Artificial Intelligence at NOAA

Harnessing Transformative Technology for Social Impact

What comes to mind when you think of artificial intelligence? Does the term conjure a sci-fi movie plot? Or does it bring to mind a distant future where technology automates all of our dull, repetitive chores, freeing us to focus our human cognitive talents on solving more interesting challenges?

That future is now at NOAA's Center for Artificial Intelligence (NCAI). NOAA is leveraging the transformative technology of AI to help scientists understand the environment and our place in it. NESDIS is helping NOAA build a fully capable NCAI technology hub by accelerating the AI-readiness and public cloud accessibility of NOAA data, building a community of practice through public workshops, and collaborating with the research community to integrate ethical AI into NOAA's services.

NOAA has long been a pioneer in the use of AI. In the 1980s, NOAA was one of the first organizations to employ AI to analyze satellite data and improve weather forecasting models. In 2020, Congress passed the National AI Initiative Act, which codified the mandate for NOAA's pioneering coordination of AI application across climate, ocean, earth, and space sciences.

This story highlights just a few of the many AI projects at NOAA. Collectively, these projects span from the bottom of the ocean to the outer atmosphere.

Predicting Dangerous Currents

A relaxing day at the beach can quickly turn dangerous under the wrong conditions. Rip currents are responsible for 80 percent of beach rescues and approximately 100 deaths in the United States annually. They are as dangerous as they are difficult to detect.

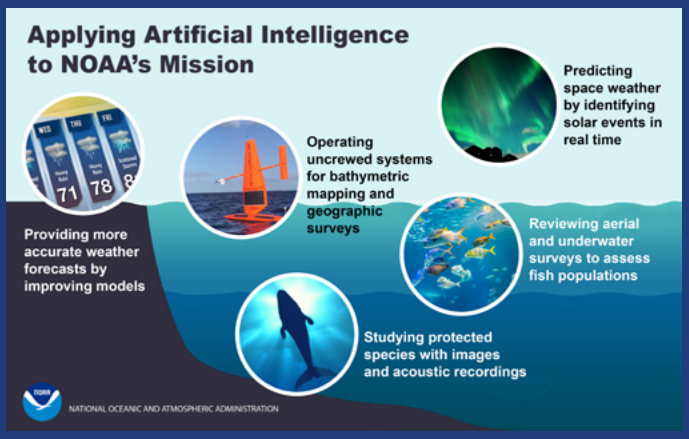
Rip currents are powerful, narrow channels of fast-moving water that are prevalent along the coasts of the United States, as well as the shores of the Great Lakes. Panicked swimmers often try swimming straight back to shore, into the current, putting themselves at risk of drowning because of fatigue.

Today NOAA uses AI technology to more accurately predict the likelihood of hazardous rip currents, offering hourly predictions up to six days in advance.

The National Ocean Service and National Weather Service collaboratively developed and deployed a rip current model using the logistic regression machine learning technique, which uses wave and water level data to predict rip currents. Similar to predicting weather or precipitation, the model predicts the likelihood of dangerous currents on a scale, from 0–100 percent.

Mapping Urban Heat Islands

Summer promises longer days filled with outdoor activities. But dangerously high temperature and humidity can turn those summer days hazardous. Excessive heat is the leading weather-related killer in the United States, disproportionately affecting low-income people and communities of color.



The NOAA Climate Program Office is working with the interagency National Integrated Heat Health Information System (NIHHIS) and partners to develop high-resolution air temperature and humidity data maps. A pilot effort by NESDIS NCAI is developing an AI-ready humidity dataset by blending measurements from ground stations and satellites using AI methods. The ultimate goal is to inform policy decisions by empowering communities researching heat health and developing applications with high resolution maps that combine environmental, land use, land cover and social economic information. For more information, see the NESDIS Impacts Brief Extreme Events story and AI at NOAA StoryMap.

Monitoring Tropical Cyclones

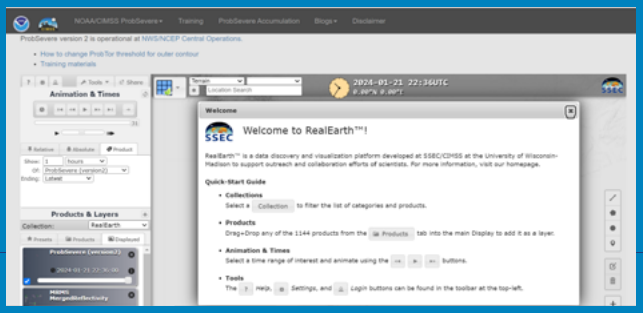
Tropical cyclones form in every tropical and subtropical oceanic region, with devastating impacts to vulnerable coastal areas (see also internal link here to the NESDIS Impacts Brief Extreme Events story). AI-ready and accessible benchmark satellite datasets are driving the future of tropical cyclone impact prediction–that is, the likelihood and severity of coastal flooding and other risks to people, businesses, and community infrastructure.

NOAA's Center for Satellite Applications and Research partnered with the Cooperative Institute for Atmospheric Research at Colorado State University to publish an AI-ready dataset for tropical cyclone research: the Tropical Cyclone PRecipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED).

This new dataset collocates and subsets LEO and GEO satellite imagery along with ancillary model information to create a 22-yr period of tropical cyclone centric scenes. TC PRIMED is a new AI-ready and cloud-accessible dataset that enables the broader community to develop machine-learning applications and better understand tropical cyclones to improve the lead-time and accuracy of severe weather warnings for coastal communities.

Predicting Extreme Weather

Extreme weather and cascading hazards account for an increasing number of high-impact, Billion Dollar disasters. ProbSevere (shorthand for "probability of severe") is an application that uses machine learning and AI to distill massive volumes of environmental data into actionable information to improve lead-time and accuracy of severe weather warnings.



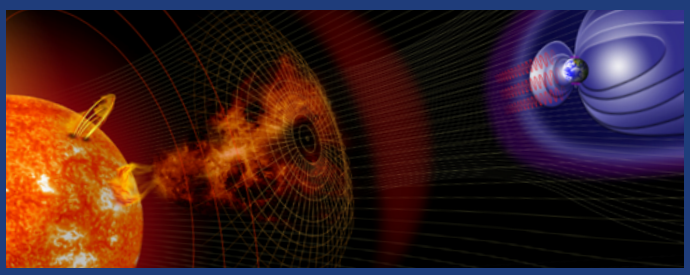
Mapping Fire Weather

Between January and September 2023, the United States experienced 18 weather and climate disasters that each caused upward of a billion dollars in damage. Devastating wildfires fanned by the winds from Hurricane Dora destroyed the historic town of Lahaina on the Maui Island of Hawaii. The fires killed 97 people and destroyed thousands of homes, vehicles and businesses. In response, NOAA is combining advanced satellite products, fuels, terrain, and fire weather data to train machine learning models that predict extreme fire behavior and will help improve wildland fire incident preparedness and response. For more information, see the NESDIS Impacts Brief Fire Weather story and the NESDIS Impacts Brief Extreme Events story.

Improving Navigation and Magnetic Field Forecasts

The Earth's geomagnetic field is an invisible shield that envelops the planet. This magnetic field prevents Earth from bombardement by harmful solar and cosmic radiation that would render our planet uninhabitable. This field is also crucial to the functioning of various navigation and technical devices such as antennas, satellites, and smartphones.

To better understand geomagnetism and improve our ability to forecast changes in the magnetic field, NOAA and the Cooperative Institute for Research in Environmental Sciences (CIRES) developed models of the geomagnetic field and maintain archives of geomagnetic data. In December 2020, NOAA partnered with NASA to launch a global crowdsourcing challenge called "MagNet: Model the Geomagnetic Field" to develop better models that can predict changes in the magnetic field in response to space weather.



The competition challenged developers to create a forecast of the Disturbance Storm-Time Index (Dst), a measure of magnetic activity at the Earth's surface. More than 600 participants from across the world submitted more than 1,200 predictions based on a set of data that included solar wind speed and intensity, real-time Dst, and other factors. The challenge demonstrated that AI/ML models could outperform scientists in predicting the reaction of the Earth's magnetic field to space weather, even without detailed knowledge of the physics involved, effectively diversifying the community of potential solvers for NOAA's data science challenges.

Looking to the Future

NOAA and its partners are leveraging AI on a vast range of environmental and ecological issues, from monitoring and mitigating the effects of climate change to predicting and reducing harm from natural disasters. AI-powered sensors and monitoring systems will help track changes in air, water, and soil quality, while predictive algorithms will aid ecosystem management, reduce the risks of invasive species, and protect endangered wildlife. AI helps NOAA promote sustainable and responsible management of natural resources and ensure the protection and preservation of the environment for future generations.

> ***"NOAA recognizes that AI–especially human-centered AI–is one of the most transformative technologies we've ever seen. The NOAA Center for AI is working to harvest the galaxy of AI possibilities to improve our ability to deliver critical products and services to all communities. The science of AI is dedicated to enabling machines to mimic human behavior, but the goal of AI is not to replace the human element, but rather for humans and machines to work together to improve our environment."***
>
> *—Dr. Robert Redmon, NOAA Center for AI Director*