9 December 2019

US Environmental Protection Agency
1200 Pennsylvania Avenue NW
Washington, DC 20460

Presentation and Related Comments of John Bachmann on the draft EPA Policy Assessment for Ozone

To: EPA Administrator Andrew Wheeler and the Clean Air Scientific Advisory Committee (CASAC)

My thanks to EPA and CASAC for the opportunity to provide these comments. I worked for EPA's Air Office for 33 years, much of that as Associate Director for Science/Policy and New Programs. In that capacity I had extensive experience in the NAAQS review process, as well as advocating for policy relevant research that would support NAAQS reviews, accountability research, improved science-based implementation for ozone and PM NAAQS, programs for acid precipitation and regional haze, as well as air pollution and climate interactions. These comments reflect my own views. They include the presentation slides and expand on the remarks I gave at the CASAC meeting on December 5th.

I have three main points:

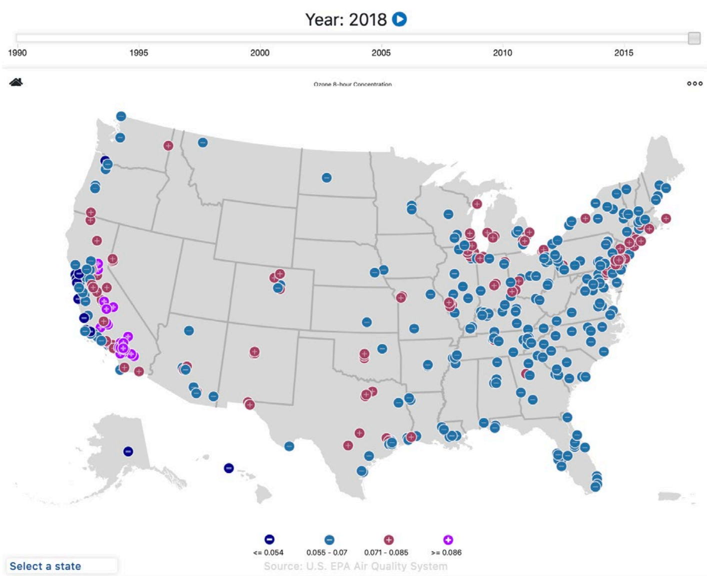
- To thank the EPA staff who worked on the draft Ozone Integrated Science Assessment and the Policy/Risk and Exposure Assessments under very difficult time constraints and made advances in presentation and analyses. To also thank the seven CASAC members who have faced a greater challenge and workload than any prior committee due to the tight schedule and overlapping reviews of the equivalent of five major documents over three months without the assistance of pollutant specific panels that in the past have included many additional experts in multiple disciplines.

- To recommend future research on trends in alternative averaging times for ozone exposure and potential health effects.

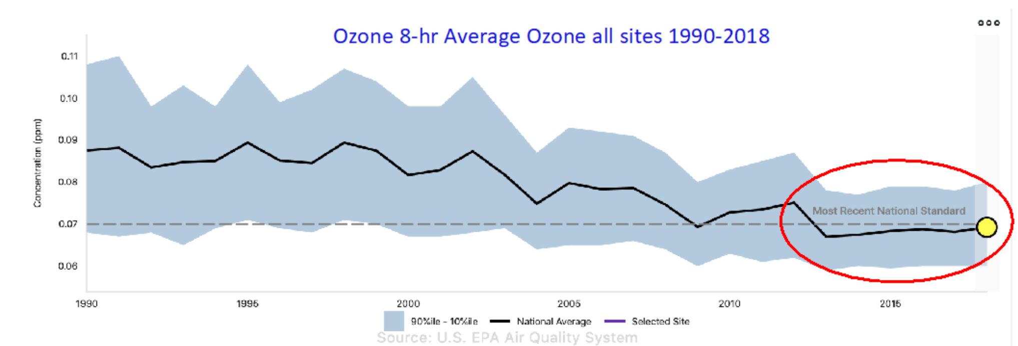
- To recommend that CASAC request that EPA conduct the kind of analysis of potential effects of ozone on climate that they requested in their review of the PM secondary standard.

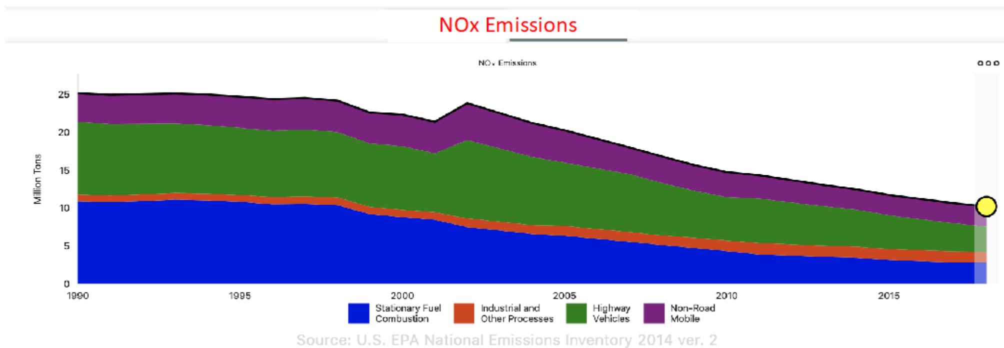
Ozone air quality trends for the NAAQS and other averaging periods – Implications for control strategies and health

Air quality data presented in the draft ISA and PA stops at 2017 because the analyses began before national air quality data were available for 2018. EPA released the 2018 data in their annual report *Our Nations Air: 2019* at https://gispub.epa.gov/air/trendsreport/2019/#home. The figure below shows 4th maximum 8-hour ozone (MDA8) data for 2018. Because these are single year data, they cannot be directly compared to the NAAQS, which requires a three-year average. Note these 2018 data for some sites, e.g. Utah, were not available.



Of more interest for this presentation are the national trends for MDA8 ozone, which are presented in the figure below.





The chart shows the national average for all trends monitors (black line) and ranges for sites above and below (blue).[1] The trend shows the marked progress that began with the adoption of regional and national NOx reductions following the 1990 Clean Air Act amendments and EPA policies and state responses to address multistate transport in the Eastern US. Federal tailpipe and state programs to reduce VOC in urban areas also contributed. As highlighted on the figure, however, despite continued reductions, the apparent progress in ozone stops after 2014.

A full understanding of the recent ozone trends will require more work, and results will vary by regions in the U.S. Nevertheless, some preliminary explanations have been offered. In his response to Dr. Boylan's

[1] An obvious implication for the draft ozone ISA and PA is that adding an additional year to the charts would make little if any difference.

questions on the draft PA, Dr. David Parrish suggests it is related to the USB, noting "The primary reason for this behavior is that there is not much room left for improvement." While this might be the case in the west, it seems unlikely as a primary reason for a flattening of national trends, based on Dr. Parrish's 0wn excellent commentary on USB estimates and trends response to CASAC questions on the ISA (See especially figures 2 and 3).

EPA's recent trends analyses continue the practice of adjusting the data for meteorological influences, notably related to temperature and humidity, see https://www.epa.gov/air-trends/trends-ozone-adjusted-weather-conditions. These adjusted trends suggest nationwide average ozone reductions continued through 2016, and the overall trends show apparent sensitivities to years with higher temperatures. Some regions show an increase in MDA8 since 2016, and in two cases possibly driven by warmer conditions. This is supported by an analysis by Lin et al (2017), who found "regional NO_x reductions alleviated the O_3 buildup during the recent heat waves of 2011 and 2012 relative to earlier heat waves (e.g., 1988, 1999)." Although more work is needed, this is consistent with forecasts that higher temperatures or drought caused by climate change will make it increasingly difficult to attain the ozone standard.

Most ozone air quality trends analyses have understandably focused on the 8-hour standard. In evaluating NOx and other ozone control programs, however, it is important to examine trends for other averaging times. In VOC limited central urban areas, local NO emissions serve to reduce ozone concentrations, but can contribute to elevated ozone downwind. The following chart shows the results of an analysis of seasonal and annual US ozone trends at different times of day: daily (24 hours), daytime, and nighttime. Results for various time periods show ozone is decreasing during daylight hours in summer, but for all other seasons and annually ozone is increasing during day- and nighttime. Reduced titration by NO is likely a major cause. The implications of NO_x reductions increasing off-peak seasonal ozone exposures[2] in urban areas while reducing NO_2 exposures for public health is a key research question.

Table 2. Observed trends for seasonal and annual ozone over the eastern (25–50° N, 65–100° W) and western (25–50° N, 100–125° W) United States during various time periods.

	MAM	JJA	SON	DJF	Annual
Daily mean ozone trend (ppb yr^{-1})					
1990–2014 US	0.21^a	0.02	0.14^a	0.13^a	0.16^a
1990–2014 eastern US	0.19^a	−0.03	0.12^a	0.12^a	0.12^a
1990–2014 western US	0.25^a	0.12^a	0.16^a	0.16^a	0.20^a
2004–2012 US	0.34^a	0.16^a	0.29^a	0.27^a	0.30^a
2005–2011 US	0.27^a	0.09^b	0.20^a	0.21^a	0.23^a
2002–2014 US	0.12^a	0.04	0.07^b	0.06	0.08^b
Daytime mean ozone trend (ppb yr^{-1})					
1990–2014 US	0.17^a	-0.08^b	0.09^b	0.12^a	0.09^b
1990–2014 eastern US	0.15^a	-0.11^b	0.07^b	0.11^b	0.06
1990–2014 western US	0.21^a	0.03	0.10^b	0.15^a	0.13^a
2004–2012 US	0.26^a	−0.03	0.20^a	0.24^a	0.19^a
2005–2011 US	0.21^a	−0.04	0.14^a	0.16^a	0.13^a
2002–2014 US	0.09^b	0.03	0.05	0.06	0.05
Nighttime mean ozone trend (ppb yr^{-1})					
1990–2014 US	0.26^a	0.13^a	0.19^a	0.14^a	0.21^a
1990–2014 eastern US	0.24^a	0.05	0.16^a	0.13^a	0.18^a
1990–2014 western US	0.30^a	0.20^a	0.23^a	0.17^a	0.25^a
2004–2012 US	0.46^a	0.35^a	0.40^a	0.30^a	0.43^a
2005–2011 US	0.35^a	0.24^a	0.28^a	0.25^a	0.31^a
2002–2014 US	0.16^a	0.06	0.11^b	0.07^b	0.13^a

[a] P value < 0.01. [b] P value < 0.05 after an F test.

US Ozone Trends 1990- 2014

Ozone is *decreasing* – daytime hours in summer (and 8-hr max)

Ozone is *increasing* daytime and nighttime, for all other seasons and annual

Implications for health a key research question

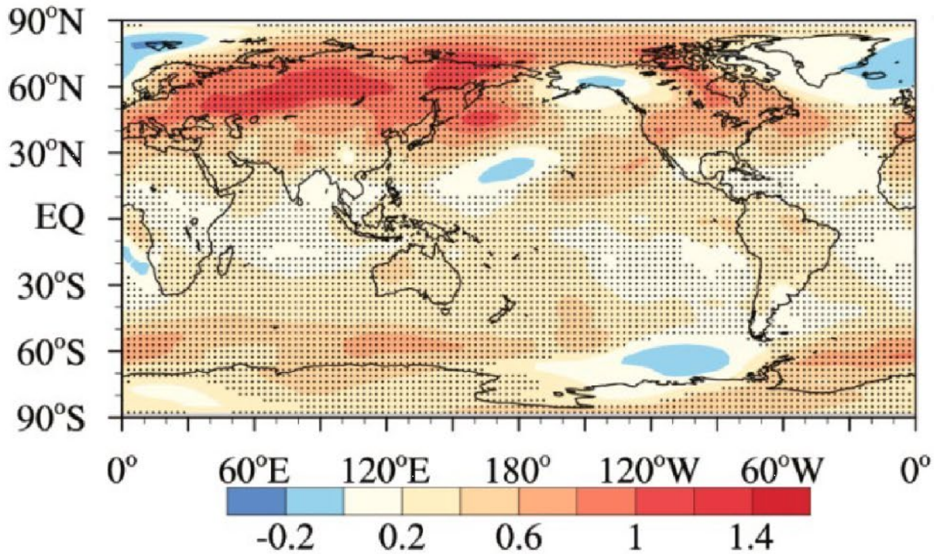
Y. Yan et al.: 2017. Ozone trends over the United States at different times of day

[2] For example, Figure 1b in the Harvard Medicare cohort study (Di et al, 2017) is a map of six month (April-September) ozone for 2000-2012 that presents a geographic pattern of high ozone that is very different from that for MDA 8.

What about implications of long-term ozone increases for unexamined welfare effects?

Ozone is a greenhouse gas that causes regional and hemispheric increases in temperature - US emissions can affect apparent background levels in the US

The increasing trends in the table above reflect ground level monitors mainly located in or near urban areas. While these are clearly of interest for assessing population exposures, the effect of ozone as a greenhouse gas extends to the entire vertical distribution in the troposphere and is not limited to urban areas. Tropospheric ozone is transported around the northern hemisphere and U.S. emissions can contribute to the background that is transported to the western U.S. Methane, which is normally excluded from VOC regulations, is an important precursor on this scale and is itself a potent greenhouse gas. The draft ozone ISA reproduces the figure below based on a model simulation[3] of the effects of post-industrial anthropogenic emissions of ozone precursors on temperature; i.e. these estimates do not include the contribution from natural sources. These results suggest ozone is producing significant temperature increases that are larger in the northern hemisphere, including the U.S. The ISA concludes effects of ozone on radiative forcing are causal and the effects on temperature and precipitation are likely causal.

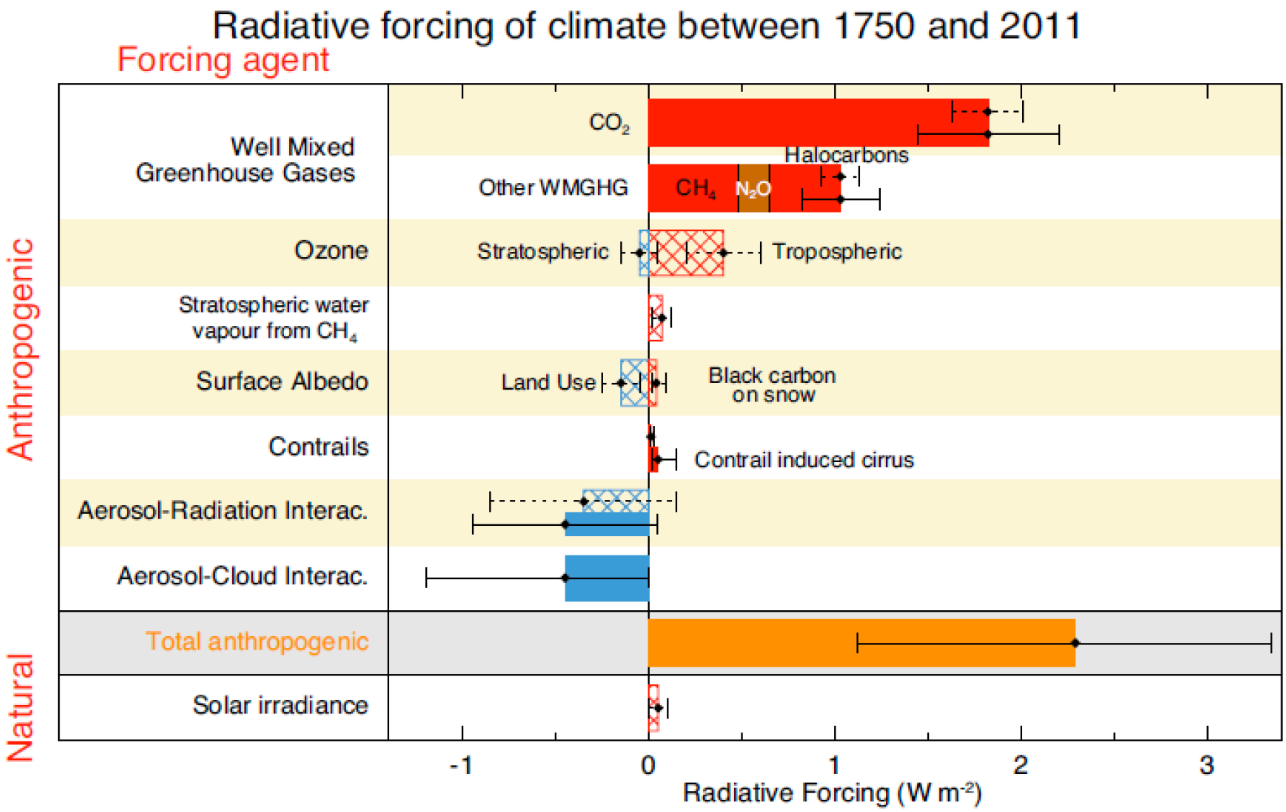


Mean annual change in surface temperature (°C) resulting from tropospheric ozone concentration changes from 1850−2013.

Ozone is a short-lived climate forcer. The bar chart below (ISA Figure 9) is taken from the AR5 IPCC report. These are estimates of radiative forcing for multiple greenhouse pollutants, including ozone and methane, one of its major precursors on a global scale. Dr. David Parrish's response to CASAC questions on the ISA notes that the estimate of 0.4 W/m^2 forcing for tropospheric ozone may be underestimated by more than 50%. The major anthropogenic precursors to ozone forcing on a global scale are in order of

[3] Figure 9-7; Xie et al (2016).

importance, methane, NOx, CO, and non-methane VOCs (ISA Figure 9-3). In addition to its contribution as an ozone precursor, anthropogenic methane contributes close to 0.5 W/m^2 to total radiative forcing.



Section 302(h) of the Clean Air Act specifies includes effects on climate as an effect on public welfare. As noted above, ozone is a greenhouse gas that causes regional and hemispheric increases in temperature. U.S. emissions can affect the apparent background levels in the U.S. In terms of analysis, the issue is clearer for ozone and a major precursor, methane, than it is for undifferentiated particulate matter (PM). CASAC should recommend analyses of ozone effects on climate that are at least comparable to those you have proposed to make for PM in the draft letter on the PM PA.

Given EPA's choice to severely limit the time for this review and limited resources, it appears unlikely such assessments for ozone or PM will be done in the current reviews, yet your recommendations still provide important advice to the Administrator with respect to the significant effects of even short-lived climate forcers on climate. In the case of ozone, it would be optimal for add a recommendation for research to combine the issues of climate change and the need to address anthropogenic background ozone and trends for alternative ozone averaging times. For example, Dr. Parish's work summarized in his comments suggests that USB ozone may have been declining in recent years. It will be important to examine the extent to which reductions of ozone precursors in Europe and North America may have contributed.

As an author of the first draft of Section 179 (International Border Areas) of the 1990 Clean Air Act Amendments, it is important that we not only research ways to better identify exceptional events from wildfires, stratospheric intrusion and international transport to better exclude violations. We should also be examining the joint issues of the need to reduce the effects of ozone on climate as well as limiting the contribution of anthropogenic emissions from the U.S. and other nations to U.S. and global background. Dr. Jaffee's response to CASAC questions estimates that methane emissions contribute about 5 ppb to anthropogenic background. The US has had some success in the past in negotiating international agreements on stratospheric ozone, acid rain, and ground level ozone. Not all of USB is truly uncontrollable. It would be helpful for CASAC to include recommendations for analyses and research examining the joint issues of ozone effects on climate and the contribution of anthropogenic methane and other precursors on background and ozone.