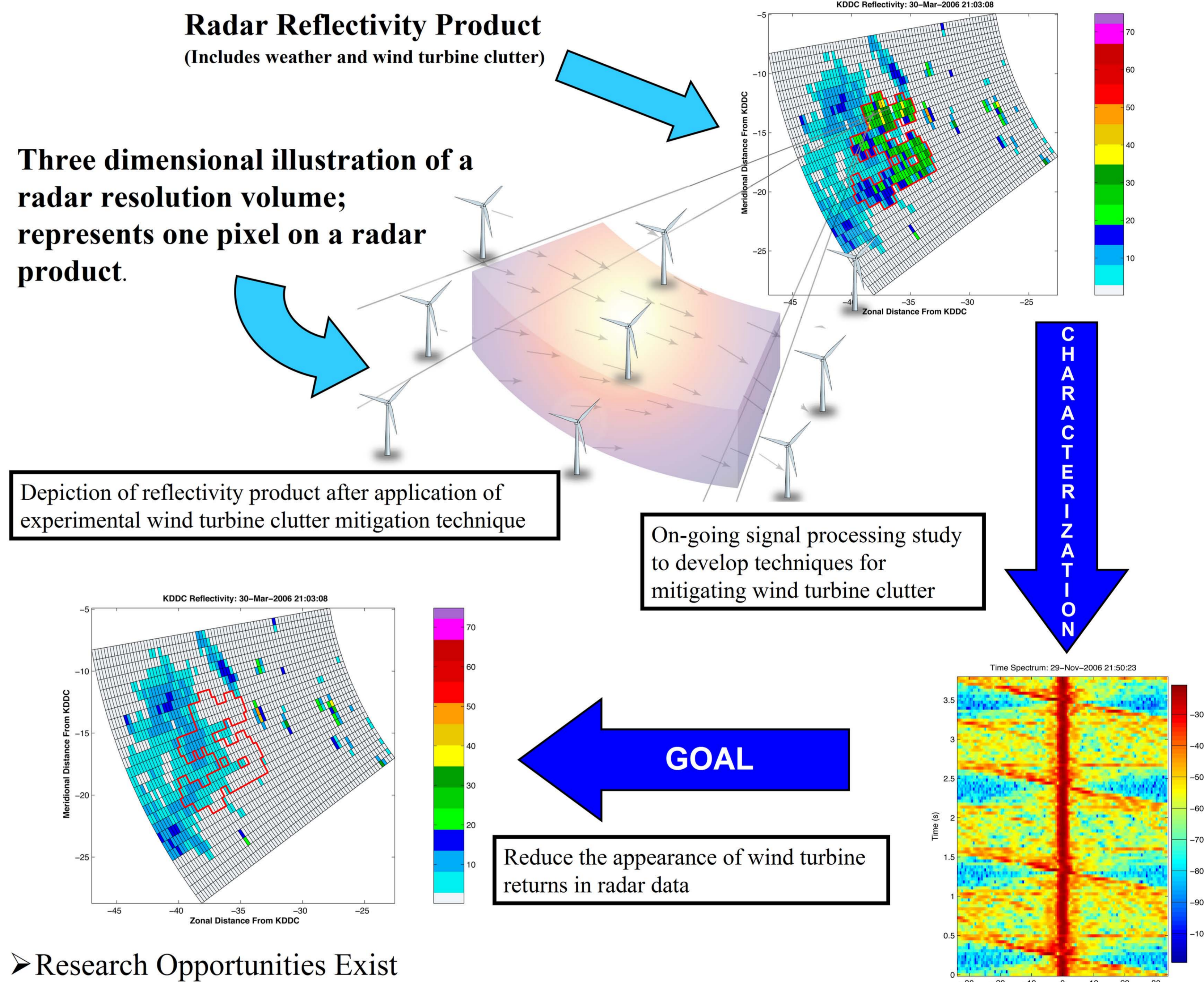
## NEXRAD NETWORK

- Operated by Federal Departments of Commerce, Transportation, and Defense
- Data available worldwide and used by government meteorologists, emergency managers, television broadcasters, private industry, researchers, and the public
- Data from network utilized to issue tornado/severe weather/flashflood warnings, weather forecasts, and hydrological forecasts which protect citizens, reduce property damage, and improve air traffic efficiency and safety
- Independent scientific analysis verified the use of NEXRAD data has reduced expected tornado fatalities by 45% and expected injuries by 40%

## NEXRAD COMPARED TO AIR SURVEILLANCE RADAR (ASR)

- **Many techniques used to mitigate effects of wind turbine clutter on the ASR are not applicable to the NEXRAD**
- Targets of interest are significantly different; Distributed vs. Point Targets
  - Weather (Distributed): rain, snow, hail, particulates (diffuse, weak); many different Doppler velocities (e.g., turbulence, wind shear)
  - Aircraft (Point): hard, very reflective; more distinct Doppler velocity
- NEXRAD designed with greater sensitivity (lower noise floor) than ASR systems; signals are processed differently resulting in different clutter solutions

## CURRENT MITIGATION STUDIES



- Research Opportunities Exist
  - Advanced signal processing methods using NEXRAD and phased array radars
  - Laboratory experiments hold promise for turbine-feedback based filtering
- Several effects of wind turbine clutter on NEXRAD will be difficult if not impossible to eliminate (e.g., shadowing, multipath scatter)
- See poster *Wind Turbine Clutter Characterization and Mitigation on Federal Weather Radars (NEXRAD)* for additional details

## SUMMARY

- NEXRAD enables timely, accurate life-saving forecasts and warnings, as well as safe and efficient air transportation
- Wind farm interference can result in spurious echoes which are difficult to mitigate, reduce radar algorithm performance, and confuse radar users
- Our studies are revealing more about wind farm impacts on weather radars and possible mitigation techniques
- We want to work with the wind energy industry on siting decisions to ensure mutual success of our National roles
  - Best mitigation is to keep wind turbines *outside the radar line of sight*
  - Recommend developers coordinate with the National Telecommunications Information Administration (NTIA) early in the siting process
- We have successfully worked with some developers to mitigate impacts to both turbines and radars