

Introduction to Radar Next

*The Future of a National Doppler Weather Radar
Capability*

Jessica Schultz

Frank W. Gallagher III, Mat Grow, and Cynthia Fay

NOAA/NWS/OBS

National Weather Service

1 May 2024



Mission Need

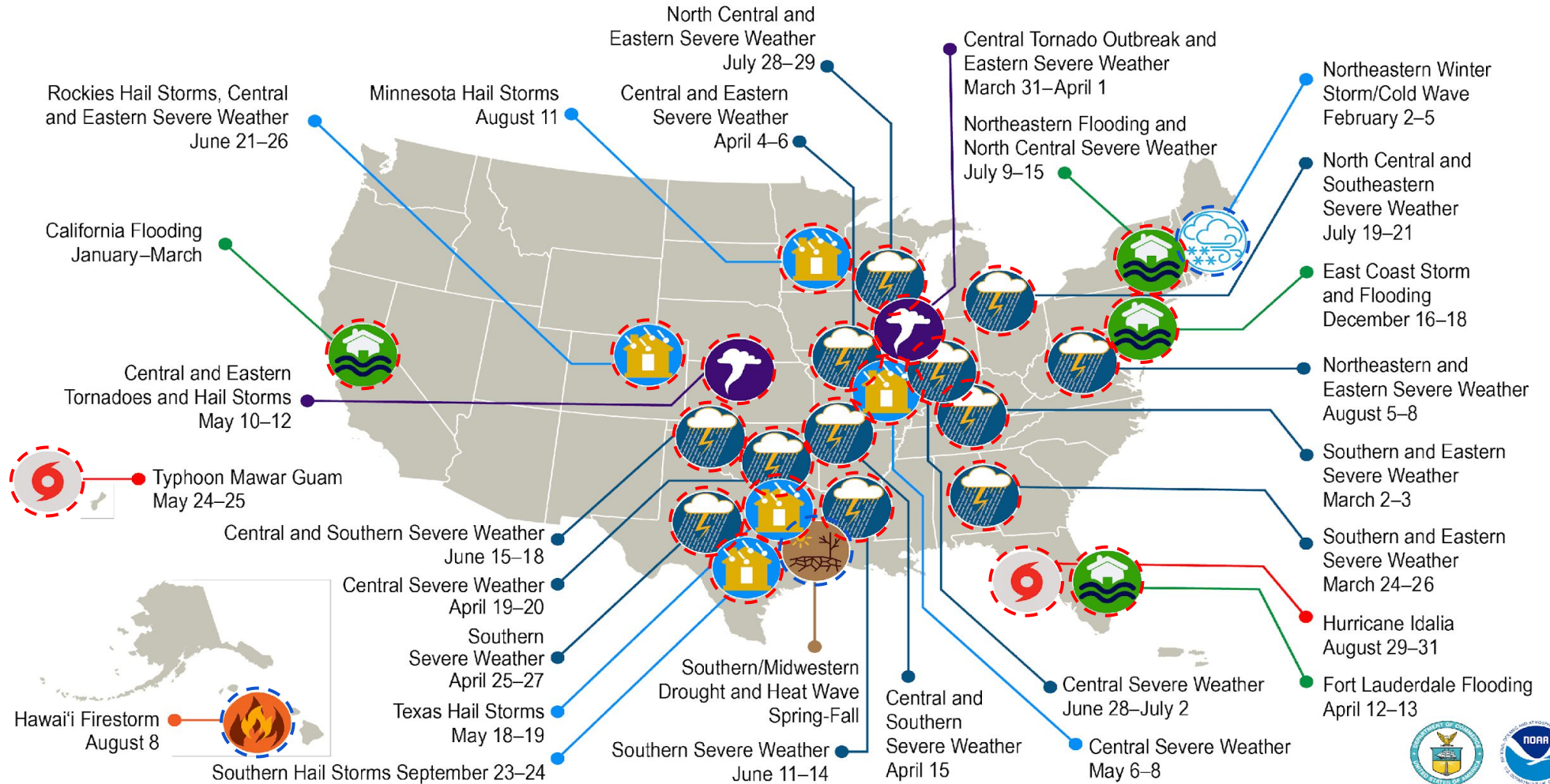
U.S. 2023 Billion-Dollar Weather and Climate Disasters



- Drought/Heat Wave
- Flooding
- Hail
- Hurricane
- Severe Weather
- Tornado Outbreak
- Wildfire
- Winter Storm/Cold Wave

Warnings Supported by Radars

Disaster Supported by Radars



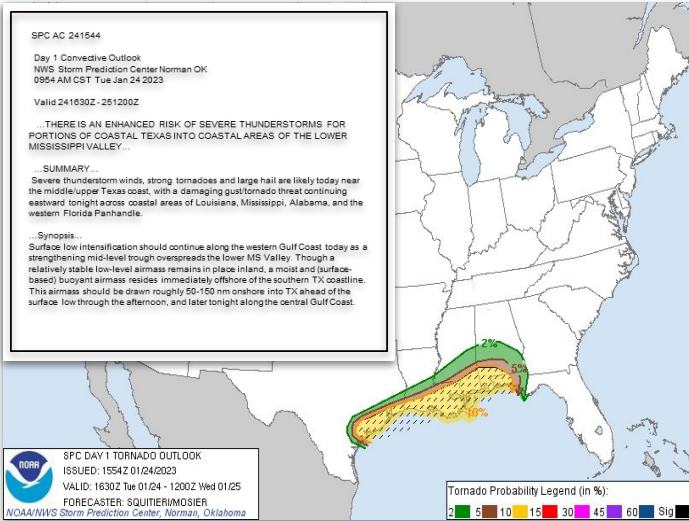
This map denotes the approximate location for each of the 28 separate billion-dollar weather and climate disasters that impacted the United States in 2023.



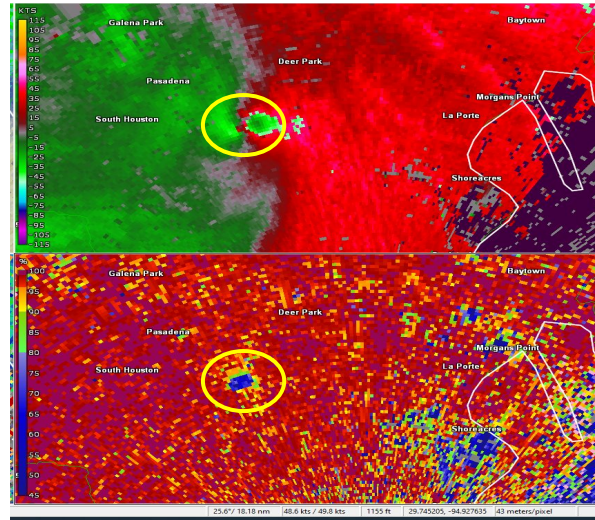


Example: January 24, 2023 Southeast Houston Tornado

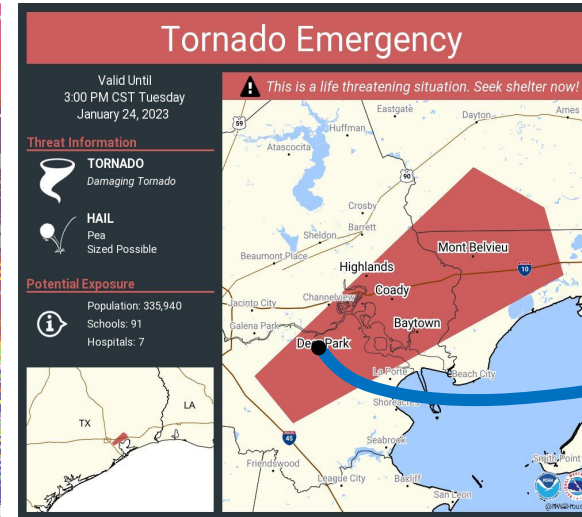
SPC Convective Outlook and Probabilistic Tornado Graphic



Radar



Warning

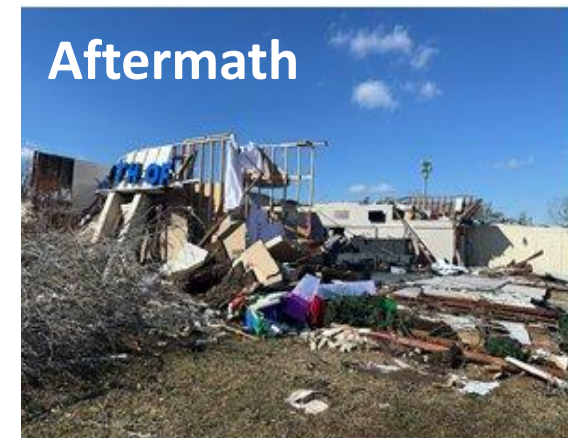


Tornado



● Tornado in major populated area

- EF3 tornado (140 mph winds); 18.8 miles long track; 1,000 yards width
- Minor injuries, **no fatalities**
- Tornado **rain-wrapped, no visual cue** to persistence, strength, or size
- Radar data (debris signature) vital to informing forecasters and media partners that tornado remained in progress and was large, damaging
- WFO issued Tornado Emergency based **solely on radar data**

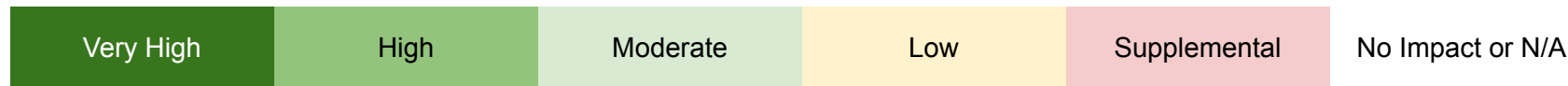




Mission Impact

- NEXRAD is the most impactful NOAA observational asset supporting severe weather, flash floods, and ***air traffic management***
- NEXRAD provides high societal impact

Observing System	NWS Mission Service Area											
	Climate Prediction	Aviation Weather	Fire Weather	Tropical Cyclones	Water Prediction	Marine Weather	Winter Weather	Routine Weather	Severe Weather	Space Weather	Tsunami	Modeling
NEXRAD Radars	Moderate	Very High	Very High	High	Very High	High	Very High	Very High	Very High	N/A	N/A	High



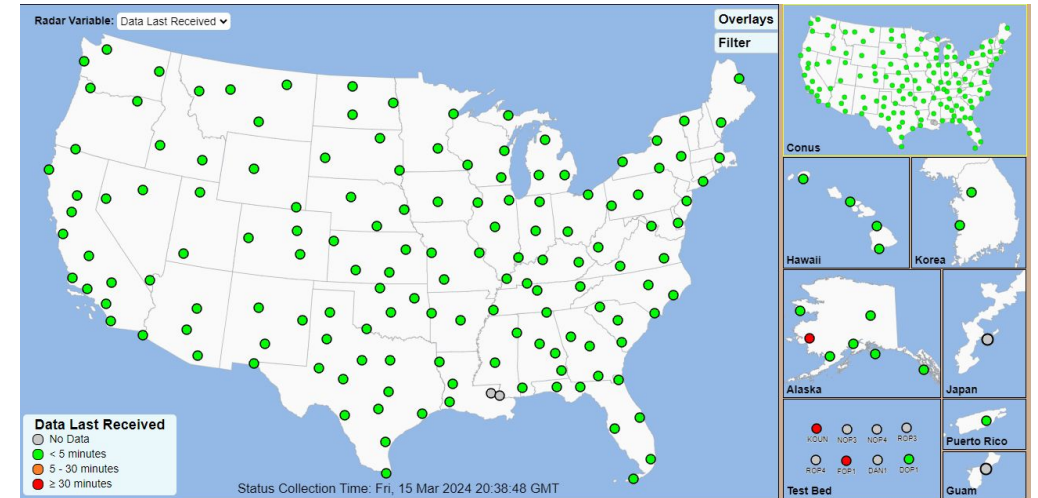
Results of the TPIO NOSIA-II evaluation of NEXRAD radars to NWS Mission Service Areas.



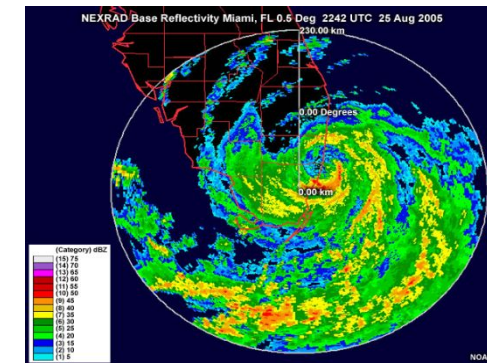


NEXRAD Program: Current Operational Weather Radar

- Network of 159 S-band Doppler weather radars jointly operated by NWS, USAF, FAA
- Provides mosaic coverage of most of the Continental United States
- Most impactful NOAA observational asset supporting severe weather, flash floods, and air traffic management. The radar network provides high national societal impact
- Installed in the 1990s with a 20-year expected design life
- Dual Polarization Upgrade in the 2013 and Service Life Extension Program in the late 2015 - 2024



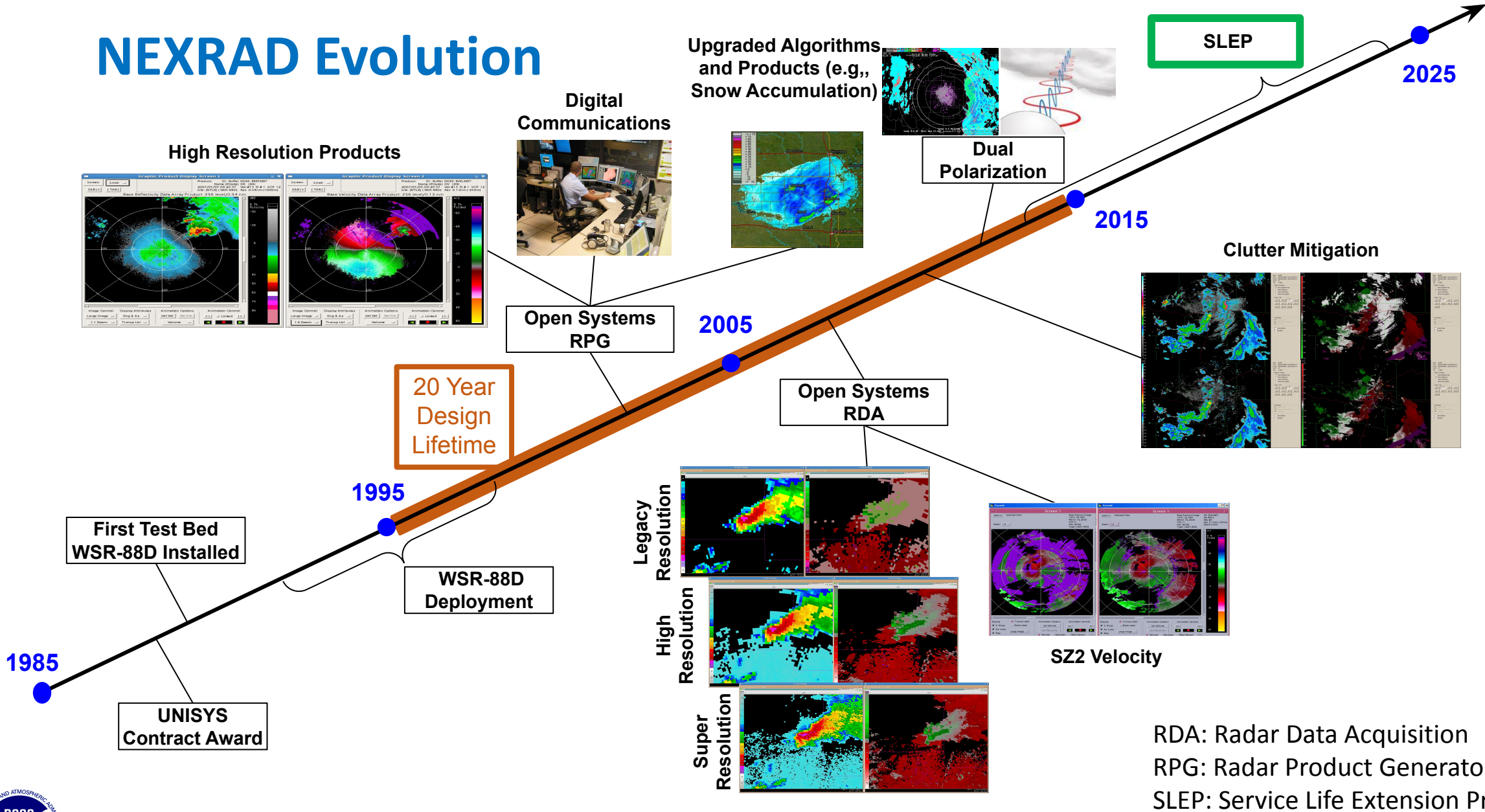
KGLD - Goodland, KS



KAMX - Hurricane Katrina
25 AUG 2005 - 2242 UTC



NEXRAD Evolution



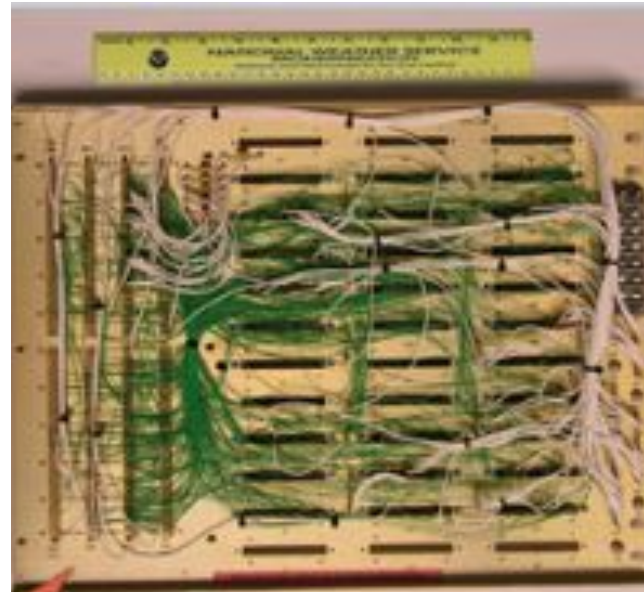
RDA: Radar Data Acquisition
 RPG: Radar Product Generator
 SLEP: Service Life Extension Program



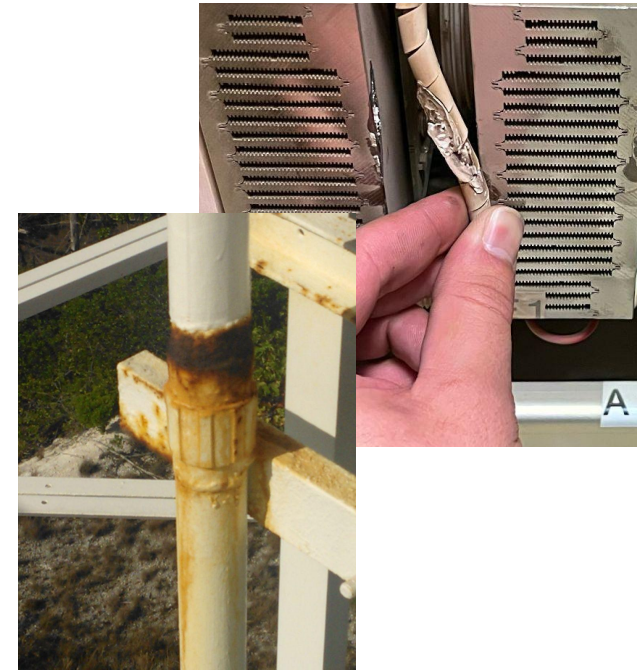
NEXRAD is Operating Beyond Design Lifetime



Metal Fatigue/Damaged Components



Obsolete Parts



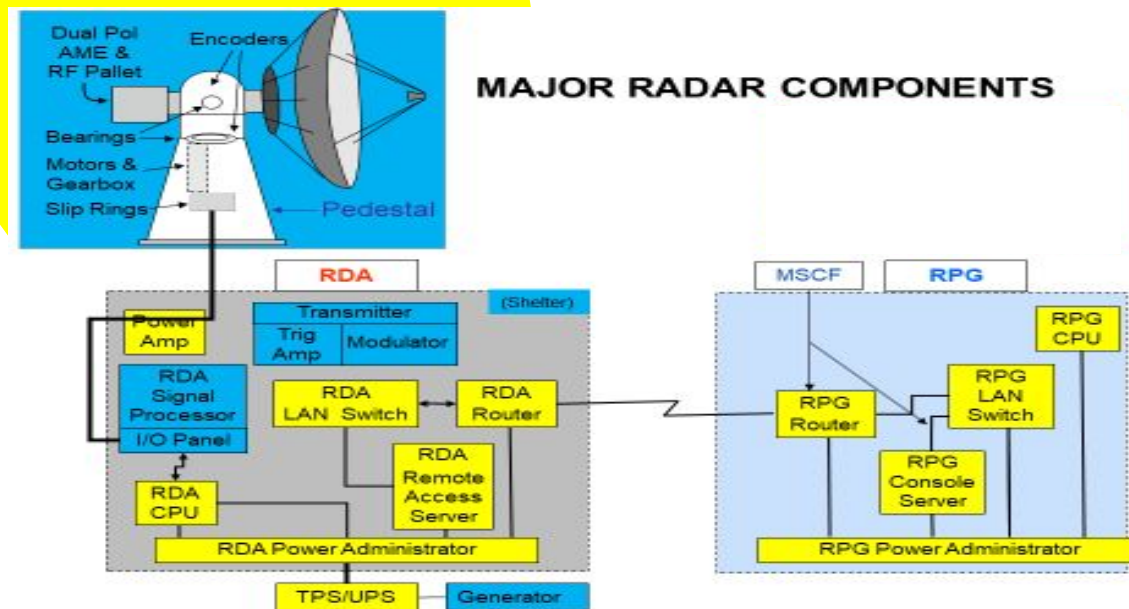
Wiring and Environmental Issues



NEXRAD Service Life Extension Program (SLEP)

- SLEP extended the life of the Digital Signal Processors, Transmitters, Pedestals, Equipment Shelters, and Generator/Engine/Automatic Transfer Switches
- SLEP did **NOT** address all NEXRAD components
 - Each of the three major NEXRAD components contains multiple “line replaceable units” subject to wear-out and/or obsolescence (~4,000 total)

Radome



Component Addressed by SLEP
 Component NOT Addressed by SLEP



Why an Investment in Future Radar is Needed Now

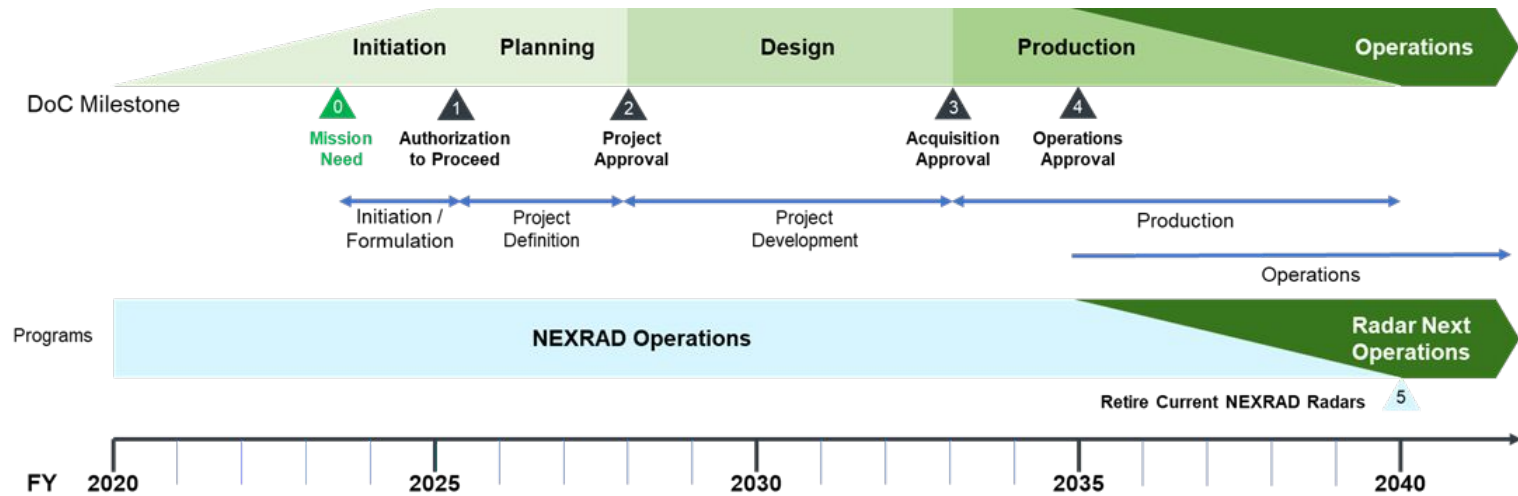
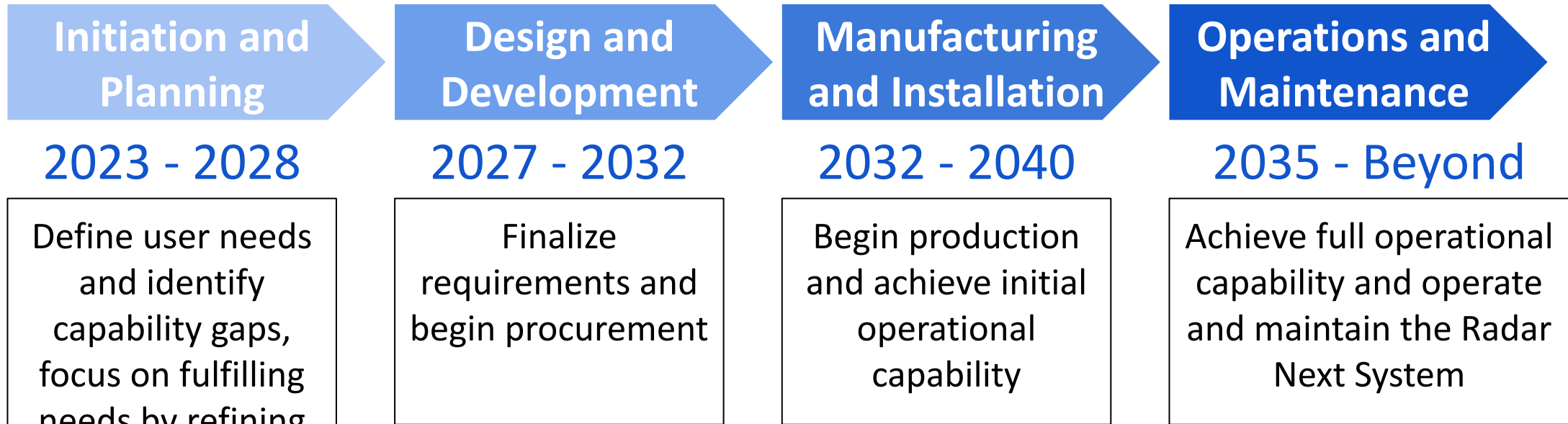
- 1** Ongoing maintenance and SLEP does not address all NEXRAD Issues:
 - Aging infrastructure leading to reduced reliability, availability, and maintainability
 - Obsolescence / Unavailability of commercial parts
 - Third-party supply chain disruptions
 - Inflationary pressures (e.g., NEXRAD optical position encoders increased in price from ~\$4K to \$44K)
- 2** Replacement of NEXRAD will allow for:
 - Modern infrastructure including computer capacity and network data transfer
 - Capability and technological advancements
 - Product Upgrades
 - Addressing NEXRAD shortfalls such as gaps in low-level coverage

Due to the estimated time to plan for a new generation of radars, it is crucial to initiate and implement the Program now to avoid increased high risk of gaps in radar coverage due to unscheduled outages.





Radar Next Program's Timeline





Technology Solution (Analysis of Alternatives)

Radar Next Program will identify and assess various alternatives, comparing strengths and weaknesses, and select the best option(s) based on the analysis.

Examples of Alternatives:

- Replace NEXRAD with new rotating reflector dish (Rip and Replace)
- Replace WSR-88D with new technology, including various electronically steerable (e.g., phased array - PAR) concepts
- Hybrid solutions encompassing different technologies which may include the purchasing of commercial data, rotating parabolic dish, rotating PAR, stationary PAR, other electronically steering technology, and mobile radars

A replacement architecture for NEXRAD has not been selected!





Radar Next – Improved Weather Radar Capabilities

Radar Next is actively investigating improvements to weather radar capabilities

Improve Data Quality

- Mitigate interference from ground clutter
- Spectrum interference

Spatial and Temporal Resolution

- See smaller features
- Scan faster for quicker update rate

Expand coverage

- Expand Areal Coverage
- Address traditionally underserved communities

Adaptable, flexible scan strategies

- Focus on active severe weather
- Avoid obstructions and interference

Rapid Volumetric Updates

- Improve model assimilation





Radar Next – Improved Weather Radar Capabilities Provide Increased Value

Severe Weather Forecasting



Improve the capability of existing severe weather forecasting and warnings.

Public Safety



Support national priorities for weather forecasting, disaster preparedness, flood and fire support, public safety, and protection of the Nation's infrastructure and natural resources.

Economic Impact



Help businesses and communities prepare for adverse weather conditions, reducing disruptions to transportation, supply chains, and services.

Data Infrastructure



Provide a data collection infrastructure to significantly improve the severe weather forecasting and warnings, support research and commercial users, and maximize the value of radar data.

Climate Data



Support an integrated earth observing system that provides the nation accurate/reliable environmental and climate data.





Start with User Needs: Collection Approach

- Radar Next is starting to collect the full scope of validated, technically realizable, Doppler weather radar user needs that are **implementation agnostic and without regard to budget**
- Two pronged approach to collect user needs
 - Current Needs
 - How do you currently use NEXRAD?
 - What operational problems does NEXRAD solve?
 - What operational problems does NEXRAD not support?
 - Future Needs
 - What problems do you envision solving with a future capability?
 - What improvements to current NEXRAD capabilities would help to do your job better?
 - What would an “optimal” future radar network look like?

What is the problem you are trying to solve?

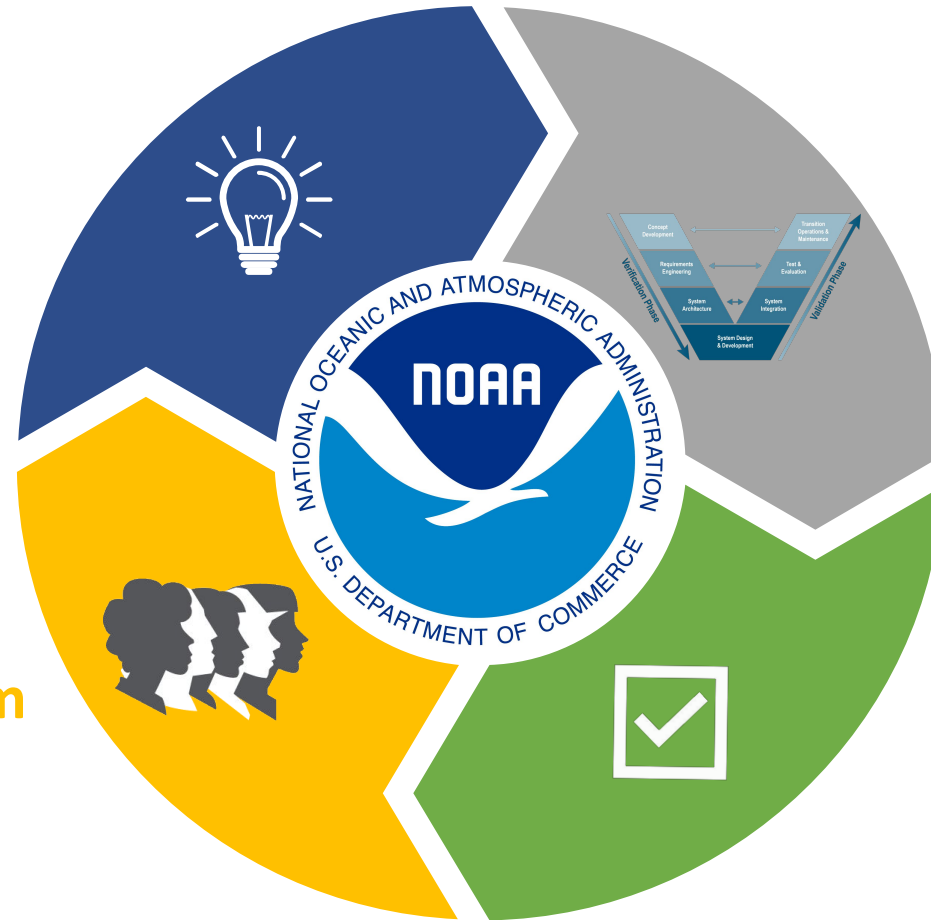


User Need Collection Approach

Implementation Agnostic

- Allows for any method of data acquisition: traditional, phased array, blended, data purchase, etc.
- For the Observational Objectives, we state the “what,” not the “how”

Gather user needs from a broad spectrum of diverse users



Connects high level requirements with field user needs

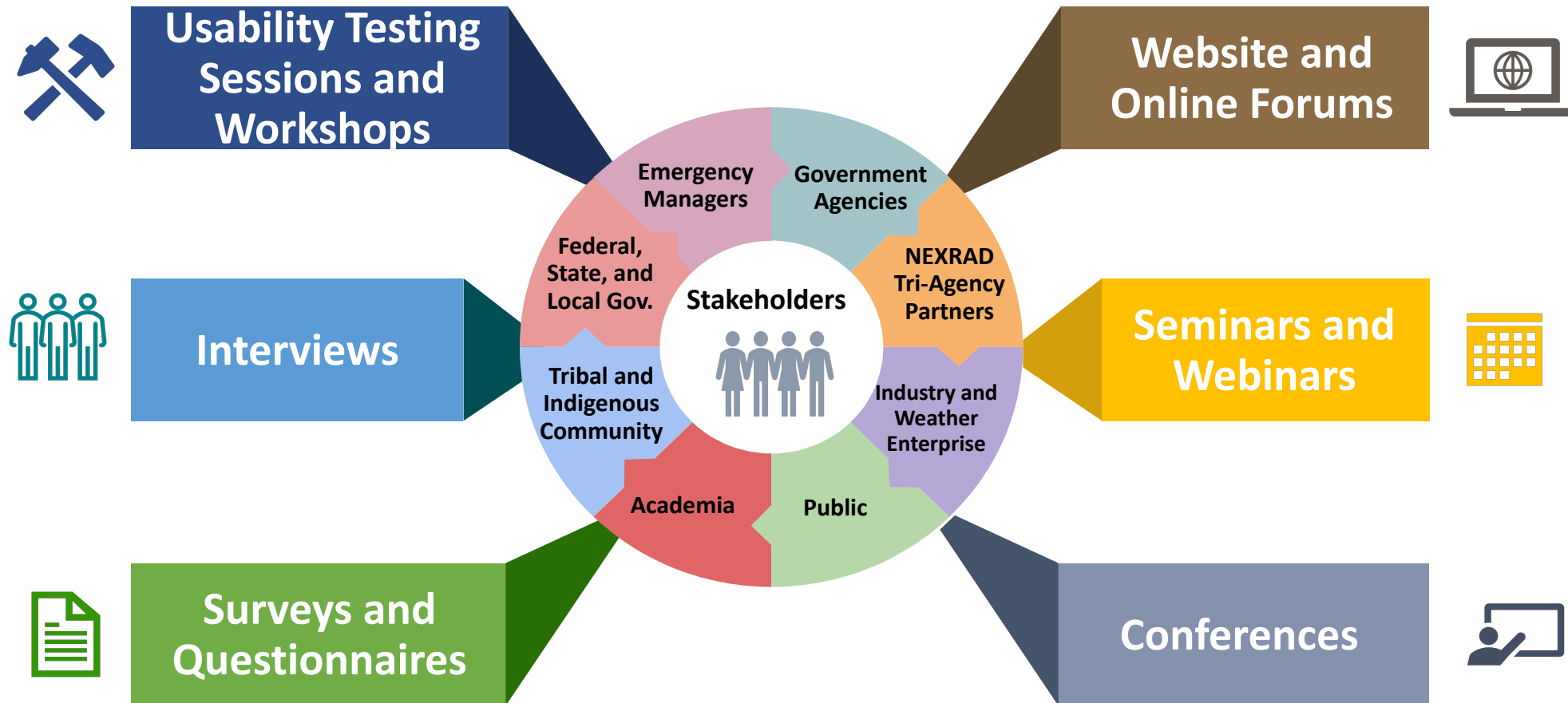
- Example: connects sample precipitation to reflectivity to 460 km

Explore Alternatives

- Sets the trade space for AoA
- Allows for future program growth and “top cover” to develop performance above Threshold (within budget)

Collection of User Needs and Assessments

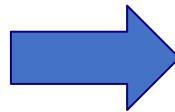
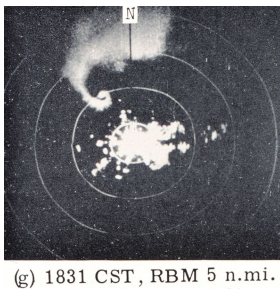
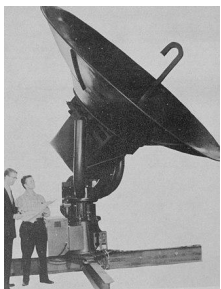
Radar Next will conduct many user engagement activities over the next several years.



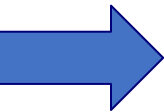
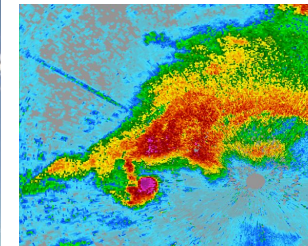
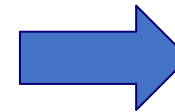
Summary

The Next Generation of Weather Surveillance Doppler Radars

- Radar Next is starting to collect the full scope of validated, technically realizable, Doppler weather radar user needs.
- These needs will establish the framework for developing technical alternative solutions.
- Radar Next will conduct many user engagement activities over the next several years.
- We welcome and encourage participation from the all interested communities.



Combined WSR-57 and WSR-74 Radar Network: Coverage below 10,000 feet AGL





Final Words

- It starts with the understanding and collection of user's needs – now and in the future
- Program formulation is dynamic; timely communication is vital to success
- New programs, such as the next generation radar project, occur generationally; the opportunity to shape the future of radar observations is exciting
- Our expectation is to build upon and improve the current world-class NEXRAD system to provide even more critical information to the users and the public.



Questions and Answers

