COVID-19 lockdown highlights ozone chemistry in China

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In early 2020, daily life in Northern China slammed to a halt as the region entered a strict period of lockdown to slow the spread of COVID-19. Emissions from transportation and industry plummeted. Emissions of nitrogen oxides (NO_x) from fossil fuels fell by 60 to 70 percent.

And yet, environmental researchers noticed that ground-level ozone

pollution in Beijing and the Northern China Plain skyrocketed during this time period, despite the decrease of NO_x, a component of ozone.

The region is no stranger to severe ozone pollution but until about five years ago, most ozone events occurred during the summer. Recently, the ozone season in China has been getting longer, spreading into early spring and late winter. As it turns out, the COVID-19 lockdown can help explain why.

Researchers from the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) and the Nanjing University of Information Science & Technology (NUIST) have found that another component of ozone, volatile organic compounds (VOCs), may be to blame for the increase in winter ozone.

The research is published in the *Proceedings of the National Academy of Sciences* (*PNAS*).

"The COVID-19 lockdown was an involuntary experiment in which the emissions decreased abruptly and a lot of ozone appeared suddenly," said Daniel J. Jacob, the Vasco McCoy Family Professor of Atmospheric Chemistry and Environmental Engineering at SEAS and co-corresponding author of the paper.

Ozone is formed through a series of chemical reactions, starting with the oxidation of VOCs. This reaction forms chemical radicals, which drive reactions between NO_x and VOCs to produce ozone in the presence of sunlight. In a previous study, researchers from SEAS and NUIST found that in the summertime, particulate matter (PM2.5) acts like a sponge for the radicals needed to generate ozone pollution, sucking them up and preventing them from producing ozone.

In that paper, the researchers found that air pollution policies instituted

by the Chinese government that reduced PM2.5 were causing an increase in harmful ground-level ozone pollution, especially in large cities.

In this research, the team found that NO_x plays a similar role in the wintertime, scavenging radicals and preventing them from forming ozone. As NO_x levels decrease, either all of a sudden with lockdown or gradually with air pollution controls, there are more radicals available for VOCs to react with. This enhanced oxidation of VOCs by radicals would amplify by producing more radicals themselves, and this process optimizes the ozone production efficiency of NO_x.

"The COVID-19 experience helps explain the trend of increasing ozone pollution in the late winter and spring in China," said Ke Li, a postdoctoral fellow at SEAS and first author of the study. "As NO_x emissions have decreased, the ozone season in China is getting longer."

The research highlights the need to better understand the sources and species of VOCs and regulate their emissions.

"VOC emission controls would stop the spread of the ozone season and have major benefits on public health, crop production, and particulate pollution," said Hong Liao, Professor at NUIST and co-corresponding author of this work.

More information: Ke Li el al., "Ozone pollution in the North China Plain spreading into the late-winter haze season," *PNAS* (2021). www.pnas.org/cgi/doi/10.1073/pnas.2015797118

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