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

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For Consideration by CASAC

May 19, 2014

E.S. Executive Summary

- Background O_3 is tightly linked to the cumulative risk estimated for the current as well as the alternative O_3 standards and attainment of the O_3 standard. Based on these findings, background O_3 is a major player in the EPA Administrator's decision-making process that evaluates the level of the O_3 standard.

- The Policy Assessment Document notes the particularly large contribution that background O_3 makes in the western U.S. to current O_3 levels. The difficulty this poses for meeting a standard below 70 ppb is, however, generally minimized in the Document.

- 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 O_3 concentrations.

- In the PA, the EPA CAMx source apportionment modeling found that a major portion of the total modeled O_3 was contributed by background O_3 over the western half of the U.S., as well as other regions of the U.S., implying that background O_3 levels factor prominently into model-estimated health risk.

- While background O_3 contributes more to ambient concentrations in the West and Intermountain West, background O_3 also plays an important role in other parts of the country.

- Information contained within the REA 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. This is the range of concentrations associated with background O_3 and these concentrations are not necessarily controllable (Fig. E1).

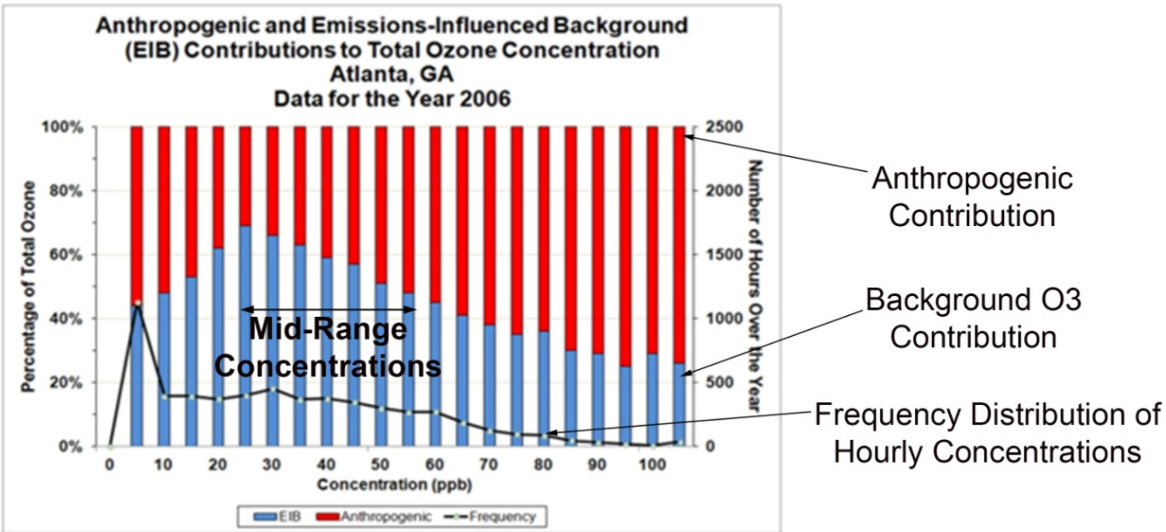

Fig. E1. Binned (5 ppb) frequency distribution of observed hourly total O_3 (black curve; right axis) and average relative binned contributions of maximum hourly EIB and anthropogenic O_3 (bars; left axis) for ambient conditions in 2006 at Atlanta. (Source: Lefohn et al., 2014a). The percentage that background O_3 contributes in the 25-55 ppb range to observed O_3 will increase as emissions are reduced from current levels.

- It is very problematic that CASAC recommends in its draft letter to the Administrator that EPA seek opportunities for international cooperation to reduce background O_3.

- While CASAC has assumed that anthropogenic emissions in Asia contribute a substantial amount to background O_3, research results published in the literature indicate large discrepancies in the attribution of the levels of Asian pollution O_3 to background O_3. Clearly, these discrepancies reported in the literature are a topic that requires further research.

- At this time, based on research published in the peer-reviewed literature, it is unclear what effect international emission reductions would have on surface O_3 concentrations in the U.S. Research results indicate that natural uncontrollable contributions from the stratosphere enhance surface O_3 4-5 times more than O_3 associated with the long-range transport from Asia (see Table 2 below from Lin et al., 2012b).

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

[a]Includes the contribution from Asian pollution and stratospheric O_3.
[b]Based on AM3 simulations as described by *Lin et al.* [2012].

- Thus, even if international cooperation could be achieved on Asian emissions reductions, it is unclear if background O_3 could be substantially reduced because of the contribution from uncontrollable, natural sources of O_3.

- It appears that CASAC will recommend lowering the O_3 health standard below the current 75 ppb level. *We strongly recommend that CASAC identify the specific new scientific studies and their associated results that support the lowering of the O_3 standard*.

- During the CASAC meeting on March 25-27, 2014 in Chapel Hill, there was considerable discussion by Panel members about setting the upper range of the recommended standard range below 70 ppb. Should the selection of the upper range be associated with the results reported by Schelegle et al. (2009), it is important that CASAC inform the Administrator that the Schelegle et al. (2009) experiment applied higher hourly average concentrations than intended. Schelegle et al. (2009) reported that their average concentration was 72 ppb in their experiment rather than the 70 ppb exposure regime designed by Dr. A.S. Lefohn.

1. Introduction

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 O_3 in affecting both the risk and attainability of alternative O_3 standards. The determination of background O_3 levels from photochemical models and the fidelity of these modeled O_3 levels in comparison with observed O_3 amounts under conditions likely to be representative of "background" conditions were discussed in the ISA. Background O_3 is reviewed in Chapter 2 of the Policy Assessment and the important contribution that it makes to observed O_3 is described for the U.S. The Policy Assessment Document notes the particularly large contribution that background O_3 makes in the western U.S. to current O_3 levels. The difficulty this poses for meeting a standard below 70 ppb is, however, generally minimized. The topic of background O_3 was heavily commented on by public testimony at the March 25-27, 2014 CASAC Ozone Review Panel Meeting as noted in the draft CASAC PA letter to the Administrator. Information contained within the REA 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. This is the range of concentrations associated with background O_3 and these concentrations are not necessarily controllable. In the PA, the EPA CAMx source apportionment modeling for the April-October seasonal mean found that a major portion of the total modeled O_3 was contributed by background O_3 over the western half of the U.S., as well as other regions of the U.S., implying that background O_3 levels factor prominently into model-estimated health risk (Fig. 1).

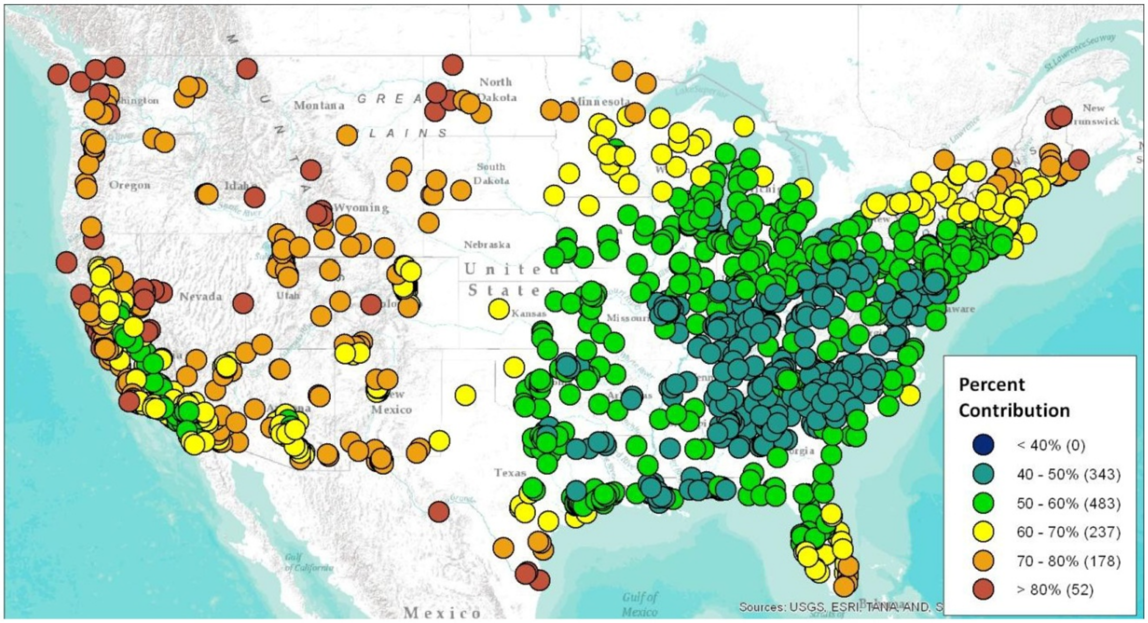

Fig. 1 Map of apportionment-based U.S. background percent contribution to seasonal mean O_3 based on 2007 CAMx source apportionment modeling. (Source: page 2-18 of PA).

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 O_3 (NAB) on 8-hour maximum daily average O_3 (MDA8) at or near current air quality standards. In particular, during the spring and early summer, NAB O_3 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 O_3 concentrations.* These findings emphasize the need to provide a balanced view that recognizes the significant contribution of NAB to observed (total) O_3, its role in the cumulative health and welfare risks, and the attainment of an O_3 standard.

An ongoing evaluation of background O_3 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 O_3 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 O_3 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 O_3, found that the two models' attribution of background O_3 was very similar at a number of sites particularly in the U.S. Intermountain West (Fig. 2).

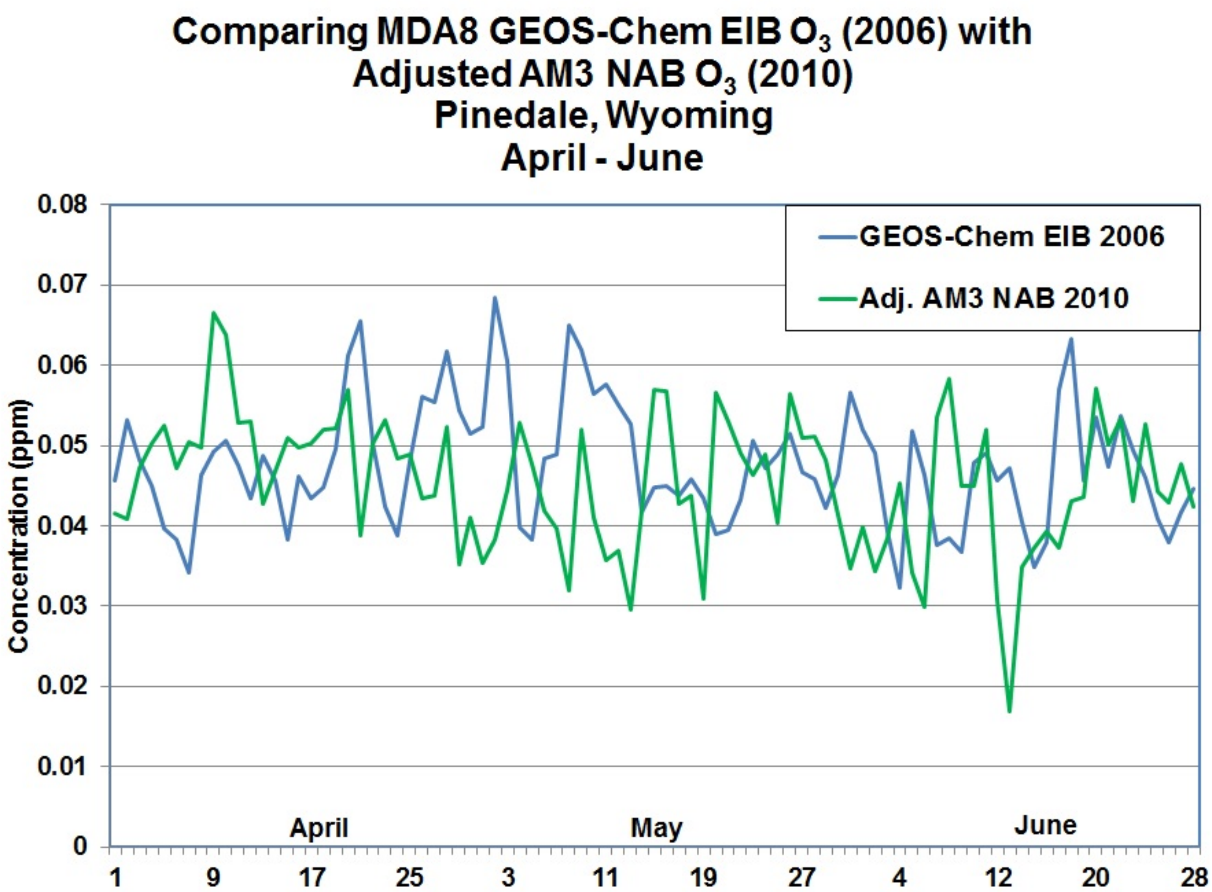

Fig. 2. Comparison of GEOS-Chem/CAMx model emissions influenced background (EIB) with adjusted GFDL AM3 NAB. Bias corrected EIB and NAB show very similar levels even when comparing different years. (Source: Lefohn et al., 2014b).

In its draft PA letter to the EPA Administrator, CASAC notes the importance of background O_3 in a policy and standard-setting context. CASAC states

> …More importantly, the Second Draft PA is not clear as to how background estimates might impact the primary and secondary standards and whether these impacts may differ regionally. The Second Draft PA cites a 2002 court decision (*American Trucking Associations, Inc. v. EPA, 283 F.3d at 379*) that allows the EPA to consider relative proximity to peak background levels when evaluating alternative standards but it also cites a case where the court said "attainability and technological feasibility are not relevant considerations in the promulgation of the NAAQS" (*American Petroleum Institute v. Costle*, 665 F. 2d at 1185). The Second Draft PA was silent as to how the EPA intends to navigate between these two legal guidelines when considering background ozone in a policy and standard-setting context. This question became an important issue in the CASAC deliberations as we listened to public comments that included information regarding high background levels in the intermountain Western United States.

Published research results indicate that background O_3 concentrations contribute an important amount to currently measured mid-level O_3 concentrations across the U.S. (Lefohn et al., 2014a). While background O_3 contributes more to ambient concentrations in the West and Intermountain West, background O_3 also plays an important role in other parts of the country. Fig. 3 illustrates under ambient conditions in 2006 the percent of background O_3 (blue) compared to total O_3 concentrations measured at Atlanta, Georgia. Background O_3 contributes from 50 to 70% to the total O_3 in the mid-range concentrations (25-55 ppb). As noted in the PA, as emissions are reduced, the percentage contribution of background O_3 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.

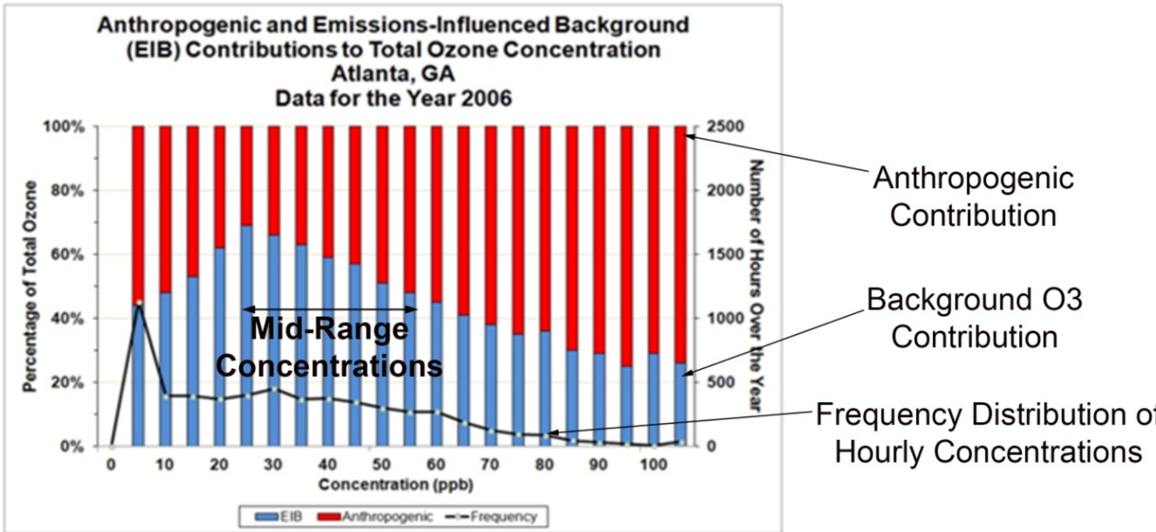

Fig. 3 . Binned (5 ppb) frequency distribution of observed hourly total O_3 (black curve; right axis) and average relative binned contributions of maximum hourly EIB and anthropogenic O_3 (bars; left axis) for ambient conditions in 2006 at Atlanta. (Source: Lefohn et al., 2014a). The percentage that background O_3 contributes in the 25-55 ppb range to observed O_3 will increase as emissions are reduced from current levels.

Based on our research experience, we believe that high background O_3 levels in the U.S. Intermountain West make achieving a standard below ≤70 ppb a very difficult (or nearly impossible) task given the large percentage that background O_3 contributes to current O_3 levels.

2. CASAC's Hypothesis for Controlling Background Ozone

On page 3 of the draft PA letter, we find it very problematic when CASAC recommends to the Administrator

> …that EPA seek opportunities for international cooperation to reduce long-range transport of ozone.

There are several reasons for our strong objection in the CASAC letter highlighting such a recommendation to the Administrator. It is unclear why this particular strategy for attaining the NAAQS was recommended in the letter as opposed to recommending other control strategies. To the best of our knowledge, CASAC has not received information in the ISA, REA, and PA documents indicating the effectiveness of alternative control strategies that affect the attainment of the O_3 NAAQS. There appears to be no basis for recommending in the CASAC draft PA letter a control strategy that focuses on the reduction of long-range transport.

In the draft PA CASAC letter, two studies (Fiore et al., 2009; Zhang et al., 2011) are cited as evidence for justifying the potential effectiveness of controlling international emissions in reducing background O_3 over the U.S. In particular, the modeling results described in Zhang et al. (2011) attributes a very large contribution of international long-range transport to background O_3 over the U.S. of 9 ppb in spring-summer at low-elevation sites and 13 ppb at high-elevations sites. It is our expert opinion that the high values attributed in Zhang et al. (2011) to international long-range transport are not representative or consistent with other studies reported in the peer-reviewed literature. The Fiore et al. (2009) work cited in the draft of the CASAC PA letter reports much lower values for spring and summer over the U.S. (Fig. 4). In particular, levels closer to 2 ppb for the contribution from East Asian and European emissions over the U.S. are presented (Fig. 4). Two published studies by Lin et al. (2012a, 2012b) report that for the period in 2010 of their study, the contribution from Asian pollution to the western US was ~5 ppb (Fig. 5 and Table 2 from Lin et al., 2012b). Lin et al. (2012a) estimate east of the Intermountain West that O_3 enhancements from Asian pollution were ~ 2-4 ppb. Lin et al. (2012a) indicate that long-range transport of Asia mostly affects sites in the West and Intermountain West and that the contribution of Asian emissions on surface O_3 is much less than stratospheric O_3 (i.e., approximately 20% of the contribution estimated for stratospheric O_3) (Table 2 from Lin et al., 2012b).

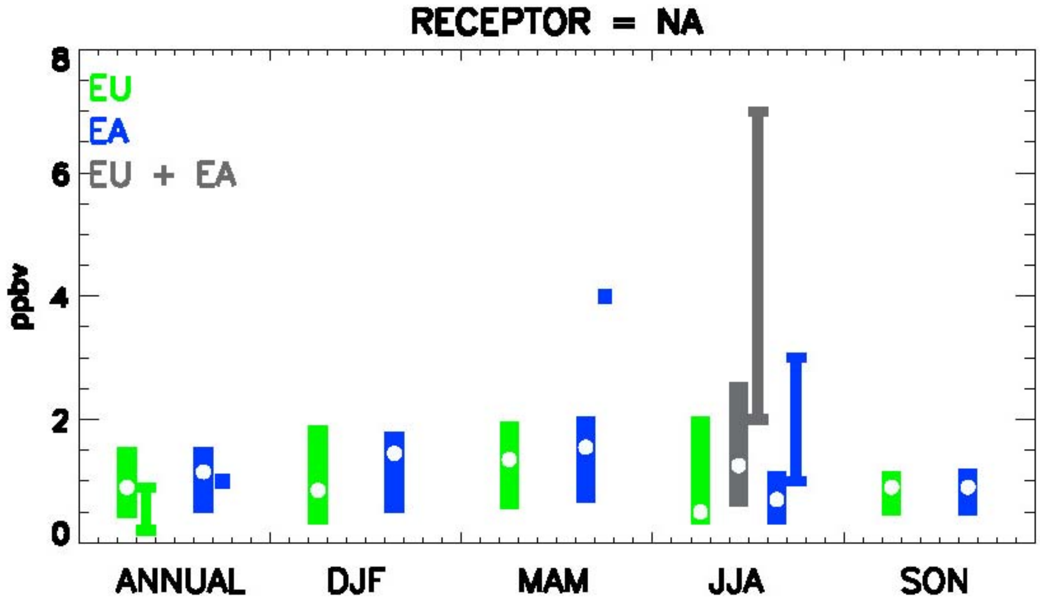

Fig 4. Annual and seasonal mean contribution to total surface O_3 from foreign source regions as estimated from the individual model results in this study (colored by source region: green for EU, blue for EA, gray for EA + EU, and red for NA) and from studies in the published literature (thin vertical bars for ranges across studies and regions; squares where one value is reported; note that regional definitions, methods for source attribution, and reported metrics (e.g., 24-h versus afternoon versus daytime mean) vary across studies). (Source: Fiore et al., 2009).

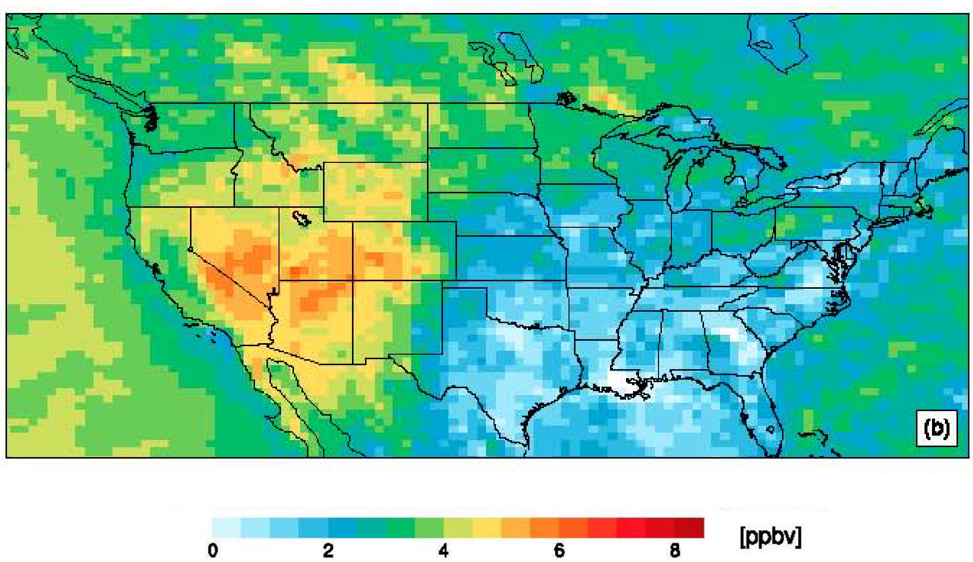

Fig. 5. Asian pollution enhancements to daily maximum 8-h ozone in surface air for May–June 2010, estimated with ~50 km AM3. (Source: Lin et al., 2012a).

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
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[a]Includes the contribution from Asian pollution and stratospheric O_3.
[b]Based on AM3 simulations as described by *Lin et al.* [2012].

Source: Lin et al. (2012b).

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 O_3 contributions associated with frequent stratospheric enhancements. In many cases, Lefohn et al. (2014a) noted that the GEOS-Chem/CAMx model underestimated total O_3 concentrations and that these underestimates appeared to be associated with the model's underestimates of the importance of stratospheric O_3. For the GFDL AM3 model, Lefohn et al. (2014b) found that the adjusted daily stratospheric MDA8 O_3 concentrations substantially contributed to surface O_3 at the high-elevation sites in the West and Intermountain West.

Results published in the literature indicate large discrepancies in the attribution of the levels of Asian pollution O_3 to background O_3. Clearly, these discrepancies reported in the literature are a topic that requires further research. We strongly urge CASAC to delete the entire paragraph on page 3 that recommends EPA seek opportunities for international cooperation to reduce long-range transport of O_3 and abandon their hypothesis that is not based on clear scientific evidence. At this time, based on research published in the peer-reviewed literature, it is unclear what effect international emission reductions would have on surface O_3 concentrations in the U.S. Results from Lin et al. (2012b) indicate that stratospheric intrusion enhances surface O_3 4-5 times greater than O_3 associated with the long-range transport from Asia. Thus, even if international cooperation could be achieved on Asian emissions reductions, it is unclear if background O_3 could be substantially reduced because of the O_3 contribution from uncontrollable, natural stratospheric intrusions.

3. Justification Should be Provided for Any Recommendation of the Lowering of the Ozone Health Standard

On page 2 of the draft letter, CASAC states that it finds scientific justification that current evidence and exposure/risk information call into question the adequacy of the current O_3 standard. Furthermore, CASAC believes there is scientific support for the need to revise the standard to achieve additional public health protection. Because it appears from the contents of the draft letter that CASAC is going to recommend a lowering of the O_3 standard below the current 75 ppb level, we strongly urge CASAC to identify the specific new scientific studies and their associated results that support its apparent decision to recommend that the current standard be lowered. For example, the EPA's REA notes that for epidemiological risk

> The mortality and morbidity risk assessment is the analysis that is most sensitive to the increases in O_3 in the lower part of the distribution of initial O_3 concentrations at some monitors and on some days after meeting the existing and alternative standards in some urban case study areas. As demonstrated in the heat maps (Figures 7-2 and 7-3), the increases in O_3 (and resulting estimated increases in risk) occur largely on days with initial O_3 concentrations in the range of 10 to 40 ppb. In addition, mean O_3 concentrations for the urban case study areas change little between air quality scenarios for meeting the existing and alternative standards, because mean concentrations reflect both the increases in O_3 at lower concentrations and the decreases in O_3 occurring on days with high O_3

concentrations. This leads to small net changes in mortality and morbidity risk estimates for many of the urban case study areas. (Page 9-44, REA)

Fig. 6 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 O_3 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).

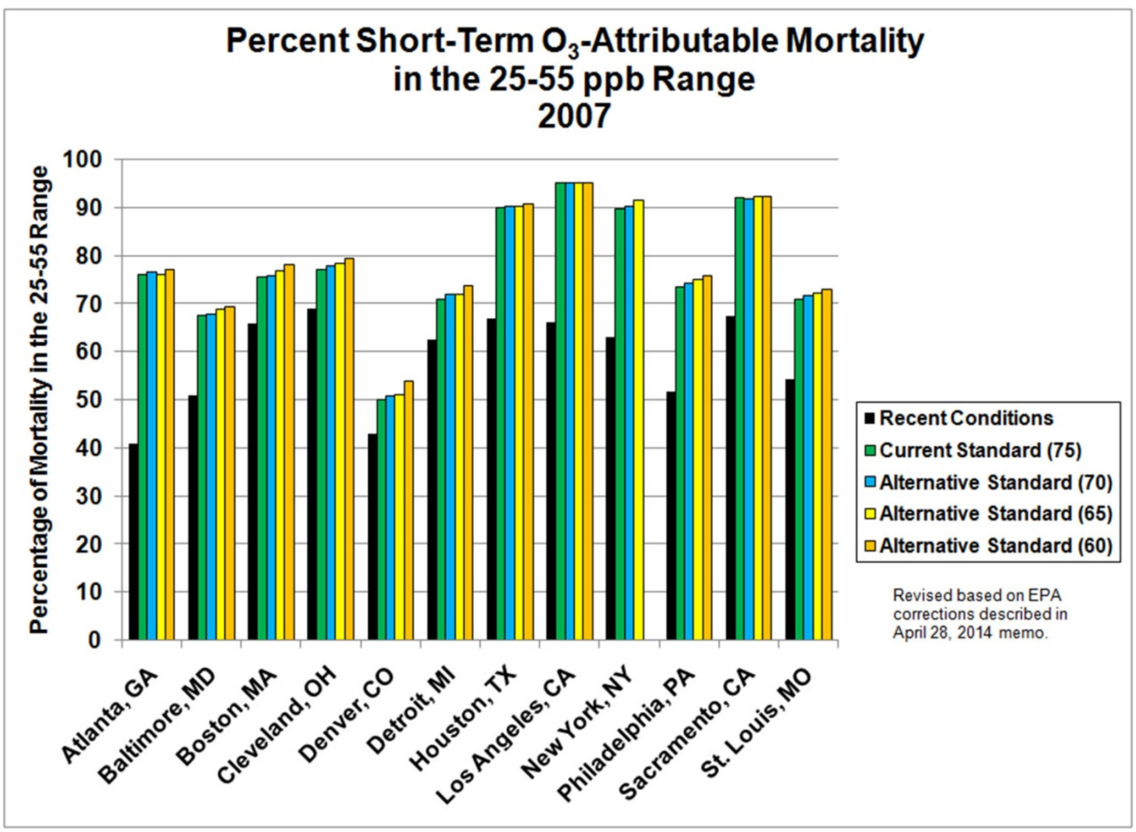

Fig. 6. Percent short-term O_3-attributable mortality in the 25-55 ppb range for various exposure conditions for 2007. (Source: Corrected data obtained from E. Sasser memorandum of April 28, 2014).

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 O_3. Thus, the cumulative risk analysis results for both the epidemiological, as well as the lung function decrements, will be affected by background O_3.

During the CASAC meeting on March 25-27, 2014 in Chapel Hill, there was considerable discussion by Panel members about setting the upper range of the recommended standard range below 70 ppb. Should CASAC decide to establish the upper range for its recommendation of possible changes to the NAAQS based on the Schelegle et al. (2009) results, the Administrator should be made aware that the experiment applied higher hourly average concentrations than they targeted for the 70 ppb experiment. Schelegle et al. (2009) reported that their average concentration was 72 ppb rather than the 70 ppb exposure regime originally designed by Dr. A.S. Lefohn.

4. Conclusion

As EPA discussed in the REA, the lung function and epidemiological risk estimates for attaining the 75, 70, 65 and 60 ppb O_3 standards indicate that a large percentage of the risks are associated with 8-hour average ambient concentrations in the 25-55 ppb range. In addition, background O_3 contributes a large percentage of the total O_3 concentration in the 25-55 ppb range. ***Therefore, background O_3 is tightly linked to the cumulative risk estimated for the current as well as the alternative O_3 standards. Based on these findings, background O_3 is a***

major player in the EPA Administrator's decision-making process that evaluates the level of the O_3 standard.

The EPA in the PA has provided clear and concise guidance to the Administrator concerning the relative contribution of (1) anthropogenic (i.e., controllable) O_3 and (2) background O_3 (non controllable) to its human health risk estimates. The lung function and epidemiological risk estimates for attaining the current and alternative standards indicate that background O_3 contributes a large percentage to the cumulative estimates. Background O_3 concentrations are not controllable.

Results published in the literature indicate large discrepancies in the attribution of the levels of Asian pollution O_3 to background O_3These discrepancies are a topic that requires further research. CASAC should delete the entire paragraph on page 3 that recommends EPA seek opportunities for international cooperation to reduce long-range transport of O_3. CASAC should abandon its hypothesis that background O_3 can be reduced by reducing international emissions. CASAC's hypothesis is not based on clear scientific evidence. It is unclear what effect international emission reductions would have on surface O_3 concentrations in the U.S. Results published in the peer-reviewed literature indicate that natural stratospheric intrusion enhances surface O_3 4-5 times greater than O_3 associated with the long-range transport from Asia. Therefore, it is unclear if background O_3 could be substantially reduced because of the contribution from uncontrollable, natural sources of O_3.

CASAC believes there is scientific support for the need to revise the standard to achieve additional public health protection. Should CASAC recommend a lowering of the O_3 standard below the current 75 ppb level, CASAC needs to identify the specific new scientific studies and their associated results that support the Panel's decision to recommend a lowering of the current O_3 standard.

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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.