Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2017-160-RC1, 2017

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Summer ozone in the Northern Front Range Metropolitan Area: Weekend-weekday effects, temperature dependences and the impact of drought" *by* Andrew A. Abeleira and Delphine K. Farmer

Anonymous Referee #1

Received and published: 31 March 2017

The manuscript investigates ozone formation in Colorado, a region that consistently exceeds the 8-hour ozone standard. The authors' find that the region is transitioning to a NOx-limited regime, as well as observe temperature dependencies of ozone attributed to drought. Overall, I found this manuscript to be very informative and straightforward, and timely for a region that is relatively less-studied than other areas of the country. The manuscript is well-written and figures clear. Most of my comments are minor and relate to clarity. With minor revisions, I recommend this manuscript for publication in ACP.

General Comments

(1) There is inconsistency in the statistics used. Figures 2 and 3 show 5th and 95th percentiles, while later figures show one siqma. Sometimes the standard deviation of the sample is shown (e.g., Figure 7) and other times the standard error of the mean (e.g., Figure 8). For clarity, I believe the authors should maintain consistency throughout the manuscript, and at a 95% confidence interval, needed to assess the statistical significance of results.

Specific Comments

(2) Lines 78-31. Do the authors mean *1980-1993* instead of "1980-2008"? Also, the ratio of VOC/NOx emissions has evolved with time in cities (Parrish et al., 2011; McDonald et al., 2013), which could also affect ozone trends.

Parrish, D. D., H. B. Singh, L. Molina, and S. Madronich (2011), Air quality progress in North American megacities: A review, Atmos Environ, 45, 7015-7025, doi:10.1016/j.atmosenv.2011.09.039.

McDonald, B. C., D. R. Gentner, A. H. Goldstein, and R. A. Harley (2013), Long-term trends in motor vehicle emissions in U.S. urban areas, Environ Sci Technol, 47, 10022-10031, doi:10.1021/es401034z.

(3) Line 164. This is an example where I found the inconsistency in statistics confusing. The error bars shown would suggest that all these results are statistically significant, rather than only at the 95th percentile.

(4) Lines 174 – 178. The authors' qualify the AVOC emissions trend shown in Figure 4 as an inventory estimate. I think this paragraph could be strengthened by referencing studies that have assessed emission trends for key sectors of this analysis, e.g., motor vehicles (e.g., McDonald et al., 2013), and oil and gas (e.g., Duncan et al., 2016), as well as studies that have reported uncertainties in emissions (e.g., Petron et al., 2014). What explains the hump in VOC emissions from petroleum industries around 2011? Is

this realistic, and comport with oil and natural gas production statistics from the Energy Information Administration? Such a rapid increase and decrease in VOC emissions would likely have some influence on observed ozone, as many of the points shown in Figure 6 are still on the NOx-saturated side of the curve. Also, McDuffie et al. (2016) suggested that maximum O3 was sensitive to NOx and reductions in VOCs in the Front Range.

Duncan, B. N., L. N. Lamsal, A. M. Thompson, Y. Yoshida, Z. F. Lu, D. G. Streets, M. M. Hurwitz, and K. E. Pickering (2016), A space-based, high-resolution view of notable changes in urban NOx pollution around the world (2005-2014), J Geophys Res-Atmos, 121, 976-996, doi:10.1002/2015jd024121.

Petron, G., A. Karion, C. Sweeney, B. R. Miller, S. A. Montzka, G. J. Frost, M. Trainer, P. Tans, A. Andrews, J. Kofler, D. Helmig, D. Guenther, E. Dlugokencky, P. Lang, T. Newberger, S. Wolter, B. Hall, P. Novelli, A. Brewer, S. Conley, M. Hardesty, R. Banta, A. White, D. Noone, D. Wolfe, and R. Schnell (2014), A new look at methane and nonmethane hydrocarbon emissions from oil and natural gas operations in the Colorado Denver-Julesburg Basin, J Geophys Res-Atmos, 119, 6836-6852, doi:10.1002/2013jd021272.

McDuffie, E. E., P. M. Edwards, J. B. Gilman, B. M. Lerner, W. P. Dube, M. Trainer, D. E. Wolfe, W. M. Angevine, J. De Gouw, E. J. Williams, A. G. Tevlin, J. G. Murphy, E. V. Fischer, S. McKeen, T. B. Ryerson, J. Peischl, J. Holloway, K. Aikin, A. O. Langford, C. J. Senff, R. J. Alvarez II, S. R. Hall, K. Ullmann, K. O. Lantz, and S. S. Brown (2016), Influence of oil and gas emissions on summertime ozone in the Colorado Northern Front Range, J Geophys Res-Atmos, 121, doi:10.1002/2016JD025265.

(5) Line 172. The NEI is reported for a single year. I believe the authors mean the EPA Trends Report, which is now reported by state.

(6) Line 187. The weekday/weekend effect is really due to a drop-off in heavy-duty truck traffic (Marr et al., 2002; McDonald et al., 2014). Passenger cars drive similar

amounts on weekends and weekdays.

Marr, L. C., and R. A. Harley (2002), Modeling the effect of weekday-weekend differences in motor vehicle emissions on photochemical air pollution in central California, Environ Sci Technol, 36, 4099-4106, doi:10.1021/Es020629x.

McDonald, B. C., Z. C. McBride, E. W. Martin, and R. A. Harley (2014), High-resolution mapping of motor vehicle carbon dioxide emissions, J Geophys Res-Atmos, 119, 5283-5298, doi:10.1002/2013jd021219.

(7) Line 209. I found the variability in concentrations across days, as shown in Figure 5, distracting for discerning weekday-weekend effects. I think this figure could be made clearer by showing a mean and confidence interval of weekdays (Mon-Friday), and of weekend days (Sa/Su) combined. Also, I think 95th confidence intervals should be shown, to make it easier for the reader to discern statistical significance.

(8) Lines 212-213. Are these 24 hour averages or daytime averages? If it is the former, could nighttime chemistry affect the weekday-weekend effect?

(9) Line 226-227. This sentence is confusing. Suggest revising.

(10) Lines 281-287. On Line 283, I believe the authors mean *2002-03* instead of "2001-02". To my eye in Figure 9, it is clear that 2008 and 2011-12 are suppressed, but I found it harder to see for 2002-2003. For 2002-2003, it only looks like the Fort Collins and Welby sites are suppressed, and not the other locations.

Minor Comments

(11) Line 211. Terminology switches from “weekday-weekend” to “weekend-weekday”. Suggest choosing one word ordering and sticking with it.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2017-160, 2017.