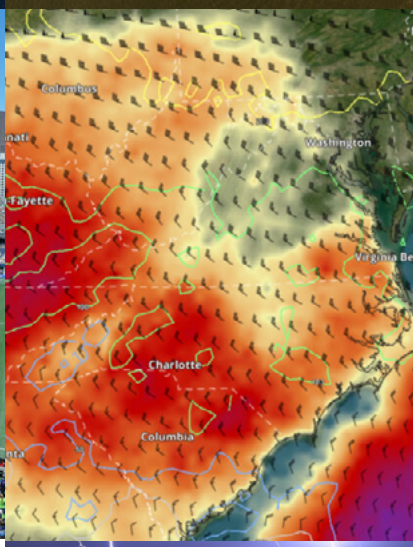
NOAA Annual Transition Report

Fiscal Year 2025





U.S. Department of Commerce
National Oceanic and Atmospheric Administration

Fiscal Year 2025 NOAA Annual Transition Report

NOAA Technical Memorandum NOAA Science Council-011

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Layout

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Cover Photos

(Left column top to bottom)

Aerial view of Captains Bay, home of Dutch Harbor, and the cloud enshrouded Makushin Volcano in the Aleutian Islands of Alaska. Credit: Mr. Tom Ward, NOAA Teacher at Sea Program under license CC BY 2.0

An artist's rendering of NOAA's GOES-19 satellite in orbit. Credit: NOAA/NESDIS

Soccer match at Lumen Field in Seattle, Washington. Credit: SounderBruce under license CC BY-SA 4.0

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A Rice's whale surfaces to breathe. Image taken under Directed Take Permit #14450. Credit: NOAA Fisheries/ Laura Dias

The Interstate 20 and old Highway 80 bridges at Vicksburg, Mississippi, take automobiles and trains over the Mississippi River. Low water reveals the sandbars. Credit: Justin Wilkens,/Shutterstock

HRRR Cast forecast of severe thunderstorm indicators, including wind speed and direction. Image generated by GSL's experimental DESI visualization system. Credit: NOAA/OAR/GSL

View of a thunderstorm near the Denver Airport. Credit: Accessed at https://pxhere.com/en/photo/1275532, Public Domain under CC0

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* Please refer to Appendix A for laboratory and program acronyms.

Contents

Introduction

Transitioning research and development (R&D) to operations (R2O), commercialization (R2C), applications (R2A), and other uses—collectively known as R2X—remains central to the National Oceanic and Atmospheric Administration's (NOAA's) ability to fulfill its mission of understanding and predicting changes in climate, weather, oceans, and coasts, and sharing that knowledge to inform decisions and safeguard lives and property. By moving scientific discoveries, data products, models, tools, and technologies into use, NOAA ensures that federal research investments deliver practical value to the American public. In Fiscal Year 2025 (FY25), these transitions strengthened NOAA's services in many ways, including earlier and more actionable weather guidance, improved drought and water decision support, advances in fisheries science and protected species monitoring, and new capabilities for space weather and environmental forecasting. This iterative pipeline from research to end use helps NOAA improve the accuracy, timeliness, accessibility, and societal value of its services. As underscored by the NOAA Administrative Order (NAO) Policy on R&D Transitions (NAO 216-105B), a strong R2X process is essential for maximizing the impact of NOAA's research enterprise and maintaining U.S. leadership in earth system science.

This report focuses on research projects that met their intended end use during FY25, between October 1, 2024 and September 30, 2025. This includes projects that advanced from Readiness Level (RL) 8 to 9, as well as projects that were completed, demonstrated, or transitioned into sustained use at other RLs. The FY25 report highlights a selection of impactful transition stories from across NOAA, emphasizing why these projects matter, what capabilities were delivered, and how they improved NOAA's ability to serve the nation. In addition, the report provides an overview of FY25 transition data, including the total number of transition projects, their transition types, and the end users and adopters they were designed to support.

The Case for Tracking Research Transitions

The FY24 Annual Transition Report was NOAA's inaugural annual report focused on research transitions. Building on that foundation, the FY25 Annual Transition Report continues NOAA's effort to track how R&D investments are translated into operations, applications, commercialization, and other uses across the agency.

Tracking research transitions helps NOAA understand how scientific advances are being applied to meet mission needs and serve the public. NOAA invests significant public resources in R&D, and transition tracking helps demonstrate how those investments lead to real-world outcomes such as improved forecasts, better decision-support tools, more effective environmental monitoring, and stronger resource management. In this way, transition tracking supports accountability for taxpayer investment in R&D while also helping NOAA identify successful pathways, strengthen collaboration across line offices, and improve how future research is moved into use.

Fiscal Year 2025 Results (October 1, 2024–September 30, 2025)

During FY25, 253 NOAA research and development projects transitioned to their intended end use. Summary charts of these projects by NOAA line office, transition type, and end user/adopter type are displayed below.

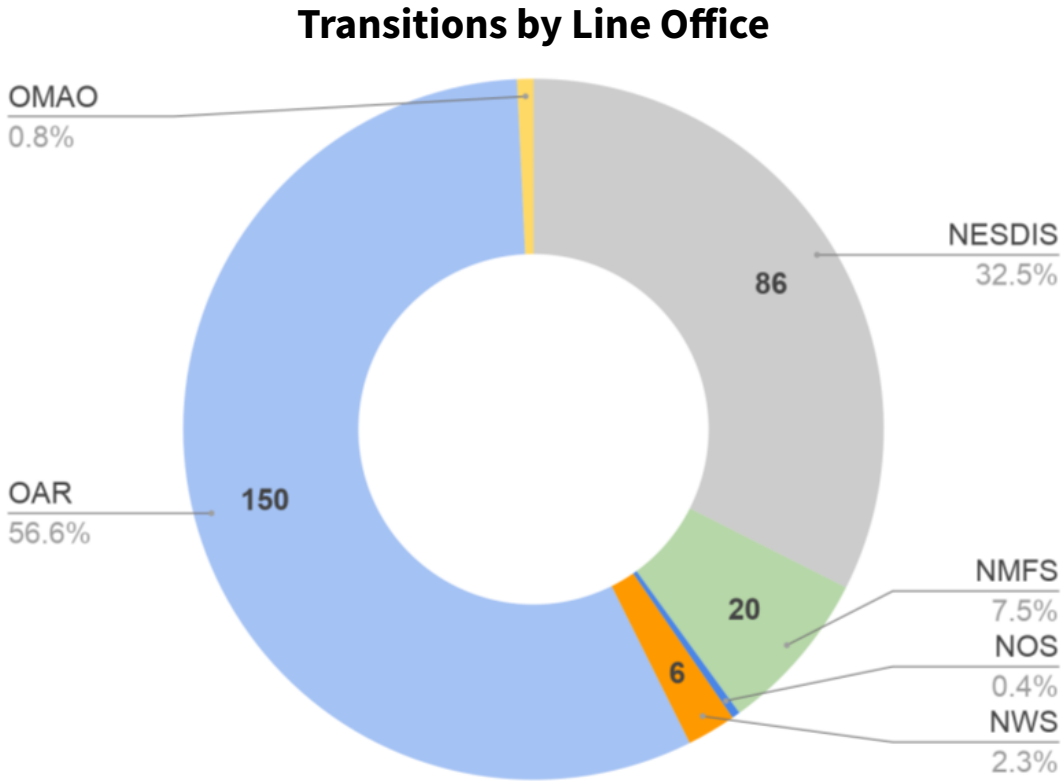


Figure 1: Total number of FY25 transitions as reported to the LOTMC by each line office where the R&D originated.

- **265 total transitioned projects were reported in FY25 across all six line offices where R&D originated:**
  - OAR - 150
  - NESDIS - 86
  - NMFS - 20
  - NWS - 6
  - OMAO - 2
  - NOS - 1
- 253[1] unique projects were identified.

[1] The total number of "Transitioned Projects" is greater than the number of "Unique Projects" because some projects were reported by multiple line offices: in FY25, 12 projects were reported by two line offices. It is common for multiple line offices to collaborate on R&D; therefore, multiple line offices can report on the same project. For example, OMAO's Uncrewed Systems Operations Center (UxSOC) collaborated with OAR's Global Systems Laboratory (GSL) on "Investigating the Impact of Uncrewed Aircraft Systems Observations on Weather Forecasts from a Regional Weather Model Using Observing System Simulation Experiments," and both line offices reported on that project.

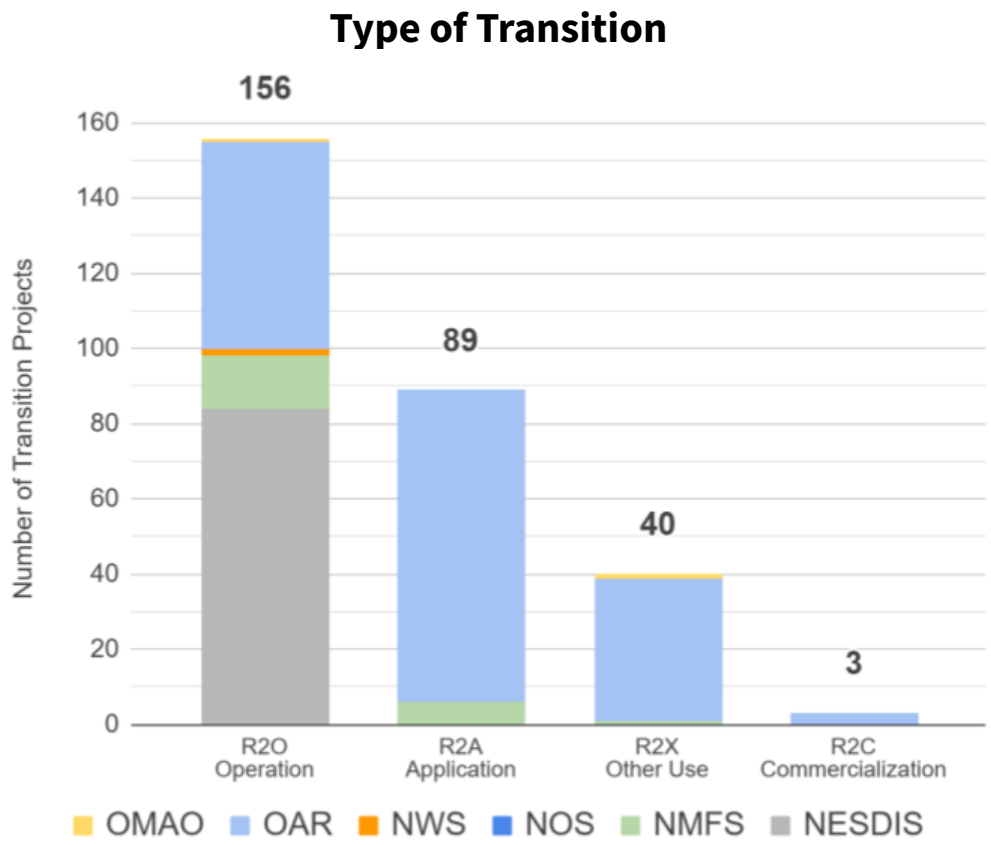


Figure 2: Number of transitions during FY25, as reported by type (R2O, R2A, R2C, R2X) to the LOTMC, color coded by the line office where the R&D originated.

- 288[2] total transitions are displayed above by transition type:
  - 156 Research to Operations (R2O) projects from five line offices (NESDIS, NMFS, NWS, OAR, OMAO)
    - Operations - NOAA R&D that provides sustained and reliable mission activities to deliver products & services
  - 89 Research to Applications (R2A) from two line offices (NMFS & OAR)
    - Applications - The use of a NOAA R&D output as a system, process, product, service, knowledge transfer, or tool
  - 40 Research to Other Uses (R2X) from three line offices (NMFS, OAR, & OMAO)
    - Other Uses - Government policies, regulations, synthesis of research, public education and outreach, or other intended use
  - 3 Research to Commercialization (R2C) from one line office (OAR)
    - Commercialization - The process of introducing a NOAA product or technology into the commercial market

[2] The total of "transition types" is higher than the unique number of transitioned projects (253), as some projects reported being transitioned to two or three uses. For example, 17 projects transitioned to both operations (R2O) and applications (R2A), and 12 projects transitioned to both applications (R2A) and other uses (R2X).

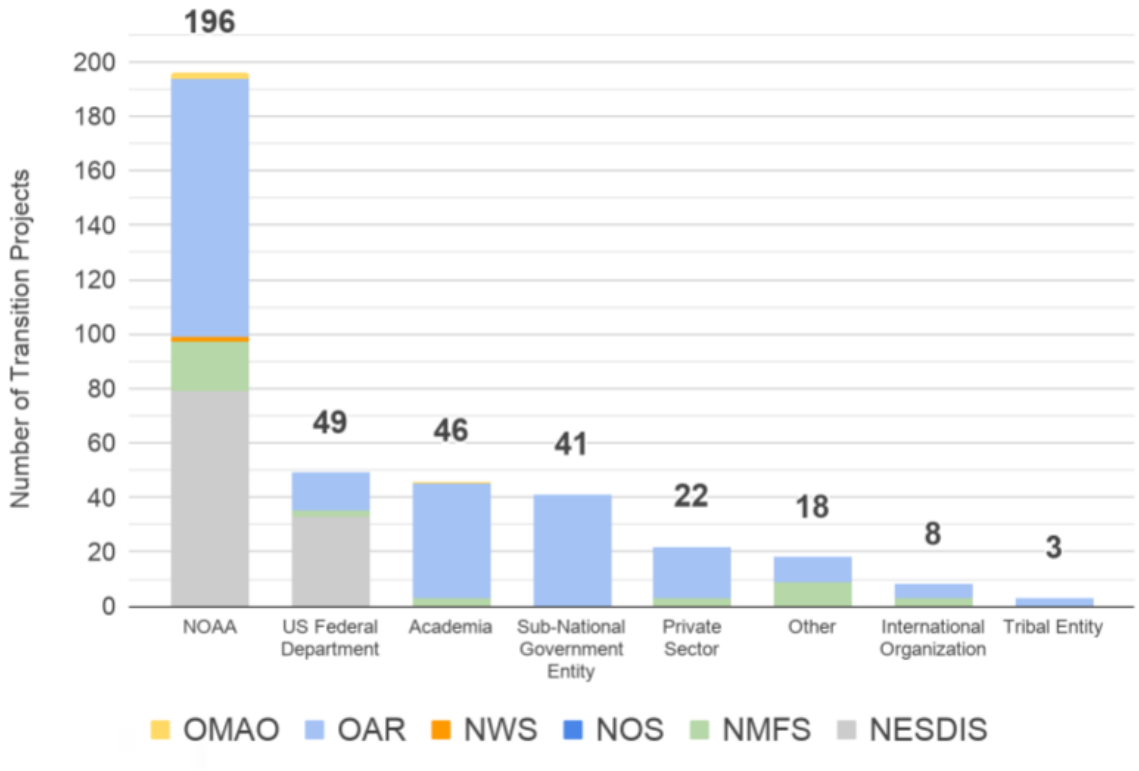


Figure 3: Number of transitions during FY25, sorted by end user or adopter category as reported by each originating line office to the LOTMC.

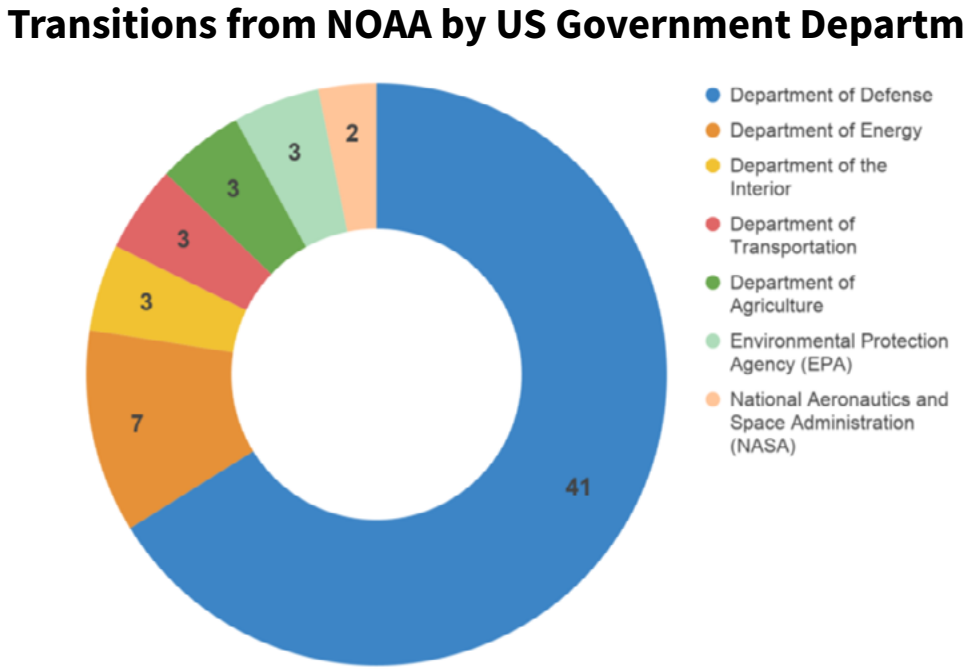


Figure 4: A breakdown of the US Government Departments that were reported to the LOTMC as end users or adopters, under the "US Government Department" category.

- 383[3] total transitions are displayed above by adopter/end user:

[3] The total number of "adopters/end users" is higher than the total number of transitioned projects (253), as at least 113 projects transitioned to multiple adopters/end users (e.g., 33 projects reported that end users include both the Department of Defense and NOAA).

- 196 transitions were adopted by internal NOAA end users
  - *Many transitions to NOAA adopters/end users are also used by and benefit the general public, private sector users, and many others outside of NOAA. Examples of these transitions include, but are not limited to:*
    - Operational forecast products, satellite maintenance updates, fisheries stock assessments, numerical model software and code updates, new model releases, public website updates and launches, observational tools and methodology, annual reports, transfers of knowledge, upgraded radar products, and uncrewed systems developments.
  - Transitions with NOAA end users range from large operational products to incremental code updates. Ultimately, all transitions serve to advance NOAA's mission in service to society.
- 49 transitions were adopted by other US Government departments & agencies (excluding NOAA)
- 46 transitions were adopted by academic partners
- 41 transitions were adopted by sub-national government entities (states, cities, municipalities, etc.)
- 22 transitions were adopted by the private sector
- 18 transitions were adopted by end users identified as "other"
- 8 transitions were adopted by international organizations, including, but not limited to:
  - World Meteorological Organization (WMO)
  - European Meteorological Network (EUMETNET)
  - International Council for the Exploration of the Sea (ICES)
  - Grupo Jaragua
  - Seacology
  - Global Ocean Acidification Observing Network (GOA-ON)
  - Great Lakes Fishery Commission (GLFC)
  - Universidad Veracruzana
  - Universidad Nacional Autónoma de México (UNAM)
- 3 transitions were adopted by tribal entities

Comparison to Fiscal Year 2024 Results

The FY25 Transition Report demonstrated an overall increase in the number of reported research transitions to 265 reported transitions in total, up from 247 in FY24. It should be noted that reporting of transitions was from the office conducting the R&D and not the receiving (adopter) office[4]. OAR and NESDIS remained the highest-volume offices; notably, OAR's output grew from 104

[4] While the FY24 report relied on data initially pulled from the NOAA Research and Development Database and refined by lab and program focal points, the FY25 report was compiled entirely from direct input from NOAA labs and programs. Both the FY24 and FY25 reports intended to capture research transitions tallied by originating R&D line office.

to 150, while NESDIS decreased slightly from 95 to 86. Other shifts included an increase at NMFS (8 to 20), and decreases at NWS (26 to 6), NOS (8 to 1), and OMAO (6 to 2). Changes in administration priorities contributed to the noted decreases in research transitions. R2O remained the primary transition type despite a slight decrease (164 to 156), while R2A increased from 53 to 89. R2X and R2C remained nearly constant from FY24 to FY25.

Reported end-users shifted slightly, alongside a categorical reclassification. Internal NOAA use remained the top category, steady at 196 projects. External adopters of reported transitions diversified: private sector adoptions doubled (11 to 22) and Academia grew (37 to 46). FY24's "State & Local Partners" category was split into FY25's "Sub-National Government Entity" (41) and "Tribal Entity" (3) to better account for state, city, municipal, and tribal end users. While the US Federal Departments category decreased (60 to 49), the user base diversified by adding the Department of the Interior, Environmental Protection Agency (EPA), and National Aeronautics and Space Administration (NASA), while the Department of Defense remained the largest non-NOAA federal end user.

While Line Office Transition Managers Committee (LOTMC) reporting processes remained consistent, increases in reported transitions could be attributed to improved communications from Line Office Transition Managers (LOTMs) within their line office regarding the need to capture all transitions, including incremental updates to code, software, etc.

Advancements in Technology Transfer: NOAA's Intellectual Property

Within the NOAA R2X process, the NOAA Technology Partnerships Office (TPO) serves a key role in ensuring that NOAA's research enterprise delivers practical value within the commercial space. TPO manages the pipeline for the research to commercialization (R2C) process, ensuring a formal pathway for transitioning NOAA research with commercial potential into the private sector. TPO's Technology Transfer Program also manages NOAA intellectual property, allowing NOAA to patent new technologies. U.S. businesses can then license selected patented and open-source technologies, turning them into commercial products. Finally, TPO is responsible for Cooperative Research and Development Agreements (CRADAs), a pathway for NOAA and non-federal partners to cooperate to develop innovative technologies, products, and services in a way that protects intellectual property and encourages the partner to commercialize the results of their activity. FY25 was an active year for TPO, as three R2C transitions were completed, NOAA researchers disclosed 95 inventions, and 25 CRADAs were signed. Additionally, NOAA was awarded one issued patent, and NOAA filed three patent applications and four provisional patent applications. The TPO licensing portfolio currently consists of four active invention licenses. Among the CRADAs, 15 involved small businesses, and the other 10 partners included universities, local governments, and major companies like Google, which signed a CRADA with the National Hurricane Center in June. A CRADA also contributed to the HYSPLIT transition success story below–the Air Resources Laboratory (ARL) partnered with Meteosim SL to improve the HYSPLIT atmospheric computer modeling application by testing new features.

Table 1: NOAA's advancements in technology transfer in FY25.

Technology Transfer Accomplishments	Number
Invention Disclosures Received	95
Total Provisional Patent Applications Filed	4
Total Patent Applications Filed	3
Total Active CRADAs	65
Total New CRADAs in FY25	25
Total New CRADAs in FY25 Involving Small Businesses	15

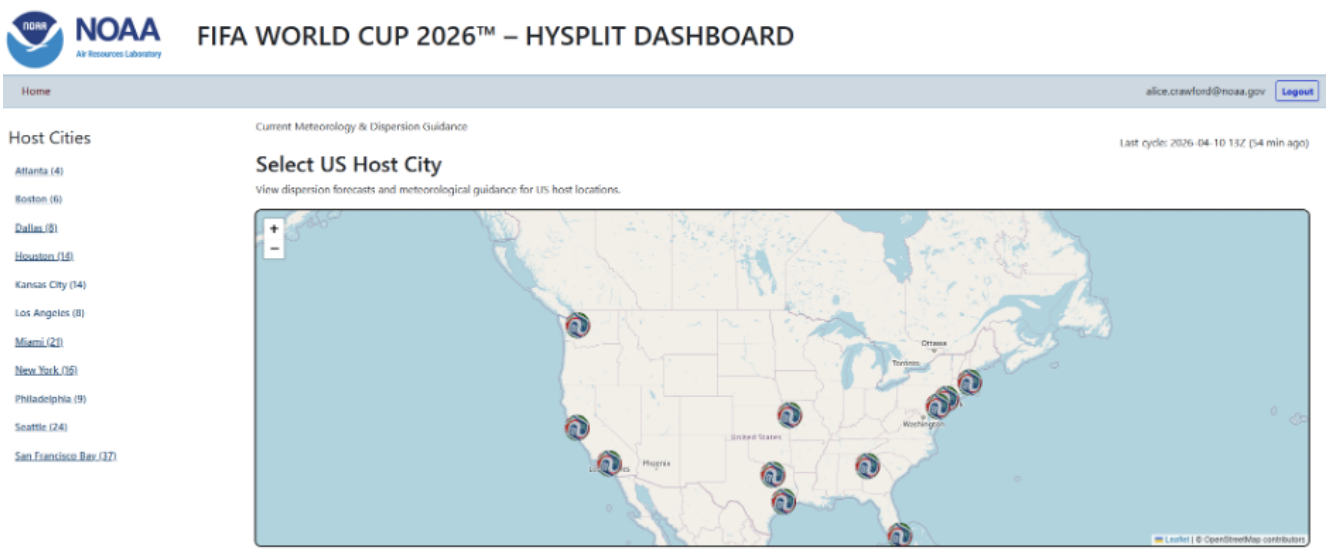
Transforming Research into Impact: Success Stories from Across NOAA

To fulfill its mission of understanding and predicting changes in the environment and communicating that knowledge to protect lives and property, NOAA continually invests in moving research into real-world use. In FY25, NOAA advanced a diverse set of high-impact projects that strengthened weather forecasting, drought and water decision support, fisheries science, protected species research, space weather operations, and environmental modeling. This report highlights seven such success stories, each showing how scientific innovation, cross-line office collaboration, and engagement with operational users and stakeholders are helping NOAA deliver trusted, actionable information and services. From new artificial intelligence-based forecast tools and storm-scale warning guidance to improved species detection methods, public-facing drought dashboards, and new space weather observing capabilities, these examples demonstrate how NOAA's research-to-operations, research-to-applications, and broader R2X efforts translate scientific progress into practical benefits for communities, the economy, and the environment.

HYSPLIT Application Upgrades in Support of FIFA

When hazardous material is released into the air, emergency managers need to know where it may travel, how fast it may spread, and who could be affected. NOAA's Air Resources Laboratory (ARL) supports that need through the HYSPLIT tool, one of the most widely used atmospheric transport and dispersion models in the world. HYSPLIT can simulate how smoke, chemicals, ash, dust, and other airborne materials move through the atmosphere, helping forecasters and emergency officials make faster, better-informed decisions.

In FY25, ARL advanced HYSPLIT in two important ways: by improving the version used by National Weather Service (NWS) forecasters for operational support, and by releasing a major update to the public online and downloadable versions of the model. Together, these transitions strengthened NOAA's ability to support public safety at major events such as the Superbowl and the Fédération Internationale de Football Association (FIFA) World Cup and made a powerful scientific tool easier for a broader community of users to apply.



Landing page for HYSPLIT dashboard which provides automated dispersion runs for emergency response planning during the FIFA world cup. Credit: NOAA/OAR/AR

The first transition from research to operations involved upgrades to the HYSPLIT application ARL provides to National Weather Service (NWS) Weather Forecast Offices (WFOs) around the country. WFOs can use HYSPLIT to run dispersion scenarios on demand, including hypothetical chemical release events before high-profile gatherings so emergency planners can have information ready if an incident occurs. In the lead-up to 2026 FIFA World Cup matches, ARL made a tailored website containing pre-loaded dispersion model runs to cover each match location and make the results readily available. Additionally, ARL made other HYSPLIT improvements for WFOs to make the system more reliable in time-sensitive response settings, such as fixes to prescribed burn modeling for small burn areas, better default graphics on the interactive dispersion map, and improved emissions tracking and troubleshooting. These changes helped streamline the tool for operational users and supported planning for public safety preparations for major events.

> **“Having a look at potential plumes gave us a chance to plan on where we would look into pushing evacuations, if necessary. We will also want to include the Seattle Center area. That is where the “fan Zone” will be set-up throughout the time the matches will be held. That could be an everyday event.**
>
> - LT Ryan Nash, Seattle FD HAZMAT Team Lead

The second transition from research to operations was the release of HYSPLIT version 5.4.0 for public users in May 2025, updating both the online and downloadable versions of the model. This was a major release focused on making HYSPLIT more flexible and easier to use. ARL added upgraded graphics capabilities that produce more user-friendly visual outputs, introduced the ability to create diagrams that summarize wind speed and direction over time, and expanded

controls that give advanced users more flexibility. The release also modernized outputs by improving file formats, which helps users move results into other software more easily than with older, harder-to-import formats. In addition, version 5.4.0 improved model handling near the earth's poles and the international dateline and fixed several bugs, including rare errors that could cause incorrect calculations or crashes. Because HYSPLIT is used not only by NOAA but also by other federal agencies, researchers, international partners, and private-sector users, these improvements extended the benefits of NOAA research and development for several purposes around the world.

HYSPLIT model forecast of a hypothetical chlorine leak from a rail tanker close to Lumen Field stadium in Seattle, WA. The plume shows the likely direction and dispersion from the site and into the surrounding area. Credit: NOAA/OAR/ARL

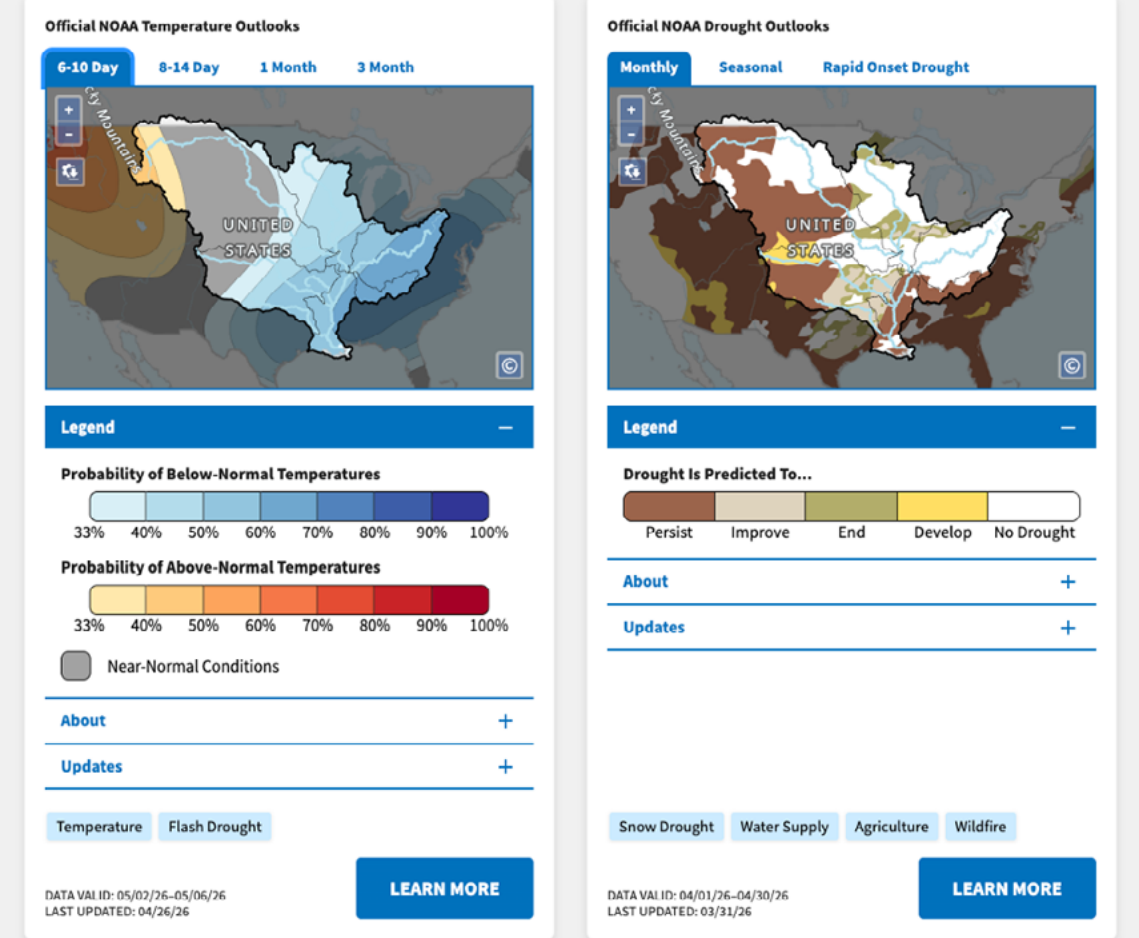
Together, these FY25 HYSPLIT upgrades show how NOAA transitions research and development into practical tools that protect people and improve decision-making. The NWS-facing improvements strengthened operational support for emergency planning around large public events such as the World Cup, while the public release broadened access to a more capable and user-friendly version of the model. In both cases, the work reflected years of scientist and user feedback focused on making HYSPLIT faster, clearer, and more useful in real-world situations. By improving both operational and public-facing capabilities, ARL increased NOAA's ability to deliver trusted, actionable information when communities need it most.

Mississippi River Basin Drought and Water Dashboard

The Mississippi River is one of the most important river systems in the United States, providing drinking water for millions of people, supporting fish and wildlife, and serving as a major commercial waterway that moves freight, crops, and other goods across the country. According to the National Park Service, 92% of the nation's agricultural exports are produced in the Mississippi River Basin, and over 500 million tons of goods are shipped through Mississippi River ports each year. Drought conditions have significant and diverse impacts on not just transport on the Mississippi River, but throughout the entire Mississippi River Basin, and can include decreased crop

production, increased wildfires, and impacts on drinking water. For example, drought conditions in 2023 caused river barges to reduce the weight of cargo they carried, several parishes in southern Louisiana faced drinking water shortages, and the state's crawfish agriculture industry lost an estimated $139.8 million.

> **The dashboard will take data currently spread over [several] federal agencies and collect it into a one-stop shop to augment communication and decision support across the Mississippi River corridor.**
>
> - Melisa Logan, Mayor of Blytheville, Arkansas



Snapshot of the Mississippi River Basin Drought and Water Dashboard, including interactive maps of temperature and drought outlooks from the National Weather Service Climate Prediction Center. Credit: NOAA/OAR/CPO/NIDIS and NOAA/NESDIS/NCEI

In September 2025, the National Integrated Drought Information System (NIDIS), an interagency program within the NOAA Climate Program Office, released the public-facing Mississippi River Basin Drought and Water Dashboard. With contributions from NOAA's National Weather Service and National Centers for Environmental Information, the U.S. Army Corps of Engineers, the U.S. Coast Guard, the U.S. Geological Survey, state governments, regional and local partners, the Mississippi River Basin Drought and Water Dashboard brings together real-time, curated drought information,

tools, and data to support decision-making so users can better understand conditions across the 31-state Mississippi River Basin and its major sub-basins.

Developed in response to requests from stakeholders across the Mississippi River Basin, this product turns science into actionable knowledge and provides a clearer and more efficient way to find trusted information. During previous low-water crises, important information was spread across many federal sources and was not easy to access or interpret quickly. NIDIS worked with partners across the region to build and receive feedback on a single, publicly-available resource that curates authoritative information, adds customizable maps and graphics, and provides educational context about drought and water management. In FY25, NIDIS conducted extensive stakeholder consultation including one-on-one conversations, usability testing, and a series of listening sessions. This feedback made the Dashboard well suited for users across state, tribal, and local governments and the private sector.

> **America's Watershed Initiative and…more than 60 partners tested scenarios and provided feedback that led to the outstanding product released today. As an organization focused on providing the best available science to decision-makers, we are excited about this tool's utility for multiple users. This easy-to-use tool will help users across sectors better understand drought impacts on these vital economic resources for our watershed and nation.**
>
> - Kimberly A. Lutz, Executive Director, America's Watershed Initiative

Average flow contribution of Mississippi River tributaries to the Lower Mississippi River. The drainage basin spans 40% of the contiguous U.S., including 31 states. Credit: Eleanor Hasenbeck, Cooperative Institute for Research in Environmental Sciences (CIRES)

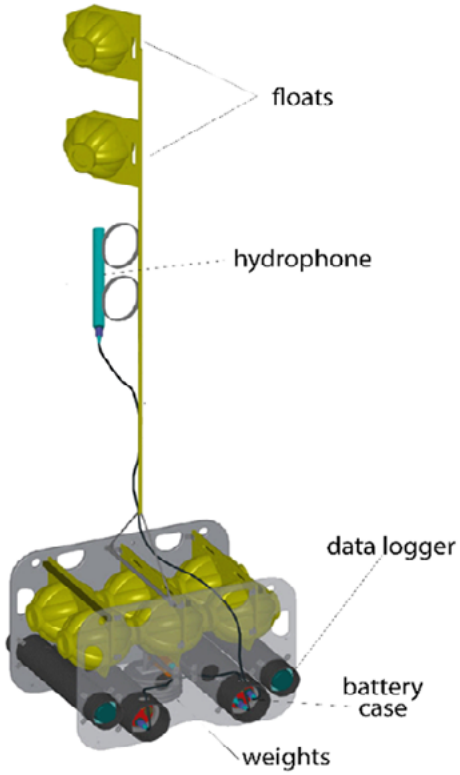
The Dashboard also includes an educational section focused on the Lower Mississippi, exploring how upstream weather patterns heavily influence downstream conditions. Low water levels can exist on the Lower Mississippi with or without drought in the region. About 90% of the Mississippi River's flow is already present at Cairo, Illinois, meaning conditions upstream strongly affect the Lower Mississippi, so it's important to understand drought and water management across the full Mississippi River Basin. The educational section of the Dashboard also explores impacts of drought on wildlife, recreation, and tourism, and explores how scientists monitor the river and forecast future conditions.

By developing the Mississippi River Basin Drought and Water Dashboard for public use, NIDIS and its partners turned diverse and hard-to-find information into a practical decision-support service and communication product for one of the nation's most important river systems. The Dashboard helps users move more quickly from information to action by providing timely, easy-to-use drought and water data in a single location. In doing so, it strengthens drought resilience across a large swath of the United States and shows how NOAA can translate coordination, science, and stakeholder engagement into a public-facing tool with direct value for communities, commerce, and water management.

Advancements in Rice's Whale Monitoring

Rice's whales are one of the rarest whales in the world and the only baleen whale known to live year-round in the Gulf of America. Listed as endangered under the U.S. Endangered Species Act, scientists estimate that fewer than 100 Rice's whales remain, which makes it especially important to find better ways to detect and study them without causing harm. Because these whales are so rare and live across a large area, traditional methods such as visual sightings and remote biopsy sampling can be difficult, expensive, and time-consuming. In FY25, NOAA's Southeast Fisheries Science Center (SEFSC) and the Cooperative Institute for Marine and Atmospheric Studies (CIMAS) advanced Rice's whale research through two important tools: a tool to identify Rice's whale calls, and a species-specific environmental DNA, or eDNA, assay that can detect Rice's whale genetic material in seawater. Scientists from NOAA and the National Museum of Nature and Science in Japan recently discovered that Rice's whale is a unique species. Both of these advancements give NOAA faster, less invasive, and more effective ways to learn about the distribution of Rice's whales in the Gulf and therefore protect this rare and unique species more effectively.

The first advancement was the development of an artificial intelligence (AI) tool to review recordings from acoustic instruments, including SoundTraps and High-frequency Acoustic Recording Packages (HARPs), to detect sounds specific to Rice's whales. Passive acoustic monitoring is one of the most effective ways to study whales because underwater recorders can listen for whale calls over long periods of time and across large areas. Before the development of this tool, SEFSC relied on other detection software that was useful but inefficient. It produced many false-positives, which meant analysts had to spend large amounts of time confirming real whale calls. In testing, the new tool reduced false positives by about 94% for downsweep calls and 80% for long-moan calls. This transition to applications has greatly increased the efficiency of data quality control and processing, allowing researchers to spend less time reviewing the recordings and more time preparing information for management-ready analysis of Rice's whale occurrence across space and time.



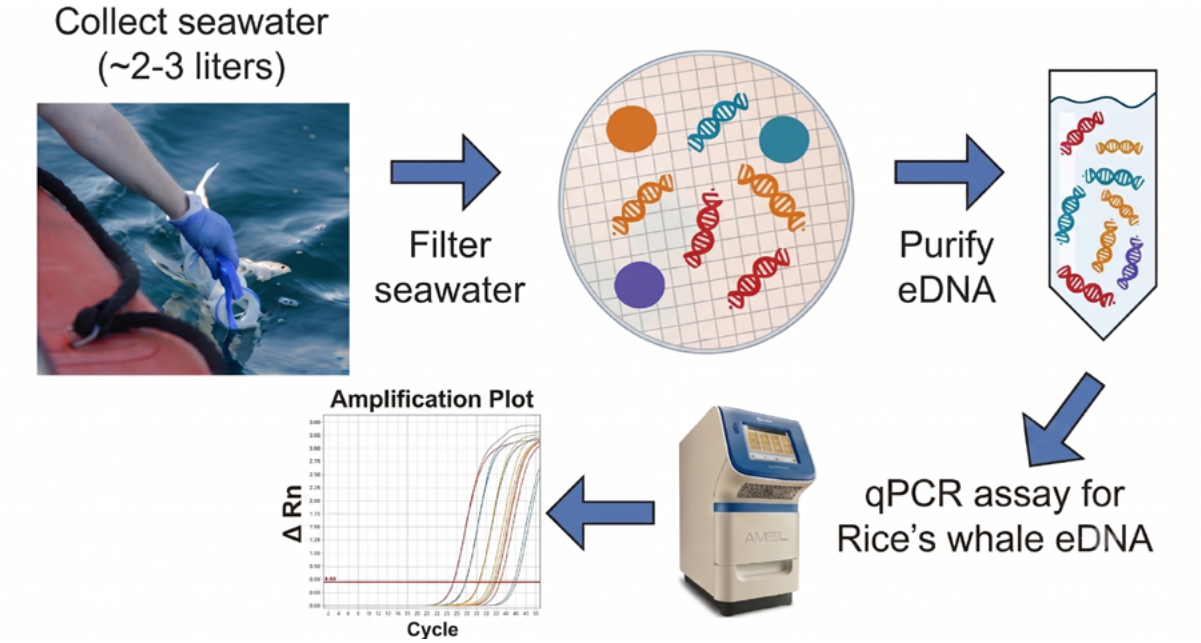
Scripps Institution of Oceanography High-frequency Acoustic Recording Package (HARP) mooring. Image is not to scale. Credit: NOAA/NMFS/SEFSC

Ocean Instruments NZ SoundTrap recorder mooring. Images are not to scale. Credit: NOAA/NMFS/SEFSC

> **“This is an excellent demonstration of the expansion of our monitoring systems’ capabilities, leveraging tested, AI-ready tools for the precise acoustic detection of rare marine mammals.**
>
> - Mridula Srinivasan, Director of the Marine Mammal and Turtle Division, NOAA Southeast Fisheries Science Center

The second advancement was the development and routine use of a genetic assay, or tool to identify specific genetic material, that can detect Rice’s whale eDNA left behind in seawater. Animals shed eDNA or genetic material into their surroundings through skin cells, mucus, and, in the case of marine mammals, also through their exhalation or “blow” when they surface to breathe. For Rice’s whales, this provides a powerful new non-invasive detection method. Before this assay was developed, confirming Rice’s whale presence usually depended on visual sightings and acoustic detections and DNA was collected with remote biopsy samples—each of which has limitations. The new assay allows scientists to test a small seawater sample for Rice’s whale eDNA without having to closely approach the animal or rely on it to vocalize. The assay was rigorously validated, can detect very low amounts of target DNA in as little as a 3-liter seawater sample, and does not amplify DNA from non-target species. This research was published in 2025 and is now

being routinely used to analyze seawater collected during surveys, enabling information about Rice's whales to be collected during almost any NOAA expedition in the region as an additional and complementary monitoring tool. Incorporating eDNA with other methods to monitor the species gives NOAA a practical way to expand monitoring across a much larger area and build a broader record of Rice's whale distribution in the Gulf.



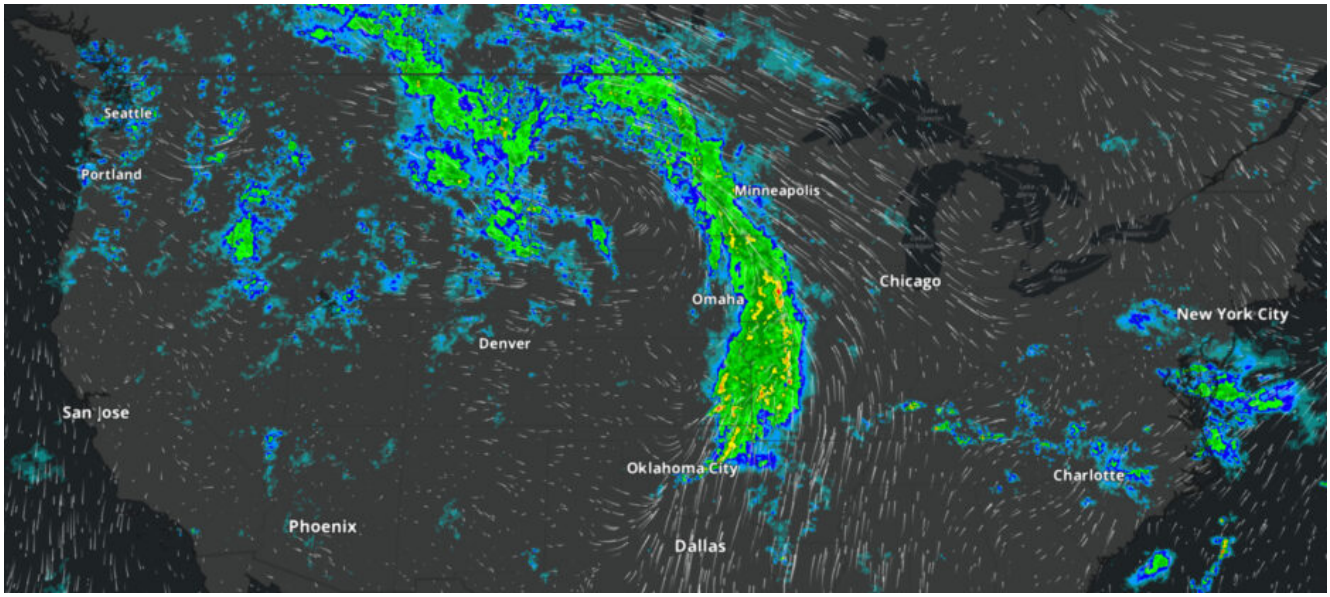
Workflow for quantitative polymerase chain reaction (qPCR) amplification used for targeted detection of Rice's whale eDNA from seawater samples. Credit: NOAA/NMFS/SEFSC

Together, these two technological innovations give NOAA a stronger and more complete monitoring system for one of the nation's most recently designated whale species. The resulting combination of genetic and acoustics data will inform NOAA's understanding of Rice's whale abundance and habitat, meaning managers can continue to designate critical habitat under the Endangered Species Act, assess the population status under the Endangered Species Act and Marine Mammal Protection Act, and inform permitting and consultation requirements across different marine sectors and resource extraction industries. Because Rice's whales are so rare, every new source of reliable information matters. By combining acoustics and DNA-based detection methods, NOAA is improving its ability to understand the species' distribution, support conservation planning, and guide management decisions needed for the long-term recovery of Rice's whales.

NOAA's First AI-Powered Regional Forecast Model: HRRR-Cast

Weather forecasters need fast, accurate guidance when dangerous storms are developing. In 2025, NOAA's Global Systems Laboratory (GSL), with funding support from the Office of the Chief Information Officer (OCIO) and in collaboration with the Cooperative Institute for Environmental Studies (CIRES), developed, demonstrated, and delivered HRRR-Cast to the National Weather Service Environmental Modeling Center (EMC) for real-time demonstration. HRRR-Cast is NOAA's first experimental artificial intelligence-powered regional forecast model. It was designed to emulate NOAA's flagship High-Resolution Rapid Refresh (HRRR) model, which is widely used for short-term forecasting of thunderstorms, precipitation, and other high-impact weather.

Traditional weather models make predictions of the future state of the atmosphere by performing complex mathematical calculations to directly simulate the physics and dynamics of the atmosphere. HRRR-Cast does not perform these calculations directly; rather, it emulates other models by using AI to predict how other models would generate the forecast. This approach greatly reduces the computing power needed to generate a forecast. By not performing the underlying calculations, HRRR-Cast can generate a forecast on a personal computer in a matter of minutes, whereas traditional models can run for up to several hours and require a supercomputer. HRRR-Cast therefore provides an additional forecasting tool to create deterministic and ensemble guidance while using only a fraction of the computing resources required by the traditional HRRR.



HRRR-Cast output showing simulated reflectivity and wind particles over the contiguous-U.S. domain for a line of strong thunderstorms that occurred May 6, 2024. This image was created using GSL's DESI tool. Credit: NOAA/OAR/GSL

> **"This represents a significant leap forward in the application of artificial intelligence to environmental modeling. By leveraging new, high-resolution observations that help us better understand fine-scale physical processes, physical models can be improved, thereby improving the data on which AI-driven models are trained.**
>
> - Isidora Jankov, Scientific Computing Branch Chief, NOAA Global Systems Laboratory

What makes HRRR-Cast stand out is both its speed and its promise. The model can produce a full run in about seven minutes, and its deterministic version is roughly 1,000 times faster to run than the operational HRRR, while the probabilistic version is about 100 times faster. This makes it one of NOAA's first demonstrations that AI can be used for high-resolution regional probabilistic forecasting to highlight areas of potential high-impact weather events. In FY25, the project moved

rapidly from early development into a demonstration phase, helping forecasters and model developers begin learning how an AI-based regional model could fit into future probabilistic forecasting operations. This is NOAA's first regional-scale AI ensemble modeling system, built from scratch and moved to demonstration in just a few months, which made it an important proof of concept for future AI forecasting systems.

HRRR-Cast ensemble showed early skill in forecasting likelihood for high-impact events, emerging as a possible future probabilistic operational tool. The ensemble system provides outputs such as reflectivity, hourly precipitation, temperature, wind, cloud cover, and visibility, among others, and future versions are being developed to improve ensemble performance, add more diagnostic fields, and support specialized applications such as fire weather forecasting. In March 2026, GSL reported that the newest version of the system had reached 3-kilometer resolution, achieved comparable forecast skill to the operational HRRR in reflectivity and precipitation statistical measure of performance at all forecast times, and produced ensemble forecasts similar to the Rapid Refresh Forecast Ensemble System. The HRRR-Cast ensemble system now runs in real-time, and is publicly accessible through the DESI visualization tool.

The rapid FY25 development of HRRR-Cast ensemble system by GSL and EMC and the transition to real-time demonstration with EMC exemplifies NOAA's new frontier in weather prediction. Rather than replacing traditional models, HRRR-Cast shows how AI-powered systems can complement them by delivering fast, high-resolution guidance that may be especially useful when forecasters need quick, real-time probabilistic updates on high-impact events. By developing and demonstrating this new regional model to NWS, NOAA created an important step toward future AI-assisted forecasting and showed what may be possible as these systems continue to improve.

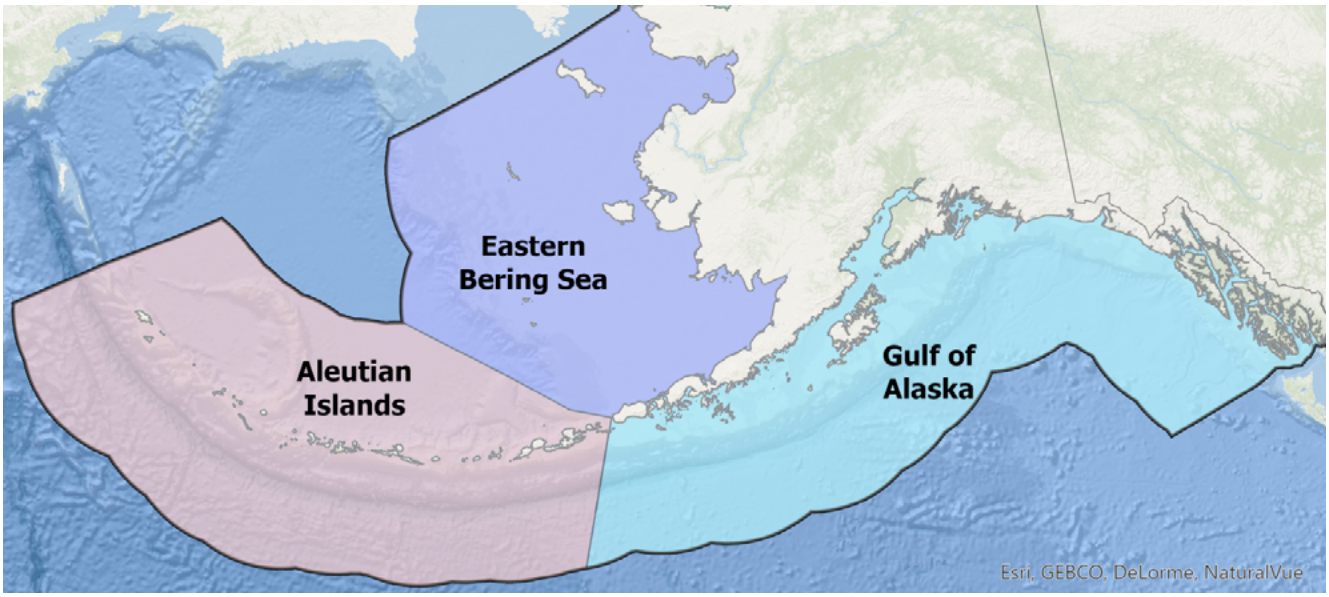
Aleutian Islands Pacific Cod Stock Assessment

Pacific cod are a highly important groundfish in Alaska, and sustainable management of this fishery depends on accurate assessments of the population that can reliably estimate the status of the stock and support science-based catch limits. In December 2024, scientists at NOAA Fisheries' Alaska Fisheries Science Center successfully completed a comprehensive, age-structured stock assessment for Aleutian Islands Pacific cod, replacing the more data-limited approach previously used for management and paving the way for a more comprehensive and environmentally informed tactic for management. The age-structured assessment provides a more comprehensive picture of Pacific cod stock dynamics by incorporating multiple sources of biological information collected both from NOAA surveys and from the fishing industry, including length data, age data, maturity information, and environmental considerations related to recent warm conditions in the Aleutian Islands. This assessment contributes to the growing number of stock assessments that have worked to incorporate or account for environmental changes, and continues the agency's work to advance climate-informed science in support of ecosystem-based fisheries management. The improvement in the best available science available for fishery managers of the Aleutian Islands Pacific Cod stock marked a major advancement in NOAA's ability to assess and manage this unique stock in support of this vital industry in Alaska.

Researcher Dr. Peter Munro looking at a pot of Pacific cod caught during a NOAA research survey. Credit: Sandi Neidetcher

> **This was a team effort by stock assessment scientists at the Alaska Fisheries Science Center that demonstrates NOAA's dedication to strengthening fisheries management through cutting-edge science. The transition to this more nuanced stock assessment model for Pacific cod in the Aleutian Islands improves NMFS's ability to understand the population size, set catch limits more accurately, bolster the economy, sustain harvest opportunities for the American people, and ensure cod continues to reach the dinner plate.**
>
> - Ingrid Spies, Research Fisheries Biologist, NOAA Alaska Fisheries Science Center

This new assessment was especially important because earlier genetic research showed that Aleutian Islands Pacific cod are distinct from Pacific cod in the eastern Bering Sea, supporting the need to manage them as a separate stock with their own assessment and catch limits. Since the stocks were split for management in 2014, Alaska Fisheries Science Center scientists worked over multiple years to develop an age-structured model suitable for management use. After repeated model development, internal review, and refinement in response to feedback from the North Pacific Fishery Management Council, the model was accepted in 2024, marking a major accomplishment for the lead scientists. The accepted model also included an innovative time block on natural mortality associated with recent marine heatwave conditions, reflecting evidence that Pacific cod in the Aleutian Islands are thermally sensitive and that prolonged warm conditions likely affected stock productivity.



Map of Alaska's ocean regions (not pictured: the Chukchi-Beaufort Seas region). NOAA manages Pacific Cod in the Aleutian Islands, Gulf of Alaska, and Eastern Bering Sea as separate stocks. Credit: NOAA/NOS/NCCOS

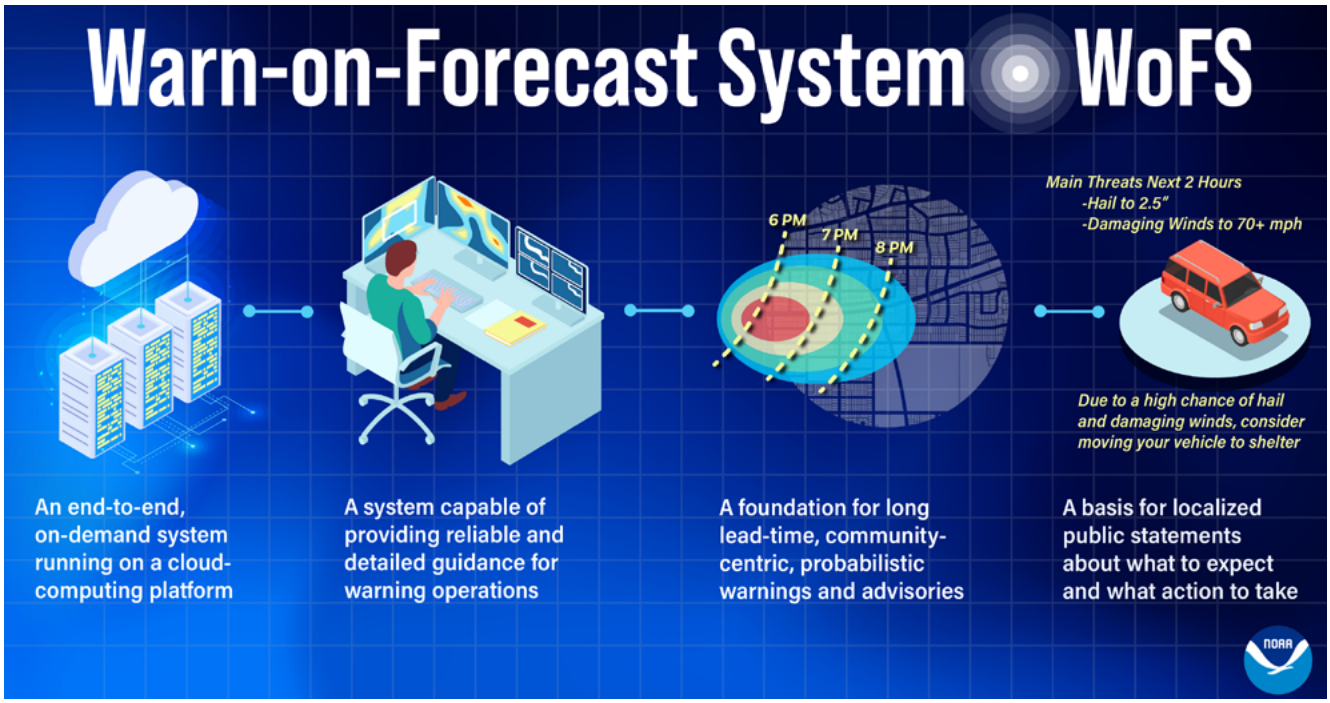
The completed Tier 3 assessment provided the first formal evaluation of Aleutian Islands Pacific cod and updated the stock's biological reference points and harvest advice. The preferred model estimated a 2025 spawning biomass of 25,078 metric tons and advised an allowable catch of 13,376 metric tons. The new assessment suggests that, under average conditions, the overfishing limit could possibly increase over the next six years as the stock rebuilds. By delivering a more reliable and biologically realistic assessment framework for this distinct Aleutian Islands stock, this project strengthens NOAA's capacity to support long-term sustainability, environmentally-informed fisheries management, and therefore economic opportunities in Alaska.

Warn-on-Forecast System Transition to Demonstration

Severe storms can grow and change very quickly, which gives forecasters a short time to warn people in harm's way. Between 2010 and 2016, NOAA's National Severe Storms Laboratory (NSSL) designed the Warn-on-Forecast System (WoFS) to give forecasters fast-updating, storm-scale guidance before dangerous weather fully develops. WoFS is an experimental ensemble forecasting system that frequently takes in radar and satellite data, and gives forecasters probabilistic information about hazards such as tornadoes, damaging winds, and flash floods. In FY25, NSSL and NWS began a WoFS Demonstration to facilitate operational transition. They built a copy of the original cloud-based WoFS prototype using NOAA VLAB (VLAB-WoFS), designed methods for initiating targeted regional WoFS runs, and tested the system on a wide range of events; the Demonstration greatly expanded the spectrum of weather for which WoFS can be used to protect lives and property.

In the prior eight years of experimentation, WoFS proved to be a highly valuable resource for severe weather and heavy rainfall. Testing, however, frequently focused on springtime storms in the central and eastern United States, and application to other decision support services was limited. The NWS WoFS Demonstration provided the financial and personnel support to expand the availability of WoFS runs. The NWS WoFS Demonstration began in October 2024 using the

WoFS prototype at NSSL, and by July 2025, real-time ensemble runs had moved to VLAB-WoFS. Onboarding of a system administrator at NWS facilitated frequent WoFS runs, and these gave more forecasters real-time experience using the system for events relevant to their area. This also meant WoFS could be applied to more parts of the country through all seasons, including a focus on tropical cyclones, atmospheric rivers, and fire weather.



Graphic illustrating NOAA's Warn-on-Forecast System (WoFS), an end-to-end, on-demand forecasting system designed to support reliable, probabilistic severe weather guidance and localized public warning statements. Credit: NOAA/NWS/OSTI

During the WoFS Demonstration the Storm Prediction Center, and the Weather Prediction Center were given a web-based display to define the time and place for each WoFS run, prompted when their respective national outlook products met certain criteria. WoFS Demonstration project managers also sought opportunities to run WoFS outside of the criteria to more fully explore potential IDSS applications. As of April 2026, the Demonstration had provided more than 100 days of WoFS runs, including 100 consecutive hours of forecast guidance during a prolonged severe weather outbreak in spring 2025. In December 2025, WoFS runs supported flood disaster recovery in the Pacific Northwest, and by early 2026, the Demonstration included runs for high-profile public events like the Super Bowl, where WoFS aided aviation-related forecasts for three major airports in California. Each WoFS run was announced to Weather Forecast Offices (WFOs) via email and chatrooms. Affected WFOs then monitored and participated in chat room discussions with NSSL and NWS WoFS experts to harness real-time insights as forecast signals emerged. These experiences through the WoFS Demonstration led to protocol and best practices for WoFS.

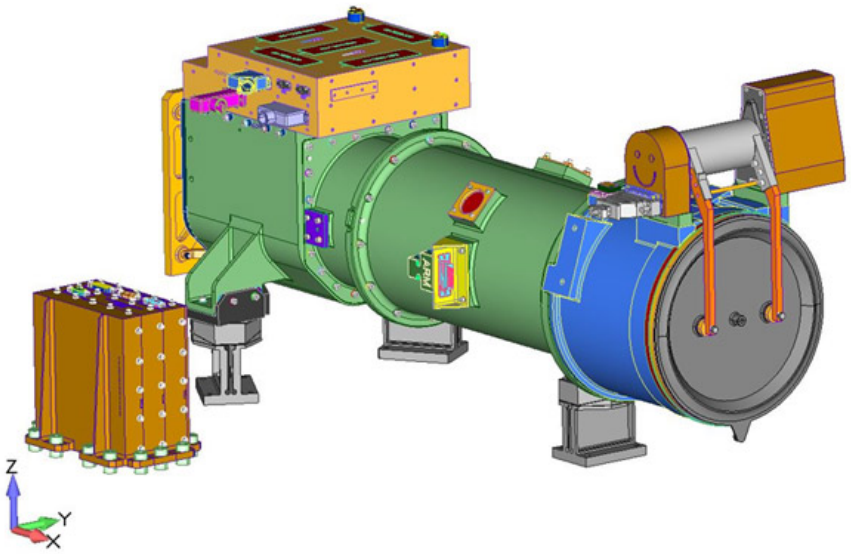
The WoFS Demonstration matters because it is helping forecasters use rapidly updating, uncertainty-aware guidance in the watch-to-warning time frame, when even small gains in lead time can save lives. As of early 2026, the Demonstration had produced documented examples of 1- to 2-hour lead time for county-level messaging about tornadoes, damaging winds, flash flooding, and other hazards. In one March 2025 case, forecasters used WoFS guidance to alert officials in

Carter County, Missouri, about the risk of a strong, long-track tornado roughly two hours before a tornado struck. The early message helped local officials spread the word, and a community shelter that had only four people inside grew to 125 before the tornado arrived. The broader goal is to make this kind of early, proactive storm messaging normal practice, while also building an NWS workforce that is ready to use WoFS effectively when it moves closer to operations.

> **“I can’t praise him enough for the early warning. I can’t say how many lives he saved, but I’ll guarantee you he called us early enough, we got our people notified and we had no loss of life.**
>
> - Emergency Manager in Missouri (Collected from an Anonymous Survey)

The FY25 WoFS Demonstration advanced both technology and practice at NOAA. It moved a game-changing capability from a research-led prototype toward NWS readiness, while spurring new decision support services. This transition shows how research-to-operations can do more than hand off a tool — it can build the knowledge, workflows, and user confidence so that tool can make a real difference in protecting lives and property.

Compact Coronagraph-1 (CCOR-1) Solar Imager on the GOES-19 Satellite



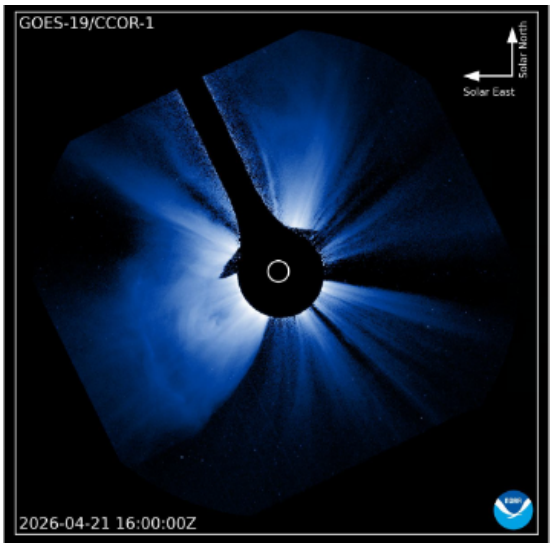
A digital rendering of the CCOR-1 instrument. Credit: U.S. Naval Research Laboratory

Space weather describes the space environment around our Earth that is caused by the interaction between the Sun and the Earth; space weather events and storms are driven by solar phenomena such as coronal mass ejections (CMEs), solar flares, and solar wind. With the risk of disruption to the power grid, satellites, radio communications, and navigation services, ensuring early warning for space weather events is highly impactful. One of the best ways to track dangerous solar activity is to watch for CMEs, which are large eruptions of outer solar plasma driven by energy stored in the solar

magnetic fields. The Compact Coronagraph-1 (CCOR-1) on NOAA's GOES-19 satellite was built to do that job by imaging the sun's outer atmosphere allowing forecasters to measure the size, speed, and direction of CMEs. GOES-19 launched on June 25, 2024, and became NOAA's operational GOES East satellite on April 4, 2025, a significant accomplishment in FY25. CCOR-1 is the first operational space-based coronagraph and is NOAA's first coronagraph instrument. It is significantly contributing to the ability of the NOAA National Weather Service (NWS) Space Weather Prediction Center (SWPC) to provide warnings more than a day in advance of possible geomagnetic storms.

In FY25, NOAA completed an important research-to-operations transition for CCOR-1, ending operational reliance on research coronagraphs by establishing a new NOAA operational capability. NESDIS successfully handed over the CCOR-1, transferring the instrument and programmatic, technical, and budgetary responsibility from system development by the Office of Space Weather Observations (SWO) to NOAA operational branches. The NESDIS Office of Satellite and Product Operations (OSPO) will provide day-to-day mission operations and engineering support, the NWS SWPC will produce and distribute real-time products for forecasters and users, and the NESDIS National Centers for Environmental Information (NCEI) will provide extended calibration analysis, scientifically authoritative data, and archive all of the data which is made accessible via the new Space Weather Data Portal. That means the instrument is now backed by the organizations needed to run it, turn its observations into usable products, and preserve the data for future research and analysis.

> **"CCOR-1 is a game-changer for ensuring our nation is resilient to solar storms, allowing us to monitor massive eruptions of energy from the sun in real time. With dramatically improved resolution and faster detection, it helps us better predict dangerous space weather that can impact satellites, GPS, astronaut safety, aviation and power grids, ensuring we can protect critical technology and infrastructure like never before.**
>
> - Clinton Wallace, Director of the NOAA Space Weather Prediction Center



CCOR-1 coronagraph image showing the Sun's outer atmosphere, or corona, and a coronal mass ejection (CME) being emitted from the southeastern limb of the Sun on April 21, 2026. Credit: NOAA/NWS/SWPC

This research-to-operations transition marked the deployment of years of research and development into real-world application and established the long-term support structure needed to keep CCOR-1 working as a vital NOAA capability. CCOR-1 quickly and reliably delivers imagery within 30 minutes of acquisition, much faster than older scientific coronagraph sources that deliver images on an unpredictable schedule that could take up to eight hours. In early 2025, SWPC began regularly acquiring and processing GOES-19 CCOR-1 data, with new images being generated every 15 minutes. Consistently fast access to CME imagery improves NOAA's ability to detect solar eruptions sooner and better support warnings about geomagnetic storm conditions. In addition, CCOR-1 also supports the ability of the scientific space weather research community to better understand and characterize our solar system by providing a new source of consistent, high-quality coronagraph observations.

The FY25 transition of CCOR-1 on GOES-19 is a key step in NOAA's larger effort to strengthen space weather forecasting. By moving responsibility from the development program into operations across OSPO, SWPC, and NCEI, NOAA ensured that this new solar imager is not only functioning, but is fully embedded in the operational system needed to support forecasters, data users, and the public. That support is especially important because CCOR-1 fills a critical role in NOAA's space weather mission: continuously monitoring the solar corona so forecasters can better detect, track, and characterize CMEs before they affect Earth. This transition helped turn a new satellite instrument into a sustained operational service that protects technology, critical infrastructure, and most importantly, lives and public safety.

Conclusion

This FY25 Annual Transition Report underscores the critical role of research and development transitions in enabling NOAA to deliver on its mission of understanding and predicting changes in climate, weather, oceans, and coasts, and sharing that knowledge to inform decisions and safeguard lives and property. The featured stories in this report, along with the many additional transitions reported across NOAA, show how scientific research, technological innovation, and strong partnerships can be translated into practical tools, services, and capabilities that benefit the nation, the public, and the economy.

Together, these transitions demonstrate the value of tracking how NOAA research is put into use. They show how taxpayer investments in research and development support improved forecasts, stronger decision-support tools, more effective monitoring systems, and better stewardship of natural resources. Moving forward, NOAA will continue to build on the foundation established by its annual transition reporting process, using these reports to improve visibility into research outcomes, strengthen transition pathways across line offices, and maximize the impact of the agency's scientific investments.

Appendix A: Acronyms

AI	Artificial Intelligence
ARL	Air Resources Laboratory
CCOR-1	Compact Coronagraph-1
CIMAS	Cooperative Institute for Marine and Atmospheric Studies
CIRES	Cooperative Institute for Research in Environmental Sciences
CME	Coronal Mass Ejection
CPO	Climate Program Office
CS	Chief of Staff
eDNA	Environmental DNA
EMC	Environmental Modeling Center
EUMETNET	European Meteorological Network
FY24	Fiscal Year 2024
FY25	Fiscal Year 2025
GLFC	Great Lakes Fishery Commission
GOA-ON	Global Ocean Acidification Observing Network
GSL	Global Systems Laboratory
HARP	High-frequency Acoustic Recording Package
HRRR	High-Resolution Rapid Refresh
ICES	International Council for the Exploration of the Sea
IDSS	Impact-based Decision Support Services
LOTM	Line Office Transition Manager
LOTMC	Line Office Transition Managers Committee
NAO	NOAA Administrative Order
NCEI	National Centers for Environmental Information
NESDIS	National Environmental Satellite, Data, and Information Service
NIDIS	National Integrated Drought Information System
NMFS	National Marine Fisheries Service

NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NRDD	NOAA Research & Development Database
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
OAR	Oceanic and Atmospheric Research
OCIO	Office of the Chief Information Officer
OMAO	Office of Marine and Aviation Operations
ORTA	Office of Research, Transition, and Application
OSPO	Office of Satellite and Product Operations
OSTI	Office of Science and Technology Integration
POC	Point of Contact
qPCR	Quantitative Polymerase Chain Reaction
R&D	Research and Development
R2A	Research to Applications
R2C	Research to Commercialization
R2O	Research to Operations
R2X	Collective term for R2O, R2C, and R2A transitions
RL	Readiness Level
SEFSC	Southeast Fisheries Science Center
SWO	Office of Space Weather Observations
SWPC	Space Weather Prediction Center
TRWG	Transition Report Working Group
UNAM	Universidad Nacional Autónoma de México
WFO	Weather Forecast Office
WMO	World Meteorological Organization
WoFS	Warn-on-Forecast System

Appendix B: Methods

The FY25 NOAA Annual Transition Report is the second report in this series. Therefore, this year's methodology followed the precedent set by the FY24 NOAA Annual Transition Report. This report's development followed the five steps defined by the LOTMC Transition Report Working Group (TRWG) in preparation for the inaugural Annual Transition Report in FY24: **1) prepare, 2) collect, 3) analyze, 4) review, and 5) report**.

Prepare: At the end of FY25 (October 1, 2025), the LOTMC communicated to all LOTMs the purpose of the Annual Transition Report, and the information to be collected. The Office of Research, Transition, and Application (ORTA) began the annual reporting process by creating a Google folder and spreadsheet to collect FY25 transition project information.

This spreadsheet was pre-populated with (1) project information collected during the FY24 Transition Report that was identified to have instead transitioned during FY25, and (2) project information queried from the archived NOAA Research & Development Database (NRDD), which was retired at the start of FY25 Q3. ORTA queried the archived NRDD data for FY25 Q1 & Q2 project information, following each of the three criteria:

- Projects reported in NRDD that moved from RL8 ->RL9 in FY25;
- Projects reported in NRDD that were marked as "Transitioned" in FY25; and
- Projects reported in NRDD that identified an *Actual Transition Date* greater than 9/30/2024 AND *Actual Transition Date* is less than 10/1/2025.

ORTA then shared this spreadsheet, pre-populated with the aforementioned project information, with the LOTMC Executive Secretariat (Exec Sec) team for distribution to the LOTMs.

Collect: The LOTMC Exec Sec distributed the tasking email to LOTMs with instructions to review, contribute, and update project information within the data collection spreadsheet. LOTM's were tasked to: 1) review the spreadsheet to confirm accuracy of pre-populated project information, 2) add project information for all transitions within their respective line office during FY25, if needed by consulting with POCs to obtain accurate information, and 3) conduct a survey of impactful transitions across their respective Line Office. LOTMs ensured that projects included in this report have met their intended end use, either at RL 9 or another completion stage. The LOTMC Exec Sec collected LOTM input in the spreadsheet, and shared it with ORTA for the next step (~March 16th).

Additionally, the LOTMC Exec Sec team tasked the LOTMs to nominate projects to highlight in the Annual Transition Report. LOTMs then voted on the final list of projects to include in the report at the March 26th LOTMC meeting.

Analyze: ORTA then utilized the collected data to analyze project information and project highlights, composing data visualizations/figures, statistics, and narratives of key project highlights. The first part of the analysis produced a narrative highlighting seven projects that have transitioned or had been put into use (at the discretion of the LOTMs).

Review: ORTA pulled the project highlights and the figures into this report. The draft report was sent to the LOTMC Exec Sec to share with the LOTMC for review.

Report: Once approved, the LOTMC Chair and Exec Sec created a slideshow with the report figures and highlights to be presented to the NOAA Science Council. The report is to be posted to the Science Council website and the NOAA Institutional Repository.