AIR QUALITY RESEARCH PROGRAM

Texas Commission on Environmental Quality
Contract Number 582-15-50047
Awarded to The University of Texas at Austin

Quarterly Report

December 1, 2018 through February 28, 2019

Submitted to

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Texas Air Quality Research Program

Quarterly Report

September 1, 2018 – November 30, 2018

OVERVIEW

The goals of the State of Texas Air Quality Research Program (AQRP) are:

(i) to support scientific research related to Texas air quality, in the areas of emissions inventory development, atmospheric chemistry, meteorology and air quality modeling,

(ii) to integrate AQRP research with the work of other organizations, and

(iii) to communicate the results of AQRP research to air quality decision-makers and stakeholders.

PROGRAM ACTIVITIES FOR THE QUARTER

In early December 2018, the final Task Order was fully executed and all projects were in progress. Throughout the quarter, Project Managers worked with project teams to ensure all reporting requirements were met and assisted with project activities as needed. The Federal government shut-down from December 22, 2018 through January 25, 2019, made it difficult for some projects to obtain data, resulting in a delay in project activities. The TCEQ was able to provide alternate sources for several data requests, and those projects that were delayed have not indicated any issues in regards to completing the overall project on time.

As projects began, program management communicated the invoicing and financial status report (FSR) requirements to each entity, and reviewed each invoice/FSR for compliance prior to submission for payment.

BACKGROUND

Section 387.010 of HB 1796 (81st Legislative Session), directs the Texas Commission on Environmental Quality (TCEQ, Commission) to establish the Texas Air Quality Research Program (AQRP).

> Sec. 387.010. AIR QUALITY RESEARCH. (a) The commission shall contract with a nonprofit organization or institution of higher education to establish and administer a program to support research related to air quality.
>
> (b) The board of directors of a nonprofit organization establishing and administering the research program related to air quality under this section may not have more than 11 members, must include two persons with relevant scientific expertise to be nominated by the commission, and may not include more than four county judges selected from counties in the Houston-Galveston-Brazoria and Dallas-Fort Worth nonattainment areas. The two persons with relevant scientific expertise to be nominated by the commission may be employees or officers of the commission, provided that they do not participate in funding decisions affecting the granting of funds by the commission to a nonprofit organization on whose board they serve.
>
> (c) The commission shall provide oversight as appropriate for grants provided under the program established under this section.
>
> (d) A nonprofit organization or institution of higher education shall submit to the commission for approval a budget for the disposition of funds granted under the program established under this section.
>
> (e) A nonprofit organization or institution of higher education shall be reimbursed for costs incurred in establishing and administering the research program related to air quality under this section. Reimbursable administrative costs of a nonprofit organization or institution of higher education may not exceed 10 percent of the program budget.
>
> (f) A nonprofit organization that receives grants from the commission under this section is subject to Chapters 551 and 552, Government Code.

The University of Texas at Austin was selected by the TCEQ to administer the program. A contract for the administration of the AQRP was established between the TCEQ and the University of Texas at Austin on July 29, 2015 for the 2016-2017 biennium. Consistent with the provisions in HB 1796, up to 10% of the available funding is to be used for program administration; the remainder (90%) of the available funding is to be used for research projects, individual project management activities, and meeting expenses associated with an Independent Technical Advisory Committee (ITAC).

On September 4, 2017, the AQRP contract was renewed for the 2018 – 2019 biennium and additional funding of $750,000 per year was awarded.

RESEARCH PROJECT CYCLE

The Research Program is implemented through a 9 step cycle. The steps in the cycle are described from project concept generation to final project evaluation for a single project cycle.

1.) The project cycle is initiated by developing (in year 1) or updating (in subsequent years) the strategic research priorities. The AQRP Director, in consultation with the ITAC, the Council and the TCEQ, develop research priorities; the research priorities are released along with a Request for Proposals.

2.) Project proposals relevant to the research priorities are solicited. The Request for Proposals can be found at http://aqrp.ceer.utexas.edu/ .

3.) The Independent Technical Advisory Committee (ITAC) performs a scientific and technical evaluation of the proposals.

4.) The project proposals and ITAC recommendations are forwarded to the TCEQ. The TCEQ evaluates the project recommendations from the ITAC and comments on the relevancy of the projects to the State's air quality research needs.

5.) The recommendations from the ITAC and the TCEQ are presented to the Council and the Council selects the proposals to be funded. The Council also provides comments on the strategic research priorities.

6.) All Investigators are notified of the status of their proposals, either funded, not funded, or not funded at this time, but being held for possible reconsideration if funding becomes available.

7.) Funded projects are assigned an AQRP Project Manager at UT-Austin and a Project Liaison at TCEQ. The AQRP Project Manager is responsible for ensuring that project objectives are achieved in a timely manner and that effective communication is maintained among investigators involved in multi-institution projects. The AQRP Project Manager has responsibility for documenting progress toward project measures of success for each project. The AQRP Project Manager works with the researchers, and the TCEQ, to create an approved work plan for the project.

    The AQRP Project Manager also works with the researchers, TCEQ and the Program's Quality Assurance officer to develop an approved Quality Assurance Project Plan (QAPP) for each project. The AQRP Project Manager reviews monthly, annual and final reports from the researchers and works with the researchers to address deficiencies.

8.) The AQRP Director and the AQRP Project Manager for each project describe progress on the project in the ITAC and Council meetings dedicated to on-going project review.

9.) The project findings are communicated through multiple mechanisms. Final reports are posted to the Program web site; research briefings are developed for the public and air quality decision makers; and a bi-annual research conference/data workshop is held.

During this reporting period all Program activity concentrated on Step 7 of the Research Project Cycle.

RESEARCH PROJECTS

FY 2018 – 2019 Projects

Project 18-005 **STATUS: Active – October 31, 2018**

Next steps for improving Texas biogenic VOC and NO emission estimates

University of California-Irvine – Alex Guenther
Ramboll – Greg Yarwood
AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Doug Boyer

Funded Amount: $168,146
(UC-Irvine $139,193, Ramboll $28,953)

Abstract
The emissions of gases and particles into the atmosphere are the primary drivers of regional air quality. There are a wide variety of emission sources including automobiles, factories, and biological organisms including vegetation and microbes. While emissions from combustion sources and industrial activities dominate in urban and industrial locations, biogenic emissions dominate on global scales and contribute to atmospheric composition in urban and nearby areas.

The overall goal of this project is to improve numerical model predictions of regional ozone and aerosol distributions in Texas by reducing uncertainties associated with quantitative estimates of biogenic volatile organic compound (BVOC) and biogenic nitric oxide (BNO) emissions from Texas and the surrounding region. Although there have been significant advancements in the procedures used to simulate these biogenic emissions, there are still major uncertainties that limit predictability of Texas air quality simulations. In this project, we will improve the capability of the Model of Emissions of Gases and Aerosols from Nature (MEGAN) framework to estimate emissions of these compounds for application in numerical air quality models. To accomplish this, we will conduct high quality measurements of speciated BVOC emission factors at eastern Texas field sites near San Antonio, Dallas, and Houston. These results and other recent advances, including an improved approach for modeling BNO emissions, will be integrated into MEGAN.

The primary output of the proposed research will be a more accurate approach for estimating BVOC and BNO emissions. The overall benefit of this project will be more accurate VOC and NO emission estimates for the Texas air quality simulations that are critical for scientific understanding and the development of regulatory control strategies that will enhance efforts to improve and maintain clean air.

Project Activities
A summary of activities for the period December 1, 2018 through February 28, 2019 is provided below:

Task 1. Measure Texas BVOC emission factors and their variability

We initiated efforts to prepare for the May/June field study in Texas. This included the development and testing of the two BVOC enclosure measurement approaches and completing our strategy for selecting target plants. Initial tests demonstrated that a portable GC-MS provides better results than the portable GC-PID system we had originally proposed for isoprene

measurements. We set up two portable GC-MS systems and optimized our sampling and analytical approach and have initiated field tests with trees on the UCI campus including Quercus virginiana, a dominant Texas isoprene emitter.

Task 2. MEGAN model improvements

The specific coding tasks required for implementing the new soil NO emission algorithm have been identified and assigned to the project team. Updates are being made to the MEGAN-EFP python code and BVOC emission inputs.

Task 3. MEGAN3.1 sensitivity analysis of Texas biogenic emissions

Not yet initiated. The work on this task is scheduled to start in May 2019.

The agreement between UCI and UT was completed in December and the project is back on track. We expect to complete the tasks on time and the project is expected to proceed as planned.

Project 18-007 **STATUS: Active – October 16, 2018**

DDM Enhancements in CAMx: Local Chemistry Sensitivity and Deposition Sensitivity

Ramboll – Greg Yarwood

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Jim Smith

Funded Amount: $150,000

Abstract
The Texas Commission on Environmental Quality uses the CAMx photochemical air quality model in planning activities for ground-level ozone. Estimating uncertainty in a model's predictions due to uncertainties in all the inputs and parameters, known as a global uncertainty analysis, is a challenge due to the hundreds or even thousands of inputs and parameters and the relatively long computer runtimes for photochemical models. This project will develop a new and efficient sensitivity analysis tool for CAMx called Chemistry Sensitivity Analysis (CSA) that is based on the decoupled direct method (DDM) for sensitivity analysis already present in CAMx. Then, we will use CSA to estimate the uncertainty range in ozone predictions in Texas due to chemistry uncertainty by creating alternative chemistry mechanisms with high and low ozone productivity. Also, we will extend the implementation of DDM in CAMx to calculate sensitivity to dry deposition velocity which has been identified as an important factor influencing ozone predictions. We will combine the effects of estimated uncertainty in the chemistry with uncertainty due to model emissions, boundary concentrations, and dry deposition velocity to estimate an overall uncertainty in CAMx ozone predictions for Texas.

Project Activities
This AQRP project is being performed by Ramboll in collaboration with Dr. Alan Dunker, an independent consultant. A summary of activities for the period December 1, 2018 through February 28, 2019 is provided below:

Task 1: Develop the Chemistry Sensitivity Analysis (CSA) Tool for CAMx
Dr. Dunker and Ramboll continued work on the CSA tool. Dr. Dunker developed the variance-covariance formulas representing the correlation of uncertainty in product stoichiometric coefficients and calculated the uncertainty variance-covariance matrices for the 34 CB6r4 reactions with correlation of product stoichiometric coefficients. Dr. Dunker documented the analysis of uncertainties in the rate constants and stoichiometric coefficients of the CB6r4 chemical mechanism as well as the methodology for estimating the effects on ozone of these uncertainties. Ramboll is currently reviewing the document prior to implementing the methodologies.

Task 2: Apply CSA for Ozone in Texas to Investigate Chemical Mechanism Condensation and Uncertainty
This task will be conducted after Task 1 above is completed.

Task 3: Implement DDM for Dry Deposition Velocity in CAMx
Ramboll has completed the development of the CAMx DDM interface for dry deposition and is currently implementing the code to calculate the dry deposition sensitivities.

Task 4: 3-D DDM Analysis
This task has not yet been initiated.

Task 5: Reporting
This task has not yet been initiated.

Ramboll received authorization to begin work on the project in October 2018. We do not expect this delay in initiating the study to impact the overall schedule for delivering the draft final report by August 1, 2019.

We intend to use all funds allocated to the project by 08/31/2019.

Project 18-010 **STATUS: Active – October 26, 2018**

A synthesis study of the role of mesoscale and synoptic-scale wind on the concentrations of ozone and its precursors in Houston

Texas A&M University – Qi Ying

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Jonathan Steets

Funded Amount: $121,000

Abstract
While it is known that low synoptic-scale winds and mesoscale recirculation contribute to high ozone formation in Houston, a comprehensive synthesis of all relevant data and analyses to elucidate the interaction between the mesoscale and synoptic-scale winds and air pollutants is not yet available. An improved understanding of the roles of mesoscale and synoptic-scale processes would allow researchers and policy makers to distinguish between days dominated by local emissions and those dominated by regional contributions. The overall objective of this research is to synthesize existing data, previous analyses, and photochemical model experiments to provide a comprehensive and reconciled description of how mesoscale and synoptic-scale winds affects dispersion and accumulation of air pollutants emitted in the Houston area and from other regions, and how they contribute to high ozone events. The relationship between surface winds and boundary-layer mesoscale transport features will be clarified, and a novel source- and age-resolved regional air quality model will be applied to investigate selected high ozone events under the influence of mesoscale circulations. The results from this study will facilitate a better understanding of the interaction between the mesoscale and synoptic-scale winds and air pollutants and how they contribute to high ozone events in Houston. Such information is extremely useful for understanding high ozone events as they occur and for developing appropriate control strategies and policy options for the unique Texas meteorological environment.

Project Activities
Task 1 is on synthesis of mesoscale wind structures in the synoptic-scale context. All available radar wind profiler data were downloaded for the eastern Texas (Houston, Beaumont, DFW areas) for the period 2005-2018 from the NOAA online wind profiler database. The data were formatted appropriately and are currently under evaluation. Appropriate episodes will be selected for further modeling investigation. Timely progress has been made on Task 2 of the project, which is to develop a source and age-resolved CMAQ model to analyze contributions of fresh and aged emissions to ozone formation in Houston. The unified source-oriented approach for the source/age apportionment of ozone, NOx and VOCs has been updated from SARPC-99 to SAPRC-07. The model has been applied to analyze the atmospheric age distribution of ozone at regional scale and at receptor sites for the summer ozone periods in the Houston-Galveston area in 2000 and 2006. High contributions of highly aged ozone (>8 hours old) occurred at both Aldine and Galveston on the nights of September 1-2, 4-5, 5-6 and 6-7. On 5-6 and 6-7, the aged ozone originated from Louisiana but on the other two nights it was due to emissions originated in Texas (Figure 1). We also observed that there is more non-background ozone at the Galveston site in the 2006 episode we modeled (September 1 to 15, 2006) and the non-background ozone was relatively aged.

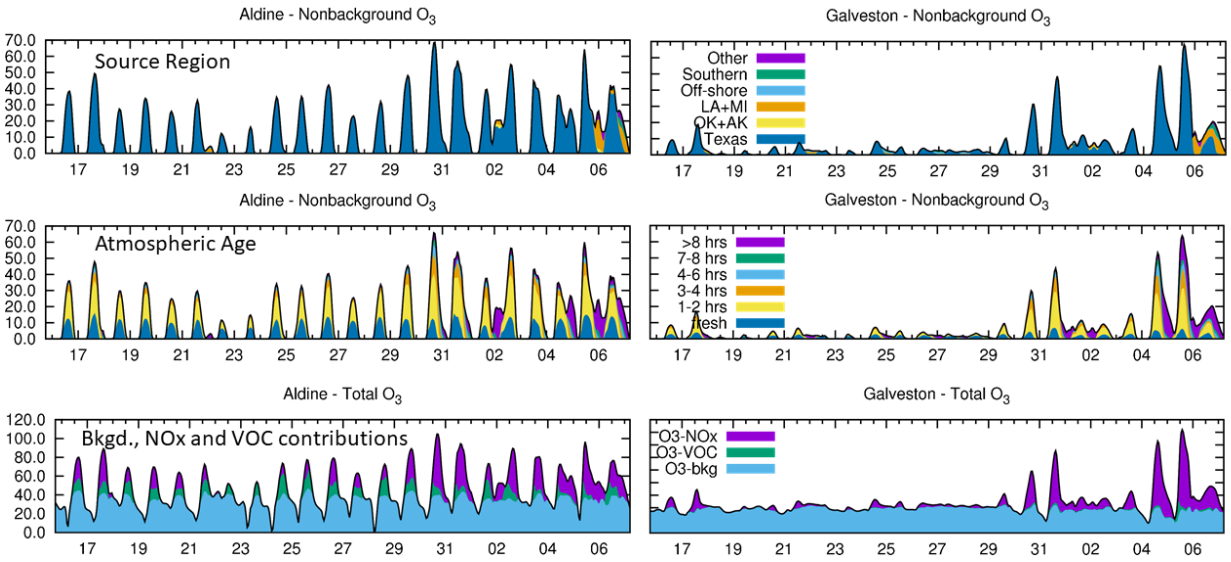

Figure 1 Source region (first row), atmospheric age (second row) and background vs. non-background analysis of ozone time series at the Aldine and Galveston sites between August 15 and September 7, 2000.

At this point, all funds allocated to the project are expected to be used by 8/31/2019.

Project 18-022 **STATUS: Active – September 1, 2018**

Development and Evaluation of the FINN v.2 Global Model Application and Fire Emissions Estimates for the Expanded Texas Air Quality Modeling Domain

University of Texas at Austin – Elena McDonald-Buller
Sonoma Technology, Inc. – Fred Lurmann

AQRP Project Manager – David Sullivan
TCEQ Project Liaison – Stephanie Shirley

Funded Amount: $172,114
(UT Austin $85,768, Sonoma Tech $86,346)

Abstract
Wildland fires and open burning can be substantial sources of ozone precursors and particulate matter. Air quality in Texas can be affected by fire events that occur locally, regionally, or across longer distances from within the United States or across its international borders. With this recognition, the Texas Commission on Environmental Quality's future air quality model domain has been extended to include all of Mexico and large parts of Central America and the Caribbean. The Fire INventory model from the National Center for Atmospheric Research (FINN) estimates daily emissions of trace gases and particles from open biomass burning. The objectives of this project are to leverage new findings and data products from ongoing laboratory studies, surface and airborne field measurement campaigns, and satellite-based sensors in the development of FINN and to produce a fully operational, next generation global FINN application. The new FINN application will be used to develop fire emissions estimates for 2012-2017, a time period that includes 2016, which is the base year for the U.S. Environmental Protection Agency's national air quality modeling platform. FINN performance will be assessed using a new satellite algorithm, the Multi-Angle Implementation of Atmospheric Correction (MAIAC), for aerosol optical depth (AOD) retrievals, with a focus on fire events that originate from within Mexico, Central America, or the Caribbean and influence Texas air quality. The project is a collaborative effort between the University of Texas at Austin, Sonoma Technology, Inc., and Dr. Christine Wiedinmyer.

Project Activities
During the quarter ending 2/28/2019, the team has been working to produce a fully operational global FINNv.2 application. Dr. Kimura from the University of Texas at Austin traveled to the University of Colorado, Boulder, to work collaboratively with Dr. Wiedinmyer and Mr. Joseph on the FINN development. The FINN modeling system consists of three primary components, including the preprocessor, emissions model, and chemical speciation code. The implementation of the FINN preprocessor within the Docker environment has been completed and quality assurance is on-going. Three updates were implemented to the preprocessor. The algorithm was implemented in PostGIS, a database that supports geospatial data types and operations, which resulted in improved performance (i.e., shorter execution time) for the model. Active fire detections from the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor were incorporated as an option that could be applied alone or in combinations with the Moderate Resolution Imaging Spectroradiomeer (MODIS) detection data. Finally, in order to facilitate the comparison of FINN emissions estimates with observational data, the FINN preprocessor was modified to

use local time in the specifications of the date of a fire. Within the main FINN code, updates were made to the emissions factors and fuel loadings to reflect findings from recent field campaigns and laboratory studies. Global simulations of fire activity in 2012 with the new modeling system are currently being tested.

The University of Texas at Austin and Sonoma Technology, Inc. have been establishing a procedure to calculate Aerosol Optical Depth (AOD) from air quality model predictions for comparison with retrievals from a new satellite algorithm, the Multi-Angle Implementation of Atmospheric Correction (MAIAC).

The Texas Forest Service provided a dataset of fire detections and burn perimeters, which is a relatively new product under development. The team has been making preliminary comparisons with the FINN burned area algorithm as well as the MODIS burned area product.

Two abstracts have been submitted for consideration for the 2019 Emission Inventory Conference to be held July 29-August 2, 2019 in Dallas, Texas.

The project is on-schedule, and all funds allocated are intended to be utilized by August 31, 2019.

Project 19-023 **STATUS: Active – September 5, 2018**

Emission Inventory Development and Projections for the Transforming Mexican Energy Sector

University of Texas at Austin – Elena McDonald-Buller
Ramboll – Greg Yarwood

AQRP Project Manager – David Sullivan
TCEQ Project Liaison – Michael Ege

Funded Amount: $158,309
(UT Austin $93,296, Ramboll $65,013)

Abstract
Within Texas, characterizing emission sources along its border and within Mexico has been recognized as essential for air quality modeling. Mexico's energy sector has been undergoing potentially transformational changes as part of Constitutional reforms ratified in 2013. A primary motivation is to encourage domestic and foreign investment and productivity growth in the oil, gas and power sectors. The reforms have the potential to significantly transform the magnitudes and spatial distributions of emissions from the oil and gas and power generation sectors over the next one to two decades. The overall objective of the proposed project is to apply new information to develop a bottom-up assessment of emissions for the upstream and midstream oil and gas sectors and power sector and to develop future emission projections based on likely outcomes of on-going bid rounds that are attracting new investment for exploration and production of oil and gas resources. Information and analytics for Mexico's upstream and midstream oil and gas sectors and power sector will be used to develop a 2016 base year emissions inventory, which coincides with the U.S. Environmental Protection Agency's national air quality modeling platform and will likely be the basis for future air quality modeling by the Texas Commission on Environmental Quality. Plans and results for the hydrocarbon bid rounds will be used as the basis for three future emissions projections that compare continued development of Mexico's onshore conventional and shallow water resources, which is consistent with historical practices, with expansion of its deep water and onshore shale regions that have been underdeveloped to date relative to their potential. The project is a collaborative effort between the University of Texas at Austin and Ramboll U.S Corporation.

Project Activities
During the quarter ending 2/28/2019, the team focused on an overall strategy for developing the base year upstream and midstream emissions inventory components. These include on-shore oil and gas well site exploration and production (upstream sector), off-shore oil and gas exploration and production platforms (upstream sector), compressor stations (midstream sector), natural gas processing plants (midstream sector), and electric power plants.

For the upstream sector, an initial emissions inventory for on-shore natural gas drilling and producing well sites was developed for the Burgos and Sabinas Basins in northern Mexico for the 2016 base year based on activity data from Mexico's National Hydrocarbons Information Center (CNIH) and IHS Markit and emission factors developed for the U.S. Western Gulf Basin. A similar approach is being developed for other on-shore basins, including Tampico Misantla, Veracruz, and Cuencas del Sureste. In contrast to the Burgos and Sabinas Basins, these basins

include wells with a mix of oil and gas production. Initial estimates will be refined to account for differences in emissions controls between Mexico and the U.S. Off-shore production in Mexico has been occurring in shallow waters (<200ft) with deep water resources still under development. The 2016 CNIH data provide off-shore oil and gas well site locations and production levels. The team expects to use U.S. production and emissions data for shallow water platforms in the Gulf of Mexico from the Bureau of Ocean Energy Management (BOEM) inventory to estimate emissions per unit of production. As feasible, these estimates will be refined by depth distribution and comparisons between U.S. and Mexican gas to oil ratios by area.

For the midstream sector, natural gas plants active during 2016 were identified through IHS Markit data. Initial emissions estimates are being developed based on production/throughput and plant characteristics. Many of these plants were included the 2008 Mexican Emission Inventory (MXEI2008) that was used in the development of the U.S. EPA's National Emissions Inventory (NEI) such that the emissions can be scaled between years. In contrast, natural gas compressor stations in the IHS Markit database could not be matched to any emission points in the NEI, suggesting they are missing. Overlays of the compressor stations with the pipeline network were created. The IHS data appears to capture not only large compressor stations along major trunk lines but also smaller compressor stations both in-field and along pipelines. The level of information available varies for different compressor stations, and strategies are being developed to estimate emissions.

The team has been working on two aspects of the development of emissions estimates for Mexico's power sector, identifying and locating power plants and identifying appropriate emissions factors.

The project is on-schedule, and all funds allocated are intended to be utilized by August 31, 2019.

Project 19-025 **STATUS: Active – October 16, 2018**

Apportioning the Sources of Ozone Production during the San Antonio Field Study

Aerodyne Research, Inc. – Tara Yacovitch AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Bright Dornblaser

Funded Amount: $199,974

Abstract
Ozone high up in the stratosphere is protective against UV rays, but when it is present at ground-level, it is a pollutant that can cause shortness of breath and other respiratory health problems. With new federal ozone standards in effect, it is more important than ever to understand the causes of ozone in and around San Antonio.

Ozone is formed when volatile organic hydrocarbons (VOCs) react with nitrogen oxides (NOx, the primary component in smog). A wide variety of VOCs are present in the air around cities such as San Antonio; they stem from sources as varied as vehicle exhaust, oil and gas extraction, and trees and vegetation. This project aims to discover which sources contribute to the formation of ground-level ozone in and around San Antonio, and in what quantities.

Raw data from the 2017 San Antonio Field Study (SAFS) will be examined closely and analyzed in full to identify characteristic sets of VOCs associated with different source types. Computer modeling of air transport will help identify the broad geographic areas where the measured air originated. An ozone formation computer model, in which individual source categories can be turned on, off, or varied, will be used to understand how each source type contributes to ozone formation in and around San Antonio.

Project Activities
Raw data from the 2017 San Antonio Field Study (SAFS) is being analyzed to identify characteristic sets of VOCs associated with different source types. Task 1 consists of high-resolution analysis of raw data from three separate instruments followed by identification of any new chemical species of atmospheric importance. Task 2 involves use of a mathematical technique called "Positive Matrix Factorization" (PMF) to group together chemical species that vary together in time, and thus are likely to have similar sources. Task 3 uses an ozone formation computer model, in which individual categories of VOC sources can be turned on, off, or varied, and will be used to understand how each source type contributes to ozone formation in and around San Antonio. Finally, Task 4 uses computer modeling of air transport to help identify the broad geographic areas where the measured air originated.

Progress in this second quarter has been made on all fronts. Task 4, which does not depend on other tasks, is largely completed: a full set of air transport model results has been produced and can be leveraged when interpreting other results. Progress on Task 1 (high-resolution analysis) is also satisfactory, with fit results from the third and final instrument expected early next month. Developments have been made within Task 2 (PMF), which uses results from Task 1. Several iterations of the analysis have been done on the first of three instruments, and the results critically discussed among the relevant experts in the project team. A strategy for running PMF on the unique 2-dimensional data from a second instrument (the gas chromatograph time-of-

flight mass spectrometer, GC-ToF) has been developed. In coming months, the third and final instrument dataset will undergo PMF analysis, and results from all three will be used to better understand the classes of VOCs present during the field study. Major strides have been made getting the ozone formation computer model (Task 3) running, investigating different modes of operation, and developing a framework to easily include experimental data into the model.

The main challenges this past quarter have been technical in nature: analysis of the 2-dimensional GC-ToF dataset, and spinning up of the ozone-formation model. Regular project-wide meetings as well as smaller focused scientific discussions have been crucial in pushing these tasks forward. Next quarter, one expected challenge will be integrating results from the various tasks and interpreting them as a whole, with the ultimate goal of understanding and apportioning ozone formation. This aspect of the project will be approached by emphasizing coordinated analysis and timely sharing of preliminary results among project members.

In February, Aerodyne Research requested a change in Key Personnel, to be effective in mid-April. Dr. Tara Yacovitch, the current Principal Investigator (PI), will be on leave until mid-August 2019. During her absence, Aerodyne has requested permission to have Dr. Joseph "Rob" Roscioli as the acting PI. Upon receipt of this request the AQRP Project Manager and TCEQ Liaison discussed this change and met with Dr. Yacovitch and Dr. Roscioli to ensure that all project activities would continue as planned. Once satisfied that the project would continue as detailed in the Work Plan, the change in Key Personnel was approved.

This project is currently on track to use all available funds and finish by 8/31/2019.

Project 19-031 **STATUS: Active – October 26, 2018**

Detecting events and seasonal trends in biomass burning plumes using black and brown carbon: (BC)2 El Paso

Baylor University – Rebecca Sheesley
University of Houston – James Flynn
AQRP Project Manager – David Sullivan
TCEQ Project Liaison – Erik Gribbin

Funded Amount: $131,294
(Baylor $98,087, UH $33,207)

Abstract
Recent efforts by the Texas Air Quality Research Program (AQRP) and TCEQ to monitor and study air quality in Texas cities has resulted in improved understanding of the processes and sources which control urban air quality in e.g. Houston. As highlighted in the AQRP Priority Research Areas 2018-2019, El Paso is near the National Ambient Air Quality Standards for particulate matter (PM) and ozone (O_3). Reductions in anthropogenic emissions through implementation of cleaner technologies for e.g. motor vehicle exhaust, coal-fired power plants, have refocused efforts to understand the contribution of biomass burning to urban air pollution. This is particularly relevant for El Paso, which can experience large impacts of periodic biomass burning/wildfire plumes transported from out-of-state. Black carbon (BC), a marker for combustion influences on air quality, has been shown to be decreasing in urban areas across the United States due to increased regulation and the use of cleaner fuels. As a result, biomass-burning contributions are likely becoming more important for BC and for urban air quality in general.

We will provide critical insight on the influence of biomass burning on the air quality in El Paso, TX through the characterization of BC and brown carbon (BrC). BrC is the carbon fraction of an aerosol that selectively absorbs short wavelengths of light. The $(BC)^2$ El Paso field campaign will include the deployment of the Baylor air quality trailer, which will be outfitted with a suite of specific technologies developed to assess biomass burning through the monitoring of BC and BrC. Biomass burning plumes will be identified using aerosol composition and light absorption properties, including BC and BrC concentrations, absorption Ångström exponents (AAE), and aerosol light absorption coefficients for specific ultraviolet (UV) and visible wavelengths. The newest technology for real-time monitoring of aerosol absorption is the tricolor absorption photometer (TAP). The TAP measures adsorption at UV, green and red wavelengths to more specifically target biomass burning. This inexpensive and continuous photometer was designed by the National Oceanic and Atmospheric Administration (NOAA) and is commercially produced by Brechtel to address issues with previous photometers, including cost, sensitivity, noise and effective scattering corrections. Although it was only recently available, Baylor and UH PIs have run this instrument successfully during the 2017 San Antonio field campaign (SAFS) in the Baylor air quality trailer. The two goals of $(BC)^2$ El Paso are to 1) address scientific air quality questions of frequency, seasonality, and optical properties of biomass burning plumes in El Paso and 2) to evaluate the TAP instrument suite for application in long-term monitoring at urban sites in Texas.

Project Activities
Progress since the last quarterly update in Dec 2018 has included a significant amount of field campaign preparation, instrument testing, a site visit to the University of Texas El Paso (UTEP) campus, and contact with UTEP facilities to monitor progress on site improvements.

For the field campaign preparation, the instruments have been tested under ambient conditions. The two new Tricolor aerosol photometers (TAPs) were ordered, arrived, and were tested in comparison with our aethalometer. The aethalometer is an established method for aerosol absorption and will also be in the field with the TAPs in El Paso during (BC)2. Baylor worked with the TAP company (Brechtel) to fix small bugs in the airflow through the system and improve intercomparability between instruments. The nephelometer has also been tested and updated, as needed, to run in the Baylor trailer.

To allow Baylor and UH to monitor the instrumentation remotely, the instruments are being set up to run through DAQ factory. This is in process.

A site visit was conducted by the three PIs (Sheesley, Usenko and Flynn) on Jan 31-Feb 1. They met with UTEP faculty and facilities to plan the site setup and to see the site and the campus. The site is on the UTEP campus adjacent to an existing TCEQ site, but not within the same fence enclosure. Funding from TCEQ Grant Activity. 582-19-92818-05, Contract No. 582-18-81339, an associated project, is being used to set-up the site. Site upgrades including ground leveling with new gravel, power upgrades to transformer and meter, and fencing around the Baylor trailer is being conducted by UTEP facilities who will charge UH under the TCEQ grant. The site leveling will be completed by Mar 15, but it is possible that the power company may be delayed in the transformer work. The PIs will proceed with as much site setup as possible while waiting for completion of the power work.

Start of the field campaign is planned for Mar 2019.

The project team does/does not anticipate any issues completing the tasks on time and the project is expected to proceed in December.

Project 19-040 **STATUS: Active – September 18, 2018**

Analysis of Ozone Production Data from the San Antonio Field Study

Drexel University – Ezra Wood

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Abstract
San Antonio is on the cusp of being in non-attainment of the U.S. Environmental Protection Agency's air quality standard for ozone, also known as photochemical smog. In order to mitigate potentially bad air quality in San Antonio, regulators will benefit from a full understanding of the sources of ozone and how future emissions can affect its concentration. During May 2017, a team of researchers from Drexel University, University of Houston, Rice University, and Aerodyne Research, Inc. conducted a field study focused on ozone air pollution in the greater San Antonio Area. The main goals were to collect data that would enable a determination of the rate at which ozone was being produced by chemical reactions in the air, to determine the relative importance of upwind and urban sources of ozone precursor emissions, and to determine the importance of different types of emissions (e.g., nitrogen oxides from fossil fuel combustion vs. biogenic volatile organic compounds from trees). The measurements from these field measurements were largely successful. In this project, the research team at Drexel University will analyze many aspects of the data in order to address the above goals. This research will consist of three tasks:

1. To characterize the relationship between the ozone production rate (calculated using measured concentrations of nitric oxide and total peroxy radicals) and the concentrations of other pollutants, including nitrogen oxides and volatile organic compounds,

2. To conduct zero-dimensional modeling of the photochemistry (in which spatial variations in pollutant concentrations are not considered) in order to determine if chemical models can successfully characterize the photochemistry, and

3. To conduct 3-dimensional air quality modeling, in which knowledge of emissions, meteorology, and the relevant chemistry are combined to predict spatially-resolved concentrations of ozone and other pollutants.

Project Activities
During the quarter ending 2/28/2019, the project team members continued work on all three tasks. For Task 1 (quantify the dependence of the ozone production rate on the concentrations of NOx, VOCs, and other measurements at the three SAFS sites where peroxy radicals were measured), we have revised the manuscript entitled "Characterization of Ozone Production in San Antonio, Texas Using Observations of Total Peroxy Radicals" in order to address the comments of two anonymous reviewers. We expect it to be fully published in the journal *Atmospheric Chemistry and Physics* in early March. Most of Task 1 is complete and appears in that manuscript. The remaining parts of task 1 are to investigate the correlation of O_3 concentrations and O_3 formation rates with the history of the air mass. In particular we will

investigate the impact on ozone concentrations of air masses whose back-trajectories indicate possible influence from Latin American fires.

For Task 2 (conduct 0-D photochemical modeling of the dataset with several model chemical mechanisms to investigate ozone production rates at four SAFS measurement sites), we have collected the most recent PTR-MS data from Baylor University for the centrally located Traveler's World site. We have started initial 0-D modeling of the data using that data, with particular attention to the sensitivity of the results to the formaldehyde data used.

Finally we have continued work on Task 3: Apportion ozone concentrations to location-specific emission sources using 3-D air quality modeling with the instrumented Community Multiscale Air Quality model (CMAQ). CMAQ version 5.2.1 was installed on the Drexel high performance computing cluster and Daniel Anderson was trained in its use by Shannon Capps. After delays due to the government shutdown we have acquired the 2017 emissions data from the EPA and commenced integrating them into our implementation of CMAQ.

FINANCIAL STATUS REPORT

Initial funding for fiscal years 2016 and 2017 was established at $1,000,000 each, for a total award of $2,000,000 for the FY 2016/2017 biennium. On September 4, 2017, the AQRP contract was renewed for the FY 2018/2019 biennium and additional funding of $750,000 per year was awarded. For each year, the funds were distributed across several different reporting categories as required under the contract with TCEQ. The reporting categories are:

Program Administration – limited to 10% of the overall funding (per Fiscal Year)
This category includes all staffing, materials and supplies, and equipment needed to administer the overall AQRP. It also includes the costs for the Council meetings.

ITAC
These funds are to cover the costs, largely travel expenses, for the ITAC meetings.

Project Management – limited to 8.5% of the funds allocated for Research Projects
Each research project will be assigned a Project Manager to ensure that project objectives are achieved in a timely manner and that effective communication is maintained among investigators in multi-institution projects. These funds are to support the staffing and performance of project management.

Research Projects / Contractual
These are the funds available to support the research projects that are selected for funding.

Program Administration

Program Administration includes salaries and fringe benefits for those overseeing the program as a whole, as well as, materials and supplies, travel, equipment, and other expenses. This category allows indirect costs in the amount of 10% of salaries and wages.

During the reporting period several staff members were involved, at various levels of effort, in the administration of the AQRP. Dr. David Allen, Principal Investigator and AQRP Director, is responsible for the overall administration of the AQRP. Maria Stanzione, AQRP Program Manager, assisted Dr. Allen in the program administration, while Maeve Cooney, Shannon Thorne, and Susan McCoy each provided assistance with program organization and financial management. Denzil Smith was responsible for the AQRP Web Page development and for data management.

Additionally, all remaining FY 2017 Contractual funds were fully expended in February 2019.

Beginning September 1, 2018, The University of Texas at Austin switched to a federally negotiated fringe benefit rate. For fiscal year 2018/2019 the fringe rates will be:

Full-time/Benefits Eligible (including Graduate Students)	29%
Part-time/Benefits Eligible	39.60%
Part-time/Non-benefits Eligible	5.80%.

The contract between the TCEQ and The University of Texas at Austin was amended during the previous quarter to reflect this change in policy.

Table 1: Administration Budgets

Administration Budget (includes Council Expenses)
FY 2016/2017

Budget Category		FY16 Budget	FY17 Budget	Total	Expenses	Remaining Balance
Personnel/Salary		$74,376.95	$73,027.36	$147,404.31	$147,404.31	$0.00
Fringe Benefits		$18,118.37	$18,695.22	$36,813.59	$36,813.59	$0.00
Travel		$34.00	$0.00	$34.00	$34.00	$0.00
Supplies		$32.98	$974.69	$1,007.67	$1,007.67	$0.00
Equipment						
Total Direct Costs		$92,562.30	$92,697.27	$185,259.57	$185,259.57	$0.00
Authorized Indirect Costs		$7,437.70	$7,302.73	$14,740.43	$14,740.43	$0.00
10% of Salaries and Wages						
Total Costs		**$100,000.00**	**$100,000.00**	**$200,000.00**	**$200,000.00**	**$0.00**

Administration Budget (includes Council Expenses)
FY 2018/2019

Budget Category		FY18 Budget	FY19 Budget	Total	Expenses	Remaining Balance
Personnel/Salary		$53,800.00	$53,700.00	$107,500.00	$57,904.98	$49,595.02
Fringe Benefits		$14,320.00	$12,930.00	$27,250.00	$15,483.34	$11,766.66
Travel		$0.00	$0.00	$0.00	$0.00	$0.00
Supplies		$1,500.00	$3,000.00	$4,500.00	$1,165.22	$3,334.78
Equipment						
Total Direct Costs		$69,620.00	$69,630.00	$139,250.00	$74,553.54	$64,696.46
Authorized Indirect Costs		$5,380.00	$5,370.00	$10,750.00	$5,790.51	$4,959.49
10% of Salaries and Wages						
Total Costs		**$75,000.00**	**$75,000.00**	**$150,000.00**	**$80,344.05**	**$69,655.95**

ITAC

Table 2: ITAC Budgets

ITAC Budget
FY 2016/2017

Budget Category		FY16 Budget	FY17 Budget	Total	Expenses	Remaining Balance
Personnel/Salary						
Fringe Benefits						
Travel		$4,076.57	$0.00	$4,076.57	$4,076.57	$0.00
Supplies		$1,079.20	$0.00	$1,079.20	$1,079.20	$0.00
Total Direct Costs		$5,155.77	$0.00	$5,155.77	$5,155.77	$0.00
Authorized Indirect Costs						
10% of Salaries and Wages						
Total Costs		**$5,155.77**	**$0.00**	**$5,155.77**	**$5,155.77**	**$0.00**

ITAC Budget
FY 2018/2019

Budget Category		FY18 Budget	FY19 Budget	Total	Expenses	Remaining Balance
Personnel/Salary						
Fringe Benefits						
Travel		$7,500.00	$7,500.00	$15,000.00	$4,384.23	$10,615.77
Supplies		$1,500.00	$1,500.00	$3,000.00	$284.86	$2,715.14
Total Direct Costs		$9,000.00	$9,000.00	$18,000.00	$4,669.09	$13,330.91
Authorized Indirect Costs						
10% of Salaries and Wages						
Total Costs		**$9,000.00**	**$9,000.00**	**$18,000.00**	**$4,669.09**	**$13,330.91**

Project Management

To fully fund the awarded research projects to be funded by FY 2019 funds, $782 was rebudgeted from FY 2019 Other to FY 2019 Research/Contractual.

Table 3: Project Management Budgets

Project Management Budget
FY 2016/2017

Budget Category		FY16 Budget	FY17 Budget	Total	Expenses	Remaining Balance
Personnel/Salary		$53,470.31	$51,727.58	$105,197.89	$105,197.89	$0.00
Fringe Benefits		$11,337.19	$12,236.62	$23,573.81	$23,573.81	$0.00
Travel		$0.00	$0.00	$0.00	$0.00	$0.00
Supplies		$0.00	$0.00	$176.36	$176.36	$0.00
Other		$0.00	$0.00	$0.00	$0.00	$0.00
Total Direct Costs		$64,938.86	$63,964.20	$128,948.06	$128,948.06	$0.00
Authorized Indirect Costs		$5,347.03	$5,172.76	$10,519.79	$10,519.79	$0.00
10% of Salaries and Wages						
Total Costs		**$70,330.89**	**$69,136.96**	**$139,467.85**	**$139,467.85**	**$0.00**

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Project Management Budget
FY 2018/2019

Budget Category		FY18 Budget	FY19 Budget	Total	Expenses	Remaining Balance
Personnel/Salary		$38,060.00	$38,060.00	$76,120.00	$29,728.25	$46,391.75
Fringe Benefits		$9,134.00	$9,134.00	$18,268.00	$10,296.28	$7,971.72
Travel		$0.00	$0.00	$0.00	$0.00	$0.00
Supplies		$1000.00	$1,000.00	$2,000.00	$0.00	$2,000.00
Other		$2,500.00	$1,718.00	$4,218.00	$0.00	$4,218.00
Total Direct Costs		$50,694.00	$49,912.00	$100,606.00	$40,024.53	$60,581.47
Authorized Indirect Costs		$3,806.00	$3,806.00	$7,612.00	$2,972.83	$4,639.17
10% of Salaries and Wages						
Total Costs		**$54,500.00**	**$53,718.00**	**$108,218.00**	**$42,997.36**	**$65,220.64**

Research Projects

A total of eight (8) projects requesting $1,231,101 in funding, were selected out of forty (40) proposals submitted to the AQRP RFP for the 2018-2019 biennium. Table 4 on the following page shows the distribution of the projects across the fiscal years for both FY 16-17 and FY 18-19.

The 2018 – 2019 budget allocates $1,223,000.00 for research projects ($611,500 per fiscal year). After all FY 2016 – 2017 research projects and program activities were complete, $7,559.39 in FY 2017 funds remained ($1,558,35 in Research/Contractual and $6,001.04 in Project Management). These funds were all transferred to the Research/Contractual category, and then assigned to partially fund project 19-023. That left a shortage of $541.61 in Research/Contractual funding. In order to fully fund all research projects, $782 was transferred from the FY 2019 ITAC funds to the FY 2019 Research/Contractual category. (Even though the total shortfall is $542, the FY 2018 projects do not use all of the funds allocated to them, and we cannot move funds between fiscal years, so the FY 2019 shortfall is actually $782.)

The portion of project 19-023 that was funded with FY 2017 was expended in February of 2019. This fully disburses all FY 2016 and 2017 funding.

Table 4: Contractual/Research Project Budget

FY 16-17

Contractual Expenses				
FY 16 Contractual Funding		**$815,000**		
FY 16 Contractual Funding Transfers		**$9,513**		
FY 16 Total Contractual Funding		**$824,513**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
16-008	University of Houston	$191,366	$189,684.87	$1,681.13
16-010	Sonoma Technology, Inc.	$69,075	$69,075.00	$0.00
16-011	Ramboll Environ	$158,134	$158,127.36	$6.64
16-019	Univ. of Texas - Austin	$118,019	$117,551.39	$467.61
16-019	Ramboll Environ	$62,622	$62,618.81	$3.19
16-031	UNC - Chapel Hill	$225,000	$223,820.08	$1,179.92
FY 16 Total Contractual Funding Awarded		$824,216		
FY 16 Contractual Funds Expended (Init. Projects)			$820,877.51	
FY 16 Contractual Funds Remaining to be Spent				$3,635.83
FY 16 Additional Expenditures				
	State of the Science	$3,788.49	$3,635.83	$152.66
			$824,513.34	
FY 16 Contractual Funds Remaining to be Spent				$0.00

Table 4: Contractual/Research Project Budget (continued)

FY 16-17 (continued)

FY 17 Contractual Funding		**$815,000**		
FY 17 Contractual Funding Transfers		**$15,863**		
FY 17 Total Contractual Funding		**$830,863**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
17-007	Univ. of Texas - Austin	$205,500	$202,348.20	$3,151.80
17-024	Atmospheric and Environmental Research, Inc.	$170,039	$170,039.00	$0.00
17-032	Drexel University	$59,000	$58,958.17	$41.83
17-039	Univ. of Alabama - Huntsville	$149,227	$149,226.81	$0.19
17-053	Aerodyne Research, Inc.	$185,193	$185,193.00	$0.00
17-SAFS	Univ. of Texas - Austin	$46,000	$35,999.96	$10,000.04
FY 17 Total Contractual Funding Awarded		$814,959		
FY 17 Contractual Funding Expended (Init. Projects)			$801,765.14	
FY 17 Contractual Funds Remaining to be Spent				$29,097.90
FY 17 Additional Expenditures				
	State of the Science	$22,211.51	$21,538.51	$673.00
19-023	UT Austin	$7,559.39	$7,559.39	$0.00
FY 17 Contractual Funds Expended			$830,863.04	
FY 17 Contractual Funds Remaining to be Spent				$0.00
Total Contractual Funding		$1,655,376		
Total Contractual Funding Awarded		$1,655,376		
Total Contractual Funding Remaining to be Awarded		$0		
Total Contractual Funds Expended to Date			$1,655,376	
Total Contractual Funds Remaining to be Spent				$0

Table 4: Contractual/Research Project Budget (continued)

FY 18-19

Contractual Expenses				
FY 18 Contractual Funding		**$611,500**		
FY 18 Contractual Funding Transfers		**$0**		
FY 18 Total Contractual Funding		**$611,500**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
18-005	UC - Irvine	$139,193	$0.00	$139,193.00
18-005	Ramboll	$28,953	$164.06	$28,788.94
18-007	Ramboll	$150,000	$12,568.46	$137,431.54
18-010	TAMU	$121,000	$1,117.96	$119,882.04
18-022	UT Austin	$85,768	$38,441.63	$47,326.37
18-022	Sonoma Tech, Inc.	$86,346	$1,760.75	$84,585.25
FY 18 Total Contractual Funding Awarded		$611,260		
FY 18 Contractual Funds Expended (Init. Projects)			$54,052.86	
FY 18 Contractual Funds Remaining to be Spent				$557,447.14
FY 19 Contractual Funding		**$611,500**		
FY 19 Contractual Funding Transfers		**$782**		
FY 19 Total Contractual Funding		**$612,282**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
19-023	UT Austin	$85,736.61	$33,141.44	$52,595.17
19-023	Ramboll	$65,013	$18,260.47	$46,752.53
19-025	Aerodyne Research, Inc.	$199,974	$26,963.05	$173,010.95
19-031	Baylor University	$98,087	$0.00	$98,087.00
19-031	University of Houston	$33,207	$0.00	$33,207.00
19-040	Drexel University	$130,264	$0.00	$130,264.00
FY 19 Total Contractual Funding Awarded		$612,282		
FY 19 Contractual Funding Expended (Init. Projects)			$78,364.96	
FY 19 Contractual Funds Remaining to be Spent				$533,917.04
Total Contractual Funding		$1,223,782		
Total Contractual Funding Awarded		$1,223,542		
Total Contractual Funding Remaining to be Awarded		$240		
Total Contractual Funds Expended to Date			$132,417.82	
Total Contractual Funds Remaining to be Spent				$1,091,364