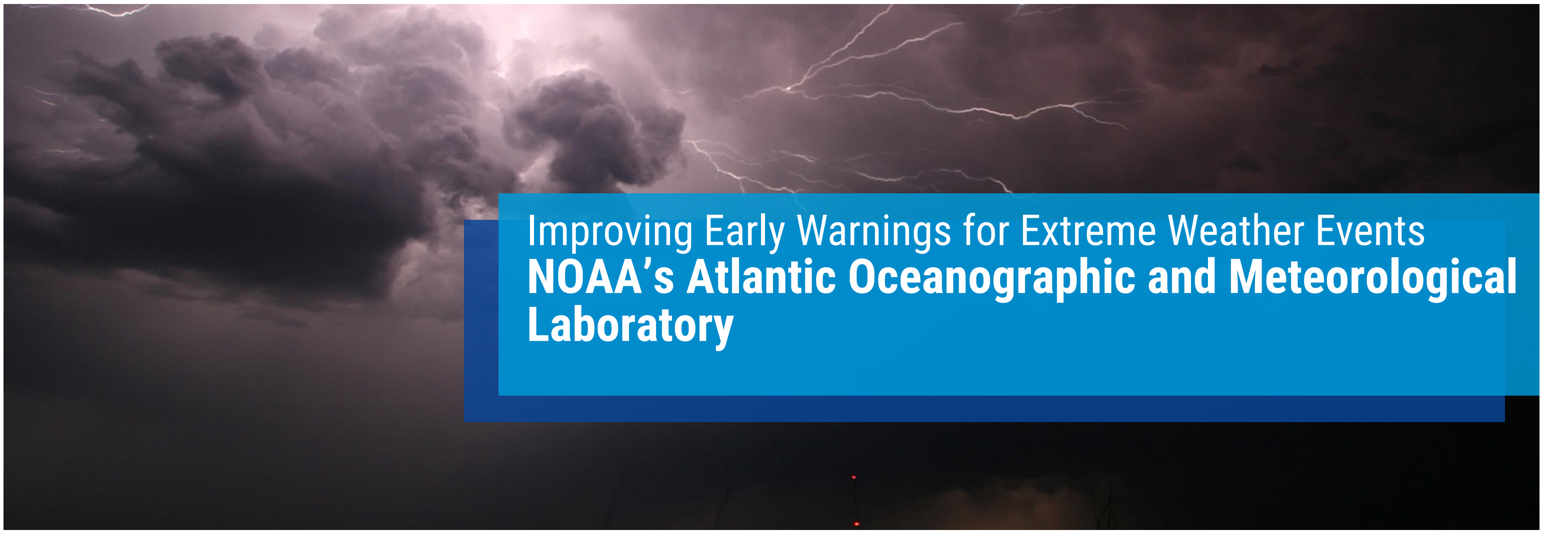


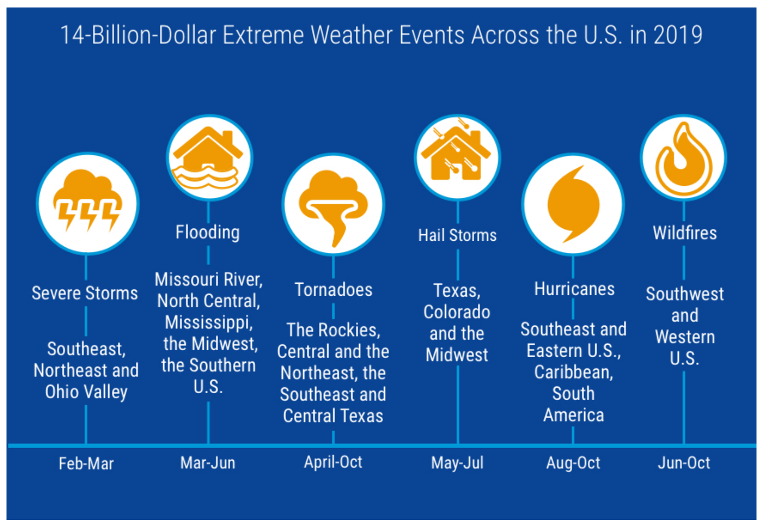
Improving Early Warnings for Extreme Weather Events
NOAA's Atlantic Oceanographic and Meteorological Laboratory

Lightning over the Great Plains. Texas. May 12, 2009. Image Credit: NOAA/NSSL, VORTEX II.

Financial Impacts from Extreme Weather Events

A recent nationwide survey indicated that weather forecasts generate $31.5 billion in economic benefits to U.S. households.[1] Since 1980, the U.S. has sustained 279 weather and climate disasters where overall damages reached or exceeded $1 billion (including Consumer Price Index adjustment in 2020 dollars); The total cost of these 279 events exceeds $1.825 trillion.[2]

AOML scientists are working to improve the forecasts of four main disaster types: tropical cyclones, tornado-related severe storms, heat waves, and extreme rainfall. Improved weather forecasts provide emergency managers, government officials, businesses, and the public with more accurate and timely warnings to minimize catastrophic loss of life and damage to critical infrastructure. This effort is crucial for informing emergency management and public preparedness.



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.

2 NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2020).

Understanding Long-Term Ocean Dynamics Leads to Better Short-Term Prediction

Extreme weather events are responsible for devastating mortality and economic impacts in the United States, but current extreme weather forecasts are only able to accurately predict events a few days in advance. Because of this, there is a pressing need to expand the current severe weather forecast beyond the 7-10 day time scale. This is known as the subseasonal forecast.

Scientists at NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) are working to extend the forecast for extreme weather events by improving subseasonal-to-seasonal predictions (from two weeks to a month ahead). Researchers are making these improvements using a combination of ocean and atmospheric observations and model simulations. For example, researchers at AOML study how temperature variations associated with El Niño and La Niña, as well as the Madden-Julian Oscillation, have far reaching impacts on global weather.

To more fully understand these connections, AOML has formed collaborative partnerships with NOAA's Climate Prediction Center, Geophysical Fluid Dynamics Laboratory, Physical Sciences Laboratory, and Environmental Modeling Center to advance our understanding of severe weather events affecting our nation with the goal of improving and extending their predictions to better protect life and property.

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An Ocean-Informed Forecast for Heat Waves, Tornadoes, and Extreme Rainfall

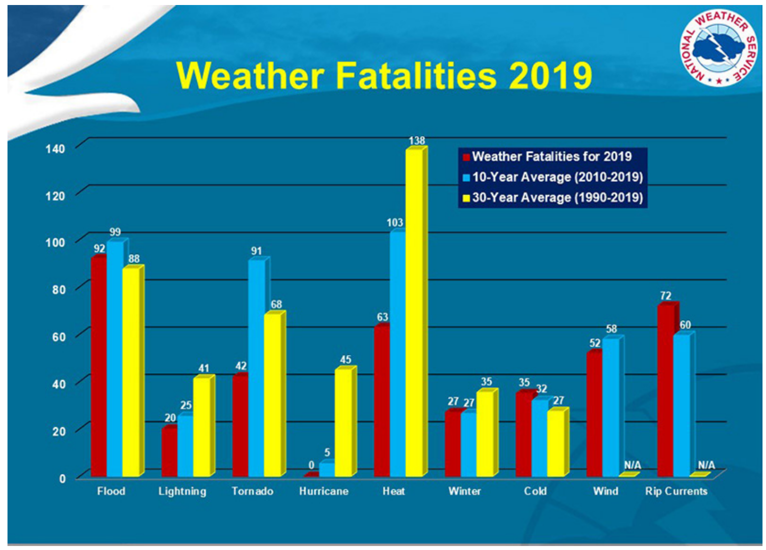
In order to improve and extend the forecasts for extreme events beyond the 7-10 day time scale, it is vital to better understand and predict how the oceans drive global weather patterns. Certain spatial and temporal patterns of upper ocean heat and circulation variations can promote recurring weather patterns that can be monitored and studied using long-term observational data. For example, AOML scientists have shown in a recently published study that the strength of the East Asian Monsoon is directly linked to the occurrence of summer heat waves in the U.S.[1]. In another recent study, AOML scientists have shown that the Madden-Julian Oscillation propagating across the tropical Indian and Pacific oceans modulates springtime tornado occurrence in the U.S.[2]. In yet another recent study, AOML scientists have identified a strong relationship between summer U.S. rainfall and the sea surface temperature contrast between the Pacific and Atlantic oceans[3].

1 Lopez, H., S.-K. Lee, S. Dong, G. Goni, B. Kirtman, R. Atlas, and A. Kumar. East Asian monsoon as a modulator of U.S. Great Plains heat waves. Journal of Geophysical Research-Atmospheres, 124(12):6342-6358, doi:10.1029/2018JD030151 2019.

2 Kim, D., S.-K. Lee, and H. Lopez. Madden-Julian Oscillation-induced suppression of northeast Pacific convection increases U.S. tornadogenesis. Journal of Climate, 33(11):4927-4939, https://doi.org/10.1175/JCLI-D-19-0992.1 2020.

3 Kim, D., S.-K. Lee, H. Lopez, G.R. Foltz V. Misra, and A. Kumar. On the role of the Pacific-Atlantic SST contrast and associated Caribbean Sea convection in August-October US regional rainfall variability. Geophysical Research Letters, 47(11):e2020G087736, https://doi.org/10.1029/2020GL087736 2020.

Researchers at AOML have also shown that improved understanding of how El Niño and La Niña evolve in time and space could provide earlier warnings for extreme weather events in winter and spring. These studies have provided the critical background science needed to improve and develop subseasonal-to-seasonal forecast systems for extreme weather events affecting the U.S. (e.g., heat waves, tornadoes and droughts).



Weather-related fatalities in 2019, compared to 10 and 30-year averages. Image Credit: NOAA National Weather Service.

Supporting Forecast Improvement with the Global Ocean Observing System

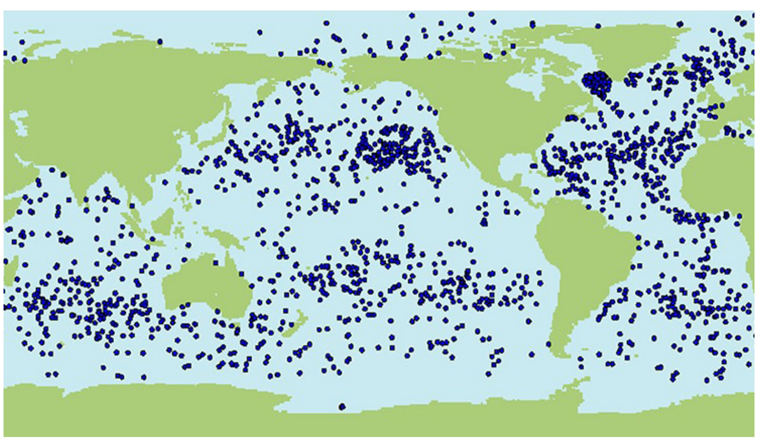


Illustration of the Global Ocean Observing System. Image Credit: NOAA.

Researchers at AOML also design, implement, maintain, and improve critical observation systems that provide long-term ocean and atmospheric datasets. AOML leads environmental data collection technology using uncrewed underwater vehicle systems such as hurricane gliders and sailing drones and instrumentation such as Argo profiling floats, drifting and moored buoys, and expendable bathythermographs). Our scientists work closely with partners from private industry, academia, and other government agencies to pilot and deploy this technology throughout our global oceans. This network is known as the Global Ocean Observing System.

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