These sharks are doing a climate job no satellite, buoy, or ship can handle alone

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Neil Hammerschlag and Laura McDonnell attach a satellite tag to a blue shark. It transmits location, temperature and depth data. Credit: Nola Schoder

A new study published in the journal *npj Climate and Atmospheric Science* shows that electronically tagged sharks can serve as mobile sensors, collecting ocean climate data in regions that are difficult to observe using conventional methods.

The study is led by Laura H. McDonnell, Ph.D., who conducted the research as a doctoral student at the University of Miami Rosenstiel School of Marine, Atmospheric, and Earth Science and the Abess Center for Ecosystem Science and Policy. The findings demonstrate that temperature and depth data gathered by tagged sharks can enhance ocean forecast accuracy in dynamic regions of the Northwest Atlantic.

By incorporating shark-collected data into a seasonal climate model, McDonnell and her team found that forecast errors at the ocean surface decreased substantially in certain regions, with improvements reaching as much as 40% in specific cases.

This is the first study to experimentally integrate animal-borne sensor data into a seasonal climate model and quantify its impact on forecast performance, suggesting potential for future operational use.

"Sharks are already moving through parts of the ocean that are challenging for us to observe," said McDonnell, now a postdoctoral investigator at the Woods Hole Oceanographic Institution (WHOI). "This research shows that data they collect can help fill important gaps and, when used carefully, can improve how we predict ocean conditions."

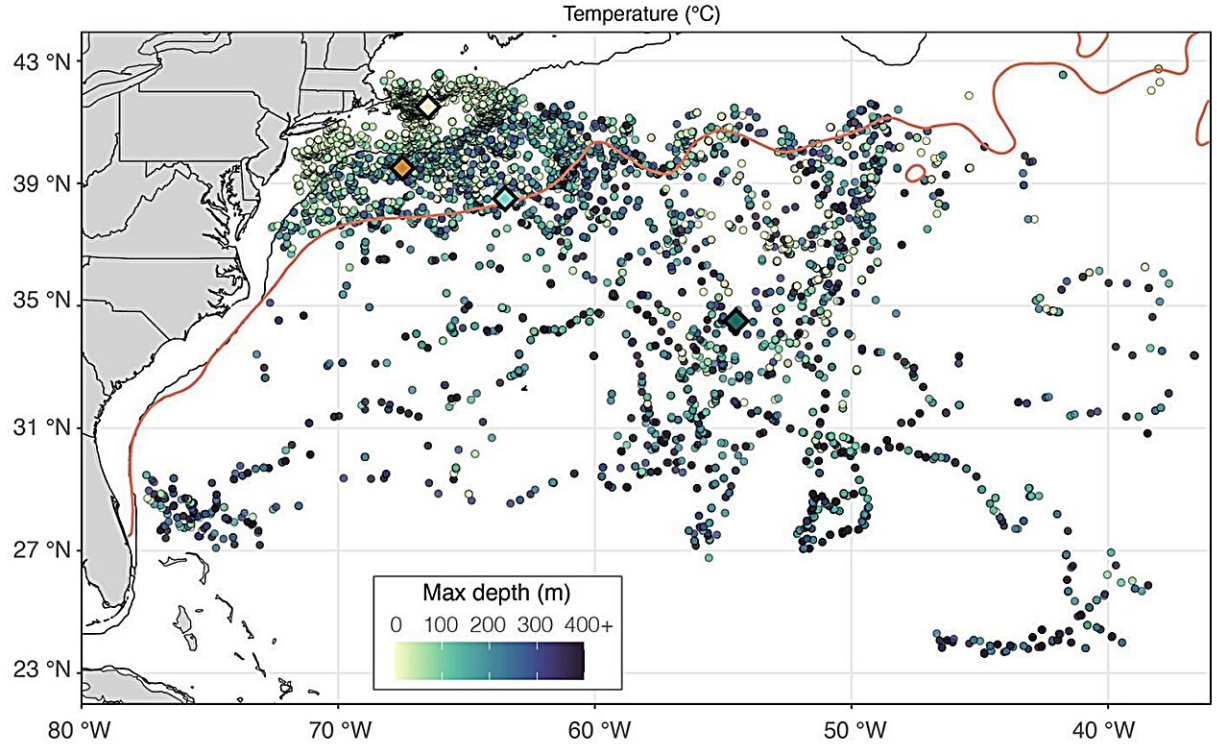
Interdisciplinary collaboration fuels innovation

The study originated from an interdisciplinary collaboration between former Rosenstiel School shark scientist Neil Hammerschlag, Ph.D. and atmospheric scientist Ben Kirtman, Ph.D., now dean of the Rosenstiel School. In 2018, they recognized that the data from shark-tagging studies used by Hammerschlag's lab to study shark ecology could also benefit climate modeling.

Satellite tags attached to sharks record depth and temperature as they

travel through the ocean, collecting and transmitting this data in near real time. While these tags have long helped scientists track shark movements, the collaboration opened a new application and a chance to create a novel proof of concept: using the same data to improve climate forecasts.

"Marine predators like sharks naturally seek out dynamic ocean features such as fronts and eddies," said Kirtman. "These are areas where models often lack sufficient observations."



Example temperature–depth profiles from tagged sharks across four biogeographic regions, shown alongside the full spatial distribution of all transmitted tag-derived profile locations during this study (October 2021–April 2022). Credit: *npj Climate and Atmospheric Science* (2026). DOI: 10.1038/s41612-026-01394-9

Testing sharks as ocean observers

McDonnell and Hammerschlag tagged 18 blue sharks (Prionace glauca) and one shortfin mako shark (Isurus oxyrinchus) in the Northwest Atlantic. WHOI oceanographer and study co-author Camrin Braun helped facilitate this fieldwork off Cape Cod, MA by connecting McDonnell and Hammerschlag with a local fisherman and co-led the forecast data analysis. The sharks transmitted more than 8,200 temperature-depth profiles across a wide range of locations and depths—down to nearly 2,000 meters.

"Key to this study was repurposing a more advanced tag capable of transmitting location data along with temperature and depth information," said Hammerschlag, co-author of the study and executive director of the Shark Research Foundation. "This allowed us to link subsurface ocean conditions directly to specific locations with known accuracy."

Kirtman integrated a subset of these data into the Community Climate System Model, a coupled ocean–atmosphere–ice–land model used in seasonal forecasting applications that forms part of the National Oceanic and Atmospheric Administration's operational North American Multi-Model Ensemble (NMME) system, of which Kirtman is the lead scientist.

The team compared the actual resulting climate conditions with the forecasted predictions from traditional models as well as the ones that integrated the shark collected data. The results showed measurable improvements in forecast performance, particularly in dynamic coastal and shelf regions that are important for marine ecosystems and fisheries.

The researchers emphasize that animal-borne sensors are not a replacement for traditional observing systems but a complementary tool.

"Tagged sharks won't replace conventional observing systems," added McDonnell. "What the preliminary results do show is that tagged marine predators can provide complementary in-situ observations at the surface and at depth."

Why it matters

Accurate ocean forecasts are critical for fisheries management, marine operations, and understanding how climate variability affects coastal communities. However, forecasts are often least reliable in regions where conditions change rapidly and observational data are lacking.

Animal-borne sensors could enhance predictions that support decision-making across multiple sectors, ranging from seafood supply chains to climate adaptation planning.

"Marine animals are already being tracked to understand their behavior in relation to environmental conditions, but this study reveals how these data can also be leveraged for forecasting and climate applications," said Hammerschlag.

"For fisheries and coastal communities, small improvements in ocean forecasts can make a big difference," said Braun. "Reducing uncertainty helps people plan, whether that's where to fish, how to manage resources, or how to respond to changing conditions."

More information: Laura H. McDonnell et al, Improved seasonal climate forecasting using shark-borne sensor data in a dynamic ocean, *npj Climate and Atmospheric Science* (2026). DOI: 10.1038/s41612-026-01394-9

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