Study first to quantify impact of oil and gas emissions on Denver's ozone problem

August 8 2016

Instrumented NASA P-3 aircraft flies by the Boulder Atmospheric Observatory during a field campaign in summer 2014. Credit: Will von Dauster/ NOAA

The first peer-reviewed study to directly quantify how emissions from oil and gas activities influence summertime ozone pollution in the Colorado Front Range confirms that chemical vapors from oil and gas activities are a significant contributor to the region's chronic ozone problem.

Summertime ozone pollution levels in the northern Front Range periodically spike above 70 parts per billion (ppb), which is considered unhealthy—on average, 17 ppb of that ozone is produced locally. The new research, published in the *Journal of Geophysical Research: Atmospheres*, shows that oil and gas emissions contribute an average of 3 ppb of the locally produced ozone daily, and potentially more than that on high-ozone days.

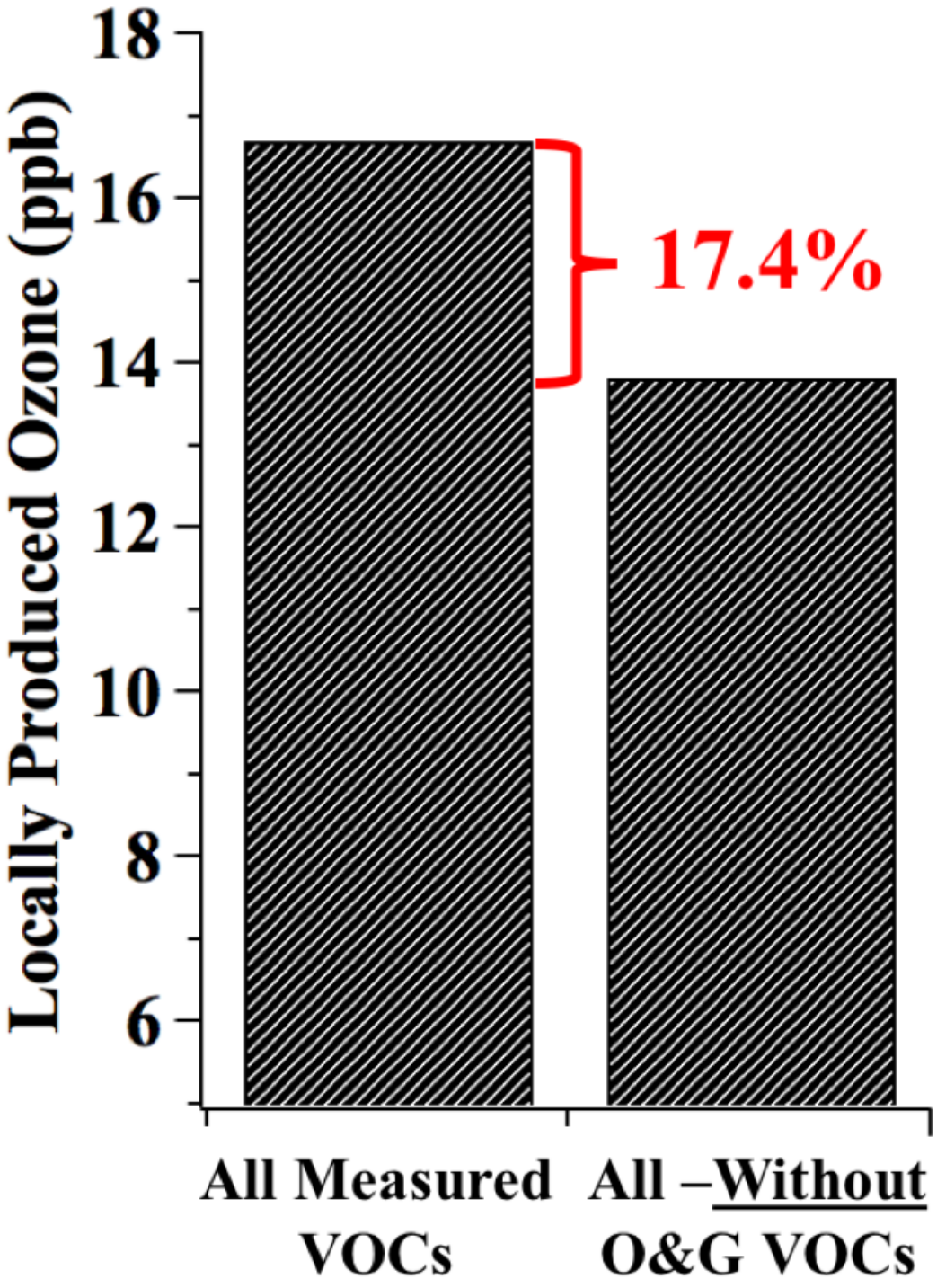
"By combining nearly 50,000, high-precision measurements of VOCs in Colorado's Front Range with an equally detailed model, we've been able to parse out the role of oil and gas," said Erin McDuffie, the study's lead author and a scientist at the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado Boulder, working in the NOAA Earth System Research Laboratory. "We expect this technique to help us better understand what factors are contributing to air quality challenges elsewhere in the West."

Ozone pollution—which can harm people's lungs and damage crops—is produced when sunlight sparks reactions between volatile organic compounds (VOCs) and nitrogen oxides (NOx). In cities like Denver, NOx comes primarily from vehicle tailpipes. VOCs can come from both natural sources like trees and anthropogenic ones, like oil and gas

activities.

Colorado's northern Front Range was an interesting location for this study for a number of reasons, the researchers said. First, it contains the major city of Denver as well as active oil and gas regions to the northeast. "This area is unique, with high concentrations of both nitrogen oxides from urban areas and VOCs from oil and gas. That allows us to look at how oil and gas emissions are influencing ozone production," said McDuffie.

Second, the region already has a high natural background of ozone—and that means there's less room between the background levels and the Environmental Protection Agency standard. The researchers determined that on an average summer day, about 58 ppb of ozone present in air above the surface is from regional background sources or residual ozone produced locally during previous days. Mixing of this ozone to the surface during the day leaves very little room for local production before hitting health-based ozone standards.



Modeled locally produced ozone as a result of all measured vocs and all minus vocs from oil and gas activity. Both scenarios were simulated with measured

amounts of nox. Credit: University of Colorado at Boulder

Third, compared to other parts of the country, the plains of Colorado's Front Range have low levels of VOCs from natural sources during daytime hours when ozone forms—making the region potentially more sensitive to any oil and gas VOC emissions entering the air.

The northern Front Range has seen a big boom in oil and gas activity in recent years: The number of active wells in central Colorado's Wattenberg gas field nearly doubled to over 27,000 between 2008 and 2015, according to state data. Colorado's Air Pollution Control Division experts use a model to identify the sources of ozone formation at various monitoring locations on various days. Considering all sources of emissions, they find that in the Northern Front Range area, the oil and gas sector can be a significant source of VOCs for ozone pollution formation, depending on meteorology and transport.

Colorado has been out of compliance with federal ozone standard since 2007. Last year, the EPA tightened the standard from 75 ppb to 70 ppb.

This study used measurements of ozone and its precursors—NOx and VOCs—made during field campaigns in the summers of 2012 and 2014 at the Boulder Atmospheric Observatory (BAO), a tall tower built specifically for atmospheric research, owned and operated by NOAA. To precisely quantify the contributions of oil and gas air to local ozone production , McDuffie used a custom model that included more than 15,000 chemical reactions.

She and her colleagues found that the VOCs from oil and gas contribute an average of 17 percent to local, chemically produced ozone during the summer. "Seventeen percent is small but potentially still significant,"

said Steven Brown, co-author and scientist at the NOAA Earth System Research Laboratory. "

He and his colleagues said they'd like to explore how oil and gas emissions may affect the number of days that ozone is above the standard; this study could not quantify that. And they'd also like to see followup work at a series of coordinated ground sites—for example, between Denver and Fort Collins to the north—to capture what's going on in different places across the region. And the team would like to use this new technique in other places in the U.S West, to analyze the various sources that contribute to ozone pollution there.

Provided by University of Colorado at Boulder