Forecasting and explaining bad air days in Utah's oil and gas fields

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To accurately forecast wintertime bad air days in Utah's Uintah Basin, researchers must use real atmospheric measurements to estimate chemical emissions from nearby oil and natural gas fields, a new study in Atmospheric Chemistry and Physics has found.

When a team of researchers, including those from the Cooperative Institute for Research in Environmental Sciences (CIRES) and the National Oceanic and Atmospheric Administration (NOAA), fed an air quality model with emissions estimated instead from national and state inventories, they couldn't reproduce those bad air days

"We can accurately simulate these events," says Stuart McKeen, a CIRES scientist working at NOAA's Earth System Research Laboratory in Boulder. "The bottom line is how important it is to use air measurements to get these emissions estimates right."

CIRES is a joint institute of NOAA and the University of Colorado Boulder.

At ground level, ozone is a major pollutant, affecting human health and vegetation. Typically, ozone pollution is a summertime problem in urban and suburban areas, occurring when sunlight-triggered chemical reactions cook up ozone from nitrogen oxides (NOx) and volatile organic compounds (VOCs). Federal health-based standards currently limit ozone to 75 parts per billion (ppb), averaged over 8 hours. The Environmental Protection Agency has proposed tightening that limit to

70 or 65 ppb.

But in the Uintah (also called Uinta) Basin, wintertime ozone levels spiked as high as 160 parts per billion, measured during a field campaign in 2013. By comparison, during the relatively warmer winter of 2012, ozone levels were far lower.

The researchers already knew a great deal about what causes the wintertime high-ozone episodes. They occur in low-lying geographic basins, common in the western United States, near oil and gas fields, when it's very cold and clear with widespread snow cover. Those conditions trap cold air—including gases released from oil and gas operations—at the Earth's surface. Sunlight passes through the trapped gases and reflects off bright snow back into the atmosphere, triggering ozone production. The snow cover also prevents the ozone from being destroyed by the ground, keeping levels high.

The researchers tried to reproduce these high wintertime ozone pollution events using an air quality model (Weather Research and Forecasting with Chemistry, or WRF-Chem) that incorporates meteorological conditions, emissions data, and ozone chemistry. Unlike other studies, this one used the WRF-Chem model to accurately forecast the very stagnant weather conditions important in wintertime ozone formation, as well as to quantify other, more subtle meteorological and chemical processes.

The researchers used two sets of emissions data in their model runs. The first came from the latest EPA inventory for the region, released in 2013. That inventory used emissions estimates from the state of Utah and the Western Regional Air Partnership. The second data set was based on the research team's own measurements of methane, nitrogen oxides, and VOCs taken onsite during the winters of 2012 and 2013.

When the researchers plugged the EPA emissions data into the model, they couldn't reproduce the bad air days. When they used their own measurements of NOx, VOCs and methane from the Uintah Basin site, they could. The study also showed that EPA emissions inventories underestimated levels of methane, an important greenhouse gas, and levels of ozone precursors.

What this means, says the study's lead author and CIRES scientist Ravan Ahmadov, is that "with a top-down approach that uses ambient measurements, we have a more accurate representation of what's going on." In addition, Ahmadov says, "we need synergy between research communities, the EPA, and states in using top-down emissions estimates to improve the emissions inventories, especially for the oil and gas sector in the United States, which is changing rapidly."

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