NSSL

STRATEGIC PLAN

2021-2030

NSSL

NATIONAL SEVERE STORMS LABORATORY

NSSL is the designated national center for severe weather research in the United States. Created by Congress in 1964, the Lab has been a world leader in observing, understanding, and — through its National Weather Service partners — predicting severe weather for almost 60 years. NSSL technologies have become part of the national infrastructure and its scientific discoveries have informed forecast and warning advances that have saved countless lives and mitigated inevitable property damage.

NSSL is a laboratory of nearly 200 scientists, engineers, administrative, and IT professionals. Based in Norman, Oklahoma, the Lab conducts severe weather research with partners across the U.S. and around the world.

NSSL is a federal research laboratory, part of the Office of Oceanic and Atmospheric Research within the National Oceanic and Atmospheric Administration. NOAA is a part of the United States Department of Commerce.

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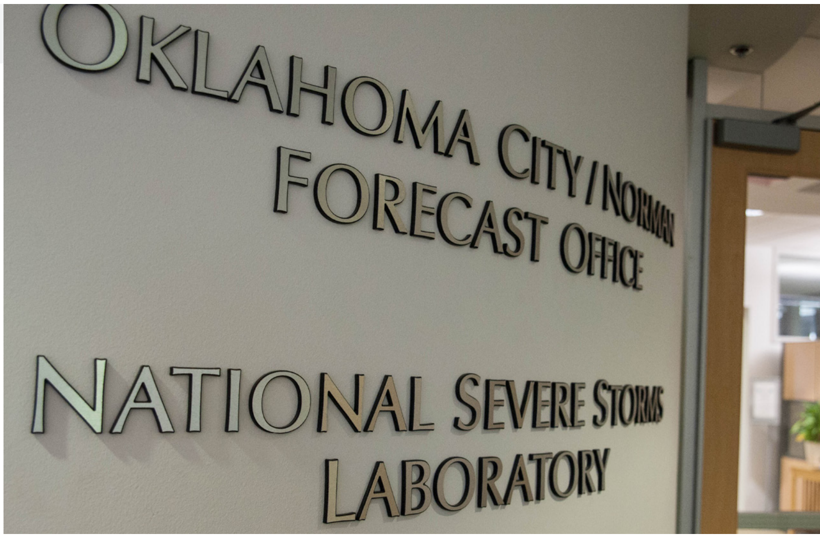
MISSION



We are the world's preeminent laboratory for observing, understanding, and modeling severe thunderstorms. We serve as a national resource for severe weather research and work collaboratively with the National Weather Service to ensure that their forecasters have the knowledge, capabilities, and technologies to remain world leaders in effectively communicating accurate, timely, and actionable forecasts and warnings of extreme weather to the public and commerce.

VISION

We will provide worldwide leadership and partnership in the development of new understanding, technologies, and implementations that enable ever better outcomes for protection of life and property from severe weather.

VALUES

Attitudes, behaviors, and beliefs that underpin what we do

EXCELLENCE that delivers the highest quality science relevant to society through the dedicated effort and integrity of every team member.

INNOVATION that advances our mission and energizes the organization through the creative ideas and unique talents of every contributor.

TEAMWORK AND PARTNERSHIPS that value the contributions of all, blending the full range of skills, experiences, and perspectives.

OPENNESS in distribution of our data and approach to research.

COMMUNICATION of our science that engages and informs those we serve in the region, the nation, and the world.

INTEGRITY in how we conduct and communicate our science.

STEWARDSHIP of the resources that Congress and taxpayers entrust to us.

COMMITMENT to achieving diversity, equity, inclusion, and accessibility in the earth sciences.

INTRODUCTION

Severe weather poses a recurring threat to life and property in our society.

Severe weather has the potential to destroy life. Furthermore, severe weather can destroy property, infrastructure, the livelihoods of people, and can negatively impact the economy. We can't stop severe weather, but we can understand, predict, and prepare for it better, and in so doing mitigate its impact on life, property, and economic prosperity.

NSSL supports NOAA's mission of Science, Service, and Stewardship, and provides information that is crucial to NOAA and the world.

Our work directly supports NOAA's Oceanic and Atmospheric Research's strategic goals of Detecting Changes in the Ocean and Atmosphere, Improving Forecasts, and Driving Innovative Science.

At NSSL, development of novel technologies and observation strategies is inspired by our common passion for observing and understanding the environments and processes that lead to severe weather. The strong integration of our engineering capabilities with our scientific exploration is a foundational strength of the Lab, leading us to pioneering observations, scientific discoveries, and prediction capabilities.

The bedrock of our success is our world-class federal workforce, with additional foundational capacities derived from our Cooperative Institute partners and the technical expertise of our government IT contractors. Similarly, we derive tremendous benefits from collaborations with other NOAA labs and line offices, in addition to other domestic and international partners. All of these partnerships provide value-added capacities for research, development, and application. Furthermore, in synergy with our internal initiatives to increase diversity and inclusion in our workforce, they provide diversity of experience, thought, and perspective that ensures a focus on service and stewardship that benefits all members of society.

STRATEGIC GOALS

This strategic plan describes NSSL's four key goals for the next ten years.

GOAL 1

Develop and deploy innovative observation technologies, data collection strategies, and analysis techniques; synthesize the resulting information to develop new insights, conceptual models, and prediction strategies for severe weather.

GOAL 2

Advance severe weather prediction capabilities through development of analysis and guidance tools that will enable significant improvements in NWS forecasts and warnings.

GOAL 3

Engage users, stakeholders, and customers to refine tools, techniques, and communication strategies for maximum positive impact on society.

GOAL 4

Position NSSL to succeed in a changing world by nurturing the passion and dedication of our people, building vibrant and diverse partnerships, and investing in a diverse, inclusive, and high-performing organization.

In the following pages, we outline a series of strategic objectives under these four goals. These objectives reflect both current activities and future steps to be taken as we move forward in the coming decade.

GOAL 1

Develop and deploy innovative observation technologies, data collection strategies, and analysis techniques; synthesize the resulting information to develop new insights, conceptual models, and prediction strategies for severe weather.

Efforts to understand severe weather phenomena (i.e., thunderstorm-induced tornadoes, high winds, large hail, and flash floods) have been remarkably productive, but gaps in our understanding remain.

At NSSL we continuously strive to fill these gaps through better observations of the phenomena themselves, of antecedent atmospheric processes, and enabling environmental conditions. One way that we push the frontiers of understanding is by developing advanced observation technologies and deploying a wide range of instruments, ranging from mobile mesonets to weather radar. We innovate, calibrate, and field-test instruments that are custom-designed to measure atmospheric properties and/or observe phenomena that are not measurable or observable with routinely available observations. We design and plan collaborative, internally and externally funded field programs to execute targeted deployments of these instruments and collect uniquely valuable datasets. We then use these data to make foundational advances in our knowledge and understanding of severe weather.

Selected innovations in technology and instrumentation are further developed by NSSL for implementation in National Weather Service (NWS) operations. For example, NSSL has been a national leader in developing the scientific basis, engineering foundations, and sampling strategies for weather radars since the Lab's inception, leading directly to the nationwide next generation (NEXRAD) Doppler weather radar network in 1988. Pioneering work in dual-polarization resulted in the upgraded capability of the NEXRAD radar network in 2012. NSSL is currently exploring Phased Array Radar (PAR) technology as a potential third generation weather radar.

Weather radar

1.1 Grand 10-year Challenge: Investigate Phased Array Radar (PAR) and its capabilities to provide the future weather radar observations needed by NOAA to accomplish its mission.

Develop, refine, and evaluate the engineering and science technologies of new radar systems and understand their application to weather radar operations. This knowledge will provide the foundation to enable an informed and pivotal decision on the technological and operational design of the next generation weather-radar network that must be robust enough to serve us decades into the future as a critical piece of the national infrastructure.

1.2 Develop evolutionary signal processing techniques and new diagnostic capabilities for the current generation, national network of WSR-88D radars (NEXRAD), focusing mainly on utilization of dual-polarization data for hydrometeor classification, severe weather nowcasting, and quantitative precipitation estimates.

Boundary-layer profiles

1.3 Develop and deploy observing platforms aimed specifically at sampling and understanding boundary-layer processes, including platforms designed for ground-based remote sensing, e.g., the Collaborative Lower-Atmosphere Mobile Profiling System (CLAMPS), and in-situ measurements from instrumented, uncrewed aerial systems.

Data collection and analysis

1.4 Organize and conduct collaborative field experiments with broad community engagement, specifically aimed at filling the gaps in our observations and understanding of severe weather processes.

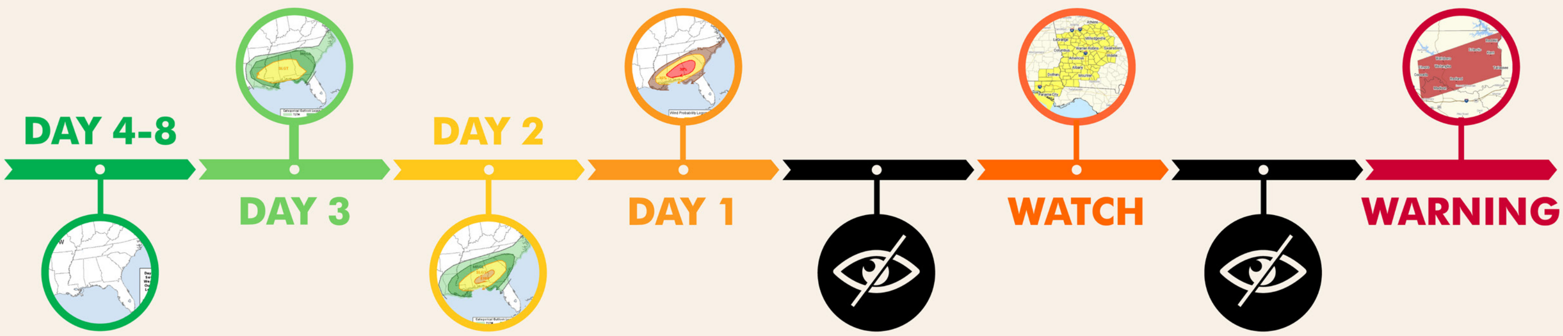
1.5 Develop and deploy instruments to detect and characterize lightning initiation and propagation.

1.6 Develop and apply innovative data analysis techniques and strategies that will give birth to new insights and conceptual models of severe convective processes that produce high-impact, disruptive phenomena such as tornadoes, large hail, high winds, and flash floods.

GOAL 2

Advance severe weather prediction capabilities through development of analysis and guidance tools that will enable significant improvements in NWS forecasts and warnings.

Groundbreaking scientific research at NSSL is parlayed into societal impacts through the development and application of experimental modeling and analysis systems.



Being part of the research arm of NOAA, NSSL scientists do not issue forecasts or warnings, but they enable better public products by working with the forecast community to develop ever better diagnostic and forecast tools and techniques that make it possible to take forecast and warning performance to the next level. We strive to improve severe weather prediction across all time and space scales. In fact, part of the reason that NSSL scientists developed the FACETs (Forecasting A Continuum of Environmental Threats) concept was to provide a framework for continuously updating threat information as lead time and geographic specificity for events change.

On the research side, threat levels and spatial and temporal distributions are expressed as fields of Probabilistic Hazard Information (PHI) that provide calibrated probabilistic guidance for prediction of severe hail, wind, tornado, lightning, and flash flooding. This guidance is on scales ranging from relatively broad regions several days ahead of time to very localized threats associated with individual storms on time scales of minutes to hours. These fields are derived from a number of different sources. For longer forecast lead times, output from numerical-model ensemble prediction systems (EPSs), post-processed and calibrated, is the primary source of data used to populate PHI fields. On time scales of more than a few days, input for the PHI guidance system is derived primarily from relatively coarse resolution, global-scale EPSs, while higher resolution regional EPSs become increasingly important as the lead time shrinks toward the time scale of individual thunderstorms.

For lead times of a few hours or less, NSSL's Warn-on-Forecast System (WoFS), a storm-scale EPS with sub-hourly updates, becomes increasingly important. Within approximately 1 hour of an event, WoFS output is complemented by calibrated guidance derived from statistical, analog, and machine-learning/artificial-intelligence (ML/AI) approaches based on observations and historical datasets. For example, NSSL's Multi-Year Reanalysis Of Remotely Sensed Storms (MYRORSS) dataset provides an extremely valuable foundation for reliably extrapolating storm observations into near-term realizations of severe weather threats.

NSSL is constructing a forecast-guidance database for all time and space scales using the FACETs framework. This framework will be used to track the objective skill of our probabilistic-guidance products over time to ensure that the guidance that we provide to the NWS continues to improve and enable commensurate improvements in forecasts and warnings issued by the NWS.

Probabilistic guidance

2.1 Grand 10-year Challenge: Increase the lead time for current levels of probabilistic-guidance skill by a factor of three across all time scales out to 8 days, including prediction guidance for tornadoes, large hail, thunderstorm-induced high winds, lightning, and flash floods.

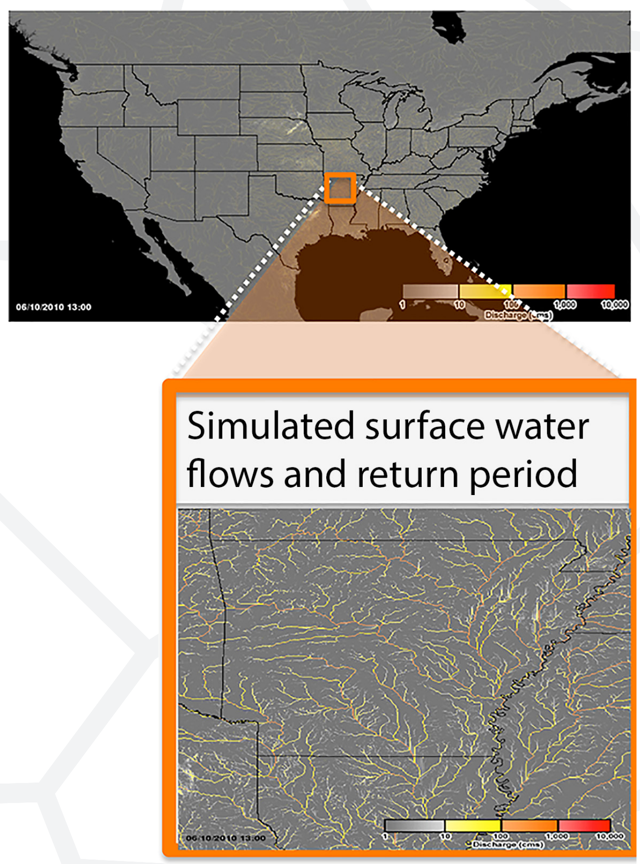
For example, current levels of guidance skill at 20 minutes lead time will be produced with 1-hour lead time, current 1-hour skill achieved at 3 hours, etc.

2.2 Improve the WoFS by 1) advancing storm-scale data assimilation techniques, including the assimilation of data from non-traditional sources such as uncrewed aerial vehicles (UAVs) and ground/satellite-based remotely sensed data; 2) incorporating Unified Forecast System (UFS) components, cloud-based computing capacities, and computational efficiencies; and 3) adopting advanced post-processing strategies such as ML/AI.

2.3 Continually enhance high-quality multi-year reanalyses of data from individual radars and MRMS and use these datasets to produce calibrated, reliable short-term guidance for severe weather hazards.

2.4 Extend the flash flood prediction capabilities of the Flooded Locations And Simulated Hydrographs (FLASH) system by incorporating short-term precipitation nowcasts and rainfall forecasts from the WoFS to yield probabilistic, impact-based flash flood guidance for extended lead times.

2.5 Develop optimal strategies for combining and blending probabilistic guidance derived from multiple sources such as analog-based AI and numerical-model-based WoFS.



Simulated surface water flows and return period

Applications development

2.6 Optimize MRMS capabilities and improve warning decisions by 1) incorporating new terrestrial and space-borne radars and satellite data to enhance coverage, and 2) researching, vetting, and implementing new multi-sensor algorithms that are physically based and/or derived from applications of ML/AI techniques.

2.7 Develop and transition advanced multi- and single-radar algorithms that maximize the advantages of both dual-polarization and phased array technology and leverage the advantages of new ML/AI techniques.

2.8 Implement cloud-based solutions for research and software development and testing, increasing the speed of research-to-operations (R2O) transitions.

2.9 Blend lightning sensors from surface and space instruments into MRMS and WoFS to serve as both guidance for and diagnosis of severe storm intensity and also for data assimilation in regions of poor radar coverage.

GOAL 3

Engage users, stakeholders, and customers to refine tools, techniques, and communication strategies for maximum positive impact on society.

We cultivate relevance and success at NSSL by continuously interfacing with those who are most closely impacted by our research. User-informed research and development strategies are integral parts of our workplace culture.

At NSSL we ensure that internal prioritization of our research activities is informed by the specific needs of users, stakeholders, and the general public. Furthermore, we insist that the outcomes of the research and development conducted by our scientists and engineers directly address those needs.

We have a unique capacity to operate this way because we are surrounded by partner organizations in a common facility — the National Weather Center (NWC). NSSL is the designated national center for severe weather research in the U.S., and in the NWC we are surrounded by three closely aligned NWS national centers: the national center for severe weather prediction (the Storm Prediction Center, or SPC), severe weather forecaster training (the Warning Decision Training Division), and NEXRAD radar operations (the Radar Operations Center). Within the NWC we also have a thriving partnership with the Norman/Oklahoma City local NWS Weather Forecast Office and

the University of Oklahoma (OU) School of Meteorology. These collaborations and their inherent back-and-forth interactions (i.e., two-way migration of thought and process between research and operations, or R2O and O2R) keep us focused on relevance to forecasting operations, and ensure that the needs of operational meteorologists, a primary user of NSSL research, are carefully considered.

A common link to most of these partners is OU's Cooperative Institute for Severe and High-Impact Weather Research and Operations (CIWRO). We also have thriving partnerships with OU's Center for Analysis and Prediction of Storms and Advanced Radar Research Center, in addition to social scientific research institutions at OU, including the Center for Risk and Crisis Management, Center for Applied Social Research, and academic departments from Psychology to Economics and Geography. These connections strengthen our work at the interface of society, including research with emergency management, crisis communication, and broadcasting, and for weather-vulnerable populations within the U.S. public. Partnerships also extend far outside the OU campus, and include connections with the Oklahoma State Department of Emergency Management, Federal Aviation Administration, other NOAA laboratories, NOAA Sea Grant, Federal Emergency Management Agency, and international engagement with key governmental organizations such as the World Meteorological Organization, the United Kingdom Meteorological Office, and Environment and Climate Change Canada. By nurturing these relationships, we interface with many aspects of the weather-sensitive economy and population, and buoy international efforts to improve weather resilience.

3.1 Grand 10-year Challenge: Deliver a fully developed prototype of the FACETs paradigm for severe convective weather.

The FACETs paradigm emerged from NSSL through its multi-faceted collaborations with the NWS and other stakeholders and users. Per design, FACETs has become much bigger than NSSL or the severe weather community alone, with dual FACETs programs currently spinning up in NOAA's Office of Oceanic and Atmospheric Research (OAR) and the NWS to explore broad implementation. Our goal at NSSL is to continue to forge the innovation path for FACETs, working collaboratively with the broader OAR and NWS FACETs programs as well as users and stakeholders to deliver an operations-ready FACETs-Severe prototype early in the next decade.

3.2 Continue the development and scientific focus of the NOAA Hazardous Weather Testbed (HWT) as a facility where interdisciplinary research scientists and developers work side by side with forecasters and other users to evaluate the efficacy of new forecasting and communication tools in simulated operational forecasting/warning operations. The HWT paradigm is recognized by NOAA leaders as a model for conducting successful and productive collaborations between research scientists and practitioners, increasing the operational relevance of NOAA research and accelerating transitions from research to operations. The HWT has traditionally been a vibrant space in the springtime, while remaining relatively quiet the rest of the year. Our goal for the coming decade is to expand HWT activities in a smart and responsible way, retaining the intimacy, relevance, and enthusiasm that has always characterized the HWT while broadening the range of specialty topics that are explored within its confines.

3.3 Fully integrate social, behavioral, and economic (SBE) sciences into our research initiatives and strategic planning. SBE scientists bring insights and scientific rigor into our efforts to deliver forecasts and warnings that improve the severe weather resilience of U.S. populations. They help us improve the string of communications that ends in the public receiving, and responding effectively to, a forecast or warning, including improvements in the ways key communicators — like broadcasters and emergency managers — receive, understand, and utilize weather information in their own messaging and decisions. SBE scientists reveal nuanced relationships between population characteristics, adaptive capacity, and messaging strategies that inform development decisions and inspire new outreach efforts. Our goal is to continue growth of capacities in the SBE sciences that will foster improved methods of R2O and O2R, bringing population and user insights into the process of physical science discovery and better forecasts and warnings that produce measurable, positive societal impacts.

GOAL 4

Position NSSL to succeed in a changing world by nurturing the passion and dedication of our people, building vibrant and diverse partnerships, and investing in a diverse, inclusive, and high-performing organization.

NSSL's organizational health underlies all its successes. Therefore, our fourth critical goal for the next ten years focuses on enhancing the conditions and culture in which we work.

We support an inclusive culture and robust workforce, nurturing mentorship and opportunities for career development. We will develop and enhance organizational structures that complement our goals and facilitate our science and communication. Finally, we will strengthen two-way engagement with our partners and stakeholders to maximize the use and value of our work. Because our sustained success is dependent on our ability to garner sustained support, we will strive to ensure that we are using existing resources efficiently, and allow us to demonstrate our value to key partners and stakeholders.

Optimizing organization and business practices

4.1 Modernize the NSSL organization, business, and IT processes to improve coordination, integration, transparency, strategic communications, efficiency, and decision-making.

4.2 Ensure the competitiveness of our science and our ability to engage in novel scientific activity by enhancing the financial sustainability of the organization.

Cultivating the workforce of the future

4.3 Ensure growth and continuity of expertise at the cutting edge of science and research to maintain NSSL's leadership role in severe weather science and technology and to promote scientific and technological discovery and breakthrough thinking.

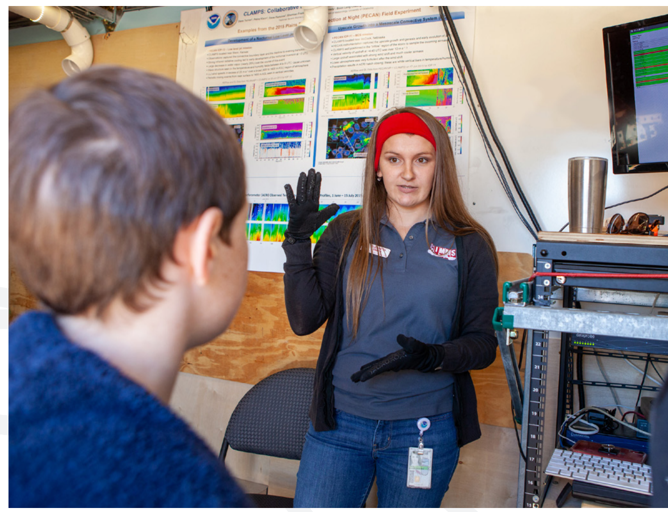
4.4 Promote and ensure diversity, equity, inclusion, and accessibility (DEIA) within NSSL and the atmospheric sciences by identifying, challenging, and eliminating organizational structures, policies, practices, and attitudes that inhibit DEIA, and building those that facilitate DEIA.

4.5 Engage and support the workforce in continuous improvement activities to maximize inclusivity, diversity, teamwork, transparency, and workflow.

Strengthening partnerships through strategic capacity building and engagement

4.6 Strengthen our partnerships throughout the lifecycle of NSSL activities to understand partner needs, complement and enhance partner capabilities, and deliver useful products.

4.7 Accelerate the transition of NSSL research and technology products to implementation-ready partners.



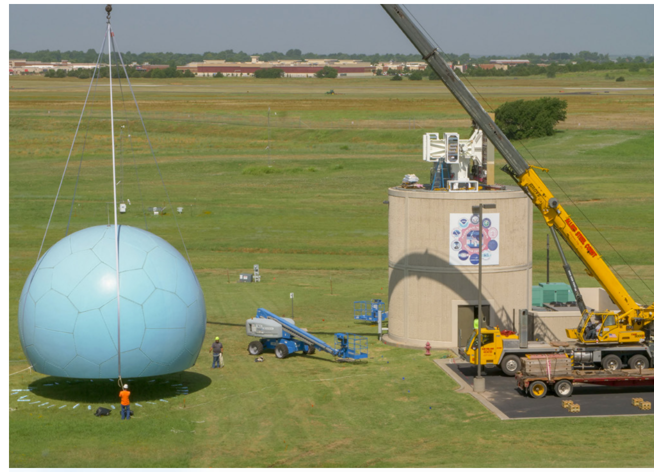
Enhancing communications, outreach, and education

4.8 Develop and execute multi-faceted strategic communications to broadly communicate the societal value and relevance of NSSL research, engage the public and local community in NSSL science, and ensure that stakeholders are involved in developing and using NSSL research outcomes.

4.9 Value and invest in targeted education, outreach, and mentorship efforts to support the next generation of scientists, including those from our local and national underserved communities.

MOVING FORWARD

NSSL will review and update this strategic plan periodically to ensure that it remains in alignment with agency and national needs. In addition, we will have implementation plans that track our progress toward achieving each strategic objective. Together, these efforts will ensure that our financial and organizational resources are both sustained and consistent with our stated goals.



NSSL, the world's preeminent laboratory for severe weather research, works in collaboration with many partners and stakeholders.

We will build on this scientific excellence to enhance our capacity to respond to emerging needs, ensuring that we continue to serve the nation and the world into the next decade.

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