Human-caused climate change played limited role in Beijing's 2013 'airpocalypse'

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Heavy air pollution has resulted in widespread smog. These photographs, taken in August 2005, show the variations in Beijing's air quality. Credit: Bobak Ha'Eri

In January 2013, a suffocating, poisonous haze hung over Beijing for four days. The record high levels of fine particulate matter in the air caused airports to close and thousands of coughing, choking citizens to seek hospital care.

Although the particulate matter that filled the winter skies resulted from both human and natural emissions, a new Northwestern University study concludes that human-caused climate change played only a minor role in the air's stagnation.

The study, which used computational simulations of climate, is one of the first to tie an air quality episode to human-caused climate change. This type of research is part of the growing subfield of climate science called "detection and attribution of extreme events," which assesses how human emission of greenhouse gases may have contributed to the occurrence and/or severity of a particularly impactful event.

"Typically, single event detection and attribution work is performed on 'charismatic' extreme weather events, such as hurricanes, heat waves and droughts. Here, we perform the analysis on something less glamorous—still air over Beijing," said Northwestern's Daniel Horton, the study's senior author. "Our work applies detection and attribution methods to a less glamorous yet highly impactful—particularly for public health—meteorological phenomenon."

The lingering haze—that was signature to Beijing's 2013 "airpocalypse" and other smog events—requires two factors: the emission of pollutants and still air that allows the pollutants to build. Beijing's coal-burning power plants and 5 million motor vehicles are responsible for much of the city's pollution. Horton and first author Christopher Callahan aimed to discover if human-caused climate change played a role in the meteorological conditions that led to the still air.

"Even though we found that climate change has not had a major influence on winter air quality over Beijing to date, this work adds some meteorological diversity to recent examinations of links between climate change and individual extreme events," said Callahan, a former undergraduate student in Horton's lab, who led the research.

The study will publish April 30 in the *Journal of Geophysical Research: Atmospheres*. Horton is an assistant professor of Earth and planetary sciences in Northwestern's Weinberg College of Arts and Sciences. Callahan is currently a Ph.D. candidate in geography at Dartmouth

College, where he studies climate modeling and impacts.

To explore the meteorological conditions underlying the airpocalypse, the team compared climate simulations: one set of model experiments included the current trend of human-caused climate change and one set as if human-made climate change did not exist. The researchers found that, in both scenarios, meteorological conditions conducive to poor air quality in Beijing still occurred.

The simulations did indicate, however, that if human-caused climate change continues along the same trend, it might lead to more extreme air quality events. Already, 4.2 million deaths worldwide are caused by air pollution, according to the World Health Organization. Many of these deaths result from pollution-related respiratory diseases, heart disease or stroke.

"We found that climate change was not the most important factor in shaping air quality during Beijing's past winters. Natural atmospheric fluctuations were conducive to air quality degradation," Callahan said. "However, we found a small human fingerprint that could increase into the future."

Even though human emission of greenhouse gases only played a minor role in Beijing's past poor winter air quality events, Callahan contends that humans can greatly improve air quality by cutting air pollutant emissions. Such reductions are often coincident with greenhouse gas reductions. Thus, not only would reductions help curtail global climate change, they also would have the added benefits of clean air and fewer pollution-related illnesses.

"Climate change mitigation, at its core, requires greenhouse gas emission reductions," he said. "If we can do that while also reducing pollutant emissions, it's a win-win."

More information: C.W. Callahan et al, Multi-index attribution of extreme winter air quality in Beijing, China, *Journal of Geophysical Research: Atmospheres* (2019). DOI: 10.1029/2018JD029738