

Mission Statement and Vision:

The National Severe Storms Laboratory serves to enhance NOAA’s capabilities to provide information leading to accurate, timely, and actionable forecasts and warnings of hazardous weather events in order to save lives, protect property, and enhance the nation’s economic viability. The NSSL accomplishes this mission through research to advance the understanding of weather processes, and to improve forecasting and warning technologies, techniques and applications. The primary customer of this research and development effort is the National Weather Service, with direct benefits extending to other federal agencies, the commercial weather and emergency services sectors.

Core Competencies:

The NSSL seeks to improve the accuracy and timeliness of forecasts and warnings of hazardous weather events such as tornadoes, hail, damaging winds, flash floods, lightning, and winter storms. NSSL accomplishes this goal through a balanced research program, which aims to:

- Advance the understanding of weather processes;
- Develop new forecast and warning technologies, techniques, and applications, and evaluate them for operational use;
- Develop, evaluate, and transfer to the NWS enhancements for the NEXRAD (WSR-88D) Doppler weather radar;
- Develop new radar technologies (e.g., dual-polarization and phased-array radar);
- Transfer knowledge, technologies, techniques, and applications to the NWS and other agencies;
- Conduct field programs using mobile radars and other experimental remote sensing systems.

Statutory Authority and/or Charge Under NOAA Strategic Plan:

- U.S. Weather Research Program (USWRP) Authorization Act.
- National Weather Service Organic Act, 15 U.S.C. §313 et seq.
- The Weather Research and Forecasting Innovation Act of 2017 (“The Weather Act” [P.L. 115-25]). NSSL research is directed at many of the elements included in The Weather Act, specifically:
 - Weather Research and Forecast Innovation Program (Sec. 102)
 - Tornado Warning Improvement and Extension Program (Sec. 103)
 - Weather Research and Development Planning (Sec. 105)
 - U.S. Weather Research Program (USWRP, Sec. 109)
 - Improving Communication of Hazardous Weather and Water Events (Sec. 406)
 - NEXRAD Coverage Gaps Study and Recommendations (Sec. 408)
- NSSL is aligned under NOAA’s Weather and Water Goal within the Science, Technology and Infusion, and Integrated Water Forecasting Programs, and NOAA’s Commerce and Transportation Goal within the Aviation Weather Program. NSSL’s research specifically addresses the objectives to:
 - Increase lead time and accuracy for weather and water warnings and forecasts
 - Improve predictability of the onset, duration, and impact of hazardous weather and water events
 - Increase application and accessibility of weather and water information leveraging public (federal, state, local, tribal) private and academic partnerships
 - Increase the development, application, transition of research to operation and services
 - Integrate local, regional, and global observation systems into NOAA’s weather and water services to increase collaboration between NOAA and external environmental partners.
 - Reduce uncertainty associated with weather and water forecasts and assessments
 - Enhance environmental literacy and improve the value of weather and water information

Science Themes and Research Areas:

1. ***“Severe and Hazardous Weather Research”*** includes topics such as storm-scale and mesoscale numerical weather prediction, storm electrification and lightning, winter weather, automated algorithms, the warning decision-making process, and activities of the Hazardous Weather Testbed. Research activities are focused on drastically increasing tornado lead times and delivering probabilistic hazard information to emergency managers and the public. The NSSL conducts this research to improve the

performance and capability of NOAA's National Weather Service to issue forecasts and warnings for severe and hazardous weather for its stakeholders.

2. **“Storm-scale Hydrometeorology Research”** includes efforts to obtain the best Quantitative Precipitation Estimation (QPE) from all available observations (radar, rain gauge, satellite) to allow better management of the nation's water resources. This high resolution QPE integrated with distributed hydrologic models supports the development of greatly improved flash flood warnings to numerous end users (including NWS).
3. **“Weather Radar Research & Development”** includes investigating ways to improve the current utilization of the WSR-88D radar through better hazardous weather-detection algorithms and signal processing techniques as well as the development of dual polarization products. Research also entails investigating the utilization of other radar resources including locally-available gap-filling radars that may augment the WSR-88D network. The NSSL also coordinates radar research activities with the NWS Radar Operations Center and provides radar expertise to help investigate, diagnose, and identify solutions to improve WSR-88D performance. NSSL is performing research (with NOAA, DOD, and FAA) to investigate the feasibility and benefits of using phased array radars for improving severe weather forecasts and warnings. A major goal is the successful implementation of dual polarization capability in phased array radar technology.

Products and Results:

- NSSL played a major role in research and development leading to the national network of WSR-88D weather radars that increased warning lead-times from 6 to 13 minutes and reduced deaths and injuries, as well as the implementation of dual-polarization capability to these radars, resulting in significant improvement in QPE and the ability to detect tornado debris. Radar-based estimates of precipitation helped NWS increase flash flood lead times from 17 to 45 minutes.
- Most of NOAA's lightning safety guidelines were derived from NSSL research in concert with NWS. The NSSL also has played a pivotal role in the evaluation and use of both privately provided national lightning data and the GOES Lightning Mapper (GLM) data that became operational in 2018.
- Other examples of Research-to-Operations transition products include:
 - Extending the capability of the NEXRAD radar through a continuous infusion of science and technology such as open systems architecture, super resolution, and dual polarization;
 - Improving radar detection and associated warning systems by uniquely combining technologies such as
 - Google Earth, reverse look-up phone databases, and advance experimental algorithms allowing NSSL researchers and local weather forecast offices to better verify severe weather and flash flood warnings;
 - Developing techniques to assimilate radar data into numerical weather prediction models with very rapid updates;
 - Creating a national multi-radar, multi-sensor system to provide rainfall analyses for use in the NWS National Water Model, nowcasting and weather forecast model initialization and verification, and severe weather products for NWS Forecast Offices and Centers.

Customers:

NOAA's National Weather Service is the primary customer of the NSSL's research. NSSL radar and severe weather warning and forecast research and development are aimed at improving the services of the NWS's 122 local Weather Forecast Offices and 13 River Forecast Centers. Modeling R&D is targeted at enhancing products and services provided by the NWS National Centers for Environmental Prediction (NCEP), especially the Storm Prediction Center and the Environmental Modeling Center.

Hydrometeorological R&D is accomplished under the NOAA Water Initiative within the Hydrometeorological Testbed, in coordination with the National Water Center, the Weather Prediction Center, and the NWS Office of Water Prediction. New knowledge resulting from NSSL research is used by the NWS Warning Decision Training Division in course material for forecaster training. Other NSSL customers include the FAA (aviation safety related to severe weather), other government agencies, the academic research and instructional communities, and private sector companies serving weather sensitive clients.

Future Expectations:

NSSL expects to contribute to long-term strategic goals by remaining a national leader in weather radar science and engineering. NSSL will continue its leadership in the development of mobile surface-based technology for observing severe weather, the continuous refinement of the conceptual models of severe weather (including cloud microphysics, precipitation characterization, and storm electrification), and probabilistic, short-term forecasting efforts on behalf of NOAA. NSSL will strengthen its expertise in QPE and its application to flash flood warnings and forecasting systems, as well as help lead the convection initiation research that is becoming increasingly important for the NWS in support of its mission and the FAA NextGen weather initiative.