Towering wildfire clouds are affecting the stratosphere and the climate, demonstrates study

March 1 2023

The Williams Flats fire in northeastern Washington state generated a fire cloud, or pyroCb, that injected smoke into the stratosphere on August 8, 2019. A NASA aircraft flew in to investigate. Credit: David Peterson, NRL

Images of vast clouds of wildfire smoke towering into the sky have become all too familiar during the recent years of record-breaking fires across the western United States and elsewhere. Now, a team of atmospheric scientists has demonstrated these plumes have major impacts on the stratosphere and climate. The results were just published in the journal *Science*.

Big wildfires can send smoke plumes to immense heights. These towering clouds, called pyrocumulonimbus or pyroCbs, are generated when the intense heat of a wildfire triggers a huge thunderstorm that carries smoke into the stratosphere, five to seven miles above the surface.

In 2017, a U.S. airborne mission to study the atmosphere over the remote oceans intersected with smoke from an enormous pyroCb event in the Pacific Northwest. The smoke was so widespread that remote sensing instruments around the globe monitored it for more than eight months. Measurements showed that it and several additional Northern Hemisphere pyroCb events that year dominated contributions of black carbon and organic carbon to the lower stratosphere, outpacing human emissions from vehicles, industry, heating, cooking and agricultural land-clearing. The net effect was to cool the planet.

"Fire-triggered thunderstorms are growing larger and more frequent—witness record-breaking events in 2017, 2019 and 2020," said study co-author Joshua Schwarz of the U.S. National Oceanic and Atmospheric Administration, which led the research. "Their recent impacts on the stratosphere have been impressive."

"We've known that huge fires emit lots of aerosols. But we didn't realize that these aerosols they could be injected so high into the atmosphere," said atmospheric chemist and study co-author Roísín Commane of the Columbia Climate School's Lamont-Doherty Earth Observatory. Commane flew on the long-distance airborne missions over the oceans that captured data about the aerosols.

Scientists are interested in learning more about pyroCbs because their smoke lingers in the atmosphere longer than that from typical fires. The research should also provide insights about the behavior of aerosols from volcanoes, aviation or potential future solar geoengineering efforts.

Critical measurements of these huge clouds have so far been extremely limited because of their highly episodic nature, and the logistical challenges of getting scientific instruments airborne and into the smoke on short notice. As a result, the distribution and duration of smoke from these events is poorly known, as is the overall impact on climate and stratospheric aerosol chemistry, including the ozone layer.

One surprising finding of the study was the discovery of an extremely thick coating of other chemicals on solid black carbon particles generated by wildfires. Scientists are not quite sure how the gunky coating forms, but it seems to be made of organic aerosols and gases that condense on the particles as the smoke plume rapidly rises and cools in the atmosphere, said study co-author Kara Lamb of Columbia's Data Science Institute.

A more recent airborne mission provided direct sampling of hours-old pyroCb smoke from the 2019 Williams Flats fire in northeastern Washington state. Analysis of black carbon from that fire gave researchers more confidence about the conclusions drawn from the 2017 smoke.

The thick coating on black carbon particles, along with their size and mass, was a remarkably stable feature of pyroCb smoke that the researchers realized could be used to "fingerprint" these particles in the lower stratosphere. Using these fingerprints, they re-examined data from a total of 12 previous airborne mission datasets going back to 2006 to estimate long-term pyroCb influences on the lower stratosphere on recent climate.

They found that even in those years with relatively few pyroCbs before the more active fire seasons starting in 2020, the impact of smoke was significant, contributing roughly 20% of all stratospheric black carbon and organic carbon in the lower stratosphere in the previous decade.

"This gave us a reasonable estimate representing the period before things really started lighting up," Schwarz said. "We now recognize pyroCbs' longer term influence on the stratosphere. It's not just an important blip, but a steady state influence that needs to be accounted for."

More information: J. M. Katich et al, Pyrocumulonimbus affect average stratospheric aerosol composition, *Science* (2023). DOI: 10.1126/science.add3101.
www.science.org/doi/10.1126/science.add3101

Provided by State of the Planet

Citation: Towering wildfire clouds are affecting the stratosphere and the climate, demonstrates study (2023, March 1) retrieved 22 June 2024 from https://phys.org/news/2023-03-towering-wildfire-clouds-affecting-stratosphere.html