Earth System Sciences, LLC

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To: **Members of the Clean Air Scientific Advisory Panel (CASAC)**

Date: **March 13, 2014**

Subject: **Comments on 2nd Draft Health REA, Welfare REA, and PA for Ozone**

Executive Summary

The second draft Health REA, Welfare REA and PA are significant improvements over the first draft documents. In particular, the inclusion of the HDDM based method to estimate ozone under alternative standards has significantly improved the underlying science related to air quality characterization in the documents. There are several remaining issues, however, that remain to be addressed.

1. Significant artifacts to modeled ozone distributions can be introduced with a regression based HDDM approach. (Related to HREA Charge Question #4)
2. Applying HDDM modeling from one partial year of data to 5-years of the ozone record may introduce significant uncertainty due to different meteorology between years. (Related to HREA Charge Question #4)
3. EPA should highlight the different response between urban and suburban areas to changes in emissions. Urban areas are less sensitive to changes in emissions, and may experience a net increase in integrated ozone as emissions are reduced. Suburban areas tend to be more sensitive to changes in emissions. EPA should evaluate whether this has implications for at-risk populations. (Related to HREA Charge Question #4)
4. Composite monitor averaging is not appropriate over the wide city areas that EPA used in the risk analysis. (Related to HREA Charge Question #15)
5. EPA should evaluate the risk for the entire calendar year for all cities, rather than just for the ozone season. (Related to HREA Charge Question #4)
6. EPA should calculate and present the administrator with the risk at background to give her a complete perspective to determine what standard protects health with an adequate margin of public safety. (Related to PA Charge Question #2-2)
7. Background ozone is likely a significant contributor to current W126 values, particularly in the Western United States
8. Using EPA's regional rollback method it appears that the current primary standard is protective of welfare and the proposed W126 thresholds are redundant with the primary standard. (Related to PA Charge Question #5-1)

A more complete discussion of these comments will be available from the docket on 3/25/2013.

These comments are made on behalf of Earth System Sciences, LLC

I. Comments on Health Risk and Exposure Assessment for Ozone

1. The use of HDDM to estimate ozone under alternative air quality standards (Relevant to CASAC HREA Charge Question #4)

a) Overview

The use of an HDDM based method to estimate ozone concentrations under alternative air quality standards is a significant improvement over previous methods. The HDDM based rollback captures the highly non-linear response of ozone concentrations to reductions in emissions, an important feature of the atmospheric chemistry of ozone. Importantly, the HDDM rollback also estimates the spatial distribution of changes in emissions, which can be dynamic as the relative balance of NOx and VOCs shifts in a particular area.

b) Application of a partial year of modeling data to multiple years

Rather than conducting HDDM modeling to estimate the sensitivity of ozone to changes in emissions over the five years analyzed in the REA, EPA developed a regression based approach to apply the sensitivities of 7-months of HDDM modeling to the full 5-year record. Chris Emery (Environ) and I evaluated a similar regression based technique for an HDDM model run conducted for 2006 (Yarwood et al. 2013), and we discovered several limitations to this approach. We found that even for the year in which the modeled HDDM regressions were derived, that significant artifacts can be introduced by a regression based approach. This leads to spurious modeled ozone, particularly at extreme high and low ozone levels. We found that regression estimated sensitivity coefficients were not a suitable replacement for actual modeled sensitivity coefficients for the year in which they were derived. Applying regressions for sensitivity coefficients derived in one year to a different year with different emissions and meteorology may introduce significant uncertainty in the HDDM analysis. <u>EPA should conduct a model performance evaluation for select time periods in different years with different meteorology to evaluate the uncertainty introduced by the regression approach.</u> A more complete description of the analysis conducted by Chris Emery and myself can be found in his comments submitted to CASAC.

c) Effect of regression based HDDM methodology on estimates of emissions

reductions necessary to meet alternative standards

A regression based HDDM approach generally leads to lower emission reductions necessary to attain a proposed standard (Figure 1). Because the natural variability of the data is collapsed onto a line in the regression based approach, there is less variability away from the mean. Attainment of a proposed standard is achieved when the 4th highest 3-year average MDA8 reaches a specific threshold, and this threshold is easier to meet when the natural variability in the data is reduced. A more complete description of the analysis conducted by Chris Emery and myself can be found in his comments submitted to CASAC.

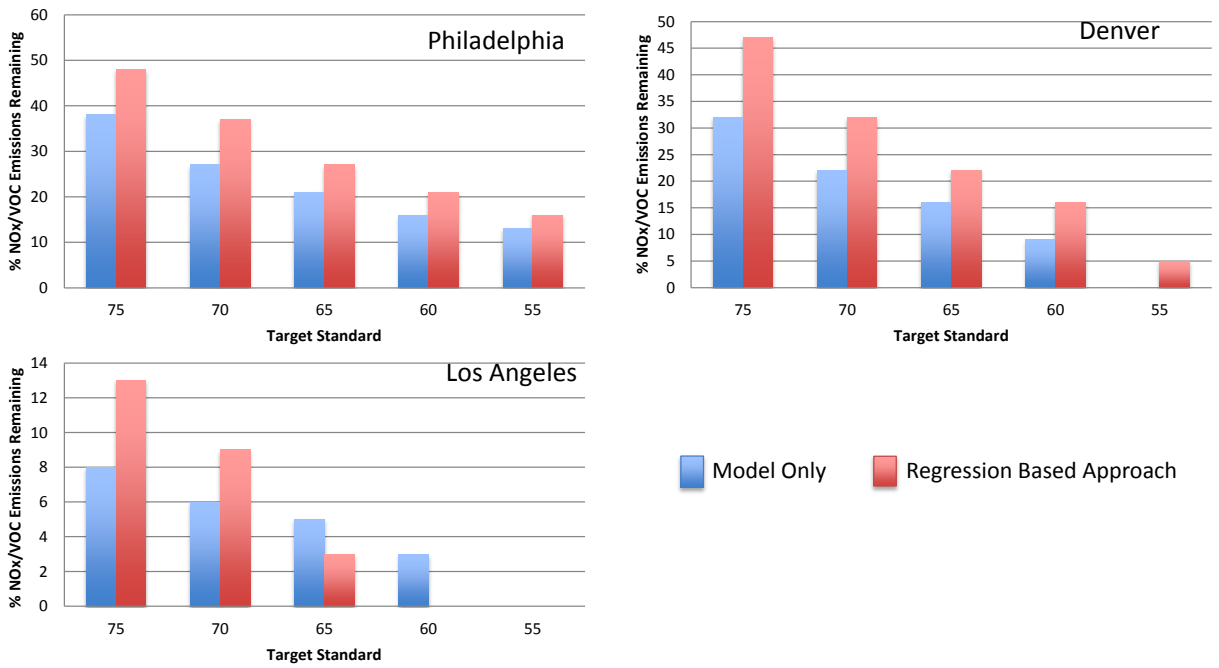

Figure 1. Percent NOx/VOC emissions remaining to meet target ozone standards for both HDDM Model only and regression based simulations.

2. **The importance of complex spatial dynamics of ozone responses to changes in emissions (Relevant to CASAC HREA Charge Question #15)**

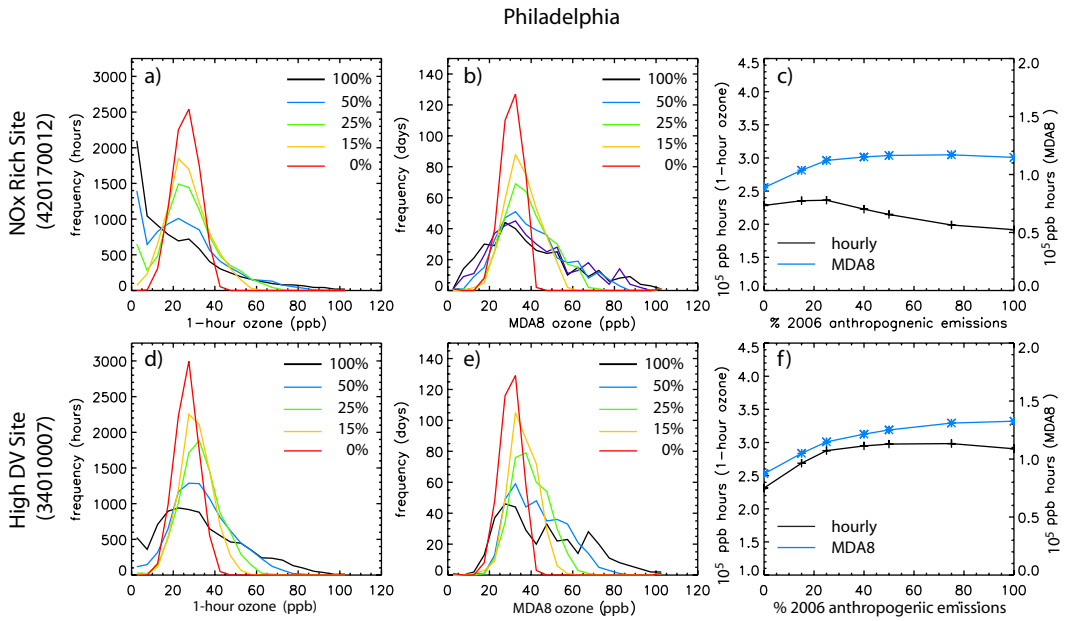

Figure 2. Ozone frequency distributions as a function of % of 2006 anthropogenic emissions for two sites in Philadelphia generated from HDDM modeling using CAMx (Yarwood et al. 2013). Percents are percent of 2006 anthropogenic emissions. From Downey et al. submitted to Environmental Science and Technology.

a) Urban vs. Suburban Response

At current emission levels at urban core NOx rich sites there is a high frequency of very low ozone (< 20 ppb), along with high ozone hours (> 60 ppb) (Black line, Figure 2a). As emissions are reduced to eliminate peak ozone events, there is a corresponding reduction in the frequency of low ozone hours, and an increase in the frequency of mid-level ozone (Red line, Figure 2a, 2b). This is driven by the reduction in NOx scavenging in the urban core as emissions are reduced. In urban core sites, the overall integrated hourly ozone can increase as emissions are reduced (Figure 2c). The integrated exposure for hours contributing to the daily MDA8 tends to show minimal response to changes in emissions over a wide range of anthropogenic emission scenarios in urban core sites. The patterns are similar for more suburban sites (Figure 2d, 2e), but there tend to be fewer hours at very low ozone in the base case. This leads to a stronger net decrease in integrated ozone at suburban sites as anthropogenic emissions are reduced (Figure

2f). Much of the discussion and figures related to the dynamic response of ozone to changes in emissions appears in the Appendices of the HREA. EPA should bring more of this discussion forward to the main document to highlight the possible differences to changes in responses for Urban and non-Urban populations and should evaluate whether this has implications for at-risk populations.

b) Composite Monitor Averaging

EPA employs a simple composite monitor average to generate a single time series for a city for use in the mortality risk estimates. This is justified in the document because the underlying health effects studies used a composite monitor average. The agency has, however, extended the spatial area under consideration outside the urban core areas evaluated in health effects studies (Figure 3). Due to the differences in responses of ozone to changes in precursor emissions in suburban vs. rural areas (Figure 2), straight averaging of monitors from both urban and suburban areas may significantly misrepresent the mean ozone changes for the city-wide population. It is more appropriate to either use the individual monitor records, or to generate a population weighted monitor average to accurately describe the mean ozone changes experienced by people living within a city and it's suburbs.

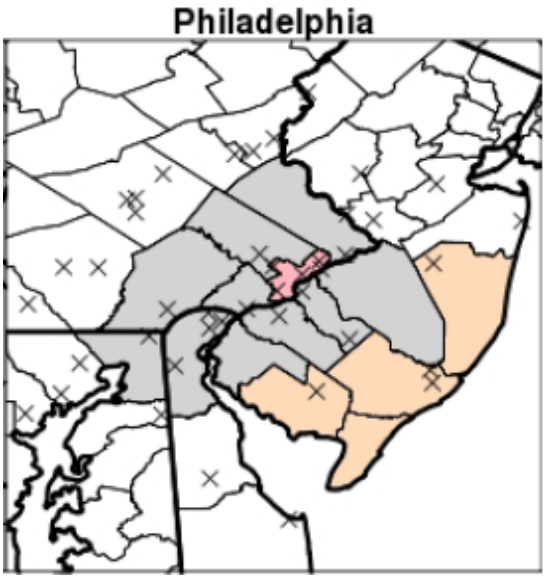

Figure 3. From Figure 4-5a, 2nd draft REA. Core urban area (pink) considered in the underlying health effects study and outlying areas considered in the REA. Black x's represent monitor locations.

c) **Ozone season vs. full year**

In the HREA, EPA evaluates the risk over the ozone season, which in many cities is only defined as the more photochemically active portion of the year (spring/summer). With the paradigm shift toward evaluating the risk of all ozone down to zero, the historic definition of the ozone season is outdated. EPA should evaluate the risk for the entire calendar year for all cities. In cities where a full year of monitoring data is not available, EPA should evaluate the impact of considering only the ozone season vs. the full year with modeling data. In fall and winter, a less photochemically active portion of the year, there is more NOx scavenging and a stronger depression of ambient ozone in NOx saturated environments. The difference between considering the April to September and the full year for two sites in Philadelphia consistently leads to an overestimate in reductions of total ozone exposure (Figure 4). This is a significant effect, which may impact health risk estimates and should be quantified in the HREA.

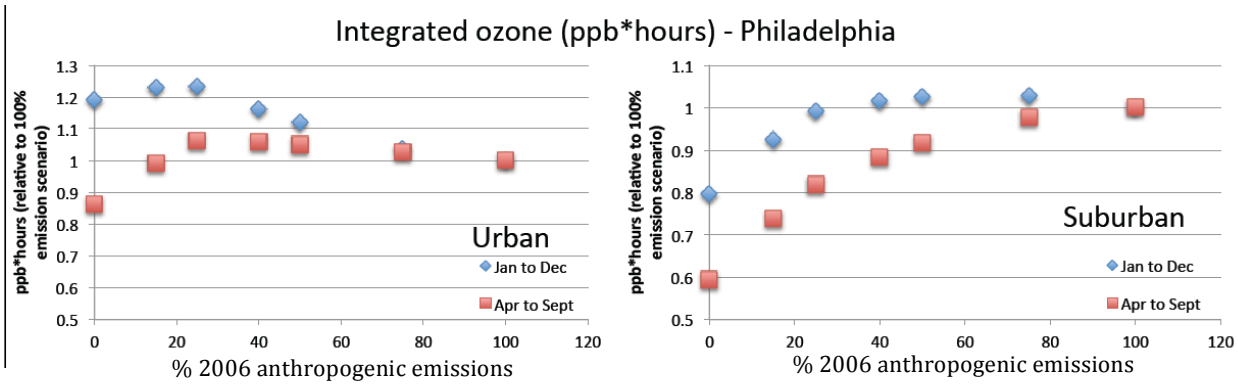

Figure 4. Modeled integrated ozone concentrations (ppb*hours) relative to base-case scenario with 100% anthropogenic emissions at an urban and suburban site for April to September (red) and the full year (blue). Consideration of the shorter 'ozone season' leads to an overestimate in the relative reduction of integrated ozone.

3. **The importance of presenting the risk at background in the HREA**

The HREA argues that the new HDDM modeling implicitly includes background, and that background warrants no further discussion in the document. Based on the 2012 CASAC meeting on the 1st draft REAs and PA, some members expressed the need to

present the administrator with the risk at background to give her a complete perspective of what risk is controllable by US policies. This is an important consideration in the standard setting process. The appropriate method to estimate the risk at background is to conduct the same morbidity and mortality modeling that was completed for the current and alternative standards using a time series of background ozone from a zero out run such as Zhang et al. (2011) or Emery et al. (2012). This modeling should include an estimate of the uncertainty introduced by the known inability of these models to capture peak background ozone events.

II. Comments on Welfare Risk and Exposure Assessment for Ozone

1. Background ozone is likely a significant contributor to W126

EPA has not presented background contributions to the W126 metric in the WREA. As shown in Figures 5 and 6, there is significant overlap between peak background ozone and W126 in excess of 7 ppm hours in the Western United States. EPA should evaluate the contribution of background ozone to the proposed secondary standard, and evaluate whether that standard is attainable with contemporary background ozone. Considerations of attainment, cost and feasibility can be considered in setting the secondary standard.

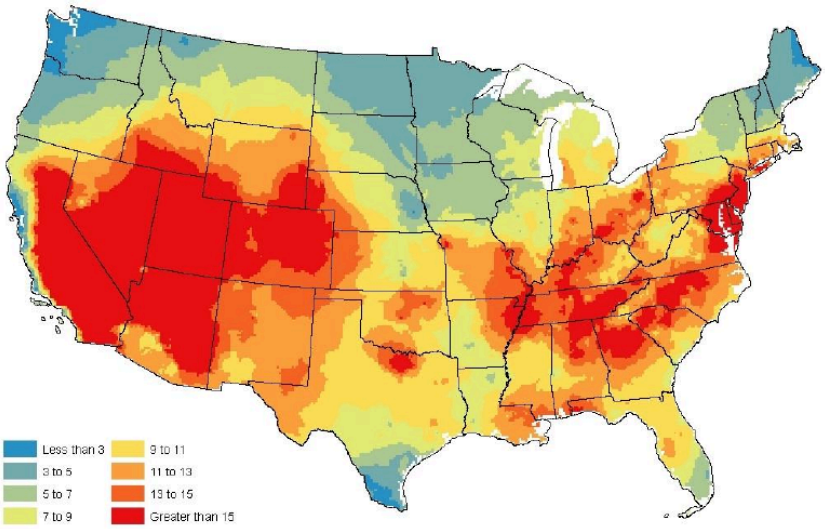

Figure 4-5 National surface of observed 2006-2008 average W126 concentrations, in ppm-hrs

Figure 5. National surface of observed 2006 to 2008 average W126 concentrations. Taken from the Welfare REA.

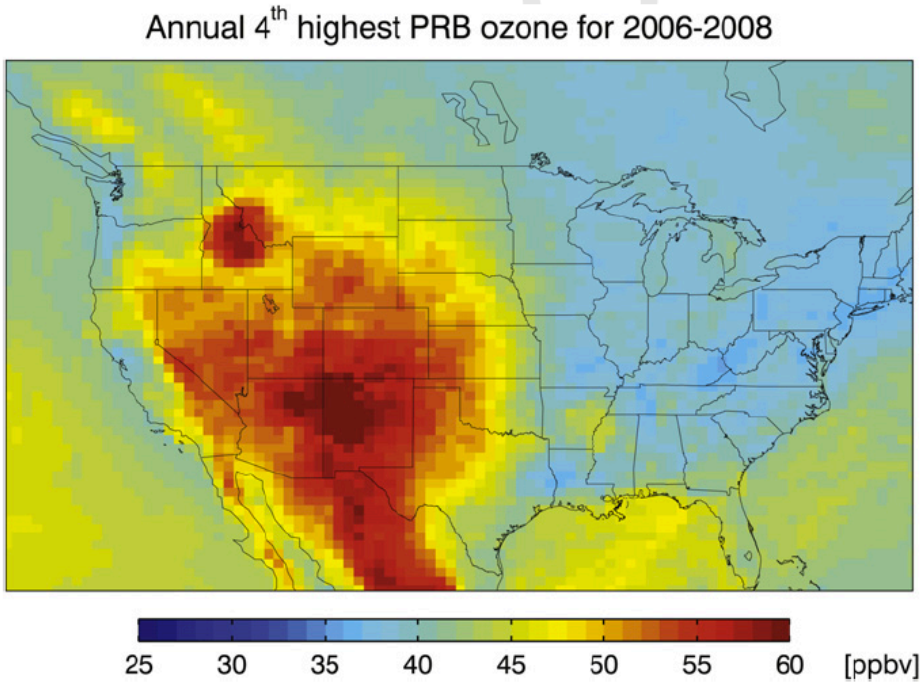

Figure 6. National modeled 4th highest MDA8 background ozone from Zhang et al. (2011).

III. Comments on Policy Assessment for Ozone

1. Background ozone (Relevant to CASAC PA Charge Question #2-2)

The policy assessment presents new source apportionment and zero-out modeling based estimates of background ozone. In the main PA document, there is significant emphasis placed on the results of the source apportionment run, particularly with respect to the contribution of background ozone to 'high' ozone levels. In a source apportionment run, both background ozone and anthropogenic emissions interact, leading to the destruction of background ozone by anthropogenic NOx emissions. This is an accurate representation of the contribution of background ozone to observed ozone levels, but should not be used to infer background ozone levels for any other emissions scenarios. If anthropogenic emissions are reduced, the destruction of background ozone by anthropogenic NOx will decrease, and background ozone will be higher (Figure 7). The background ozone scenario from a zero-out run represents the minimum risk possible by US anthropogenic emissions reductions because as anthropogenic emissions are reduced, the risk due to background increases. The source apportionment runs presented in the policy analysis do not add any value, and confuse the background ozone issue. The policy assessment should bring forward more of the zero-out run discussions found in appendix 2, and should focus on the zero-out runs as the minimum risk possible with US anthropogenic controls. Discussions based on source apportionment runs should be removed from the PA.

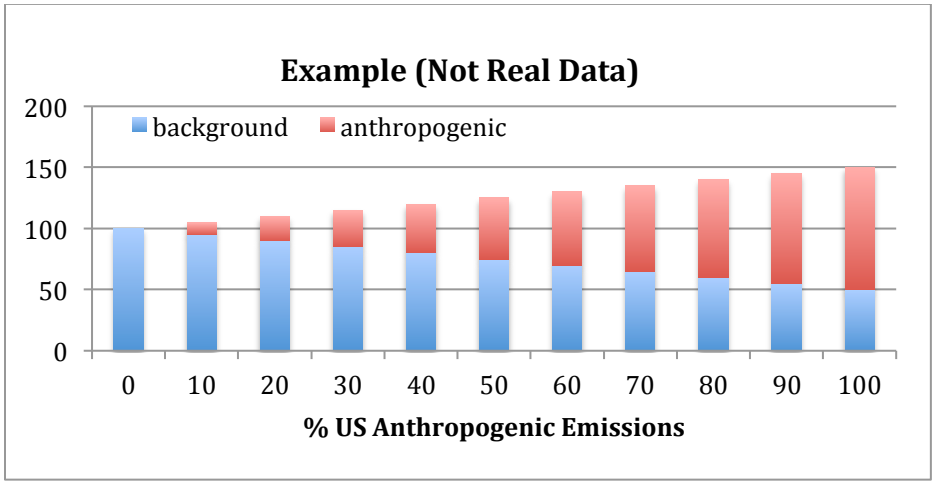

Figure 7. Hypothetical distribution of background as a function of anthropogenic emissions. A source apportionment run will generate an estimate of background at 100% anthropogenic emissions, while a zero-out run will generate an estimate of background at 0% anthropogenic emissions.

2. **Adequacy of the secondary standard (Relevant to CASAC PA Charge Question #5-1)**

   In the PA, EPA argues that the secondary standard is not adequate to protect welfare from the effects of ozone. Their analysis, however, of W126 values across the nation under the current standard (Figure 8) shows that bringing the nation into compliance with the current standard would lead to drastic reductions in W126. Nearly all areas are below a threshold of 11 ppm hours, and all national parks are below the 10.46 threshold EPA argues is important for foliar injury. <u>It is clear that the current primary standard is protective of welfare, and that attainment of the proposed W126 thresholds are redundant.</u>

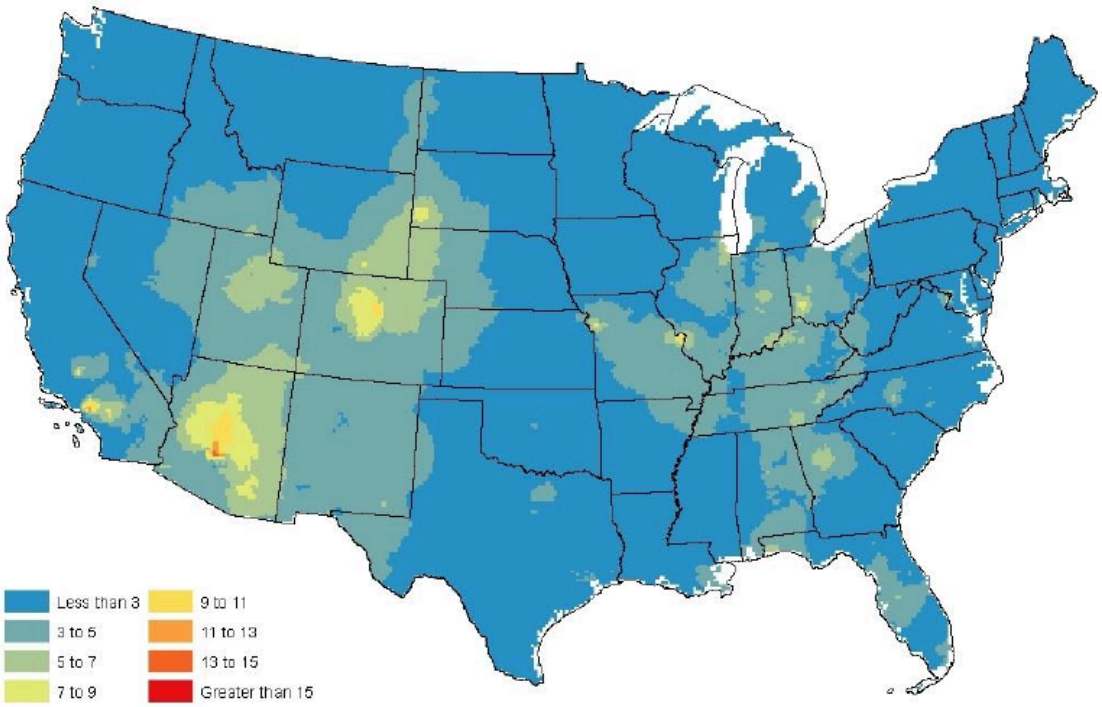

Figure 4-7 National surface of 2006-2008 average W126 concentrations (in ppm-hrs) adjusted to just meet the existing O_3 standard of 75 ppb

Figure 8. National surface of 2006 to 2008 average W126 concentrations (ppm*hours) adjusted to meet the existing standard of 75 ppb.

References:

Downey, N., Emery, C., Jung, J., Sakulyanontvittaya, T., Hebert, L., Blewitt, D., Yarwood, G.: Emission reductions and urban ozone responses under more stringent US standards, submitted to Environmental Science & Technology, 2014.

Emery, C., J. Jung, N. Downey, J. Johnson, M. Jimenez, G. Yarwood, R. Morris, 2012. Regional and global modeling estimates of policy relevant background ozone over the United States. *Atmospheric Environment*, doi:10.1016/j.atmosenv.2011.11.012.

Yarwood G., C. Emery, J. Jung, U. Nopmongcol, and T. Sakulyanontvittaya: A method to represent ozone response to large changes in precursor emissions using high-order sensitivity analysis in photochemical models, Geosci. Model Dev., 6, 1601–1608, doi:10.5194/gmd-6-1601-2013, 2013.

Zhang L., Jacob D.J., Downey N.V., Wood D.A., Blewitt D., Carouge C.C., van Donkelaar A., Jones D.B.A., Murray L.T., Wang Y., 2011. Improved estimate of the policy-relevant background ozone in the United States using the GEOS-Chem global model with 1/2°×2/3° horizontal resolution over North America. *Atmospheric Environment*, doi:10.1016/j.atmosenv.2011.07.054.