Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-1174-AC3, 2019

Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Estimating background contributions and U.S. anthropogenic enhancements to maximum ozone concentrations in the northern U.S." *by* David D. Parrish

Parrish

david.d.parrish@noaa.gov

Received and published: 8 January 2019

The discussion paper currently under review has important scientific and policy implications. Scientifically, the paper argues that a simple, mathematically based, conceptual model can accurately estimate two contributions to U.S. ozone design values (ODVs) in the northeastern U.S.: the first from U.S. background ozone, and the second from enhancements produced by photochemical ozone production from U.S. anthropogenic ozone precursor emissions. Assuming that the first is constant and the second is decreasing exponentially allows these two contributions to be estimated separately. I believe that this is currently the only observationally based approach for estimating

background ozone contributions to U.S. ODVs. Further, the paper argues that U.S. background ozone estimates from regional photochemical models have large uncertainties, as evidenced by the large differences between the results from different models. These two results are important from an air quality policy perspective, since policy makers consider estimates of the background ozone contribution in formulating ozone air quality standards. Given its scientific importance and policy relevance, this paper should be published provided that it is scientifically sound.

The analysis in the paper relies on fitting long-term trends of ozone design values (ODVs) in the northeastern U.S. to an exponential decrease with a constant positive offset (Equation 1 of the text). The ODV time series in the northeastern U.S. are too short to allow all 3 model parameters to be accurately extracted from the fits, so the exponential time constant derived from prior work for southern California (21.9 years) is assumed to be appropriate for the northeastern U.S. as well. The U.S. background ODVs are then estimated from the constant offset (y_0) values derived from the non-linear regression fits to Equation 1 with that time constant. The results indicated no statistically significant difference in the derived U.S. background ODVs over the northeastern U.S., giving a regional average U.S. background ODV of 45.8 $\pm$ 1.7 ppb.

Both referees question various aspects of this analysis approach, particularly the fitting of the anthropogenic ODV enhancements to an exponential decrease with a time constant equal to that found in southern California. Importantly, there is an independent analysis that can also estimate the U.S. background ODV. Section 2.3 of Parrish et al. (2017) demonstrates a different, somewhat more general approach that is based upon correlations of ODVs between different regions. This approach does not assume any specific functional form for the time dependence of the ODV enhancements. Instead, the time series of ODVs from one region is selected as a reference, and other time series are linearly correlated with that reference. A different assumption does underlie this approach, namely that the U.S. background ODVs vary in a similar manner in all regions under investigation. Given this assumption, the U.S. background ODV for a region is taken as the ODV where the line derived from a linear correlation of that region's ODVs with those of the reference region equals 1; at that point the ODVs from the two time series are equal, which is necessarily at that regionally uniform U.S. background ODV. Section 2.3 of Parrish et al. (2017) show that the results of this approach for seven southern California air basins are nearly identical to the results from the fits to Equation 1.

The results from applying this second approach to the northeastern U.S. are shown in Figures S1-S7 of the Supplement for the 13 regional data sets given by the black lines in Figure 8 of the discussion paper. Here the time series of maximum observed ODVs in the New York City urban area (included in Figure 12a of the discussion paper) is selected as the reference, because they are some of the largest ODVs recorded in the northeastern U.S., and because after 2000 this time series closely follows an exponential decrease with little interannual variability. Figure 1 below collects all of the linear regressions for the 13 regional data sets, and Table 1 summarizes the results, which have significant variability (36 to 62 ppb) and wide confidence limits (4 to 13 ppb), but with an average of 49.2 $\pm$ 3.9 (95% confidence limit) ppb. One reason for the high bias in this second determination is that the fits were obtained from standard linear regressions, which assign all of the uncertainty to the data set plotted on the ordinate. The analysis can also be done utilizing a reduced major axis regression with equal weighting of the two correlated data sets, which gives a corresponding average of 43.2 $\pm$ 5.7 ppb. These two results bracket the result (45.8 $\pm$ 1.7 ppb) reported in the discussion paper, and neither average is statistically significantly different from the original result. The analysis presented in this comment demonstrates that the fitting of long-term trends of ODVs to Equation 1 of the text does not compromise the accuracy of the results presented in the discussion paper.

Reference

Parrish, D.D., Young, L.M., Newman, M.H., Aikin, K.C., and Ryerson, T.B.: Ozone design values in Southern California's air basins: Temporal evolution and U.S.

background contribution. Journal of Geophysical Research: Atmospheres, 122, 11,166–11,182. https://doi.org/10.1002/2016JD026329, 2017.

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2018-1174/acp-2018-1174-AC3-supplement.pdf

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-1174, 2018.

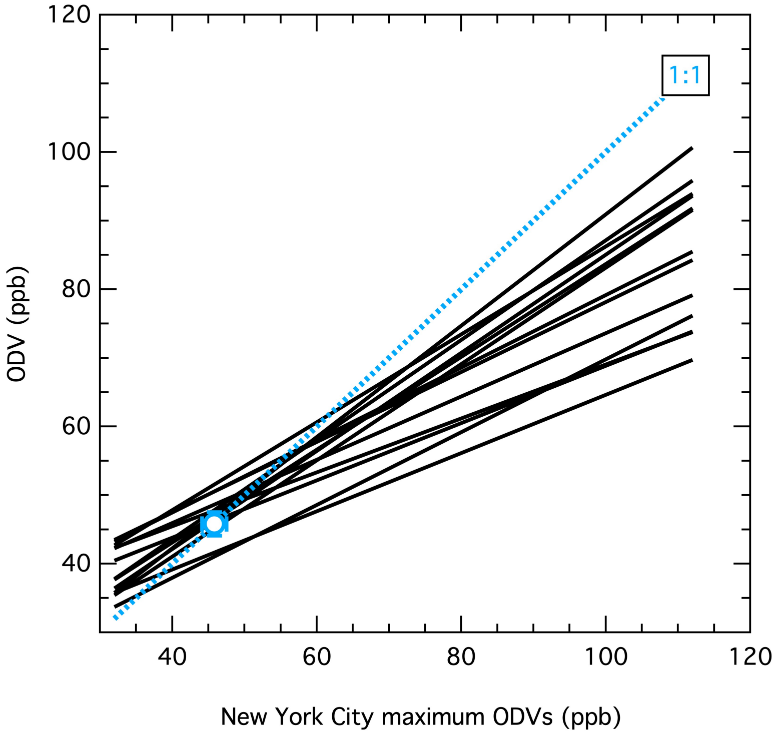

Fig. 1. Results of standard linear regressions between the ODVs from 13 regions in the north-eastern U.S. and the maximum ODVs recorded in New York City as illustrated in Figures S1-S7 of the Supplement.

Table 1. Results of the intercepts of the linear regressions illustrated in Figure 1 with the 1:1 line.

State/sites	U.S. background ODV (ppb)	r^2	years fit
New York/rural upwind	43 ± 6	0.75	2000-2017
New Jersey/all sites	52 ± 4	0.83	2000-2017
Rhode Island/all sites	62 ± 6	0.84	2000-2017
Massachusetts/Boston	47 ± 11	0.75	2000-2017
Massachusetts/suburban	50 ± 10	0.82	2000-2017
Massachusetts/coastal	53 ± 7	0.89	2000-2017
New Hampshire/coastal	55 ± 8	0.77	2000-2017
New Hampshire/northwest	49 ± 6	0.60	2000-2017
Vermont /all sites	51 ± 7	0.79	2000-2017
Maine/interior	39 ± 11	0.44	2000-2017
Maine/NE coast	36 ± 10	0.89	1991-2017
Maine/SW coast	56 ± 6	0.77	2000-2017
Maine/Cadillac Mtn.	48 ± 13	0.85	2000-2017

Fig. 2. Table 1