Product Improvement Update

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Radar Operations Center, Office of Observations
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NEXRAD Technical Advisory Committee

Outline

- NEXRAD R2O Transition Efforts
- Product Improvement Projects
- Summary

NEXRAD R2O Transition Efforts

Radar Product Improvement Manager (M. Istok)

- Improving Data Quality
  - RDA-centric contract with NCAR
  - ROC Engineering Branch (Olen Boydstun)
  - Budget Exhibit: OC25,DIR,Long Term Sys Improvement
- Radar Product Improvement
  - New Science and Signal Processing Techniques MOU with NSSL
  - ROC Directors Office (Mike Istok)
  - Budget Exhibit: R2O part of OC25,DIR,NSSL Technology Transfer
- Technology Transfer
  - RPG-centric MOU with NSSL
  - ROC Engineering Branch (Heather Grams)
  - Budget Exhibit: Tech Transfer part of OC25,DIR,NSSL Technology Transfer
  - Budget Exhibit: OC25,DIR, Precipitation / Snow Algorithm Improvement

Scope of Projects

- Base Data Coverage, Bias, Variance, Resolution
  - Calibration, environmental and system impacts
  - Clutter mitigation: ground, wind turbine, sea, bird, etc..
  - Radar moments and dual polarization variable estimators
  - Range/Velocity ambiguity mitigation
  - Radar data quality control
  - Range oversampling

- Radar-Meteorological Algorithms and Products
  - Data quality monitoring and data use considerations
  - Hydrometeor classification: warm and cold season; surface and aloft
  - Severe weather: tornado, mesocyclone, hail, severe wind
  - Precipitation: rain and snow; microphysics and accumulation

Improving Data Quality (1 of 1)

Period of Performance 8/1/18 to 7/30/19

- Dual Polarization Calibration
  - Support ROC software development, integration, and testing of solar box scans
  - Investigate use of 30 to 60 deg elevation data as a proxy for vertical pointing
  - Evaluate use of ground clutter scans and/or hydrometeors as a means to track system bias stability
  - Support ROC investigation of a possible dependence of ZDR bias on antenna temperature
  - Support potential modification of the RF Pallet and associated polarimetric calibration subsystems
- Hybrid Spectrum Width Estimator (HSWE)
  - Support ROC software development, integration, and testing of HSWE for the Staggered-PRT (SPRT) processing mode
- Clutter Mitigation Decision (CMD) based Clutter Filtering
  - Support ROC implementation of mitigation to “clutter footprint”
  - Analyze the issue of the “clutter flash”
  - Mitigate SZ-2 vulnerability to CMD false detections of insect echoes in outflow boundaries
  - Improve CMD detection performance at lower Clutter-to-Signal Ratios (CSR)

Radar Product Improvement (1 of 3)

Performance of Period 10/1/18 to 9/30/19

- Ground Clutter Mitigation
  - Support ROC implementation, integration, validation and testing of WET and CLEAN-AP
  - Investigate improvements to clutter mitigation
- Range-and-Velocity Ambiguity Mitigation
  - Support ROC implementation, integration, validation and testing of the Staggered-PRT and SZ-2
  - Investigate SZ-2 “double processing” to improve recovery of overlaid echoes with similar strength
- Meteorological-Variable Estimators
  - Support ROC implementation, integration, validation and testing of the new CC estimator
  - Develop Hybrid-Scan polarimetric-variable estimators (combines information from multiple scans)
  - Explore estimators based on “matched” correlations, and higher-lag estimators at low SNR
  - Develop hybrid estimators to adaptively select the best estimator for the given conditions
- Radar Data Quality Control
  - Support ROC implementation, integration, validation and testing of new censoring techniques and thresholds to improve performance of SZ-2 processing mode
  - Investigate techniques to detect and mitigate contamination by pulse interference
- Range Oversampling
  - Support ROC implementation, integration, validation and testing of range oversampling
  - Investigate interactions between range oversampling and current and future WSR-88D signal-processing techniques

Radar Product Improvement (2 of 3)

Period of Performance 10/1/18 to 9/30/19

- Collaborate with NCAR and ROC on FY19 Data Quality Tasking
  - SZ-2 improvements
  - Hardware performance effects on HSWE and SPRT data quality
  - Potential tech refresh of RVP-900 digital receiver and signal processing system
  - Assist ROC with planning for a community wide signal processing workshop
- Investigate Impacts of System Differential Phase upon Transmission (Phi_t)
  - Theoretically investigate the impact of Phi_t on values of ZDR and CC in snow and hail
  - Measure Phi_t on two WSR-88Ds (KOUN and KCRI)
- Identify Areas and Sources of Reduced Radar Data Quality
  - Develop methods to detect three-body scatter, non-uniform beam filling, and ground clutter
- Hydrometeor Classification of Winter Precipitation (WsHCA)
  - Evaluate performance of WsHCA on the dev-MRMS test platform and investigate improvements
  - Improve the cool season performance of Melting Layer Detection
- Identify Features in Convective Storms
  - Study the relationships between size and location of hail at the ground and the characteristics of the parent storm

Radar Product Improvement (3 of 3)

Period of Performance 10/1/18 to 9/30/19

- Quasi-Vertical Profiles (QVP) and Column Vertical Profiles (CVP) Methodologies
  - Implement range-defined QVP technique to improve the quality of QVP at lower levels
  - Further optimize the CVP product to reduce gaps and "jitter noise"
  - Demonstrate the CVP in real time using cloud computing as a test platform
- Nowcasting Cold Season Precipitation using Polarimetric Signatures Aloft
  - Analyze correlation between KDP enhancement in the dendritic growth layer (DGL) and subsequent precipitation intensification at the surface along the particle trajectories
  - Analyze relation between ice water content and snow flux in the DGL and precipitation rate
- Quantitative Precipitation Estimation (QPE) in Pure Rain or Rain Mixed with Hail
  - Examine performance of the R(A) algorithm in devastating land-falling hurricanes events, identify challenges and limitations
  - Explore solutions to optimize the α parameter in areas with differing microphysical properties
- QPE in Snow and Mixed Precipitation
  - Test the concept of polarimetric estimation of snow in the dendritic growth layer aloft
  - Test the polarimetric VPR technique to mitigating bright band contamination

Technology Transfer (1 of 2)

Period of Performance 10/1/18 to 9/30/19

- Dual Polarization QPE Improvements
  - Update the VPR algorithm to use dual pol data to better mitigate bright band contamination near the surface
  - Generate non-standard beam blockage tables for each WSR-88D incorporating the R(A) rain rate method
  - Implement R(A) algorithm updates on the dev-MRMS test platform and evaluate performance
  - Develop and test an orographic/tropical rainfall correction algorithm
- Mesocyclone Detection Algorithm (refresh)
  - Modify prototype algorithm to address deficiencies identified in FY18
  - Investigate if higher elevation angle data and/or additional environmental input improves performance
  - Conduct forecaster evaluation at the Hazardous Weather Testbed (HWT)
  - Evaluate anticyclone detections from LLSD technique and add to algorithm to report anticyclonic features
- Tornado Detection Algorithm (refresh)
  - Modify prototype algorithm to address deficiencies identified in FY18
  - Investigate if higher elevation angle data and/or additional environmental input improves performance
  - Conduct forecaster evaluation at the Hazardous Weather Testbed (HWT) – deferred to FY20
- Hail Detection Algorithm (refresh)
  - Complete remaining algorithm modifications to the prototype and evaluate performance

Technology Transfer (2 of 2)

Period of Performance 10/1/18 to 9/30/19

- Assess Echo Tops and Vertically Integrated Liquid products
  - Compare Echo Tops products: WSR-88D ET and EET, MRMS, and an experimental product
  - Compare Vertically Integrated Liquid products: WSR-88D VIL and DVL, MRMS product
- Bird Detection Algorithm
  - Investigate developing an algorithm to discriminate birds from insects, large birds from small birds, large concentrations of birds from small concentrations, and to forecast the movement of large birds and large concentrations of birds
- Develop Applications to use Expanded Scale ZDR Data
  - Identify impacts of the expanded ZDR scale on existing algorithms dependent on ZDR
    - Hydrometeor Classification, Precipitation Estimates, ZDR Error estimates, etc.
  - Identify possible applications of the expanded ZDR scale data
    - Build 19 change: -13 dB to +20 dB at 0.03125 dB steps (from +/- 7.9 dB at 0.0625 dB steps)

Summary

- Funding is adequate to accomplish primary R2O initiatives
- Priority is on Dual Pol projects to leverage that investment
- Data quality efforts leverage new SLEP RSP/IFDR investment

NEXRAD: Still the Best and Continuing to Get Better

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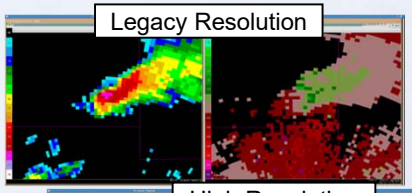
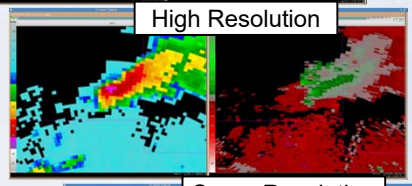
Director, NEXRAD Radar Operations Center

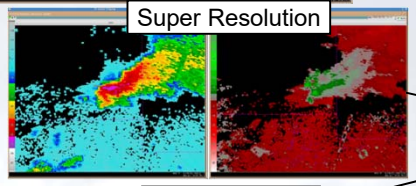
2040

WSR-88D is the World's Best Operational Weather Radar thanks to NEXRAD Product Improvement, Tech Refresh investments, and new science infusion. These initiatives have increased capabilities while controlling O&M costs.

Through sustaining engineering and Tech Refresh investments, WSR-88D continues to be upgradable, reliable and maintainable through 2040.







1987

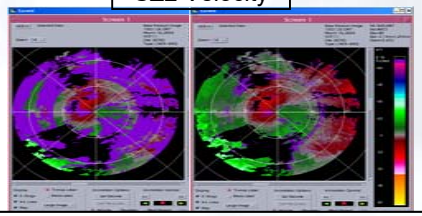
- Unisys Contract Award
- Operational Support Facility (OSF), now known as the Radar Operations Center (ROC), established
- **WSR-88D Deployment Began**
- Fastest Update Interval for 0.5° (Lowest Elevation) 295 secs
- First Test Bed WSR-88D Installed
- Conversion from circular polarization to linear horizontal polarization

1990

- Last WSR-88D Installed 1997 (Avg age 21 yrs)
- **After installation of WSR-88D, percentage of tornadoes warned for increased from 35% to 60%, while mean lead time on warnings increased from 5.3 to 9.5 min.**
  Simmons and Sutter, 2005

1995

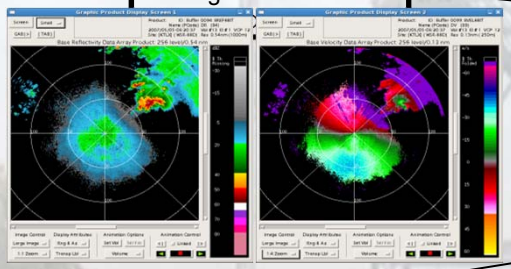
- Fastest Update Interval for 0.5° (Lowest Elevation) 180 secs
- **ORDA**
  Digital Receiver, GMAP Clutter Filter, Open Systems processor and software that support infusion of new science, faster VCPs, etc.,
- Fastest Update Interval for 0.5° (Lowest Elevation) 250 secs
- SZ2 Velocity



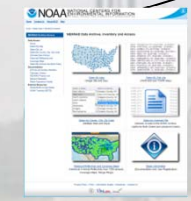
- Reduces Range-Folded Data to <10% of the Field

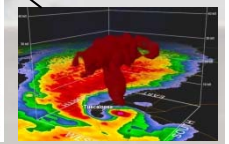
2000

- High Resolution



- **ORPG**
  Open Systems processor and software that support infusion of new science
- Digital Communications

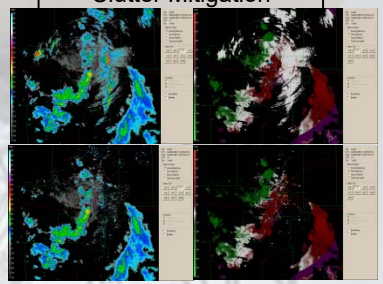




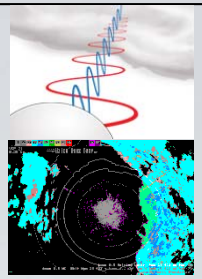
- MPDA, SCIT, REC, MDA, TDA, DVIL, EET, Upgraded Hydromet Algorithms and Products, Snow Accumulation Algorithms and Products, Automated Data Quality Algorithms, etc.,

2005

- Real-time Level II Distribution



- Clutter Mitigation



2010

- **Dual Polarization**
  Improved QPE, Hydrometeor Classification, etc.,
- Improved Severe Weather Identification and Increased Leadtime
- Fastest Update Interval for 0.5° (Lowest Elevation) 75 secs
- Dynamic Scanning: AVSET and SAILS

2015

- **Service Life Extension Program**
  Signal Processor, Transmitter, Pedestal & Shelter

2020

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