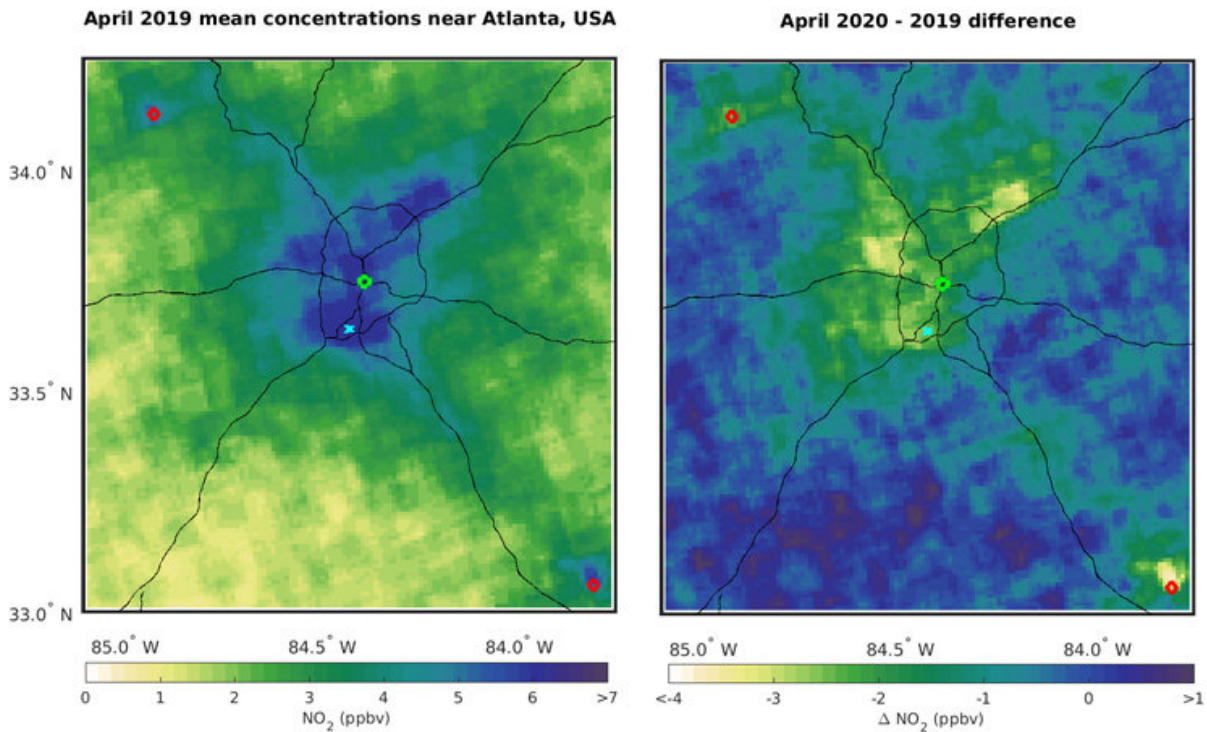# Lockdown drove pollution changes between—and even within—cities

January 19 2022, by Brandie Jefferson

April 2019 and 2020-2019 difference of inferred ground level nitrogen dioxide (NO_2) mixing ratio near Atlanta. The green circle represents downtown Atlanta, the red diamonds represent coal-burning power plants with capacities > 2000 MW. The blue "X" represents Hartsfield-Jackson International Airport. The black lines indicate major highways. Satellite-based estimates of air pollution allow us to observe the spatial distribution in a way that ground monitoring cannot. The figure shows 2019 NO_2 concentrations and the 2020-2019 difference around Atlanta. The population-weighted NO_2 concentration in Atlanta and the surrounding region dropped by 28% from April 2019 to 2020,

but with significant spatial variability in the observed change. The greatest NO_2 decreases are found near a large coal-powered electricity plant to the southeast of the city, with significant changes near another plant to the northwest (red diamonds). Decreases were also larger near the Hartsfield-Jackson International Airport (blue "X") and over suburban regions to the west and northeast of the city center, than in the downtown core (green circle). Credit: Martin Lab/WashU

During COVID-19 lockdowns, the internet was flooded with images from Delhi to Los Angeles, showing mountains typically hidden behind smog or clear blue skies where they were once gray.

People speculated that, because fewer people were driving, industry slowed and many airports were functionally closed, levels of pollution had dropped everywhere.

They had, depending on your vantage point.

Researchers from Washington University in St. Louis developed a method using satellite measurements that allowed them to determine levels of nitrogen dioxide—NO_2—on a scale never before accessible—even in areas where there are no monitoring capabilities on the ground. NO_2 is a key contributor to the smog associated with bad traffic or areas of intense industry.

Developed in the lab of Randall Martin, the Raymond R. Tucker Distinguished Professor in the Department of Energy, Environmental & Chemical Engineering, the method allows researchers to infer levels of NO_2 in regions as small as a neighborhood.

When they used it to compare levels of NO_2 before and during COVID-19-related lockdowns across the globe, they found that,

although there was a [significant decrease](#) in NO_2 worldwide in areas under lockdown, there were also striking discrepancies on smaller scales.

The results were published Jan. 19 in the journal *Nature*.

"We can determine differences, not just from city to city, but within cities we were seeing interesting differences in levels of NO_2," said Matt Cooper, first author of the study. "Changes within cities weren't uniform; some areas saw a larger decrease than others."

Prior to the COVID-19-related lockdowns, Cooper had been working on ways to improve the detection of NO_2 in the atmosphere using a new satellite technology. Then the pandemic hit.

'Interesting test case'

"It was an interesting test case for the new method," Cooper said. "And there was plenty of interest in air quality, which seemed to be improving."

Cooper was able to improve on methods that use modeling, satellites and ground-monitoring data to infer surface-level amounts of NO_2 on any point on the globe. This new method makes better use of the finer-resolution satellite data, enabling researchers to determine levels of NO_2 on a scale of about one kilometer.

Understanding levels of NO_2 is important for a better understanding of human health. The chemical is one of the primary air pollutants, and it is a precursor to the creation of fine particulate matter. High exposure to NO_2 is associated with a variety of health problems, mainly respiratory in nature, as well as a higher risk of mortality, overall.

Because it is primarily formed by burning fuel, researchers suggested the

COVID-related lockdowns might lead to decreases in NO_2. They did. Significantly.

Taking into account the variations expected by weather trends, and the fact that emissions have been generally decreasing over the past several years due to technological improvements, the researchers were able to infer decreases in surface-level NO_2 were almost 30% larger in countries with strict lockdowns versus those without.

Overall, Martin said, "The global decrease during lockdowns was comparable to 15 years of annual reductions from emission controls."

When they took a closer look, however, researchers found that the decreases were not evenly distributed. "We see very striking spatial variation," Cooper said. "Find any city and you'll see a signal."

Take Atlanta, for one. Accounting for population, the concentration of NO_2 decreased by 28% across the metro area between April 2019 and April 2020. But there is a lot of variation represented within that average rate.

For example, more than 1.2 million people in the region saw a more than 40% decrease in NO_2 levels. However, nearly 1 million people experienced decreases of only 10% or less. Changes were generally larger for those living near coal-powered plants or the airport than in the downtown core.

Or Paris. More than 1 million people in the Paris metropolitan area saw a decrease in NO_2 of 75% or more, while other metro areas saw a decrease in NO_2 of 23% or less.

The benefits to this finer resolution go beyond identifying the unequal burden of pollution between neighbors. It also can help researchers

better infer pollution levels in areas where there is no other way to determine levels of NO_2. A significant part of the world does not have sufficient—or any—ground monitoring of pollutants.

Of the 215 cities the researchers investigated, 68 had no previous ground-monitoring data. Most of those cities, the researchers noted, were in lower-income countries in Africa and Southeast Asia. The average gross national income per capita for these unmonitored cities was $7,000. That's in comparison with $25,000 for cities in countries with reliable ground monitoring.

"Although lower-income countries are less likely to have local air quality monitoring," Cooper said, "large lockdown-driven changes in exposure to NO_2 occurred regardless."

More information: Matthew Cooper, Global fine-scale changes in ambient NO2 during COVID-19 lockdowns, *Nature* (2022). [DOI: 10.1038/s41586-021-04229-0](). [www.nature.com/articles/s41586-021-04229-0]()

Provided by Washington University in St. Louis