AQRP Monthly Technical Report

PROJECT TITLE	Analysis of Ozone Production and Its Sensitivity in Houston Using the Data Collected during DISCOVER-AQ	**PROJECT #**	Choose an item. 14-020
PROJECT PARTICIPANTS	University of Maryland College Park	**DATE SUBMITTED**	7/8/2015
REPORTING PERIOD	**From:** June 1, 2015 **To:** June 30, 2015	**REPORT #**	5

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

During the period from June 1-30, 2015, the team at University of Maryland College Park has accomplished the following tasks:

(1) Attended the AQRP workshop to report the results of ozone production and its sensitivity to NOx and VOCs during the DISCOVER-AQ in Houston in 2013.

(2) Further analysis of box model results.

(3) Started CMAQ process analysis to map the ozone production efficiency (OPE) and nitrogen oxides (NOx) and VOC limited areas throughout the Houston metropolitan area.

Preliminary Analysis

Vertical profiles of ozone production rate ($P(O_3)$), ozone loss rate ($L(O_3)$), and net ozone production calculated using the box model results show that (1) RO_2 + NO makes about the same amount of O_3 as HO_2 + NO in the model; (2) O_3 photolysis followed by $O(^1D)+H_2O$ is a dominant process for the photochemical ozone loss; and (3) the maximum net $P(O_3)$ appeared near the surface below 1 km (Figure 1).

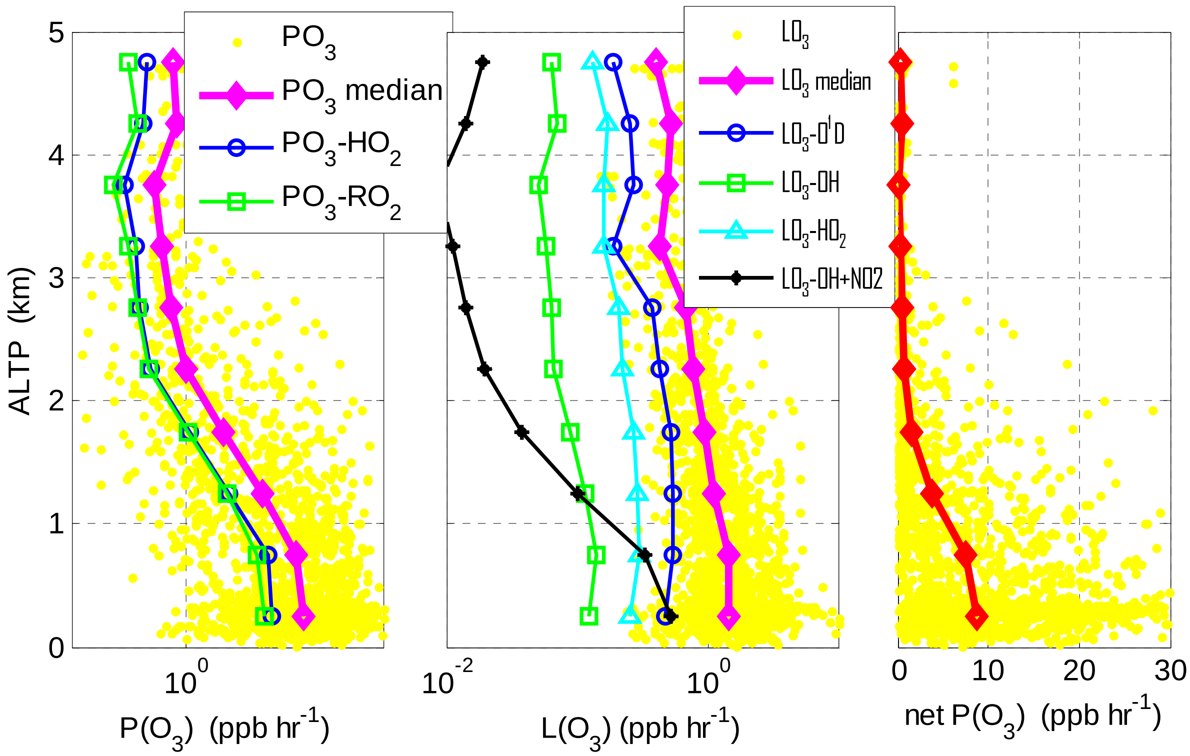

Figure 1. Vertical profiles of ozone production rate (left), ozone loss rate (middle), and net ozone production rate (right) during DISCOVER-AQ in Houston in 2013.

The dependence of $P(O_3)$ on NO mixing ratio shows that when NO mixing ratio is less than ~1 ppbv, ozone production increases as [NO] increases, i.e., $P(O_3)$ is in NOx sensitive regime. When NO mixing ratio is great than ~1 ppbv, ozone production levels off as NO mixing ratio further increases, i.e., $P(O_3)$ is in NOx saturated regime (Figure 2). We can also found that at a given NO mixing ratio, higher production rate of HOx results higher ozone production rate, as points shown inside the blue circle in Figure 2.

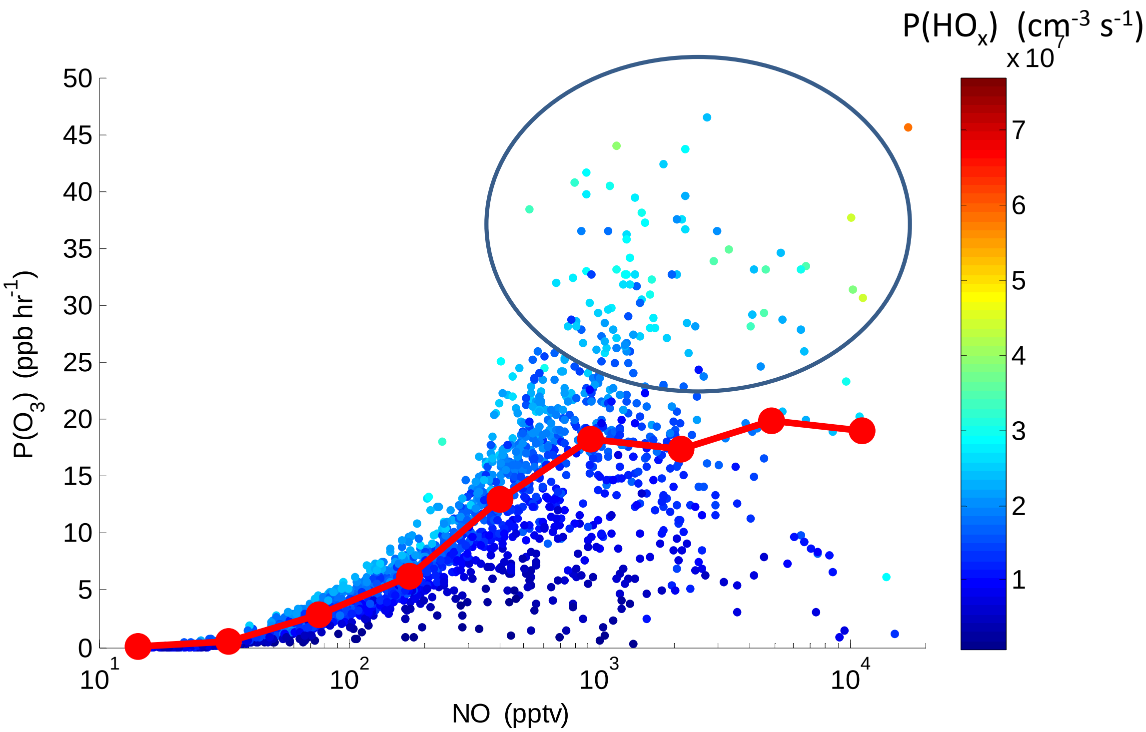

Figure 2. Ozone production as a function of NO mixing ratio. Individual data points are the 1 minute averages and are colored with the production rate of HOx (= OH + HO_2). The linked solid red circles represent the median values in [NO] bins. Note a log scale is used for the x axis.

Diurnal variations of ozone production rate at 8 individual locations where the P-3B conducted vertical spirals show that ozone production at locations with high NOx and VOC emissions such as Dear Park, Moody Tower and Channel View is on average greater than 10 ppb hr^{-1}, while at locations away from the urban center with lower emissions such as Galveston, Smith Point, and Conroe, ozone production is usually less than 10 ppb hr^{-1} on average (Figure 3).

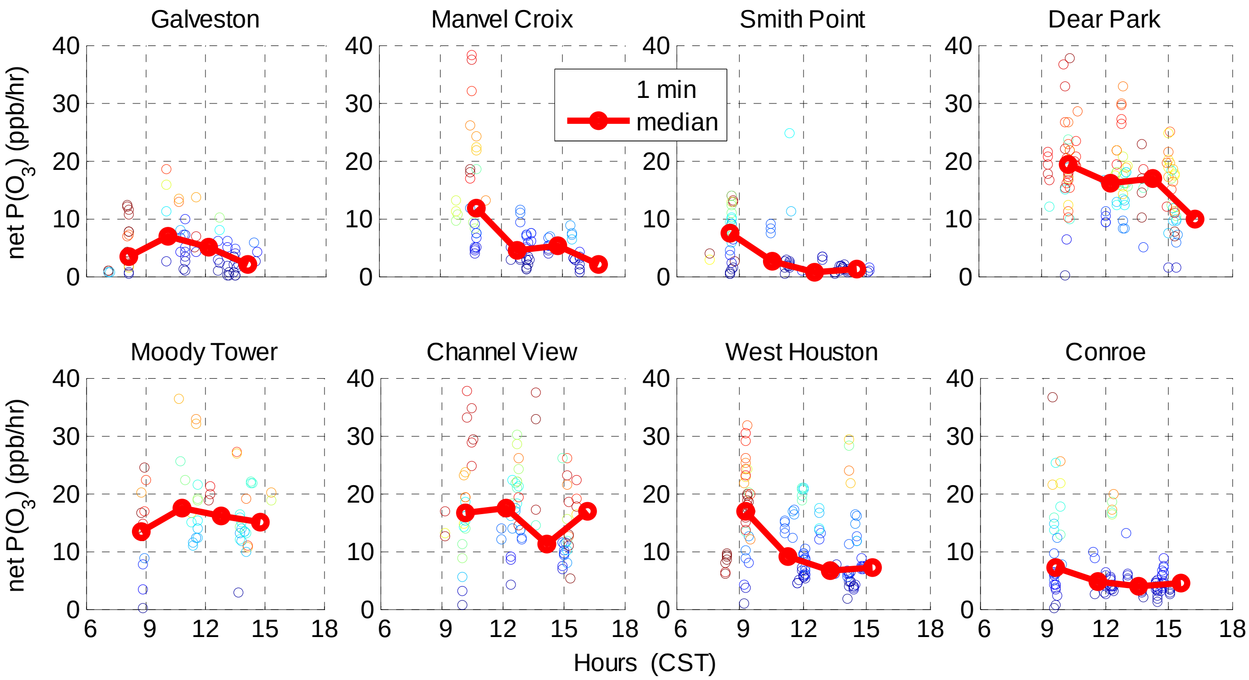

Figure 3. Diurnal variations of ozone production rate at 8 individual spiral locations. Individual points are 1-min data and the linked red circles represent the median values in hourly bins of $P(O_3)$. Data are limited with the pressure altitude less than 500 m to represent the lowest layer of the atmosphere.

Using box model results, we also looked at the OH reactivity and its distribution. For total OH reactivity, non-methane hydrocarbons (NMHC) and oxygenated volatile organic carbons (OVOCs) are the two biggest contributors (Figure 4, left). For OH reactivity due to NMHC, alkanes and alkenes are the biggest contributors followed by biogenically emitted VOCs such as isoprene and monoterpenes (Figure 4, right). This indicates that the emission control of anthropogenic VOCs in Houston can significantly reduce OH reactivity in this area and can thus reduce ozone production due to reduction of HOx production as shown in Figure 2.

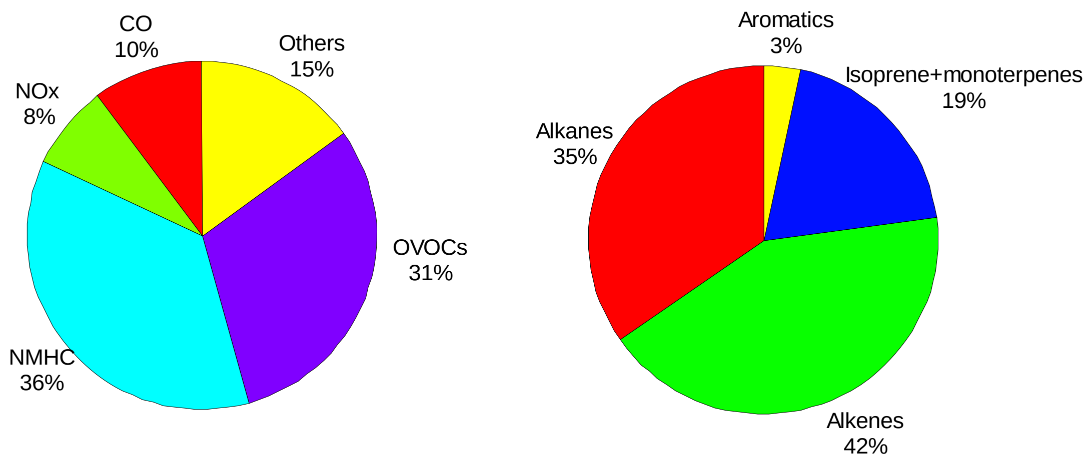

Figure 4. Contribution of different categories of air pollutant to total OH reactivity (left) and the distribution of OH reactivity due to different categories of non-methane hydrocarbons (NMHC, right) during DISCOVER-AQ in Houston in 2013.

Data Collected

None.

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments

None.

Goals and Anticipated Issues for the Succeeding Reporting Period

(1) Continue the sensitivity analysis of the box model to investigate the uncertainty associated with the use of CMAQ-calculated alkanes and alkenes to constrain the box model.

(2) Continue CMAQ process analysis to map the ozone production efficiency (OPE) and nitrogen oxides (NOx) and VOC limited areas throughout the Houston metropolitan area.

(3) Start to prepare for the draft of final report.

Detailed Analysis of the Progress of the Task Order to Date

We attended the AQRP workshop this month and reported the results we have so far from this project. Everything regarding the Task Order schedule and progress is going well. There were no delays in completing tasks and project goals during this reporting period.

Submitted to AQRP by: Xinrong Ren

Principal Investigator: Xinrong Ren