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**	12/06/2016
REPORTING PERIOD	**From:** 11/01/2016 **To:** 11/30/2016	**REPORT #**	2

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: Meteorological parameters over HGB have been extracted from the NARR dataset. The occurrences of two extreme weather events, heat waves and stagnation, have been identified based on the meteorological parameters. The analysis of the extreme weather events is ongoing. Preliminary results include lists of high ozone days and extreme weather days.

Task 2: Not started.

Task 3: We redefined the selection criteria and identified fire-impact days of different sources during 2000-2015. The impacts of Central American fires on HGB background ozone were also quantified.

Task 4: Not started.

Preliminary Analysis

Task 1

Definitions of high ozone days, MDA8 15%, background 15%, and exceedance, are as following:

- MDA8 15%: the highest 15% of daily MDA8 ozone concentrations for each calendar month (Apr-Oct), corresponding to a total of 72 days per month over the 16-year period (2000-2015);
- Background 15%: the highest 15% of daily background ozone concentrations for each calendar month (Apr-Oct), corresponding to a total of 72 days per month over the 16-year period (2000-2015);
- Exceedance: the days when at least two surface monitors in the HGB region exceeded 70 ppbv.

Definitions of extreme weather event days, heat waves and stagnation, have been described in the last report.

Figure 1 shows the time series of the annual count of MDA8 15% and background 15% days. Both decreased remarkably during 2000 – 2015. For MDA8 15% days, the mean count is 32 days per year. Maximum count, 65 days per year, appeared on 2000 and 2005. Minimum count, 2 days per year, appeared 2014. Besides 2005, another peak value, 28 days per year, appeared on 2010. For background 15% days, the mean count is 32 days per year. Like MDA8 15% days, the first peak value appeared in 2005 which was 65 days per year. And minimum count, 8 days appeared in 2014. Its second peak appeared in 2011 which was 35 days per year. No time series were plotted for the monthly count of MDA8 15% and background 15% days since their definition keeps the count the same in each month.

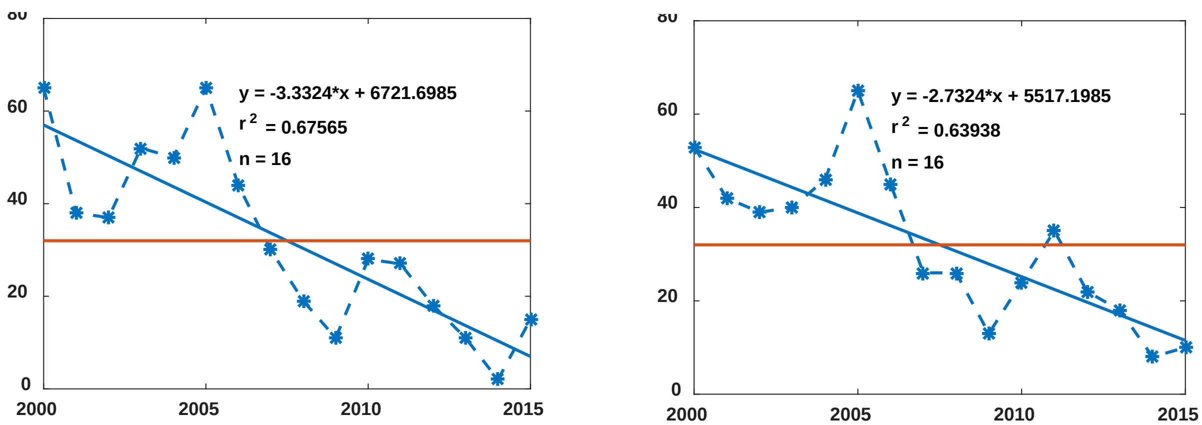

Figure 1. Time series of the annual count of MDA8 15% (left) and background 15% (right) days during the ozone season (April to October 2000 - 2015). Blue continuous lines show the linear trend. Red continuous lines show the mean values.

Figure 2 shows the time series of annual and monthly count of exceedance days. For annual count, it shows great similarity with MDA8 15% and background 15% days. The mean count was 38.44 days per year. The first peak appeared on 2005 which was 64 days per year. The minimum, 8 days per year, appeared in 2014. The second peak appeared in 2010 and 2011, which were 34 days per year. For monthly count, it shows double-peak distribution. The mean count was 87.86 days. Maximum count appeared on August which was 132 days. Minimum count appeared on July which was 53 days.

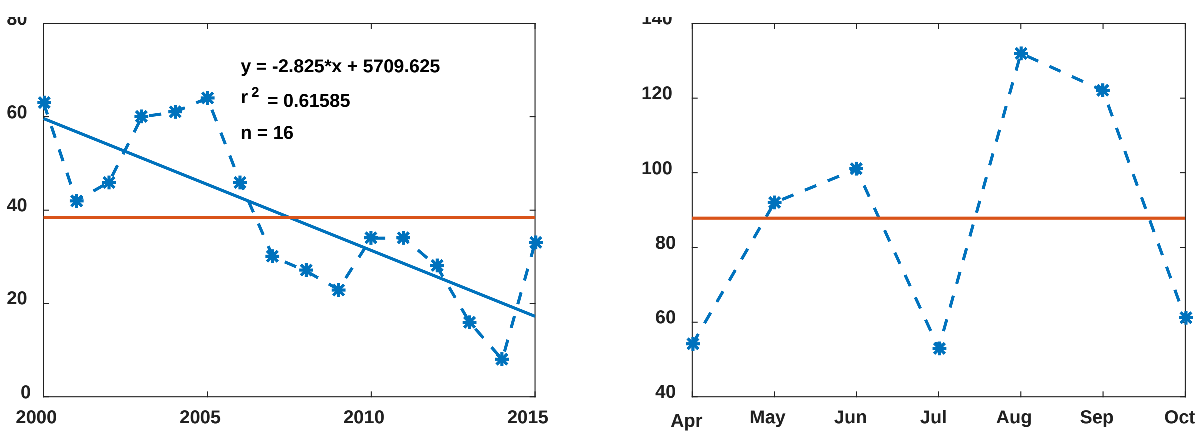

Figure 2. Time series of annual (left) and monthly (right) count of exceedance days during the ozone season (April to October 2000 - 2015). Blue continuous line shows the linear trend. Red continuous lines show the mean values.

Figure 3 shows the time series of annual and monthly count of heatwave days. For annual count, it shows large interannual variability. The mean count was 8.75 days per year. The most heat wave days appeared in 2011 which was 67 days per year. There were no heat wave days in 2003, 2007, 2008, 2014, and 2015. For monthly count, the mean count was 20 days. The maximum count appeared in April and June which was 30 days. The minimum count appeared in July which was 8 days.

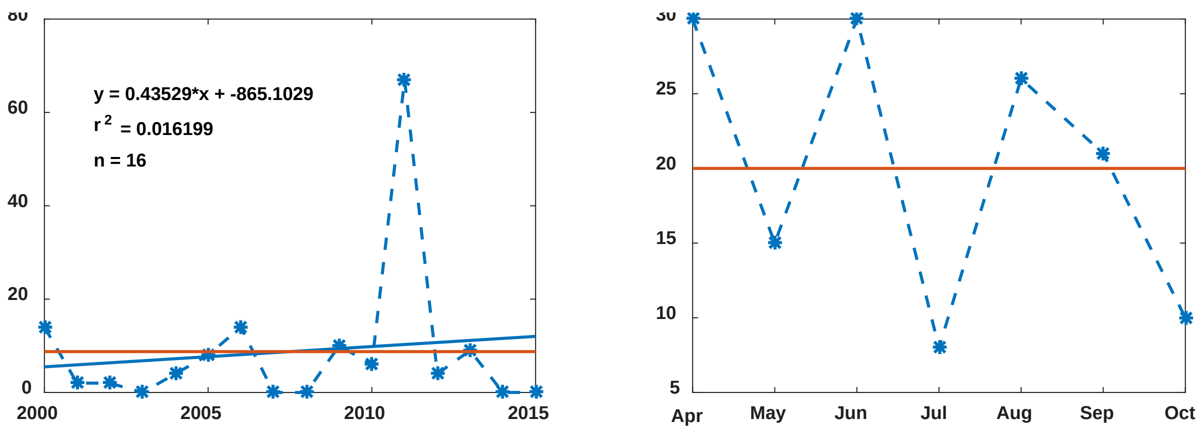

Figure 3. Time series of annual (left) and monthly (right) count of heatwave days during ozone season (April to October 2000 - 2015). Blue continuous line shows the linear trend. Red continuous lines show the mean values.

Figure 4 shows the time series of annual and monthly count of stagnation days. For annual count, it varied between 20 and 41 except for 2013. The mean count was 28.38 days per year. Maximum count appeared in 2007 which was 41 days. Minimum count appeared in 2013 which was 13 days. For monthly count, the mean count was 64.86 days. Maximum count appeared in October which was 94 days. Minimum count appeared in August which was 44 days. There was a peak in June which was 83 days.

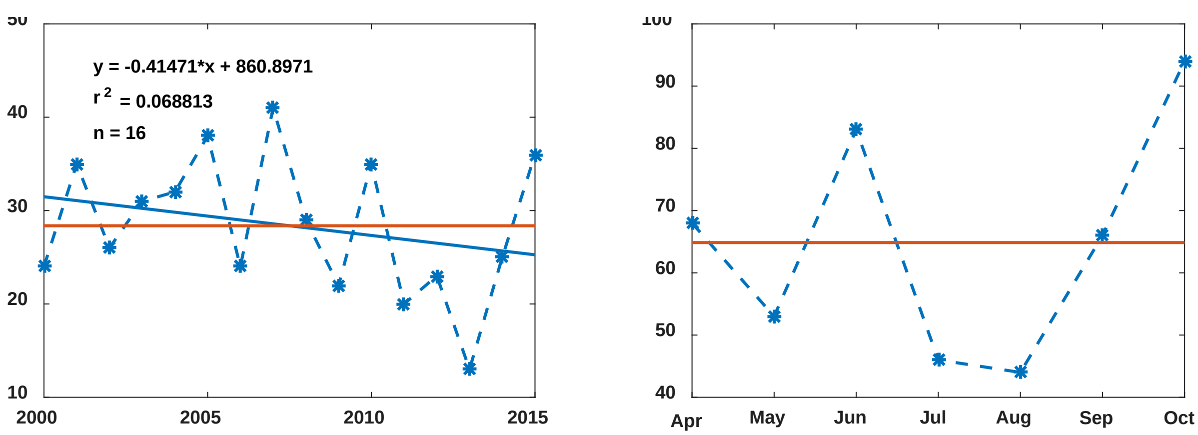

Figure 4. Time series of annual (left) and monthly (right) count of stagnation days during the ozone season (April to October 2000 - 2015). Blue continuous line shows the linear trend. Red continuous lines show the mean values.

Task 3:

In the previous analysis, we defined two sub-domains (boxes 1 and 2 in Figure 5) to select the 72-hour back trajectories passing through the Yucatan and Mexico areas, respectively. Within Cluster 2 (i.e., the southern cluster), 51.7% of trajectories passed through the Yucatan and 21.5% through Mexico. Corresponding to those trajectories, only the dates with greater or equal to four trajectories passing through either regions were selected as the fire-impact days. Based on the selection, the fire-impact days are categorized into the following groups indicating their sources: Yucatan (Y), Mexico (M), and the Yucatan and Mexico (Y&M). Overall, 37.2% of days are fire-impacted days during April-May 2000-2015. We also defined another group called Gulf-clean (G) which includes trajectories originating in the Gulf of Mexico and do not pass over any land areas. Therefore, Gulf-clean represents the clean maritime background which does not pick up direct emissions from land during the 72 hours before they reach HGB.

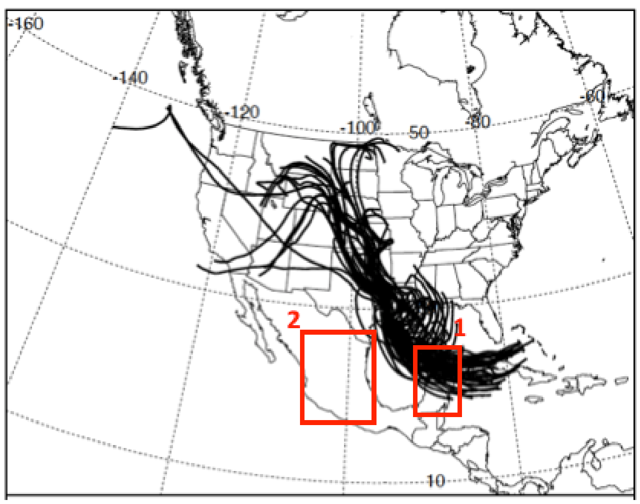

Figure 5. The back trajectories in April 2011. The red boxes in the figure show the sub-domain of the Yutacan (box 1, 17.23°N-21.65°N; 85.45°W-91.79°W) and Central Mexico (box 2; 16.35°N-25.97°N; 97.59°W-105.72°W).

Figure 6 shows the box plot of HGB background ozone in April and May of 2000-2015 in each group. The category of all data has a wide range of background ozone from 10 ppbv to 70 ppbv. It is not surprising that the Gulf-clean category has relatively lower background ozone. The background ozone in the Mexican group has larger minimum, median, and maximum values compared to the other two types in the fire group. The mean background ozone in each group in April and May during 2000-2015 was calculated (Table 1). Since there are no other outside contaminations in the Gulf-clean group, Gulf-clean can be a reference to quantify the impact of fires. Thus, the impact of Yucatan fires on HGB background ozone is 4.26 ppbv. Fires from Mexico contribute 12.81 ppbv on HGB background ozone. The reason why Mexican fires have a larger impact is because the distance between Mexico and HGB is smaller than the distance between Yucatan and HGB. The impact also depends on how much ozone is produced in the fire plumes which remains to be further investigated. In addition, the air masses passed through Mexico bring not only fire pollution but also anthropogenic emissions in Mexico. These two reasons may cause the larger impact on HGB background ozone in the Mexican group.

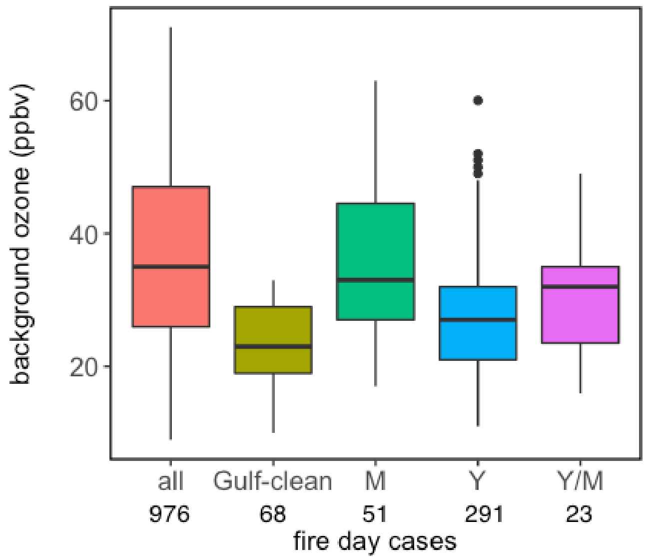

Figure 6. The boxplot of HGB background ozone in April and May 2000-2015 in each group.

Table 1. The calculated mean background ozone in each group during April-May 2000-2015.

Category	**Mean background ozone (ppbv)**
Gulf-clean	23.43 ± 6.14
Mexico(M)	36.24 ± 11.58
Yucatan(Y)	27.69 ± 8.07
Mexico&Yucatan(Y/M)	31.04 ± 8.14
all	36.46 ± 12.81

We also analyzed the maximum MDA8 ozone distribution in each group by boxplot (Figure 7). Since MDA8 ozone includes ozone from the background and local emission. The effect of fires on MDA8 ozone is not as clear as the effect of fires on the background ozone. However, the Gulf-clean category still has relatively lower minimum, median, and maximum values compared to the all-data group or the Mexican group.

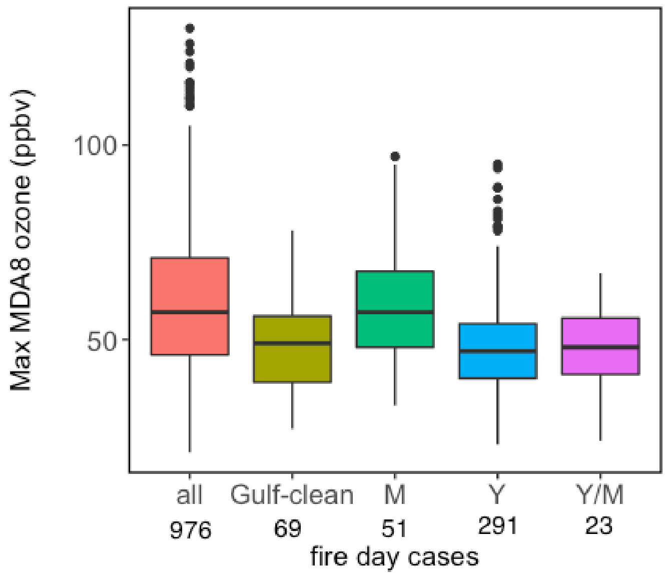

Figure 7. The boxplot of HGB maximum MDA8 ozone in April and May 2000-2015 in each group.

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: We will adjust the method of selecting MDA8 15% and background 15% days to screen the effect of the interannual variation of high ozone days. Then we will investigate the relationship between high ozone days and extreme weather event days.
Task 3: The upper 25% of background ozone in fire-impact days will be picked and analyzed. GEOS-Chem model simulation for some cases which were identified in the literature and were picked in our study.

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

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
None this period.