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NEWS EARTH

Wildfires and farm fertilizer use are fueling ozone pollution

Those sources now rival cars and factories in emitting the chemicals that help create ozone

Wildfire smoke, seen here blanketing Los Angeles in 2020, can drive up ground-level ozone pollution.
E4C/GETTY IMAGES

By Rachel Berkowitz

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Images of California's wildfires this winter speak for themselves about the fires' devastating effects. But those pictures don't tell the whole story. Together with soil emissions, the fires are driving an increase in ground-level ozone pollution — causing a fundamental shift in our atmosphere's chemistry, researchers say, and potentially rendering air pollution standards unmeetable.

"We're entering a new air pollution regime," says Ian Faloona, an atmospheric chemist at University of California, Davis.

Analyzing satellite data and ground-level observations, Faloona and his colleagues have teased apart the sources that contribute to ozone in major air basins in the southwestern United States. Soil and wildfire emissions of nitrogen-containing ozone precursors, collectively referred to as "NOx," are increasingly raising ozone levels, the team found. These NOx emissions levels are now comparable with those from such human-made sources as cars and factories throughout the southwestern United States, Faloona says. He reported his initial findings January at the American Meteorology Society's annual meeting in New Orleans.

Ground-level ozone typically comes from other primary pollutants that react with sunlight and stagnant air. It has been linked to adverse health effects, including increased respiratory illness, reproductive problems, premature death and some cancers. That's why it is among six main air pollutants that the U.S. Environmental Protection Agency has regulated since the 1970s.

Over time, the standard for ozone has been ratcheted down, most recently in 2015; it's now 70 parts per billion over an eight-hour average. But "estimates of future emissions are overlooking an immense source from agricultural emissions, and wishing away wildfires," Faloona says.

While regulations have limited NOx production by human-made sources, particularly in urban areas, satellite data since 2015 began to show rising NOx levels in remote areas of California. Faloona found patterns linked with an alarming rise in recent wildfire activity and increasing soil emissions due to a warming climate and rising fertilizer use.

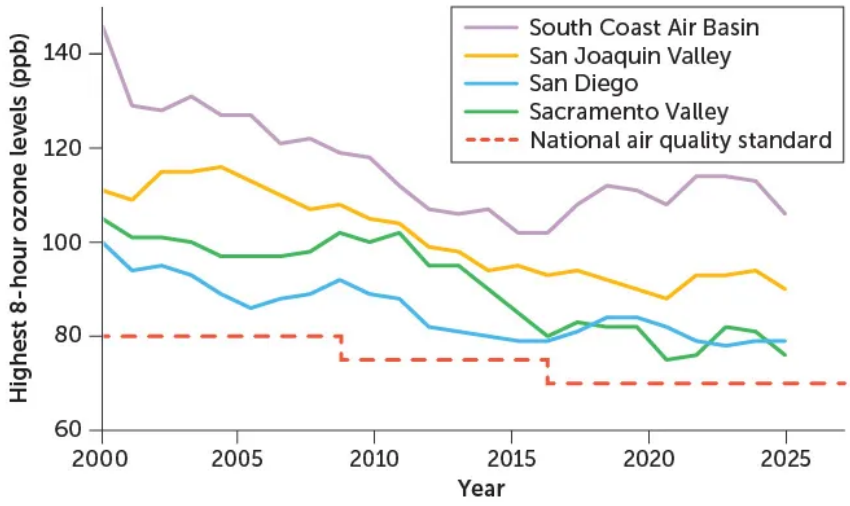
The findings come as wildfires have ravaged areas coast-to-coast in the

United States, from January's devastating fires in Los Angeles to more recent conflagrations in South Carolina and Long Island, N.Y.

Leveling off

While ozone levels in different California air basins have dropped over the past few decades, they remain persistently above the EPA standard (red dashed line) for ambient air quality. That includes in both urban (San Diego) and more agricultural areas (like the Sacramento Valley). A new study teases out how wildfires and agricultural practices may be contributing to the problem.

Ozone levels in select California locations, 2000–2023



Previous research has shown how wildfire smoke wafting over cities can jump-start ozone production. And Dan Jaffe, a climatologist at the University of Washington in Bothell, Wash., recently showed that the number of days that exceed national air quality ozone thresholds doubles during high wildfire years.

But how much wildfire smoke, along with fertilizer emissions, contributed to the problem was unknown.

Faloona developed a method to derive how much of the ozone came from various sources, and found a fundamental shift. A steady decrease over the past z several decades has now stalled. The vast majority of ozone — 64 to 70 ppb — still wafts in from the Pacific Ocean from sources beyond U.S. borders, as it has since the 1990s. Meanwhile, now-regulated automobile and industrial sources, which once accounted for as much as 15 to 20 ppb in mid-sized cities, now contribute under 6 ppb in most urban areas (excluding megapolises like Los Angeles).

Wildfire and soil impacts boost ozone by another 1 to 7 ppb, he found, or up to 50 percent of the excess ozone. In a follow-up study focused on one air basin free of wildfire impacts, he found that some 2 ppb of NOx in the air came from agricultural fertilizers.

Those numbers might not sound like much. But when it comes to trying to stay below 70 ppb, every bit counts. What emerges is that unregulated sources of ozone precursors from wildfires and agricultural soils are presently contributing as much to most urban areas in the U.S. Southwest as are traditional anthropogenic sources.

Yet some of that data aren't always figured into efforts to combat ozone. For instance, for states calculating ozone compliance, the EPA offers a mechanism to exclude data that came from exceptional events — like wildfires. Demonstrating that a day was influenced by smoke is so complicated that states rarely invoke the rule. "If you're holding the wrong person accountable for pollution they didn't cause, our system breaks down," Jaffe says.

CITATIONS

I. Faloona, Soils, wildfires and background ozone: The rise of a new air quality photochemical regime. American Meteorological Society meeting, New Orleans, January 14, 2025.

H. Lee and D.A. Jaffe. Wildfire Impacts on O_3 in the continental United States using $PM_{2.5}$ and a generalized additive model (2018–2023). *Environmental Science & Technology*. Vol. 58, August 20, 2024, p. 14595. Doi: 10.1021/acs.est.4c05870