

Comments on the Letter to the Administrator from the CASAC Ozone Review Panel on the Second Draft HREA Assessment

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E.S. Executive Summary

- Background O₃ is a major player in the decision-making process that results in the setting of the O₃ NAAQS. It is our opinion that background O₃ must have a seat not just at the table, but a seat at the head of the table when the final standard-setting decisions are made by the EPA Administrator.
- The CASAC draft HREA letter correctly notes that sources of background O₃ are incorporated into the EPA modeling that is used in the HREA. Thus, the distribution of model-derived estimates of hourly average O₃ concentrations used in the risk analyses consists of both anthropogenic and background concentrations, whose combination affects the risk estimates.
- While background O₃ contributes more to ambient concentrations in the West and Intermountain West, background O₃ also plays an important role in other parts of the country.
- In the PA, the EPA CAMx source apportionment modeling found that more than 50% of the total modeled O₃ consisted of background O₃ for most regions of the U.S., with many sites in the western half of the U.S. experiencing over 70%, implying that background O₃ levels factor prominently into model-estimated health risk.
- Elevated background is a persistent feature in the spring and early summer in the western U.S. and is likely not easily identifiable as exceptional events but rather it contributes on a continuous basis as enhancements to surface O₃ concentrations.
- Background tropospheric O₃ affects both the health risk and attainability of alternative O₃ standards.

- Information contained within the HREA points out that cumulative lung function and epidemiological risk estimates for attaining the 75, 70, 65 and 60 ppb standards indicate that a large percentage of the risks are associated with 8-hour average ambient concentrations in the 25-55 ppb range (Fig. E1).

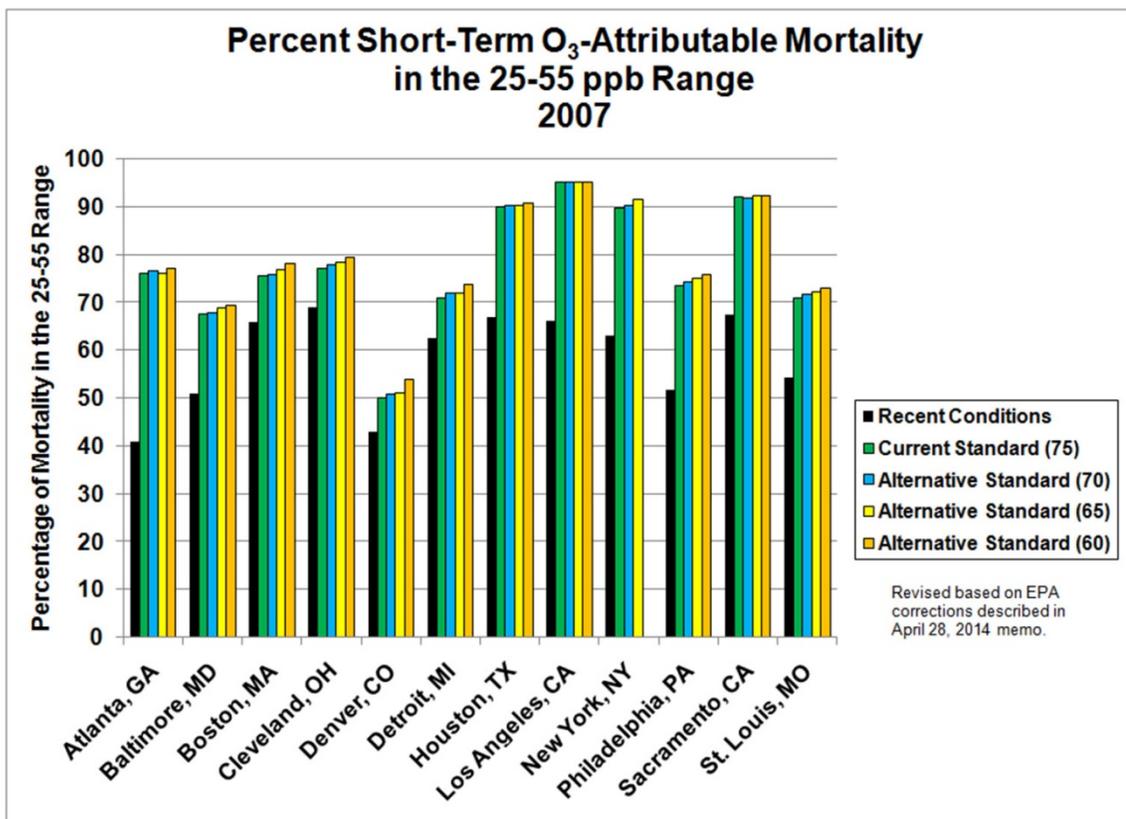


Fig. E1. Percent short-term O₃-attributable mortality in the 25-55 ppb range for various exposure conditions for 2007. (Source: Corrected data obtained from E. Sasser memo of April 28, 2014).

- The 25-55 ppb range of concentrations, where a large percentage of the health risks are associated, is the range of concentrations associated with background O₃ and these concentrations cannot necessarily be substantially reduced (Fig. E2).
- In its HREA letter, CASAC presents a summary of the model-estimated number of *premature deaths avoidable* for short-term exposure to O₃ as a function of alternative O₃ standards. A large percentage of the summary numbers presented are heavily influenced by values for New York and Los Angeles. On Page 4-19 of the HREA, EPA concludes that estimates of risk for these two cities are significantly uncertain. When the two cities are eliminated from CASAC’s calculation, the results support the EPA’s conclusion in the HREA on page 9-23 that mortality and morbidity risks did not show large responses to meeting existing or alternative levels of the standard.

- Many of the modeling-estimated avoidable deaths estimated by CASAC appear to be associated with background O₃, whose levels cannot necessarily be substantially reduced by international reductions in emissions.

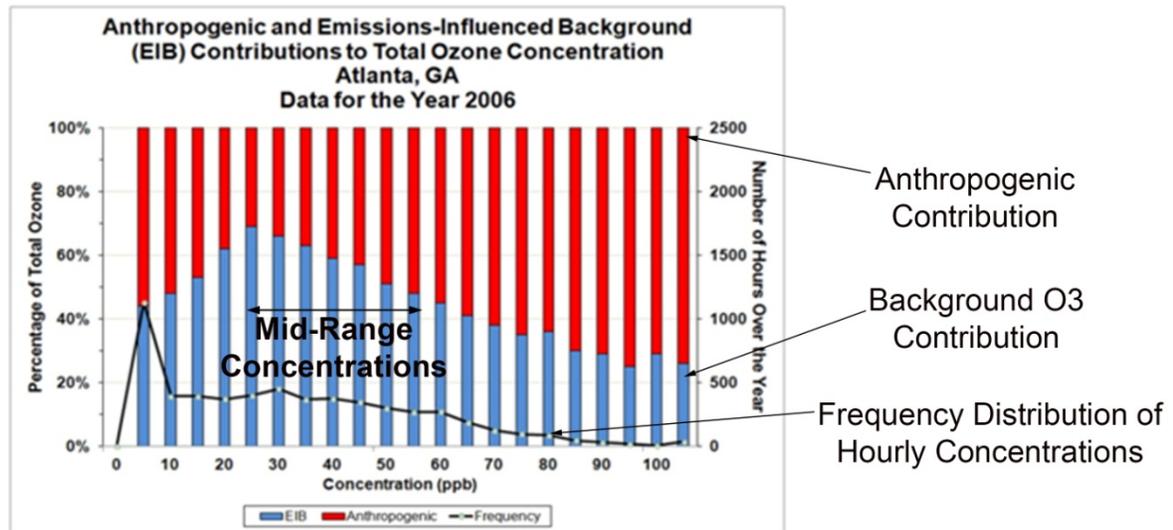


Fig. E2 . Binned (5 ppb) frequency distribution of observed hourly total O₃ (black curve; right axis) and average relative binned contributions of maximum hourly EIB and anthropogenic O₃ (bars; left axis) for ambient conditions in 2006 at Atlanta. (Source: Lefohn et al., 2014a). The percentage that background O₃ contributes in the 25-55 ppb range to observed O₃ will increase as emissions are reduced from current levels.

1. Background Ozone

In previous comments both written (Lefohn and Oltmans, 2014a, 2014b) and oral (<http://yosemite.epa.gov/sab/sabproduct.nsf/bf498bd32a1c7fdf85257242006dd6cb/84006d7423b29d9b85257b96004a8381!OpenDocument&Date=2014-03-25>) to the EPA and CASAC, we emphasized the importance of the role, levels, and relevance of background tropospheric O₃ in affecting both the health risk and attainability of alternative O₃ standards. The CASAC draft HREA letter correctly notes that sources of background O₃ are incorporated into the EPA modeling that is used in the HREA. The distribution of model-derived estimates of hourly average O₃ concentrations consists of both anthropogenic and background concentrations. EPA quantified the contribution of background O₃ across the U.S. in Chapter 2 of the EPA Policy Assessment document and notes the large contribution to current O₃ levels that background O₃ makes across the entire US, particularly in the western U.S. Lefohn and Oltmans (2014a, 2014b) presented to CASAC and the EPA Docket in March scientific results published in the literature, including our own analyses, that support the observation that the range of background O₃ concentrations estimated from models indicates that background O₃ levels factor prominently into model-estimated health risk and therefore, background O₃ will affect discussions concerning the levels of alternative O₃ standards. Based on the information generated by EPA in the PA and modeling results described in Lefohn and Oltmans (2014a, 2014b), we believe that background O₃ is a major player in the decision-making process that results in the setting of the O₃ NAAQS. It is our opinion that background O₃ must have a seat not just at the table, but a seat at the head of the table when the final standard-setting decisions are made by the EPA Administrator.

The topic of background O₃ was heavily commented on by public testimony at the March 25-27, 2014 CASAC Ozone Review Panel Meeting. Information contained within the HREA

points out that cumulative lung function and epidemiological risk estimates for attaining the 75, 70, 65 and 60 ppb standards indicate that a large percentage of the risks are associated with 8-hour average ambient concentrations in the 25-55 ppb range (Lefohn and Oltmans, 2014a, 2014b; Lefohn et al., 2014a, 2014b). This is the range of concentrations associated with background O₃ and these concentrations cannot necessarily be substantially reduced. As we note in Lefohn and Oltmans (2014c), research results published in the literature indicate large discrepancies in the attribution of the levels of Asian pollution O₃ to background O₃. Research results indicate that natural uncontrollable contributions from the stratosphere enhance surface O₃ 4-5 times more than O₃ associated with the long-range transport from Asia (Lin et al., 2012a). Table 2 below reproduced from Lin et al. (2012a) provide modeling results that compare the relative contribution to observed O₃ levels at 15 high-elevation sites in the West from the long-range transport of Asian emissions and natural uncontrollable stratospheric O₃.

Table 2. Surface MDA8 Ozone Concentrations (in ppbv) Averaged Over 15 High-Elevation Western U.S. Sites for April June 2010

Sources	Mean	Mean for Days > 60 ppbv
Total observed	55.3 ± 8.3	65.1 ± 4.4
Total modeled	61.0 ± 8.6	66.0 ± 8.3
NA anthropogenic	11.0 ± 5.0	11.6 ± 5.3
Total background ^a	50.0 ± 10.6	54.5 ± 10.6
Asian anthropogenic ^b	4.7 ± 2.4	5.3 ± 2.6
Stratospheric	22.3 ± 11.5	25.4 ± 12.3

^aIncludes the contribution from Asian pollution and stratospheric O₃.

^bBased on AM3 simulations as described by *Lin et al.* [2012].

Source: Lin et al. (2012a).

An ongoing evaluation of background O₃ levels in two chemistry transport models, the Geophysical Fluid Dynamics Laboratory (GFDL) AM3 and GEOS-Chem, has shown that these models are able to capture a number of the important features of NAB O₃ over the U.S. A recent

study (Fiore et al., 2014) compared the two models and the authors reported that although both the AM3 and GEOS-Chem models capture a number of the important features of NAB O₃ over the U.S., important differences occur. For several reasons discussed in Fiore et al. (2014), biases were found over the western U.S. in the spring, with underestimates for GEOS-Chem and overestimates for AM3. The need for adjusting for model biases in both models was noted in the paper. Based on recent work (Lefohn et al., 2014a, 2014b), adjustments for biases, primarily associated with the stratospheric contribution to background O₃, found that the two models' attribution of background O₃ was very similar at a number of sites particularly in the U.S. Intermountain West. Lefohn et al. (2014a) reported for the GEOS-Chem/CAMx model that many of the sites across the US, during the spring, fall, and winter months, experienced global background O₃ contributions associated with frequent stratospheric enhancements. In many cases, Lefohn et al. (2014a) noted that the GEOS-Chem/CAMx model underestimated total O₃ concentrations and that these underestimates appeared to be associated with the model's underestimates of the importance of stratospheric O₃. For the GFDL AM3 model, Lefohn et al. (2014b) found that the adjusted daily stratospheric MDA8 O₃ concentrations substantially contributed to surface O₃ at the high-elevation sites in the West and Intermountain West. In our previous summary provided to CASAC (Lefohn and Oltmans, 2014a, 2014b) of the characterization of background O₃, we noted that background O₃ contributed a large percentage of the observed O₃ in the 25-55 ppb range.

In the PA, the EPA CAMx source apportionment modeling for the April-October seasonal mean found that more than 50% of the total modeled O₃ consisted of background O₃ for most regions of the U.S., with many sites in the western half of the U.S. experiencing over 70%,

implying that background O₃ levels factor prominently into model-estimated health risk across the U.S. (Fig. 1).

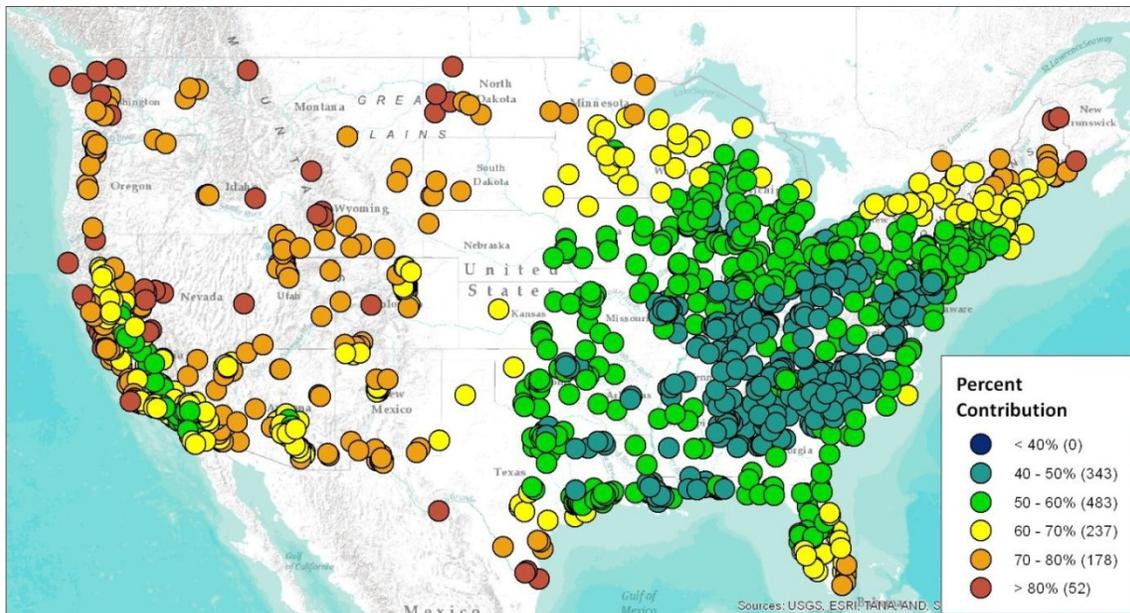


Fig. 1 Map of apportionment-based U.S. background percent contribution to seasonal mean O₃ based on 2007 CAMx source apportionment modeling. (Source: page 2-18 of PA).

Recent published work (Zhang et al., 2011; Lin et al., 2012a, 2012b; Lefohn et al. 2014a) and ongoing research (Fiore et al., 2014; Lefohn et al., 2014b) reinforce the important contribution of North American background O₃ (NAB) on 8-hour maximum daily average O₃ (MDA8) at or near current air quality standards. In particular, during the spring and early summer, NAB O₃ over the western U.S. is routinely elevated. *Elevated background is a persistent feature in the spring and early summer in the western U.S. and is likely not easily identifiable as exceptional events but rather it contributes on a continuous basis as enhancements to surface O₃ concentrations.* These findings support the significant contribution of background O₃ to observed (total) O₃, its role in the cumulative health and welfare risks, and the attainment of an O₃ standard.

2. CASAC’s Comments on Estimated Short-Term Mortality Associated with Ozone

In its draft HREA letter to the EPA Administrator, CASAC presents summarized information that indicates that the annual mean number of *premature deaths avoidable* for short-term exposure to O₃ ranges from 140 to 270 at a level of 70 ppb; 650 to 990 for a level of 65 ppb; and 790 to 1170 for a level of 60 ppb, compared to just meeting the current standard (i.e., 75 ppb). Using information contained within Table 7-7 published in the April 28, 2014 memorandum entitled, *Corrections to Estimates of Epidemiology-based Mortality and Morbidity Risks Presented in the Health Risk and Exposure Assessment for Ozone, Second External Review Draft* written by Dr. Erika Sasser, we reconstructed in Table 1 the CASAC estimates as follows:

Table 1. Relative Changes in Incidences for Model-Derived Estimates of Short-Term O₃-attributable All Cause Mortality (2007 and 2009) Compared to 75 ppb Incidences

Study Area	2007 (70)	2009 (70)	2007 (65)	2009 (65)	2007 (60)	2009 (60)
Atlanta, GA	10	7	18	13	28	19
Baltimore, MD	7	4	14	9	23	14
Boston, MA	4	-1	11	3	18	8
Cleveland, OH	8	7	20	18	40	31
Denver, CO	1	0	3	1	5	5
Detroit, MI	18	-17	33	-5	54	12
Houston, TX	4	-1	9	3	20	12
Los Angeles, CA	26	25	52	53	96	98
New York, NY	150	96	740	500	740*	500†
Philadelphia, PA	26	14	56	33	86	51
Sacramento, CA	3	3	6	5	10	9
St. Louis, MO	15	7	31	17	49	30
SUM	272	144	993	650	1169	789

*In the CASAC HREA letter, CASAC provided the 2007 estimate of 740 at the 65 ppb level for the 2007 estimate at the 60 ppb level. EPA provided no estimate in Table 7-7 in the Sasser memorandum.

†In the CASAC HREA letter, CASAC provided the 2009 estimate of 500 at the 65 ppb level for the 2009 estimate at the 60 ppb level. EPA provided no estimate in Table 7-7 in the Sasser memorandum.

The comparison between CASAC's and our estimates is as follows:

CASAC	270	140	990	650	1170	790
Our Estimates	272	144	993	650	1169	789

The results of the comparison indicate that apparently both CASAC and we are using the same source of data. Note in Table 1 above, the sum of the estimates for New York and Los Angeles contribute a substantial amount to the relative total incidences summarized in the CASAC HREA letter. In Table 2, the relative contribution of New York and Los Angeles to the SUM value is presented for each of the 6 cases summarized in Table 1.

Table 2. Percent Contribution of New York and Los Angeles to the Summation Value in Table 1 Above.

Study Area	2007 (70)	2009 (70)	2007 (65)	2009 (65)	2007 (60)	2009 (60)
New York/LA	65%	84%	80%	85%	72%	76%

In the HREA on page 4-18, EPA notes that for New York and Los Angeles there are uncertainties in the application of the HDDM adjustment methodology that resulted in the inability of the methodology to estimate O₃ distributions in these two cities which would meet lower alternative standard levels (65 ppb for New York, 60 ppb for Los Angeles). In addition, on page 4-19 in the HREA, EPA concludes that estimates of risk for these two cities for the alternative standards will be significantly more uncertain. Thus, when one eliminates the identified uncertain relative incidence estimates for New York and Los Angeles, the SUM calculations support the observation made by the EPA in the HREA on page 9-23 that mortality and morbidity risks did not show large responses to meeting existing or alternative levels of the standard.

In its HREA letter, CASAC refers to the number of relative changes in incidences as *premature deaths avoidable* for short-term exposure to O₃. Many of the deaths attributable to avoidable modeled deaths for each of the cities that make up the SUM calculations in the CASAC letter appear to be associated with background O₃ that may not be substantially changed. Cumulative model-derived estimates of mortality are mostly associated with the 25-55 ppb range. On page 9-23 of the HREA, as noted above, EPA summarized its mortality and morbidity risks by observing that generally these risks did not show large responses to meeting existing or alternative levels of the standard for several reasons.

- First, these risks were based on concentration-response (C-R) functions that were approximately linear along the full range of concentrations, and therefore reflected the impact of changes in O₃ along the complete range of 8-hour average O₃ concentrations. This included days with ***low baseline O₃ concentrations*** that were predicted to have ***increases*** in O₃ concentrations, as well as days with ***higher starting O₃ concentrations that were predicted to have decreases in O₃ concentrations*** as a result of just meeting existing and alternative standards.
- Second, these risks, according to the EPA, reflected changes in the urban-area wide monitor average, which would not be as responsive to air quality adjustments as the design value monitor, and which included monitors with both decreases and increases in 8-hour concentrations.
- ***Third, the days and locations with predicted increases in O₃ concentrations (generally those with low to midrange starting O₃ concentrations) resulting from just meeting the existing or alternative standard levels generally were frequent enough to offset days and locations with predicted decreases in O₃. The heat maps presented in Figures 7-2 and 7-3 in the REA demonstrated that just meeting progressively lower alternative standard levels narrowed the distribution of risk across the range of O₃ concentrations. In addition, the distribution of risk tended to be more centered on area-wide average concentrations in the range of 25 to 55 ppb after just meeting an alternative standard of 60 ppb. The focus of the epidemiological studies on urban case study area-wide average O₃ concentrations, and the lack of thresholds coupled with the linear nature of the C-R functions meant that in this analysis, the impact of a peak-based standard (which seeks to reduce peak concentrations regardless of effects on low or mean concentrations) on estimates of mortality and morbidity risks based on results of those studies was relatively small.***

As indicated in the third bullet, the distribution of risk tended to be centered in the 25-55 ppb range of 8-hour daily maximum concentrations after just meeting an alternative standard of 60 ppb. Further investigating the data in the HREA Appendix for Chapters 7-9, in most cases it appears that the greatest percentage of risk tended to also be in the 25-55 ppb range for recent conditions (2007), current standard (75 ppb), alternative standard (70 ppb), alternative standard (65 ppb), and alternative standard (60 ppb). Fig.2 illustrates that reducing emissions to attain the various standards increased the risk in the 25-55 ppb mid-range concentrations from the current conditions and this range of concentrations made up the greatest percentage of the risk. The figure shows for most of the 12 cities that most of the cumulative risk (70-95 percent) was associated with the concentrations in the 25-55 ppb range. Thus, the health benefits achieved by reducing high O₃ concentrations experienced by relatively few people will be offset by increased health effects among the large number of people exposed to mid-range concentrations (i.e., 25-55 ppb).

Ozone background concentrations contribute a substantial amount (i.e., generally 50-90% for EPA's cities) to these mid-range concentrations (Lefohn and Oltmans, 2014a, 2014b, 2014c). Fig. 3 (adopted from Lefohn et al., 2014a) illustrates under ambient conditions in 2006 the percent of background O₃ (blue) compared to total O₃ concentrations measured at Atlanta, Georgia. Background O₃ contributes from 50 to 70% to the total O₃ in the mid-range concentrations (25-55 ppb). As noted in the PA, as emissions are reduced, the percentage contribution of background O₃ in the 25-55 ppb range will increase. The higher concentrations will shift downward toward the mid-range and the lower concentrations will move upward toward the mid-range.

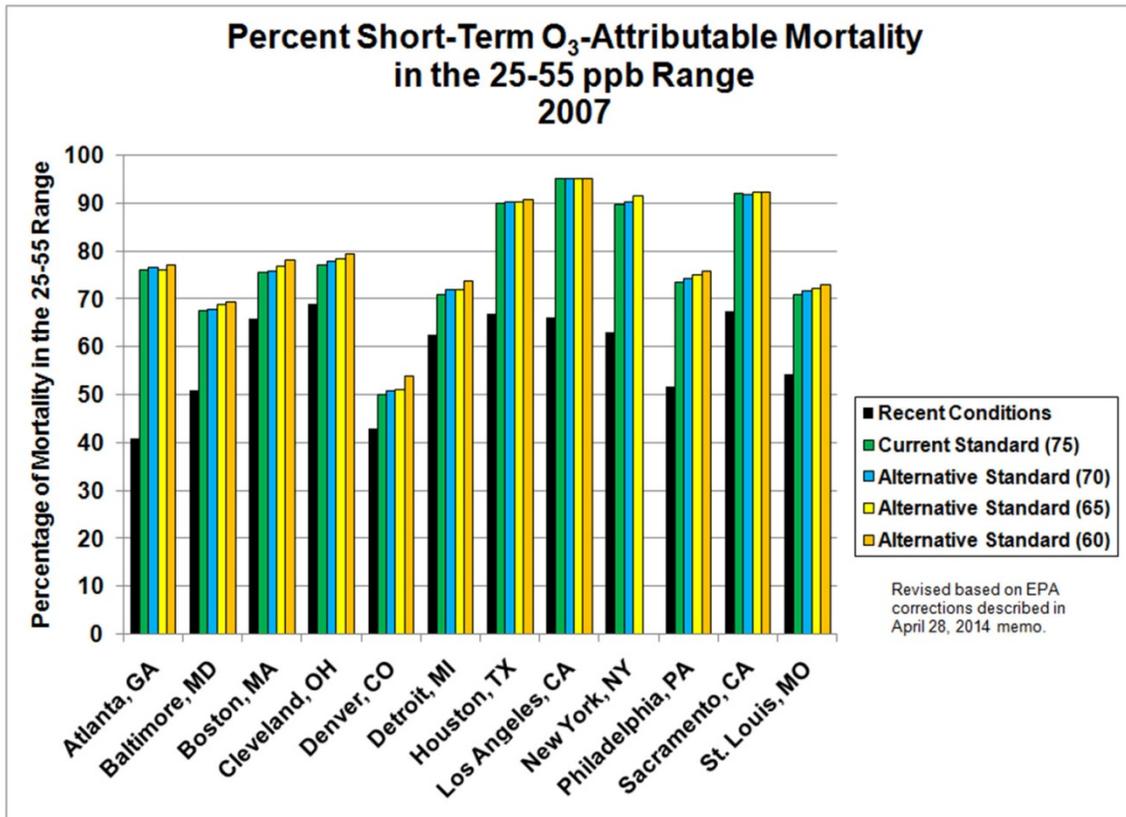


Fig 2. Percent short-term O₃-attributable mortality in the 25-55 ppb range for various exposure conditions for 2007. (Source: Corrected data obtained from E. Sasser memo of April 28, 2014).

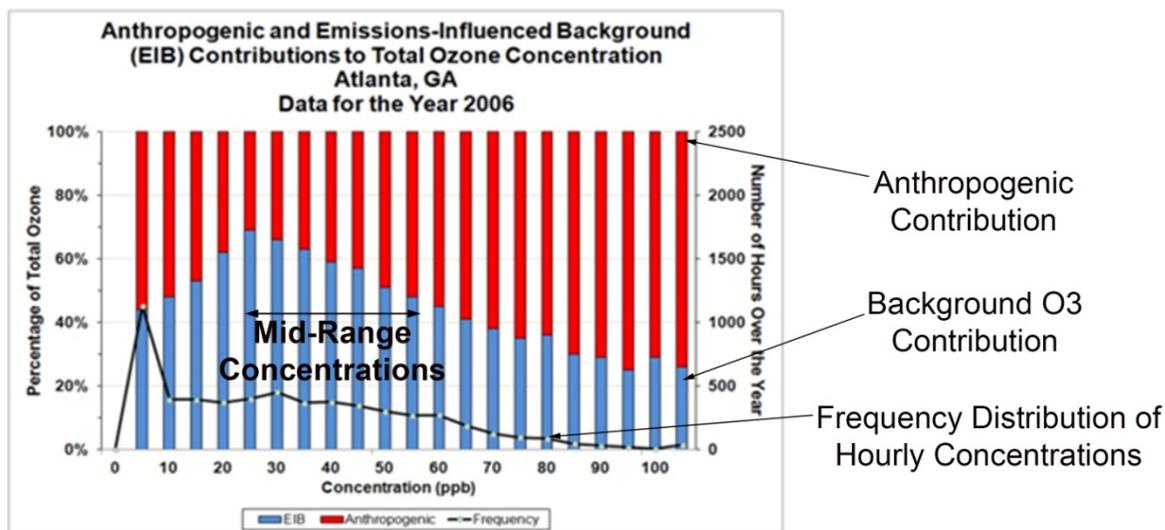


Fig. 3. Binned (5 ppb) frequency distribution of observed hourly total O₃ (black curve; right axis) and average relative binned contributions of maximum hourly EIB and anthropogenic O₃ (bars; left axis) for ambient conditions in 2006 at Atlanta. (Source: Lefohn et al., 2014a). The percentage that background O₃ contributes in the 25-55 ppb range to observed O₃ will increase as emissions are reduced from current levels.

Similarly, EPA’s estimates of cumulative risk associated with lung function decrements will be affected by the same mid-range concentrations, which contain an important contribution from background O₃. Thus, the cumulative risk analysis results for both the epidemiological, as well as the lung function decrements, will be affected by background O₃.

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Biographic Sketches of the Authors

***Allen S. Lefohn** is President and Founder of A.S.L. & Associates in Helena, Montana, a firm he founded in 1981. He received his Ph.D. in physical chemistry from the University of California at Berkeley in 1969. Dr. Lefohn has published over 125 peer-reviewed publications, edited four books, presented oral papers, and participated in a number of panel presentations. Over the past 48 years, besides focusing his research on understanding the relative importance of background ozone, Dr. Lefohn's research developed exposure-response relationships and indices that describe

the effects of ozone on vegetation and human health, as well as the analysis of air quality data in biologically relevant forms for effects assessment purposes. Dr. Lefohn was the lead consultant scientist for the EPA in authoring the air quality characterization chapter and the vegetation exposure-response section for the Ozone Criteria Document in 1996 and contributed to the Ozone Criteria Documents in 1985 and 2006. For the period 1989 – 1999, Dr. Lefohn served as an Executive Editor of the internationally recognized technical journal *Atmospheric Environment* and is an Emeritus Editor of the Journal. Dr. Lefohn is a co-guest editor with Dr. Owen Cooper of the NOAA Earth System Research Laboratory in Boulder, Colorado for the upcoming *Atmospheric Environment* special issue: Observations and source attribution of ozone in rural regions of the Western United States. He is currently an Adjunct Professor of Environmental Engineering at Montana Tech in Butte, Montana.

†**Samuel J. Oltmans** is currently a Research Associate with the Cooperative Institute for Research in the Environmental Sciences (CIRES) at the University of Colorado at Boulder. Prior to his retirement in 2011, Mr. Oltmans conducted atmospheric and environmental research for NOAA/ESRL and its predecessors for nearly 40 years. Prior to joining NOAA Mr. Oltmans pursued graduate studies in Astro-Geophysics at the University of Colorado, where he worked with Prof. Julius London. After completing his graduate studies, Mr. Oltmans joined the newly formed Geophysical Monitoring for Climatic Change (GMCC) unit of the NOAA Air Resources Laboratory, where he had worked part time as graduate student. His initial research effort at GMCC was to establish a surface ozone monitoring program at several baseline observatories including Mauna Loa, Hawaii; Barrow, Alaska; South Pole, Antarctica; and American Samoa. These were among the first ozone observations in what is now termed the “background” atmosphere, remote from traditional locations that were nearly exclusively focused on polluted urban conditions. In addition to his work on tropospheric ozone, Mr. Oltmans has done extensive research on the stratospheric ozone layer. Mr. Oltmans has collaborated widely with fellow observationalists and modelers and has authored or co-authored over 240 peer-reviewed publications. Mr. Oltmans has received a Department of Commerce Silver Medal and Bronze Medals for his research contributions. He is a Fellow of the American Geophysical Union and a member of the American Meteorological Society. He recently received the American Geophysical Union Yorum J. Kaufman Unselfish Cooperation in Research Award given for broad influence in atmospheric science through exceptional creativity, inspiration of younger scientists, mentoring, international collaborations, and unselfish cooperation in research.