New national standard drives cutting edge research in characterizing ground-level ozone

By Olivia Sanderfoot
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Ozone — a substance composing less than 0.0001% of the atmosphere by volume — was the focus of much debate in 2015. In October, the Environmental Protection Agency (EPA) lowered the ozone National Ambient Air Quality Standard (NAAQS) by 5 parts per billion (ppb), from 75 ppb to 70 ppb. Complying with this new standard may prove challenging for many states, several of which are still struggling to meet the earlier standard set in 2008. Understanding the sources of ground-level ozone is a key first step to designing and implementing effective air pollution regulation. To characterize ground-level ozone, researchers are turning to resources provided by the National Aeronautics and Space Administration (NASA).

Ozone forms when precursor species — nitrogen oxides and volatile organic compounds (VOCs) — react in sunlight. Nitrogen oxides are emitted upon combustion of fossil fuels, and VOCs are often produced during chemical or industrial processes. However, human activities are not the only source of ozone. Naturally occurring ozone can enter the air we breathe from the stratosphere. Some is also produced from VOCs emitted by vegetation. To complicate the story further, ozone may be blown hundreds of miles, across international borders, both into and out of the United States. This “foreign” ozone is consequently beyond the control of domestic policy, posing a challenge to regulators.

Quantifying this “background ozone” presents a number of interesting research questions. As global issues, these questions are a good fit with the earth science tools — including satellites, suborbital data, and models — used by the NASA Air Quality Applied Sciences Team (AQAST). Recognizing the need to quantify background ozone, AQAST scientists have teamed up with air quality managers across the country to investigate how naturally occurring ozone and ozone from foreign sources may contribute to total ambient ozone concentrations.

So far, the results have surprised scientists. AQAST researchers Daniel Jacob, Arlene Fiore, and Meiyun Lin recently used regional and global modeling of satellite data obtained from several NASA instruments, including the Tropospheric Emission Spectrometer (TES) and the Ozone Monitoring Instrument (OMI), to estimate the contribution of background ozone to total ozone concentrations across the United States. They found that background ozone alone could add up to as much as 60 to 70 ppb to total concentrations at high-elevation sites in the western U.S. under certain meteorological conditions. However, background ozone is far less important in most other regions and contexts, especially at low-elevation sites and more populated urban centers in the eastern U.S.

Key findings from Dr. Fiore’s work were included in the EPA’s 2013 Integrated Science Assessment and 2014 Policy Assessment — two important documents that provided justification for the EPA’s recommendation to lower the NAAQS.

“We have leveraged a lot of Arlene [Fiore]’s work in characterizing background ozone,” EPA scientist Pat Dolwick said in a recent article. “Her work has been incorporated in several of our scientific and technical support documents for the proposed ozone standard revisions.”

Work from AQAST members Greg Carmichael, Daven Henze, and Min Huang along with other colleagues has also furthered the air quality management community’s understanding of background

ozone. Using observations from TES and OMI, Carmichael and Henze were able to constrain estimates of background ozone. Their work, published in the *Journal of Geophysical Research*, emphasizes the value of NASA satellite data and modeling tools in the scientific study of Earth.

Reducing ambient concentrations of ozone is an important public health measure. High concentrations of ozone cause respiratory damage and have been linked to premature mortality. AQAST members hope the results of their research will not only help air quality managers design and implement effective emission reduction strategies to lower ozone concentrations, but also support states with areas subject to high levels of background ozone in explaining and communicating the obstacles they face in meeting the new ozone standard.

Ground-level ozone may make up just a tiny fraction of the air we breathe, but it's certainly giving us a lot to talk about. To learn more about the EPA's revision of the ozone standard, please visit their website.

While volatile organic compounds (VOCs) are produced during chemical or industrial processes, natural VOC emissions from vegetation also play a role in ozone formation. Credit: Olivia Sanderfoot.

Intercontinental transport of ozone poses a major challenge to regulators. The United States is primarily subject to ozone transport from Asia. Credit: Wikimedia Commons.

Dr. Arlene Fiore presents her research on background ozone at the 2015 Energy Summit in Madison, WI. Credit: Wisconsin Energy Institute.