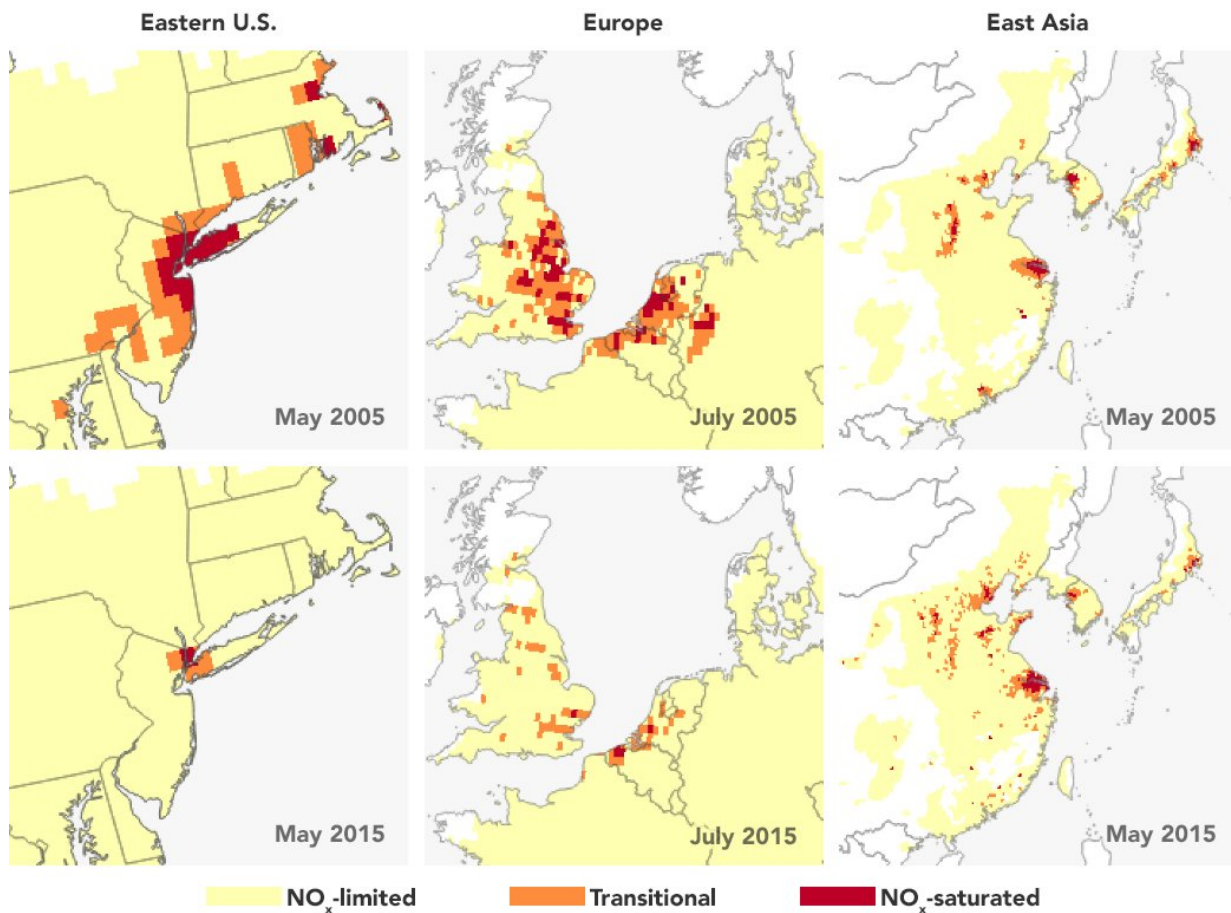


NASA satellite tracks ozone pollution by monitoring its key ingredients

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The top row of images show each region in 2005, which had abundant NO_x in urban areas where human emissions are high, leading to systems where ozone formation was controlled by VOC amounts. As pollution controls were put into place on NO_x emissions, by 2015, the systems in Europe, the United States, and East Asian urban areas became limited by NO_x, meaning that further controls on

NO_x would help reduce ozone formation. With the industrial growth of the last decade, the results in China outside the major cities show an increase in areas transitioning to being controlled by VOC amounts. Credit: NASA

Ozone pollution near Earth's surface is one of the main ingredients of summertime smog. It is also not directly measurable from space due to the abundance of ozone higher in the atmosphere, which obscures measurements of surface ozone. New NASA-funded research has devised a way to use satellite measurements of the precursor gases that contribute to ozone formation to differentiate among three different sets of conditions that lead to its production. These observations may also assist air quality managers in assessing the most effective approaches to emission reduction programs that will improve air quality.

Unlike its presence at high altitude where ozone acts as Earth's sunscreen from harmful ultraviolet radiation, at low altitudes, ozone is a health hazard contributing to respiratory problems like asthma and bronchitis. It is formed through complex chemical reactions initiated by sunlight and involving two types of gases, [volatile organic compounds](#) (VOC) and nitrogen oxides (NO_x). Both are represented in the study by a major gas of each type, the VOC formaldehyde and NO₂, that are measurable from space by the Dutch-Finnish Ozone Monitoring Instrument aboard NASA's Aura satellite, launched in 2004.

"We're using satellite data to analyze the chemistry of ozone from space," said lead author Xiaomeng Jin at the Lamont-Doherty Earth Observatory at Columbia University in Palisades, New York. Their research was published in *Journal of Geophysical Research: Atmospheres*, a publication of the American Geophysical Union.

With a combination of computer models and space-based observations,

she and her colleagues used the concentrations of ozone's precursor molecules to infer whether ozone production increases more in the presence of NO_x, VOCs, or a mix of the two, for a given location. Their study regions focused on North America, Europe and East Asia during the summer months, when abundant sunlight triggers the highest rates of ozone formation. To understand their impact on ozone formation, Jin and her team investigated whether VOC or NO_x was the ingredient that most limited ozone formation. If emissions of that molecule are reduced, then ozone formation will be reduced—critical information for [air quality](#) managers.

"We are asking, 'If I could reduce either VOCs or NO_x, which one is going to get me the biggest bang for my buck in terms of the amount of ozone that we can prevent from being formed in the lower atmosphere?'" said co-author and atmospheric chemist Arlene Fiore at Lamont-Doherty, who is also a member of NASA's Health and Air Quality Applied Sciences Team that partially funded this work and fosters collaboration between scientists and air quality managers.

The findings show that cities in North America, Europe and East Asia, are more often VOC-limited or in a transitional state between VOC and NO_x-limited. In addition, the 12-year data record of satellite observations show that a location's circumstances can change. For instance, in 2005 New York City's ozone production during the warm season was limited by VOCs, but by 2015 it had transitioned to a NO_x-limited system due to reduced NO_x emissions resulting from controls put into place at both regional and national levels. This transition means that future NO_x reductions will likely further decrease [ozone production](#), said Jin.

Volatile organic compounds occur in high volume naturally, given off by some plants, including certain tree species. They can also arise from paint fumes, cleaning products, and pesticides, and are a by-product of

[burning fossil fuels](#) in factories and automobiles. Nitrogen oxides are a byproduct of burning fossil fuels and are abundant in cities, produced by power plants, factories, and cars. Because VOCs have a large natural source during summer over the eastern United States, for example, emission reduction plans over the last two decades in this region have focused on NO_x, which is overwhelmingly produced by human activities.

Space-based methods for monitoring [ozone](#) chemistry complement surface-based measurements made by air quality management agencies. The view from space offers consistent coverage of broad areas, and provides data for regions that may not have ground stations.

Provided by NASA's Goddard Space Flight Center

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