## *How much difference does it make for a wildfire to burn under extreme wind conditions? Does wind create megafire conditions?*

# Extreme winds alter influence of fuels and topography on megafire burn severity in seasonal temperate rainforests under record fuel aridity

**Citation** Evers, C., Holz, A., Busby, S., Nielsen-Pincus, M. (2022). Extreme winds alter influence of fuels and topography on megafire burn severity in seasonal temperate rainforests under record fuel aridity. *Fire*, 5, 41. https://doi.org/10.3390/fire5020041

**Can Oregon's 2020 Labor Day wildfires help us understand how different factors influence how megafires affect temperate rainforests?**

Pacific northwest rainforests have historically had long periods between large wildfires and therefore, there is no consensus around how forests may respond to wildfires and how management practices may affect wildfire severity. Five megafires started within the western hemlock zone of Oregon's temperate rainforest on Labor Day 2020. The authors analyzed these fires to determine patterns in burn severity in relation to winds and landscape conditions, two factors that may be impacted by a warming climate.

**What was the main driver of burn severity?**

Fire growth happened mainly during the extreme wind and high aridity period (85%), however, 15% occurred during the period with mild winds and high aridity. The areas within fire perimeters likely to have high burn severity were 2.5 times higher during the extreme wind period.

Within each fire, the extent of high severity fire was inversely correlated with latitude and annual precipitation.

**Aside from wind speed and direction, which factors were most important for burn severity?**

For all fires and both time periods, the strongest predictor of burn severity was canopy height, then winds, slope, elevation and canopy cover. Stands shorter than 20 m had a higher chance of high burn severity and the chance was even higher for stands shorter than 10 m.

During the high wind period, the impact of topography on burn severity was more pronounced, with slope having the most impact. However, during the mild wind period, the impact of the topography was more equal to the remaining forest structure factors.

High burn severity was associated with steep ridges and crests and with valley bottoms and depressions. The impact of heat load and topographic position on burn severity was also highest on steep ridges and in valley bottoms.

**How did topographic and environmental factors interact to influence burn severity?**

Weather period had the most interactions across the entire fire event. When controlling for weather period, latitude and slope had interactions with the most other variables during the extreme wind period and ownership and elevation had the most interactions during the mild wind period.

There were a few notable interactions. One was between canopy height and canopy cover, which had compounding effects and overrode the impacts of other variables on burn severity. Another was elevation, which had a dampening effect on burn severity.

**Where there differences among the land ownership categories?**

Private lands had a higher proportion of high severity fire than any other ownership category and the amount of land burned was much higher on private lands.

During the mild wind period the proportion private forest land with severe fire was 83% while on public forest land it was only 17%. This difference was driven by differences in vegetative structure.

**What should managers be on the lookout for in a post-fire period?**

- Fire managers should be alert for reburn potential in the decades after megafires. Reburns were common after the historical megafires, perhaps because early successional vegetation falls into the category most susceptible to high severity burn.

**What are takeaways for land managers working to limit susceptibility to fire?**

- The authors recommend against prescribed burns and mechanical removal of fuels to reduce risk of megafires because temperate rainforests quickly regrow fuels and the highest fire severity was driven by extreme winds.
- Land management makes a difference. Private forest lands had, in general, shorter trees and lower canopy closure, which were related to higher burn severity.
- Although fuels will be more likely to reach high aridity under warming climate conditions, large megafires are not likely to occur without the presence of extreme wind events, which are uncommon in summer. However, if dry seasons lengthen, they may overlap with the fall period of stronger winds and create conditions for megafires.

**Research Approach/Methods**

- The authors used boosted regression trees (BRTs) to assess how burn severity was impacted by topography and vegetation structure during two time periods, which differed in wind intensity.
- Topographic variables included elevation, slope, heat load index, and topographic wetness index to account for topography impacts on microclimate and fuel moisture. Structure variables included canopy height, stand age, and canopy cover.
- The researchers based wildfire severity calculations on satellite-captured surface reflectance obtained from Google Earth. They calculated burn severity as the relativized differenced normalized burn ratio (RdNBR). They then classified all areas with RdNBR > 0.676 and tree mortality > 75% as having high burn severity.
- The authors used the extreme and mild wind periods to assess how the relationship between burn severity, topography, and vegetation structure differed under different wind regimes. They also estimated and ranked the interaction between each pair of response variables in the model.
- The researchers used spatial overlays to determine how burn severity patterns differed by land ownership category. They also compared the actual severely burned areas with the areas identified by the model as expected to be severally burned.

**Keywords** wildfire, Oregon 2020 fires, Labor Day fires, western Cascades, high-severity fire, climate-limited fire regime

**Images**

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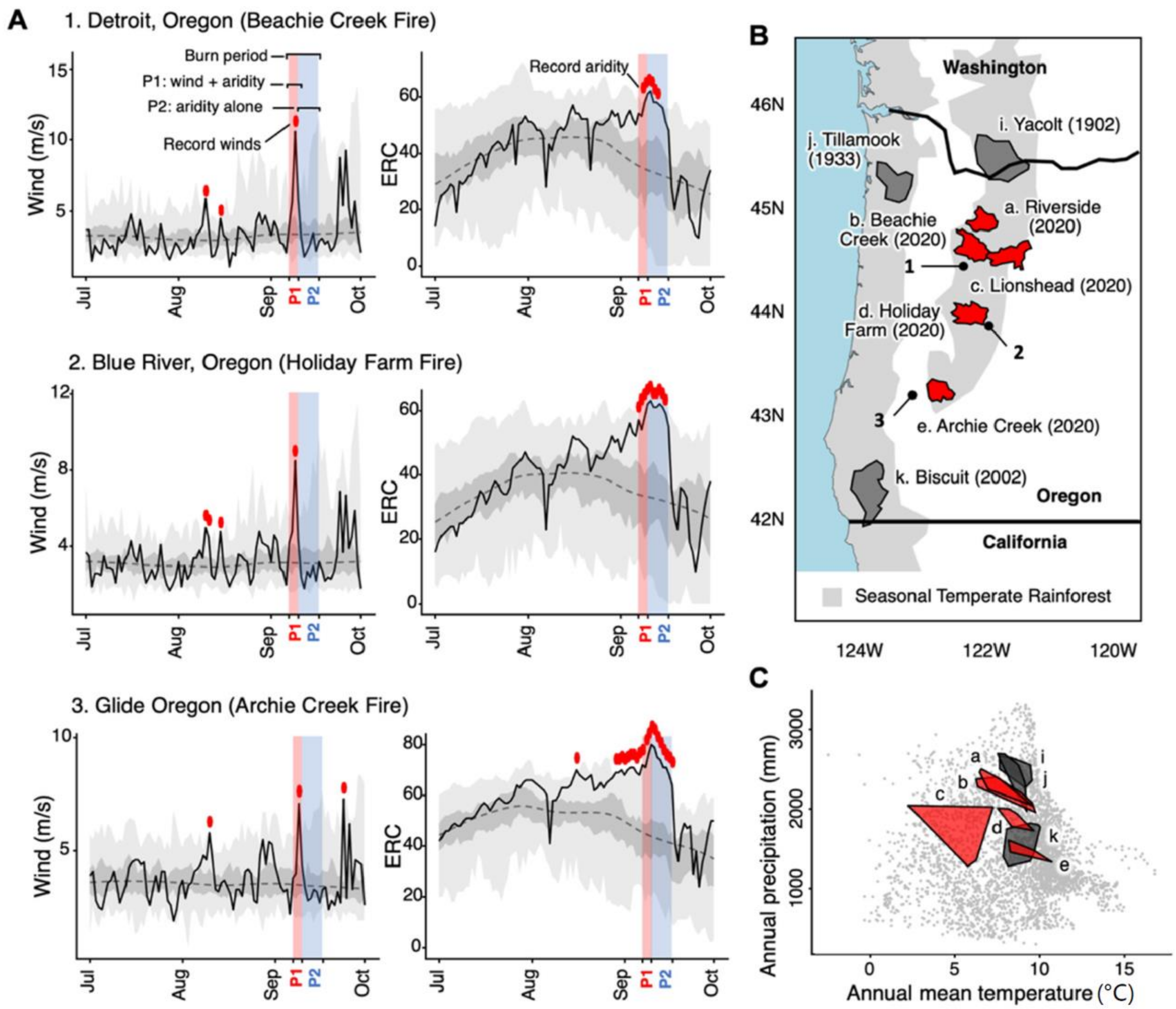


**Figure 1 in Evers et al. 2022.** (**A**) Long-term (1979–2020) and 2020 weather conditions for the PNW fire season (July to October) from north (top panel) to south (bottom panel) in the western Cascade Range of Oregon (source: GridMET, https://www.climatologylab.org/gridmet.html, accessed on 8 January 2021). Long-term maximum daily values for wind and energy release component (ERC; a metric of mid- to coarse fuel aridity) are shown in light gray; the interquartile range in darker gray; the median daily value as a dashed line. Daily values for 2020 are shown as a solid black line (record-breaking daily values denoted with bold red emphasis). Based on wind patterns, the five synchronous megafires are divided into two periods: period 1 (P1) with extreme winds and fuel aridity (red), and period 2 (P2) with extreme fuel aridity alone (blue). (**B**) From north (top) to south (bottom), the GridMET stations are located in (1) the Santiam River watershed, near Detroit, Oregon (Beachie Creek Fire; top left panel), in (2) the McKenzie watershed, near Blue River, Oregon (Holiday Farm Fire; middle left panel), and in (3) the Umpqua River watershed near Glide, Oregon (Archie Creek Fire; bottom left panel). (**C**) The regional context of these fires within temperate rainforests is shown to the right. Climate envelope data are built from by BioClim for PNW seasonal temperate rainforests [22].

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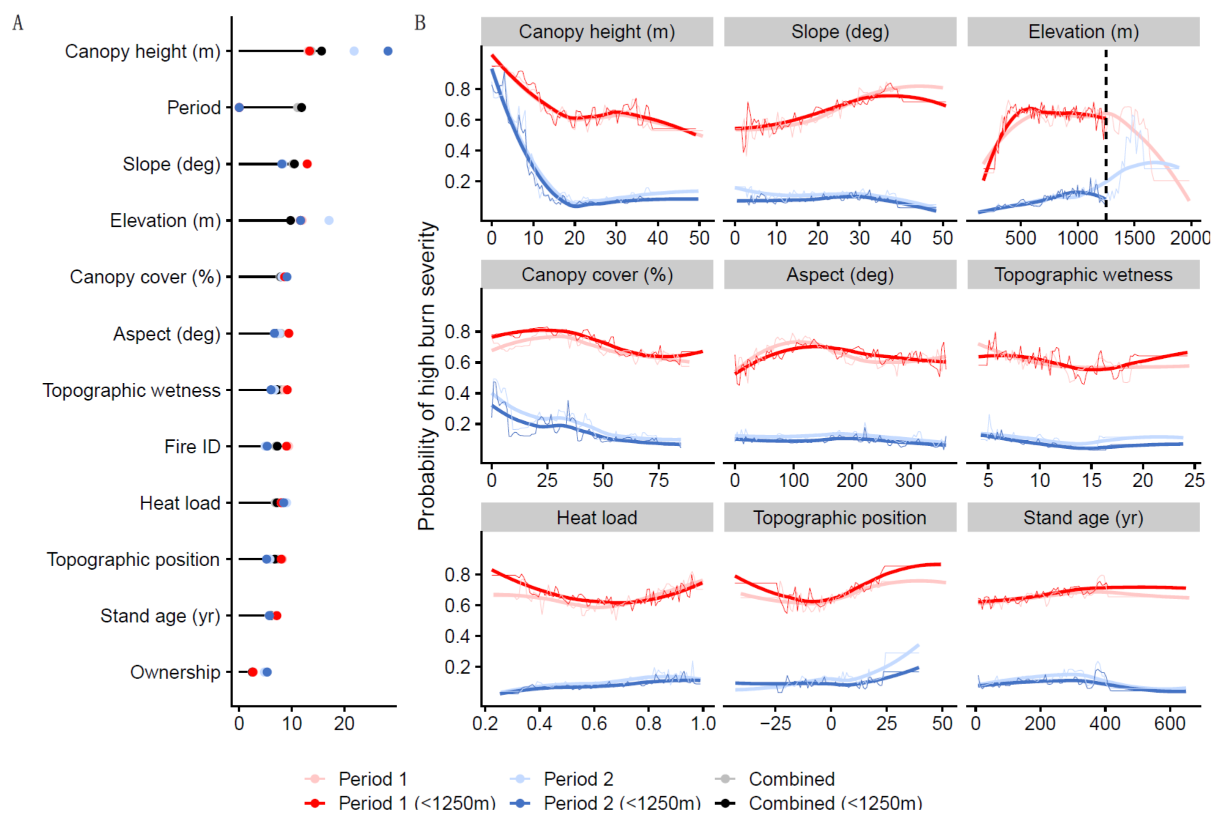


**Figure 2 in Evers et al. 2022.** (**A**) Variable importance of both fire periods ranked by stratified sample (below 1250 m) as shown by horizontal black lines. Points show variable importance for models fit individually to both periods at all elevations and at elevations less than 1250 m. (**B**) Partial dependence of high-severity for continuous variables ordered by importance. Lines plotted for P1 (red) and P2 (blue) are shown with (dark) and without (light) the elevation filter (see elevation panel for reference). From top-left to bottom-right panels are ordered by relative importance as shown in (**A**).

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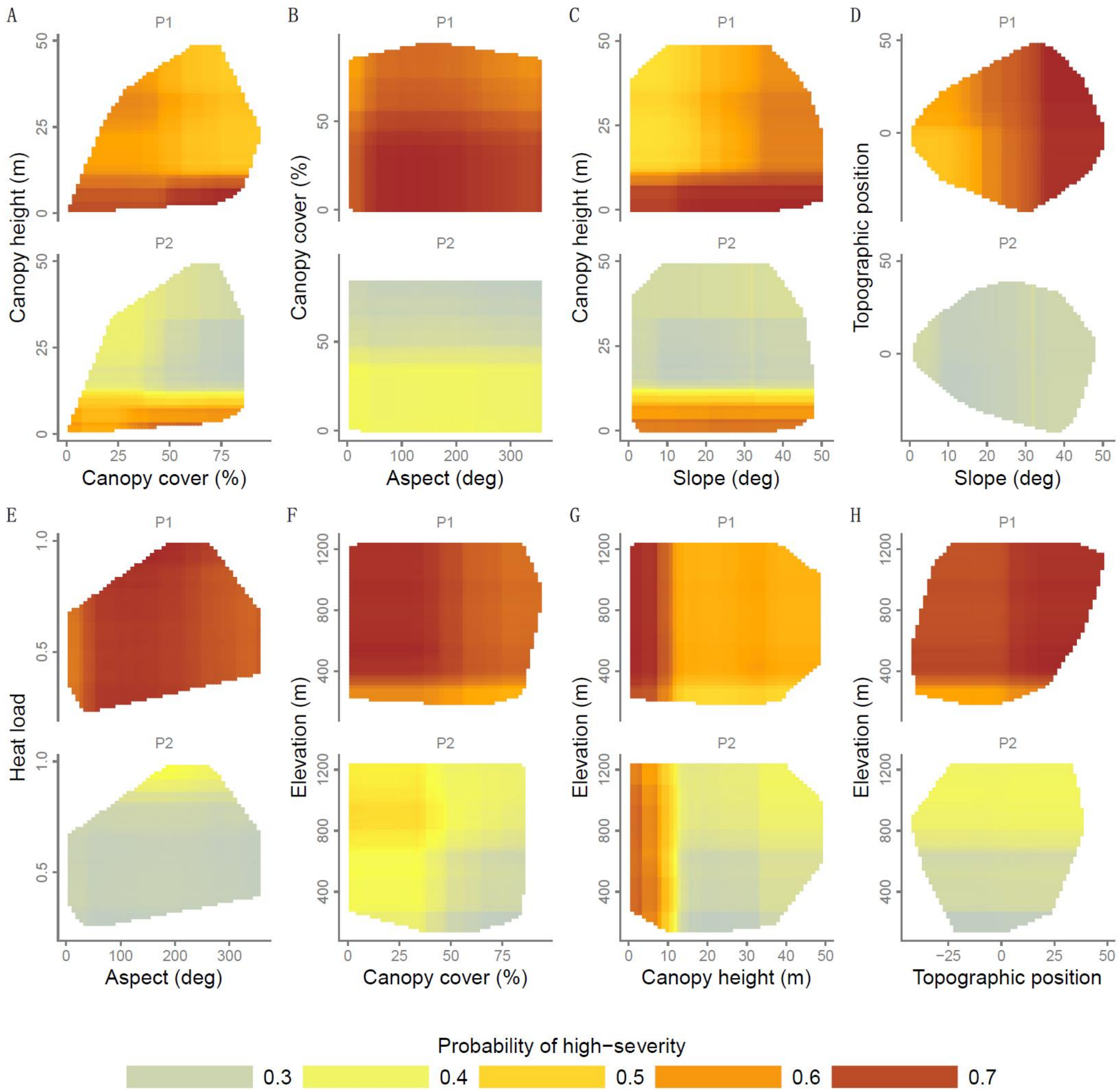


**Figure 3 in Evers et al. 2022.** Notable interactions among several variable pairs (**A**–**H**) are shown for both periods 1 and 2. The likelihood of high burn severity for both periods and each variable combination is described by the color ramp shown in the legend at bottom. For example, (**A**) shows forests with canopy heights less than 10 m were most likely to see severe burns during P1 and P2, but higher probabilities for severe burns were also observed in taller stands in P1, particularly as slopes increased beyond 20 degrees (**C**).