Scope of Work For

Project 14-009
Analysis of Surface Particulate Matter and Trace Gas Data Generated During the Houston Operations of Discover-AQ

Prepared for

Air Quality Research Program (AQRP)
The University of Texas at Austin

by

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May 29, 2014

BACKGROUND

The City of Houston and Harris County have a long history of air quality issues because of their large population, extensive industrial activity, and sub-tropical climate. These issues predominantly have been manifested through ozone (O_3) mixing ratios that exceed the National Ambient Air Quality Standards (NAAQS) established by the United States Environmental Protection Agency. However, recent measurements indicate that Harris County barely achieves compliance with the NAAQS that have been established for particulate matter (PM), specifically for particles with diameters less than or equal to 2.5 micrometers.

In recent years, the National Aeronautics and Space Administration (NASA) has placed considerable emphasis on the use of satellite remote sensing in the measurement of species such as O_3 and PM that constitute air pollution. However, additional data are needed to aid in the development of methods to distinguish between low- and high-level pollution in these measurements. To that end, NASA established a program titled Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ). DISCOVER-AQ began in summer 2011 with work in the Mid-Atlantic Coast that featured satellite, airborne, and ground-based sampling. The DISCOVER-AQ program conducted operations in and near Houston in September 2013.

During the Houston operations of DISCOVER-AQ, there was a need for ground-based measurement support. The predecessor to this project filled that need by providing quantitative measurements of sub-micron particle size and composition and mixing ratios of volatile organic compounds (VOCs) and other photochemically relevant gases such as O_3 and oxides of nitrogen (NO_x = nitric oxide (NO) plus nitrogen dioxide (NO_2)). The instrumentation for these measurements was deployed using the University of Houston (UH) mobile laboratory. The current project focuses on the analysis of data generated during the mobile laboratory operations during DISCOVER-AQ.

1. STATEMENT OF WORK

1. 1 TASKS TO BE PERFORMED

The tasks that will be completed in order to are listed below, with investigator responsibility noted. Each task will be performed in order to complete the project. The project starts with tasks that do not require data sharing between investigators from this and related projects (10-024 and 10-029). If tasks subsequent to data sharing will use data from other investigators, it is noted. Note that some tasks will occur simultaneously.

1. Determine PM emission rates by particle size by source (with characterization of source when possible) when plume sampling is easily identified (Rice primary; UH secondary; no data share required as this will be performed for data not associated with stationary field sites);
2. Identify sources that are responsible for short-lived but high in local impact increases in PM loadings (Rice; no data share required as this will be performed for data not associated with stationary field sites);

3. Share final PM particle composition data with collaborators from University of Texas at Austin (Prof. L. Hildebrandt Ruiz, project 14-024) and Baylor University (Prof. R. Sheesley, project 14-029), including time series of mobile laboratory photochemically relevant gas and PM data and PM data collected continuously at a field site at Manvel Croix. Corresponding data are expected from collaborators at the same time (particle composition and size distribution as well as gas-phase data from a Chemical Ionization Mass Spectrometer at Conroe from Prof. Hildebrandt Ruiz and particulate water-soluble organic carbon concentrations at Manvel Croix from Prof. Sheesley) (Rice and UH). Compare PM data from the mobile laboratory with those generated at the stationary field sites (received from collaborators) as part of the quality assurance for this project (Please see separate quality assurance document.) (Rice; requires data share);
4. Assess the diurnal character of PM concentrations across Houston (Rice; data from projects 14-024 and 14-029 will be included);
5. Assess the relative contributions of PM constituents across Houston (Rice; data from projects 14-024 and 14-029 will be included);
6. Estimate the relative oxidation of organic PM as a function of space and time across Houston (as manifest by the attribution of organic aerosol to hydrocarbon-like organic aerosol versus oxidized organic aerosol, the evaluation of the O to C and H to C ratios within the organic PM, and the estimation of the oxidation state of the organic aerosol) (Rice). This does not require data share, but results will be provided to (and received from) collaborator Prof. Hildebrandt-Ruiz so that a comparison between results can be made at times when the mobile laboratory was stationed at Conroe;
7. Investigate secondary processes of import with respect to PM in Houston (SO_2 oxidation to sulfate; VOC oxidation to secondary organic aerosol (SOA); organics limiting neutralization of acidic particles by NH_3) (Rice primary; UH secondary; no data share required as SO_2, VOC, and NH_3 were not monitored at the stationary sites continuously);
8. Assess the importance of biogenic activity on O_3 and SOA formation (UH primary, Rice secondary);
9. Compare in situ NO2 measurements with available column NO_2 measurements such as satellite and Pandora retrievals to evaluate inter- and sub-pixel variability;
10. Evaluate the production rate of O_3 (using a zero-dimensional model) spatially, temporally, as a function of meteorological conditions, and as a function of NO, NO_2, and NO_x levels across Houston (UH); and
11. Evaluate the relative importance of various radical sources across Houston using the same zero-dimensional model in terms of the impact on radical reservoirs and production of O_3 (UH).

1.2 BRIEF DESCRIPTIONS OF MEASUREMENTS AND DEPLOYMENT PLAN

1.2.1 Measurements

The UH Mobile Atmospheric Laboratory consists of a fiberglass truck body that installs in the bed of a full-size pickup, providing approximately 325 ft^3 of air conditioned laboratory space with ports for *in situ* sampling and remote sensing. A mast mounted meteorological sensor with a global positioning system attaches to the front bumper to collect data while stationary and in motion. The vehicle's crew is comprised of two to four scientists, depending on the mission and truck configuration. In the summer of 2012, UH purchased a Chevrolet 3500 HD crew cab one-ton pickup truck with an 8-ft bed and single axle to be the permanent home of the mobile laboratory. The fiberglass shell has a 40" x 30" sunroof and instrument racks. After accounting for the weight of the fiberglass shell, four instrument racks, four scientists, and a full fuel tank, the mobile laboratory has a usable payload capacity of 2000 pounds for instruments, pumps, and cylinders. The vehicle has thus far been modified to include an adjustable air bag-cushioned suspension, three high-capacity alternators, a battery bank, and four inverters for a total science electrical capacity of 6.4 kW. With additional alternators (and inverters), the science electrical payload could be increased to as much as 14 kW. By placing the 6.5-ft long shell on an 8-ft bed, an additional 30 ft^3 of protected outside storage space is available. The meteorological instruments have been mounted on the front bumper to ensure that they are in the free air stream.

Lead by co-PI Lefer, the UH team measured the ambient mixing ratios of CO, NO, NO_2, NO_y, O_3, and SO_2, actinic flux, and basic meteorological and navigation parameters. Through collaborative efforts, we also have access to mixing ratios of certain VOCs. Lead by co-PI Griffin, the Rice team measured size-resolved aerosol chemical composition at high time resolution.

1.2.2 Deployment

The mobile laboratory had two operating modes during DISCOVER-AQ: Lagrangian and stationary. When the NASA airplane had flights and spiraled over a certain location, the mobile laboratory operated along a corridor between the bottoms of two spirals to the northwest of downtown Houston. Similar Lagrangian measurements were made when moving from one stationary location to another.

1.3 KEY PERSONNEL

1.3.1 Dr. Robert Griffin (rob.griffin@rice.edu, 713-348-2093)

Co-PI Griffin was an Associate Professor of Civil and Environmental Engineering at Rice University from 2008 until 2013, when he was promoted to Professor. Previous academic appointments were held at the University of New Hampshire and Duke University. Griffin received degrees in Chemical Engineering (BS Tufts; MS and PhD Caltech) and has over 17 years of research experience in the air quality field. He has more than 70 published papers to his credit. Funds will be used to support a post-doctoral scholar.

1.3.2 Dr. Barry Lefer (blefer@uh.edu, 713-893-1741)

Co-PI Lefer is an Associate Professor of Earth and Atmospheric Sciences at the University of Houston, where he has been on faculty since 2004. Lefer received degrees in Environmental Sciences (BA University of Virginia) and Earth Sciences/Geochemistry (MS and PhD UNH), has over 20 years of research experience in the atmospheric chemistry/air pollution meteorology field, and has published over 100 peer-reviewed manuscripts. Student support will be used to fund an upper-level graduate student pursuing a doctoral degree in Atmospheric Sciences.

1.4 DELIVERABLES

A description of the specific reports to be submitted and their due dates are outlined below. One report per project will be submitted (collaborators will not submit separate reports), with the exception of the Financial Status Reports (FSRs). The lead PI will submit the reports. For the sake of planning, a start date of July 1, 2014 currently is assumed.

Executive Summary

At the beginning of the project (assumed to be within two weeks of project commencement), an Executive Summary will be submitted to the Project Manager for use on the AQRP website. The Executive Summary will provide a brief description of the planned project activities, and will be written for a non-technical audience.

Due Date: Tuesday, July 15, 2014

Quarterly Reports

The Quarterly Report will provide a summary of the project status for each reporting period. It will be submitted to the Project Manager as a Word doc file. It will not exceed 2 pages and will be text only. No cover page is required. This document will be inserted into an AQRP compiled report to the TCEQ.

Quarterly Report Due Dates:

Report	Period Covered	Due Date
Quarterly Report #1	July and August 2014	Friday, August 30, 2014
Quarterly Report #2	September, October, November 2014	Monday, December 1, 2014
Quarterly Report #3	December 2015, January & February 2015	Friday, February 27, 2015
Quarterly Report #4	March, April, May 2015	Friday, May 29, 2015
Quarterly Report #5	June, July, August 2015	Monday, August 31, 2015

Technical Reports

Technical Reports will be submitted monthly to the Project Manager and TCEQ Liaison as a Word doc using the AQRP FY14-15 MTR Template found on the AQRP website.

Technical Report Due Dates:

Report	Period Covered	Due Date
Technical Report #1	July 1 - 31, 2014	Friday, August 8, 2014
Technical Report #2	August 1 - 31, 2014	Monday, September 8, 2014
Technical Report #3	September 1 - 30, 2014	Wednesday, October 8, 2014
Technical Report #4	October 1 - 31, 2014	Monday, November 10, 2014
Technical Report #5	November 1 - 30 2014	Monday, December 8, 2014
Technical Report #6	December 1 - 31, 2014	Thursday, January 8, 2015
Technical Report #7	January 1 - 31, 2015	Monday, February 9, 2015
Technical Report #8	February 1 - 28, 2015	Monday, March 9, 2015
Technical Report #9	March 1 - 31, 2015	Wednesday, April 8, 2015
Technical Report #10	April 1 - 28, 2015	Friday, May 8, 2015
Technical Report #11	May 1 - 31, 2015	Monday, June 8, 2015

Financial Status Reports

Financial Status Reports will be submitted monthly to the AQRP Grant Manager (Maria Stanzione) by each institution on the project using the AQRP FY14-15 FSR Template found on the AQRP website.

FSR Due Dates:

Report	Period Covered	Due Date
FSR #1	July 1 - 31, 2014	Friday, August 15, 2014
FSR #2	August 1 - 31, 2014	Monday, September 15, 2014
FSR #3	September 1 - 30, 2014	Wednesday, October 15, 2014
FSR #4	October 1 - 31, 2014	Monday, November 17, 2014
FSR #5	November 1 - 30 2014	Monday, December 15, 2014
FSR #6	December 1 - 31, 2014	Thursday, January 15, 2015
FSR #7	January 1 - 31, 2015	Monday, February 16, 2015
FSR #8	February 1 - 28, 2015	Monday, March 16, 2015
FSR #9	March 1 - 31, 2015	Wednesday, April 15, 2015
FSR #10	April 1 - 28, 2015	Friday, May 15, 2015
FSR #11	May 1 - 31, 2015	Monday, June 15, 2015
FSR #12	June 1 - 30, 2015	Wednesday, July 15, 2015
FSR #13	Final FSR	Wednesday, August 15, 2015

Draft Final Report

A Draft Final Report will be submitted to the Project Manager and the TCEQ Liaison. It will include an Executive Summary. It will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources.

Due Date: Monday, May 18, 2015

Final Report

A Final Report incorporating comments from the AQRP and TCEQ review of the Draft Final Report will be submitted to the Project Manager and the TCEQ Liaison. It will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources.

Due Date: Tuesday, June 30, 2015

Project Data

All project data including but not limited to QA/QC measurement data, databases, modeling inputs and outputs, etc., will be submitted to the AQRP Project Manager within 30 days of project completion. The data will be submitted in a format that will allow AQRP or TCEQ or other outside parties to utilize the information.

AQRP Workshop

A representative from the project will present at the AQRP Workshop in June 2015.

1.5 SCHEDULE

The project timeline is given below. Note that this schedule does not include the items described in the Deliverables section above as those Deliverables will be provided in addition to the performance of the tasks prescribed here.

- Task 1 – Emissions factors determination, July 1 – August 20, 2014
- Task 2 – Large emission event investigation, August 21 – September 15, 2014
- Task 3 – Data sharing and comparison, September 16 - 30, 2014
- Task 4 – Diurnal PM assessment, October 1 - 31, 2014
- Task 5 – Relative PM composition assessment, November 1-30, 2014
- Task 6 – Oxidation state (and related metrics) determination, December 1, 2014 – February 28, 2015
- Task 7 – Secondary process investigation, March 1 – May 31, 2015
- Task 8 – Biogenic activity investigation, July 1 – September 15, 2014
- Task 9 – NO_2 comparisons and variability, September 16 – December 15, 2014
- Task 10 – Ozone production rate modeling, December 16, 2014 – March 15, 2015
- Task 11 – Radical source modeling, March 16 – May 31, 2015