

The Value of Improved Hurricane Forecasts NOAA's Atlantic Oceanographic and Meteorological Laboratory

Improvements in Track Forecasting for 3-day Forecasts since 1990.
Image Credit: National Hurricane Center.

Building a Weather-Ready Nation Through Improved Forecasting

Improving hurricane track and intensity forecast predictions are critical for protecting the public and reducing property damage. Key decision makers in the private sector, emergency management, public safety, and healthcare rely on accurate forecast guidance from the National Hurricane Center (NHC) and other operational partners to make emergency and evacuation decisions.

The Atlantic Oceanographic and Meteorological Laboratory (AOML) conducts research in ocean, coastal, and atmospheric science that enhances products like NOAA's hurricane forecasts. Through the Hurricane Forecast

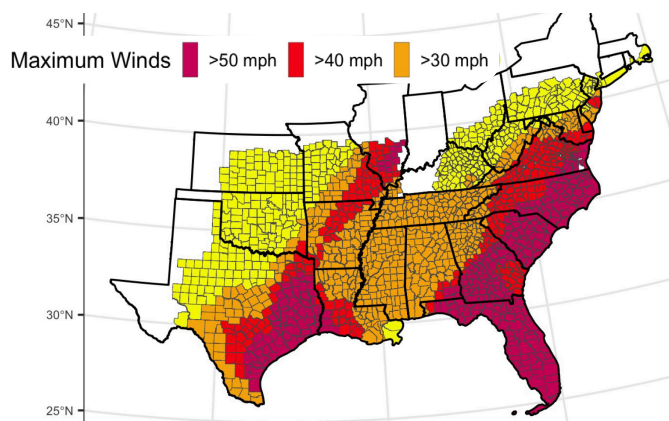
Improvement Program, the Weather Research and Forecasting Act, and ongoing work with our partners in academia and other NOAA laboratories/offices, we conduct interdisciplinary research to gain a more accurate understanding of how environmental conditions drive and affect hurricanes.

This Earth Systems approach integrates in-situ observations from the atmosphere and the ocean to better understand the storm environment and improve model predictions of extreme weather in the Atlantic and Eastern Pacific basins.

Financial Impacts from Hurricanes are Reaching Farther Inland

From 1985-2015, hurricanes in the US caused insured losses of \$515.4 billion dollars; Florida, Texas, and New York alone accounted for 32% of that of damage.¹ Economic damages from Harvey, Maria, and Irma in 2017 cost taxpayers \$265 billion dollars². While most damage occurs in coastal areas, flooding, power outages, and property damage can still affect inland communities. In fact, 25% of tropical cyclone-related deaths in the U.S. do not occur along the coast³.

The figure to the right shows how hurricane-force winds have affected counties across the eastern U.S. and Gulf of Mexico regions between 2006 and 2018.⁴



1 Office of Coastal Management, Hurricane Costs Fast Facts. September, 2020
 2 NOAA. 2018. NOAA's Contribution to the Economy; Powering America's Economy and Protecting Americans.
 3 NOAA, Inland Flooding: A Hidden Danger of Tropical Cyclones. June, 2018.
 4 Molina et al. 2020. Striving for Improvement: The Perceived Value of Improving Hurricane Forecast Accuracy. Working Paper.



Innovations in Forecast Science Target Track, Intensity, and Impacts

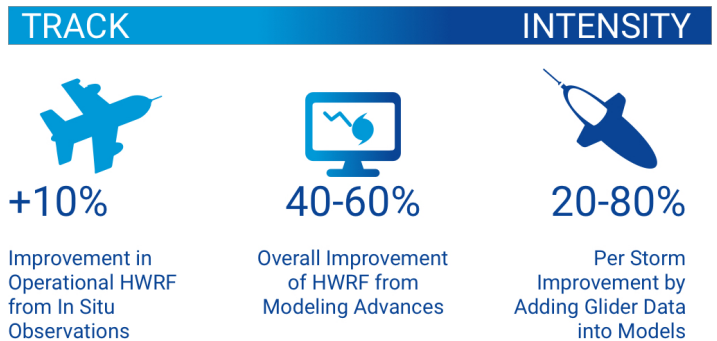
NOAA found that the value provided by weather forecasts is 6.2 times the cost of producing them, with \$5.1 billion in spending (both private and public sector) creating \$31.5 billion in economic benefit¹.

AOML contributes to improving hurricane forecasts specifically through the use of observations and hurricane modeling research. We provide direct support during hurricane season with missions tasked by NOAA's Environmental Modeling Center to collect in-situ hurricane observations as storms progress, use observations to validate and improve our research models, and deploy ocean gliders with partners during hurricane season to better understand how the ocean influences hurricane development.

Our focus for the future is on providing real-time, high resolution data from tail Doppler radar and other instruments to better support forecasters and usher in the next generation of hurricane modeling.

By working with our partners, we are developing new data assimilation methods for models to integrate environmental observations in their storm predictions.

Lastly, we conduct social behavioral science to provide more value to the public. Improved forecast visualizations and tools allow people to better assess their individual risk of storm surge, wind damage, and precipitation intensity during landfalling events. The infographic below shows how AOML reduces forecast error to improve accuracy.



¹ U.S. Department of Commerce/National Oceanic and Atmospheric Administration. (2018, June). NOAA By The Numbers: Economic Statistics Relevant to NOAA's Mission. Silver Spring, Maryland: United States.

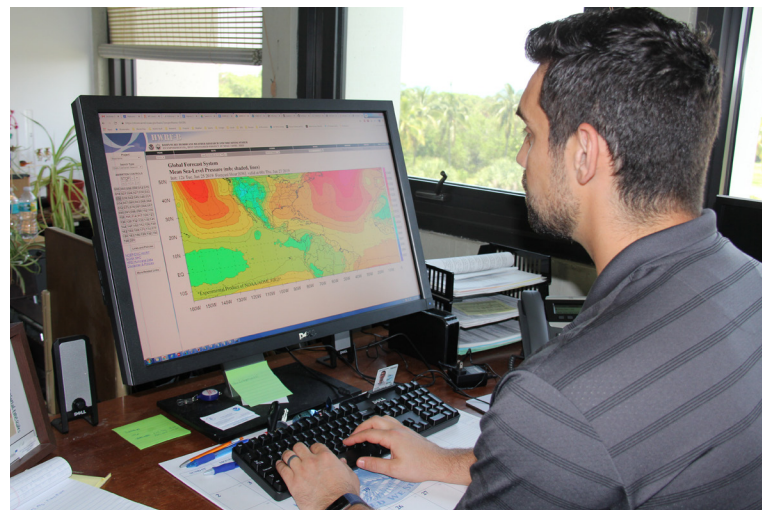
The Public Values Continuous Forecast Improvements

In a recent study to quantify the demand for forecast improvement, AOML partnered with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. It was found that there was an average willingness to pay of \$16-\$28 per household per year for a better forecast, varying by improvement type (shown below).¹ An aggregation across counties affected by Hurricane Michael and Hurricane Florence suggests the total willingness to pay is about \$39 to \$67 million a year¹.

WILLINGNESS TO PAY For Improved Hurricane Forecasts



¹ Molina et al. 2020. Striving for Improvement: The Perceived Value of Improving Hurricane Forecast Accuracy. Working Paper.



Scientists at AOML are working to improve a research quality hurricane model known as Basin-Scale HWRF. Photo Credit: NOAA AOML.

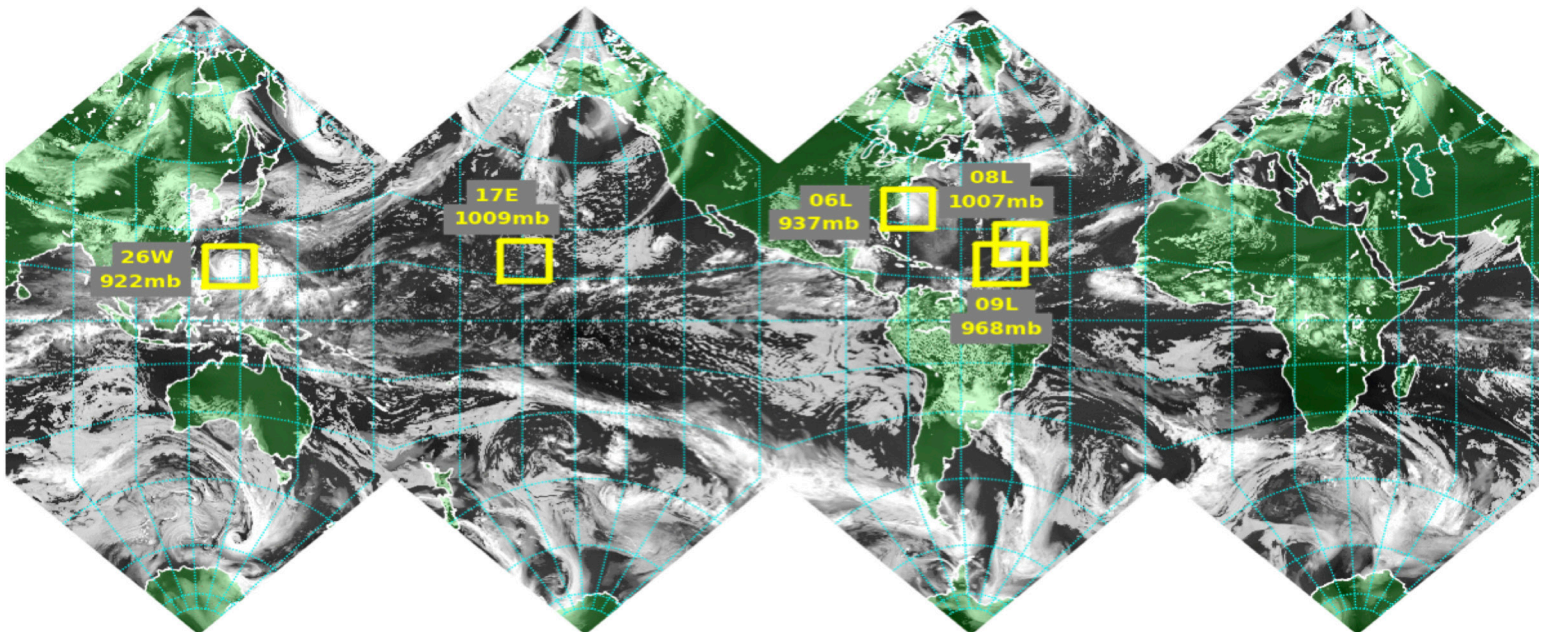
AOML & NHC Partner to Conduct Forecast Improvement Science

A recent paper published in *Weather and Forecasting* quantified track and intensity forecast error reduction for the Atlantic basin as a result of work performed through our partnership with the National Hurricane Center. This paper characterizes the ~50% reduction in track errors since the mid 1990s as a major accomplishment for Earth science in the last half-century¹. The authors credit these significant advances to improvements in numerical weather prediction models, as it is the model output that provides guidance to National Hurricane Center forecasters. The reduction in intensity forecast error has historically not been as significant as the reduction in track error. However, in the last decade intensity error has dropped by nearly 30% for the 120-hour or 5-day forecast².

The potential annual cost of evacuating 417 miles of coastline with each hurricane warning is approximately \$1.5 billion. Typically, hurricane force winds impact only about 25% of the area under warning, conceivably resulting in over \$1 billion in unnecessary expenditures³. The continual early warning improvements in intensity and track forecasts for hurricanes greatly benefit public preparedness actions and emergency management decision-making.

- 1 Cangialosi, J. P., Blake, E., DeMaria, M., Penny, A., Latto, A., Rappaport, E., & Tallapragada, V. (2020). Recent progress in tropical cyclone intensity forecasting at the National Hurricane Center. *Weather and Forecasting*, 35(5), 1913-1922.
- 2 Dong, J., R. Domingues, G. Goni, G. Halliwell, H.S. Kim, S.K. Lee, M. Mehari, F. Bringas, J. Morell, and L. Pomales (2017). Impact of assimilating underwater glider data on Hurricane Gonzalo (2014) forecasts. *Weather and Forecasting*, 32(3), pp.1143-1159.
- 3 Desai, S. P., Harris, C. A., & Gordon, J. (2019). The economic impact of hurricane evacuations on a Coastal Georgia Hospital: a case study. *Frontiers in public health*, 7, 149.

Hurricane Analysis and Forecast System: The Next Generation of Hurricane Modeling



Looking to the future of hurricane forecasting, AOML is contributing to the development of NOAA's Hurricane Analysis and Forecast System. The Hurricane Analysis and Forecast System is based upon NOAA's flagship weather model, the Global Forecast System (known as the GFS) and will incorporate technology from the basin-scale HWRF model such as multiple-moving nests and simultaneous

modeling of multiple storms for a more accurate representation of the storm environment and storm interactions. AOML is leveraging hurricane supplemental funding to accelerate this development, furthering NOAA's efforts to improve the accuracy of tropical cyclone track and intensity forecasts.