State of the Science FACT SHEET

Fire Weather

Wildfires and weather

Wildfires can have devastating impacts on communities across the U.S., with wildfire disasters in California, Colorado, Hawaii, New Jersey, North Carolina, Texas, and many other locations throughout the country in the last few years. In the summer of 2023, major cities in the northeastern U.S. were suffocated by dangerous air quality due to smoke from a record-breaking Canadian fire season. Wildfire activity now starts earlier in the spring and extends further into the fall, and more extreme wildfire events are being observed both in the U.S. and globally.

Wildfires increasingly demonstrate extreme fire behavior and are becoming more complex to manage. As a result, wildfire activity over the last 10 years has produced some of the most destructive and costly wildfire events in U.S. history. The 5th National Climate Assessment indicates many regions of the U.S. will experience increases in potential fire activity driven by warmer and drier conditions, including more frequent and severe drought.

Wildfires create the potential for other natural hazards such as postfire flooding, erosion, and landslides. When structures and vehicles burn in wildland fires, hazardous pollutants are released into the environment. All of these hazards can persist for years, harming communities, watersheds, ecosystems, infrastructure, and recreation locally and downstream. Additionally, wildfire smoke can travel thousands of miles, lowering air quality along its way, leading to substantial economic losses, negative health impacts, and loss of life. The negative effects of smoke on public health are compounded when they coincide with other extreme events such as heatwaves and often affect communities with limited access to resources.

Firefighters, emergency managers, local and state officials, land management agencies, and frontline communities need enhanced observational and forecast model products. These products will help maximize lead times for fire weather watches and warnings, identify real-time changes in weather influencing fire behavior, and provide early wildfire detection and smoke forecasts for both wildfires and prescribed burning.

NOAA supports a fire-ready nation

The National Oceanic and Atmospheric Administration (NOAA) plays a vital role in supporting federal, state, local, and tribal partners before, during, and after wildfire events. NOAA provides these decision-makers with the information they need to prepare for the threat of wildfires and best manage them to protect life, health, and property. NOAA's forecast products range from short-term fire weather watches and warnings to long-term seasonal predictions, and include air quality and smoke forecasts related to wildland fires. NOAA also provides real-time fire and smoke detection using new imaging capabilities from satellites. Postfire forecasts prepare communities for potential flooding and debris flow events that are exacerbated by the loss of vegetation and soil changes caused by wildfire.

Early detection

Early detection of potentially hazardous wildfire conditions are crucial to limiting negative impacts. NOAA's satellites provide critical observations to assess vegetation health, identify new fires, monitor the growth and behavior of existing fires, detect lightning, and characterize and track fire emissions. NOAA has developed an advanced algorithm that

NOAA Fights Fire with Science

automatically detects subtle heat signatures in satellite imagery for early detection of new fires and monitoring of fire intensity.

New observing systems

Observing systems, such as uncrewed aerial systems (drones) instrumented with imagers or other sensors help detect wildfires and monitor their impacts on the surrounding environment. NOAA is developing fixed and mobile weather stations that measure land-surface properties, atmospheric profiles of temperature, wind, and humidity, and the radiative impacts of smoke and clouds. This data will reveal links between the surface and atmosphere, and provide information for early warnings of high-risk conditions. New technologies such as uncrewed aerial systems can make observations in difficult-to-reach locations such as in very rough terrain or near fires to inform forecasting and fire management activities.

Updated prediction models

NOAA uses numerical weather prediction models to predict the evolution of high-impact weather at timescales ranging from hours to weeks ahead in both high-resolution regional models like the 3-km High-Resolution Rapid Refresh (HRRR) and lower resolution global models such as the 13km Global Forecast System (GFS). This includes forecasts of dry and windy hazardous wildfire conditions as well as strong storms that might have heavy precipitation and lightning. Incorporating new observations and calculations of physical processes in the models make forecasts more accurate. NOAA is also working with machine learning techniques and artificial intelligence tools to predict lightning hazards, the potential for lightning-ignited fires, extreme fire behavior, and seasonal fire risk.

Smoke research

Poor air quality causes an estimated 4.2 million fatalities each year worldwide. NOAA investigates how wildfire smoke contributes by combining data from field campaigns that measure smoke and other air particles with chemical modeling studies. Researchers also use new data from NOAA satellites to improve smoke forecasts and track carbon emissions from fires.

A new NOAA Fire Weather Testbed

NOAA established a Fire Weather Testbed so developers, forecasters, emergency managers, fire practitioners, and meteorologists can fully test and evaluate new fire-weather products in real-life scenarios and during operations. NOAA social and behavioral scientists evaluate user feedback and
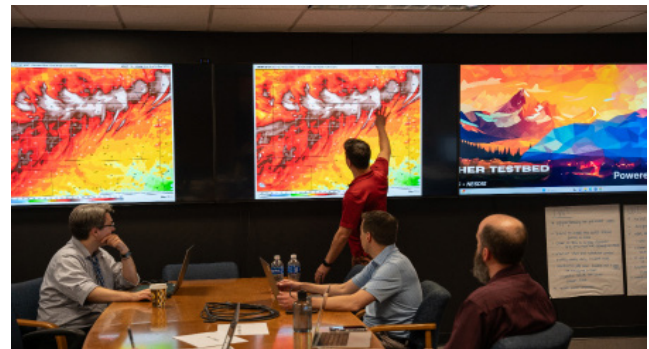
study how the public responds to the new products to promote equitable societal outcomes. This work supports the safe management of lands and fire, and the protection of fire personnel and the public.

Wildland fire is an important part of the natural ecosystem for the vast majority of the United States, and it is critically important to restore wildfire's beneficial effects to mitigate the current 'crisis'. However, wildfires can also threaten lives, destroy homes, disrupt economies, and alter the landscape. Through new observing systems, advanced high-resolution forecast models, and accelerated transition of experimental products to operations, the U.S.'s investment in NOAA's fire weather research, observations, and services will help build a Fire-Ready Nation.

Visit our new web hub, noaa.gov/wildfire

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