Oil and gas emissions a major contributor to bad ozone days

November 6 2017, by Karin Vergoth

Credit: University of Colorado at Boulder

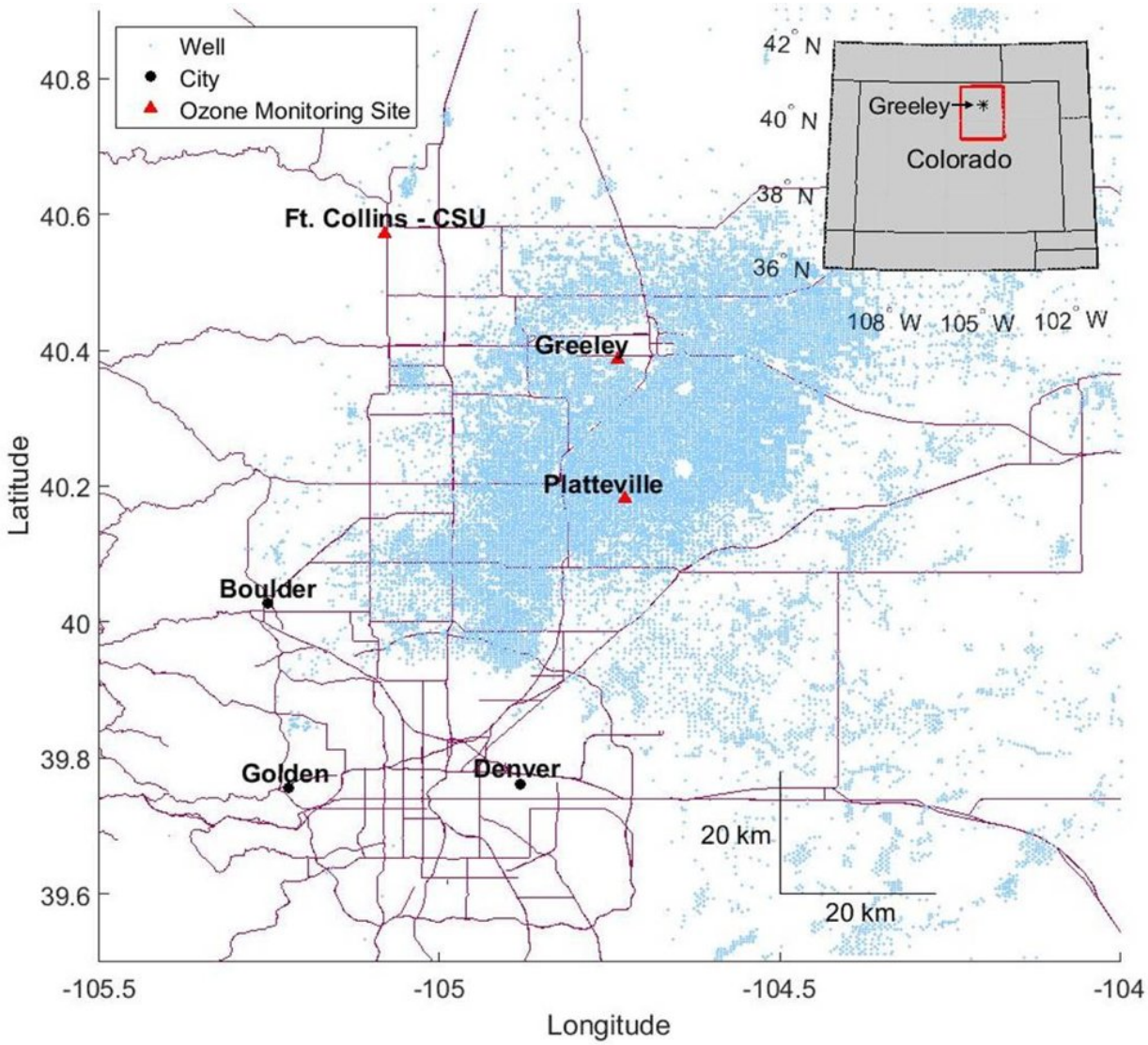
On certain days in 2014, oil and gas emissions made a big contribution to high summertime ozone levels in northeastern Colorado, according a new study led by CIRES and NOAA researchers. High concentrations of summertime ozone in the northern Front Range of Colorado aren't limited to the urban Denver area. High ozone levels were also observed in rural areas where oil and gas activity was the primary source of ozone precursors, the study found.

"If conditions are right, emissions from oil and gas can contribute up to 20-30 parts per billion (ppb) on bad ozone days and could lead to exceedances of the Environmental Protection Agency (EPA) standards,"

said Lucy Cheadle, who led the work as a research associate in the Cooperative Institute for Research in Environmental Sciences at the University of Colorado Boulder working in the NOAA Earth System Research Laboratory. The paper is published in the journal *Elementa: Science of the Anthropocene*.

Summertime ozone is a problem in Colorado's northern Front Range, where concentrations periodically exceed the current 75 ppb health standard (met when the fourth-highest maximum daily 8-hour average, averaged over three years, is less than or equal to 75 ppb). Maximum summertime ozone in Denver has increased slightly in recent decades, in contrast with many locations in the eastern United States, where maximum summertime ozone has decreased significantly in response to emissions reductions.

One reason oil and gas emissions in northeastern Colorado can sometimes push ozone levels over the EPA standard is that underlying background ozone levels there are only approximately 20 ppb below the 75 ppb standard, according to the study's calculations. In this study, the researchers estimated that on an average summer day in Colorado's northern Front Range, about 45-55 ppb of ozone present in air above the surface is from regional background sources or residual ozone produced locally during previous days. That starting point leaves very little room for local ozone production before levels hit the health-based standard.



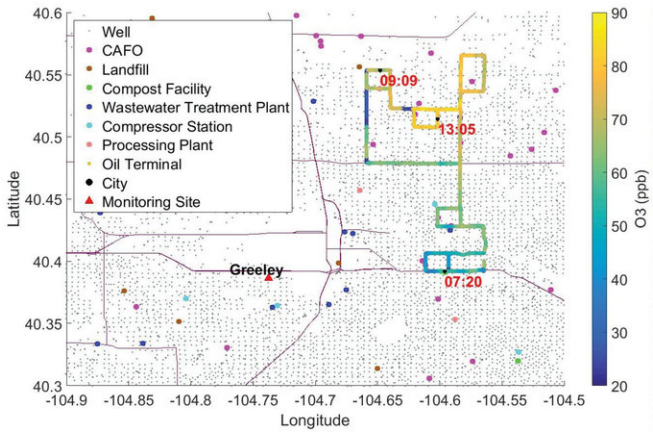
Map of the Wattenberg oil and gas field in northern Colorado. Light blue dots indicate wells present during summer 2014. Credit: University of Colorado at Boulder

For this study, the researchers used data collected during the summer of 2014, when intensive measurements of the region's atmosphere took place. Researchers from a number of institutions including NOAA, NCAR, NASA, Aerodyne, Colorado Department of Public Health and

Environment, CU Boulder, and UC Irvine made measurements by aircraft, balloons, mobile laboratories, and other ground-based facilities to characterize emissions from many possible sources—including oil and gas activities, motor vehicles, power plants, industrial activities, agriculture, wildfires, and transported pollution.

Cheadle and her colleagues focused on three days (July 23, August 3, and August 13) when a mobile laboratory measured pollutants near Greeley, Colorado, in the Wattenberg oil and gas field northeast of Denver. For each day, the researchers dissected the relative roles of oil and gas activities, agriculture, and other factors on ozone levels. They did this by looking at concentrations of several of gases measured along with ozone—including methane, ethane, carbon monoxide, nitrous oxide—that are used to identify different sources of ozone precursors.

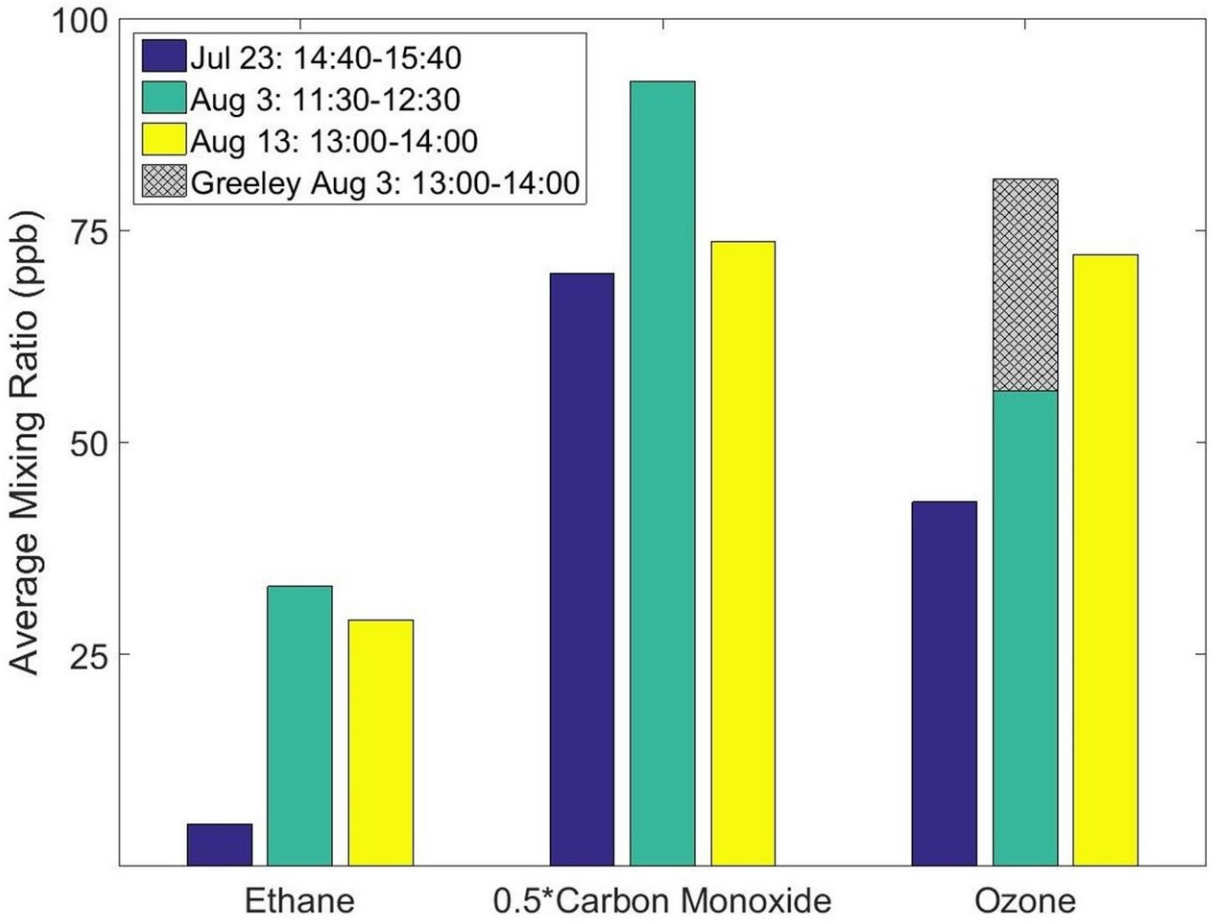
Overall, the researchers found a large influence of oil and gas emissions on ozone formation in the study area, along with some influence of urban emissions. On July 23, ozone levels were lower than on the other two days, providing researchers a baseline, or low emissions, case. On both August 3 and August 13, ozone levels were much higher: 30 ppb or more above concentrations on "average" ozone days, or days with limited local ozone production, according the study.



Left: Map of ozone measured during the mobile laboratory drive on August 13, 2014 northeast of Greeley, Colorado. Times (in red) show the location of the mobile laboratory. Ozone measured during this drive was elevated 20-30 ppb above median levels on limited production days and was approximately 75-80 ppb from 13:00-13:45. Right: The Aerodyne Mobile Lab. Credit: University of Colorado at Boulder

"All of our case studies showed the potential influence of emissions from oil and gas activities on ozone production, but August 13 showed the clearest evidence," said Cheadle. "On that day, other ozone precursor emission sources were low, and oil and gas was the primary emissions source present and the main contributor to high ozone production."

These results are significant because exceedances of EPA standards are based on single days and not overall enhancement averaged over multiple days. "The high ozone levels we observed on days when oil and gas activity was a primary contributor underscore the importance of better quantifying the contribution from oil and gas operations," Cheadle said. "That understanding could support strategies aimed at keeping the region within ozone limits."



Average ethane, carbon monoxide (CO), and ozone measured by the mobile laboratory in the northern Front Range during the three case study drives. August 3 showed more influence of urban emissions (indicated by high CO levels), but also oil and gas emissions (high ethane levels), on ozone production. Average ozone at the Greeley site is included to estimate peak ozone in the drive area on August 3. August 13 was A HIGH OZONE DAY, with the major contribution from oil and gas emissions (ethane levels well above regional background) along with low urban emissions (CO levels). Credit: University of Colorado at Boulder

More information: L. C. Cheadle et al. Surface ozone in the Colorado northern Front Range and the influence of oil and gas development

during FRAPPE/DISCOVER-AQ in summer 2014, *Elem Sci Anth* (2017). DOI: 10.1525/elementa.254

Provided by University of Colorado at Boulder