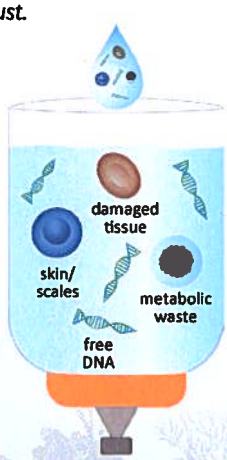
NOAA 'Omics Strategy

The NOAA 'Omics Strategy will dramatically expand our application of 'omics—a suite of leading-edge methods used to analyze materials such as DNA, RNA, or proteins—by improving the efficiency, effectiveness, and coordination of 'omics development and usage across the agency. As 'omics are revolutionizing our ability to monitor and understand the biological communities of the oceans and Great Lakes, this Strategy will guide transformative advancements in the quality and timeliness of NOAA science, products, and services.

This at-sea 'omics laboratory to promote biodiversity and deep-sea exploration represents a collaboration between NOAA's Northwest Fisheries Science Center and the Ocean Exploration Trust. Photo Credit: Ocean Exploration Trust.



eDNA can provide comprehensive biological data with increased efficiency, resulting in more timely public access to information.

Demonstrated Leadership in 'Omics

In recent years, NOAA and its multisector partners have worked tirelessly to advance successful 'omics solutions that address our mission priorities. Specific fields include genomics, transcriptomics, proteomics, and metabolomics. Now we are leveraging that experience to integrate modern 'omics technologies across our agency. These advances will increase operational efficiency, improve ecosystem assessments and forecasts, and support stewardship. Example applications include:

- Sustaining fisheries;
- Developing aquaculture;
- Combating harmful and invasive organisms;
- Improving seafood forensics and traceability;
- Discovering pharmaceuticals and other beneficial compounds; and
- Protecting vulnerable species and habitats, such as corals, that provide essential fish habitat and support tourist economies.

The draft 'Omics Strategy is being made available for public comment at https://nrc.noaa.gov/NOAA-Science-Technology-Focus-Areas.

'Omics Strategy Goals

1. Enhance infrastructure to meet the analytical demands of 'omics data.
2. Execute 'omics research targeted to support and advance the American Blue Economy.
3. Accelerate transition of 'omics research into operations.
4. Expand partnerships to advance 'omics research and applications across the agency.
5. Promote workforce proficiency in 'omics.

At-sea eDNA analysis conducted by NOAA Fisheries' Dr. Jeanette Davis during a U.S. west coast survey by the NOAA Ship Bell M. Shimada to estimate fish distributions and generate biomass indices.

NOAA's 'Omics Strategy aligns with:

- The National Science and Technology Council's *Science and Technology for America's Oceans: A Decadal Vision* as well as the Executive Office of the President's August 30, 2019, Memorandum "Fiscal Year 2021 Administration Research and Development Budget Priorities."

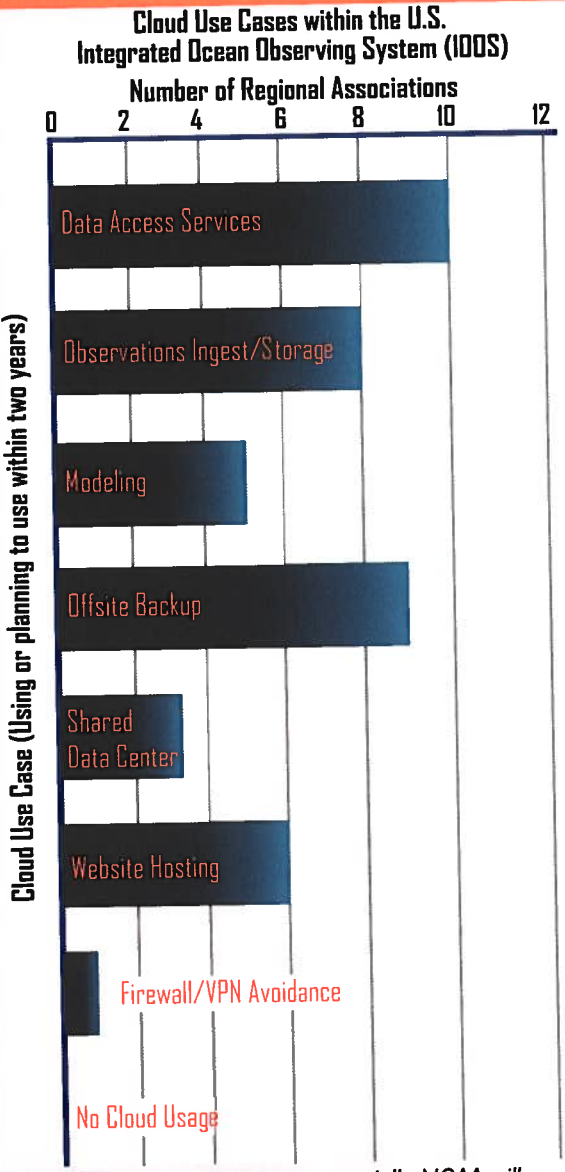
A sample collected from a Monterey Bay Aquarium Research Institute UUV is prepared for 'omics analysis at the NOAA Great Lakes Environmental Research Laboratory by microbiologist, Dr. Kelly Goodwin. Expanding UxS applications can provide timely and affordable comprehensive biological data.

Bold New Era in Harnessing 'Omics

To ensure the NOAA 'Omics Strategy realizes transformational advances in quality and efficiency, NOAA is developing an 'Omics Strategic Implementation Plan or "Roadmap" that defines detailed action items, deadlines, and responsibilities. In the meantime, the NOAA 'Omics Strategy is already improving performance in achieving our economically impactful missions and setting the course to strengthen our renowned environmental science and technology leadership. Through this, NOAA will achieve our agency priority to sustainably expand the American Blue Economy.

NOAA Cloud Strategy

NOAA will migrate suitable IT services to commercial cloud computing environments to reduce costs, improve efficiency, provide unlimited seamless scalability, and maintain high levels of security. Cloud represents a transformative technology that will not only improve general operational IT services, but also ensure many of NOAA's functions across the entire value chain—from observations, data management, and numerical weather prediction to end-user products and applications—will better serve the public and more effectively enable us to carry out our mission.



As data volumes increase exponentially, NOAA will increasingly leverage the commercial cloud for a variety of services, such as those leveraged by the NOAA IOOS Regional Associations.

Demonstrated Leadership in Cloud

NOAA's cutting-edge innovation and strategic academic and industry partnerships for developing cloud applications are already demonstrating improvements in performance and skill in areas such as satellite data products and services, numerical weather prediction, ocean models, and big data analysis, storage, and dissemination.

Cloud services will be further leveraged to expand benefits, such as:

- Accelerated timeline to acquire new computing resources;
- Increased security posture through security automation;
- More accessible and monetizable NOAA data to customers, such as academia and industry;
- Reduced transition time from research into operations;
- Scalable infrastructure that supports scientific and HPC requirements; and
- A more agile and innovative organizational culture.

Earth Prediction Innovation Center (EPIC)

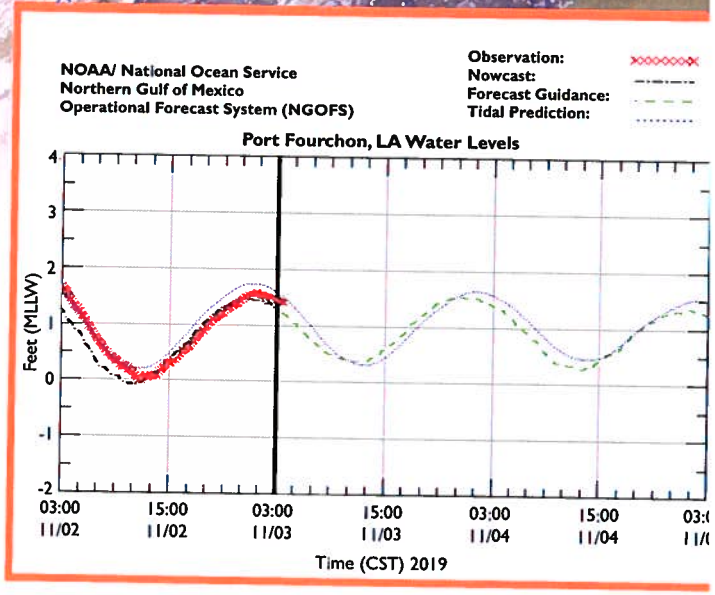
EPIC will enable NOAA to regain and maintain international leadership in numerical weather prediction through a novel community-driven approach to accelerate cutting-edge research into operations. An integral part of EPIC will be transitioning to cloud-based high-performance computing and storage to broaden community engagement and improve stakeholder access to NOAA's code and data.

Cloud Strategy Goals

1. Boost innovation through rapid adoption of cloud-based services.
2. Drive smart migration to the cloud.
3. Ensure secure access and stable environments.
4. Provide effective governance for shared services.
5. Empower a cloud-ready workforce.

NOAA's Cloud Strategy aligns with:

- The Executive Office of the President's August 30, 2019, Memorandum "Fiscal Year 2021 Administration Research and Development Budget Priorities."



Under NOAA's Big Data Project, datasets, such as the output from Operational Forecast System (OFS) coastal ocean models, have already moved to the commercial cloud.

Bold New Era in Harnessing the Cloud

To ensure the NOAA Cloud Strategy realizes transformative techniques to enhance the quality and timeliness of NOAA products and services, NOAA is developing a Cloud Implementation Plan or "Roadmap" that defines detailed action items, deadlines, and responsibilities. In the meantime, the NOAA Cloud Strategy is already improving performance in our lifesaving and economically impactful missions and setting the course to strengthen our renowned environmental science and technology leadership. Through this, NOAA will achieve our top agency priorities to regain and maintain global leadership in numerical weather prediction and sustainably expand the American Blue Economy.

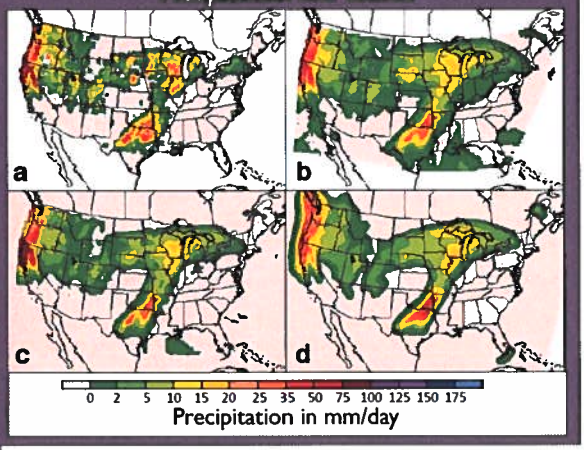
Cloud computing provides more rapid access to data and superior scalability to enable a growing array of decision support services that will enhance NOAA's ability to keep Americans out of harm's way.

NOAA Artificial Intelligence Strategy

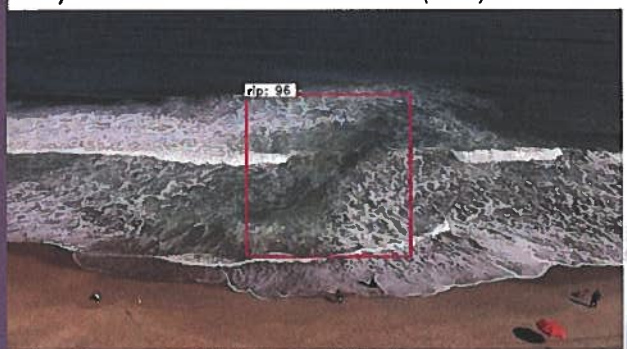
The NOAA AI Strategy will dramatically expand the application of artificial intelligence (AI) in every NOAA mission area by improving the efficiency, effectiveness, and coordination of AI development and usage across the agency. As data exploitation capabilities continue to increase exponentially with improved data from a scalable consolidated satellite architecture, unmanned systems, and commercial data sources, AI methods will provide transformative techniques to enhance the quality and timeliness of NOAA science, products, and services.

Example of AI (NN)-based Ensemble: Nonlinear Multimodel Ensemble Mean

Precipitations over ConUS



NOAA National Weather Service demonstrates the use of AI to improve ensemble modeling accuracy. (a) Climate Prediction Center (CPC) analysis (ground truth); (b) Ensemble mean of eight models: NCEP (global and regional) and six international models. Reduced maximum and diffused sharpness of fronts due to slightly shifted maps from ensemble members, produced many false alarms; (c) AI-based Ensemble composite. Closer to CPC with maintained sharpness and minimal alarm rates; (d) the forecast produced by human analyst at the Weather Prediction Center (WPC).



NOAA National Ocean Service and National Weather Service are partnering with researchers at UC Santa Cruz to use AI to detect rip currents from coastal imagery. The rip current observations are supporting implementation and improvement of the NOAA rip current forecast model.

Demonstrated Leadership in Artificial Intelligence

Artificial Intelligence involves techniques in machine learning and deep learning including neural networks, evolutionary computation, probabilistic and statistical methods. NOAA's robust experience with AI applications across a range of mission areas is already demonstrating improvements in performance and skill at greatly reduced costs and compute time as the examples in this handout illustrate. Additional cost savings are shown in arenas as diverse as deep-sea exploration, habitat characterization, and processing of earth observations. By strengthening AI coordination, operational capabilities, workforce proficiency, and multisector partnerships, NOAA's national and global leadership in AI will support science, public safety, and security. Example applications include:

- Aerial and underwater surveys from ships and autonomous platforms to assess the abundance of marine mammal and fish populations;
- Robotics for deep-sea exploration;
- Quality control of weather observations;
- Improving physical parameterization for weather, ocean, and ice modeling, and the computational performance of numerical models;
- Automating weather-warning generation;
- Operation of unmanned systems for bathymetric mapping, habitat characterization, hydrologic, oceanographic, atmospheric, fishery, ecosystem, and geographic surveys;
- Using machine learning to analyze satellite imagery for severe weather detection and prediction, oil spill and hazardous material trajectory, wildfire detection and movement, ecosystem health, and detection of potentially illegal fishing activity; and
- Using machine learning for reliable and efficient processing, interpretation, and utilization of earth observations.

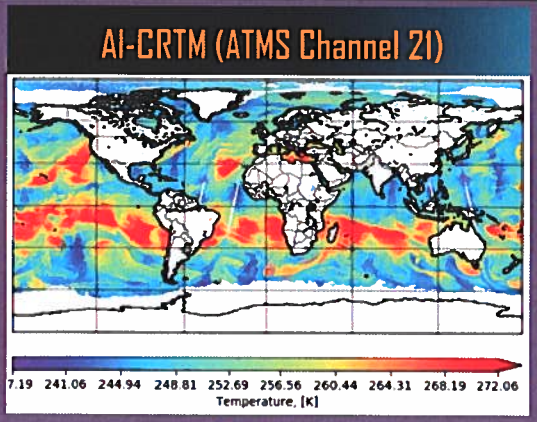
The draft AI Strategy is being made available for public comment at https://www.nesdis.noaa.gov/NOAA-Science-Technology-Focus-Areas

Artificial Intelligence Strategy Goals

1. Establish an efficient organizational structure and processes to advance AI across NOAA.
2. Advance AI research and innovation in support of NOAA's mission.
3. Accelerate the transition of AI research to operational capabilities.
4. Strengthen and expand AI partnerships.
5. Promote AI proficiency in the workforce.

NOAA's Artificial Intelligence Strategy aligns with:

- The Executive Order on *Maintaining American Leadership in Artificial Intelligence.*
- The National Science and Technology Council's *The National Artificial Intelligence Research and Development Strategic Plan: 2019 Update* and its *Science and Technology for America's Oceans: A Decadal Vision.*
- The Executive Office of the President's August 30, 2019, Memorandum "Fiscal Year 2021 Administration Research and Development Budget Priorities."

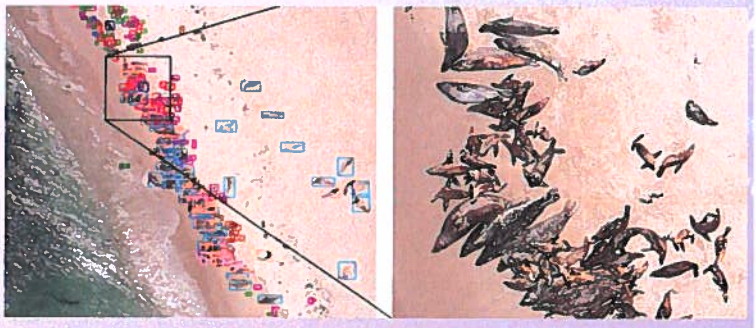


Processing time for 1 day of ATMS: AI-CRTM, 1 s; CRTM, 1.3 h

Simulated JPSS-1 ATMS channel 21 (183 GHz mid-upper tropospheric water vapor channel) from AI-based radiative transfer model (AI-CRTM) trained using CRTM (top), and operational CRTM (bottom). CPU time required to simulate 1 day of JPSS-1 ATMS (all channels) is reduced from 1.3 hrs using CRTM, to 1 second using AI-CRTM.

Bold New Era in Harnessing AI

To ensure the NOAA AI Strategy realizes transformational advances in performance, skill, and efficiency, NOAA is developing an AI Strategic Implementation Plan or "Roadmap" that defines detailed action items, deadlines, and responsibilities. In the meantime, the NOAA AI Strategy is already improving performance in our lifesaving and economically impactful missions—and setting the course to strengthen our renowned environmental science and technology leadership for the coming decades. Through this, NOAA will achieve our top agency priorities to regain and maintain global leadership in numerical weather prediction and sustainably expand the American Blue Economy.



NOAA Southwest Fisheries Science Center uses machine learning to deliver higher quality and more timely science for policy decision on protected and endangered species. In this example, machine learning has provided automated detection and identification of seals during aerial surveys.

NOAA Unmanned Systems Strategy

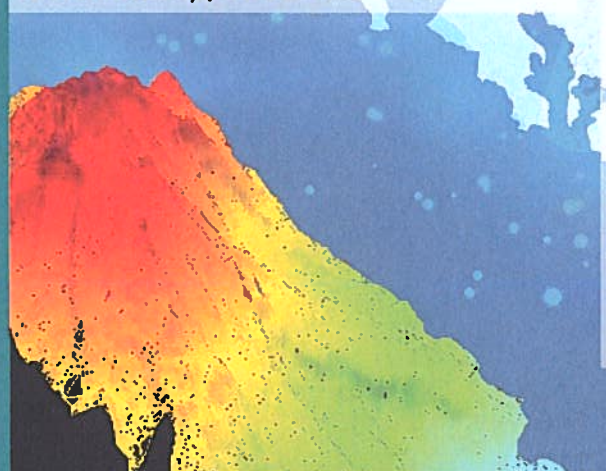
The NOAA Unmanned Systems (UxS) Strategy will dramatically expand the application of unmanned aircraft and marine systems (together, "unmanned systems" or "UxS") in every NOAA mission area by improving the efficiency, effectiveness, and coordination of UxS development and operations across the agency. As future data exploitation opportunities continue to increase exponentially with improved UxS platforms and architectures, the integration of artificial intelligence, and new commercial data sources, this Strategy will guide transformative advancements in the quality and timeliness of NOAA science, products, and services.

Demonstrated Leadership in Unmanned Systems

Many NOAA programs have pioneered the innovative use of UxS as a valuable force multiplier—augmenting data collection often at lower costs, increased safety, and reduced risk, especially in remote or extreme environments. The systems we have used to conduct research and operations include unmanned underwater vehicles (UUVs), such as gliders, remotely operated vehicles (ROVs), unmanned surface vehicles (USVs), and unmanned aerial vehicles (UAVs). UxS data are improving fishery stock assessments, hurricane intensity forecasts, and ocean and habitat mapping. Accelerating and expanding the use of unmanned systems across every NOAA mission area will provide NOAA customers with higher-quality, cost-effective services at faster cycle times that result in higher operational performance and safety. Example applications include:

- Hydrographic and disaster response surveys;
- Ocean exploration;
- Seafloor and shoreline mapping;
- Weather and flood damage assessment;
- Remote sensing for hazardous weather warnings;
- Marine mammal surveys;
- Fishing surveys for stock assessment; and
- Satellite sensor calibration.

NOAA's Integrated Ocean Observing System partnered with the U.S. Navy and Shell Oil Co. to share data from over 20 gliders deployed in the Gulf of Mexico in 2018. Salinity and temperature data from gliders can improve hurricane intensity forecasts.



The draft UxS Strategy is being made available for public comment at https://prc.noaa.gov/NOAA-Science-Technology-Focus-Areas

Unmanned Systems Strategy Goals

1. Coordinate and support UxS operations at an enterprise level.
2. Expand UxS applications across NOAA's mission portfolio.
3. Accelerate transition of UxS research to operations.
4. Strengthen and expand UxS partnerships.
5. Promote workforce proficiency in UxS use and operations.

NOAA research biologists, Katie Sweeney and Dr. Brian Fadely, deploy a hexacopter to monitor depleted northern fur seal populations with minimal disturbance. UxS can be ideal for marine mammal monitoring in difficult-to-traverse environments, such as the remote Aleutian Islands, at reduced cost and risk to scientists.

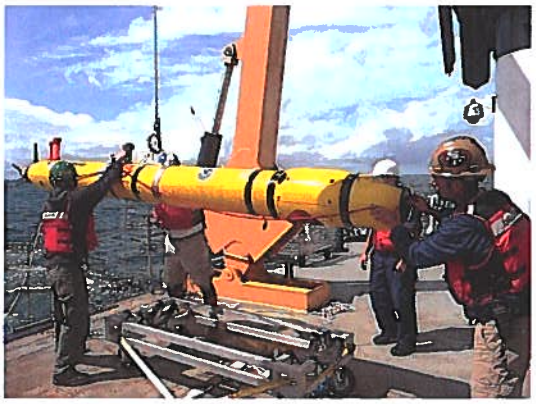
The FY 2020 President's budget includes $4M to support establishing a NOAA Unmanned Systems Operations Program and aligns with:

- Bipartisan Congressional action, such as the *Commercial Engagement Through Ocean Technology Act of 2018 (CENOTE).*
- The Executive Order on *Maintaining American Leadership in Artificial Intelligence.*
- The National Science and Technology Council's *Science and Technology for America's Oceans: A Decadal Vision* as well as the Executive Office of the President's August 30, 2019, Memorandum "Fiscal Year 2021 Administration Research and Development Budget Priorities."

For the third year in a row, NOAA is using Environmental Sample Processors designed by the Monterey Bay Aquarium Research Institute and mounted on a UUV to study potentially toxic algal blooms in Lake Erie in collaboration with NOAA's Great Lakes Environmental Research Laboratory.

Bold New Era in Harnessing UxS

To ensure the NOAA Unmanned Systems Strategy realizes transformational advances in performance, skill, and efficiency, NOAA is developing a UxS Strategic Implementation Plan or "Roadmap" to define detailed action items, deadlines, and responsibilities. Meanwhile, NOAA's use of UxS is already improving performance in our lifesaving and economically impactful missions, and setting the course to strengthen our renowned environmental science and technology leadership for the coming decades. Through this, NOAA will achieve our top agency priorities to regain and maintain global leadership in numerical weather prediction and sustainably expand the American Blue Economy.



NOAA's Office of Coast Survey prepares to launch a Hydroid REMUS 600 autonomous underwater vehicle on a bathymetric mapping mission. This vehicle can operate for 20+ hours at depths up to 450 meters while maintaining acoustic communications with the host ship.