Glaciers may record the story of the coronavirus pandemic

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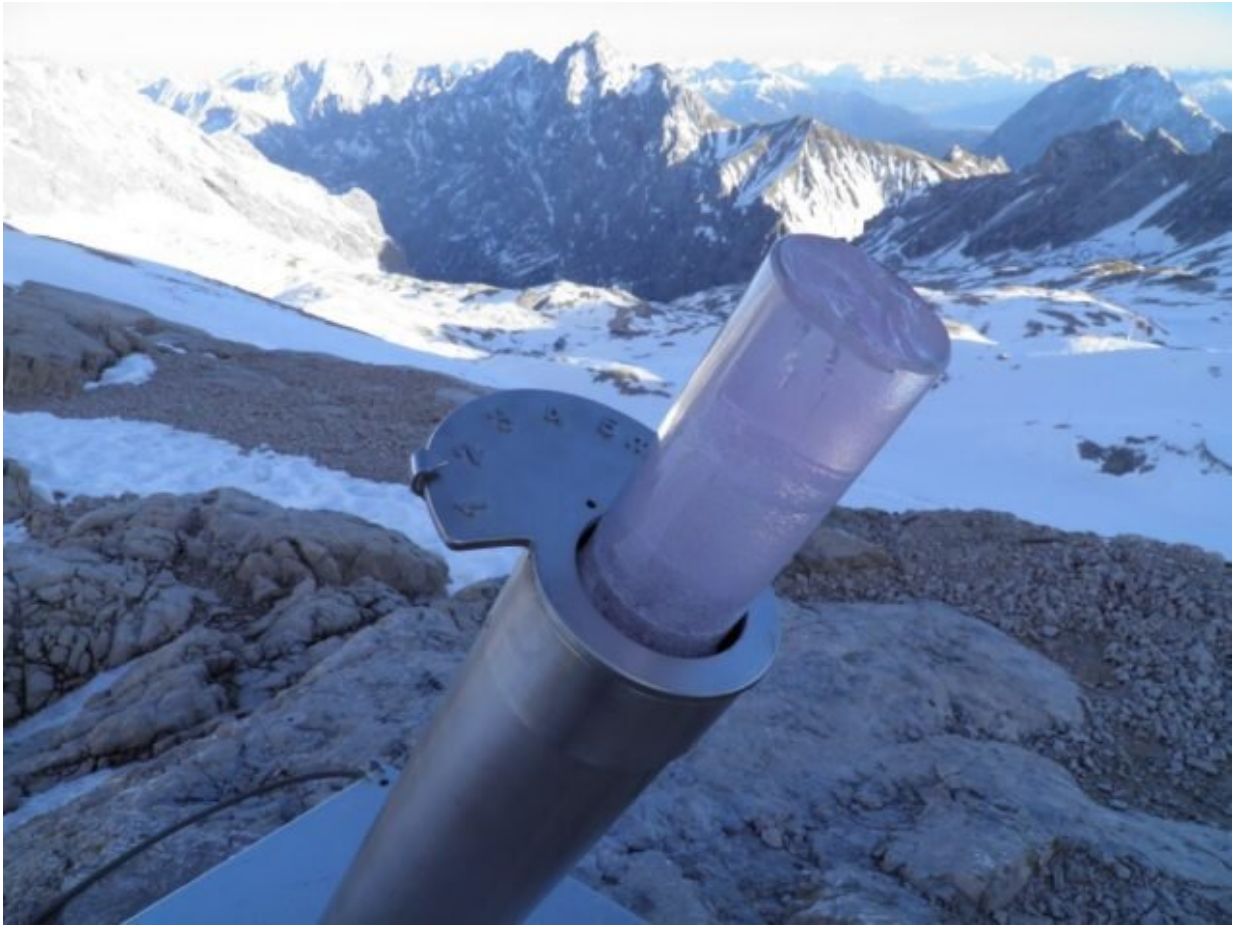


Replica of an ice core extracted from Schneeferner glacier. Credit: Laura Roberts

The coronavirus pandemic will be remembered for decades to come through history books, oral narratives and an abundance of personal protective equipment. However, the glaciers of the Himalayas, the Alps, Patagonia and other regions may also hold the story of this time. Among the layers of ice lay records of many things—volcanic eruptions, other pandemics, ancient civilizations, and anthropogenic climate change. The precipitous decline in air pollutants, the reduction of greenhouse gas emissions, and changes in atmospheric composition during the coronavirus pandemic might eventually be observed in glacial ice.

Atmospheric wind currents carry gases, particulates, and other substances to glaciers. When snow containing these particulates and dissolved chemicals from the air collects on glaciers, it traps the transported substances. Air bubbles—samples of the gases in the atmosphere (e.g. long-lived gases like carbon dioxide)—also form. Over months and years as more snow accumulates, older layers of snow and gas are compressed and sealed—preserving samples of atmospheric conditions at the time of precipitation. By drilling below the surface, scientists extract ice cores which contain these substances. The chemical composition of the ice and air trapped within it serves as a proxy for researchers to analyze atmospheric changes over time.

Roxana Sierra-Hernandez, a paleoclimatologist at the Byrd Polar and Climate Research Center at Ohio State University told GlacierHub, an ice core "really reproduces the atmosphere somehow. You can go back in time to understand how the environment was changing" when there were no human records. For example, through lead concentration measurements, glaciologists discovered mining virtually stopped during the Black Death because of the death of mine workers, the abandonment of mines and a subsequent decline in population. Moreover, she added, in "ice cores you will have data from certain latitudes, from the poles, from areas that cannot be reached most of the time by people to do ground measurements."

The atmospheric changes caused by the COVID-19 lockdowns could similarly be recorded in glacial ice for future scientists to analyze. With planes, trains, and cars coming to a grinding halt, the effects of a drastic drop in transportation has already been seen in reductions in nitrogen dioxide emissions in China and northern Italy. Nitrogen oxides (NOx) are a group of greenhouse gases associated with vehicle exhaust emissions; they also contribute to smog and acid rain.

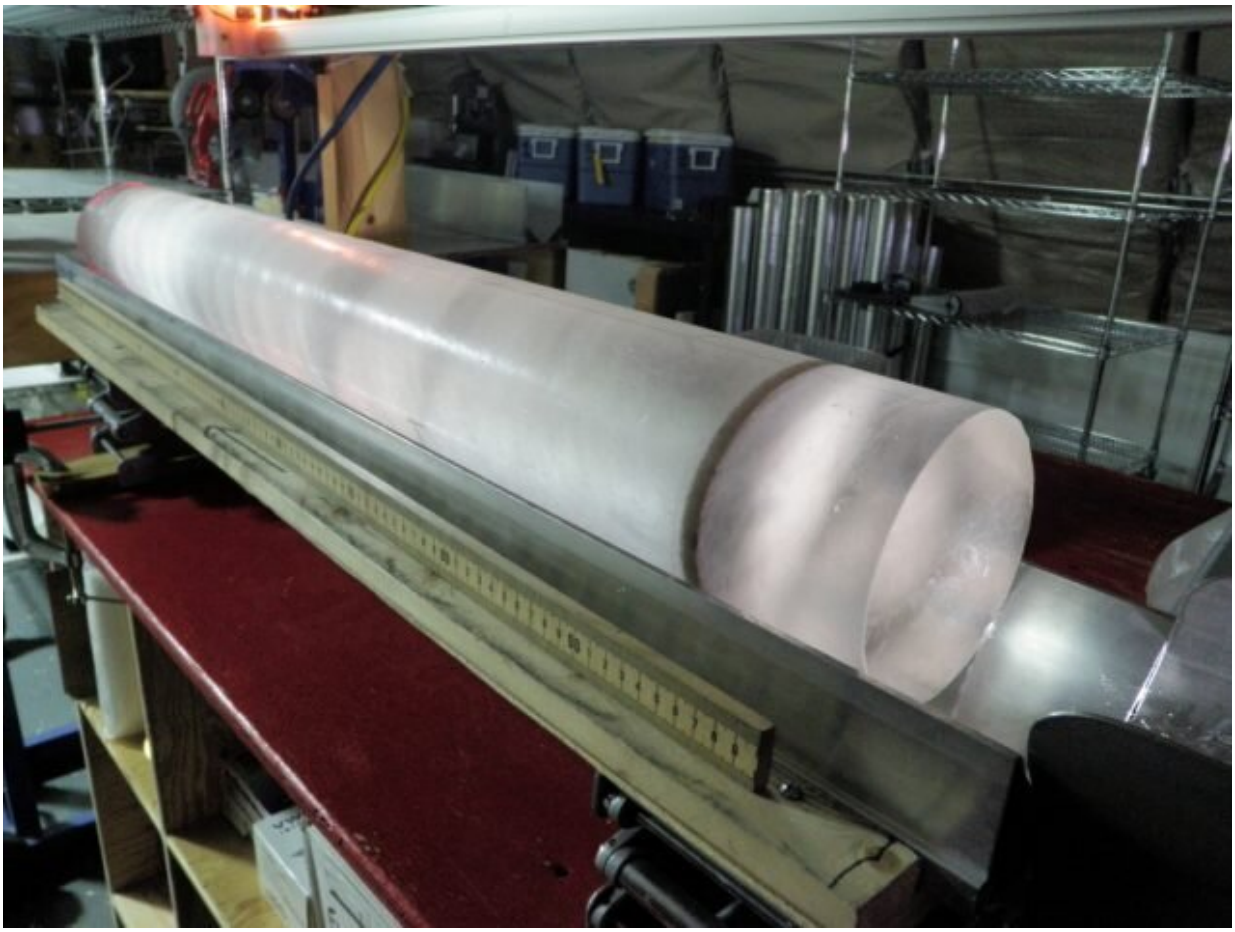
In the atmosphere, nitrogen oxides transform to nitrates, which are deposited on surfaces such as glaciers where they are preserved. Becky Alexander, an atmospheric scientist at the University of Washington, told GlacierHub, "we think that human activity dominates NOx emissions so we might be able to see a signal of that potentially in glaciers and ice cores. And because we have seen a decrease in concentrations in the atmosphere at least in cities, we might expect to see a [decrease] in nitrate concentrations [in glaciers]."

Many cities have also seen a reduction in air particle pollution, specifically PM 2.5—particulate matter released through emissions from industrial production, vehicles and fossil fuel burning (e.g. dust, ash and soot, black carbon). At the height of their lockdowns, Delhi, India had a 60 percent reduction in PM 2.5 and Los Angeles, California had a 31 percent reduction. According to Sierra-Hernandez and Paolo Gabrielli, a glaciologist at the Byrd Center, the reduction in particulate levels might be reflected in the ice deposits from this time.

However, there may be no single answer to what glacial records from the coronavirus pandemic will hold. Because glaciers capture atmospheric changes along specific air mass trajectories, glaciers in different regions might show distinct changes that reflect the varying lockdowns and emission sources around the world. Glaciers reflecting Chinese emissions might show a reduction in emissions from coal, whereas glaciers reflecting American emissions might reveal a reduction in

emissions from petroleum and other liquid fuels. "If we can study glaciers in Greenland, in Tibet, in the Himalayas, we will see those differences," said Sierra-Hernandez.

Glacial records have other limitations too. Despite a projected 4-7 percent global reduction in carbon dioxide emissions in 2020 compared to mean 2019 levels, glaciers will likely not hold evidence of this change. According to Alexander, "gases like CO_2 that are recorded in ice cores are smoothed a bit so the record represents an average over a period of time so you can't really get a snapshot." Despite the current greenhouse gas reductions, glacial records will still show a trend of rising carbon dioxide levels. Therefore, experts warn against hailing current emission reductions as significant, because, when averaged over time, they are not.



The dark band in this ice core from the West Antarctic Ice Sheet Divide is a layer of volcanic ash that settled on the ice sheet approximately 21,000 years ago. Credit: Heidi Roop, NSF

While scientists have offered educated guesses about what the ice cores could hold, much remains to be seen. Gabrielli told GlacierHub, "the coronavirus pandemic will be too short and any linked climatic change will be too small to be captured by ice cores." But he also pointed out there could be changes we might not be aware of, which "is the beauty of the ice as recorder of a multitude of environmental information."

Analyzing ice cores from the coronavirus pandemic could also unearth

new links between human activity and atmospheric processes. "We know a lot now, but there might be new discoveries," said Sierra-Hernandez, adding, "it will be interesting because now there are more satellite images, scientists studying directly atmospheric conditions, so we can do those comparisons with glaciers." By comparing direct observations of reductions in greenhouse gas emissions and particulate matter with glacial records from the pandemic, researchers in the future can test hypotheses about expected glacial signatures.

Furthermore, with isolated changes in human emissions, researchers can draw direct causal relationships between human emissions and atmospheric conditions. Alexander explained that there is currently some uncertainty about the effect of nitrates from human emissions of nitrogen oxides on nitrogen isotope concentrations in glacial ice. With a reduction in human emissions of nitrogen oxides from vehicles into the atmosphere during the pandemic, and a likely consequent reduction in nitrate concentrations in glacial ice, future scientists can determine how the nitrogen isotope concentration is affected. Examining the nitrogen isotope concentration over time could help scientists understand changes in the global nitrogen cycle, which affects human health and ecosystems.

Although glaciers are a treasure trove for climate scientists, some glaciers, especially in the tropics, are shrinking. According to Gabrielli, "ice melting is impacting massively the capability of glaciers to record current environmental and climate variations, in particular in glaciers at low altitude and low latitude (much less so in polar regions). Past ice core records are overprinted and even ablated by meltwater percolation through the firn [old snow] and the ice layers." As a result, glaciers' ability to serve humanity by providing ancient atmospheric data is already compromised and will continue to become increasingly limited unless there is significant action on climate change in the present and short-term future. But while glaciers exist, there is much we can learn from them.