



Chasing Fire Tornadoes for Science

Recent research suggests that fire-generated vortices are always present during wildfires.

By Emily Shepherd

6 September 2022



The Dixie Fire, which raged through Northern California in August 2021, generated swirling vortices that ultimately did not develop into fire tornadoes. Credit: Kiera Malarkey

Last year, Neil Lareau, an atmospheric scientist at the University of Nevada, Reno, was perusing weather data for Northern California's then raging Dixie Fire when he decided he would drive there as soon as possible. He was going to look for fire-generated tornadic vortices (FGTVs), more commonly called fire tornadoes.

“Vortices are an omnipresent feature of wildland fire,” said [Lareau](#). Smaller vortices, called fire whirls, are a common sight during wildfires, spanning a few meters and dissipating in minutes.

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The biggest vortices can reach a kilometer across and generate tornado-force winds. Though vortices both large and small can be a dynamic agent affecting wildfire behavior, the forces that create and propel them remain mysterious.

Lareau joined forces with a crew from San José State University's (SJSU) [Fire Weather Research Laboratory](#) at a highway rest stop 18 kilometers from the Dixie Fire. They expected the fire to surge down the slopes after a few hours, but instead, a firebrand falling from the sky ignited a spot fire on a ridge nearby.

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Fiery Fieldwork

In 2020, the National Weather Service issued its first [fire tornado warning](#), during the Loyalton Fire in California. Later that summer, the Bear and Creek fires, also in California, also spawned FGTVs.

Lareau was [researching FGTVs](#) well before the Loyalton warning and continues to study the phenomenon. In a paper published recently in the [Bulletin of the American Meteorological Society](#), Lareau used open-access Next Generation Weather Radar ([NEXRAD](#)) data to create a conceptual model identifying shared characteristics of FGTVs.

Like water flowing around a boulder in a stream, he found, wind is forced to split around the plume of superheated air and ash rising off a wildfire. And just like water flowing around a boulder, “these two eddies develop,” said Lareau, “which we call counterrotating vortices [CRVs]. Between those CRVs there’s this kind of wake—air moving back toward the fire in opposition to what the wind would be doing if the fire wasn’t there.”

Lareau recognized limitations to conclusions he could draw from these data, he said. The NEXRAD resolution was coarse, and it could observe the plume only high aloft, not near the ground. That’s where SJSU’s truck-mounted mobile research radar came in.

“One truck has our mounted radar on it, and the other truck actually houses our lidar,” said [Kate Forrest](#), who was there that day. Forrest is an SJSU graduate student and operator of the Fire Weather Research Laboratory’s research radar, which produces superhigh-resolution data. Because the truck-mounted radar can be driven to the fire, it can take readings from the flames to the sky.

“That’s when the fire really came down the lee side of the Sierra,” said Forrest. “We actually started to see those rotation plumes on either side; one of them started to rotate, and it got super ashy. The wind completely reversed.”

Lareau had hoped to capture data of CRVs forming from several kilometers away. Instead, he and the SJSU crew were watching them form with their own eyes. “And boom, there they are,” said Lareau.

Lareau and Forrest noted that the vortices at the Dixie Fire were not true fire tornadoes because they did not generate tornadic winds. But the vortices confirmed that the stream eddy principle, which Lareau said emerged from anecdotal knowledge of firefighters, can predict real-time fire behavior. What’s becoming clearer through Lareau’s research is the ubiquity of the stream eddy phenomenon and the process of transformation from a small CRV into a true FGTV.

However, even when vortices don’t become tornadoes, they “can become the dominant driver of fire spread,” said Lareau. “If we want to understand the coupled fire-atmosphere system, how a fire travels through the landscape, how it consumes fuel, understanding these vortices is of critical importance.”

—Emily Shepherd ([@emilyshep1011](#)), Science Writer

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