Soil emissions are much-bigger-than-expected component of air pollution

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Nitrogen oxides produced by huge fires and fossil fuel combustion are a major component of air pollution. They are the primary ingredients in ground-level ozone, a pollutant harmful to human health and vegetation. But new research led by a University of Washington atmospheric scientist shows that, in some regions, nitrogen oxides emitted by the soil are much greater than expected and could play a substantially larger role in seasonal air pollution than previously believed.

Nitrogen oxide emissions total more than 40 million metric tons worldwide each year, with 64 percent coming from fossil fuel combustion, 14 percent from burning and a surprising 22 percent from soil, said Lyatt JaeglÃ©, a UW assistant professor of atmospheric sciences. The new research shows that the component from soil is about 70 percent greater than scientists expected.

Instead of relying on scattered ground-based measurements of burning and combustion and then extrapolating a global total for nitrogen oxide emissions, the new work used actual observations recorded in 2000 by the Global Ozone Monitoring Experiment aboard the European Space Agency's European Remote Sensing 2 satellite.

Nitrogen oxide emissions from fossil fuel combustion are most closely linked to major population centers and show up in the satellite's ozone-monitoring measurements of nitrogen dioxide, part of the nitrogen oxides family. Other satellite instruments can detect large fires and the resulting emissions also can be measured by the ozone-monitoring

experiment, JaeglÃ© said.

But the satellite also picks up other nitrogen oxide signals not attributable to fuel combustion or burning, and those emissions must come from soil, JaeglÃ© said.

"We were really amazed that we could see it from space, but because the pulse is so big the satellite can see it," she said.

Soil emissions are seen primarily in equatorial Africa at the beginning of the rainy season, especially in a region called the Sahel, and in the mid-latitudes of the Northern Hemisphere during summer. When the rains come to the Sahel after a six-month dry season, dormant soil bacteria reawaken and begin processing nitrogen. The satellite then detects a sudden pulse of nitrogen oxides, JaeglÃ© said. Similarly, emissions in the mid-latitudes of the Northern Hemisphere spike during the growing season, spurred by warmer temperatures after a cold winter, but also perhaps magnified by fertilizer use.

"The soil emissions were much larger than we expected," she said. "The biggest areas were the dry topical regions like the Sahel, and in the mid-latitude regions where there is a lot of agriculture."

During summer in North America, Europe and Asia, nitrogen oxides emitted from soil can reach half the emissions from fossil fuel combustion.

"And this is at a time when there are already problems with air pollution," JaeglÃ© said.

Nitrogen oxides comprise a group of highly reactive gases containing nitrogen and oxygen in varying amounts. Besides producing ozone smog, they help form the dirty brown clouds that often hang over major cities,

they contribute to acid rain and they play a role in global climate change.

In addition to equatorial Africa, hot spots for soil emissions include the central plains of the United States; southwestern Europe, primarily the Iberian Peninsula; much of India; and the northern plains of Asia, she said. All of those areas are highly agricultural.

The new research was published in May in Faraday Discussions, a journal of England's Royal Society of Chemistry. Co-authors are Linda Steinberger of the UW; Randall Martin of Dalhousie University in Halifax, Nova Scotia; and Kelly Chance of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. The work was funded by the National Aeronautics and Space Administration's New Investigator Program in Earth Science.

JaeglÃ© noted that agricultural activity is likely to increase in the future, bringing more fertilizer use. As a result, there could also be even greater soil emissions of nitrogen oxides.

"We don't know how emissions will change, but we now have a way to monitor them from space," she said.

Source: University of Washington