AQRP Monthly Technical Report

PROJECT TITLE	High Background Ozone Events in the Houston-Galveston-Brazoria Area: Causes, Effects, and Case Studies of Central American Fires	**PROJECT #**	16-008
PROJECT PARTICIPANTS	University of Houston	**DATE SUBMITTED**	01/07/2017
REPORTING PERIOD	**From:** 12/01/2016 **To:** 12/31/2016	**REPORT #**	3

A Financial Status Report (FSR) and Invoice will be submitted separately from each of the Project Participants reflecting charges for this Reporting Period. I understand that the FSR and Invoice are due to the AQRP by the 15th of the month following the reporting period shown above.

Detailed Accomplishments by Task

Task 1: We investigated distributions of MDA8 and background ozone mixing ratios during weather events and high ozone days. We also studied the overlapping of weather events and high ozone days.

Task 2: Not started.

Task 3: The simulation of surface ozone on the specific fire-impact day using GEOS-Chem was conducted, and the selected monthly simulation has been completed.

Task 4: Not started.

Preliminary Analysis

Task 1

To screen the effect of inter-annual variation of high ozone days, we adjusted our previous method of selecting MDA8 15% and background 15% days. Now MDA8 15% and background 15% days are defined as the highest 15% of daily MDA8 and background ozone days for each calendar year during the April to October ozone season, corresponding to a total of 32 days per year, respectively.

To investigate the long-term trend of weather and high ozone events, we divided the whole 16-year research period into two 8-year halves (2000-2007 and 2008-2015).

Figure 1 shows boxplots of MDA8 and background ozone mixing ratios during weather events and high ozone days. Medians and range of MDA8 and background ozone during all types weather events and high ozone days decreased (except median of MDA8 15% during exceedance). For MDA8 ozone, median during the whole ozone season, MDA8 15%, background 15%, exceedance, heat wave, and stagnation decreased 7, 9, 6.5, 6, 4.5, and 6 ppbv respectively and range decreased 5, 8, 8, 8, 8, and 17 ppbv respectively. For background ozone, the median during the whole ozone season, MDA8 15%, background 15%, exceedance, heat wave, and stagnation decreased 4, 4, 3, 2, 0, and 2 ppbv respectively and range decreased 15, 13, 12, 13, 14, and 12 ppbv respectively. The median of MDA8 ozone decreased faster than background ozone while the range of MDA8 ozone decreased slower than background ozone. Compare to MDA8 ozone, background ozone had fewer outliers.

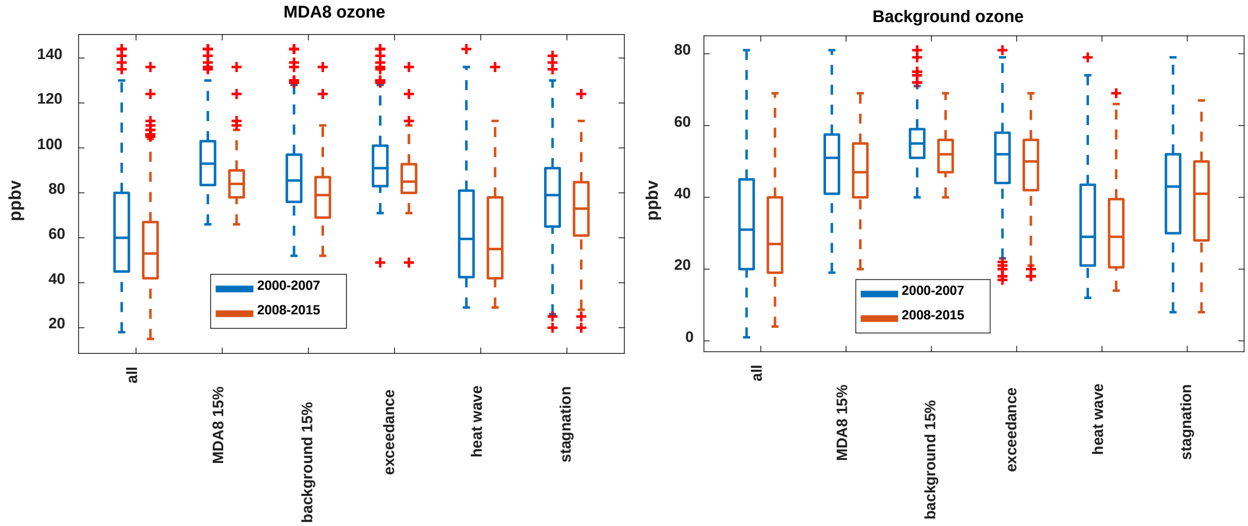

Figure 1. MDA8 (left) and background (right) ozone mixing ratios during weather events and high ozone days 2000-2007 (blue boxes) versus 2008-2015 (red boxes).

Figure 2 shows the probability density curves of MDA8 and background ozone mixing ratios during weather events and high ozone days. Compared to 2000-2007, all the peaks moved to the left during 2008-2015.

For MDA8 ozone, MDA8 15% and exceedance peaks during 2000-2007 both are wider and skewed to the right more obviously than 2008-2015. During 2008-2015 MDA8 15% and exceedance peaks almost overlapped to each other while MDA8 15% peak located at the right of exceedance peaks during 2000-2007. Background 15% peak during 2008-2015 was higher than during 2000-2007. Heat wave peak was symmetrical during 2000 to 2007 while it was right-tailed during 2008-2015. Heat wave peak during 2008-2015 almost overlapped with the “all data” set peak. Stagnation peaks during 2000-2007 and 2008-2015 both are left-tailed but peaked during 2008-2015 was narrower than from 2000-2007.

For background ozone, MDA8 15% and background 15% ozone peaks are almost overlapped both during 2000-2007 and 2008-2015. But the exceedance peak had a higher left shoulder during 2000-2007 while it also had a lower left shoulder during 2008-2015. Background 15% peak during 2008-2015 was higher than during 2000-2007 like the MDA8 ozone peak. Heat wave peaks were also close to “all data” set peaks with longer right-tails during both 2000-2007 and 2008-2015. The stagnation peak during 2008-2015 had a higher left shoulder than during 2000-2007.

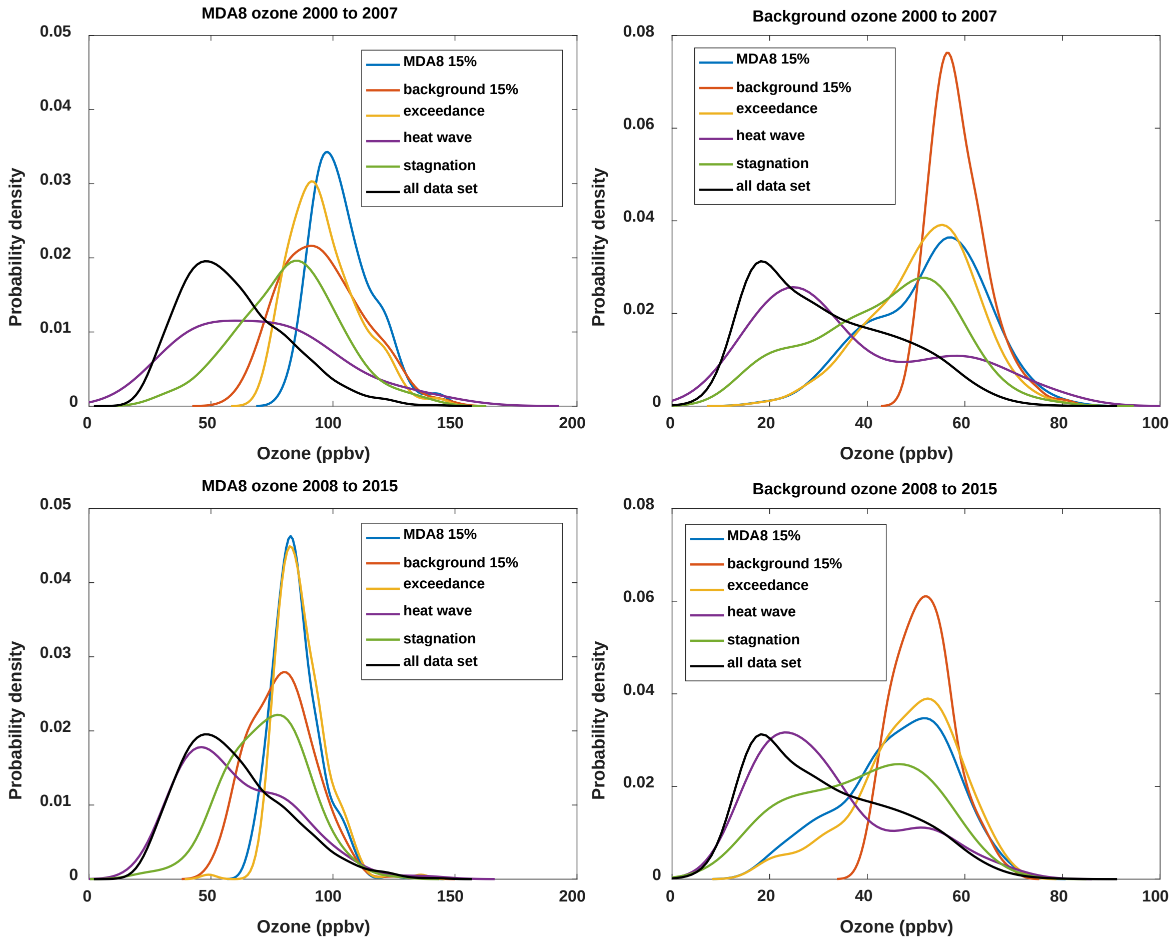

Figure 2. MDA8 (left column) and background (right column) ozone mixing ratios during weather events and high ozone days 2000-2007 (upper row) versus 2008-2015 (lower row).

Figure 3 shows the overlapping percentage of weather and high ozone events. For heat waves, the percentage during all three types of high ozone days showed great uniformity. The percentages of the whole ozone season in 2008-2105 were higher than in 2000-2007 since most of heat wave days happened in 2008-2015. The percentage of MDA8 15% increased from 2.73% to 8.98%. The percentage during background 15% increased from 3.52% to 5.47%. The percentage during exceedances increased from 3.16% to 9.36%. The percentage in each month showed great variability. In April, count of the heat wave was high, percentages during all three types of high ozone days are still zero since ozone concentration were low in April. The highest percentage (35.48% for MAD8, 30.00% for background 15%, 35.48 for exceedance) during all three types of high ozone days appeared in June 2008-2015 during which both heat wave count and ozone mixing ratios were high. But the percentages were zero in June during 2000-2007 since no heat waves occurred. The percentage in August and September are close to the all ozone season. In October, percentages were zero since both heat wave count and ozone mixing ratios were low.

For stagnation, percentages were much higher than heat waves since its occurrence frequency was much higher than heat waves. Unlike heat waves, comparing 2000-2007 with 2008-2015 percentage of stagnation during MDA8 15% slightly decreased from 35.55% to 34.77% and percentage of background 15% slightly decrease from 29.30% to 27.73%, but the percentage of exceedance increased from 33.98% to 41.38%. This inconsistency also appeared in May, July, and

August when stagnation count was low. Monthly percentages were consistent with the variation of stagnation count. Relative high percentage appeared in April, June, and October during all three types of high ozone days when the stagnation count was high. Like heat waves, percentages in June 2008-2015 were much higher than in June 2000-2007 during all three types of high ozone days. Great percentage differences between 2000-2007 and 2008-2015 also appeared in April during MDA8 15% days and April and July during background 15% days.

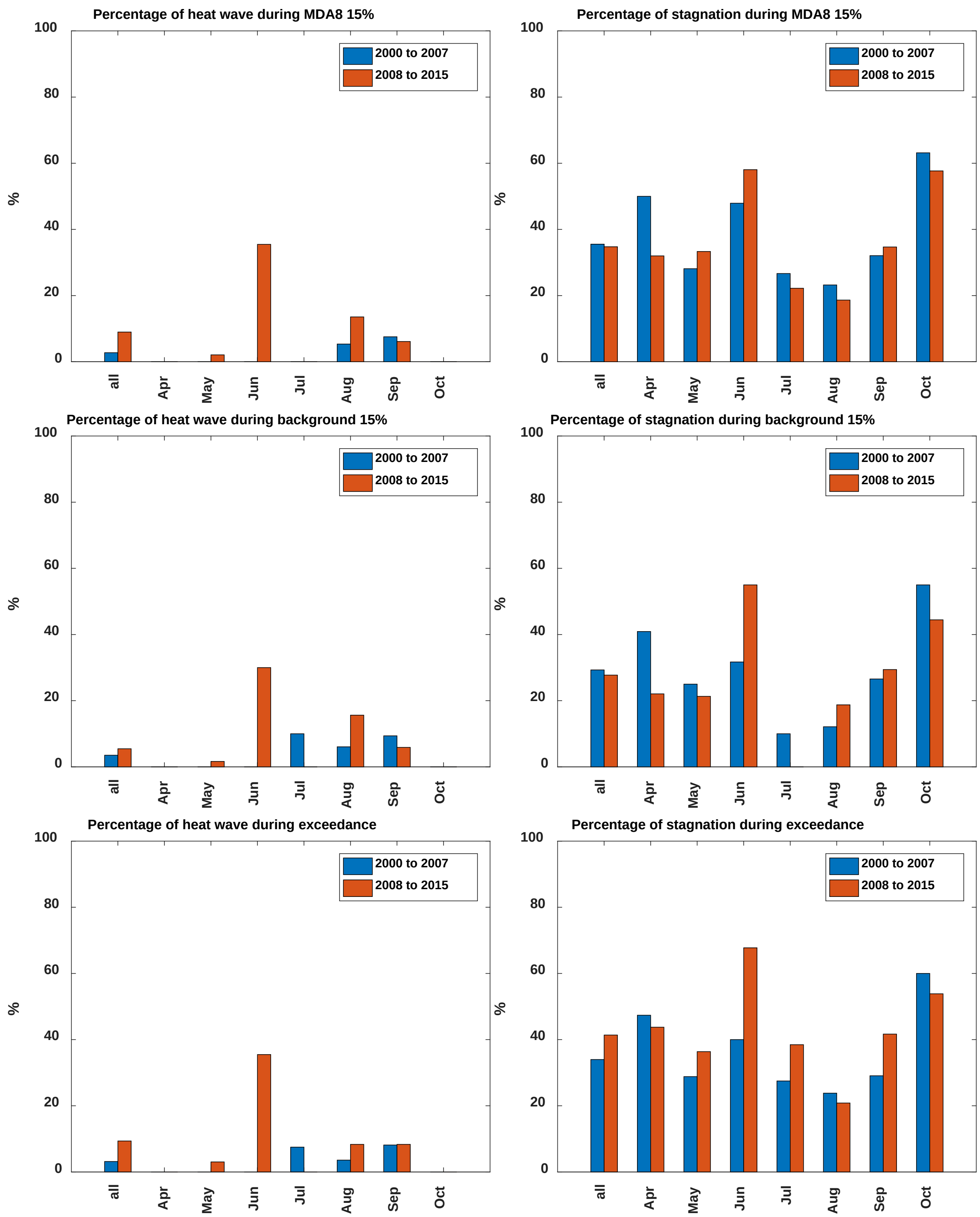

Figure 3. Percentage of weather event days (left column: heat wave, right column: stagnation) during high ozone days (first row: MDA8 15%, second row: background 15%, third row: exceedance) 2000-2007 (blue bar) versus 2008-2015 (red bar).

Task 3:

GEOS-Chem simulations have been conducted for April 2011 using the GEOS-5 assimilated meteorology with the resolution $0.5^{o} \times 0.667^{o}$. Figure 4 shows the simulated surface ozone from April 26, 2011, to April 27, 2011, which has been reported in Saide et al. (2015). According to our simulation, there is a plume that originated from the Yucatan Peninsula and ended near the Gulf coast region. In order to test the impact of Central America fires, we conducted a sensitive simulation by turning off the biomass burning emissions in the selected domain (Figure 5) over the Central America. Figure 5 shows the differences of surface ozone concentration with and without Central American fires (With fires simulation minus without fires) by turning off fires in the selected region in the model on April 26 and 27 2011. The plume caused by the fires in Yucatan is clearly shown in Figure 6. Near the HGB area, the contribution of fires on ozone is around 3-5 ppbv, which is consistent with our previous analysis from background ozone observations.

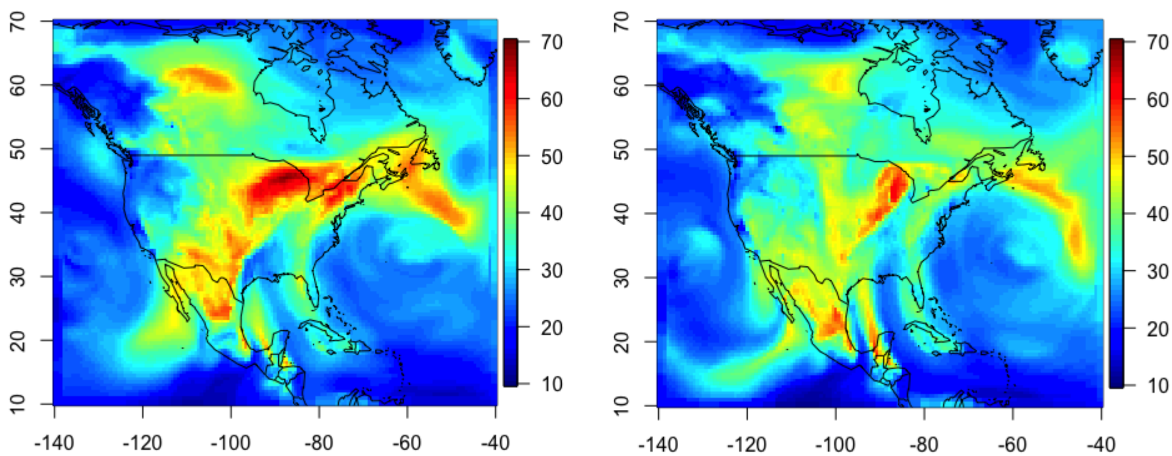

Figure 4. Simulated surface ozone on April 26 (left) and April 27(right) 2011.

Figure 5. The domain (10N-26N; 83.33W-110W) where the fires were turned off in the sensitivity simulation.

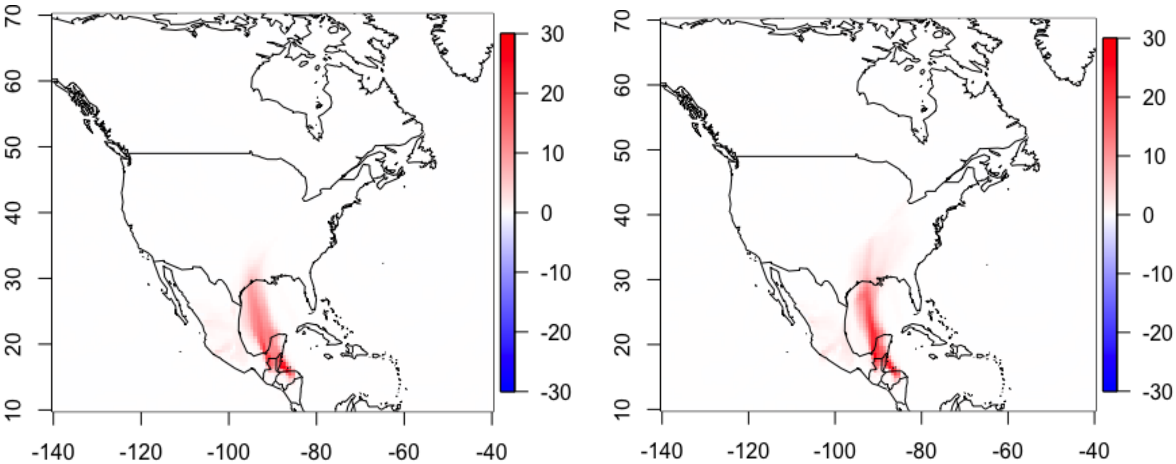

Figure 6. Differences in surface ozone mixing ratios with and without Central American fires on April 26 (left) and 27 (right).

Figure 7 shows observed daily ozone compared with model simulations with and without Central American fires. Overall, the model captured the background ozone variability in April 2011 (the blue line and red line in Figure 7) with some positive bias on peaked-ozone days, like April 11 and 17. The simulation results of with and without Central American fires (blue line and black dashed line in Figure 7) shows around five days in April 2011 were impacted by the fires with ozone differences around 3-5 ppbv. These five days were also picked into fire-impact days in our previous analysis. This shows the consistency in both ground observations and model simulations.

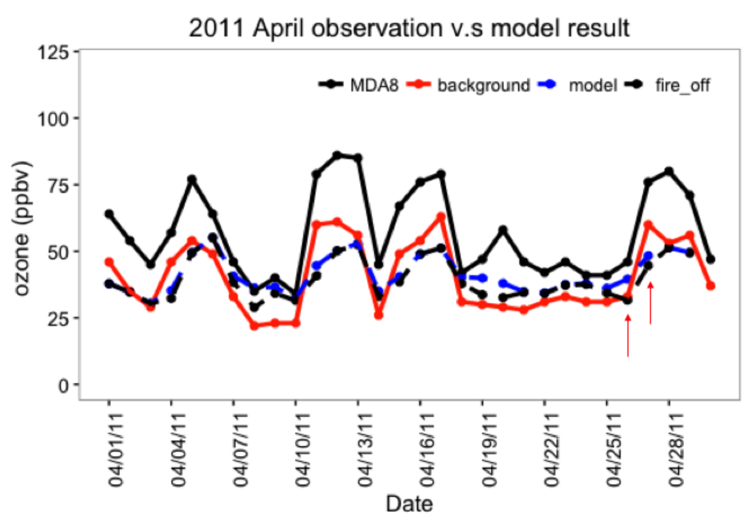

Figure 7. Observed daily ozone compared with model simulation with and without Central American fires. Red arrows indicate the case run presented above.

Data Collected

None this period.

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments

None this period.

Goals and Anticipated Issues for the Succeeding Reporting Period
Task 1: Specific months with high overlapping percentages of weather events and high ozone days will be picked and analyzed.
Task 3: The upper 25% of background ozone in fire-impact days will be picked and analyzed. GEOS-Chem model simulation for other cases which were identified in the literature and were picked in our study will be done.

Detailed Analysis of the Progress of the Task Order to Date
Progress on the project is ongoing.

Do you have any publications related to this project currently under development? If so, please provide a working title, and the journals you plan to submit to.

___Yes √ No

Do you have any publications related to this project currently under review by a journal? If so, what is the working title and the journal name? Have you sent a copy of the article to your AQRP Project Manager and your TCEQ Liaison?

___Yes √ No

Do you have any bibliographic publications related to this project that have been published? If so, please list the reference information. List all items for the lifetime of the project.

___Yes √ No

Do you have any presentations related to this project currently under development? If so, please provide working title, and the conference you plan to present it (this does not include presentations for the AQRP Workshop).
√ Yes ___No

2016 AGU Fall Meeting
Poster 1: Impacts of Central American Fires on Ozone Air Quality in Texas
Poster 2: The Relationship between Ozone Exceedance and the Meteorological Events in the Houston-Galveston-Brazoria Area

Do you have any presentations related to this project that have been published? If so, please list reference information. List all items for the lifetime of the project.

___Yes √ No

Submitted to AQRP by

Principal Investigators: Yuxuan Wang and Robert Talbot

References

Saide, P. E., Spak, S. N., Pierce, R. B., Otkin, J. A., Schaack, T. K., Heidinger, A. K., and Carmichael, G. R. (2015). Central American biomass burning smoke can increase tornado severity in the U.S., Geophysical Research Letters, 42(3), 956-965.