



# Phased Array Radar: How Technologies are Improving our Future Observations

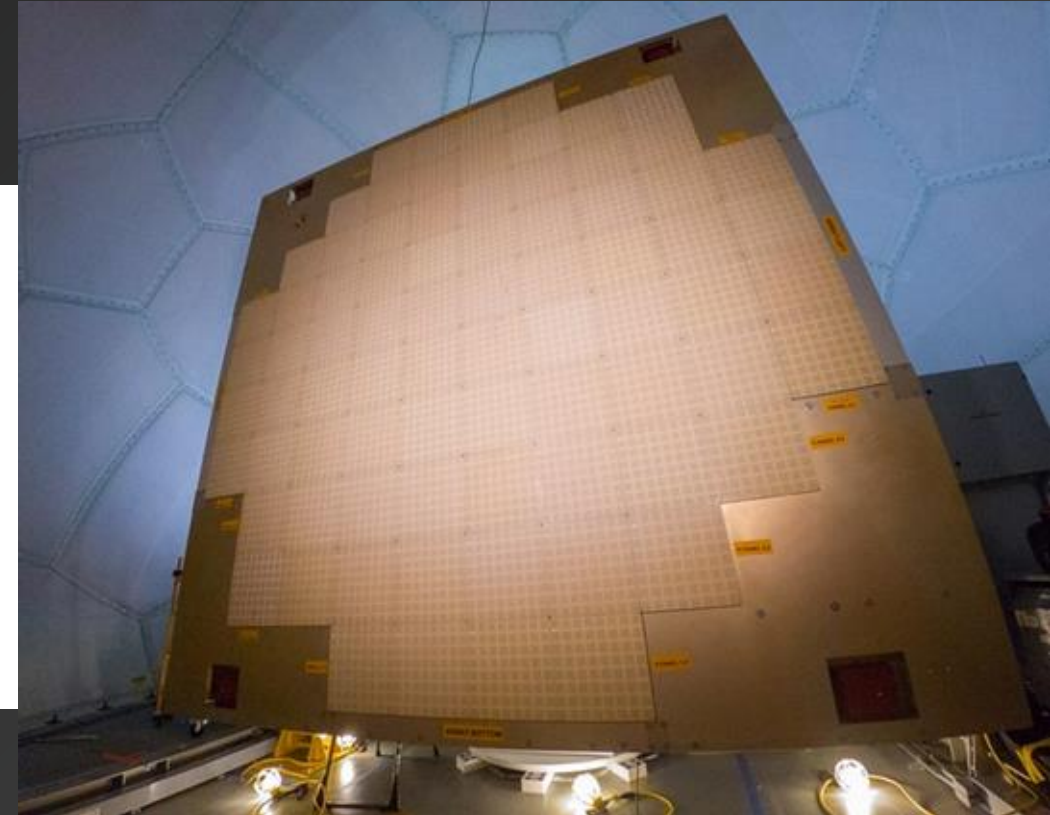
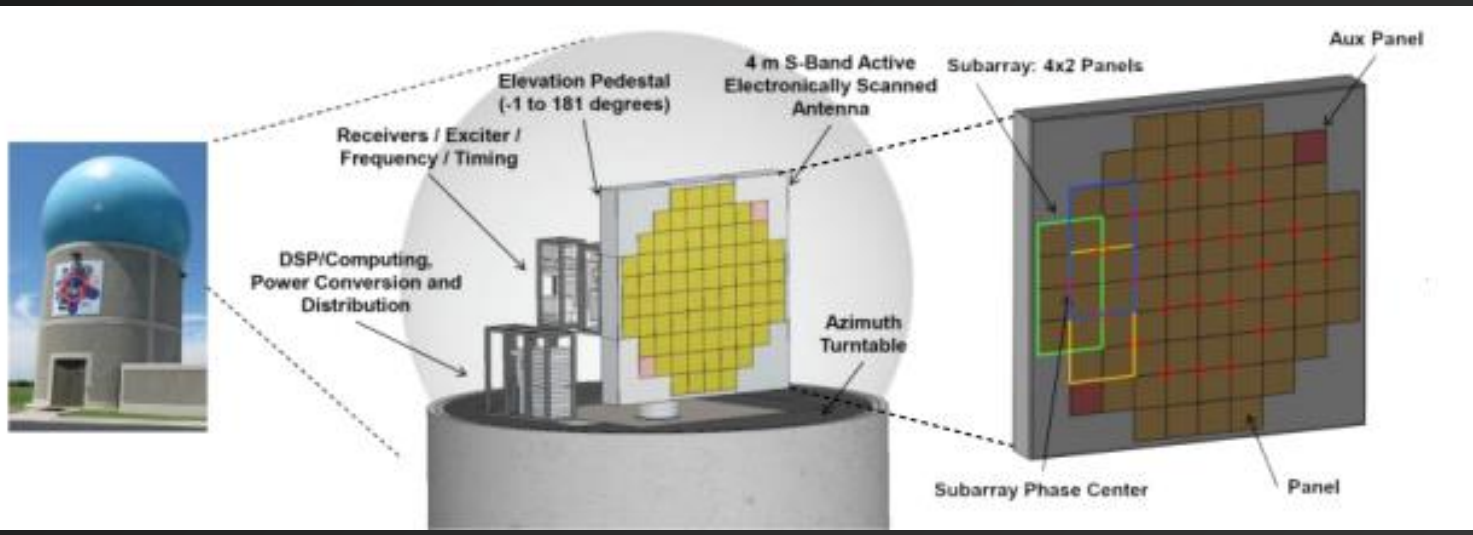
Anthony Reinhart NOAA/OAR/NSSL

## National Weather Radar Testbed in Norman Oklahoma





# Phased Array Radar (PAR)



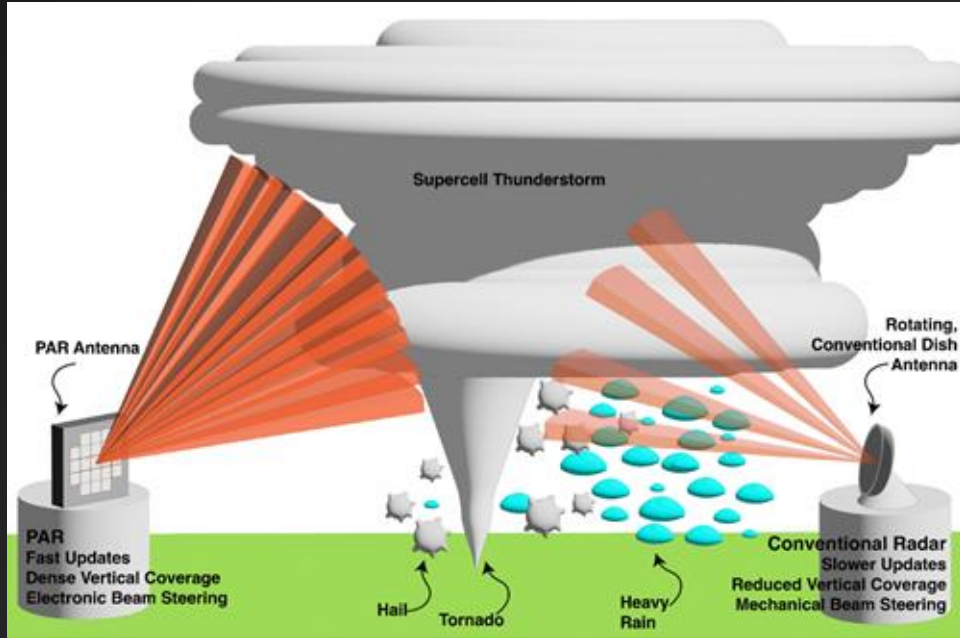
- S-band, dual-polarization weather radar with a 1.6° beam at broadside.
- Replicates **one side of a 4-face panel** concept. Has a 90° field of view and can be repositioned to scan any sector of interest.

Above: The Advanced Technology Demonstrator (ATD), dual-polarization PAR at NSSL.





# PAR CAPABILITIES AND BENEFITS



Capability	NEXRAD	Rotating PAR	Four-Face PAR	Potential Impacts
Volume update time	4-5 min (~6 min with SAILS)	~ 1.5 min	~ 1 min	<ul style="list-style-type: none"> <li>Improved tornado and severe warnings</li> <li>Improved guidance for weather hazards</li> <li>Improved Model Performance</li> <li>Improved forecaster confidence</li> </ul>
Adaptive scanning	Very Limited	Limited	Yes	<ul style="list-style-type: none"> <li>Improved characterization and forecasting of storms</li> <li>Flexible scanning</li> </ul>
Frequency Agility	No	Yes	Yes	<ul style="list-style-type: none"> <li>Reduced interference from other signals for improved data quality</li> <li>Spectrum efficiency</li> </ul>
Adaptive beam shaping	No	Potential	Potential	<ul style="list-style-type: none"> <li>Wind farm clutter mitigation</li> </ul>



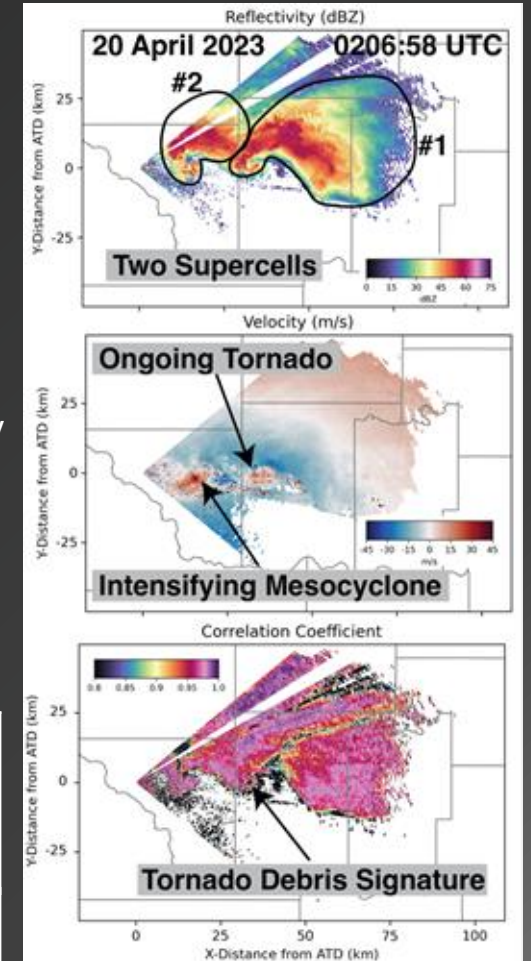


# ATD DATA COLLECTION (2021-PRESENT)

- ATD has collected over 500 hours of weather data across 100+ events.
- Enables scientists and engineers to continue to drive innovative science and advance NOAA's understanding of PAR technology and meteorology
- Provides NWS Norman WFO with real-time access to ATD data for use during severe weather events
- Near real-time figures and all past figures: <https://apps.nssl.noaa.gov/par/>
- 2023 and future years of data are located: [data.nssl.noaa.gov/](https://data.nssl.noaa.gov/)

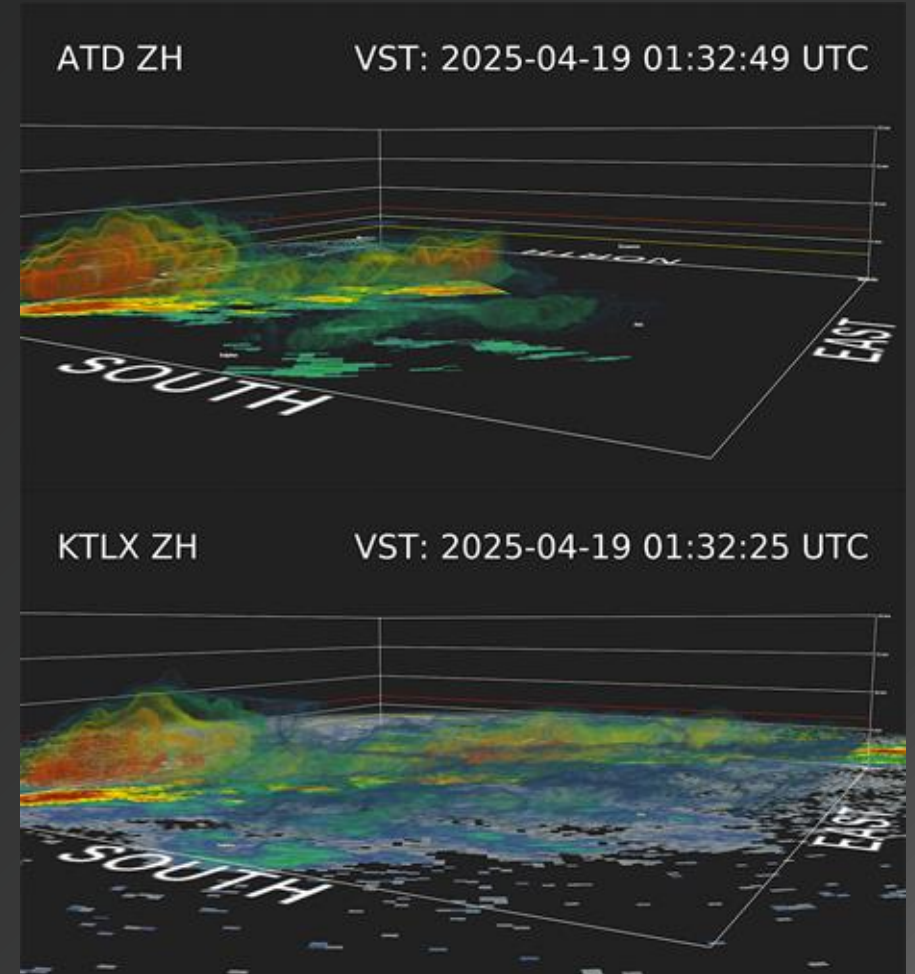
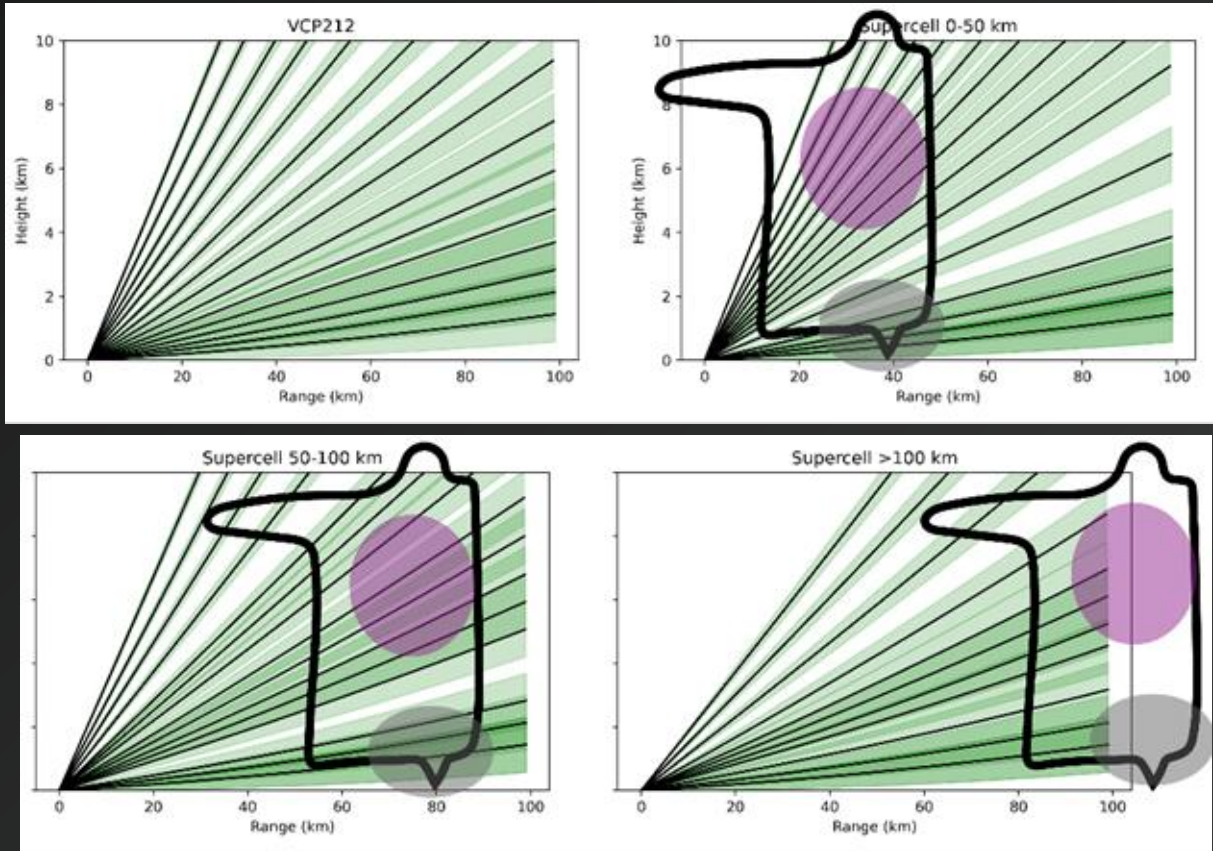
## 2021 – Present Data Collection Event Type

Tornadic Supercells	Severe and Non-severe MCS	Severe Multicell Convection	Non-severe Multicell Convection	Downburst	Winter Weather	Clear Air & Engineering Tests
20	25	25	20	10	10	18





# ATD DATA COLLECTION



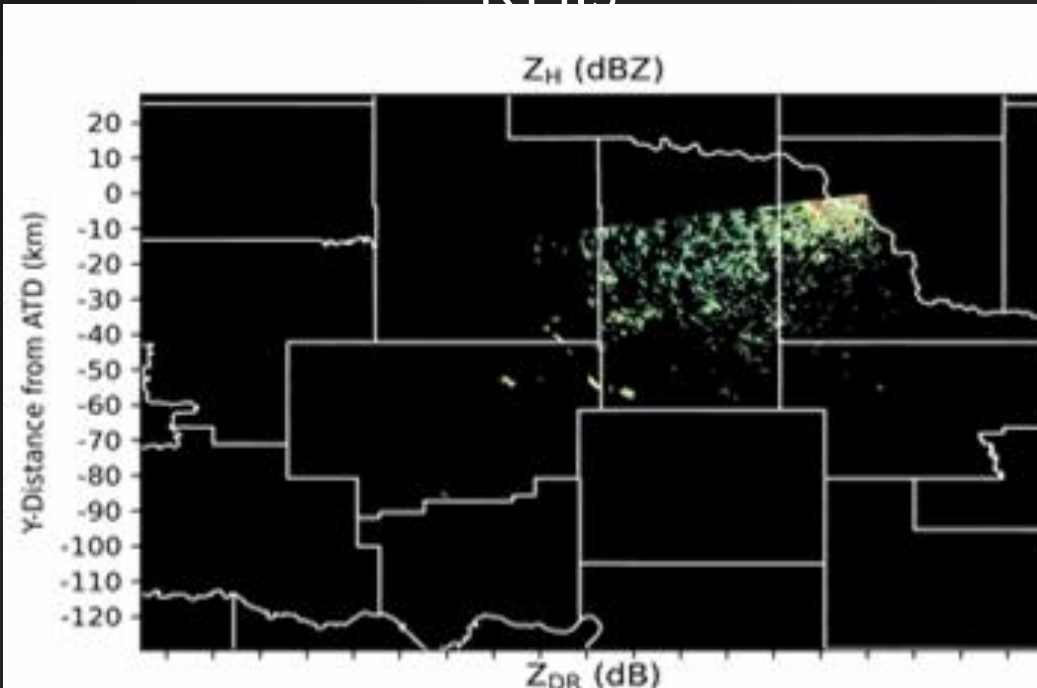
Volumetric PAR (top) and WSR-88D (bottom) data. The first half of the animation shows radar reflectivity (ZH) and the second half shows normalized rotation (NROT). Brighter reds (blues) in NROT depict increasingly intense cyclonic (anti-cyclonic) rotation. VST is the volume start time.





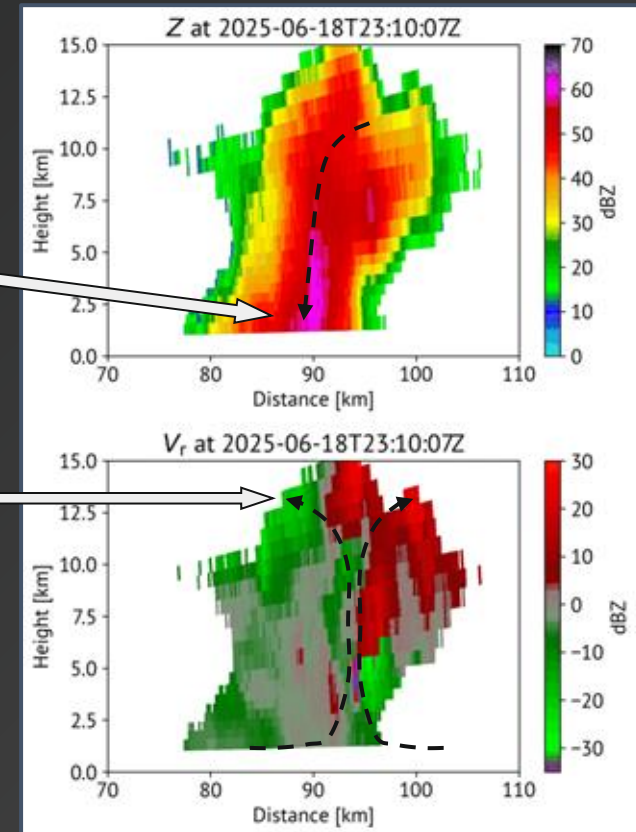
# ATD New Data Collection Methods

## Adaptive Scanning RHIs



Precipitation  
fallout

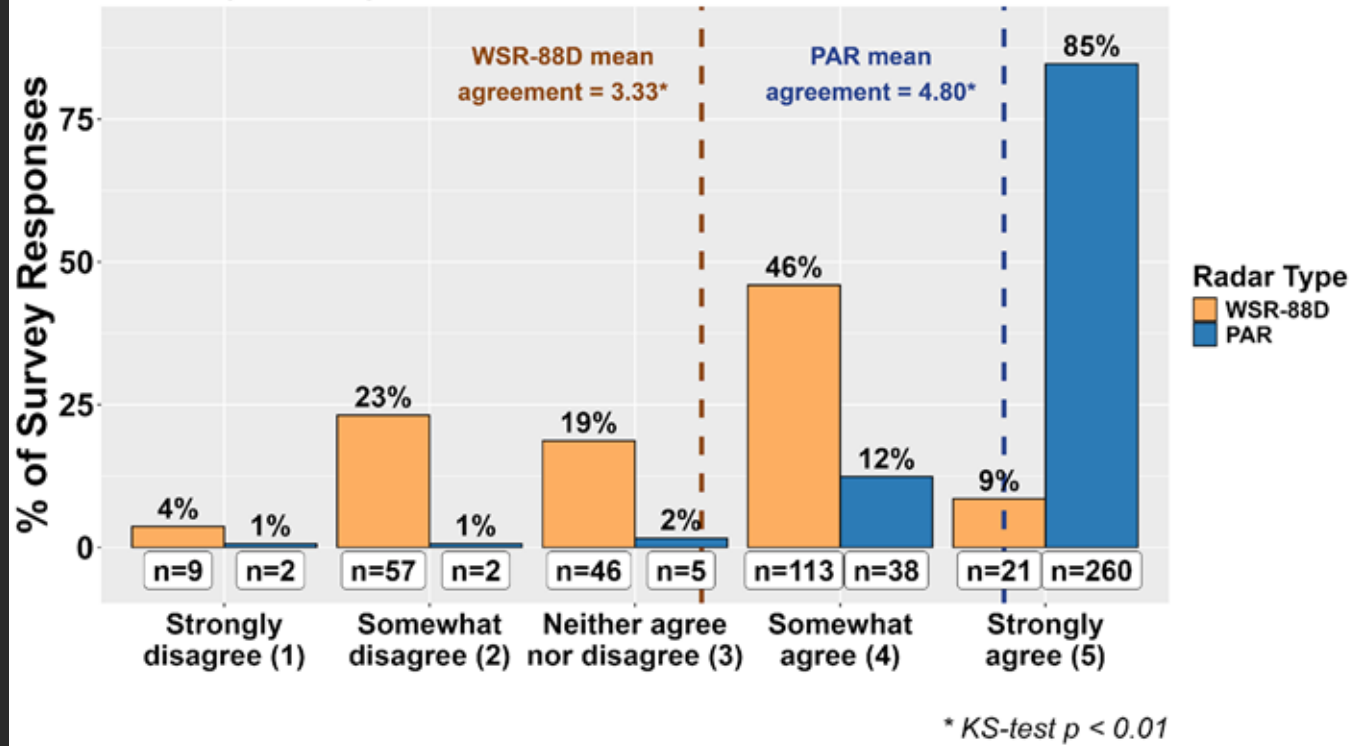
Storm-top  
divergence



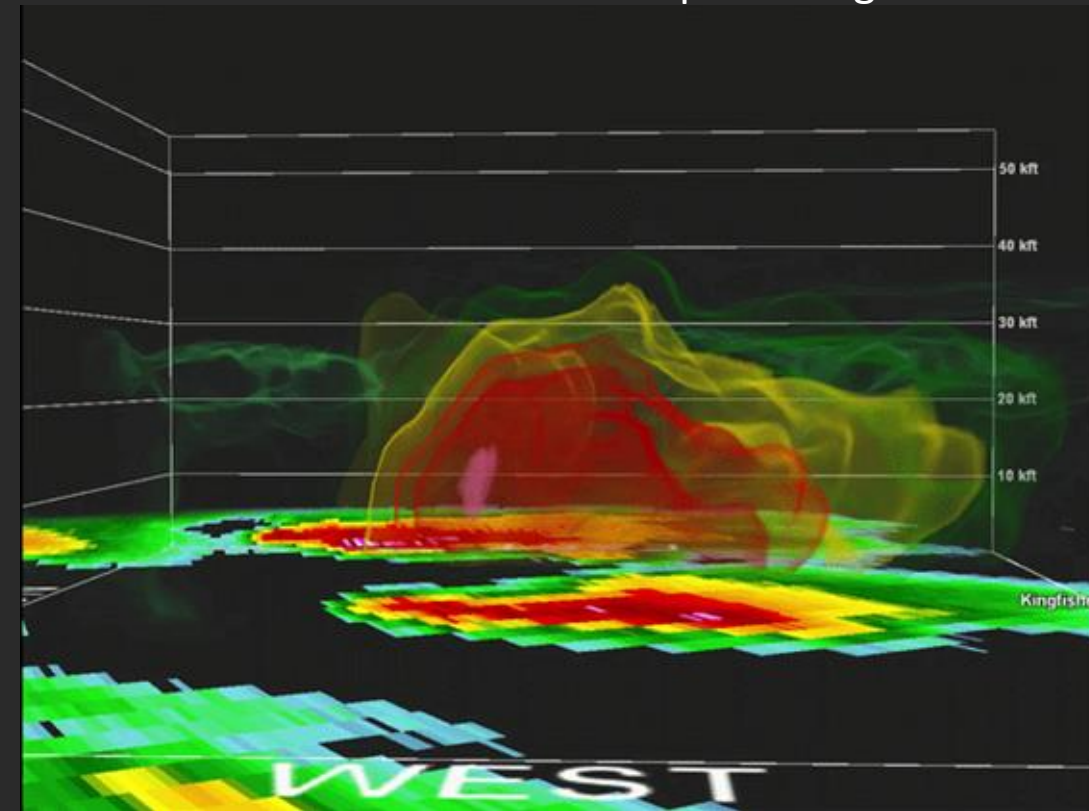
# Forecaster Evaluation in the Hazardous Weather Testbed

PAR data helped forecasters identify storm-scale processes and have better conceptual understanding of the storms

The volume update time was sufficient for me to easily identify storm-scale processes



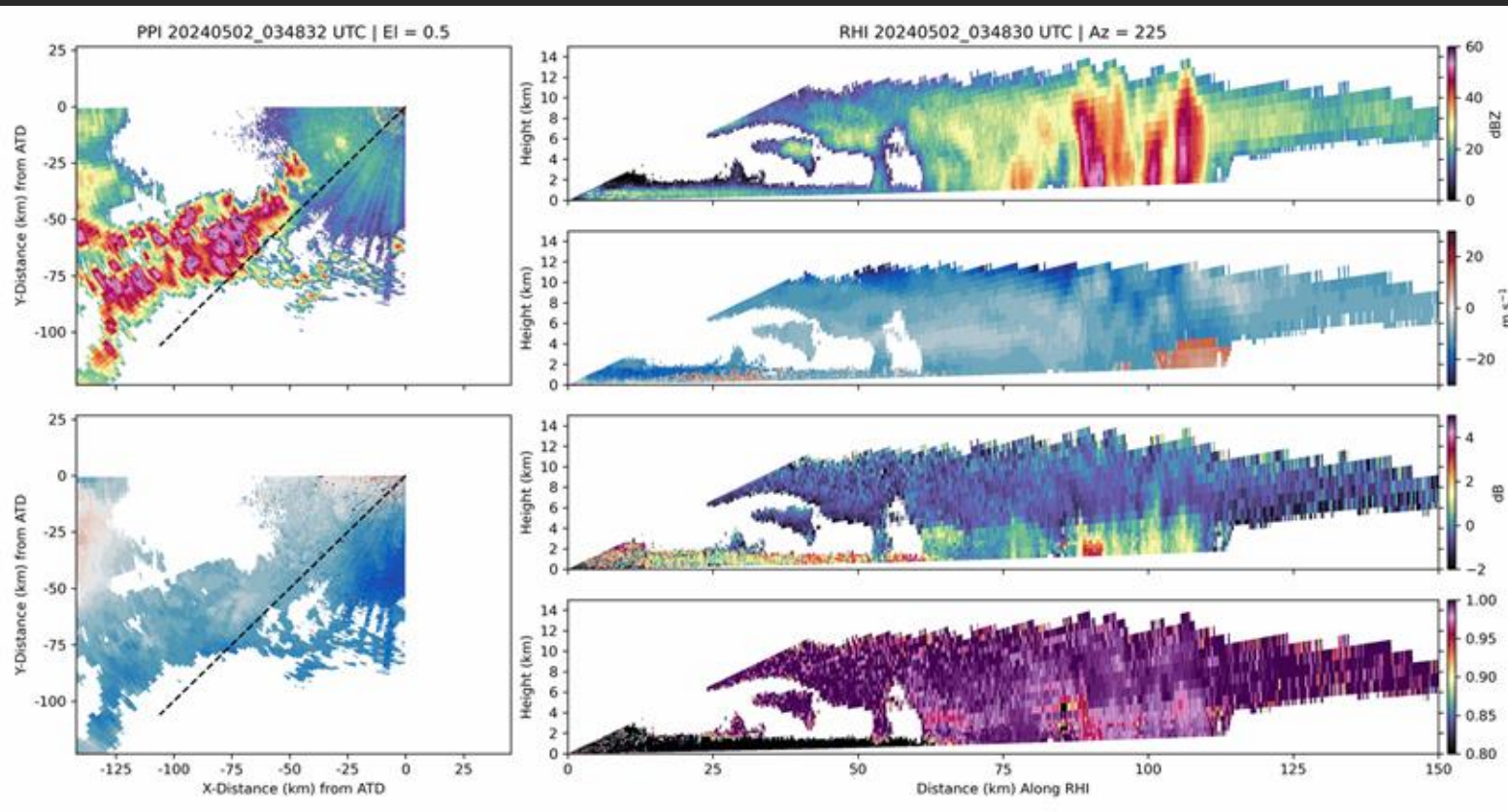
12 min of PAR data in a hail-producing storm



“The biggest factor [for increased warning confidence] is **watching a process**, and seeing the evolution of signatures...With the 88D, you may be able to catch one scan or two of it, but then it is gone. Here, **I was able to apply basic supercell, QLCS, and multi-cell concepts** when analyzing the data. **I spent less time reacting, and more time anticipating.**”

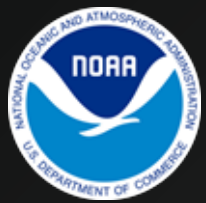
# Data Visualization is Important

Horizontal (left) and vertical (right) scans collected by the ATD



“And the fact that you have **so much more flexibility and customizability** with the phased array radar **opens up so many options for sampling storms based upon convective mode and the most likely storm hazards.**”

What I would want to have is some ability to have like for example, reflectivity layers, and you could... zoom into it, peel back layers, change up and down... **so that you can see that 3D evolution of important storm features**... If there was a way that I could interact with it and see it in three dimensions... **it would be a lot easier for me to synthesize what I'm seeing and be able to make warning decisions** using that kind of visualization environment...



# Summary

NOAA's PAR R&D Program continues to advance our understanding of meteorology and radar engineering

A future PAR **smart radar network** will be able to leverage AI/ML to 'see' evolution; adjust scans; and maximize data need for end users

Future Aviators will benefit from these new technologies

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# Discussion

