Smoke from Western wildfires can influence Arctic sea ice, researchers find

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Arctic sea ice floats in the Arctic Ocean. Credit: Patricia DeRepentigny

Sea ice and wildfires may be more interconnected than previously thought, according to new research out today in *Science Advances*.

By digging into differences between climate models, researchers from the University of Colorado Boulder and the National Center for Atmospheric Research (NCAR) found that soot and other burned biomass from wildfires here in Colorado and elsewhere in the Northern Hemisphere can eventually make their way to the Arctic. Once there, it can affect how much—or how little—sea ice persists at any given time.

This, in turn, can cause ripple effects on climatic patterns for the rest of the globe, reinforcing a feedback loop between the two systems in a way that hasn't been previously seen.

"This research found that particles emitted from wildfires where people live can really impact what happens in the Arctic thousands of miles away," said Patricia DeRepentigny, the lead author on the paper and a postdoctoral fellow at NCAR.

"Sometimes the Arctic can be seen as this region that we shouldn't care about because it's so far away from where we live … but the fact that there's this back-and-forth of what happens here with the wildfires can affect the sea ice, and a diminishing sea ice can then lead to more wildfires here, connects us with the Arctic a little bit more."

Climate models, which are simulations of how different parts of the climate interact, have long been used by governments around the world to help guide future policies related to climate change. As science has become more advanced, so too have these models, gaining sophistication and capability.

However, DeRepentigny and colleagues noticed that in a recent model, the NCAR-based Community Earth System Model version 2 (CESM2), there was a drastic acceleration of Arctic sea ice loss towards the end of the 20th century that wasn't seen in the previous models. So they decided to understand why.

What they found when comparing the forcings (the different ways a climate model can be influenced, such as carbon dioxide or methane emissions or solar radiation) between the new and previous generation of climate models was that biomass burning emissions had the biggest effect on Arctic sea ice loss when simulated.

When they dug deeper into why these biomass burning emissions mattered so much, they found that the main difference is due to the non-linear cloud effects that can emerge when aerosols, small particles or liquid droplets, released by fires interact with Arctic clouds. When there are a lot of aerosols released during a heavy fire year, it can lead to more and thicker clouds, whereas those clouds are thinner on lighter fire years—allowing for more solar radiation to get through and melt more ice.

Previous research had already shown that when the sea ice melts, large wildfires become more widespread over the western U.S. By showing that smoke from wildfires can help protect the ice, this new research suggests that this variability may be creating more of a feedback loop than previously thought.

"When we think about climate, everything's really interconnected, and this is really a great example of that," said Alexandra Jahn, an author on this paper and an associate professor in atmospheric and oceanic sciences and the Institute of Arctic and Alpine Research (INSTAAR) at CU Boulder.

"When we're thinking about climate processes, it's really a global problem, and we can't study it in any isolated fashion. We really always have to look at the global picture to understand all these different interactions."

The researchers caution that this research was model-specific, which means that it only looked at one specific climate model, but that their experiments provide a great starting point for future research. This includes potentially pinpointing the effects of specific fires, rather than fires broadly speaking, and fine-tuning the models so that they can do simulations where the model itself can generate the fires; thus, if there's predicted to be a dry year, the model could then simulate more fires, which in turn would factor into the projections for future sea ice loss.

"The goal that we're trying to achieve here is to have these climate simulations be more reliable and give us projections that can then inform policy makers and societal choices," DeRepentigny said, adding that this study "helps us get closer to something that can truly help us make the best decisions as a society."

Other authors on the paper include Marika M. Holland, John Fasullo, Jean-François Lamarque, Cécile Hannay, David A. Bailey, Simone Tilmes and Michael J. Mills at the National Center for Atmospheric Research and Jennifer E. Kay and Andrew P. Barrett at CU Boulder.

More information: Patricia DeRepentigny et al, Enhanced simulated early 21st century Arctic sea ice loss due to CMIP6 biomass burning emissions, *Science Advances* (2022). DOI: 10.1126/sciadv.abo2405

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