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Interactive comment on "Decadal Trends and Variability in Intermountain West Surface Ozone near Oil and Gas Extraction Fields" *by* Ying Zhou et al.

Anonymous Referee #1

Received and published: 18 April 2019

The authors have correctly identified a need to examine long-term ozone records in the Intermountain West to determine if oil and natural gas extraction (O&NG) is having an impact on ozone. However, this paper is overly ambitious and attempts to explore a wide range of potential influences on ozone at 13 rural sites across the Intermountain West. The result is not convincing at all, as the analyses do not have the depth required to understand the observed ozone variability. My recommendation to the editor is that the paper be rejected on the grounds that the conclusions cannot be supported by the thin evidence provided. I encourage the authors to pursue the general theme of the paper but to focus on just one or two sites and conduct a very thorough and in-depth analysis of the transport, weather and emissions influences on the interannual

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variability and trends of ozone. Once the methodology has been developed for one or two sites then the authors could produce a follow-up paper that applies the methods to all 13 sites.

The authors have chosen the annual 4th highest MDA8 ozone value (A4DM8HA) as the metric to explore ozone trends at the rural sites and they then attempt to understand the factors that affect the trends. While A4DM8HA is of interest because it is directly relevant to the NAAQS for ozone, it's not a good metric for understanding processes. This is because the 4th highest value is just one daily measurement per year and it can be influenced by regional scale pollution, long range transport (urban or forest fire plumes) and by stratospheric intrusions. To try to understand the trend in 10 values (one value per year) in the face of such high variability just isn't feasible. I illustrate this limitation by considering the 2005-2015 trend at Mesa Verde National Park (MEVE) in southwestern Colorado. The negative trend in the A4DM8HA at MEVE is largely driven by the very high value in 2005. This trend is a major motivation for the paper but the authors provide no detailed analysis to explore the causes of this trend or to even describe the transport and weather conditions associated with the high ozone events at MEVE. For example, I went to the TOAR database (https://join.fz-juelich.de/access/db/) and very quickly plotted the MDA8 ozone values for every day at MEVE. In 2005 there was a 4-day period in July with ozone over 70 ppbv. It would be very easy to conduct a focused transport analysis of this period to see if ozone precursors were transported from O&NG regions. But the 4th highest value for this year actually occurred on May 16 (76 ppb). What was the cause of this springtime peak? Was it due to O&NG, or was it a stratospheric intrusion? Similarly in 2006 the 4th highest value occurred on May 11. Given that this site experiences high ozone events in spring and summer, with the potential for very different processes controlling these events, the authors should focus their attention on specifically analyzing the situations for each A4DM8HA event in each year. I think they will find that this metric is too erratic for use as an indicator of O&NG emissions from basins that are nearly 100 km away. A better method would be to study the transport, weather and emissions associated with the 20 highest events at MEVE

each year (roughly the 95th percentile) to then see if O&NG has a clear association to ozone pollution events at this site. There are 8 additional ozone monitors surrounding Mesa Verde, some in remote areas and others in the oil and gas extraction regions, all available from the TOAR database. Data from these sites can be used to help determine if MEVE is affected by O&NG.

Other comments:

The opening sentence is almost a verbatim copy of the opening sentence from Cooper et al. [2014]: This work:

“Tropospheric ozone (O3) is a short-lived trace gas that either originates naturally from the stratosphere (Stohl et al., 2003) or is produced in situ by photochemical oxidation of nitrogen oxides (NOx) and volatile organic compounds (VOCs) or carbon monoxide (CO) (e.g., Monks et al., 2009).”

Cooper et al. [2014]: “Tropospheric ozone is a short-lived trace gas that either originates naturally in the stratosphere (Junge, 1962; Danielsen, 1968; Stohl et al., 2003) or is produced in situ by photochemical reactions involving sunlight and ozone precursor gases including nitrogen oxides (NOx) and non-methane volatile organic compounds, methane (CH4) or carbon monoxide (The Royal Society, 2008; Monks et al., 2009).”

Cooper, O. R., D. D. Parrish, J. Ziemke, N. V. Balashov, M. Cupeiro, I. E. Galbally, S. Gilge, L. Horowitz, N. R. Jensen, J.-F. Lamarque, V. Naik, S. J. Oltmans, J. Schwab, D. T. Shindell, A. M. Thompson, V. Thouret, Y. Wang, R. M. Zbinden (2014), Global distribution and trends of tropospheric ozone: An observation-based review, Elem Sci Anth, 2:29, DOI: http://doi.org/10.12952/journal.elementa.000029

Line 515 “This study is the first one to investigate the long term impact of O&NG extraction activities on the distribution and trend of surface O3 over the intermountain U.S. “ This statement is not entirely true as Bien and Helmig recently explored ozone trends across Colorado to look for an impact from oil and gas emissions.

Bien, T. and Helmig, D., 2018. Changes in summertime ozone in Colorado during 2000–2015. Elem Sci Anth, 6(1), p.55. DOI: http://doi.org/10.1525/elementa.300

Line 66 “Thus, long range transport from Asia and stratospheric intrusion may not be the sole contributors to the observed increasing trends in western U.S.” The latest update on rural ozone trends across the western USA shows that since the year 2000, ozone has begun to decrease in summer [Jaffe et al., 2018].

Jaffe, D. A., et al. (2018), Scientific assessment of background ozone over the U.S.: Implications for air quality management, Elem. Sci. Anth., 6(1):56, DOI: http://doi.org/10.1525/elementa.309

Line 92 Here the authors state that 6 sites in Gaudel et al [2018] show increasing ozone in winter in the inter-mountain west. But it’s not clear which sites they are talking about or how they define the intermountain west. I count more than 6 sites in Gaudel et al. with increasing ozone.

Line 199 These science questions are in the wrong place and they need to appear at the end of the Introduction as the motivation for this study.

Some other recent paper that explore the impact of O&NG on ozone are:

Oltmans, S.J., Cheadle, L.C., Johnson, B.J., Schnell, R.C., Helmig, D., Thompson, A.M., Cullis, P., Hall, E., Jordan, A., Sterling, C., McClure-Begley, A., Sullivan, J.T., McGee, T.J. and Wolfe, D., 2019. Boundary layer ozone in the Northern Colorado Front Range in July–August 2014 during FRAPPE and DISCOVER-AQ from vertical profile measurements. Elem Sci Anth, 7(1), p.6. DOI: http://doi.org/10.1525/elementa.345

Cheadle, L.C., Oltmans, S.J., Petron, G., Schnell, R.C., Mattson, E.J., Herndon, S.C., Thompson, A.M., Blake, D.R. and McClure-Begley, A., 2017. 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, 5, p.61. DOI: http://doi.org/10.1525/elementa.254

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