A realistic dual-polarization radar time-series simulator based on archived data

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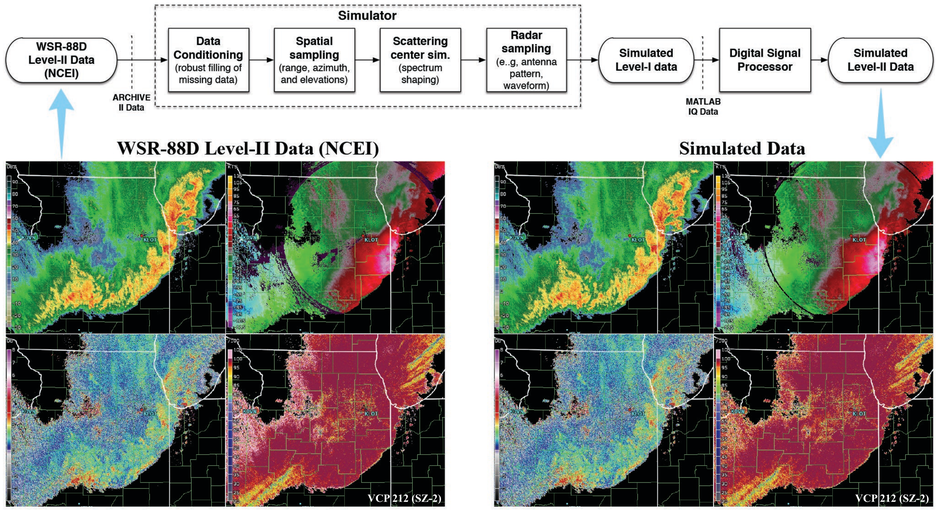
Introduction

The implementation of radar systems and signal processing algorithms, as well as the collection of good weather data can be time-consuming and expensive. Radar data from the U.S. Weather Surveillance Radar – 1988 Doppler (WSR-88D) network has been archived by the National Centers for Environmental Information (NCEI) since 1991 and are publicly available. A highly flexible simulation framework that ingests existing data could be used to study the impact of diverse radar systems and signal processing techniques on radar variables.

Simulation Framework

Our simulator ingests archived data from NCEI, and after a data conditioning step, it produces dual-polarization time-series data (Level-I) incorporating the effects of user-defined simulation parameters. It gives the user the possibility to recreate any archived weather event under desired radar system characteristics. For example, one user could be interested in recreating a specific weather event using a different scanning strategy, or Volume Coverage Pattern (VCP), than the one originally used to collect the data. Other users could be interested in recreating a weather event using the same VCP, as if the event was observed using a Phased Array Radar (PAR).

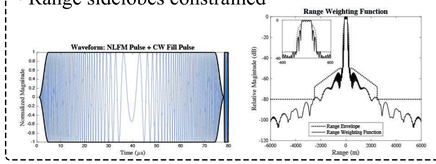


Advanced Technology Demonstrator (ATD) Simulation

The ATD is a radar system being developed through a joint collaboration of the National Oceanic and Atmospheric Administration (NOAA) and the Federal Aviation Administration (FAA). It consists of an S-band, active, electronically scanned, dual-polarization phased array radar. Our simulator is being used to design, implement, and validate the expected radar system performance and DSP techniques on simulated data modeling the radar characersitics and scanning parameters of the ATD.

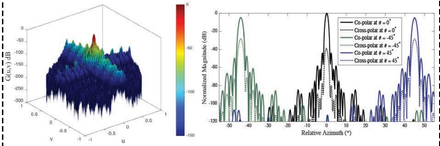
Waveforms

- Pulse compression (6 MHz) + CW 'fill' pulse
- Range sidelobes constrained



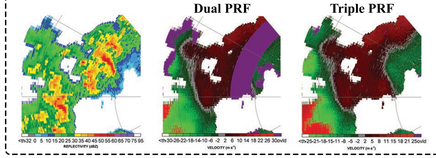
Antenna Patterns

- Simulated Co- and Cross- polarization patterns
- Beamwidth of 1.58° with 50% overlap
- Pencil-beam or spoiled (x3, x5) patterns



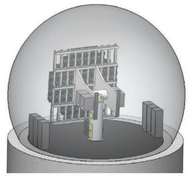
Scanning Strategies

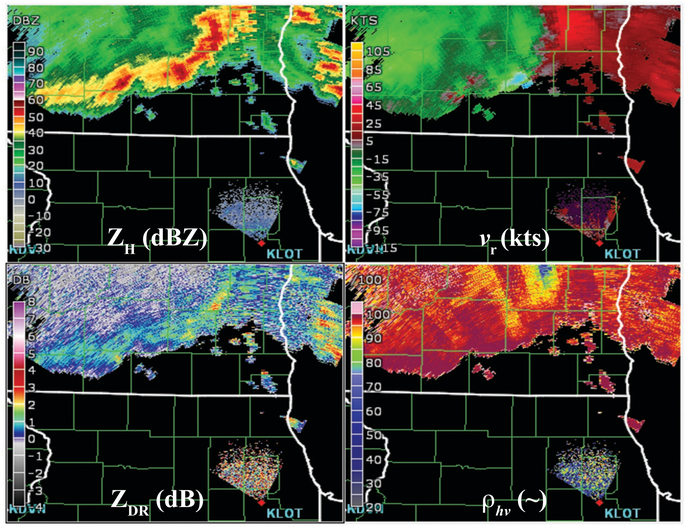
- 3-PRF strategy for unfolding with pulse comp.
- 19 elevations, takes 87.51 s/90° volume



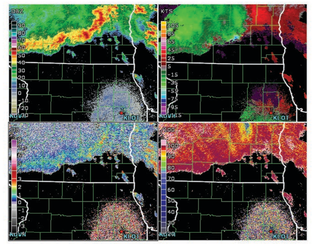
Features:

- Pulse compression
- Phase coding
- Range oversampling
- Simultaneous/Alternate transmission modes
- Antenna patterns
- Scanning strategies
- Multi-PRF
- Sensitivity effects
- Ground clutter

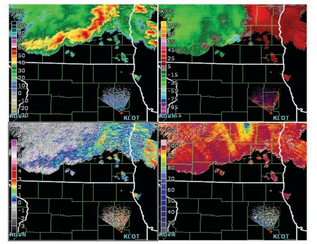




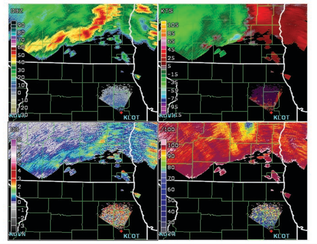
WSR-88D Data



Simulated High Cross-pol



Simulated Spoiled Beam(x3)



Conclusions: We developed a realistic radar simulation framework based on WSR-88D data. The simulator can be used to design radar systems and DSP algorithms quickly and inexpensively. It is being expanded to produce time-series of volumes and design adaptive scanning algorithms.

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