



# 2026 Radar Technology Community Workshop

## Final Report

*10 June 2026*

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*Sponsored by the United States National Science Foundation*





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## I. DOCUMENT PURPOSE

Per the deliverables of this National Science Foundation (NSF)-supported Radar Technology Community Workshop, the conveners and steering committee were tasked with writing a final report. The report defines a set of recommendations and specific tasks to develop a prioritized list of radar technology and facility needs, along with opportunities for interagency and industry partnerships. The content is based on a synthesis of recorded presentations and discussions held during the workshop.

The primary audience for this report is NSF and partner federal agencies. The priorities and recommendations are intended to highlight critical needs, guide investment decisions, sustain essential capabilities, and support continued U.S. leadership in atmospheric radar science over the coming decade. The findings also equip the weather radar community with a reference document to encourage accountability among agencies and institutions for implementing the recommended actions and support.

## II. EXECUTIVE SUMMARY

The United States (U.S.) weather radar enterprise remains a world-class scientific asset, but it is at a pivotal juncture. Recent advancements have enabled major breakthroughs across a wide range of applications, such as dual-polarization technology, mobile radar platforms, and open-source software. Sustaining this momentum, however, requires a deliberate and forward-looking strategy in the face of growing system pressures and emerging capability gaps. Preserving U.S. leadership in atmospheric radar science over the coming decades will require coordinated action to address vulnerabilities in existing infrastructure, limited access to mobile and deployable facilities, the continued absence of a community-accessible airborne precipitation radar, fragmented software ecosystems, and a looming technical workforce gap. The urgency is real: infrastructure is aging, costs are increasing for next-generation systems, and the window for strategic, coordinated interagency investment is rapidly narrowing.

### Strategic Imperatives

The NSF and partner agencies face four decisions that should not be deferred:

- **Sustain and maximize value of existing facilities.** Current radar facilities require stable, long-term support to enable cutting-edge research, rapid response to extreme weather events, and applications relevant for national security. Without sustained investment, scientific productivity declines, institutional knowledge erodes, and societal vulnerabilities increase.
- **Invest strategically in emerging technologies.** Phased array radar (PAR), distributed radar networks (i.e., multiple radar systems) and integrated environments, and Artificial Intelligence (AI)-assisted operations offer transformative capabilities. Maintaining a healthy balance between existing infrastructure and next-generation technologies will require sustained, coordinated investment rather than isolated, short-term projects. Specifically for PAR, increased calibration and cost demands necessitate technology maturation and risk reduction support to ensure proper adoption in the community.
- **Invest in the next generation airborne precipitation radar.** The need for a community-accessible airborne precipitation radar has been identified in every major community planning effort since 2012. Numerous studies have demonstrated the unique value of airborne radar observations for improving understanding and forecasting. A realistic, lower-risk development pathway for Doppler and dual-polarimetric PAR applications now exists, but coordinated agency commitment and investment is needed to move this capability forward.
- **Build the infrastructure that science depends on.** Efficient and meaningful access to datasets and software tools is essential for a rapidly evolving scientific community. Establishing a centralized hub for software, data, standards, and training provides critical infrastructure to support innovation and empower the next generation of radar science.

NSF investment should maximize scientific return by enabling comprehensive, high-quality observations while prioritizing broad utility, cost-effectiveness, and operational reliability over niche technological advances. Building a unified radar environment to accelerate AI-enhanced sensing, pursue a proper phased development and integration for PAR across deployment platforms, and strengthen the national radar workforce pipeline will sustain long-term leadership in atmospheric radar infrastructure and science. Addressing these key topics will enable the U.S. to transition from a collection of aging, largely siloed sensors to an integrated and coordinated radar ecosystem.

### III. UP-FRONT PRIORITIES WITH COORDINATED ACTIONS

The NSF National Center for Atmospheric Research (NCAR)'s Earth Observing Laboratory (EOL) hosted the NSF-funded Radar Technology Community Workshop (RTCW) on 10–12 March, 2026 in Boulder, Colorado. The 2.5-day workshop drew 184 participants from universities, federal agencies, and industry, spanning career stages from students to senior scientists and engineers. Its purpose was to evaluate the state of the enterprise across three dimensions: technical strengths that should be sustained and leveraged, weaknesses and vulnerabilities that require mitigation, and transformative opportunities that could reshape radar science over the next decade.

The U.S. weather radar community retains substantial strengths: broad frequency coverage, wide geographic reach, extensive dual-polarization capability, and established mechanisms for community access to facilities and datasets. At the same time, the workshop confirmed several growing vulnerabilities including aging infrastructure, insufficient technical staffing, a persistent gap in airborne precipitation radar community access, and a fragmented software ecosystem. **These challenges are interconnected and cannot be addressed in isolation.**

#### Workshop Central Findings

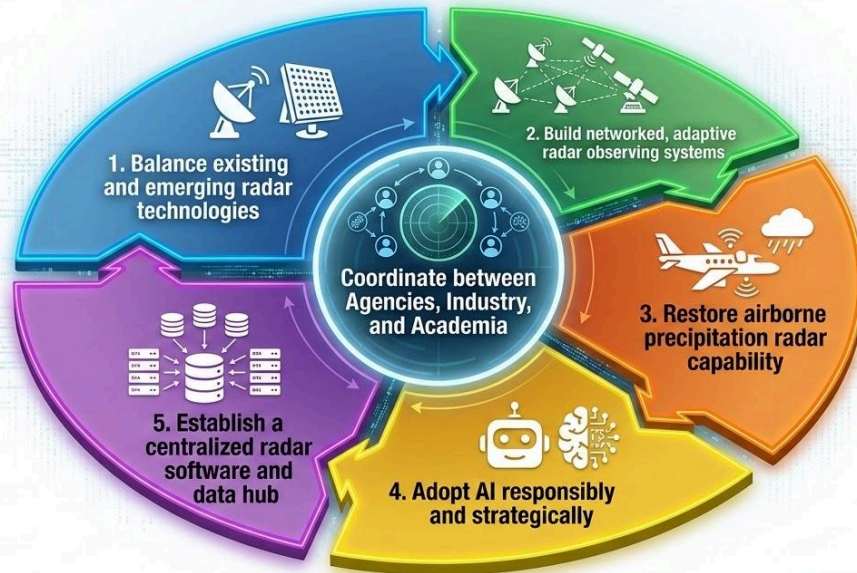
Discussions and presentations were organized around several strategic themes. The high priority items summarized below received strong, cross-cutting community support. Figure 1 illustrates how these priority areas are interconnected. Details on these topics are presented in Section VI.

1. **Balance existing and emerging radar technologies.** Participants emphasized the importance of sustaining proven ground-based and mobile radar systems while selectively integrating emerging capabilities such as PAR and bistatic sensing. To understand how to properly establish this balance, development of a comprehensive Science Traceability Matrix (STM) that explicitly links scientific objectives to radar measurement requirements and facility capabilities is essential. The STM will serve as a roadmap for proper use of different assets while identifying areas that are primed for advancement with emerging technology.
  - **Near-term recommendation:** Commission the advisory committees needed to develop an STM with actionable guidelines.
2. **Build networked, adaptive radar observing systems.** To improve temporal and spatial coverage of significant weather phenomena, the community envisions radars operating as connected, coordinated components of a broader observing network. Dynamically adapting measurement needs in response to evolving conditions and inputs from operational radars and satellites, lidar, cameras, lightning networks and uncrewed aerial systems (UAS) creates opportunities for advanced research and improved decision support. Achieving this vision

will require investment in real-time software integration, cyberinfrastructure, and multi-agency coordination.

- **Near-term recommendation:** Strengthen the software development and cyberinfrastructure facilities as foundational support for connected radar systems.
3. **Invest in advanced airborne precipitation radar capability.** The absence of a community-accessible airborne precipitation radar remains one of the most significant and longest-standing capability gaps in the U.S. radar enterprise, which will widen as the National Oceanic and Atmospheric Administration (NOAA) transitions away from the WP-3D aircraft. Supporting and investing in the next-generation Doppler, dual-polarimetric airborne precipitation radar will ensure that new capabilities associated with joint dynamics and microphysics will advance future scientific discoveries. With aircraft integration posing a significant hurdle for traditional mechanically scanning radars onto the future airframes (e.g., C-130), PAR technology is considered the best option for meeting the needs of the community. Participants agreed that a phased development strategy offers the most realistic and affordable path forward, but emphasized that action is needed now.
- **Near-term recommendation:** Initiate the first phase of airborne precipitation radar development by evaluating commercially available PARs with opportunities for dual-polarimetric capabilities.
4. **Adopt Artificial Intelligence responsibly and strategically.** AI is already contributing to radar quality control, adaptive scanning, and microphysical retrievals. Broader adoption is appropriate. Participants stressed the need for benchmark datasets, transparency standards, validation frameworks, and governance policies before AI can be deployed responsibly at scale.
- **Near-term recommendation:** Consolidate AI standards through interagency needs and identify or produce initial AI training datasets for benchmarking.
5. **Establish a centralized radar software and data hub.** Radar data volumes now exceed what many current community tools and workflows were designed to handle. A centralized hub, modeled on a Development Testbed Center (DTC), should consolidate open-source software support, benchmark datasets, data standards, and training resources. Such a facility should be treated as a critical national research infrastructure.
- **Near-term recommendation:** Create a formal charter, leadership structure, and implementation plan for a centralized data, software, and training hub through NSF investment and support.

## 5 PRIORITY AREAS FOR ADVANCING RADAR SYSTEMS



#RADARPRIORITIES

Figure 1. The five priority areas and their interconnections through coordination among federal agencies, industry, and academia.

The complete set of recommendations across near-, mid-, and long-term horizons is detailed in Section VII. The workshop emphasized that the challenges facing the radar community are shared across agencies and institutions. NSF has a central convening and investment role to play, but sustained progress will require genuine coordination among NSF, NOAA, National Aeronautics and Space Administration (NASA), Department of Energy (DOE), universities, and industry. Participants agreed that now is the appropriate time to establish and strengthen that coordination.

### IV. BACKGROUND, OBJECTIVES, AND SCOPE

The last NSF-funded workshop focused specifically on radar technology was held in November 2012. That effort, summarized in Bluestein et al. (2014), identified major science questions requiring radar observations and outlined the capabilities needed to address them. Priorities included advancing polarimetric radars for precipitation and cloud studies, expanding S-band Bragg scattering radars for clear-air processes, increasing access to airborne radars for oceans and remote regions, developing ship- and buoy-based systems for data-sparse areas, expanding deployable radar networks with adaptive scanning, broadening PAR adoption, and improving software, archives, data access, standardization, and training.

More than a decade later, several of these goals have been realized. The U.S. possesses a highly mature foundation in dual-polarization radar technology. This capability has successfully

transitioned from basic research into critical national infrastructure through the NEXRAD (WSR-88D) network upgrade, now used operationally for improved precipitation microphysics characterization, hydrometeor identification, and flash flood forecasting. This transition represents one of the most successful research-to-operations (R2O) pathways in atmospheric science and provides a strong base for future innovations. Community access to airborne cloud radars has also expanded. Open-source software frameworks (Heistermann et al. 2015) and standardized data formats and workflows have matured through platforms such as Lidar and Radar Open Software Environment (LROSE, Dixon et al. 2026) and the Python ARM Radar Toolkit (Py-ART, Helmus and Collis 2016). PAR development has also advanced through partnerships among federal agencies, universities, and industry (e.g., *SKYLER*, Kollias et al. 2022b; *Horus*, Palmer et al. 2023; *Advanced Technology Demonstrator*, Torres 2024; *APAR*, Joseph et al. 2025, Vivekanandan and Loew 2018), but the technology has yet to be broadly adopted.

Important capability gaps nevertheless remain. The 2023 NSF NCAR Facilities for Atmospheric Research and Education (FARE) Users Workshop (Baeuerle et al. 2024; Geerts et al. 2025) reaffirmed many of the priorities identified in 2012, particularly the need to sustain mobile radar access, invest in new centimeter-wavelength PAR systems, strengthen open-source radar software, and improve data access and processing capabilities.

Deployable and mobile radars are consistently requested for a variety of research needs and field campaigns. These radars provide critical information on high-impact weather systems yet deployment and staffing resources do not match the needs across the community. This raises an important question related to the methods for utilizing these radars (e.g., single field campaigns). Previous input from the FARE Users' Workshop suggests a more flexible approach that increases and expands deployable radar resources for gap-filling and coordinated missions across multiple, simultaneous weather systems is of interest. Strategically placed and adequate staffed mobile radar systems at several regional sites could improve community access and better serve atmospheric science research needs.

Another capability gap that has remained unresolved across successive planning cycles is the lack of a community-accessible airborne precipitation radar. The Airborne Phased Array Radar (APAR) program represented the most recent and ambitious attempt to close this gap, but the custom solution proved technically and financially unsustainable as a single-stage development effort, and NSF support was withdrawn. Since then, the gap has widened further. NOAA's fleet transition from the WP-3D to C-130J aircraft is expected to discontinue the Tail Doppler Radars (TDR) with a short development window to build and integrate on the new airframe. No equivalent interim capability currently exists across any U.S. agency. These developments are directly shaping the community's recommended path forward.

At the same time, several existing NSF-funded radar systems continue to age, increasing the urgency of decisions related to maintenance, modernization, recapitalization, and replacement. Delayed action is likely to increase future costs and reduce community access in the interim. Against this backdrop, the RTCW was convened to assess current capabilities, identify high-priority gaps, and define a path forward for the next generation of U.S. radar infrastructure and science.

## V. WORKSHOP OVERVIEW

The RTCW was held in hybrid format and included participants from universities, federal agencies, private industry, and the early-career research community. Image 1 shows the large group of in-person attendees outside the UCAR Center Green Campus on March 10, 2026. The program combined expert presentations, community input, and structured discussions designed to identify actionable priorities for future radar investment.



Image 1. All of the in-person attendees convened outside the UCAR Center Green Campus on Day 1, prior to the poster session and reception.

To support identifying priorities, the steering committee organized discussions around four strategic themes:

1. **Next-Generation Radar Technology** – emerging radar systems, evolving measurement needs, and pathways for technology transition.
2. **Sustainable Facility Operations and Partnerships** – maintaining community access to radar assets through modernization, coordination, and shared investment.

3. **Community Software and Data Integration** – improving software interoperability, data access, standards, and algorithm development.
4. **Engaging the Future Workforce** – strengthening training pathways, technical staffing, and hands-on learning opportunities across career stages.

Across all sessions, participants consistently emphasized that radar science challenges can no longer be separated from infrastructure, software, workforce, and partnership needs. Scientific priorities, including severe storms, tropical cyclones, winter weather, boundary-layer processes, and cloud microphysics, were repeatedly linked to the need for sustained facility support, modern software ecosystems, accessible data, and technical staffing. Participants also highlighted the growing importance of radar data for numerical weather prediction, data assimilation, AI applications, and integrated observing networks.

A consistent conclusion emerged across sessions and open discussions: the U.S. retains substantial strengths in radar infrastructure and science, but progress is increasingly constrained by aging infrastructure, fragmented software ecosystems, limited technical staffing, and uneven access to training and field experience. Participants from academia, federal agencies, and industry agreed that future success will require coordinated investment in both sustaining existing capabilities and developing next-generation systems, supported by stronger interagency collaboration, clearer governance, and long-term planning.

The workshop discussions directly informed the cross-cutting priorities and recommended actions presented in the following section. Additional details on session content and discussion themes are provided in the appendices.

## VI. STRATEGIC FINDINGS AND COMMUNITY PRIORITIES

Across the workshop discussions, participants converged on several recurring themes and priorities that warrant both near- and long-term NSF and interagency investment. These priorities are strongly interconnected and collectively define a practical path forward for the U.S. radar enterprise. Given the breadth of expertise represented—including radar developers, operators, facility managers, data providers, and scientific users—they should be viewed as an authentic reflection of the community’s most pressing needs and strategic priorities for advancing atmospheric radar science.

### **Balance Existing Infrastructure with Emerging Technologies**

Existing research radars remain highly capable and continue to support fundamental atmospheric research. Long-term, quality-controlled datasets from established systems are essential for process studies, model validation, and benchmarking new technologies. Sustained support for NSF-funded facilities, including the Lower Atmosphere Observing Facilities (LAOF),

Community Instruments and Facilities (CIF), and specialized systems such as W-band radar remains critical. Without continued investment, deferred maintenance, reduced reliability, and reduced production of trusted datasets will further weaken current capabilities.

At the same time, emerging technologies warrant continued evaluation and targeted investment. PAR systems continue to attract attention because of their potential scientific value (Kollias et al., 2022a), operational reliability and long-term cost-effectiveness. While important tradeoffs in capabilities and complexity remain under evaluation, existing commercial developments may provide lower-risk and cost-effective entry points that allow researchers to gain operational experience while industry adapts these systems for atmospheric science applications.

Participants do not support wholesale replacement of conventional radars with new technology. Instead, they favor a balanced portfolio that sustains proven infrastructure while integrating new capabilities where they provide clear scientific benefit. Operating conventional and emerging radar systems together can improve coverage, calibration, scan strategy development, and retrieval performance, while established systems provide an essential validation baseline for new technologies. Recent experiments involving operational and research PAR systems and bistatic radar networks (Emmerson et al. 2025) demonstrate the value of this approach. By specifically allocating financial resources to increase the pool of deployable conventional radar platforms (such as S-Pol, [Hubbert et al. 2018] or Doppler on Wheels, [Wurman et al. 1997, Wurman et al. 2013]), new technology validation priorities and expanded research capabilities are achievable.

To guide future investment decisions, participants recommend development of an STM linking radar capabilities—including conventional scanning radars, PAR systems, bistatic networks, multi-frequency radars, W-band systems, and profiling radars—to priority science requirements across ground-based, mobile, shipborne, and airborne applications. Such a framework would help agencies evaluate priorities, sustainability needs, and long-term return on investment across competing scientific and operational demands.

### **Develop Advanced Networked Radar Capabilities**

Existing radar networks, including Next Generation Weather Radar (NEXRAD), were designed for well-defined operational missions but offer limited flexibility for adaptive research observing strategies. Newer gap-filling radar networks improve spatial coverage but typically operate as largely independent systems with limited coordination. While these radar networks have substantially improved weather monitoring, they do not yet provide the integrated observational capability needed for more advanced research applications.

Transforming radars from passive collectors into adaptive, intelligent observing systems represents a generational opportunity. Agentic AI frameworks can enable real-time scan strategy optimization (e.g., automatically increasing scan density in regions of rapid storm development),

automated quality control and artifact removal, and Machine Learning (ML)-based retrieval of thermodynamic and microphysical quantities. These capabilities substantially increase the scientific value of existing hardware without requiring major new capital investments.

Participants, therefore, support a more capable framework in which individual radars operate as coordinated components of a broader observing system that may also include operational radars, geostationary satellites, lidar, cameras, UAS, and in-situ instrumentation (Kollias et al., 2020). In such a configuration, information from across the networked sensor suite would help determine how each radar operates, concentrating observations where scientific value is greatest while reducing unnecessary sampling elsewhere.

AI-based system coordination could support dynamic tasking of multiple observational assets in rapidly evolving environments (Kollias et al., 2026). Demonstrations of this concept already exist in convective storm studies (e.g., Lamer et al., 2023). This approach is particularly well suited to research applications, where flexibility and rapid adaptability are possible (e.g., airborne PARs).

The workshop identified strong community interest in an NSF-supported deployable networked radar capability for high-impact weather studies. Realizing such a capability would require investments not only in radar hardware, but also in logistics, real-time software integration, communications infrastructure, and coordinated access to complementary observing systems.

### **Continue Pursuit of an Airborne Precipitation Radar Capability**

Airborne and shipborne radars provide irreplaceable access to precipitation and cloud processes over oceans and remote regions where ground-based observations are sparse or unavailable. Existing NSF-supported systems, including the Wyoming Cloud Radar (WCR, Haimov et al. 2018) and the High-performance Instrumented Airborne Platform for Environmental Research (HIAPER) Cloud Radar (HCR, Romatschke et al. 2025), are highly valuable for cloud-scale processes but do not address the broader community need for an airborne precipitation radar as described previously.

NOAA's TDR partially fills this gap for hurricane reconnaissance, but the aircraft carrying those radars primarily support operational missions and are not readily available for community access. NASA has also fielded airborne precipitation radars for satellite validation and precipitation studies, though several previous platforms are no longer active.

Participants identified community access to a next-generation airborne precipitation radar as one of the highest priority unmet needs in the U.S. radar enterprise. However, future availability remains uncertain across agencies because of evolving agency priorities, aircraft transition plans,

and platform integration challenges. Potential opportunities may exist across NSF, NOAA, and NASA platforms.

It was clearly stated among the participants that maintaining the status-quo is not acceptable for the next-generation airborne radar. While long-standing capabilities, such as dual-Doppler measurements, should be supported, taking advantage of significant advancements in dual-polarization capabilities would create many opportunities for advanced technical and scientific research. As part of the lessons learned from APAR, pursuing a custom, single large-scale deployment effort is not desirable. Rather, workshop participants strongly support a phased development strategy. This approach would reduce technical and financial risk while enabling incremental progress in radar technology, software integration, calibration, and aircraft integration. Additionally, the development pathway maintains progress toward a capability repeatedly identified as nationally important.

Participants suggested the following pathway:

- Evaluate commercially available, lower cost PAR systems within ground-based testbed environments.
- Develop supporting software, calibration procedures, and operational workflows.
- Assess aircraft integration approaches on candidate aircraft platforms.
- Transition toward scalable, community-accessible airborne precipitation radar systems once technical risks are sufficiently reduced.

### **Supervised AI Integration Across Radar Applications**

There is significant momentum in applying artificial intelligence and machine learning (AI/ML) to radar operations, data quality control, and adaptive scanning, and its role will continue to expand. The central question is no longer whether to adopt AI but how to do so while maintaining scientific credibility, physical consistency, and user trust. Participants emphasize that achieving this will require institutional structures, validation standards, and governance frameworks that are not yet fully established across the radar enterprise.

On the operational side, AI-assisted adaptive scanning has demonstrated value in convective storm studies by enabling real-time adjustment of scan strategies across multiple platforms. Participants agree that broader use of these approaches is appropriate and should be supported. However, fully autonomous radar operations, where AI systems independently control scan decisions (Kollias et al., 2026) without human oversight, are viewed as premature under current validation and operational standards.

The workshop outcome, therefore, favors a near-term “AI-assisted” approach, in which AI systems provide guidance and recommendations (shadow mode of operations) while human

operators retain authority over consequential decisions. Any transition toward greater autonomy should require documented performance benchmarks, rigorous validation, and formal approval from the operating institution and relevant agency partners.

Participants also noted that AI methods are sufficiently mature for broader application in data quality control and retrieval algorithms, particularly for identifying non-meteorological returns, isolating and tracking features, and improving polarimetric microphysical retrievals. These applications were viewed as lower risk than autonomous operational control and therefore suitable for earlier deployment.

Participants identified four specific structural elements needed for responsible scaling of AI across radar applications:

1. **Shared benchmark datasets.** Collections of labeled radar data spanning diverse weather regimes, frequency bands, and edge cases should be curated so algorithms can be consistently evaluated across institutions. These datasets should include data collected from research and operational radars with the expansion to a set of simulated radar datasets. Simulated radar data can prove vital for testing software and improving model estimates in a similar manner to using a trusted numerical weather model ‘nature run’ to understand performance metrics. AI training is a foundational requirement and depends on substantial quantities of representative data. Therefore, combining trusted real and simulated data would ensure the legitimacy of AI methods.
2. **Transparency standards.** Models used in community radar applications should document training data provenance, known failure modes, and the physical constraints. Systems that cannot meet minimum transparency standards should not be relied upon as ground truth.
3. **Validation frameworks.** Traditional metrics such as bias and skill scores remain necessary but are insufficient for evaluating AI behavior. The community needs methods to stress-test AI models under rare, novel, or out-of-distribution conditions.
4. **Governance policies.** Agencies and universities need clear policies defining responsibility for AI model performance, failure reporting, investigation procedures, and conditions for removal from service.

The centralized hub proposed elsewhere in this report is the natural home for these elements. Benchmark datasets, transparency standards, validation tools, and governance templates should be maintained there so oversight evolves alongside the technology rather than lagging behind it.

### Centralized Hub for Software, Data, and Training Resources

Emerging data models are transforming how researchers access and analyze radar observations. The Radar DataTree framework (Ladino et al. 2025) and Analysis-Ready, Cloud-Optimized (ARCO) data formats are reducing the time scientists spend on data discovery and wrangling from an estimated 80% of workflow time to as little as 5%, enabling massive-scale parallel

computation and faster scientific discovery on cloud computing platforms. The NSF NCAR Geoscience Data Exchange (GDEX) is another infrastructure enabling fast data discovery. Across discussions on software development, data access, benchmarking, and workforce training, participants repeatedly identified the need for a centralized coordinating entity modeled after a DTC or similar national community resource.

While NSF NCAR is recognized as a strong potential host because of its existing infrastructure and community role, participants emphasize that no single institution should necessarily serve as the sole solution. Participants instead suggest that existing organizations with community data systems, software engineering capability, and user-support infrastructure could provide strong starting points. Participants also note that many software and processing environments currently operate independently with limited interoperability, leading to duplicated effort, inconsistent workflows, and barriers for users.

The proposed hub would support four primary functions:

1. **Software and Data Access:** Support open-source tools, improve interoperability, standards, and next-generation radar systems.
2. **Benchmarking and Validation:** Maintain curated real and simulated datasets for evaluating retrievals, algorithms and AI applications.
3. **Training and Education:** Expand access to practical learning through interactive tools, guided data exploration, workshops, and modern online training resources.
4. **Apprenticeship and Practicum Programs:** Connect students and early career researchers with hands-on observational and technical experience.

Participants emphasize that such a hub should be viewed as shared national infrastructure supporting software, data stewardship, benchmarking, standards development, and workforce growth rather than as a standalone hardware facility.

## VII. RECOMMENDED ACTIONS

The priorities identified throughout this report point to a set of practical actions spanning near to long-term horizons. These recommendations are intended for consideration by agency leaders to enable the community to address the identified priorities. They are organized by implementation timeline: near-term (0–2 years), mid-term (3–5 years), and long-term (greater than 5 years). Items are not ranked by priority within each tier, and several actions will necessarily span multiple timeframes. As funding conditions, technology readiness, and community needs evolve, these recommendations should be revisited and refined. Table 1 below provides a breakdown of action items and milestones based on broad category initiatives and implementation timelines. Primary ownership of actions is highlighted based on a specific agency, interagency

collaboration, or academic partnership. The green highlighted actions in the “Near-term” column indicate actions that need attention due to dependencies later in the timeline. The timelines are intentionally broad to set an initial expectation of achieving the goals. A set of additional details is provided after Table 1 to provide context on the anticipated timeline.

Table 1. A list of near-, mid-, and long-term actions to support identified priority areas is provided. Items highlighted in green should receive more attention as other activities are reliant on these actions. Action ownership is defined based on broad sections within the radar community. Initial movement by these larger entities will assign detailed tasks to specific groups or institutions.

Topic	Near-term	Mid-term	Long-term	Key Milestones	Ownership
<b>Collaborative Oversight and Planning</b>	Commission Advisory Committees for: <ul style="list-style-type: none"> <li>Creation of a Science Traceability Matrix</li> <li>Define New Facility Types</li> <li>Centralized software and data access hub</li> <li>AI standards and policies</li> <li>Workforce development, training, and retention strategy</li> </ul>	Sustain Advisory Committees as needed to facilitate future actions based on Near-Term actions		<ul style="list-style-type: none"> <li>U.S. radar inventory and Science Traceability Matrix created (Q1-Q3 FY27)</li> <li>AI integration and standardization plan created (Q1-Q3 FY27)</li> <li>Workforce development charter plan and future strategy created (Q4 FY26-Q2 FY27)</li> </ul>	Federal (NSF, NOAA, NASA, DOE)
	Establish a Future Workshop Planning Team with expectations for RTCW at least every 5 years	Create a Mechanism for Mid-to-Long-Term Planning for Workshops		<ul style="list-style-type: none"> <li>Scope and objectives for next specific-topic radar workshop created (Q3 FY27 - Q1 FY28)</li> </ul>	Academia Private Industry NSF NCAR
<b>Infrastructure and Facilities</b>	Sustain funding mechanisms for existing radar facilities	Expand criteria and solicit new, verified technology to be included in the deployment pool.		<ul style="list-style-type: none"> <li>Funding commitments for LAOF and CIFs communicated (Q1-Q2 FY27)</li> <li>New opportunities advertised for institutional radars (Q2-Q4 FY27)</li> </ul>	Federal (NSF, NOAA, NASA, DOE)
	Commission creation of a Living Document of radar facilities across the U.S.	Maintain document as necessary		<ul style="list-style-type: none"> <li>Initial inventory document created (Q4 FY26 - Q1 FY27)</li> </ul>	NSF NCAR Academia
	Develop and Support Initial Development and Testbed Phase for Airborne Precipitation Radar	Solicit and Support Technology Acquisition and Software Development for Airborne Testing	Deploy Scaled and Verified Airborne Precipitation Radar	<ul style="list-style-type: none"> <li>Charter and approve plan for airborne precipitation radar (Q4 FY26 - Q2 FY27)</li> <li>RFI and RFQ for COTS radars for ground-based and airborne testbed evaluated (Q2 FY27 - Q1 FY28)</li> <li>Funding secured for testbeds</li> </ul>	Federal (NSF, NOAA, NASA)



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Topic	Near-term	Mid-term	Long-term	Key Milestones	Ownership
				(Q2-Q4 FY28) <ul style="list-style-type: none"> <li>• Testbed operated with performance metrics (Q2 FY29 - Q2 FY30)</li> <li>• Airborne precipitation radar integration and test flights completed (Q3 FY30 - Q4 FY31)</li> </ul>	NCAR Academia Private Industry
	Solicit proposals for Joint Radar Initiatives - Combining Emerging and Standard Platforms	Create an Official Networked Radar Facility for Field Deployments using STM		<ul style="list-style-type: none"> <li>• Scope and plan for integrated, networked radar facility created (Q1-Q3 FY27)</li> <li>• Additional radars (dish, PAR, etc.) for field deployments solicited (Q3-Q4 FY27)</li> <li>• Software and AI networked infrastructure developed and field tested (Q4 FY28 - Q3 FY29)</li> <li>• New or repurposed radars purchased and deployed (Q4 FY28 - Q2 FY29)</li> <li>• Integrated, networked radar facility becomes deployable (Q4 FY30 - Q3 FY31)</li> </ul>	NSF NCAR Academia Private Industry
<b>Data Access, Software, and AI initiatives</b>	Create initial charter for central hub based on Advisory Committee	Establish the centralized access hub - treat as national infrastructure	Establish a sustainable funding model for long-term support of centralized hub	<ul style="list-style-type: none"> <li>• Charter, scope, and regulations for centralized hub created (Q1-Q3 FY27)</li> <li>• Prototype centralized hub is created and open for community use (Q4 FY28 - Q2 FY29)</li> <li>• Operational access and training resources through the centralized hub deployed (Q3 - Q4 FY29)</li> <li>• Long-term, federal agency funding mechanism finalized (Q1 - Q2 FY30)</li> </ul>	Federal (NSF) NCAR Academia
	Identify common benchmark test datasets	Maintain and update common benchmark test datasets under the hub		<ul style="list-style-type: none"> <li>• Benchmark cases tested and finalized (Q2 - Q4 FY27)</li> </ul>	NCAR Academia



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Topic	Near-term	Mid-term	Long-term	Key Milestones	Ownership
	Update inventory of existing software and data access points	Maintain, update, and port cross-institute software and data into the hub		<ul style="list-style-type: none"> <li>Full inventory of software and data repositories created (Q3 FY27 - Q1 FY28)</li> </ul>	Federal (NSF, NOAA, NASA, DOE)
					NCAR
	Identify existing AI training datasets and models	Maintain, update, or add new AI training datasets and associated models into hub		<ul style="list-style-type: none"> <li>Initial AI training datasets and algorithms confirmed (Q2 - Q4 FY27)</li> </ul>	NCAR
					Academia
<b>Workforce Development</b>	Expand access and increase prominence of existing training programs	Expand hands-on and immersive experiences to all career stages	Develop standard practicum, leveraging the Networked Radar Facility	<ol style="list-style-type: none"> <li>Expanded workforce development strategy launched (Q3 - Q4 FY27)</li> <li>Workforce/training focus group identified (Q4 FY27 - Q2 FY28)</li> <li>Focus group provides evaluation of training resources (Q3 FY28 - Q1 FY29)</li> </ol>	Federal (NSF, NOAA, NASA, DOE)
					NCAR
		Academia			
		Private Industry			
	Develop standard training criteria based on recommendations from Advisory Committee	Iterative updates for standard training criteria		<ul style="list-style-type: none"> <li>Primary and advanced resources identified (Q2 - Q4 FY27)</li> <li>Resources updated based on focus group feedback (Q3 FY28 - Q1 FY29)</li> </ul>	Federal
					NCAR
					Academia
	Create technician retention program	Evaluate retention program effectiveness through periodic surveys within the field		<ul style="list-style-type: none"> <li>Targeted outreach plan created (Q4 FY26 - Q2 FY27)</li> <li>Technical retention plan evaluated with performance metrics (Q4 FY27 - Q4 FY28)</li> </ul>	Private Industry
					Federal
Academia					

Details on the action items in Table 1 are provided below in the three timeline tiers.

### Near-term Actions

1. Sustain funding mechanisms for existing radar facilities, including LAOF, CIF, and institutional radars. Expand the pool of university radars eligible for inclusion in the CIF program to broaden community access.
2. Establish and maintain a publicly accessible inventory of U.S. atmospheric radars that includes system type, operational status, operating frequency, platform, and institutional affiliation. A current and comprehensive inventory is essential for informed coordination and investment decisions.
3. Initiate the first phase of airborne precipitation radar development by evaluating commercially available PAR systems within a testbed environment. This phase should include trade studies of radar wavelength, mounting, and scientific objectives while producing documented performance assessments, validated calibration and software procedures, and clearly defined airborne integration requirements. Participants emphasized the need for dedicated funding and a designated lead institution independent of broader facility competition cycles.
4. Establish interagency and cross-institutional working groups focused on key technical and scientific priorities identified during the workshop. Participants also recommend more frequent, focused community workshops to maintain momentum and evaluate progress.
5. Develop a charter and implementation roadmap for a centralized community hub supporting radar data access, open-source software, standardized benchmark datasets, and workforce training. The roadmap should define governance, agency partnerships, resource requirements, and an achievable implementation timeline.
6. Develop a coordinated framework for AI integration across radar data collection, processing, and analysis. This framework should establish shared guidelines, transparency standards, ethical principles, and validation benchmarks applicable across agencies and institutions.
7. Launch an expanded workforce development strategy that includes hands-on radar experience, field campaign participation, industry internship pathways, and stronger engagement with engineering and technical programs to expand the pipeline of radar scientists, engineers, and technicians. Participants also emphasized that sustaining institutional knowledge and retaining experienced technical staff is equally important. Workforce strategies should therefore address both recruitment of the next generation and retention of the engineers, technicians, software developers, and operational staff who maintain and advance community radar capabilities. Participants also emphasized the importance of AI literacy, including the ability to evaluate when AI methods are appropriate, recognize physically unrealistic outputs, and apply validation and transparency standards responsibly.

## Mid-term Actions

1. Formally establish the centralized community hub proposed in the near-term as a sustained national resource supporting software development, data access, benchmarking, standards, and training. Participants emphasized that this facility should be treated as critical research infrastructure.
2. Develop an interconnected radar data ecosystem that enables interoperable, cloud-based access across NSF, NOAA, DOE, and university platforms. The system should support standardized data formats, algorithm benchmarking, and seamless integration of observations from both conventional and next-generation radar systems.
3. Secure coordinated resources among NSF NCAR, NOAA, and university partners to jointly advance the development of a next-generation airborne precipitation radar. Participants recommended a phased approach beginning with lower-cost PAR or mechanically scanning radar systems deployed in ground-based testbeds, followed by validation of software, calibration procedures, and aircraft integration concepts before progressing toward airborne deployment.
4. Identify funding mechanisms to acquire, modernize, or repurpose additional mechanically scanning radars for field campaigns and long-term field sites in order to address community-identified gaps in spatial and temporal coverage.
5. Expand and evaluate workforce development programs across multiple institutions and career stages to assess their effectiveness and establish best practices for long-term community training and technical workforce growth.

## Long-term Actions

1. Deploy a next-generation airborne precipitation radar on a community-accessible research aircraft, completing the phased development initiated in the mid-term actions. Ensure access for the broader research community through established field campaign request mechanisms.
2. Transition the U.S. research radar fleet toward a deliberate mix of conventional and next-generation systems, including ground-based and airborne PAR, bistatic and multistatic networks, and multi-frequency platforms, guided by an STM developed during the earlier phases. This transition should preserve the value of existing systems while integrating new capabilities in a coordinated and community-vetted manner.
3. Establish a sustainable long-term funding model for the centralized hub that supports continuing software development, data stewardship, benchmarking, and training as radar technology continues to evolve. The hub should be positioned to absorb and support data and tools from future systems as they come online.
4. Build a radar workforce commensurate with the technical demands of a modernized enterprise: interdisciplinary in training, supported by equitable access to hands-on experience, and sustained through career pathways spanning academia, federal agencies, and private industry.

## VIII. CONCLUSIONS

The RTCW confirmed that the United States retains substantial strengths in atmospheric radar infrastructure and science, but sustaining leadership over the coming decade will require deliberate and coordinated action. The findings summarized in this report reflect both the capabilities of the current radar enterprise and the growing pressures it faces, including aging infrastructure, the continued absence of a community-accessible airborne precipitation radar, fragmented software and data ecosystems, and a workforce pipeline that has not kept pace with evolving technological demands.

Importantly, these recommendations do not require rebuilding the U.S. radar enterprise from scratch. Many foundational elements already exist, including open-source software frameworks, facility-access programs, training efforts, and interagency collaborations. What is currently missing is the coordination layer needed to connect these efforts into a coherent national enterprise. Participants repeatedly emphasized the need for centralized infrastructure supporting software, data stewardship, benchmarking, AI governance, workforce development, and long-term planning. The near-term recommendations focus on establishing this coordination framework, while the mid- and long-term recommendations build toward a modernized, interoperable, and sustainable radar ecosystem.

The workshop also made clear that the scale of the challenge exceeds the capacity of any single agency. NSF plays a central role through facility support, community coordination, and strategic investment, but long-term success will require sustained collaboration among NOAA, NASA, DOE, universities, and industry. The U.S. radar community has the scientific expertise, the institutional foundations, and now a clear set of priorities. What is needed now is follow-through: stable funding, assigned responsibilities, and interagency coordination.

Beyond advancing atmospheric science, the investments outlined in this report will strengthen the nation's ability to understand, predict, and respond to high-impact weather and environmental hazards. Radar observations underpin critical capabilities ranging from severe storm forecasting and flood prediction to hurricane research, aviation safety, water resource management, and national resilience. As weather extremes become more costly and complex, maintaining a robust and innovative radar enterprise is increasingly a matter of public benefit and national interest. Strategic investments in radar infrastructure, software, workforce development, and interagency coordination will not only accelerate scientific discovery but also improve decision-making, reduce risk, and enhance the nation's preparedness for future environmental challenges.

## IX. REFERENCES

- Baeuerle, B., M. Diao, R. Delgado, B. Geerts, A.G. Hallar, J. Lundquist, J. Mak, D. Turner, P. Veres, and J. Vivekanandan, 2024: FARE Users' Workshop Final Report. NSF NCAR Earth Observing Laboratory. <https://doi.org/10.26023/m4t2-pg36>.
- Bluestein, H. B., and Coauthors, 2014: Radar in Atmospheric Sciences and Related Research: Current Systems, Emerging Technology, and Future Needs. *Bull. Amer. Meteor. Soc.*, **95**, pp. 1850–1861. <https://doi.org/10.1175/BAMS-D-13-00079.1>.
- Dixon, M., J. DeHart, B. Javornik, T.-Y. Cha, M. Bell, and W.-C. Lee, 2026: The Lidar Radar Open Software Environment (LROSE): An End-to-End Suite of Applications for Radar and Lidar Processing. *Journal of Open Research Software*, 14(1), p. 26. <https://doi.org/10.5334/jors.630>.
- Emmerson, S., R. Palmer, D. Bodine, D. Schwartzman, P. Kirstetter, P. Skinner, and C. Fulton, 2025: Retrieval and Quantitative Evaluation of Three-Dimensional Winds in Severe Convection with Multistatic Radar. *J. Atmos. Oceanic Technol.*, **42**, 1167–1183, <https://doi.org/10.1175/JTECH-D-24-0155.1>.
- Geerts, B., and Coauthors, 2025: Recommendations for the NSF Facilities for Atmospheric Research and Education (FARE): Access and Capabilities. *Bull. Amer. Meteor. Soc.*, 106, E1077–E1086. <https://doi.org/10.1175/BAMS-D-24-0125.1>.
- Haimov, S., and Coauthors, 2018: Compact Airborne Ka-Band Radar: a New Addition to the University of Wyoming Aircraft for Atmospheric Research, *IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium*, Valencia, Spain, 2018, pp. 897-900. <https://doi.org/10.1109/IGARSS.2018.8519605>.
- Heistermann, M., and Coauthors, 2015: The Emergence of Open-Source Software for the Weather Radar Community. *Bull. Amer. Meteor. Soc.*, **96**, pp: 117–128. <https://doi.org/10.1175/BAMS-D-13-00240.1>.
- Helmus, J. J. and S. M. Collis, 2016: The Python ARM Radar Toolkit (Py-ART), a library for working with weather radar data in the Python programming language. *Journal of Open Research Software*, vol. 4. <https://doi.org/10.5334/jors.119>.
- Hubbert, J. C., J. W. Wilson, T. M. Weckwerth, S. M. Ellis, M. Dixon, and E. Loew, 2018: S-Pol's Polarimetric Data Reveal Detailed Storm Features (and Insect Behavior). *Bull. Amer. Meteor. Soc.*, **99**, pp: 2045–2060. <https://doi.org/10.1175/BAMS-D-17-0317.1>.
- Joseph, E. D., W.-C. Lee, and A. McComiskey, 2025: Airborne Phased Array Radar (APAR): The Next Generation of Airborne Polarimetric Doppler Weather Radar for Observing Heavy Precipitation and High-Impact Weather Events, 41st AMS International Conference on Radar Meteorology, Paper 12B.3, August 28, 2025, <https://ams.confex.com/ams/41Radar/meetingapp.cgi/Paper/462819>.

Kollias, P., E. Luke, M. Oue, and K. Lamer, 2020: Agile adaptive radar sampling of fast-evolving atmospheric phenomena guided by satellite imagery and surface cameras. *Geophysical Research Letters*, **47**. <https://doi.org/10.1029/2020GL088440>.

Kollias, P., and Coauthors, 2022a: Science Applications of Phased Array Radars. *Bull. Amer. Meteor. Soc.*, **103**, E2370–E239. <https://doi.org/10.1175/BAMS-D-21-0173.1>.

Kollias, P., E. P. Luke, K. Tuftedal, M. Dubois, and E. J. Knapp, 2022b: Agile Weather Observations using a Dual-Polarization X-band Phased Array Radar, *2022 IEEE Radar Conference (RadarConf22)*, New York City, NY, USA, 2022, pp. 1-6. <https://doi.org/10.1109/RadarConf2248738.2022.9764308>.

Kollias, P., E. Luke, K. Lamer, H. Hamann, B. P. Treserras, N. Allwayin, and M. Oue, 2026: Connected Radar: A New Paradigm for Atmospheric Observation and Experimentation. Accepted for publication in *Bulletin of the American Meteorological Society*.

Lamer, K., P. Kollias, E. P. Luke, B. P. Treserras, M. Oue, and B. Dolan, 2023: Multisensor Agile Adaptive Sampling (MAAS): A Methodology to Collect Radar Observations of Convective Cell Life Cycle. *J. Atmos. Oceanic Technol.*, **40**, pp: 1509–1522. <https://doi.org/10.1175/JTECH-D-23-0043.1>.

Ladino, A., M.A. Grover, S.W. Nesbitt, and K. Mühlbauer, 2025: Leveraging FAIR Principles for Efficient Management of Meteorological Radar Data. *105th Annual AMS Meeting 2025* (Vol. 105, p. 457374).

Palmer, R. D., and Coauthors, 2023: Horus—A Fully Digital Polarimetric Phased Array Radar for Next-Generation Weather Observations, *IEEE Transactions on Radar Systems*, vol. 1, pp. 96-117, 2023. <https://doi.org/10.1109/TRS.2023.3280033>.

Romatschke, U., and Coauthors, 2025: Economical and Effective Upgrades to an Airborne Cloud Radar With a Dual Pulsing Scheme, *IEEE Transactions on Geoscience and Remote Sensing*, vol. 63, pp. 1-9, 2025, Art no. 5107309. <https://doi.org/10.1109/TGRS.2025.3601429>.

Torres, S., 2024: New Capabilities of the Advanced Technology Demonstrator at the National Severe Storms Laboratory. *2024 IEEE International Symposium on Phased Array Systems and Technology (ARRAY)*, Boston, MA, USA, 2024, pp. 1-5. <https://doi.org/10.1109/ARRAY58370.2024.10880434>.

Vivekanandan, J. and Loew, E., 2018: Airborne polarimetric Doppler weather radar: trade-offs between various engineering specifications, *Geosci. Instrum. Method. Data Syst.*, **7**, pp: 21–37. <https://doi.org/10.5194/gi-7-21-2018>.

Wurman, J., K. Kosiba, and P. Robinson, 2013: In Situ, Doppler Radar, and Video Observations of the Interior Structure of a Tornado and the Wind–Damage Relationship. *Bull. Amer. Meteor. Soc.*, **94**, pp: 835–846. <https://doi.org/10.1175/BAMS-D-12-00114.1>.



Wurman, J., J. Straka, E. Rasmussen, M. Randall, and A. Zahrai, 1997: Design and Deployment of a Portable, Pencil-Beam, Pulsed, 3-cm Doppler Radar. *J. Atmos. Oceanic Technol.*, **14**, pp: 1502–1512. [https://doi.org/10.1175/1520-0426\(1997\)014<1502:DADOAP>2.0.CO;2](https://doi.org/10.1175/1520-0426(1997)014<1502:DADOAP>2.0.CO;2).

## APPENDICES

### A. List of Acronyms

AI	Artificial Intelligence
AMS	American Meteorological Society
APAR	Airborne Phased Array Radar
ARCO	Analysis-Ready, Cloud-Optimized
CIF	Community Instruments and Facilities
COTS	Commercial Off-The-Shelf
DOE	Department of Energy
DTC	Development Testbed Center
EOL	Earth Observing Laboratory (NCAR)
FARE	Facilities for Atmospheric Research and Education
GDEX	Geoscience Data Exchange
HCR	HIAPER Cloud Radar
HIAPER	High-performance Instrumented Airborne Platform for Environmental Research
LAOF	Lower Atmosphere Observing Facilities (NSF)
LROSE	Lidar Radar Open Software Environment
MAAS	Multisensor Agile Adaptive Sampling
ML	Machine Learning
NASA	National Aeronautics and Space Administration
NEXRAD	Next Generation Weather Radar
NCAR	National Center for Atmospheric Research
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
PAR	Phased Array Radar
R2O	Research-to-Operations
RFI/RFQ	Request for Information / Request for Quotation
STM	Science Traceability Matrix
TDR	Tail Doppler Radar (NOAA)
UAS	Uncrewed Aerial Systems
UCAR	University Corporation for Atmospheric Research
WCR	Wyoming Cloud Radar
WSR-88D	Weather Surveillance Radar-1988 Doppler

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Speaker	Presentation Title
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Brad Klotz	Workshop Logistics
Nick Anderson	NSF FARE Radar Facilities
Robin Tanamachi Angela Rowe	Other Radar Facilities and Networks
Sandra Yuter	Science Measurement Gaps: Winter Storms
Ghassan (Gus) Alaka	Science Measurement Gaps: Tropical Cyclones
Brenda Dolan	Science Measurement Gaps: Convective Storms and Microphysics
David Schvarzman	Advancements in PAR and Bistatic Radar Hardware and Capabilities
Venkatchalam (Chandra) Chandrasekaran	Innovative Advancements in Radar Technology for Weather Observations
Ricky Roy	Leveraging Metamaterials Antennas for Low-Cost Phased Array Radar Solutions in Atmospheric and Sea Surface Sensing
Anthony Reinhart	NSSL PAR Program Update and Research Roadmap
Pavlos Kollias	Cyberinfrastructure and Adaptive Radars
Haonan Chen	Use of AI for improving Radar Data Quality and Precipitation Estimates
Jothiram (Vivek) Vivekanandan	High-temporal and Spatial Resolution Radar with AI Application
Edward Luke	Saccadic Phased Array Radar Sampling (SPARS) of Severe Weather Phenomena - Case Study: A Microburst Event
Bart Geerts	Future of Community-Supporting Radar Facilities
Steve Nesbitt	Intersection of Radar Requirements and Scientific Advancement
Wen-Chau Lee	From Experience to Evolution: Lessons from APAR
Michael Bell Paul Reasor	Science Drivers for Future Airborne and Shipborne Radars
Brad Klotz	Feasibility Considerations: Cost, Design, and Deployment Challenges for Airborne and Shipborne Radars
Josh Wurman	Science Drivers for Future Ground-based and Mobile Radars
Tian-You Yu	Feasibility Considerations: Cost, Design, and Deployment Challenges for Ground and Mobile Radars
Scott Collis	Linking Data Processing, Management, and Products through Software
Alfonso Ladino Ricon	Radar DataTree: A Cloud-Native Data Model for Accessible, Time-Aware Weather Radar Collections
Jake Liu	Efficient Integration of Radar Observations and NWP models through JEDI for Model Evaluation and Data Assimilation
Nick Guy	Bridging the Training Gap in Private and Public Sector
Leanne Blind-Doskocil	Recalibrating University Radars: Purpose, Value, and a Sustainable Future
Rebecca Haacker	Innovation in Student Engagement and Training in Radar Meteorology and Engineering - Lessons from NSF NCAR's Workforce Development Programs

Presenter	Poster Title
Dhruva Anantha Datta	Low-Altitude Drone Monitoring Using 5G Base Stations RF Digital Beamforming
Maggie Neumiller	USDA-ARS Mobile Radar
Nithin Allwayin	Multisensor Agile Adaptive Sampling (MAAS)
Robby Frost	The Impacts of Global Regression Clutter Filtering on RaXPOL Observations of a Significant Tornado
Lauren Beard	Seeing Inside Storms with Radar How Air Motion Shapes Rainfall
Dezzynee Bryan	Wind Analysis of Tropical Cyclones Using SAMURAI and AOSPRES
Delián Colón-Burgos	Characteristics of Precipitation across the Atlantic Inter-Tropical Convergence Zone from Shipborne Sea-Pol Radar Observations
Ian Cornejo	Radar-Derived Insights of Microphysical Processes using the NSF NCAR S-POL Radar
Anik Das	Inv Marine Boundary Layer Cloud and Drizzle Microph Prop over the Southern Ocean Using Airborne In Situ and Radar Measurements
Zebulon Leffler	Observations of Internal Boundary Layers and Near-Surface Wind Estimation During the Landfalls of Hurricanes Ida
Ismail Gul	Stevens High-resolution Atmospheric Radar Project (SHARP)
Ivan Hernandez	Dual polarization time series (I&Q) analysis in updraft environments
Angela Wang	Microwave Scattering of Wildfire Ash
Zhe Xu	Leveraging Federated Learning for Generative Precipitation Nowcasting Across Diverse U.S. Climate Regimes
Hassan Al Sakka	AI-Driven Predictive Maintenance and Real-Time Health Monitoring Framework for Operational Radar Systems
Brenda Javornik Jen DeHart	Guiding the Next Phase of Radar Software Development and Data Access
Micheal Simpson	Climavision Gap-Filling Supplementary Weather Radar Network
William Brown	Radar Wind Profiler work at NCAR
John Hubbert	The Importance of S-Pol for Community Atmospheric Science Research
Brenda Philips	CASA Dallas–Fort Worth Living Lab A Real-World Testbed for Advanced Radar Technologies
Mariko Oue	Multi-Frequency Radar Facility for Small-Scale, Fast-Evolving Cloud System Research
Pierre Kirstetter	Stratospheric Balloon Radar Observation of Storms
Coltin Grasmick	Wyoming Cloud Radar (WCR) and Ka-band Profiling Radar (KPR)
Masanori Saito	A physics-based remote sensing of cold clouds using airborne radar and its synergy with other instruments.
Karen Kosiba	The updated FARM Flexible Array of Radars and Mesonets
Josh Wurman	Inexpensive Low-Risk Quickly-Developable High-Impact Broad-Impact Improvements to Observing Capabilities
Jorge Salazar	Dual-Doppler 3D Mobile Ka-band Rapid-Scanning Volume Imaging Radar for the Earth System Science (KaRVIR)
David Bodine	The Rapid X-band Polarimetric Radar Community Instruments and Facilities
Stephen Frasier	Skyler-1 X-band Dual-Polarization Phased-Array Radar
Tian-You Yu	2026 An Overview of the Shared Polarimetric Atmospheric Imaging Radar (PAIR)
Michael Bell, Chandra	CSU Sea-Going and Land Deployable Polarimetric (Sea-Pol) Radar

## C. Strategic Priority Summaries and Topical Findings

The Radar Technology Community Workshop was designed to gather broad community input on the current status and future direction of U.S. weather radar capabilities. In addition to formal presentations, the workshop relied heavily on structured discussions, breakout sessions, poster interactions, and plenary exchanges to identify priorities, concerns, and opportunities across the weather radar community. The summary below captures the discussions surrounding the strategic priorities identified for the agenda and the associated details of the technical findings.

### Current State of the U.S. Radar Enterprise

The NSF FARE program, which includes the Lower Atmosphere Observing Facilities (LAOF) and Community Instruments and Facilities (CIF), collectively supports a range of mobile, airborne, shipborne, and ground-based radars. These systems span a broad range of frequencies and are capable of studying processes from heavy precipitation to clouds. All are currently operational and available for field campaigns. Other NSF-supported non-radar facilities are part of a network of different data sources to complement radar measurements.

Beyond the NSF-supported systems, the U.S. radar landscape includes government networks from NOAA and DOE, oriented toward both operational and research goals, as well as a diverse array of university- operated radars used for local studies and educational purposes. A majority of the radars in this category are ground-based, dish radars designed to study precipitation. The university community stands out for its variety in platform architecture, application, and mobility. Across government and academic systems, approximately 70% of radars are dual-polarization capable.

The current enterprise has meaningful strengths: broad frequency coverage, wide geographic reach, dual-polarization adoption across roughly 70% of systems, and established infrastructure for facility requests and dataset access. However, significant risks and measurement gaps are also present. Funding mechanisms for NSF-supported and other government facilities face uncertainty. Many systems are aging and hardware replacement has become increasingly difficult. Staffing constraints, particularly at academic institutions, limit the ability to keep radars operational. Deployment restrictions reduce the effectiveness of mobile, shipborne, and airborne platforms. Most critically, the research community lacks an airborne radar for precipitation studies, and boundary layer observations remain limited by both coverage gaps and the absence of suitable airborne resources.

Current airborne radar geometries, particularly Tail Doppler Radars (TDRs) operating in fore-aft scanning mode, struggle to resolve atmospheric structure in the lowest 200 meters above the surface. This gap is scientifically critical: near-surface inflow layer dynamics and air-sea enthalpy fluxes in the lowest boundary layer are key drivers of tropical cyclone intensification that remain poorly observed and poorly understood. X-band Tail Doppler Radars suffer from

significant signal attenuation in heavy precipitation, limiting their effectiveness in the inner-core of tropical cyclones where observations are most needed. Current polarimetric configurations on airborne platforms also lack the full complement of parameters available on ground-based systems, limiting their ability to distinguish between liquid and ice phase hydrometeors in complex microphysical environments.

Addressing the prominent science gaps in microphysics and process rates, boundary layer dynamics, and three-dimensional wind retrieval will likely require a deliberate balance between sustaining current systems and investing in emerging capabilities. Continued pursuit of a community airborne precipitation radar remains a high priority.

### **AI Opportunities and Risks**

AI emerged as a cross-cutting theme throughout the workshop, surfacing in discussions of hardware design, data processing, adaptive operations, and workforce development. Most participants agreed that AI will play an increasing role in the radar enterprise, but also that its application requires discipline, clear objectives, and appropriate safeguards.

Current AI applications in the radar community are already demonstrating tangible value. Machine learning algorithms are being used to drive adaptive scanning, enabling radars to track meteorological features in real time and adjust scan strategies accordingly - an approach with significant potential across both research and operational contexts. AI is also advancing data quality control, with demonstrated capability to identify and filter non-meteorological returns such as ground clutter, wind turbine interference, and biological targets, as well as to improve microphysical retrievals from polarimetric data. Networked radar and instrument systems are beginning to use automated AI-driven coordination to enable storm-centric sampling strategies that span multiple platforms.

Participants also identified several emerging AI applications worth pursuing. AI agents and large language models could dramatically accelerate data discovery by enabling targeted searches across the growing archive of radar observations. One caveat to this approach is defining a methodology to classify features within large datasets that an AI-agent can identify. Allocation of resources to create the classification workflow is a crucial first step to developing this type of tool. Additionally, AI-driven waveform design and time-series processing could feed directly into adaptive scanning frameworks. More broadly, increased automation of scanning and processing decisions, when grounded in physically consistent constraints, could open new avenues for scientific discovery.

Participants also stressed that AI adoption requires oversight and clear standards. Transition to AI-based methods should occur under supervised conditions, with institutions providing clear leadership and guidelines on ethical and effective use. The community will need to develop new scientific benchmarks and evaluation metrics specific to AI and machine learning applications,

moving beyond traditional validation approaches, to establish the trust required for broader adoption. A centralized resource hub, as proposed in the software and data section, could serve as a natural home for these standards and evaluation tools.

### **Strategic Priority 1: Next-Generation and Emerging Radar Technology**

This priority examined advancements in emerging radar technology, evolving measurement requirements at key scientific frontiers, and strategies for deeper engagement with industry and inter-agency partners. Scientific discussions centered on high-impact weather systems - winter storms, tropical cyclones, severe thunderstorms, and convective events - where fundamental questions in dynamics and microphysics remained unresolved despite progress over the past decade.

The radar community is undergoing rapid technical change, with aging hardware and decades-old software coexisting alongside a new generation of observational technologies. Several emerging technologies were discussed as candidates to address current measurement gaps, including PAR, UAS, bistatic and multistatic receivers, and AI-integrated hardware and processing architectures.

Participants gave particular attention to bistatic radars and PAR systems and their potential for ground-based and airborne applications. Measurement requirements driven by key scientific challenges, spanning topics of severe weather to air quality were also discussed, along with emerging opportunities in high-frequency radars for wildfire monitoring and clear air dynamics - an area identified for further community attention beyond the workshop.

PAR has received sustained attention through efforts such as the Radar Next program, the Advanced Technology Demonstrator (ATD, Torres 2024), and the APAR program. Its core advantages - agile scanning and improved temporal resolution - are well established. UAS offer the ability to collect observations in regions inaccessible to ground-based or conventional airborne radars. AI is already improving radar operations and selected signal-processing tasks, though participants cautioned that deploying AI without well-defined objectives risks undermining rather than advancing scientific progress.

Multi-static and bistatic passive radars and distributed networks drew considerable discussion as a cost-effective alternative to conventional monostatic systems. These architectures offer wide-area coverage, relaxed line-of-sight constraints, and the ability to retrieve 3-D winds and vertical velocities without vertical integration assumptions. The use of multiple frequency combinations (e.g., S/C-band, Ka/X-band) was also discussed as a means of enhancing ice and mixed-phase microphysics retrievals and potentially complementing dual-polarization measurements. Integrating these approaches with PAR could further expand scientific analysis capabilities.

Concerns around PAR or UAS center on cost and design complexity, along with the logistical challenges of integrating these platforms with existing systems. Many participants viewed these trade-offs as acceptable if new systems are integrated with existing radar assets. Participants repeatedly noted a familiar problem: scientists describe ideal measurements, while engineers must build within cost, power, weight, and schedule limits. Scientists must articulate their core measurement needs clearly, while accepting that early development stages will involve trade-offs with industry partners. Closer collaboration with industry, including giving industry a larger role in decision-making, was seen as essential to accelerating adoption of next-generation technology.

Participants repeatedly noted that radar data now serve purposes far beyond traditional observation, specifically its growing use in data assimilation and AI-based forecasting. Understanding the needs of communities that consume radar data as a service, not just those who operate the instruments, will be essential for expanding the utility of both existing and next-generation platforms. Complementary multi-frequency systems and coordinated networks were seen as critical both for answering hard research questions and for validating emerging technology. Across all of these directions, participants emphasized that sustained collaboration among federal agencies, academia, and industry is essential to align scientific priorities with long-term technological development.

### **Strategic Priority 2: Sustainable Facility Operations and Partnerships**

Sustainable infrastructure is foundational to consistent, long-term observations and reliable community access. This priority focused primarily on NSF-supported radar facilities, while recognizing that partnerships with other radar networks introduce additional operational considerations that don't always map cleanly onto a single set of standards.

NSF-supported radar systems remain in high demand, but many are aging and increasingly difficult to maintain. Discussions addressed strategies for modernization, replacement, and partnership development to ensure long-term viability, including upgrades to supporting test and evaluation infrastructure. Participants noted that common performance standards and shared metrics could help identify overlap across partner institutions and encourage exchange of best practices for sustainment. Aligning these standards across agencies and academic partners will require deliberate coordination but offers meaningful efficiency gains for the broader radar enterprise.

### **Strategic Priority 3: Community Software and Data Integration**

This priority addressed two interconnected challenges: data processing and analysis, and data management and access. Radar processing software and data management represent two interconnected challenges that the community identified as increasingly urgent. The volume of radar data continues to grow, processing tools vary widely in scope and accessibility, and the standards governing data formats and algorithm outputs remain inconsistent across institutions.

On the processing and analysis side, participants repeatedly cited the need for a more coordinated approach to software development, one that addresses cross-disciplinary needs, supports sensor fusion, and builds on existing open-source foundations. Tools such as LROSE and Py-ART provide strong starting points, but gaps remain in accessibility, interoperability, and uncertainty quantification. Better integrated open-source tools would improve consistency and reduce analysis uncertainty for both fundamental research and operational forecasting applications.

On the data management side, radar datasets are growing rapidly in volume and variety, and processing standards vary considerably across institutions.

Data access is a foundational concern in this arena. The dominant model, in which users download large files from remote servers without reliable advance knowledge of data quality or relevance, places unnecessary burden on researchers and is poorly suited to modern data volumes. Participants strongly supported moving toward cloud-based data access and analysis, where users can query, subset, and analyze data without bulk transfers. The current standard format, CfRadial, is well supported by existing processing tools, and works well for conventional scanning radars. However, PAR and other emerging platforms will generate data that does not map cleanly onto this format, and developing an appropriate alternative will require coordinated community and agency effort.

Algorithm fragmentation and dislocation is a parallel problem. Processing and analysis tools - ranging from raw data ingest to quality-controlled products to derived quantities such as three-dimensional winds and quantitative precipitation estimates - are developed and maintained across many institutions, often producing different outputs from identical inputs. This inconsistency erodes confidence and adds time and complexity to research workflows. The community identified a centralized, curated library of benchmark datasets, spanning simulated and real-world cases across diverse weather regimes, frequency bands, and edge cases, as a high-priority need. Such a resource would give the community a shared basis for testing and comparing algorithms.

NSF NCAR, DOE, NOAA, and NASA have established different methodologies to support community data access, but broader standardization would improve the user experience and promote fidelity across institutions, particularly as new technologies introduce additional data streams and formats. Participants thus called for a dedicated organization, modeled on a DTC or similar entity, to consolidate software tools, promote collaborative development, improve awareness of existing open-source resources, and provide targeted user support. Such an organization could also serve as a bridge between research and operational communities, engage a range of agencies and academic institutions, and extend its reach to radar-adjacent fields such as hydrology. Establishing a foundation for community data access and interoperability through

an interagency approach would address the scale of the challenge, particularly with new technologies on the horizon.

#### **Strategic Priority 4: Engaging the Future Workforce**

Although this priority was initially framed around early-career scientists and engineers, workshop discussions made clear that workforce development needs span all career stages. Transitions to new software platforms, AI-enabled methods, and evolving instrumentation require ongoing training and adaptation from the entire community, not just those entering the field. Addressing this is not purely an early-career problem: the breadth of ongoing transition means that training and professional development are urgent needs across all career stages.

Therefore, the radar workforce is under pressure from multiple directions simultaneously. Emerging technologies, new software paradigms, and the growing role of AI are reshaping what radar scientists and engineers need to know, while the pipeline producing that expertise, particularly on the technical and hardware side, is thinning.

Participants stressed the importance of hands-on experience as a driver of engagement and skill development. Access to radar facilities, participation in field campaigns, and exposure to local operations all play a meaningful role in building the technical intuition that formal coursework alone cannot provide. Access to these opportunities varies widely across institutions, and expanding access, particularly for students and early-career professionals, was identified as a high-priority need. For example, NSF NCAR provides some of this access through the NSF-owned Marshall Field Site near Superior, CO and the S-Pol radar, and radar simulators offer a complementary pathway. Current capacity falls well short of community demand.

On the technical workforce side, fewer academic programs are producing radar engineers and technicians, compounding an already difficult hardware maintenance situation. This gap is self-reinforcing: as experienced technical staff retire or leave, institutional knowledge is lost, and the remaining workforce is stretched thinner across aging systems that require more, not less, attention. Interdisciplinary training - bridging atmospheric science and radar engineering - remains rare, and its absence limits the community's ability to develop researchers who understand both the measurement systems and the science they are meant to support. Leveraging relationships with industry partners could reinvigorate the connection to technical staff and training, but a specific and well-planned approach is necessary.

Existing training resources, including COMET and [openradarscience.org](http://openradarscience.org), are more extensive than their usage suggests, and visibility is poor even among active researchers. Training efforts remain heavily siloed across organizations and agencies, with little interagency coordination and no coherent curriculum connecting foundational radar physics to modern analytical methods. There is also a risk that over-reliance on AI tools could further decouple training from the underlying physics and algorithms that give those tools meaning - though AI, used deliberately,

could also serve as an effective pedagogical aid when paired with strong foundational instruction.

More broadly, the workshop highlighted gaps in interdisciplinary training and a declining technical workforce as risks to the long-term health of the radar enterprise. Closing these gaps will require action at multiple levels: federal agencies investing in structured training programs, academic institutions revisiting curriculum to reflect the current technology landscape, and facilities expanding access for students and early-career professionals. A centralized coordination mechanism, as proposed in the software and data section, could play a role here as well, serving as a hub for training resources, visibility, and interagency collaboration on workforce development.

## D. Post-Workshop Survey Results

The breakout session notes were used to identify and synthesize the main recommendations of workshop participants. A post-workshop survey was also conducted as an additional mechanism to gather input on priority topics, as well as feedback on workshop structure, agenda, and venue. This appendix summarizes the survey question types, response counts and demographics, results from evaluation questions, and key themes from short-answer responses. The complete set of survey responses is not included here but could be provided upon request, with respondents names redacted.

### High-level Summary and Demographics

The workshop drew 184 attendees, with 143 in-person participants and 41 virtual participants. Among those attending in person, 108 were career professionals and 35 were students. In addition, 45 individuals participated in the tour of the NSF Research Aviation Facility (RAF), and 120 attended the reception and poster session. A total of 62 attendees responded to the survey, corresponding to a 33.6% response rate.

Based on common benchmarks for post-event and professional community surveys, a 33.6% response rate is considered strong and suggests a highly engaged audience. Figure D.1 shows the career-stage distribution of respondents and indicates representation across the full professional spectrum.

Respondents also identified their primary areas of expertise and radar-related experience. These responses were grouped into four broad categories: Technical and Engineering, Data Science and Software, Operations and Field Experts, and Atmospheric Researchers. The diversity of backgrounds represented in the survey reflects a broad range of perspectives on workshop content and helps ensure that the resulting recommendations are grounded in both technical understanding and scientific merit.

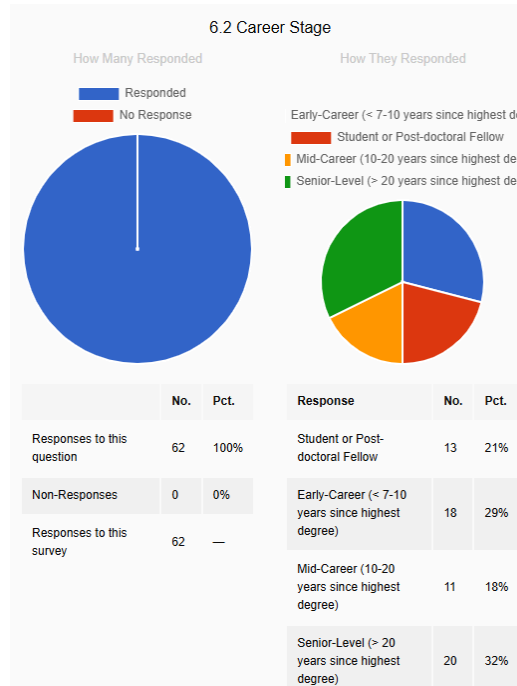


Figure D.1. Responses for the career stage for workshop attendees are provided.

Survey questions were organized into five primary sections (excluding demographics): 1) Overall Experience, 2) Content and Strategic Value, 3) Priorities and Next Steps, 4) Follow-up Engagement and Interest, and 5) Final Comments to the NSF and NCAR. The following summarizes responses within each section and the principal takeaways.

### Overall Experience

Participants were asked to rate their overall impression of the workshop, the effectiveness of the workshop format, and the quality of the presentations and speakers. Responses were highly favorable across all three categories, with at least 89% of the responses (55 of 62) rating effectiveness and quality as very good or excellent.

An optional short answer question was also included to better understand participant experiences during the breakout sessions. Approximately 75% of the survey respondents provided comments, identifying both strengths and opportunities for improvement. Opinions were mixed regarding group consistency (i.e., keeping the same participants together across all breakout sessions). Some valued the continuity this created, while others felt it limited networking opportunities and reduced exposure to different perspectives. Power imbalances within some groups were also noted, with suggestions for moderator training to promote more balanced participation. Student respondents recommended beginning sessions with brief introductions to improve networking

and engagement.

Participants generally found the guiding questions useful, though some requested additional mechanisms for anonymous feedback. Several respondents also indicated that breakout prompts and supporting materials should be distributed earlier to allow more preparation. Session timing emerged as another recurring theme, with comments that breakout periods were too short to enable deeper discussion. Presentation schedules occasionally ran long, reducing time available for group discussions. Future workshops could benefit from stricter timekeeping for speakers to preserve breakout session times.

The physical layout of the main hall also created challenges. Its open design led to acoustic interference, including crosstalk and background noise, while some smaller rooms lacked basic collaboration tools such as whiteboards or screens. Virtual-only breakout rooms were viewed as inclusive but often less active. Several respondents suggested a hybrid approach that would integrate virtual participants directly into in-person breakout rooms. Participants also expressed strong interest in brief plenary "report out" sessions in which each group could share key insights across topic areas.

Overall, respondents viewed the workshop as highly successful, professional, and scientifically valuable. At the same time, feedback indicates that future events could be strengthened through improved breakout room design, longer discussion blocks, stronger facilitation, and greater flexibility in scheduling and hybrid participation.

### **Content and Strategic Value**

The second set of questions focused on the scientific content and technical value of the workshop agenda. Figure D.2 shows the distribution of responses regarding whether the workshop content met participant expectations and whether it effectively conveyed the future strategic importance of radar technology over the next decade.

Of the 62 respondents, 90% strongly agreed or agreed that the workshop content met their expectations, while 85% strongly agreed or agreed that the workshop clearly articulated the strategic importance of radar technology for the next five to 10 years.

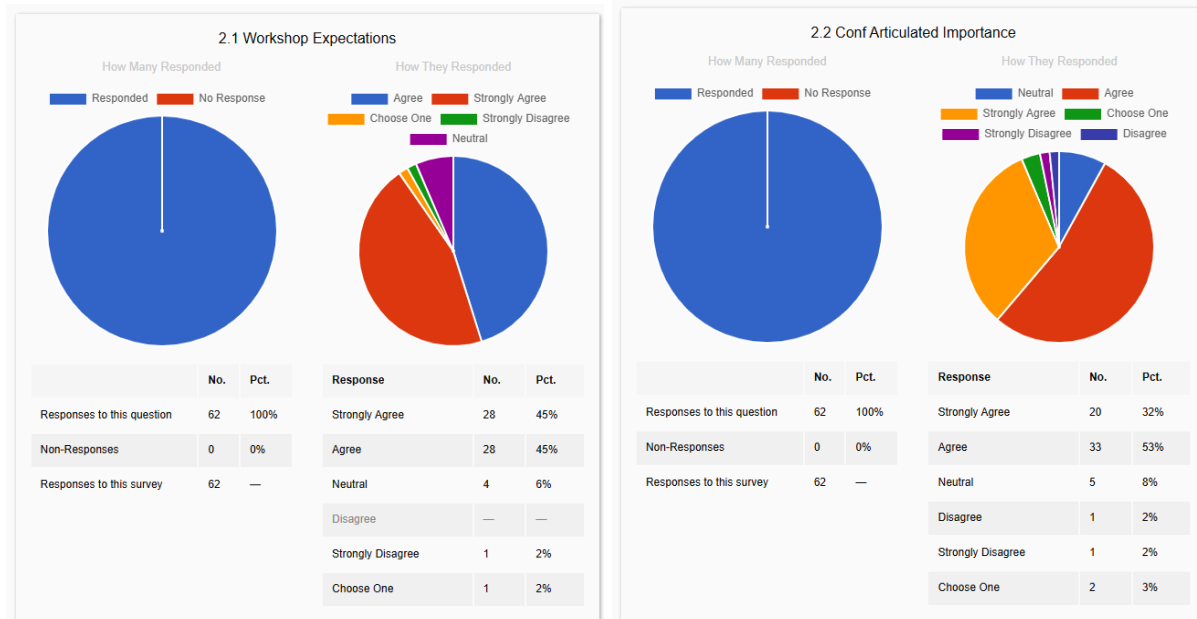


Figure D.2. Responses for the workshop content meeting expectations (left) and articulating future importance of radar technology (right) are shown.

A specific question asked respondents to identify topics or communities they felt were underrepresented at the workshop. Overall, responses emphasized the need for attention on practical applications, interagency collaboration, and sustainable workforce development. Several participants noted that stronger representation from other government agencies, such as NASA or DOE, would have improved on collaborative opportunities and shared responsibilities. Others suggested that greater engagement with international partners operating advanced radar networks, including PAR systems, could have provided a useful perspective for future U.S. planning.

Some respondents felt that the emphasis on PAR and AI overshadowed the importance of incremental improvements to existing systems and stronger integration with complementary observing technologies such as lidar. Workforce development also emerged as a significant concern, particularly the shortage of technicians and engineers, as well as the need for broader educational outreach beyond traditional university programs. Finally, several comments noted that the workshop did not sufficiently address funding realities, deployment costs, or the need for rigorous systems engineering approaches to define requirements and objectively assess the technical limitations of future radar systems.

The survey also asked attendees to identify the most valuable outcome of the workshop. While "new connections" was the most frequently cited benefit, many responses pointed to a broader recalibration of the field's strategic direction. A key outcome was renewed alignment around the transition to PAR, including clearer recognition of the trade-offs between data quality associated with dish systems and the rapid-scanning advantages of PAR. Respondents also highlighted the

need to better communicate the current capabilities and limitations of PAR technology, as well as the urgency of developing a replacement strategy for the aging WSR-88D fleet amid tightening federal budgets.

From a technical perspective, participants indicated growing consensus that software infrastructure and data accessibility are now as critical as hardware investment. Examples cited included challenges associated with emerging PAR data models and the long-term maintenance of community software tools such as LROSE. Respondents also noted interest in potentially transformative approaches, including multistatic radar, adaptive scanning, and ubiquitous, low-cost sensors.

In terms of education and workforce development, participants reported that the workshop provided useful insights for university curricula and gave students a clearer understanding of the broader scientific motivations behind their research and the scientific gaps they may help address in their careers.

Overall, one of the workshop's strongest outcomes was the synchronization of the community's internal clock. Whether through debating the trade-offs of PAR, identifying the looming operational gap in current networks, or acknowledging the need for standardized software, participants left with a clearer and more unified view of the challenges and opportunities likely to shape radar meteorology over the next decade.

## **Priorities and Next Steps**

The third section of the survey focused on community priorities and future actions. Respondents were asked to provide up to four priority actions in a short-answer format and to identify concrete next steps for NSF and the broader radar community. Their responses revealed several recurring themes and actionable areas of focus.

The highest priority identified was the need for a unified, science-driven, and cost-conscious national strategy for the future of radar in the United States. Respondents emphasized three elements of such a strategy: 1) a clear and balanced plan for PAR transition and the future of the operational network; 2) critical and sustained investment in the software ecosystem, including data standards, community software, and education, needed to maximize the value of current and future hardware; and 3) realistic approaches to funding and interagency collaboration that support long-term sustainability.

The second major priority reflected the desire for a lean and connected community ecosystem. Participants consistently signaled that the success of next-gen hardware depends heavily on supporting "soft" infrastructure such as standardized data format, open-source software, cloud accessibility, and a workforce trained in emerging tools, including AI. Many respondents stressed the importance of reducing duplication and proprietary formats and moving toward shared, interoperable systems.

The third priority focused on strengthening the "Human and Industrial Ecosystem" surrounding radar meteorology. Responses highlighted that advanced hardware systems are only as good as the people who operate them and the partnerships that sustain them. Suggested priorities included developing interagency career paths, expanded industry collaboration, and leveraging AI-enabled capabilities to address observational gaps and operational constraints.

The fourth priority focuses on "Future-Proofing the Community" through agility and workforce development. Respondents expressed interest in shifting some emphasis from large, high-risk, expensive hardware investments toward practical training opportunities at facilities such as the Marshall field site, more frequent community forums and hackathons, and stronger communication of radar's economic and societal value to broader audiences. The goal was described as building an agile workforce capable of combining proven technology with emerging AI-enabled approaches to solve the most costly weather problems.

Across responses, recommendations for the future of radar meteorology clustered into five key areas:

1. **Strengthen governance** through a unified advocacy structure and improved coordination with professional societies such as the American Meteorological Society (AMS).
2. **Stabilize infrastructure** by preserving NSF NCAR's role as a software and data hub and creating a national inventory of existing radar assets.
3. **Accelerate technology development** through near-term upgrades to existing capabilities while formalizing a longer-range "Radar Next" plan for eventual WSR-88D replacement.
4. **Expand strategic partnerships** by improving top-down federal coordination between NSF, NOAA, and NASA, and private industry.
5. **Increase community engagement** through frequent workshops, technical forums, and hands-on training opportunities.

One concern raised repeatedly by respondents, and viewed as critical to implementing these priorities, was the need for the NSF to issue a transparent statement explicitly outlining its funding priorities, particularly regarding the future of airborne radar capabilities and the transition following the discontinuation of the APAR project.

## Follow-up Engagement and Interest

This set of questions was intended to gauge participant interest in continued engagement following the workshop, as well as the likelihood that attendees would apply workshop insights within their own programs, research, or studies.

When asked about applying lessons or ideas from the workshop, 90% of respondents indicated that they were likely or very likely to incorporate workshop insights into their future work. This suggests that participants viewed the discussions as directly relevant and actionable within their respective organizations and research efforts.

Interest in continued engagement was also strong. A total of 73% of respondents stated that they wanted to stay actively involved in follow-on activities, while an additional 26% indicated that they might be interested in remaining involved. Figure D.3 summarizes the more immediate forms of engagement, with 91% expressing interest in participating in a working group.

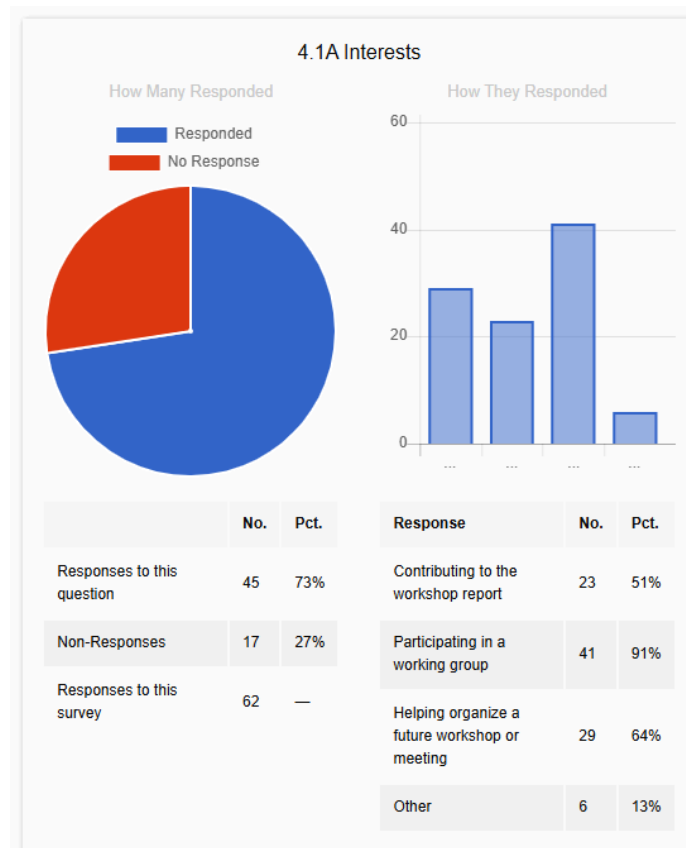


Figure D.3. Responses to the methods for remaining involved in radar community activities are provided.

While not discussed in detail here, responses indicated that maintaining momentum may be more important to participants than producing a final report alone. The most frequently desired follow-on activities were the establishment of regular, low barrier virtual engagements such as seminars, forums, or working groups, that provide an ongoing platform for collaboration.

Respondents also expressed strong interest in dedicated hackathons, training workshops, and similar hands-on events to support the next generation of radar scientists and engineers.

### **Final Comments and Recommendations for NSF and NCAR Leadership**

Attendees were given an opportunity to provide any final comments to NSF NCAR and NSF leadership regarding the workshop and the future of the U.S. radar enterprise. Approximately half of the survey respondents provided comments in this section. While diverse in tone and emphasis, many responses reinforced the priorities and recommendations identified elsewhere in the survey.

Comments directed specifically toward NCAR emphasized the importance of realism, stewardship, and community leadership. Several respondents noted the need to candidly acknowledge current technical limitations of PAR, particularly for certain polarimetric applications, while also recognizing NCAR's unique national role in sustaining community software, data hosting, and management of complex research assets such as APAR. This perspective was often coupled with concern about broader institutional restructuring and the need to preserve NCAR's long-term capabilities.

Respondents expressed strong support for NCAR as a national resource and encouraged both NCAR and NSF to remain resilient amid budgetary and organizational pressures. At the same time, many called for transparent, community-informed processes for major funding decisions, including those affecting airborne radar capabilities and the future of the NSF research aircraft fleet. To strengthen long-term resilience, comments also encouraged closer alignment of selected research investments with private-sector needs, more rigorous cost-benefit evaluation of emerging technologies, and greater emphasis on deployable, user-requested instruments that can deliver impact within practical timeframes.

Several comments also highlighted NCAR's role as a convener for the broader research community. Suggestions included increasing the frequency of workshops, expanding fellowship and training opportunities, strengthening collaboration across universities, and proactively addressing the generational transition associated with the retirement of senior scientific and technical experts.

Overall, comments directed toward NCAR reflected a desire to balance innovation with operational realism and institutional stability. While enthusiasm for PAR, artificial intelligence, and other emerging technologies was evident, respondents also emphasized the continued need for reliable core systems, trusted national infrastructure, and sustained support for NCAR as a scientific and educational hub.

A smaller subset of comments was directed specifically toward NSF. The feedback provided reflects a community deeply concerned about the stability of the U.S. scientific enterprise and

emphasized four key areas. First, respondents urged NSF to preserve NCAR as a national asset critical to U.S. scientific leadership, workforce development, and economic competitiveness. Second, they stressed the importance for maintaining NSF as an independent, merit-based organization that evaluates programs strictly on scientific merit and societal relevance. Third, respondents called for strategic and sustained long-term investment in atmospheric science, along with stronger interagency coordination with partners such as NOAA, NASA and DOE. Finally, participants recommended more proactive communications, including greater use of modern engagement platforms and more frequent strategic workshops to keep pace with rapidly advancing technology and ensure broader participation across the research community.