



The AIR Wildfire Model for the United States

ARIZONA | CALIFORNIA | COLORADO | IDAHO | MONTANA | NEVADA |
NEW MEXICO | OKLAHOMA | OREGON | TEXAS | UTAH | WASHINGTON | WYOMING

The 2017 U.S. wildfire season resulted in more than USD 13 billion in insured losses—more than double all U.S. wildfire losses from the previous decade combined. In addition, individual fires in 2017 set records for not only the largest area burned but also structures destroyed. The wildfire records set in 2017 serve to illustrate that historical loss experience alone is no longer sufficient for managing wildfire risk.

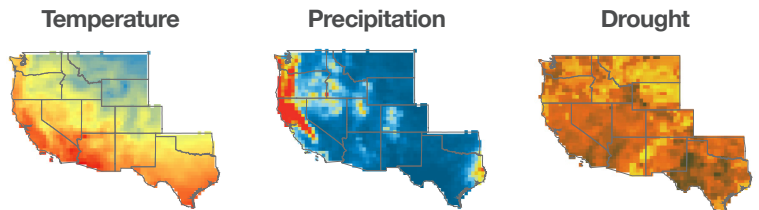


The largest insured losses from wildfire in the United States have occurred in the wildland-urban interface (WUI)—where human development meets or intermingles with undeveloped wildland. About 4,000 acres are being converted from wildland to WUI every day, and since 1990 about 60% of homes in the U.S. have been built in the WUI. Wildfire risk in the United States will continue to grow as development of the WUI expands into areas with strong fire histories to meet population demands.

Using innovative methodologies and the highest quality data available, the AIR Wildfire Model for the United States captures wildfire risk throughout the 13 western U.S. states where the most significant loss-causing wildfires have occurred and enables continuous modeling of wildfire activity across state boundaries.

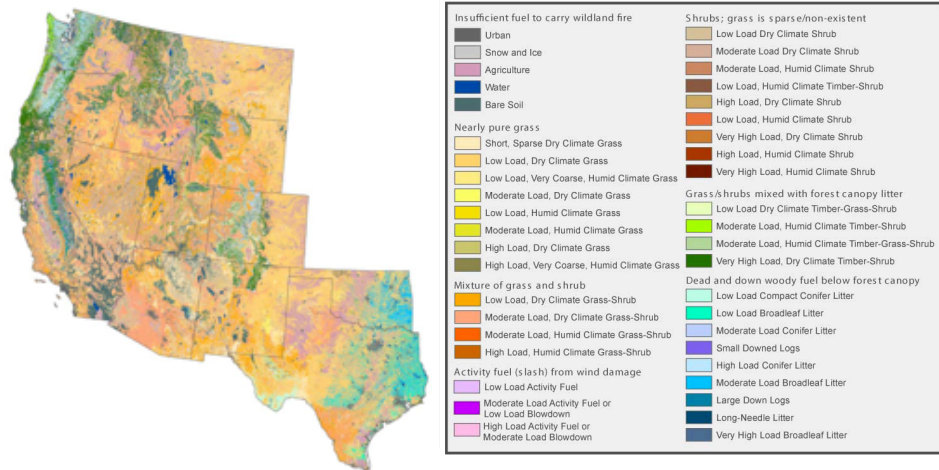
Detailed Data on Weather, Fuels, Seasonality, and Landscape Ecology Produce a Robust Event Catalog

Weather is the major influence affecting annual area burned in the U.S.—particularly relationships between temperature, precipitation, and drought. These relationships are complex and vary across space and time. AIR’s U.S. wildfire model incorporates key weather patterns to maintain natural variability in wildfire activity and capture wildfire seasonality—in terms of frequency and size—across the model domain and accurately reflect when and where wildfires are likely to occur within the 10,000-year stochastic catalog on a high-resolution 90-meter grid.



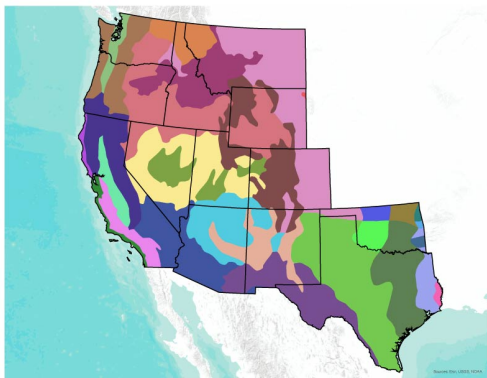
Modeled weather patterns maintain natural variability in wildfire activity in the AIR Wildfire Model for the United States.

Fires that ignite in the wildland often begin unnoticed, but they can quickly spread and threaten homes in the WUI. Spread rates are determined in part by the available fuels, or vegetation, in the region. The composition of fuels—including their moisture, current condition (live or dead), mineral, and oil content—can affect the probability of both ignition and spread. To provide the most accurate view of vegetation and wildland fuels, the high-resolution fuels layer in AIR’s U.S. wildfire model uses the latest fuels data from the LANDFIRE program.



The 40+ fuel categories captured in the fuels layer of the AIR Wildfire Model for the United States and their locations within the model domain.

Fuels, climate, elevation, and other components of landscape ecology differ greatly from region to region across the United States. To accurately reflect these spatial variations and meaningfully classify wildfire behavior spatially, the model captures wildfire activity at the *ecoprovince* level—areas with similar vegetation, topography, and weather as defined by the U.S. Forest Service.



The locations of the 29 ecoprovinces within the model domain of the AIR Wildfire Model for the United States and their classifications.

Physically Based Model Captures the Realistic Spread of Wildfire

Wind speed and direction are critical components of wildfire spread, as winds can change quickly and make fires difficult to control. To realistically capture how wildfires spread across a landscape, the model considers slope, fuel, and topography, and accounts for changes in wind speed and

California Winds and Topography Influence Rate and Direction of Wildfire Spread

The dry, easterly Santa Ana winds in Southern California and the Diablo winds in the northern part of the state can dramatically increase burn rates by drying out the fuels in their path and then steering the fire into new fuel sources.

direction every three hours. Wind can also throw embers ahead of the main fire front, allowing fires to cross roads, rivers, and other natural fire breaks. Wind-borne embers that land on and around structures increase the likelihood of ignition. The AIR model captures all the ways a fire can spread: surface spread, surface-to-canopy (ground-to-tree) transition, canopy (tree-to-tree) spread, and fire branding/spotting—the last of which is the primary mode of fire spread into the WUI and through urban areas.

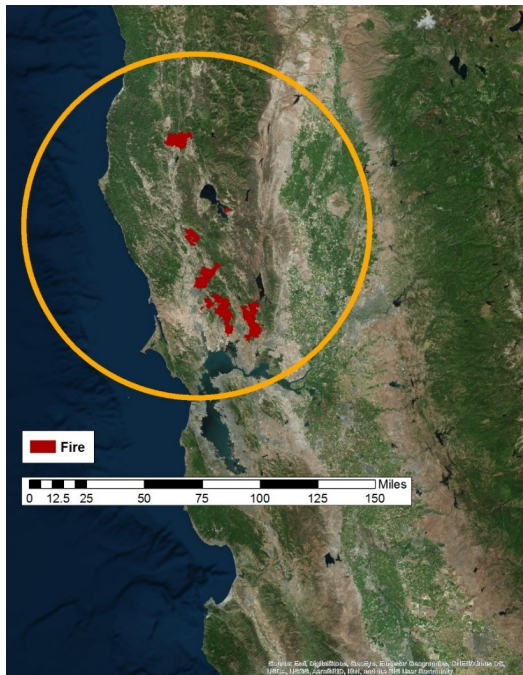
The expansion of the WUI has not only increased the number of structures at risk for wildfire in the U.S., but also the number of possible human-caused ignitions—which account for 84% of U.S. wildfires and half of the annual area burned. AIR’s U.S. wildfire model measures urbanicity by considering impervious surface area (such as paved roads) to accurately reflect the built environment and its propensity to burn.

Urban Conflagration Can Cause Significant Losses

An urban conflagration is a large destructive fire that moves beyond the WUI and penetrates an urban area, threatening entire neighborhoods. As the fire rapidly spreads, structures themselves can act as fuel, and firefighters are left with no time to construct fire breaks. The AIR model explicitly captures the combinations of factors that can result in these types of fires, reflecting real-world conditions. Urban conflagrations such as the 2017 Tubbs Fire—the most destructive in California’s history—can lead to the highest losses.

The Model Explicitly Captures Wildfire Clustering

Wildfires tend to occur in clusters in quick succession, as was the case with the 2017 Northern California fires. To accurately reflect this, events in the U.S. wildfire model are identified by cluster. Each cluster includes one or more fires ignited within 150 miles and 7 days of each other. More than 700,000 fire clusters are included in the model, each of which comprises one or more individual fires associated temporally and spatially, damages more than 100 acres, and causes losses to industry exposure.



The 2017 Northern California wildfires that occurred October 8–14 are clustered (orange circle) in the AIR Wildfire Model for the United States to reflect the real-world behavior of wildfires and policy conditions.

Building Characteristics and Flame Length Impact Wildfire Damage Extent

The AIR model assesses potential losses for residential and commercial buildings, contents, and business interruption across more than 100 construction and occupancy classes, as well as specialized risks such as automobiles, mobile homes, and industrial facilities.

In addition to the primary building characteristics of construction, occupancy, height, and year built, secondary risk characteristics—such as roofing and wall-siding materials and roof attachment—are critical to determining a structure’s vulnerability to wildfire. Susceptibility to wildfire is also impacted by retrofit and risk reduction efforts. For example, Firewise communities have taken steps outlined by the National Fire Protection Association to mitigate wildfire risk such as increasing defensible space, an area around a building where fuels have been treated, cleared, or reduced to slow or prevent the spread of wildfire.

How quickly a fire spreads and whether it can be extinguished determines the level of damage a structure experiences. Fires with flames shorter than 4 feet, for example, can be quickly extinguished with hand tools (e.g., a garden hose) and may cause little damage, whereas fires with flames longer than 8 feet may be too difficult to control and burn through exposure. The AIR model uses flame length to calculate the severity of wildfire-induced damage that a given exposure may experience.

Model Components and Losses Are Extensively Validated

To ensure the most accurate reflection of wildfire risk, the hazard and spread components have been extensively validated against scientific and historical data. Observed data have been used to validate the model's damage

functions and reflect real-world conditions. Loss estimates produced by the AIR Wildfire Model for the United States have also been extensively validated against data from historical events and show good agreement



Modeled and burn scar losses for the 17 significant historical events included in the AIR Wildfire Model for the United States show good agreement.

Model at a Glance

Modeled Peril	Wildfire
Model Domain	Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oklahoma, Oregon, Texas, Utah, Washington, and Wyoming
Supported Geographic Resolution	Latitude/Longitude, Address, ZIP Code, County
Stochastic and Historical Catalogs	10,000-year stochastic catalog includes only events that cause losses to industry exposure, and 17 historical events
Supported Construction and Occupancy Classes	<ul style="list-style-type: none">– 105 construction classes and 110 occupancy classes– Unknown damage functions when exposure information (e.g., construction type, occupancy, year built, or height) is unavailable
Industry Exposure Database	<ul style="list-style-type: none">– Provides a foundation for all modeled industry loss estimates

Model Highlights

- Captures wildfire risk throughout the 13 western U.S. states where the most significant loss-causing wildfires have occurred and enables continuous modeling of wildfire activity across state boundaries
- Physically based spread module considers wind speed and direction as a time series with 3-hour intervals, as well as slope, fuel, and topography, to realistically capture how wildfires spread across a landscape
- Explicitly accounts for fire branding/spotting—the primary mode of fire spread into the WUI and through urban areas
- Realistically captures fire spread into urban areas by considering impervious surface area as a measure of urbanicity and accounts for urban conflagration, which can lead to the highest losses
- Uses flame length to calculate the severity of wildfire-induced damage
- Supports the modeling of specialized risks, including auto, mobile homes, and large industrial facilities
- Touchstone enables users to easily run wildfire scenarios and can distribute aggregated exposure data down to a 90-meter resolution grid based on distributions in AIR’s detailed industry exposure database

ABOUT AIR WORLDWIDE

AIR Worldwide (AIR) provides risk modeling solutions that make individuals, businesses, and society more resilient to extreme events. In 1987, AIR Worldwide founded the catastrophe modeling industry and today models the risk from natural catastrophes, terrorism, pandemics, casualty catastrophes, and cyber incidents. Insurance, reinsurance, financial, corporate, and government clients rely on AIR’s advanced science, software, and consulting services for catastrophe risk management, insurance-linked securities, site-specific engineering analyses, and agricultural risk management. AIR Worldwide, a Verisk ([Nasdaq:VRSK](https://www.nasdaq.com/markets/stocks/verisk)) business, is headquartered in Boston, with additional offices in North America, Europe, and Asia. For more information, please visit www.air-worldwide.com.