A Dual-Polarimetric Doppler Radar Emulator for Education and Research

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- Simultaneously create a tool that can be used in a classroom setting to help visualize fundamental radar concepts.
- Used to investigate the detectibility of tornadic signatures by 2° beamwidth X-band radars.

Where We Were

- Capabilities
  - Full suite of radar configuration parameters
    - Wavelength
    - PRT
    - Pulse length
    - Gate length
    - Antenna rotation speed
    - Pulses per radial
    - Antenna gain and beamwidth
    - Transmit Power
    - Scan angles
    - Minimum detectable signal

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  - Marshall-Palmer distribution

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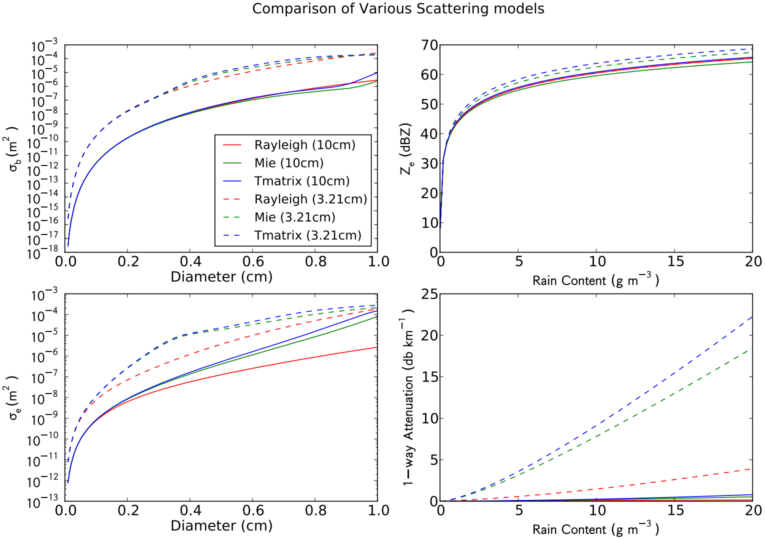
- Better output metadata

Scattering Code Plotting Example



Details, Details...

Previously:

- Propagate a discretized pulse through the model atmosphere, assigning values of attenuation, reflectivity, and radial velocity
- Sample the pulse at each range gate, yielding single values of power, velocity, and velocity variance
- Repeat until given number of pulses sampled
- Average samples together and alias the velocity as necessary

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  - An (exponentially distributed) power value is chosen
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- Complex white Gaussian noise is added to the complex sample
- This procedure is done for both H and V channels, with the two channels having the same random variations in power

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- More drop size distribution options

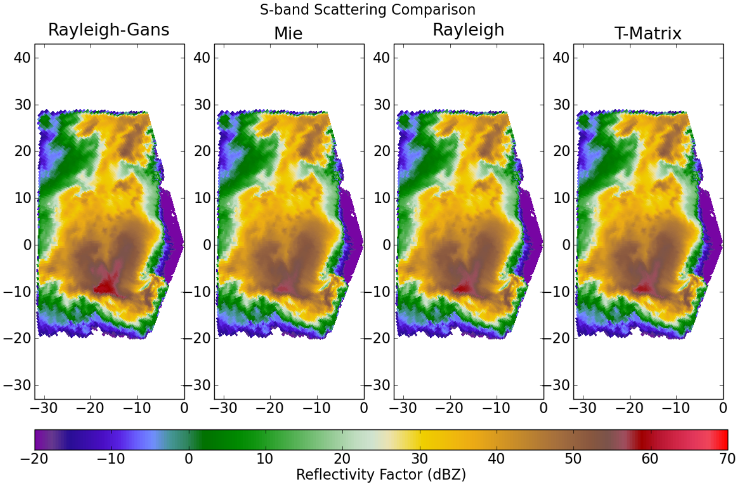
Current Limitations

- No propagation phase (*Yet!*)
- No staggered PRT
- No alternating polarization
- Still only liquid phase hydrometeors
- Marshall-Palmer distribution (from the model)

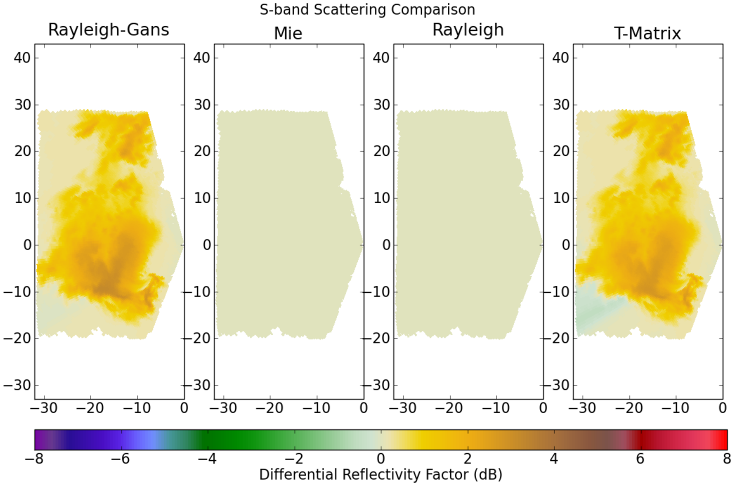
Configuration

- Wavelengths: 10 cm, 5 cm, 3 cm
- 1° beamwidth
- 250 m gates
- 1.5 μs pulse
- 750 kW transmit power
- 0.6667 ms PRT (PRF 1500 Hz)
- 20 °/s rotation rate
- 75 samples per radial
- 0.5° elevation angle sweeps
- (37.5, 18.75, 11.25) m s^{-1} Nyqust velocities

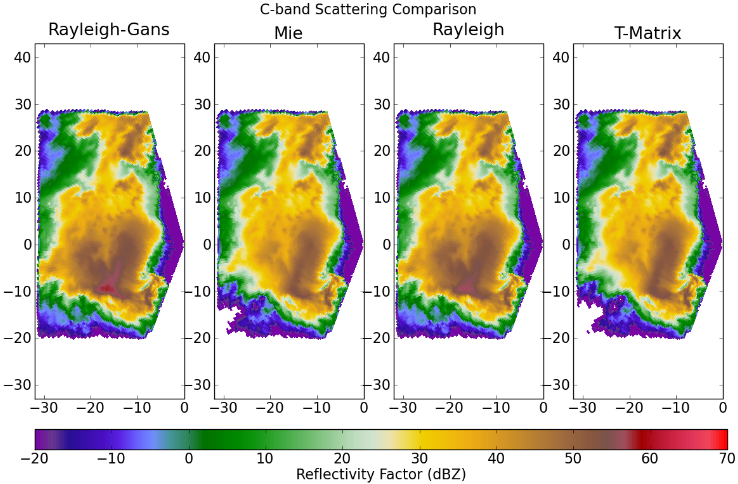
Scattering Model Effects: S-Band Reflectivity



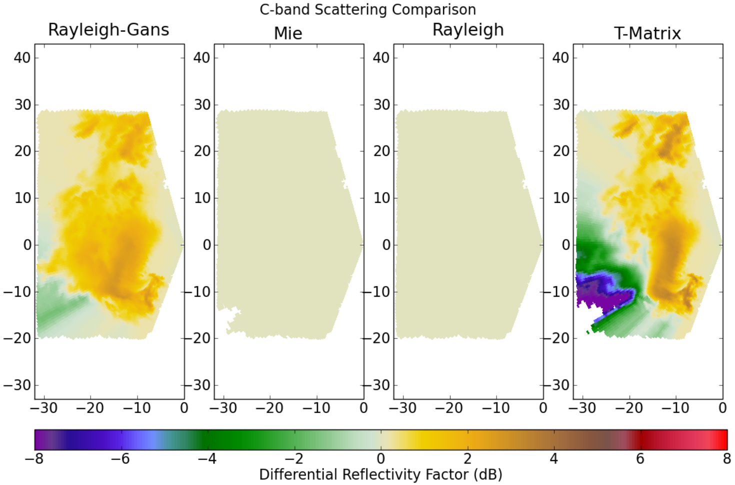
Scattering Model Effects S-Band Z_{DR}



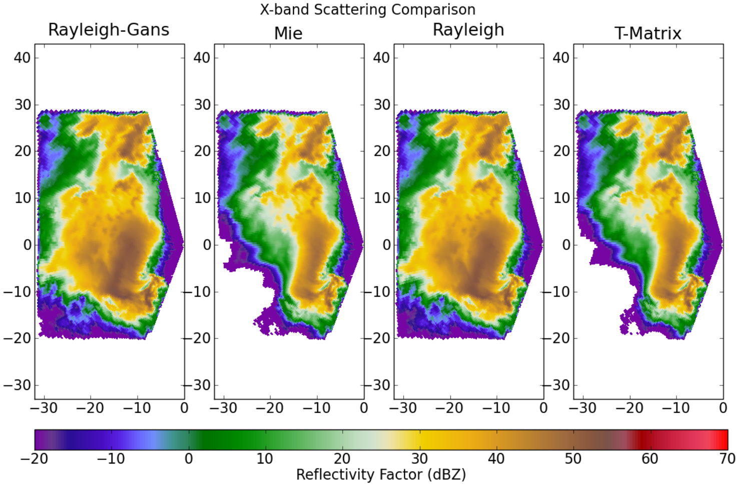
Scattering Model Effects: C-Band Reflectivity



Scattering Model Effects C-Band Z_{DR}



Scattering Model Effects: X-Band Reflectivity



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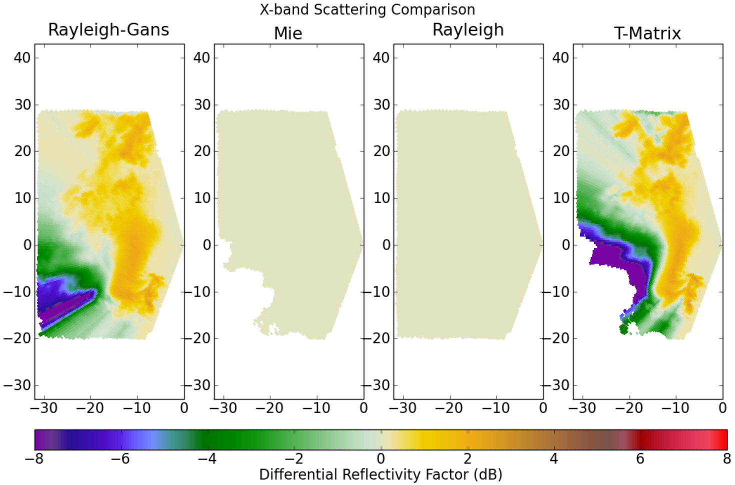
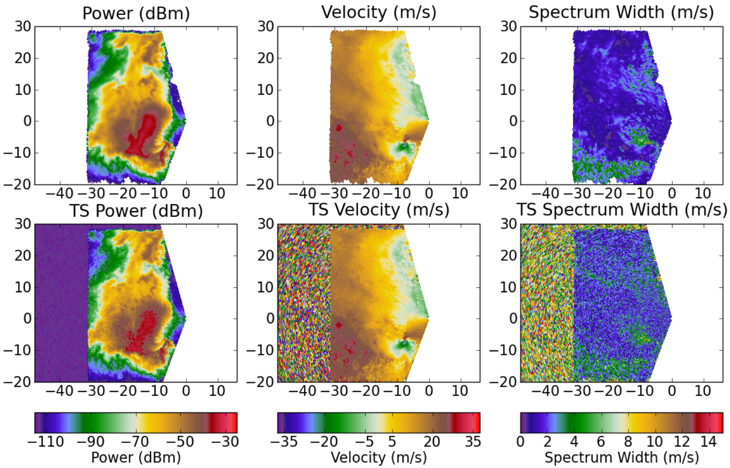
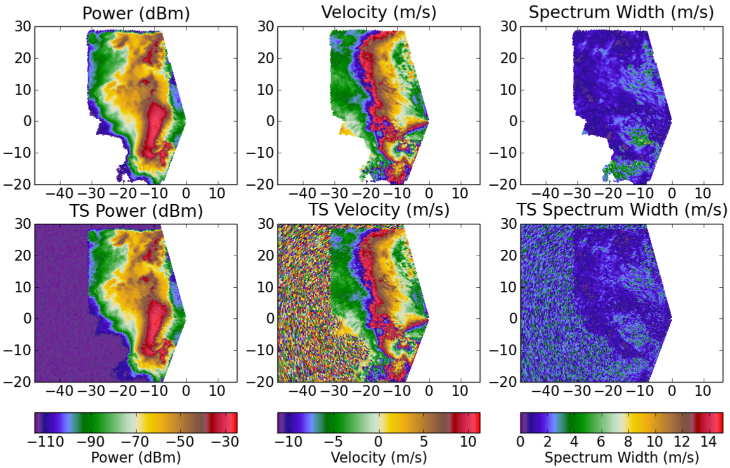


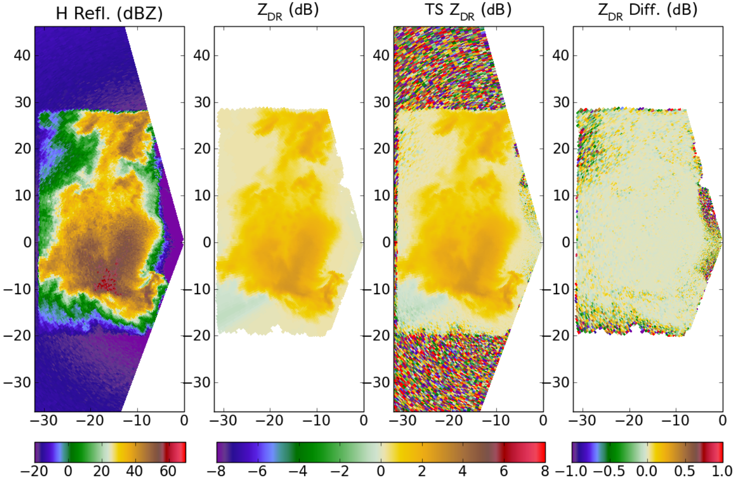
S-band Moment Comparison



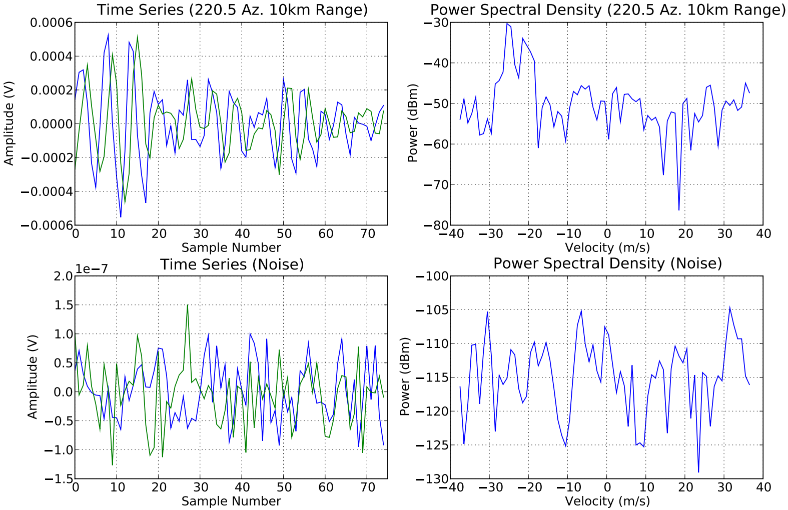
X-band Moment Comparison



Dual-Pol Moment Comparison



Timeseries Data



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- Utilize the emulator in the classroom as a teaching tool
- Add propagation phase effects

Thanks and Questions

- Python – http://www.python.org
- NumPy – http://www.scipy.org/NumPy
- SciPy – http://www.scipy.org
- Matplotlib – http://matplotlib.sf.net

Questions?