Study locates origins of glacier soot pollution in Northern India

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Light absorbing impurities in the Colorado Rocky Mountains snowpack. Credit: NASA Goddard Space Flight Center/NASA

New research identifies the relative importance of different sources of pollutants that accelerate glacial melting in the Indian Western Himalayas. This work can contribute directly to strategies to reduce

pollutants at the source. Though earlier work has recognized the significance of aerosol pollutants such as soot and dust, their origins had not been firmly established.

These dark particles are responsible for trapping heat on the surface of the glacier, thus enhancing melting. Discovering the origins of such pollutants can help to determine strategies to reduce or prevent their emission. That was the goal of Parteek Singh Thind and his research team, comprised of members from the Punjab Engineering College and Kurukshetra University in India, who published their findings last month in the journal *Atmospheric Environment*.

Soot particles are classified as light-absorbing impurities. These dark particles are known for their ability to alter a glacier's albedo—more simply referred to as its reflectivity. Pollution particles impact albedo because they partially inhibit solar radiation from bouncing off a glacier's white, shiny surface, instead absorbing the heat which results in glacier melting.

The study identifies the burning of stubble from wheat in the vast agricultural areas of the South Asian lowlands, close to and upwind of the Himalayas, along with pollution created by cars, trucks, motorbikes, and other vehicles that clog local highways as the main sources of particle emissions in the region.

Air pollutants such as soot are not only a threat to Earth's glaciers but to human health as well. The World Health Organization reports that every year, air pollution is responsible for seven million deaths worldwide. It exposes living beings to air filled with harmful chemicals, which can lead to stroke, lung cancer, and heart disease. Parteek emphasized the danger and imminent threat that these emissions pose, telling GlacierHub that, "it is imperative to reduce the contamination of different environmental media with soot particles. Soot particles comprise several

toxic pollutants and their exposure to humans may cause carcinogenic and non-carcinogenic health impacts."

By sampling snow from glaciers and using models to track pollutants back to their source, the study reveals pathways to reducing harmful pollution in the Indian Western Himalayas.

In order to gather information on how to properly combat these threats and trace the origin of these pollutants, the study authors took snow samples from three glaciers in the Indian Western Himalayas, with the goal of expanding research in this field to assist local authorities in drawing up plans for reducing the anthropogenic emission of these pollutants.

The lead author and his team set out on two separate field campaigns to visit the three glaciers. The group collected snow samples, then analyzed them to determine the chemical compositions and identify the pollutants. They coupled this data with a model that tracks the path that the air pollutants traveled, unveiling the location of pollution sources.

Darkening on the surface of Zhadang glacier in China. Credit: Dr. Pengfei Chen

This study revealed that the chemical composition of all the dark particle pollutants could be matched to five main sources: biomass burning, vehicular emissions, coal combustion, mineral dust, and sea salts. The models estimated that the burning of vegetation, otherwise known as biomass, and tailpipe car emissions were the most common contributors to black carbon pollution on these glaciers. This finding is significant because residents of this area are known to rely on biomass burning for cooking. Notably, the team was also able to pinpoint the source of vehicular pollution to urban areas such as New Delhi.

This study unveils the journey of soot particles from the sources of emission to each glacier sample site. This work is significant, for these data were the first used to identify the different sources of dark particle pollutants on surface snow in the region. Parteek told GlacierHub that he expects that "the findings of this study would assist scientists and regional authorities in developing mitigation measures and designing innovative technologies to reduce the anthropogenic emissions of the [light-absorbing impurities]."

Continued research into these pollutants is key to gaining a deeper understanding of their effects on the environment and human health, while simultaneously offering insight into what the sources of black carbon are and what we can do about them. Understanding the impact of this pollution-enhanced glacial melting in North India is crucial for the regional community, who rely on glaciers for their drinking water. Collaboration between community members, policymakers, and scientists is needed in order to develop strict regulations, reducing emissions at the source to prevent future damages.

More information: Parteek Singh Thind et al. Source apportionment of the light absorbing impurities present in surface snow of the India Western Himalayan glaciers, *Atmospheric Environment* (2020). DOI: 10.1016/j.atmosenv.2020.118173