

Update of Wind Turbine Clutter Study at the University of Oklahoma

Bob Palmer and Brad Isom

School of Meteorology / School of Electrical & Computer Engineering



<http://arcc.ou.edu/>

NEXRAD PMC Meeting, April, 2007



Outline

- KDDC Level-I Experiment, June 2006
- Simple 3D Interpolation Results
- KTFX Level-I Experiment, Nov 2006
 - ▶ Doppler Spectra from Wind Turbine Clutter (WTC)
 - ▶ Examples of *Multi-Trip* and *Three-Body Scatter* from WTC Verified by Doppler Spectra

Gray County Wind Farm

Near KDDC



- Located 25 miles SW of Dodge City, Kansas
- 170 towers
- Height of Tower: 217 feet (66m)
- Length of Blades: 77 feet (23.5m)
- RPM: 28.5
- Tip Velocity: 70.14 ms^{-1}



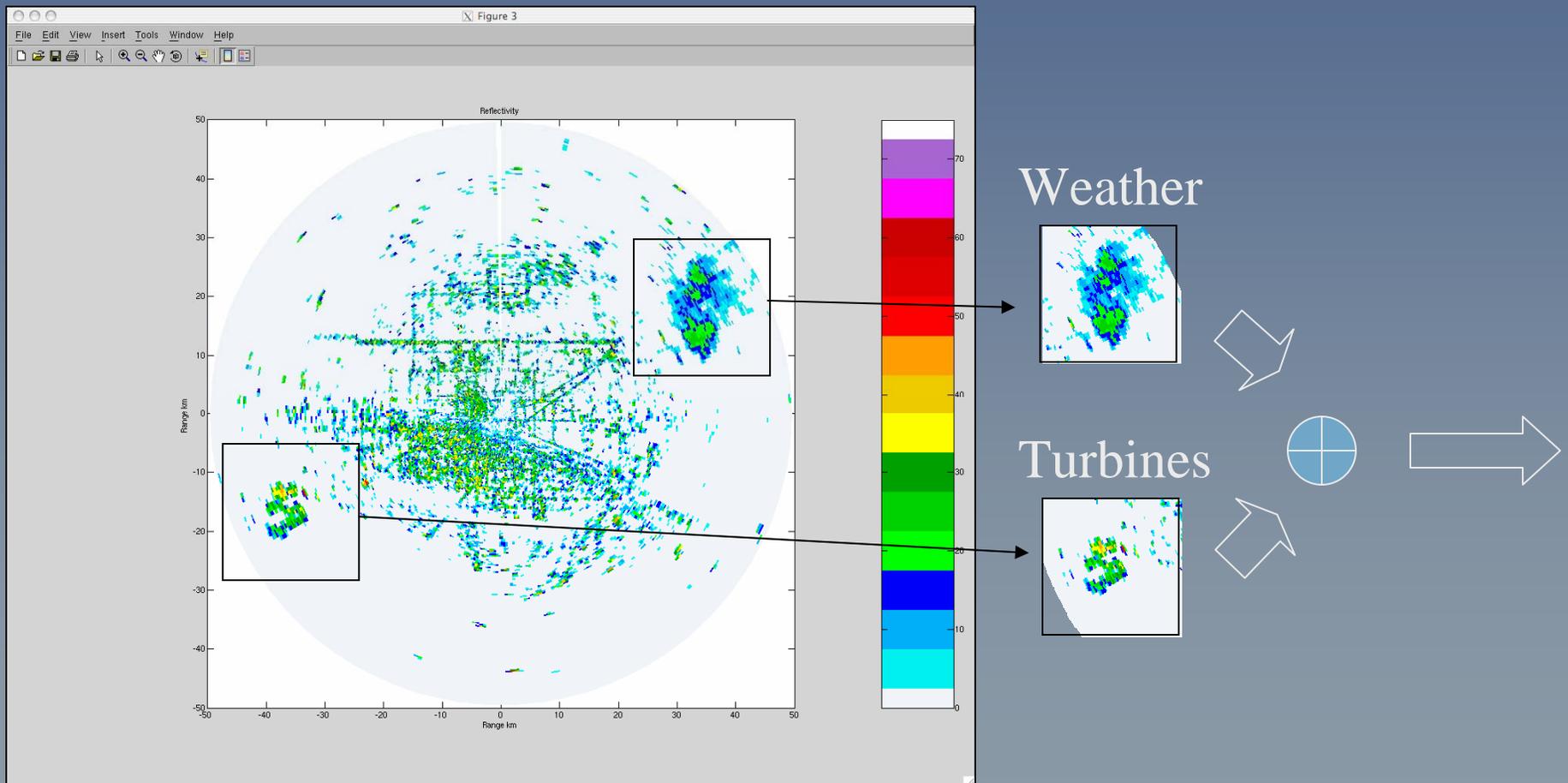
Level-II Radar Loop

Dodge City, Kansas (KDDC), June 17, 2006

QuickTime™ and a
Cinepak decompressor
are needed to see this picture.

KDDC VCP 21 Scanning Data

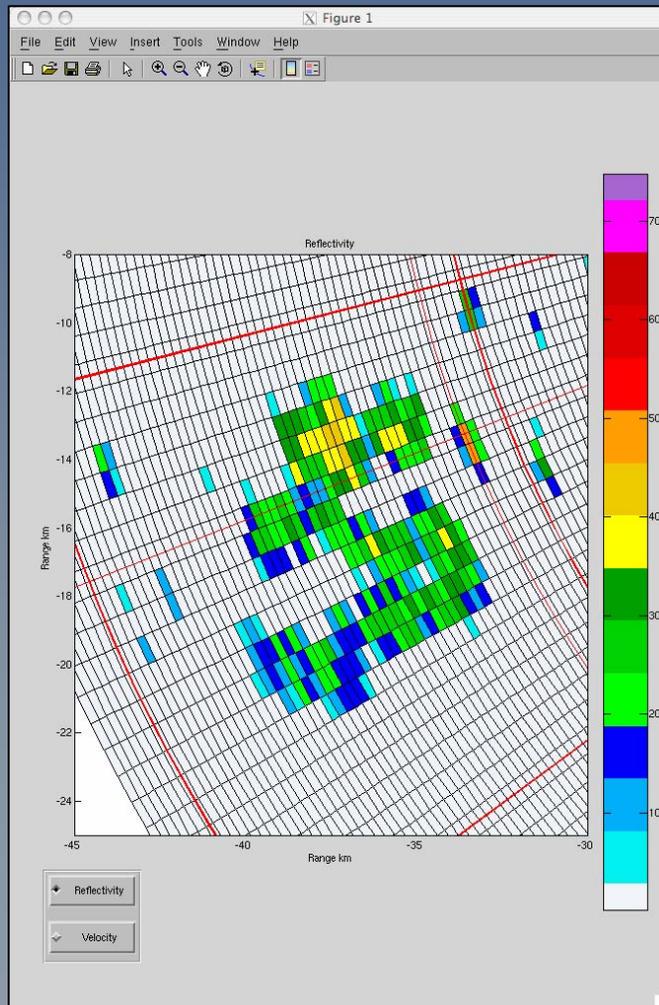
Mixed Wx and WTC, March 31, 2006



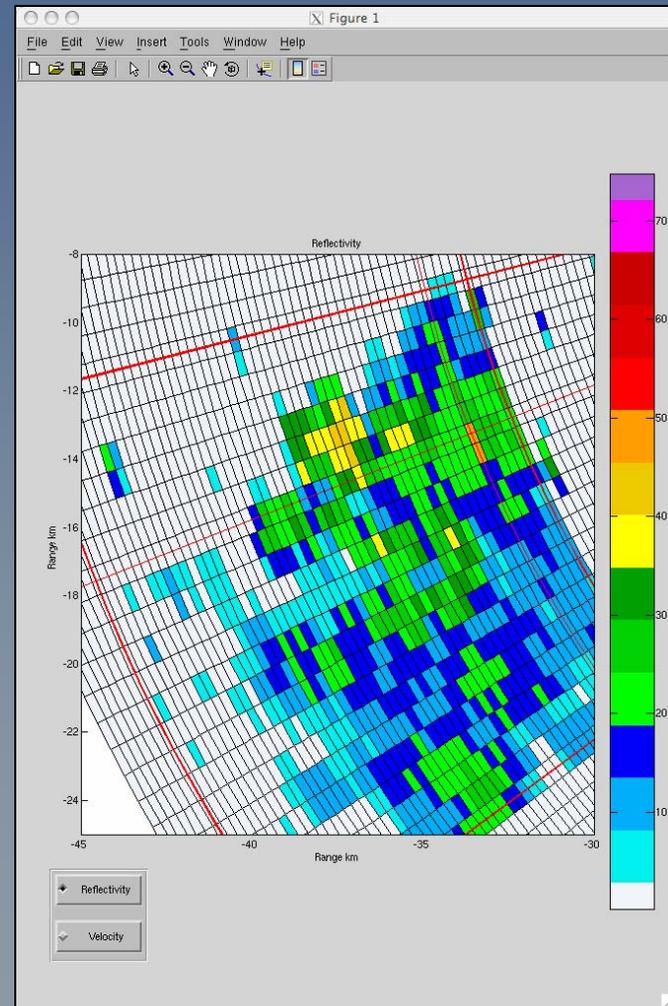
Given Level-I data, it is possible combine the Wx and WTC signals

KDDC VCP 21 Scanning Data

Wx/WTC Interaction



WTC Only



WTC and Wx

Outline

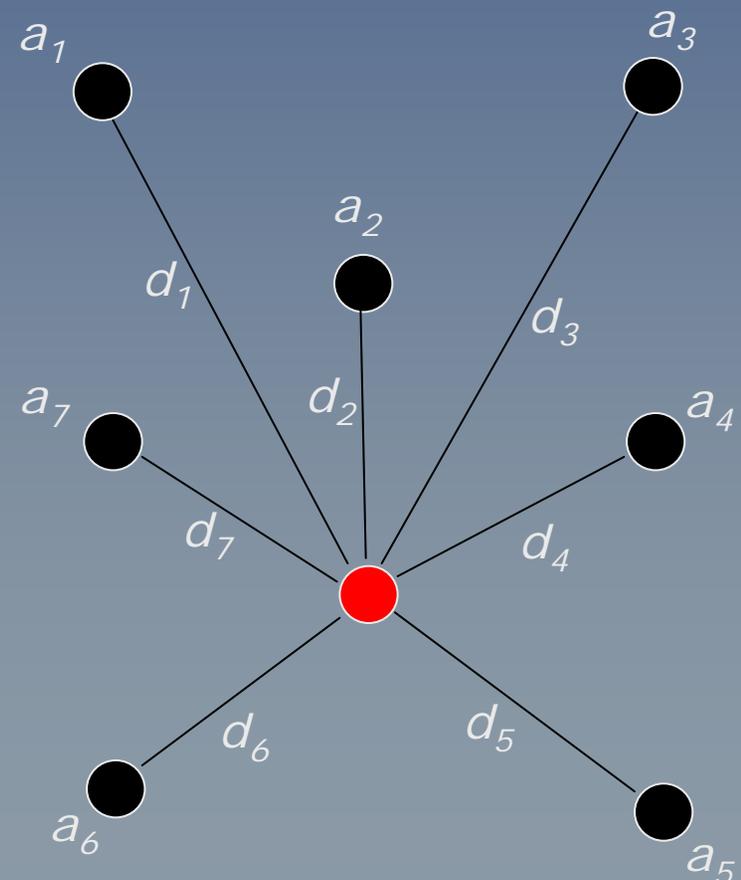
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Level-II Interpolation Method

- Global Interpolation using a Radial Basis Function, weights are determined by the distance between the points
- Use the “multiquadric” method developed by Roland Hardy, 1971
- Approximate desired function F at location x by a function S

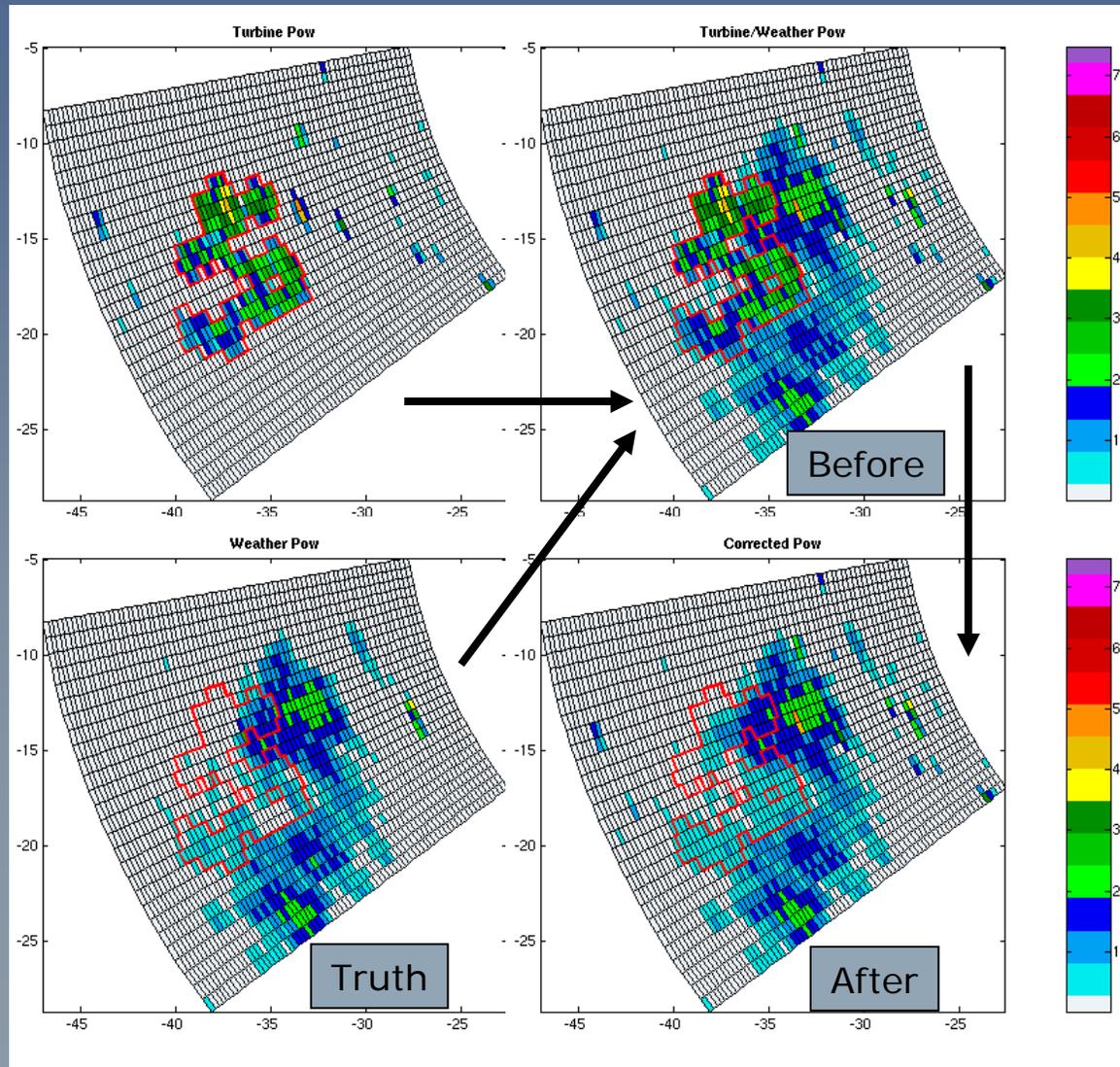
$$S(x) = \sum_{i=1}^N a_i \Phi(\|x - x_i\|)$$

$$\Phi(d) = (d^2 + c^2)^{\frac{1}{2}}$$



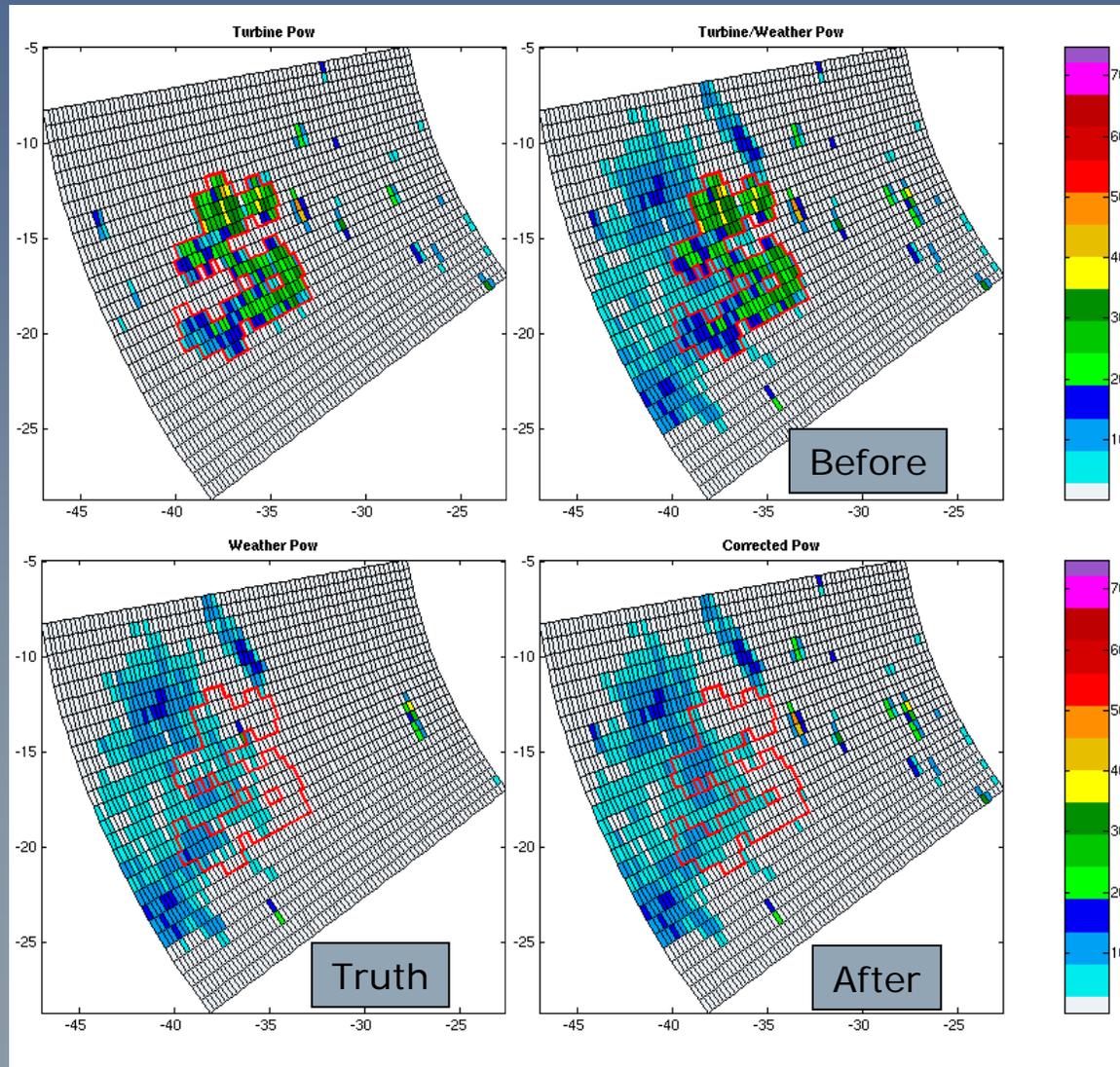
Level-II Interpolation Results

KDDC, 3D Interpolation Reflectivity



Level-II Interpolation Results

KDDC, 3D Interpolation Reflectivity



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47.5039 -111.4387 47.5061 -111.4392
47.5012 -111.4380
47.4992 -111.4376
47.4953 -111.4367 47.4973 -111.4371

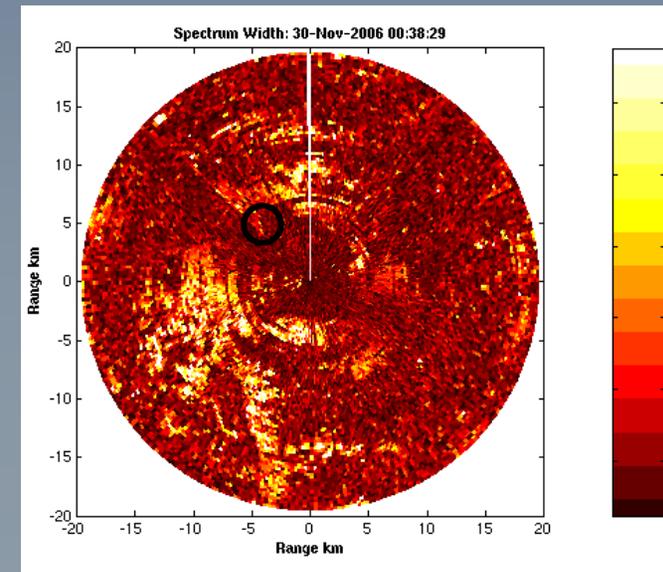
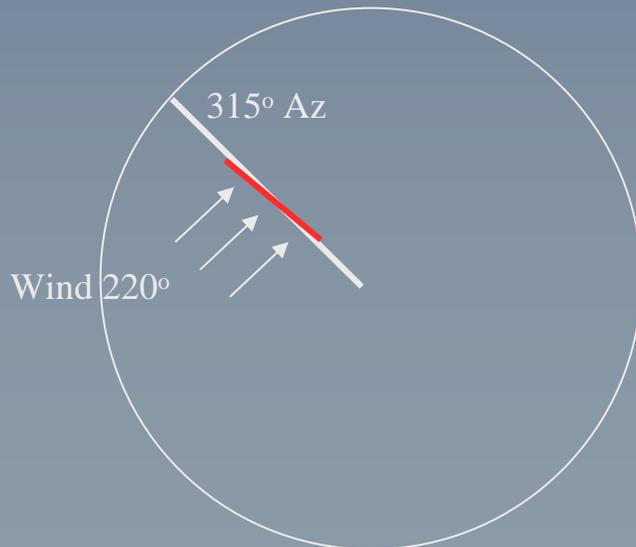
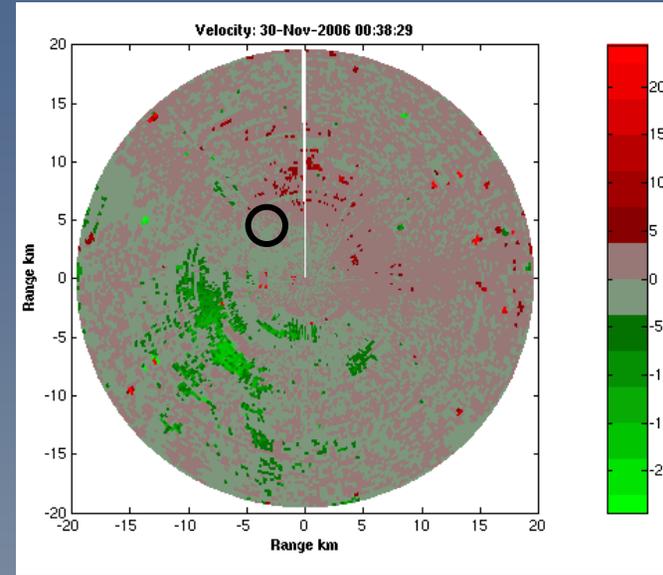
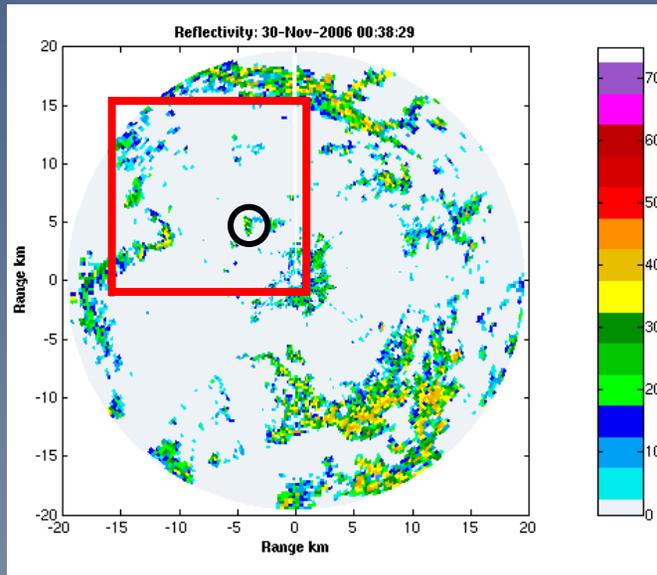
47.4597 -111.3853

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t
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47.501
47.501
47.49
W
Patterson, CA

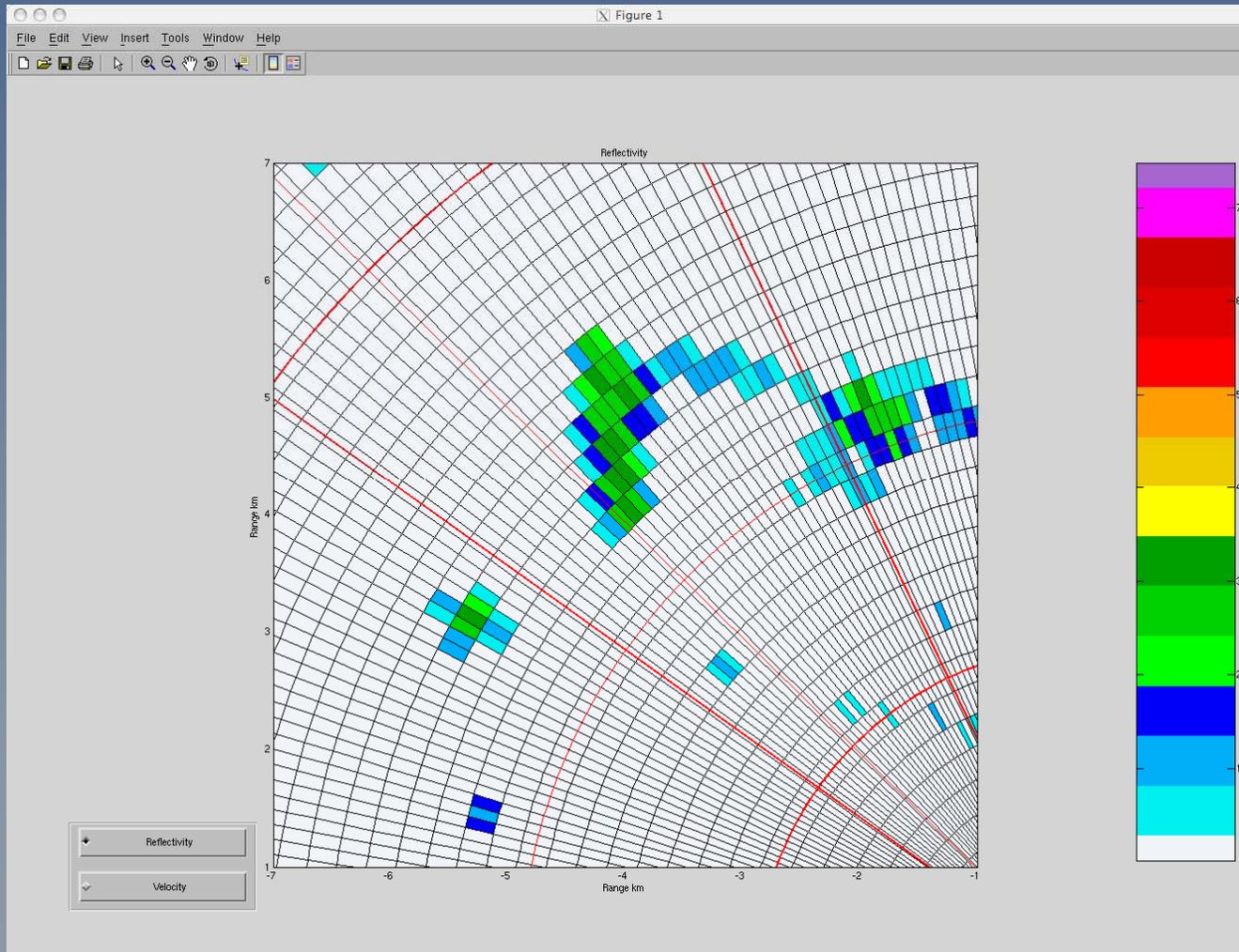
KTFX Level-II Example

November 30, 2006



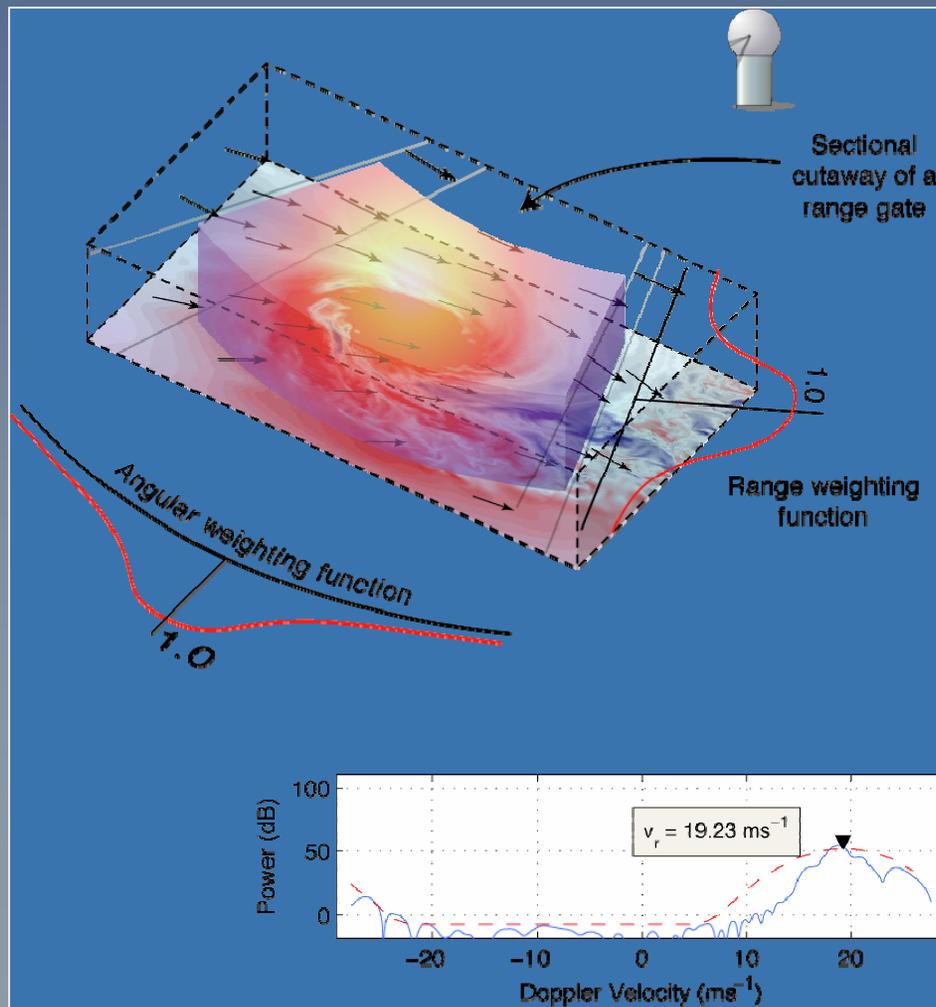
KTFX VCP 21 Scanning Data

WTC During Clear-Air



The Doppler Spectrum

Unraveling radial velocities



The Doppler spectrum is a power-weighted distribution of radial velocities within the resolution volume

Examples of unique velocity distributions:

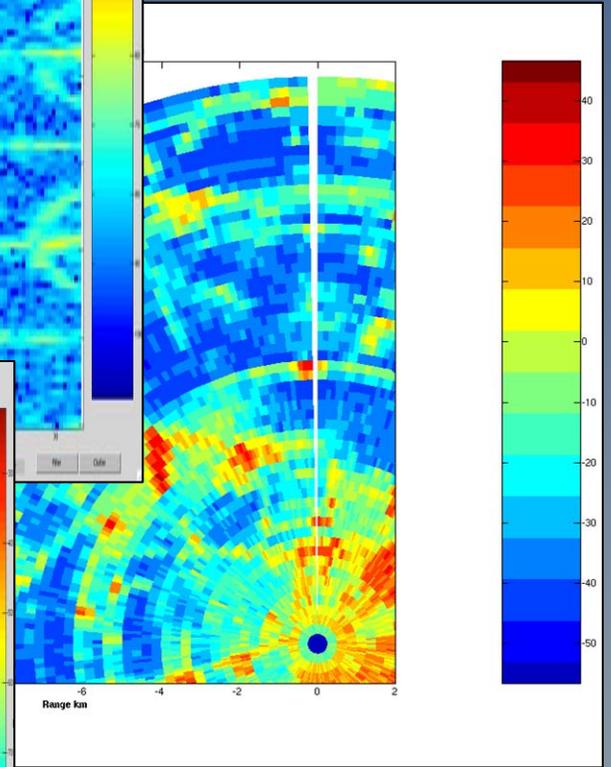
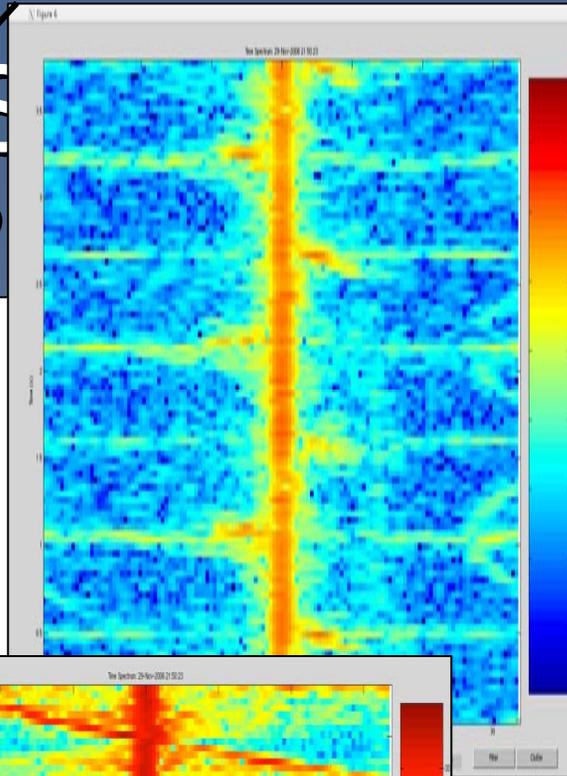
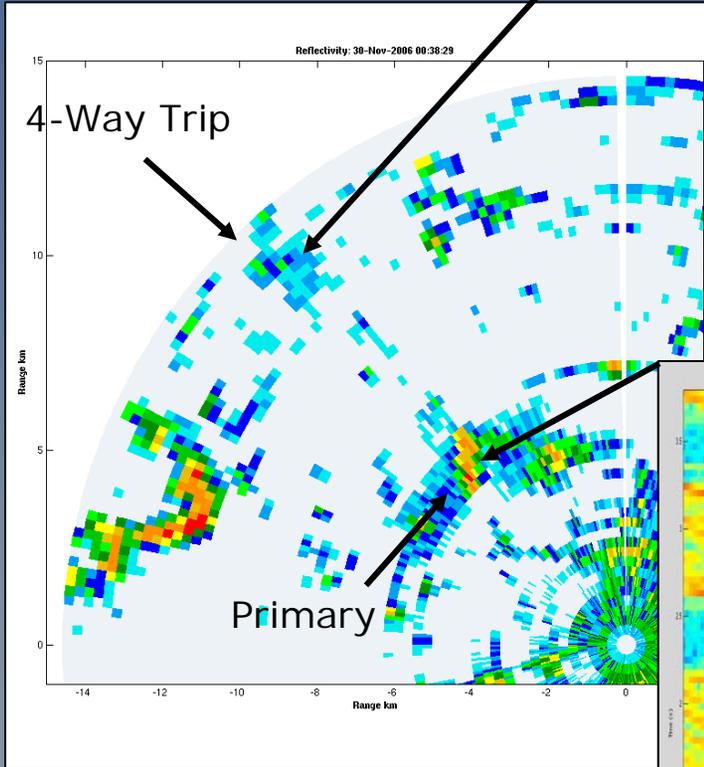
- *Tornados*
- *Ground Clutter*
- *Sea Clutter*
- *Birds*
- *Wind Turbine Clutter (WTC)*

Spectral Processing
Possible With ORDA

Interesting S Effects

KTFX, Multi-Trip

Echoes



Multi-Trip Echoes

Turbine Interaction
"Body Scatter Spike"

Summary and Future Work

- ◆ Explored WTC characteristics (Doppler spectra and moments) from Dodge City and Great Falls WSR-88Ds
- ◆ Developed simple interpolation technique (loss in resolution)
- ◆ Investigated existence & characteristics of multi-trip and three-body scatter for Great Falls case
- ◆ Future work will include interpolation scheme based on three-dimensional continuity of Doppler spectra