North Dakota Fire Danger Model

The North Dakota Fire Danger Model uses gridded weather information to produce a county-based fire danger rating forecast for each of the next seven days. The model itself relies on weather inputs to calculate wildland fire behavior indices that are well-recognized by the wildland fire community and which are hallmarks of the National Fire Danger Rating System (NFDRS) that served as the basis for the prior fire danger map that was produced for the state by the Missoula Fire Lab. Benefits of running the North Dakota Fire Danger Model locally in the state include the following:

- Use of gridded weather data, averaged for each county, rather than extrapolating between a limited set of weather stations
- Ability to produce seven days of fire danger forecasts for each county in the state

The North Dakota Fire Danger Model directly uses the following weather inputs:

- Temperature
- Relative Humidity
- Wind Speed
- Cloud Cover

The new North Dakota Fire Danger Model was based on the same approaches taken by the prior map that was produced by the Missoula Fire Lab, so the daily fire danger ratings are heavily dependent on the simulated greenness or curing of native grasses, relative humidity, and wind speeds. Cured, dormant grasses, relative humidity below 25%, and sustained winds of 20 mph or greater will produce the most severe fire danger ratings. Those type of scenarios may cause the new fire danger index to reach the Very High or Extreme category, depending on temperatures and cloud cover, both of which also influence fire behavior. However, when the model simulates extensive greenness in grasses, then the daily fire danger index will be generally be in the Low, Moderate, or High Category, even with low relative humidity and strong winds, since the green component of grasses will tend to reduce fire behavior.

In comparison to the prior fire danger map, the new North Dakota Fire Danger model will tend to do the following:

- Act similar to the map that was produced for the state from the years 2015 through 2020
- Provide fewer ratings in the Very High and Extreme category than the map that was used during most of the 2021 fire season, but likely more than it produced from 2015 through 2020

However, the new fire danger model will indeed capture the biggest fire days – as evidenced by its forecast of Extreme Fire Danger in parts of southwest North Dakota on April 1st, 2021, the day of the Medora-area wildfire. Similar behavior was observed on other critical fire weather days in the spring of 2021. **The new North Dakota Fire Danger model WILL produce ratings in the Very High and Extreme category, but only on the most serious days when grasses are cured and weather conditions support critical fire behavior. A mix of dead and green grasses combined with critical fire weather conditions may still produce ratings in the High category, similar to the map that was produced for the state in previous years.**

National Weather Service meteorologists are able to view the gridded fire danger data, and can use it to assist with determining the need for Red Flag Warnings more easily than in the past. However, they **cannot** make any adjustments to the resultant fire danger indexes. The fire danger itself will only be produced by the North Dakota Fire Danger Model using a combination of weather forecast information provided by National Weather Service meteorologists, and calculated wildland fire behavior indices.

North Dakota Fire Danger Model

For those that are interested, the following provides more technical details on the new North Dakota Fire Danger model.

The model calculates information on fuel state (including the "greenness" or "curing" of grasses) using both observed and forecast weather data. The **Live Herbaceous Fuel Moisture** represents the approximate moisture content of the live grasses in the area, and is derived from the **Growing Season Index**, which models plant green-up and curing as it relates to observed temperatures and humidity, evaporative demand to plants, and day length. Conversely, the **1-hour Fuel Moisture** reflects the moisture content of already-dead grasses. The North Dakota Fire Danger Model then uses **both the weather and fuel state** to calculate the following fire behavior indices valid daily at 1400 Local Daylight Time (as is the standard in NFDRS):

- **Ignition Component** (the probability that a firebrand will cause an actionable fire)
- **Burning Index** (estimate of the potential difficulty of fire containment; related to flame length)

The model calculates the Ignition Component and Burning Index at each location. It ranks the daily Burning Index relative to historical values of the index using "percentiles", or rankings of its magnitude. The higher the percentile ranking a Burning Index is on a given day, the greater the difficulty is in containing a fire. Finally, at each location the intersection of that day's Ignition Component and Burning Index value is found using the matrix below, yielding the fire danger rating:

Burning Index (BI)	Adjective Fire Danger Rating (R)				
< 90th Percentile BI/4	L	L	L	M	M
90th Percentile BI/4	L	M	M	M	H
90th Percentile BI/2	M	M	H	H	VH
90th Percentile BI	M	H	VH	VH	E
97th Percentile BI	H	VH	VH	E	E
Ignition Component	**0-20**	**21-45**	**46-65**	**66-80**	**81-100**

As an example of the matrix usage in the model, a Burning Index in the 90th percentile and an Ignition Component of 70% would give a Fire Danger Rating of Very High (VH). In contrast, a Burning Index in the 90th percentile, but an Ignition Component of only 15% would provide a Moderate (M) Fire Danger. The latter scenario could occur when significant live fuel moisture is present, e.g., when grasses are relatively green. This is because the Burning Index in the model is strongly driven by weather conditions, especially wind and relative humidity (which influences the 1-Hour Fuel Moisture), but the Ignition Component is strongly influenced by the Live Herbaceous Fuel Moisture while also being regulated by weather conditions. In other words, the North Dakota Fire Danger Model is very dependent on the relative greenness of native grasses, which it simulates using the Growing Season Index.

North Dakota Fire Danger Model

Following the initial ratings determined by Ignition Component and the Burning Index, the North Dakota Fire Danger Model does a check a check on combinations of wind speeds, relative humidity, and **Energy Release Component (ERC)** values that are known to be associated with problematic wildland fire conditions. The ERC is a number related to the available energy per square foot within the flaming front at the head of a fire, and is essentially a composite fuel moisture index that reflects the contributions of all live and dead fuels of various sizes, not only grass fuels. Thus, the ERC values can reflect drought-related fuel loading, and these final checks on combinations of wind speeds, relative humidity, and ERC values were added to the North Dakota Fire Danger Model following monitoring of the preliminary version of the model in the spring and summer of 2021. These checks can force the final fire danger rating into a higher category than the Burning Index and Ignition Component methodology alone, which serves as a mechanism to capture the potential for drought-stressed fuels of various sizes to contribute to fire danger.