Black carbon varies, but stubbornly persists, in snow and ice around the world

June 30 2017, by Trent Knoss

Credit: University of Colorado at Boulder

A new University of Colorado Boulder study comparing dissolved black carbon deposition on ice and snow in ecosystems around the world (including Antarctica, the Arctic, and alpine regions of the Himalayas, Rockies, Andes, and Alps) shows that while concentrations vary widely, significant amounts can persist in both pristine and non-pristine areas of snow.

Black carbon is the soot-like byproduct of wildfires and fossil fuel consumption, able to be carried long distances via atmospheric transport. Because these black particles absorb more heat than white snow, the study of black carbon concentrations in glaciers is important for predicting future melt rates.

Scientists have previously studied black carbon in areas with obvious nearby sources (such as a coal mine in Svalbard, Norway), but less is known about its complex interactions in snow-covered areas further removed from human impact.

While the exact sources of black carbon are often difficult to pinpoint in remote areas, the researchers used molecular analysis of the black carbon along with analysis of wind patterns to show that Greenland's ice sheet had recently seen clear effects of wildfires burning thousands of miles away in the Canadian Arctic.

"We could tell that the carbon was fresh from these fires," said Alia Khan, a post-doctoral researcher in CU Boulder's National Snow and Ice Data Center (NSIDC) and former graduate student at the Institute of Arctic and Alpine Research (INSTAAR). "The molecular signature from these samples was distinctly different from the rest of our dataset."

Wildfires are anticipated to increase in future years, a trend that could compound the effects of longer summer melt seasons and allow for more black carbon deposition.

"More black carbon exposure on the ice could continue to drive a feedback loop of further melt," said Khan.

The global scope of the study could help researchers set upper and lower limits for black carbon deposition and better account for the effects of photodegradation, a process by which sunlight alters the molecular composition over time.

"Photodegradation muddles the dissolved black carbon signature," said Khan. "Right now, for samples that have been exposed to sunlight over long durations, it is hard to pinpoint the source. However, fresh samples like those we collected on the Greenland Ice Sheet can show a clear wildfire signature."

The relatively high amount of black carbon measured in one glacial stream in Greenland may also suggest that the particles can be transported locally across ice surfaces through melt processes.

"The influence of distant forest fires on melt events on the Greenland ice sheet is inherently challenging to demonstrate and these clear chemical results provide another line of evidence for this connection," said Diane McKnight, a CU Boulder professor and a co-author of the study.

The research was also co-authored by Richard Armstrong and Mark Williams of CU Boulder, INSTAAR and NSIDC; Sasha Wagner and Rudolf Jaffe of Florida International University; and Peng Xian of the Naval Research Laboratory in Monterey, California.

The National Science Foundation, the United States Agency for International Development, the Dark Snow Project and Florida Coastal Everglades Long-Term Ecological Research Program provided funding for this work.

The findings were recently published online in the journal *Geophysical Research Letters*, a publication of the American Geophysical Union.

More information: Alia L. Khan et al, Dissolved black carbon in the global cryosphere: Concentrations and chemical signatures, *Geophysical Research Letters* (2017). DOI: 10.1002/2017GL073485

Provided by University of Colorado at Boulder