

Responses to CASAC Questions on the Ozone ISA from Consultant Dr. Dan Jaffe

Thank you for the opportunity to assist this round of the NAAQS review. Of course I can only respond for questions that are in my area of expertise.

Response to questions from Dr. Sabine Lange:

- 1) Regarding statistical significance in the preamble, I think the line right above your quoted line in the pre-amble is also important in this context “Other indicators of reliability such as the consistency and coherence of a body of studies as well as other confirming data may be used to justify reliance on the results of a body of epidemiologic studies, even if results in individual studies lack statistical significance.” To me, what this is saying that if a group of studies, each with significance at say a 90% confidence all demonstrate a similar effect, then this can be used to justify a conclusion, even if no single study reaches a 95% confidence.

The remaining questions are outside my area of expertise.

Response to questions from Dr. Mark Frampton:

These questions are outside my area of expertise.

Response to questions from Dr. Tony Cox:

These questions are outside my area of expertise.

Response to questions from Dr. Steven Packham:

These questions are outside my area of expertise.

Response to questions from Dr. James Boylan:

I have reviewed Appendix 1 and 2. Overall, I think the ISA is well done, but I have a lot of specific comments and questions. See comments below:

Appendix 1 Atmospheric Source, Chemistry, Meteorology, trends, and background Ozone

Overall comments

- In general, Appendix 1 is well written and accurately conveys the state of our understanding of urban and background O₃.
- The first page bullets, however, are confusing and do not represent a good summary of the section. I recommend these get completely rewritten.

- Some items that need further discussion: (1) impact of background O₃ on high elevation cities in the western US (eg Denver, Salt Lake, etc) (2) the exceptional event rule that allows a state to exclude data when it is deemed out of their control, (3) fact that nationally the declining trend in O₃ since 2013 has greatly slowed (eg Figures 1-9 and 1-10),

Detailed comments

Page 1: This seems like an odd prioritization of key points.

Bullet 1: This really overstates the uncertainties and fails to point out that we have a reasonable understanding of O₃ both in urban and background contexts.

Bullet 3

- These also impact local O₃ production due to importance on temperature and stagnation.

Bullet 4

- “U.S. background ozone continues to account for a large fraction”—what does this mean? Too vague and misleading.

Page 1-3

Page 10 Confusing. O₃ concentrations are now best expressed as mole fractions (per WMO, see Gaudel 2018) not mixing ratios and these do not depend on temp and pressure.

Line 26 Important to discuss average protocols. Significant figures are important both in the calculation of MDA8s and the ODV.

Page 1-6

Line 32 But this is also true for USB

Page 1-7

Line 1 USB is higher at high elevations. Need discussion of elevation effects on USB and its important for high elevation cities like Denver.

Lines 21-23 Add wildfires here.

Page 1-13

Lines 23-33 Good narrative.

Need to discuss approaches, e.g., models informed by observations: E.g. Reidmiller et al., 2009; Zhang et al., 2009. See refs below.

Line 28 “emissions plumes” Confusing phrase.

Page 1-15

Line 25 “high-altitude” Misleading. Usually high altitude refers to >10km.

Line 34 Insert “mountain-top observations,” into “plumes have been observed by mountain-top observations, aircraft, sondes,...”

Line 35 Delete “upper”

Page 1-16

Line 2 grammar

<u>Page 1-18</u> Fig 1-5	From Asia? From China? World?
<u>Page 1-19</u> Line 11	But still could be important regionally, e.g., CAC, central valley, or SE US
<u>Page 1-21</u> Line 28	Good summary discussion
<u>Page 1-22</u> Line 24	Cite original studies: Gong, 2017, and McClure and Jaffe 2018a. See refs below.
<u>Page 1-26</u> Line 1-2	Make change: “electrical discharge at a voltage sufficient to ionize molecular nitrogen thermally produce nitric oxide (NO).”
<u>Page 1-29</u> Line 32	grammar
<u>Page 1-31</u> Line 3	Suggest to cite Jaffe & Zhang 2017 paper on impacts of major high pressure ridge on O3 in California and Pacific Northwest. See refs below.
<u>Page 1-33</u> Line 22	Make change: “Satellite-based remote sensing methods measure the total ozone column rather than ppm or ppb the in-situ concentration in the atmosphere”
Line 25	Also discuss averaging kernel and vertical sensitivity. Generally, sensitivity in troposphere is limited to one “degree of freedom.”
<u>Page 1-34</u> Line 19	I am not familiar with any analyses that have shown satellites can get surface O3.
<u>Page 1-37</u> Line 20	For clarity please add info on how “seasons” and “warm season” are defined.
<u>Page 1-40</u> Table 1-2	title: How is warm season defined?
<u>Page 1-43</u> Figure 1-7	What is difference between Year-Round Only data and Both Data Sites?
<u>Page 1-45</u> Figure 1-9	Very little change since 2013

Page 1-46

Line 3 Need to discuss fact that no change since 2013.

Figure 1-10 No change since 2013.

Page 1-48

Line 8 Re: “early afternoon”. Many sites are late afternoon.

Line 9 How widely true is this statement? Not true in LA.

Page 1-49

Line 21 Need to include discussion of elevation of USB, especially for high-elevation cities.

Page 1-56

Line 4 While this is all true in a general sense for seasonal means, really need to discuss episodic USB events and their influence on ODV and exceptional events policy. These are well known to occur due to stratospheric smoke or international pollution.

Page 1-57

Line 1 Add strat

Page 1-61

Line 3-7 But this excludes wildfire impacts, which are part of USB. Recent analyses suggest wildfires are included and this may be (in part) cause for recent lack of O3 decline at some locations. Add references for 2 papers shown inc fire: McClure & Jaffe (2018b) Laing & Jaffe (2019). See refs below.

Suggested references to add:

- Gong, X., Kaulfus, A., Nair, U., Jaffe, D.A., 2017. Quantifying O3 impacts in urban areas due to wildfires using a Generalized Additive Model. *Environ Sci Technol* 51, 13216-13223.
- Jaffe, D.A., Zhang, L., 2017. Meteorological anomalies lead to elevated O-3 in the western U. S. in June 2015. *Geophys Res Lett* 44, 1990-1997.
- Laing, J., Jaffe, D., 2019. Wildfires are causing extreme PM concentrations in the western United States. *EM: Air and Waste Management Association's Magazine for Environmental Managers*, July 2019.
- McClure, C.D., Jaffe, D.A., 2018a. US particulate matter air quality improves except in wildfire-prone areas. *P Natl Acad Sci USA* 115, 7901-7906.
- McClure C.D. and Jaffe D.A. 2018b. Investigation of High Ozone Events due to Wildfire Smoke in an Urban Area. *Atmos. Envir.* <https://doi.org/10.1016/j.atmosenv.2018.09.021>,
- Reidmiller, D.R., Fiore, A.M., Jaffe, D.A., Bergmann, D., Cuvelier, C., Dentener, F.J., Duncan, B.N., Folberth, G., Gauss, M., Gong, S., Hess, P., Jonson, J.E., Keating, T., Lupu, A., Marmer, E., Park, R., Schultz, M.G., Shindell, D.T., Szopa, S., Vivanco, M.G., Wild, O., Zuber, A., 2009. The influence of foreign vs. North American emissions on surface ozone in the US. *Atmos Chem Phys* 9, 5027-5042.
- Zhang, L., Jacob, D.J., Kopacz, M., Henze, D.K., Singh, K., Jaffe, D.A., 2009. Intercontinental source attribution of ozone pollution at western US sites using an adjoint method. *Geophys Res Lett* 36, L11810, doi: 10.1029/2009GL037950.

Comments on Appendix 2:

Page 2-1

First bullet The spatial variability depends on the O₃ metric. For example while spatial variability of 24 hour average O₃ is low, variability is much higher for MDA8.

Page 2-2

Line 2 oxidation of VOCs with NO_x as a catalyst.

Line 7 Mole fraction is now the accepted term. See my comments on Appendix 1 above.

Lines 26-27 More correctly, VOCs are oxidized and these then react with NO_x to form NO_x. While NO₂ is photolyzed, CO is not photolyzed.

Page 2-5

Line 12 Sentence is confusing. Fixed monitors will always provide good estimates of ambient concentrations, regardless of spatial variability. This sentence is confusing two diff concepts.

Lines 20-21 Need to clarify if 6 ppb is referring to 24 hr avg O₃, MDA8 or something else.

Page 2-8

Line 31 Depends on O₃ metric considered.

Page 2-12

Line 215 MODIS does not measure O₃. Not sure which instrument this refers to.