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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Identifying biomass burning impacts on air quality in Southeast Texas 26–29 August 2011 using satellites, models and surface data" *by* David A. Westenbarger and Gary A. Morris

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Interactive comment on "Identifying biomass burning impacts on air quality in Southeast Texas 26–29 August 2011 using satellites, models and surface data" by David A. Westenbarger and Gary A. Morris

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This manuscript presents a wide array of evidence to support the claim that biomass burning fires in Louisiana and Mississippi contributed to a several-day air pollution

event in southeast Texas in August 2011. The array of evidence includes ground-level observations of ozone, aerosols, and CO; meteorological back trajectories; satellite observations of fires and air pollutants; and an atmospheric model. As its main objective, the article asserts that it "demonstrates an approach to identifying biomass burning influences on high ozone events which may be useful in determining compliance with EPA NAAQS. ... This approach could well be adapted for application to other pollution events in the HGB area as well as in other regions and at other times." This claim is true in the sense that the methods could be adapted and applied readily by a regulatory agency. The back trajectories are straightforward to run, and almost all of the observations and modeling are publicly available and conducted by others. Whether it would be at all useful for NAAQS compliance is more questionable; EPA tends to be skeptical of claims of "exceptional events", and this method cannot quantify the amount of ozone contributed by the out-of-state fires.

Author response: While we recognize that it would be very useful to present model results, this paper presents an observational approach that compares surface O3 concentrations from prior days to one of the days in question (26Aug11) to calculate an approximate O3 enhancement of 63-71 ppb. A second approach, not in the original version but integrated into the revised manuscript, is provided by examining data from an ozonesonde flight from the University of Houston on 29Aug11, the second day of concern during the period. From Figure R-1.1 below, we identify a surface O3 enhancement of about 76 ppb relative to the lower free troposphere (subtract the O3 mixing ratio of 136 ppb in the boundary layer from the O3 mixing ratio of 60 ppb in the lower free troposphere at about 3.5 km altitude). This difference represents a surface enhancement substantially in excess of a typical bad air day in the HGB region, as supported by Figure R-1.2 (below) which plots these computed gradients between the boundary layer and lower free troposphere for all 600+ soundings in the Houston region from 2004 to 2016. This plot shows that the enhancement observed on 29Aug11 (day 241) is quite exceptional over a considerable historical record (> 1 decade), as it would not even appear on this chart, which ranges from -40 to +40 ppb enhancements/disenhancements. This second approach strengthens the prior result as the computed value (76 ppb) is substantially similar to the first (63-71 ppb), which appears in the original version of the paper. Also, a new paragraph [32] has been added for clarification:

"A final piece of the puzzle is provided in Figure 9, which plots O3, relative humidity and potential temperature ('theta') measurements taken by an ozonesonde instrument on a flight conducted on 29Aug from the campus of the University of Houston. In the plot, the extreme gradient in O3 between the boundary layer at roughly 2.5 km altitude ($\sim$136 ppb) and the lower free troposphere at roughly 3.5 km ($\sim$60 ppb), is clear. This difference of $\sim$76 ppb O3 is surprisingly similar to the result obtained using surface monitors: 63–71 ppb, and is evidence of the extreme nature of the O3 regime impacting the HGB area during this event."

Figure R-1.1 Source: http://physics.valpo.edu/ozone/texasdata/20110829/trop_o3mr_20110

Figure R-1.2

The authors do not even demonstrate that the event is exceptional, despite their claim that "this evidence clearly demonstrates that O3 events on 26Aug and 29Aug were unusual even for this area." No evidence is presented of a long-term record to show whether these events were exceptional or even unusual. Author response: Please see "August 26, 2011 Exceptional Events Demonstration Package for the Houston-Galveston-Brazoria One-hour Ozone Nonattainment Area" submitted to U.S. EPA by the Texas Commission on Environmental Quality (https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/Exceptional_Event_TS specifically Figure 3-1 on page 3-2 (replicated as Figure R-1.3 below) which shows that daily maximum O3 on 26Aug11 was well above the 99th percentile for the season (late summer) in recent years (2009-2011). We incorporate this reference in the revised version of the paper.

Figure R-1.3

In terms of scientific merit, the contributions of this paper are thin. No new methods or rigorous analysis are introduced, so the main value is in demonstrating the wide array of available data and modeling results that can be assembled readily. Nevertheless, the methods are sound and the presentation is clear. Thus, the revisions described below are relatively minor in order for the paper to be publishable in some journal. The main judgment for the Editor to make is whether this paper's compilation of outside data and modeling results to analyze a single episode in a single region is sufficient to merit publication in ACP.

Specific comments:

1. 2011 was a year of extreme drought and wildfires for Texas. This should be noted, though the authors find evidence that the smoke for this particular episode was from out of state.

Author response: Text has been inserted in paragraph [6] to indicate that 2011 was a very dry year and experienced a larger than normal number of wild fires. The new text: "The year 2011 was noteworthy in North America for extreme drought in the southern Plains region of the U.S. and high incidence of wild fires, recording the 3rd most acres burned over the prior 12 years (2000-2011) (NOAA, 2012). In 2014, the Texas Commission on Environmental Quality (TCEQ) submitted to the U.S. EPA a document (TCEQ, 2014) demonstrating that the daily maximum 1-hr O3 concentration measured at the Houston East monitor on 26Aug2011 was substantially above the 99th percentile for that time of year when compared to recent years, 2009-2011 (see Figure 3-1 on page 3-2 of that document)."

2. Nothing is done to show how exceptional or unusual this event was. Thus, the paper does not "demonstrate that O3 events on 26Aug and 29Aug were unusual." (p. 3, line 14)

Author response: Please see response above.

3. In several instances, such as p. 3, lines 21- 22, and p. 5, lines 6-8, the authors give the impression that the meteorology of the Houston region makes it prone to high ozone. In fact, despite its occasional episodes of high ozone, on an average summer day Houston has less ozone than most cities and even some rural areas, thanks to its favorable meteorology of inflow from the Gulf of Mexico. That inflow also helps keep PM levels within EPA limits, despite the region's large population, heavy traffic, and numerous industrial sources. And stratosphere-troposphere exchange ozone events (p. 5, line 9) are infrequent in this region relative to mountainous regions. Yes, there are meteorological conditions such as the post-frontal conditions of this episode or other stagnant periods that are conducive to the high ozone that leads the region to non-attainment. But the article perpetuates mistaken impressions about the frequency of polluted days in Houston and the favorability of its meteorology for ozone formation beyond occasional episodes.

Author response: Due in large part to unique coastal meteorology, the HGB area is prone to experiencing two periods of high O3 during the year: one in spring and one in late summer, with lower peaks in early- and mid-summer. A number of studies have examined the various aspects of local, regional, and continental-scale meteorology that impact the area. Text has been inserted in paragraph [11] to describe the seasonality of the meteorological influence in the HGB area and list several studies on this topic. The new text:

"A substantial body of evidence has demonstrated that this coastal meteorology coupled with larger-scale influences from the Gulf of Mexico and Atlantic Ocean, such as seasonal westward migration of the Bermuda High pressure system, and the location of the city downwind of many emissions sources, subjects the HGB area to particularly O3-conducive conditions during spring and late summer, though less so in mid-summer (see e.g., Nielsen-Gammon, 2005a; Nielsen-Gammon, 2005b; Wang, 2016; Wang, 2015; Berlin, 2013; Darby, 2005)."

4. The abstract and conclusions mention the use of the CMAQ model, but that is not

presented in the paper.

Author response: Discussion of the CMAQ model has been removed from the abstract.

5. The ozone data plotted in Figure 1 are inconsistent with a claim that out-of-state biomass burning played a dominant role during this episode. Peak ozone concentrations vary by a factor of 2 across the Houston region, reflecting a typical pattern of a sharp gradient between ozone upwind and downwind of the region's main local emissions sources. Pollution traveling from days-away fires would have a more spatially uniform pattern. It is less clear from the PM/AOD/CO data whether there is a broad-based contribution from out-of-state fires.

Author response: Local sources always contribute to O3 gradients in the HGB area, even in the absence of transported pollution, and these spatial gradients can be quite substantial. Transport enhances the entire distribution in a more or less uniform manner, as the commenter notes. This paper demonstrates that the combination of regional-scale long-range transport-related O3 enhancements super-imposed over typical local O3 variability led to the exceptional O3 concentrations measured at surface monitors.

6. I find it difficult to glean much of value from the numerous histograms in Figure 3.

Author response: The main point of Figure 3 is to present a recurring pattern of vastly changing region-wide distributions across 3 distinct time periods for multiple parameters. In each case, the middle period, which is most strongly influenced by transport of ozone and precursors from biomass burning emissions, appears substantially different compared to the periods before and after. Comparisons of histograms across the 'before', 'during' and 'after' time periods, replicated across numerous parameters, are critical to demonstrating the pervasive and compelling influence of biomass burning emissions on O3 in the HGB area exhibited in the 'during' period. We have revised the figure and text in hopes of clarifying its contents (see paragraph [9]).

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-1234, 2018.

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2017-1234/acp-2017-1234-AC1-supplement.pdf

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-1234, 2018.

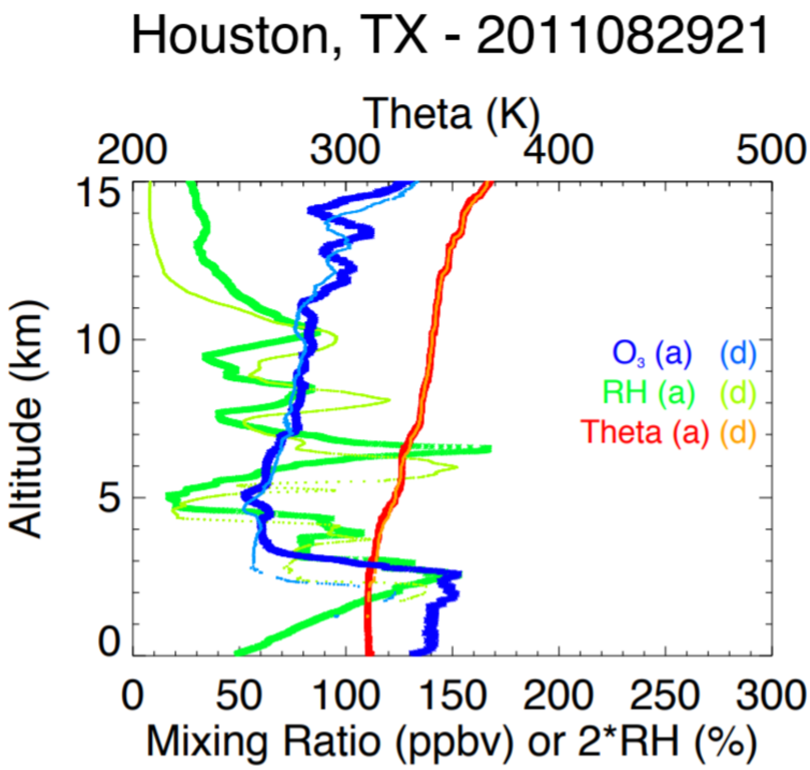

Fig. 1. Figure R-1.1 Ozone, rh and potential temperature (theta) for flight from University of Houston campus, 29Aug11

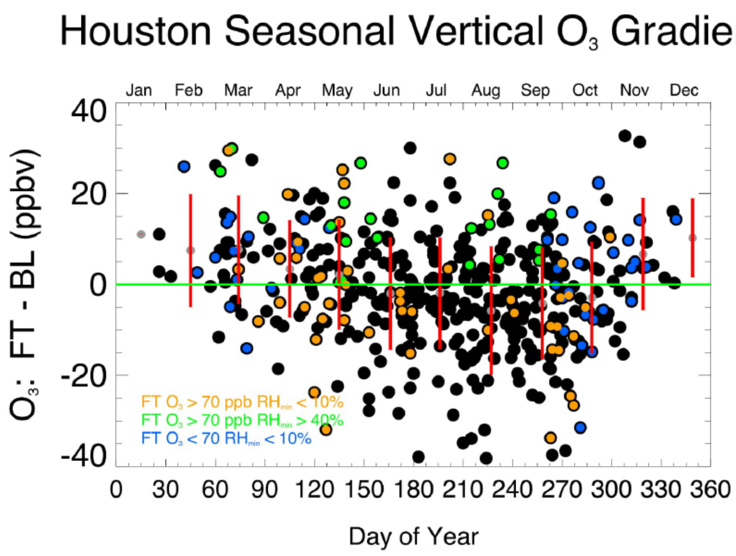

Figure 3-36. The difference between the mean ozone in the free troposphere and the boundary layer as found in ozonesonde profiles over Houston and as a function of day of the year. The color coding of the dots is associated with the three cases described in the text.

Fig. 2. Figure R-1.2 Houston seasonal vertical O3 gradient by day of year

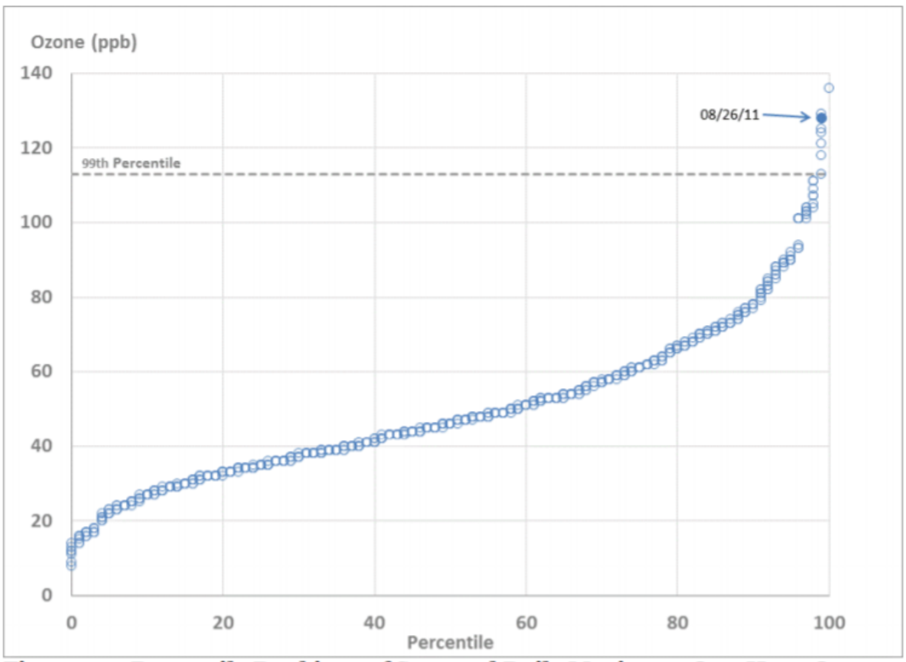

Figure 3-1: Percentile Rankings of Seasonal Daily Maximum One-Hour Ozone Concentrations at the Houston East (CAMS 1) Monitoring Site from 2009 through 2011

Fig. 3. Figure R-1.3 Percentile rankings of seasonal daily maximum one-hour ozone concentrations at the Houston East (CAMS 1) monitoring station, 2009-2011