



P 397 A Signal Processing Roadmap for NEXRAD

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The Past: Completed Projects

The Radar Operations Center, OST and their science partners have completed the following major enhancements:

- Open Radar Product Generator (ORPG)
- Open Radar Data Acquisition System (ORDA)
- Gaussian Model Adaptive Processing (GMAP) Clutter Filters
- Range Velocity Ambiguity Mitigation with SZ2 Phase Coding
- Improved Feature Detection with Super Resolution
- Extension of Doppler range to 300 km
- Five Elevation Segment Clutter Filter Control
- Multi PRF De-aliasing Algorithm
- Automatic Clutter Identification and Filtering
- Engineering Test Versions of Staggered PRT
- VCP12: faster updates, better long range vertical resolution
- High speed data transfer to operational systems e.g. AWIPS
- Full resolution Level II data distribution in near real time
- Numerous, frequent science algorithm additions and updates

On behalf of the NEXRAD agencies (DOD/USAF, DOT/FAA, DOC/NOAA/NWS, the WSR-88D Radar Operations Center (ROC), the National Weather Service Office of Science and Technology (OST), and their science partners, including the National Severe Storms Laboratory (NSSL) and the National Center for Atmospheric Research (NCAR), have continuously upgraded the NEXRAD radar network capabilities. OST, NSSL, and the ROC developed the Open Radar Product Generator (ORPG) and the Open Radar Data Acquisition (ORDA) systems, allowing the system to host software designed to improve data quality. These systems, based on commercially available open systems hardware and software, have opened new possibilities for the radar. The ROC and OST teams have deployed many new signal and radar data processing features, and currently manage several projects as part of a continuous improvement program. Technology refresh will allow additional enhancements.

This paper reviews successful projects, and addresses some that are underway or in near term development. Finally, some exciting future possibilities are listed for consideration. The vast array of possibilities can form the basis for a "Signal Processing Roadmap" for NEXRAD. The community should continue working together, framing plans for the future of meteorological radar signal processing while meeting NEXRAD agency requirements.

The Present: Current Projects

The ROC team is working on the following enhancements for near term consideration, possibly soon after deployment of the Dual Polarization Technology Upgrade:

Fully Operational Staggered PRT – the ROC is developing an operational version of staggered PRT that features a spectral clutter filter known as SACHI, developed at NSSL.

Automated Volume Scan Evaluation and Termination (AVSET) – this feature analyzes the usable radar return coverage area and terminates the volume scan early when there is no meteorologically significant data at the upper elevation tilts. This allows for shorter volume coverage times and more rapid updates of low level scans for the operators.

Hybrid Spectrum Width Estimator – NCAR has developed a spectrum width estimator that combines estimates from multiple lag processes, using each to its best advantage.

Improvements to Clutter Filtering and Censoring – the ROC is reviewing GMAP configuration parameters and clutter residue censoring in order to reduce the variance of estimates associated with clutter filtered radar data. Identification of clutter in the spectral/autocorrelation domain at a single range location is being explored.

Adaptive Data Windowing for Reducing Estimate Variance – the commercial signal processing software has been modified to allow use of less aggressive time series data windows, and the ROC is investigating how to best employ this feature

Note: The Dual Polarization Technology Upgrade, currently in progress, is a major project managed by OST. This upgrade employs simultaneous transmission of horizontal and vertically polarized signals and produces new parameters. These include differential reflectivity, differential phase and co-polar correlation coefficients. The upgrade also features adaptive threshold management for recovery of weak signals, incorporates new algorithms, and features modifications to clutter filtering. The ROC will integrate enhancements and the clutter mitigation decision (CMD) function with the dual polarization once it is deployed.

The Future - Possibilities

These enhancements are possibilities, and could form the basis of future developments aimed at maintaining the NEXRAD's prominence as a vital source of data for warnings and forecasts. Many current and future techniques may also be applicable to potential systems such as Phased Array Antenna Radar. Some possibilities include the following:

Dual Polarization based data quality enhancements, including high performance artifact identification.

Improved Clutter Identification and Mitigation, including use of autocorrelation lag, polarimetric parameter signal classification and artifact removal, time domain, and other simplified clutter filters suitable for Uniform and/or Staggered PRT

Wind Turbine Identification and Artifact Removal

Oversampling in Range with sample Whitening

Real time calibration via clutter analysis and/or monitoring critical radar parameters

Improved noise measurement and modeling, including estimation from signal data

Improved elevation noise adjustment and enhanced atmospheric attenuation models

Sea clutter Identification and Mitigation

Advanced Spectral Processing – autoregressive methods, maximum likelihood and maximum entropy, and possibly Hilbert transform analysis

Pulse Compression, for the existing transmitter or a replacement solid state unit

Refractivity Retrieval

Advanced signal quality indicators

Adaptive/predictive filtering, modifying the digital matched filters in real time based on signal characteristics

Additional Multiple PRF Waveforms beyond Batch, MPDA and Staggered PRT.

The listed prospects have been the subject of research papers and discussions within the community. The number and scope of these possibilities necessitates an integrated plan to guide the community in growing the radar's capability and in focusing research efforts on the most cost effective techniques for meeting the NEXRAD agencies' evolving needs.

The authors of this paper support framing of a plan for charting NEXRAD's course.

Background Image: The Waldseemüller map, printed in 1507, was the first to designate the New World as "America". Matthias Ringmann and Martin Waldseemüller were the first to publish that Amerigo Vespucci had discovered a "fourth part" of the world, equal to Asia, Africa, and Europe. Image source: Library of Congress, Public Domain.

For More Information, see these ROC, NSSL, and NCAR web sites:

- <http://www.roc.noaa.gov/WSR88D/PublicationsROC.aspx>
- http://publications.nssl.noaa.gov/wsr88d_reports/index.php
- <http://www.eol.ucar.edu/rsf/NEXRAD/>



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