Scope of Work For

Project 20-003

CHARACTERIZATION OF CORPUS CHRISTI AND SAN ANTONIO AIR QUALITY DURING THE 2021 OZONE SEASON

Prepared for

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

By

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Report of QA Findings: Required in Final Report

Approvals

This Scope of Work was approved electronically on **10/17/20** by Vince Torres, The University of Texas at Austin

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This Scope of Work was approved electronically on **10/17/20** by Erik Gribbin, Texas Commission on Environmental Quality

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1.0 Abstract

This project will focus on the air quality and atmospheric chemistry in two urban areas of Texas (Corpus Christi and San Antonio) that have received comparatively less attention from the local research community, despite having air quality issues documented by state and local monitoring efforts. A mobile air quality laboratory with the capability of measuring relevant trace gases, particulate matter, and meteorological parameters will be deployed during the early part of the 2021 ozone season (April – mid-May). Through combined stationary and mobile measurements, these measurements will allow characterization of the chemical nature of air being transported into Corpus Christi from the Gulf of Mexico (two weeks of stationary measurements), being transported out of Corpus Christi (one week of mobile measurements downwind), being transported into San Antonio (one week of mobile measurements upwind and two weeks of stationary measurements), and being transported out of San Antonio (one week of mobile measurements downwind). Data analysis will allow assessment of temporal and spatial patterns of air pollutants, determination of statistical values (mean, median, interquartile range, etc.) of air pollutant concentrations and particle compositions, calculation of important air quality parameters such as the production rate of ozone, and characterization of the organic fraction of the particulate matter to provide insight into the sources and chemical processes that impact its concentration. Data measured in the 2021 campaign also will be compared to data generated during the 2017 San Antonio Field Study. These data analysis techniques will be supplemented by three-dimensional air quality modeling that will be evaluated through comparison to the measured data. The air quality modeling, among other topics, will be used to investigate response of predicted air pollutant concentrations to changes in emission inputs from a variety of source types.

2.0 Background

During the early part of the past decade, the sites that comprise the air quality monitoring network in the greater San Antonio metropolitan area exhibited at least one day per year on which the observed daily maximum eight-hour average ozone (O_3) mixing ratio exceeded 70 parts per billion by volume (ppbv), the value stipulated by the National Ambient Air Quality Standards (NAAQS), based on Texas Commission on Environmental Quality (TCEQ) data, which are publicly available online. Despite these observations, an assessment of published literature revealed very limited peer-reviewed research that elucidates the causes of enhanced O_3 mixing ratios in San Antonio. One study suggests that ~30 ppbv of O_3 in San Antonio can be attributed to anthropogenic activities (for a 2002 state-wide simulation) (Farooqui et al., 2013). In addition, Choi and Souri (2015) investigated trends of nitrogen dioxide (NO_2), formaldehyde (HCHO), and O_3 using satellite-measured columns, surface monitoring, and three-dimensional modeling; they observed both positive and negative trends depending on both species and the time period considered. These studies provided limited insight into the apportionment of peak O_3 mixing ratios in San Antonio. Thus, investigation of the physical and chemical processes that control O_3 formation in this region was warranted and provided the motivation for the San Antonio Field Study (SAFS), supported by TCEQ and its Air Quality Research Program (AQRP), that occurred in spring (May) 2017.

With respect to O_3, findings from the SAFS (documented in the project final report and in Anderson et al. (2019)) indicate that San Antonio was predominantly in a nitrogen oxide (NO_X)-limited regime, which led to a very high O_3 production efficiency, especially on days with relatively strong solar radiation. Compared to NO_X, O_3 formation in San Antonio was less sensitive to major volatile organic compounds (VOCs) such as alkanes, ethane, and acetone. Isoprene, HCHO, and alkenes exhibited high reactivity (defined as the product of the species concentration and its rate coefficient for the reaction with hydroxyl radical). Local O_3 formation at San Antonio was driven both by organic peroxy radicals and the hydroperoxy radical, with a production rate peaking at mid-day.

The SAFS also included measurement of particulate matter (PM) because of the inextricable relationship between PM and trace gases relevant to O_3 formation (in terms of both co-emission and chemical interaction). Analyses of PM data from SAFS are ongoing but indicate that high sulfate plumes were mostly related to air masses coming from the Gulf of Mexico, which implied that the sulfate aerosol observed at San Antonio was less likely to be locally produced. Instead, the sulfate aerosols represented mostly a regional, background level which could be attributed to both biogenic marine sources and regional sulfate-related anthropogenic activities, including those in the Gulf of Mexico and potentially those in locations outside the United States. Additional PM analyses indicate the importance of secondary organic aerosol (SOA) formation over the San Antonio region and the lack of influence of wildfires and biomass burning in Central America on PM in San Antonio during SAFS.

A second urban area in Texas that suffers from relatively poor air quality (based on similar TCEQ data as those mentioned above for San Antonio) is Corpus Christi. Though smaller in population compared to San Antonio, Corpus Christi is home to much more significant infrastructure associated with the petrochemical industry; thus, the emission profiles of the two urban areas are quite different. The coastal location of Corpus Christi also causes its meteorology and the relevant atmospheric chemistry to be unlike those in San Antonio. The same modeling study referred to above indicates that on average ~9 ppbv of O_3 in Corpus Christi can be attributed to anthropogenic activity (Farooqui et al., 2013). Other previous research focused on or including Corpus Christi indicates the importance of Central American fires on average O_3 and PM levels along the coast of the Gulf of Mexico (Wang et al., 2018), how concentrations of highly reactive olefins associated with petrochemical emissions vary spatially across south Texas (Myers et al., 2015), and the contributions of secondary sulfate, SOA and marine aerosols to PM levels on an annual basis (Karnae and John, 2011; Subramoney et al., 2013). Specific efforts have been made to understand health impacts of local emissions in Corpus Christi (e.g., Wing et al., 2017) and how regulatory efforts can improve air quality (e.g., levels of air toxics) (Capobianco et al., 2013).

It should be stressed that the data collected and the resulting conclusions made during SAFS are relevant only for the spring portion of the O_3 season, which lasts in total from April through October. Evaluation of air quality in Corpus Christi has been limited predominantly to data collected using relevant monitoring networks. The focus of this project is the evaluation of air quality in Corpus Christi, San Antonio, and the region in between during the early part of the 2021 (calendar year) O_3 season.

3.0 Objectives

The goals of this project are to understand the following during the early (spring) portion of the 2021 ozone season: the chemical nature of air being transported into Corpus Christi from the Gulf of Mexico (including the influence of any biomass burning), the chemical nature of air being transported out of Corpus Christi, the chemical nature of air being transported in San Antonio, and the chemical nature of the air being transported out of San Antonio. We also seek to compare the measurements collected in and around San Antonio to those collected during the SAFS in spring 2017.

4.0 Task Descriptions

The tasks that will be completed in order to perform this project are listed broadly below. Each task will be a collaborative effort between the three team institutions.

Task 4.1. Campaign Preparation

Prepare for field campaign, including training of personnel, calibration of equipment, upgrading of mobile facility, installation of equipment, arranging lodging, and selection of fixed sites for stationary sampling. Each institution will be responsible for its own personnel and instrumentation. Other activities will have shared responsibility (arranging of lodging, selection of field sites). Timeline: Start of project through start of campaign (March 31, 2021).

Task 4.2. Campaign Performance

Perform the field campaign, which will consist of seven weeks: Weeks 1 and 2 (April 1 – 14, 2021): Set up and perform stationary measurements in a coastal Corpus Christi location; Week

3 (April 15 – 21, 2021): Perform daily mobile measurements downwind (to the northwest) of Corpus Christi; Week 4 (April 22 – 28, 2021): Perform mobile measurements upwind (to the southeast) of San Antonio; Weeks 5 and 6 (April 29 – May 12, 2021): Perform stationary measurements in a location upwind of the core San Antonio area; Week 7 (May 13 – 19, 2021): Perform mobile measurements downwind (to the northwest) of San Antonio or to sample downwind of any identified 'hot spots' from the SAFS results. This last week also could be used to probe the air quality impacts of the closure of a coal-fired power plant to the southeast of downtown San Antonio. Protocols for deployment are described in Leong et al. (2017) and Wallace et al. (2018). Assuming no further delays or lockdowns occur, no accommodations need to be made in the wake of the COVID-19 pandemic. If such delays occur, we will consult with AQRP to determine if a field campaign during summer 2021 to coincide with the TRACER campaign in Houston will be allowed. As each institution will have team members in the field, the responsibility of Task 4.2 is shared.

Task 4.3. Data Analysis

Analyze the collected data, including quality assurance (see separate QAPP), basic statistical operations, and air quality modeling. The goal will be to address scientific questions related to the nature of the air coming into and out of Corpus Christi, how atmospheric chemistry and air quality change as air is advected downwind of Corpus Christi and upwind of San Antonio, and how the data in San Antonio compare between this deployment and SAFS. Each institution will be responsible for basic analysis of data generated by its own instrumentation. The Rice PI will lead additional statistical analysis related to ozone production and characterization of the nature of organic particulate matter. PI Wang will lead three-dimensional modeling efforts. Deliverables include all data generated/calculated from field measurements as well as model ouput. Timeline: Begins at the start of the project (testing of model and generation of its input) and ends upon project completion and provision of data.

Task 4.4. Project Reporting and Presentation

As specified in Section 7.0 "Deliverables" of this Scope of Work, AQRP requires the regular and timely submission of monthly technical, monthly financial status and quarterly reports as well as an abstract at project initiation and, near the end of the project, submission of the draft final and final reports. Additionally, at least one member of the project team will attend and present at the AQRP data workshop. For each reporting deliverable, 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 (or their designee) will electronically submit each report to both the AQRP and TCEQ liaisons and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources. The report templates and accessibility guidelines found on the AQRP website at http://aqrp.ceer.utexas.edu/ will be followed. **Draft copies of any planned presentations (such as at technical conferences) or manuscripts to be submitted for publication resulting from this project will be provided to both the AQRP and TCEQ liaisons per the Publication/Publicity Guidelines included in Attachment G of the subaward.** Finally, our team will prepare and submit our final project data and associated metadata to the AQRP archive.

Deliverables: Abstract, monthly technical reports, monthly financial status reports, quarterly reports, draft final report, final report, attendance and presentation at AQRP data workshop, submissions of presentations and manuscripts, project data and associated metadata

Schedule: The schedule for Task 4.4 Deliverables is shown in Section 7.

5.0 Project Participants and Responsibilities

5.1 Dr. Robert Griffin

(rob.griffin@rice.edu, 713-348-2093)
Rice University primary investigator (PI) Robert Griffin is Professor of Civil and Environmental Engineering and the Interim Dean of the George R. Brown School of Engineering. Griffin received degrees from Tufts University and the California Institute of Technology. He has over twenty years of research experience in air quality and atmospheric chemistry, including most recently projects that involve the MAQL. One such project occurred in spring 2017 in San Antonio, TX; this project included characterization of PM using a high-resolution time-of-flight aerosol mass spectrometer and estimation of O_3 production rates using a pseudo-steady state zero-dimensional (LaRC) model (Olson et al., 2006). The Rice team will lead the project and will focus predominantly on high-resolution time-of-flight aerosol mass spectrometer measurements, data analysis (including LaRC modeling, positive matrix factorization (Ulbrich et al., 2009) and consideration of organic nitrogen and sulfur (Farmer et al., 2010; Huang et al., 2015; Schulze et al., 2018)), and report/publication generation.

5.2 Dr. James Flynn

(jhflynn@uh.edu, 713-743-3262)
One of the University of Houston PIs is James Flynn, Research Associate Professor of Earth and Atmospheric Sciences. He received degrees from Baylor University and the University of Houston. Dr. Flynn has over twenty years of research experience in air quality and atmospheric chemistry, including most recently projects that involve the MAQL. One such project occurred

in summer 2016 in rural Michigan; this project included characterization of PM and trace gases above and below a forest canopy. The University of Houston team led by Flynn will focus primarily on trace gas and meteorological measurements, data analysis, and report/publication generation.

5.3 Dr. Yuxuan Wang

(ywang140@uh.edu, 713-743-9049)
The second University of Houston PI is Yuxuan Wang, Associate Professor of Earth and Atmospheric Sciences. She holds degrees from Tsinghua University and Harvard University. Dr. Wang has over fifteen years of research experience and significant expertise in the modeling of air quality and atmospheric processes in Texas. The University of Houston team led by Wang will focus primarily on application of three-dimensional modeling using an updated version of WRF-GC (Lin et al., 2020) and report/publication generation.

5.4 Dr. Rebecca Sheesley

(rebecca_sheesley@baylor.edu, 254-710-3158)
One of the Baylor PIs is Rebecca Sheesley, Associate Professors of Environmental Science. She received degrees from Wheaton College and the University of Wisconsin. Dr. Sheesley has extensive expertise in running air quality campaigns, analytical and atmospheric chemistry, and the characterization of biomass burning emissions. She also has significant experience in organic aerosol speciation. Most recently, she was involved in measurement of volatile organic compounds in Jones Forest using a proton-transfer-reaction mass spectrometer in 2016 and in 2017 (post Hurricane Harvey). The Baylor team co-lead by Sheesley will focus on PTR-MS, aerosol optical properties and on field campaign logistics and performance, data analysis and interpretation, and preparation of related manuscripts and/or reports.

5.5 Dr. Sascha Usenko

(sascha_usenko@baylor.edu, 254-710-2302)
The second Baylor PI is Sascha Usenko, Associate Professors of Environmental Science. He holds degrees from Oregon State University. Dr. Usenko has extensive expertise in running air quality campaigns, analytical and atmospheric chemistry, and the characterization of biomass burning emissions. He also has significant experience in measurement and the chemistry of pesticides. Most recently, he also was involved in measurement of volatile organic compounds in Jones Forest using a proton-transfer-reaction mass spectrometer in 2016 and in 2017 (post Hurricane Harvey). The Baylor team co-lead by Usenko will focus on PTR-MS, aerosol optical properties

and participate in field campaign logistics and performance, data analysis and interpretation, and preparation of related manuscripts and/or reports.

6.0 Timeline

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 – Field campaign preparation, Start of project – March 31, 2021
- Task 2 – Field campaign performance, April 1 – May 19, 2021
- Task 3 – Data analysis including QA/QC and three-dimensional modeling, Start of project – August 31, 2021 (note that preparation of three-dimensional modeling input and data analysis can begin before and while the campaign is being performed)

7.0 Deliverables

AQRP requires certain reports to be submitted on a timely basis and at regular intervals. 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, unless that responsibility is otherwise delegated with the approval of the Project Manager. All reports 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. Report templates and accessibility guidelines found on the AQRP website at http://aqrp.ceer.utexas.edu/ will be followed.

Abstract: At the beginning of the project, an Abstract will be submitted to the Project Manager for use on the AQRP website. The Abstract will provide a brief description of the planned project activities, and will be written for a non-technical audience.

Abstract Due Date: Friday, July 31, 2020

Quarterly Reports: Each Quarterly Report will provide a summary of the project status for each reporting period. It will be submitted to the Project Manager as a Microsoft Word 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	May, June, July 2020	Friday, July 31, 2020
Quarterly Report #2	August, September, October 2020	Friday, October 30, 2020
Quarterly Report #3	November, December 2020, January 2021	Friday, January 29, 2021
Quarterly Report #4	February, March, April 2021	Friday, April 30, 2021
Quarterly Report #5	May, June, July 2021	Friday, July 30, 2021
Quarterly Report #6	August, September, October 2021	Friday, October 29, 2021

Monthly Technical Reports (MTRs): Technical Reports will be submitted monthly to the Project Manager and TCEQ Liaison in Microsoft Word format using the AQRP FY20-21 MTR Template found on the AQRP website.

MTR Due Dates:

Report	Period Covered	Due Date
Technical Report #1	Project Start - June 30, 2020	Wednesday, June 10, 2020
Technical Report #2	July 1 - 31, 2020	Friday, July 10, 2020
Technical Report #3	August 1 - 31, 2020	Monday, August 10, 2020
Technical Report #4	September 1 - 30 2020	Thursday, September 10, 2020
Technical Report #5		