UC SANTA BARBARA

THE Current

January 14, 2021
Sonia Fernandez

Extreme Fire Weather

When the Thomas Fire raged through Ventura and Santa Barbara counties in December 2017, Danielle Touma, at the time an earth science researcher at Stanford, was stunned by its severity. Burning for more than a month and scorching 440 square miles, the fire was then considered the worst in California's history.

Six months later the Mendocino Complex Fire upended that record and took out 717 square miles over three months. Record-setting California wildfires have since been the norm, with five of the top 10 occurring in 2020 alone.

The disturbing trend sparked some questions for Touma, who is now a postdoctoral researcher at UC Santa Barbara's Bren School for Environmental Science & Management.

"Climate scientists knew that there was a climate signal in there but we really didn't understand the details of it," she said of the transition to a climate more ideal for wildfires. While research has long concluded that anthropogenic activity and its products — including greenhouse gas emissions, biomass burning, industrial aerosols (a.k.a. air pollution) and land-use changes — raise the risk of extreme fire weather, the specific roles and influences of these activities was still unclear.

Until now. In the first study of its kind, Touma, with fellow Bren School researcher Samantha Stevenson and colleagues Flavio Lehner of Cornell University and the National Center for Atmospheric Research (NCAR), and Sloan Coats from the University of Hawaii, have quantified competing anthropogenic influences on

extreme fire weather risk in the recent past and into the near future. By disentangling the effects of those man-made factors the researchers were able to tease out the roles these activities have had in generating an increasingly fire-friendly climate around the world and the risk of extreme fire weather in decades to come.

Their work appears in the journal Nature Communications.

“By understanding the different pieces that go into these scenarios of future climate change, we can get a better sense of what the risks associated with each of those pieces might be, because we know there are going to be uncertainties in the future,” Stevenson said. “And we know those risks are going to be expressed unequally in different places too, so we can be better prepared for which parts of the world might be more vulnerable.”

Warm, Dry and Windy

“To get a wildfire to ignite and spread, you need suitable weather conditions — you need warm, dry and windy conditions,” Touma said. “And when these conditions are at their most extreme, they can cause really large, severe fires.”

Using state-of-the-art climate model simulations available from NCAR, the researchers analyzed the climate under various combinations of climate influences from 1920-2100, allowing them to isolate individual effects and their impacts on extreme fire weather risk.

According to the study, heat-trapping greenhouse gas emissions (which started to increase rapidly by mid- 20th century) are the dominant contributor to temperature increases around the globe. By 2005, emissions raised the risk of extreme fire weather by 20% from preindustrial levels in western and eastern North America, the Mediterranean, Southeast Asia and the Amazon. The researchers predict that by 2080, greenhouse gas emissions are expected to raise the risk of extreme wildfire by at least 50% in western North America, equatorial Africa, Southeast Asia and Australia, while doubling it in the Mediterranean, southern Africa, eastern North America and the Amazon.

Meanwhile, biomass burning and land-use changes have more regional impacts that amplify greenhouse gas-driven warming, according to the study — notably a 30% increase of extreme fire weather risk over the Amazon and western north America

during the 20th century caused by biomass burning. Land use changes, the study found, also amplified the likelihood of extreme fire weather in western Australia and the Amazon.

Protected by Pollution?

The role of industrial aerosols has been more complex in the 20th century, actually reducing the risk of extreme fire weather by approximately 30% in the Amazon and Mediterranean, but amplifying it by at least 10% in southeast Asia and Western North America, the researchers found.

“(Industrial aerosols) block some of the solar radiation from reaching the ground,” Stevenson said. “So they tend to have a cooling effect on the climate.

“And that’s part of the reason why we wanted to do this study,” she continued. “We knew something had been compensating in a sense for greenhouse gas warming, but not the details of how that compensation might continue in the future.”

The cooling effect may still be present in regions such as the Horn of Africa, Central America and the northeast Amazon, where aerosols have not been reduced to pre-industrial levels. Aerosols may still compete with greenhouse gas warming effects in the Mediterranean, western North America and parts of the Amazon, but the researchers expect this effect to dissipate over most of the globe by 2080, due to cleanup efforts and increased greenhouse gas-driven warming. Eastern North America and Europe are likely to see the warming and drying due to aerosol reduction first.

Southeast Asia meanwhile, “where aerosols emissions are expected to continue,” may see a weakening of the annual monsoon, drier conditions and an increase in extreme fire weather risk.

“Southeast Asia relies on the monsoon, but aerosols cause so much cooling on land that it actually can suppress a monsoon,” Touma said. “It’s not just whether you have aerosols or not, it’s the way the regional climate interacts with aerosols.”

The researchers hope that the detailed perspective offered by their study opens the door to more nuanced explorations of the Earth’s changing climate.

“In the broader scope of things, it’s important for climate policy, like if we want to know how global actions will affect the climate,” Touma said. “And it’s also

important for understanding the potential impacts to people, such as with urban planning and fire management.”

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.