UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NC 27711

September 23, 2015

MEMORANDUM

SUBJECT: Data Analyses Supporting Responses to Public Comments for the O_3 NAAQS

FROM: Benjamin Wells (EPA, OAQPS)

TO: Ozone NAAQS Review Docket (EPA-HQ-OAR-2008-0699)

Overview

This memo summarizes various analyses of ambient air quality monitoring data that the EPA has prepared in support of its responses to public comments received on the proposed National Ambient Air Quality Standards (NAAQS) for Ozone (O_3) rulemaking. In particular, the EPA received public comments regarding the form of the standard, and public comments regarding various aspects of the proposed data handling requirements in Appendix U to 40 CFR Part 50. The EPA has performed these analyses based on ten years (2004-2013) of quality assured and certified ambient air quality monitoring data from the Air Quality System (AQS) database. Each section below contains a summary of the public comments received, followed by a detailed description of the data analysis supporting EPA's response and a presentation of the results.

Form of the O_3 Standards

One public commenter submitted an analysis based on ambient data showing that an O_3 NAAQS based on a 3-year average of the annual 4th highest daily maximum 8-hour average (MDA8) value results in design values that are 3 to 4 ppb less than a standard based on a 3-year average of the annual 2nd highest MDA8 value, and 7 to 8 ppb less than a standard based on a 3-year average of the annual 1st highest MDA8 value. The commenter then claims that the annual 1st and 2nd highest forms are nearly as stable as the 4th highest form, and argues that EPA fails to show how the 4th highest form is necessary for "administrative stability".

To inform their consideration of this comment, the EPA examined ambient O_3 concentration data from 2004 to 2013 for monitors where the 3-year design value calculated according to Appendix P to 40 CFR Part 50 for the 2008 O_3 NAAQS was equal to 75 ppb, and monitoring sites where the 3-year design value calculated according to Appendix U to Part 50 for the revised O_3

NAAQS was equal to 70 ppb. There were 550 total 3-year periods at 415 distinct monitors where the 3-year design value for the 2008 O_3 NAAQS was equal to 75 ppb, and 493 total 3-year periods at 357 distinct monitoring sites where the 3-year design value for the revised O_3 NAAQS was equal to 70 ppb. For each site and 3-year period, EPA calculated the five highest annual MDA8 values for each year. The distribution of these values for each annual N^{th} highest max number (N = 1 to 5) are shown in Figure 1 (2008 O_3 NAAQS, 75 ppb) and Figure 2 (revised O_3 NAAQS, 70 ppb). Additionally, Table 1 lists the median, mean, and standard deviation of the distribution for each standard level and N^{th} highest max number.

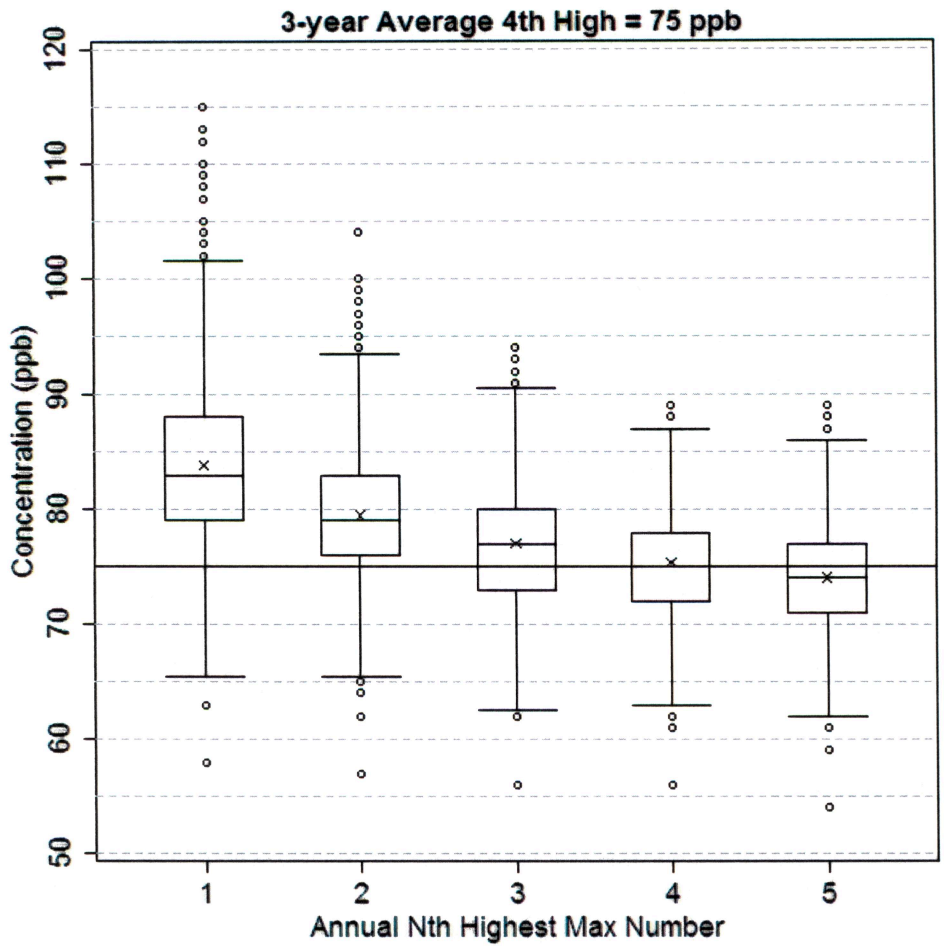

Figure 1. Box and whisker plots showing the distribution of annual 1st to 5th highest MDA8 values for monitors where the 3-year design value was equal to 75 ppb. Boxes show 75th percentile, median, and 25th percentile values, whiskers extend to +/- 1.5 times the inter-quartile range, x denotes mean value, and circles show outlier values.

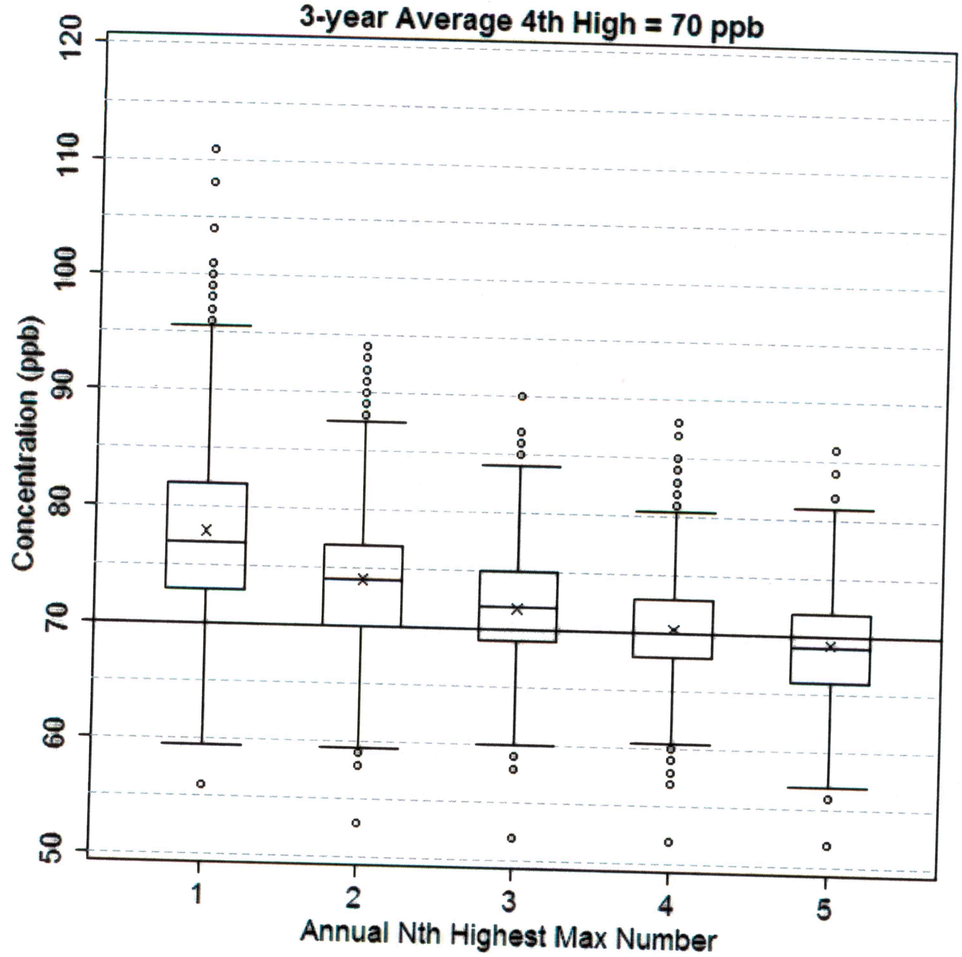

Figure 2. Box and whisker plots showing the distribution of annual 1st to 5th highest MDA8 values for monitoring sites where the 3-year design value was equal to 70 ppb. Boxes show 75th percentile, median, and 25th percentile values, whiskers extend to +/- 1.5 times the inter-quartile range, x denotes mean value, and circles show outlier values.

Table 1. Summary statistics based on Figures 1 and 2 above

Standard Level (ppb)	Annual Nth Highest Max Number	Median Value (ppb)	Mean Value (ppb)	Standard Deviation (ppb)
75	1	83	83.8	7.5
75	2	79	79.5	5.9
75	3	77	77.1	5.3
75	4	75	75.3	4.8
75	5	74	74.1	4.8
70	1	77	77.9	7.0
70	2	74	74.1	5.5
70	3	72	71.8	4.7
70	4	70	70.3	4.4
70	5	69	69.2	4.3

In general, the boxplots in Figures 1 and 2 show a similar pattern of decreasing mean and median concentrations and decreasing variability in the annual Nth highest MDA8 values as the value of N increases. These data support the commenter's claim that the annual 2nd highest MDA8 value is about 3 to 4 ppb higher than the 4th highest MDA8 value, and the annual 1st highest MDA8 value is about 7 to 8 ppb higher than the 4th highest MDA8 value. However, Figures 1 and 2 and Table 1 clearly show that the amount of inter-annual variability in the Nth highest MDA8 value decreases as N increases. Thus, the data do not support the commenter's claim that the 1st and 2nd highest MDA8 values are nearly as stable as the 4th highest MDA8 value.

Overlapping Daily Maximum 8-hour Averages

Alternative Procedure for Calculating Daily Maximum 8-hour Average Values

One regional air quality management organization and three of its member states submitted similar comments suggesting an alternative to the EPA's proposed procedure for calculating daily maximum 8-hour averages in Appendix U to 40 CFR Part 50. The alternative procedure iteratively finds the highest 8-hour period in a given year, then removes this 8-hour period and all other 8-hour periods associated with that day, including any overlapping 8-hour periods on adjacent days, from the dataset until a daily maximum value is determined for each day of the year with sufficient monitoring data.

The EPA examined a similar iterative procedure in a previous technical memo referenced in the proposal (Wells, 2014, Method 1). The data from the previous analysis were used to calculate MDA8 values according to the alternative method suggested by the commenters. A comparison of the MDA8 values calculated using the two iterative methods showed nearly identical results. Out of over 3 million site-days analyzed in the 10 year dataset, only about 3,000 site-days (0.1%) had MDA8 values which differed between EPA's Method 1 and the commenters' method. Additionally, only eight of the approximately 3,000 site-days which differed between the two methods impacted one of the four highest annual MDA8 values, and only two of these eight site-days (corresponding to a single overlapping daily maximum 8-hour event at one monitoring site) had MDA8 values greater than 55 ppb.

Thus, EPA concludes that the commenters' alternative procedure does not differ significantly from the Method 1 analyzed previously. Additionally, the full dataset used in these analyses has been included in the docket. The full dataset includes the MDA8 values for all 1,261 monitoring sites in the analysis for 2004 to 2013 calculated according to four different methods: Appendix P to 40 CFR Part 50, Method 1 and Method 2 (the method adopted in Appendix U to 40 CFR Part 50) in Wells (2014), and the commenters' alternative method.

Impact of Removing Overlapping Daily Maximum 8-hour Averages on O_3 Design Values

One commenter submitted comments referring to the Wells (2014) technical memo cited in the preamble, stating that the analysis should be extended to include an assessment of how the two alternative methods for removing the influence of overlapping MDA8 values impact the 3-year design values.

Here, the Wells (2014) analysis is extended to include an assessment of the relative impacts of Method 1 and Method 2 for removing the influence of overlapping daily maximum 8-hour events from 3-year average design value calculations. As described in the Wells (2014) technical memo, Method 1 iteratively identifies each pair of overlapping MDA8 values, keeps the higher MDA8 value in each pair, and replaces the lower MDA8 value in each pair with the next highest MDA8 value on that day which does not overlap with any other MDA8 values. Method 2 calculates the MDA8 values based on the 8-hour periods starting with 7:00 AM to 3:00 PM and ending with 11:00 PM to 7:00 AM (i.e., this method removes 8-hour periods with starting hours from 12:00 AM to 6:00 AM). Effectively, Method 2 uses all 24 hourly concentration values, but reduces the number of 8-hour averages used to determine the MDA8 values. Design values for each 3-year period from 2004-2006 to 2011-2013 (eight 3-year periods) were determined using each method, then compared with the respective design values calculated according to Appendix P to 40 CFR Part 50.

Maps showing spatial patterns in the resulting changes in the 3-year design values using these two methods are portrayed in Figures 3 to 8. First, Figures 3 and 4 show maps of the number of 3-year periods where applying Methods 1 and 2, respectively, resulted in a lower design value. Second, Figures 5 and 6 show maps of the mean decrease in the design values based on Methods 1 and 2, respectively. Finally, Figures 7 and 8 show maps of the maximum decrease in the design value at each monitoring site based on these two methods.

Nationally, 4.6% of all monitoring sites had at least one 3-year period where the design value decreased when applying Method 1, compared with 6.2% when applying Method 2. On average, 1.8% of sites per 3-year period had a lower design value using Method 1, compared with 2.2% of sites per 3-year period using Method 2. The average decrease in the design value for those sites and 3-year periods affected was 1.3 ppb using both methods. However, looking across all sites and years, the average decrease in the design value was only 0.02 ppb using Method 1 and 0.03 ppb using Method 2. Overall, the impact of both methods on design values was small, and the magnitude of the decreases in the design values was quite similar between the two methods.

According to Figures 3 to 8, the spatial patterns in the monitoring sites affected by the two methods were quite similar. Similar to the previous findings based on annual 4th highest MDA8 values, the sites where the design values decreased were predominately located in rural areas, particularly mountainous and/or coastal areas downwind from large urban areas. The impact of removing overlapping MDA8 values upon design values was 3 ppb or less in all but two cases, which occurred in two consecutive 3-year periods at the same site on the summit of Whiteface Mountain in the state of New York (see figures 7 and 8).

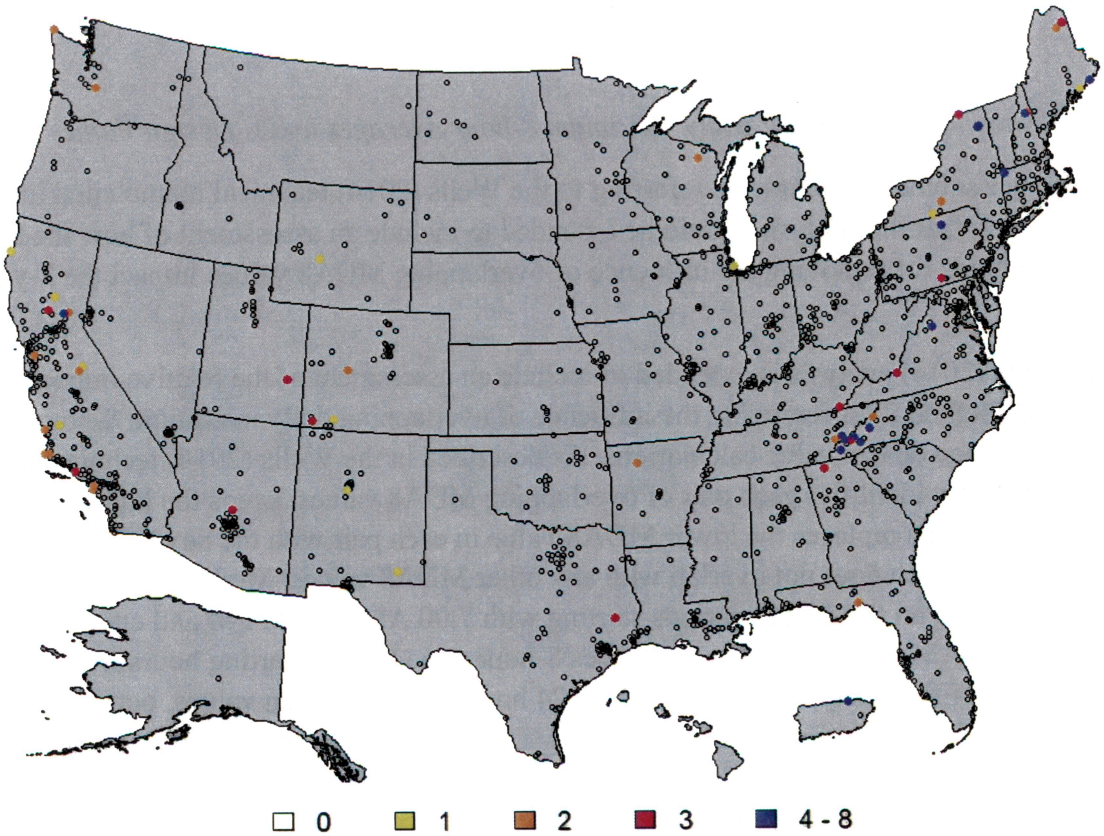

Figure 3. Number of 3-year periods in 2004-2006 to 2011-2013 where applying Method 1 resulted in a lower design value

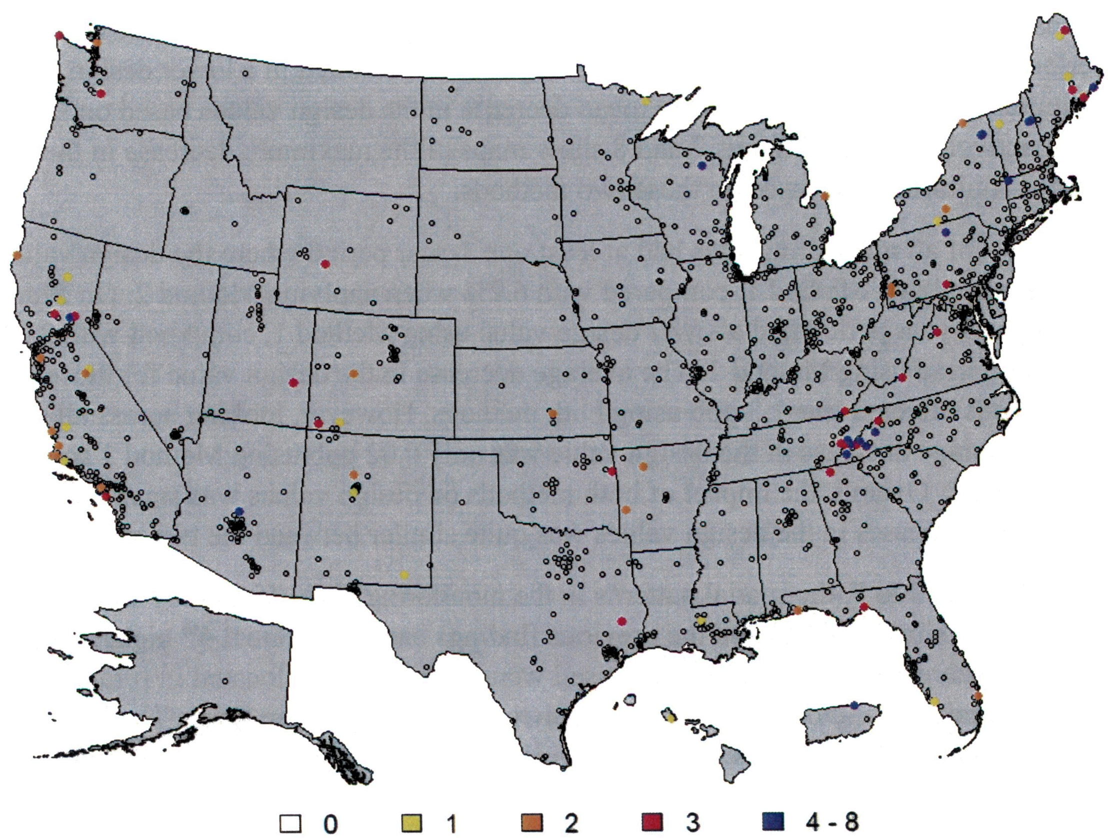

Figure 4. Number of 3-year periods in 2004-2006 to 2011-2013 where applying Method 2 resulted in a lower design value

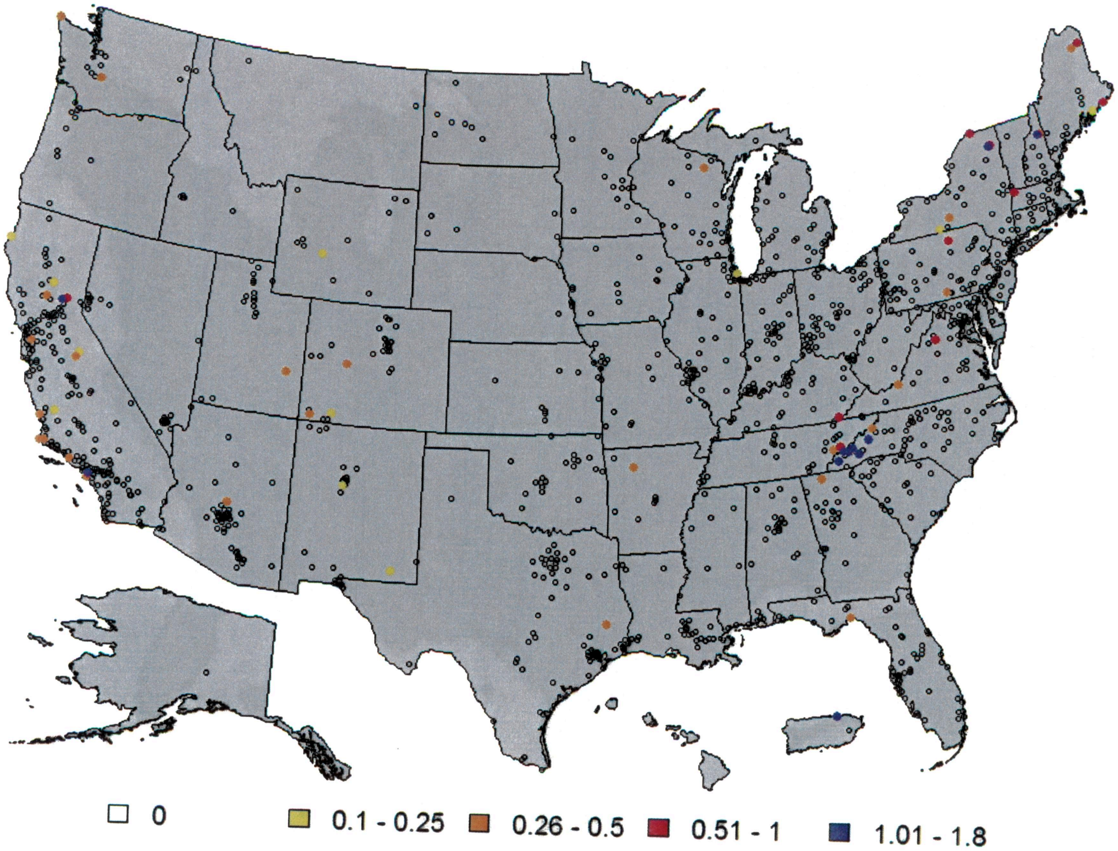

Figure 5. Average decrease in the 3-year design value (ppb) based on Method 1, 2004-2006 to 2011-2013

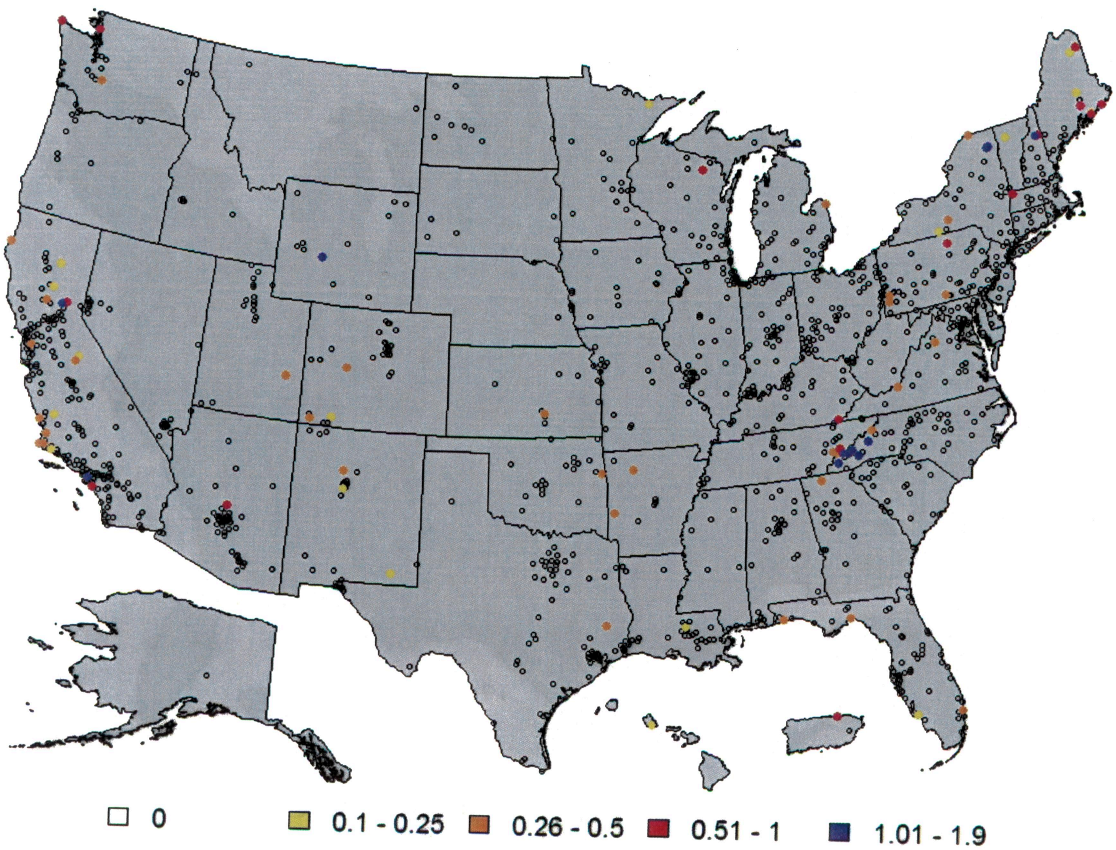

Figure 6. Average decrease in the 3-year design value (ppb) based on Method 2, 2004-2006 to 2011-2013

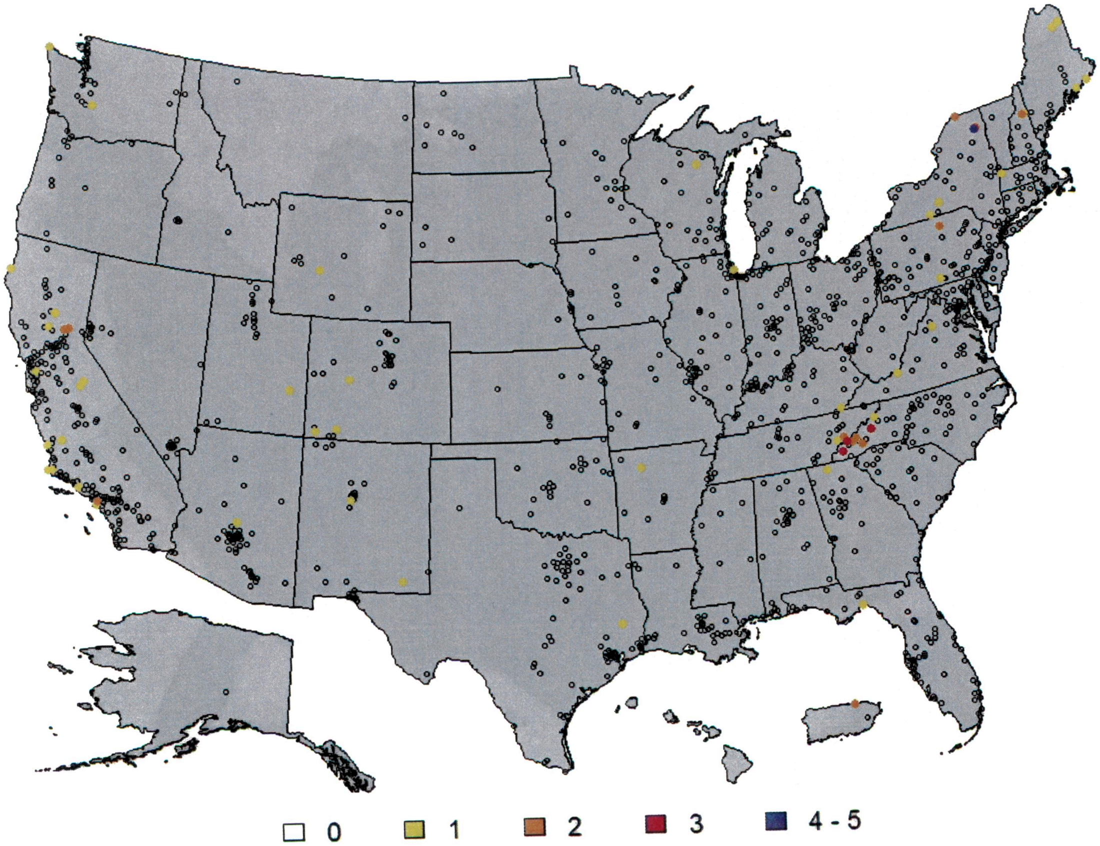

Figure 7. Maximum decrease in the 3-year design value (ppb) based on Method 1, 2004-2006 to 2011-2013

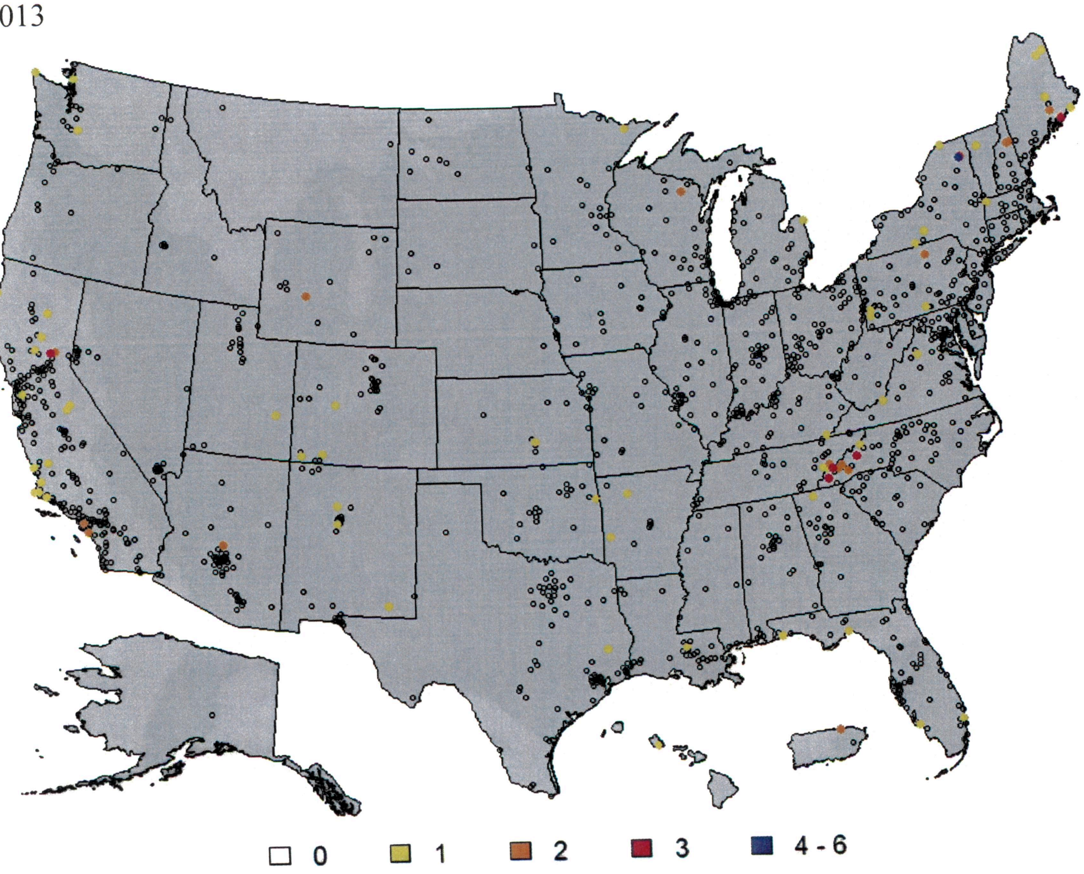

Figure 8. Maximum decrease in the 3-year design value (ppb) based on Method 2, 2004-2006 to 2011-2013

Daily Data Completeness Criteria

Three states submitted similar comments stating that they agreed with the proposed calculation procedure for daily maximum 8-hour average concentrations in Appendix U, but disagreed with the proposed data completeness requirements for determining a valid daily maximum 8-hour O_3 concentration, namely that 13 of 17 valid 8-hour averages would be required to determine a valid MDA8 value, compared with 18 of 24 valid 8-hour averages required under the previous O_3 NAAQS. These states were primarily concerned that the proposed requirements would only allow a monitoring site to have four missing 8-hour averages during a day before the entire day would be invalidated, compared with six missing 8-hour averages allowed previously. Two of these states also stated concerns that the proposed requirements would be more difficult to meet while maintaining compliance with existing monitoring requirements such as biweekly quality assurance checks.

EPA compared annual data completeness rates using the daily validity criteria from Appendix P to 40 CFR Part 50 (requiring 18/24 valid 8-hour averages) to those proposed in Appendix U (requiring 13/17 valid 8-hour averages) based on ambient O_3 concentration data in AQS from 2004 to 2013. Figure 9 below shows the empirical distribution functions of the annual data completeness rates based on these two daily validity criteria. This figure shows that the annual data completeness rates are nearly identical between the Appendix P and Appendix U criteria. The mean annual data completeness rate across all U.S. monitoring sites was 94.8% using the Appendix P criteria compared to 94.9% using the Appendix U criteria, and the median annual data completeness rate was 98% using both criteria. Approximately 96% of all monitors met the 75% annual data completeness criteria over the 10-year period using both daily validity criteria. Thus, the data do not support the commenters' concerns that the Appendix U criteria will be more difficult to meet than the previous Appendix P criteria.

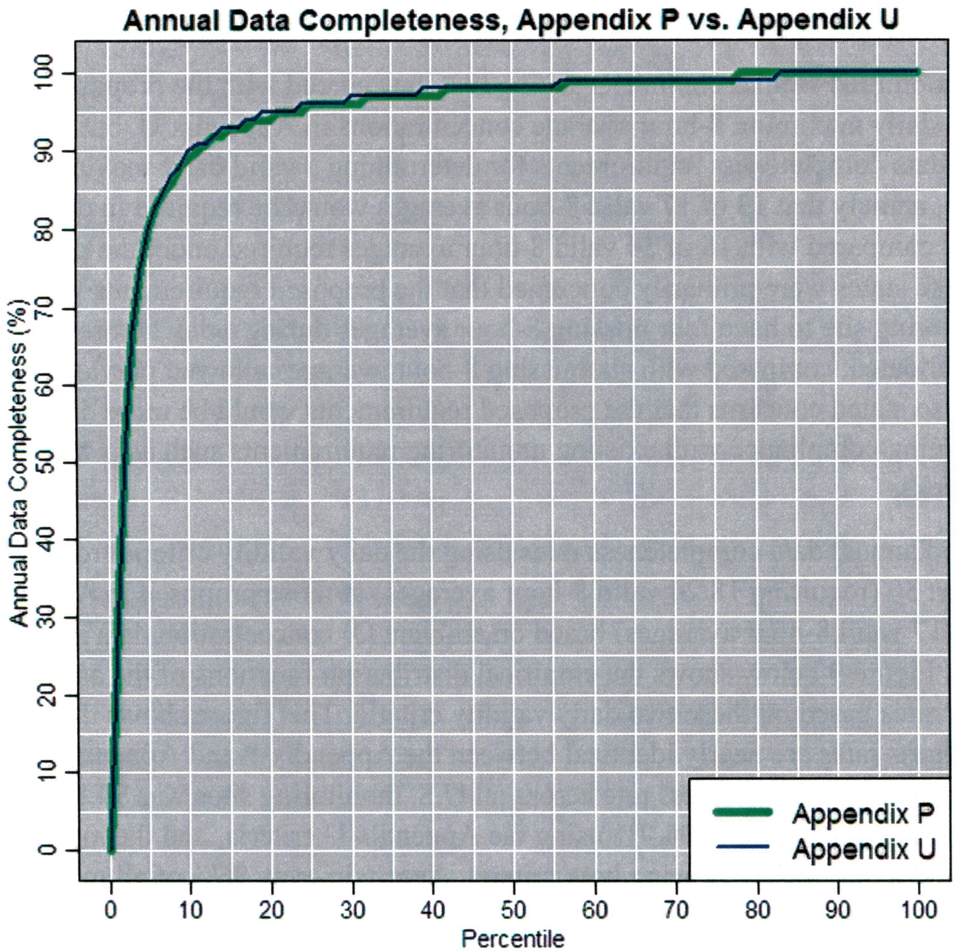

Figure 9. Empirical distribution functions of annual data completeness rates using the daily validity criteria in Appendix P to 40 CFR Part 50 (green line) and the proposed Appendix U to 40 CFR Part 50 (blue line) based on ambient O_3 monitoring data from 2004 to 2013.

References

Wells, B. (2014). Analysis of Overlapping 8-hour Daily Maximum Ozone Concentrations. Memorandum to the Ozone NAAQS Review Docket, EPA-HQ-OAR-2008-0699.