RaXPol: A MOBILE, RAPID-SCANNING, X-BAND, POLARIMETRIC DOPPLER RADAR SYSTEM

• Designed, built by ProSensing, Inc. (A. Pazmany, J. Mead) • NSF MRI grant ATM-0821231 (H. Bluestein, OU) • OU – ARRC, Norman, OK

RaXPol: photo by J. Snyder (OU)

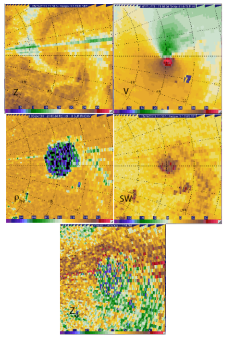
• RaXPol scans rapidly (180^0 s^{-1}), using frequency hopping to acquire enough independent samples to estimate Z, V, Z_{dr}, ρ_{hv}, ϕ_{dp} accurately

• Rapid rotation of antenna allows collection of data at more elev. angles for given volume or reduce volume update time for fixed number of elev. angles

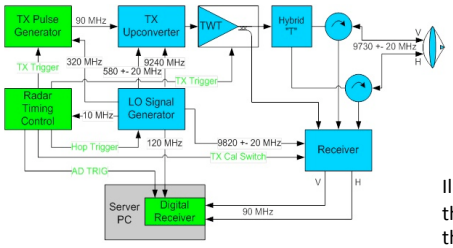
Table 1. RaXPol key system parameters.

Parameter	Value
Center Frequency	9.73 GHz +-20 MHz
Transmit Power	20 kW peak, 200 W ave.
Transmit Pulse Width	0.1 – 40 us
Transmit Waveform	RF Pulse, Linear or Custom Chirp
Transmit Polarization	Equal Power V&H
PRF	Uniform or Staggered
Antenna type	Dual-linear Polarized Parabolic Reflector
Antenna Diameter	2.4 m
Antenna Beamwidth	1.0° Half-power
Antenna Gain	44.5 dB
1st Sidelobe	27 dB
Pedestal Type	Elevation over Azimuth
Pedestal Scan Rate	180 deg s^{-1} Az, 36 deg s^{-1} El
Receiver type	Dual-channel (V & H-pol)
Receiver Noise Figure	3 dB
Receiver Bandwidth	0.5 to 40 MHz, or Custom
Range Gate Spacing	7.5 to 75 m
IF Frequency	90 MHz
Digital Receiver	Dual-channel, 16 bit ADC
Dynamic Range	90 dB @ 1 MHz Bandwidth
Processor	Industrial PC, Dual Quad-core 2.66 GHz Xeon
Clutter Filter	Coherent, User Defined Bandwidth
Pulse-Pair Data Products	Z, Z_{dr}, ρ_{hv}, K_{dp}, Doppler vel. mean and std.
FFT Data Products	Power and Cross-spectrum

EF-5 tornado near El Reno, OK, 23 May2011
Photo at RaXPol deployment site by H. Bluestein



Example of data collected at low elevation angle in El Reno tornado: Maximum Doppler velocity 125 m s^{-1}, debris ball, debris signature in ρ_{hv} , Z_{dr}, and spectrum width SW.



Simplified block diagram of RaXPol

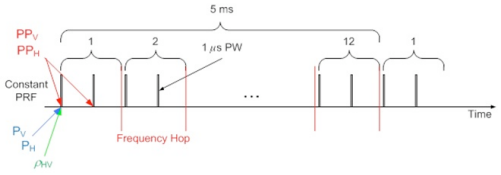
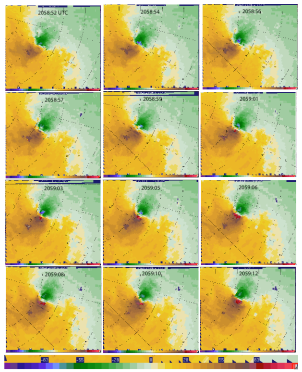
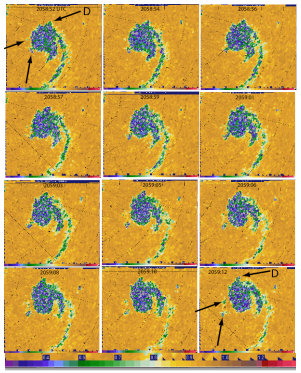


Illustration of the pulse sequence. In standard rapid-scan mode, the radar-transmitted frequency is hopped (shifted) by at least the pulse bandwidth after each pulse-pair to ensure independent sampling during the brief, 4.8 ms averaging interval. To avoid second-trip echo contamination, V- and H-channel power (P_V and P_H) and H-V correlation coefficient (ρ_{hv}) are estimated from the first sample in each pair.





Series of unfolded Doppler velocity (left, m s^{-1}) and ρ_{hv} (right) fields at two – second intervals at low elevation angle as El Reno tornado intensified. Note debris signature rotating around the tornado (D).

RaXPol deployed and probing supercells on 23 May 2011, SW OK (left), on 18 March 2011, SW OK (middle), and on 29 May 2012, central OK. Photos by H. Bluestein

PARTIAL SUMMARY OF RaXPol PROJECTS

• tornado, severe convective-storm studies (H. Bluestein, OU)
• studies of landfalling hurricanes (M. Biggerstaff, OU)
• studies of birds, bats (P. Chilson, OU)
• studies of lightning (M. Biggerstaff, OU)
• studies of different waveforms, pulse compression, strobe mode, etc. (J. Kurdzo, R. Palmer, OU; A. Pazmany, ProSensing, Inc.)