Climate change and wildfire: Synthesis of recent findings

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Concerns continue to grow about the effects of climate change on fire. Wildfires are expected to increase 50 percent across the United States under a changing climate, over 100 percent in areas of the West by 2050 as projected by some studies. Of equal concern to scientists and policymakers alike are the atmospheric effects of wildfire emissions on climate.

A new article published in the journal *Forest Ecology and Management* by U.S. Forest Service scientists synthesizes recent findings on the interactions between fire and climate and outlines future research needs. Authored by research meteorologists Yongqiang Liu and Scott Goodrick from the Forest Service Southern Research Station (SRS) and Warren Heilman from the Northern Research Station, the article homes in on the effect of emissions from wildfires on long-term atmospheric conditions.

"While research has historically focused on fire-weather interactions, there is increasing attention paid to fire-climate interactions," says Liu, lead author and team leader with the SRS Center for Forest Disturbance Science. "Weather, the day-to-day state of the atmosphere in a region, influences individual fires within a fire season. In contrast, when we talk about fire climate, we're looking at the statistics of weather over a certain period. Fire climate sets atmospheric conditions for fire activity in longer time frames and larger geographic scales."

Wildfires impact atmospheric conditions through emissions of gases, particles, water, and heat. Some of the article focuses on radiative

forcing from fire emissions. Radiative forcing refers to the change in net (down minus up) irradiance (solar plus longwave) at the tropopause, the top of the troposphere where most weather takes place.

Smoke particles can generate radiative forcing mainly through scattering and absorbing solar radiation (direct radiative forcing), and modifying the cloud droplet concentrations and lifetime, and hence the cloud radiative properties (indirect radiative forcing). The change in radiation can cause further changes in global temperatures and precipitation.

"Wildfire emissions can have remarkable impacts on radiative forcing," says Liu. "During fire events or burning seasons, smoke particles reduce overall solar radiation absorbed by the atmosphere at local and regional levels. At the global scale, fire emissions of carbon dioxide contribute substantially to the global greenhouse effect."

Other major findings covered in the synthesis include:

- The radiative forcing of smoke particles can generate significant regional climate effects, leading to lower temperatures at the ground surface.
- Smoke particles mostly suppress cloud formation and precipitation. Fire events could lead to more droughts.
- Black carbon, essentially the fine particles of carbon that color smoke, plays different roles in affecting climate. In the middle and lower atmosphere, its presence could lead to a more stable atmosphere. Black carbon plays a special role in the snow-climate feedback loop, accelerating snow melting.

Land surface changes may be triggered that also play into future effects. "Wildfire is a disturbance of ecosystems," says Liu. "Besides the atmospheric impacts, wildfires also modify terrestrial ecosystem services such as carbon sequestration, soil fertility, grazing value, biodiversity,

and tourism. The effects can in turn trigger land use changes that in turn affect the atmosphere."

The article concludes by outlining issues that lead to uncertainties in understanding fire-climate interactions and the future research needed to address them.

More information: www.sciencedirect.com/science/ … ii/S037811271300114X

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