AIR QUALITY RESEARCH PROGRAM

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

Quarterly Report

September 1, 2019 through November 30, 2019

Submitted to

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Texas Air Quality Research Program

Quarterly Report

September 1, 2019 – November 30, 2019

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

Between September 1, 2019 and November 30, 2019, the AQRP Project Administration efforts focused primarily on finalizing project invoices, draft reports, and final reports from the Fiscal Year (FY) 2018-2019. By November 30, 2019, nearly all projects had submitted their final invoices and completed their projects. The FY 18-19 Project 18-005 (University of California – Irvine) was still coordinating with the AQRP Program Manager to have their final invoice approved at the end of November 2019. Project 19-031 (Baylor University) had their final invoice approved, but not fully processed from AQRP funds. Projects 18-005 and 19-031 will have final invoices fully completed in the first part of the 2nd Quarter. FY 2018-2019 projects that remain to have final invoices approved and paid will be completed before the 2018-2019 funding expires on February 27, 2020. A full list of the awarded projects from FY 2018-2019 are listed in Appendix A.

During the first quarter, the research priorities for the upcoming 2020-2021 biennium were finalized by a quorum of the Council Members, via conference call meeting held on November 14, 2019. With the research priority questions approved, the AQRP administration staff focused efforts on updating the AQRP website with all 2018-2019 project data. The Request for Proposals (RFP) was sent out to individuals and institutions on the AQRP distribution list on December 2, 2019. RFP documents and guidelines were all updated on the AQRP site, including an updated version of the Master Agreement that will be used for contracting between The University of Texas at Austin and the entities that are awarded project funding. The RFP deadline is set for January 15, 2020 at 5:00pm CT.

Program activities in the 2nd quarter will focus on the review process for the proposals submitted in response to the RFP for the 2020-2021 biennium, which will include the Independent Technical Advisory Committee (ITAC) meeting, which is planned for early February 2020. The proposal evaluation process will be completed with compilation and scoring of ITAC proposal reviews (estimated completion for early February 2020), Council Advisory rankings of proposal

funding (estimated completion for early April 2020), and a formal release of the final list of awarded projects for the 2020-2021 biennium (estimated for mid-April 2020).

An extension to the 1st quarter report due date was approved by the TCEQ on December 10, 2019 due to AQRP staffing changes. Starting in the 2nd quarter, the AQRP Program Manager, RoseAnna Goewey, will be on Family Medical Leave which will require Center for Energy and Environmental Resources (CEER) staff to assist with the AQRP basic administration duties. The AQRP Program Manager plans to continue much of the work remotely, with the assistance of the AQRP Director, Dr. David Allen, and CEER staff support for any in-person requirements.

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. 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).

The AQRP contract was most recently renewed for the 2020-2021 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 9 for the 2018-2019 projects and Step 1 for the 2020-2021 biennium of the Research Project Cycle.

RESEARCH PROJECTS
FY 2018 – 2019 Projects

Project 18-005 **STATUS: Active – October 31, 2018**
Complete – August 31, 2019

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. This project improved 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. High quality measurements of speciated BVOC emission factors were conducted 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, were integrated into MEGAN.

The primary output of the proposed research is a more accurate approach for estimating BVOC and BNO emissions. The overall benefit of this project is 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 Update
Major activities and findings for the reporting period of June – November 2019 are listed below:

Task 1. Measure Texas BVOC emission factors and their variability: Measurements were made and analysis was completed. Results are described in detail in the final report.

Task 2. MEGAN model improvements: Code testing was completed and is described in detail in the final report.

Task 3. MEGAN3.1 sensitivity analysis of Texas biogenic emissions: The MEGAN3.1 sensitivity study and comparison of results to aircraft measurements were conducted and completed and are described in detail in the final report.

Project was completed. Final invoice is pending as of November 30, 2019. A small amount of unspent funds is expected, and UCI administration is working on determining the exact amount.

Project 18-007 **STATUS: Active – October 16, 2018**
Complete – August 31, 2019

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 developed 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, CSA was used 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, the implementation of DDM in CAMx was extended to calculate sensitivity to dry deposition velocity which has been identified as an important factor influencing ozone predictions. The effects of estimated uncertainty in the chemistry were combined with uncertainty due to model emissions, boundary concentrations, and dry deposition velocity to estimate an overall uncertainty in CAMx ozone predictions for Texas.

Project Update
Major activities and findings for the reporting period of June – November 2019 are listed below:

Task 1: *Develop the Chemistry Sensitivity Analysis (CSA) Tool for CAMx*: We completed the new CSA probing tool for CAMx.

Task 2: *Apply CSA for Ozone in Texas to Investigate Chemical Mechanism Condensation and Uncertainty*: We used the CSA probing tool in CAMx to understand which parameters in the chemical mechanisms have most influence on uncertainty in modeled ozone concentration. Then, we developed alternative chemical mechanisms with higher and lower ozone production which we used to quantify the uncertainty in modeled ozone concentration.

Task 3: *Implement DDM for Dry Deposition in CAMx*: We completed implementing the calculation of concentration sensitivity to dry deposition in CAMx.

Task 4: *3-D DDM Analysis*: We completed the CAMx simulations with DDM needed to characterize the uncertainty in ozone concentration due to uncertainties in emissions, deposition velocities and the boundary concentrations of ozone. We combined results from Tasks 2 and 4 to obtain a combined assessment of uncertainty in modeled ozone concentration.

Task 5: *Reporting*: The draft final report was submitted on July 31, 2019 and the final report on September 3, 2019. A presentation summarizing the project was made at the AQRP Workshop held on August 22, 2019 at the Center for Energy and Environmental Resources at the University of Texas at Austin.

Project Management: Ramboll submitted progress reports when required.

Project 18-010 **STATUS: Active – October 26, 2018**
Complete – August 31, 2019

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 was 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 are clarified, and a novel source- and age-resolved regional air quality model was applied to investigate selected high ozone events under the influence of mesoscale circulations. The results from this study 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 Update
We successfully completed all remaining work associated with the three Tasks in the original proposal. Regarding the synthesis of mesoscale wind structures in the synoptic-scale context, Dr. John Nielsen-Gammon generated and examined trajectories for all the high ozone episodes in 2013 and 2016 (2012 had no profiler data). Based on the analysis, WRF simulations were performed for three selected high ozone episodes (September 15-29, 2013; April 25-May 9, 2016; July 10-July 25, 2016). They all involve multiple stations exceeding the 8-hour standard, feature prominent wind rotation, but differ dramatically in the wind direction and shear. Thus, they are expected to yield different interactions between the background wind and sea breeze as well as different contributions from fresh and aged pollutants. Back-trajectory analyses were performed using WRF predicted wind fields using different boundary layer parameterizations to investigate the capability of the WRF model in resolving the recirculation patterns. Dr. Ying's group then performed CMAQ simulations for the three episodes. CMAQ emission-ready files

which include anthropogenic emissions based on the National Emission Inventory and the biogenic emissions from the BEIS v3.6.1 were generated. CMAQ simulations were performed using a base case model that does not resolve the age of the pollutants for model evaluation and the source and age-resolved model to identify the age distribution of ozone and its precursors. Detailed analyses are included in the draft final report. Clear contributions of aged ozone to total ozone are predicted, as shown in Figure 1 below for Galveston.

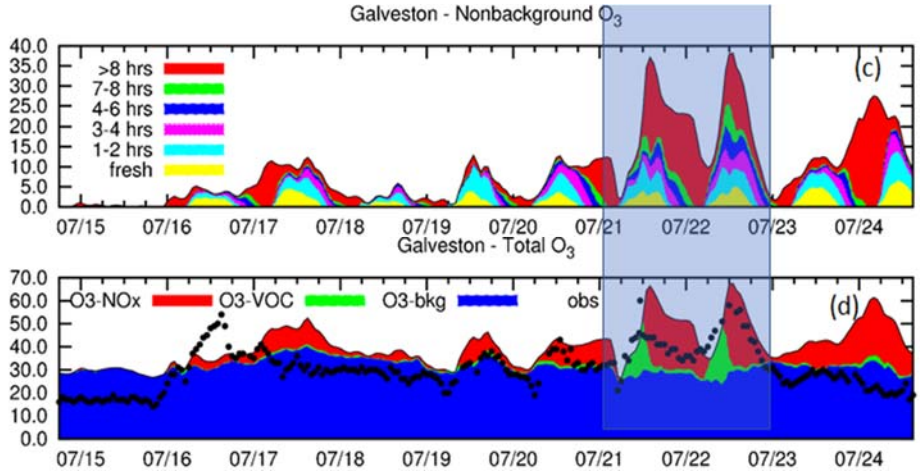

Figure 1: Predicted atmospheric age distribution of non-background ozone (i.e. ozone attributed to NOx and VOCs) at Galveston (c) and the breakdown of predicted total ozone to NOx, VOC and background contributions (d) from July 15 to July 24, 2016. Observed and predicted concentrations are in units of ppb. The age distribution results are based on 1-hr time-bin and a few age bins are combined to make it easier to visualize the results.

Project 18-022 **STATUS: Approved – September 1, 2018**
Complete – August 31, 2019

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

The 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 from the National Center for Atmospheric Research (FINN) model estimates daily emissions of trace gases and particles from open biomass burning. The objectives of this project were 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 was 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 was 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 was a collaborative effort between the University of Texas at Austin, Sonoma Technology, Inc., and Dr. Christine Wiedinmyer.

Project Update
During the quarter ending 8/31/2019, the team completed the development of FINNv2.2. FINNv2.2 simulations were completed for North America for 2012-2018 with MODIS and VIIRS active fire detections, as well as for 2012 with MODIS fire detections only. Global simulations for 2016 and 2018 with FINNv2.2 using MODIS and VIIRS active fire detections were also completed.

CAMx simulations were completed with all fire emissions removed ("no fires") as a basis for reference, with processed FINNv2.2 emissions with MODIS and VIIRS active fire detections, and with processed FINNv2.2 emissions with only MODIS detections. CAMx simulations were also completed using FINNv1.5 emissions. AOD values were calculated using CAMx simulation results and meteorology based on the second IMPROVE equation. HYSPLIT dispersion runs

were conducted using FINNv2.2 fire emissions for 2012 through 2018. Dispersed $PM_{2.5}$ was used to calculate AOD for comparison with satellite observations.

Predictions of air quality from the Comprehensive Air Quality Model with Extensions (CAMx) with FINNv.1.5 and FINNv2.2 fire emissions estimates for 2012 were evaluated with the Multi-Angle Implementation of Atmospheric Correction (MAIAC) aerosol optical depth (AOD) product to assess FINN performance. AOD calculated from HYSPLIT dispersion results were also assessed using MAIAC satellite data.

Quality assurance activities were completed. The draft final report was submitted on August 1, 2019. Comments were received from the TCEQ and addressed. A presentation about the project was made at the AQRP Workshop held on August 22, 2019 at the Center for Energy and Environmental Resources at the University of Texas at Austin. Elena McDonald-Buller and Nathan Pavlovic each made a presentation about the project at the 2019 Emission Inventory Conference on August 2, 2019, in Dallas, Texas.

The final report was submitted on September 3, 2019. Data from the project were compiled and submitted to the AQRP archive.

Project 19-023 **STATUS: Active – September 18, 2018**
Complete – August 31, 2019

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 were used to develop a 2016 base year emissions inventory, which coincides with the U.S. Environmental Protection Agency's national air quality modelling platform and will likely be the basis for future air quality modelling by the Texas Commission on Environmental Quality. Plans and results for the hydrocarbon bid rounds were 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 was a collaborative effort between the University of Texas at Austin and Ramboll U.S Corporation.

Project Update
During the quarter ending 8/31/2019, The team completed the 2016 base year emissions inventory estimates for the upstream (onshore and offshore oil and gas drilling and producing well sites; flaring) and midstream sectors (natural gas compressor stations and natural gas processing plants) and electric generating units.

Shapefiles for the bid rounds were obtained from the Mexican government. The team filtered the awarded blocks (i.e. removing those that were voided during the bid rounds) and separated them into deep water, shallow water, and onshore locations. The final maps showed onshore, shallow water and deepwater contractual areas awarded through the bid rounds. Overall these provided a perspective of where development is likely to occur in the foreseeable future. A speculative

assessment of emissions that could accompany ongoing development of the awarded contractual areas was conducted.

Quality assurance activities were completed. The draft final report was submitted on July 31, 2019 and the final report on August 30, 2019. A presentation about the project was made at the AQRP Workshop held on August 22, 2019 at the Center for Energy and Environmental Resources at the University of Texas at Austin. Data from the project were compiled and submitted to the AQRP archive.

Project 19-025 **STATUS: Active – October 16, 2018**
Complete – September 30, 2019

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 aimed 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) were examined and analyzed to identify characteristic sets of VOCs associated with different source types. Computer modeling of air transport helped 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, was used to understand how each source type contributes to ozone formation in and around San Antonio.

Project Update
Major activities and findings for the reporting period of June – November 2019 are listed below:

Raw data from the 2017 San Antonio Field Study (SAFS) was analyzed to identify characteristic sets of VOCs associated with different source types. Task 1 consisted of high-resolution analysis of raw data from three separate instruments followed by identification of any new chemical species of atmospheric importance. Task 2 involved 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 used an ozone formation computer model, in which individual categories of VOC sources can be turned on, off, or varied, and was used to understand how each source type contributes to ozone formation in and around San Antonio. Finally, Task 4 used computer modeling of air transport to help identify the broad geographic areas where the measured air originated.

For Task 1, high-resolution analysis of the mass spectral data, QA'ed datasets for various instruments were produced. A data quality audit was completed, highlighting a few issues, which were corrected. The PMF analysis (Task 2) task is complete, with the major result being an analysis that combines data from multiple instruments and shows the influence of different

sources. Task 4 is complete, with the data being used to help understand how different areas with different land cover impact the measurements.

We have completed partially constrained 0D box model runs (Task 4) for a time period of measurements at UTSA. The model is based upon the dynamically simple model for atmospheric chemical complexity (DSMACC) and incorporates the master chemical mechanisms version 3.3. This result showed how different VOCs contribute to OH formation.

A draft final report has been completed and submitted. A presentation was given at the AQRP Workshop on these draft results, and comments during the meeting are being used to help improve the final version of the report as we await official comments from our TCEQ liaison.

Project 19-031 **STATUS: Active – October 26, 2019**
Complete – September 30, 2019

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 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.

This project provides 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 includes the deployment of the Baylor air quality trailer, which was outfitted with a suite of specific technologies developed to assess biomass burning through the monitoring of BC and BrC. Biomass burning plumes were 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 study (SAFS) in the Baylor air quality trailer. The two goals of (BC)^2 El Paso were 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 Update

Progress since March 2019 has included a significant amount of field campaign data collection, additional field-based instrument testing, and several site visits to the University of Texas El Paso (UTEP) campus.

The UTEP site was modified by UTEP facilities and the Baylor University Air Quality Trailer was installed in March 2019. Measurements started March 22. Instrumentation from both Baylor and the University of Houston (UH) was housed and run remotely in the Baylor trailer. The real time instrumentation in the Baylor trailer included two new Tricolor Absorption Photometers (TAPs) (aerosol absorption alternating every hour), aethalometer (black carbon), nephelometer (aerosol scattering), and trace-level CO and NO_x.

Baylor and UH personnel remotely checked the data streams for the instruments daily. These data were archived continuously to redundant storage at UH. Nest cameras in the Baylor trailer were used to do remote visual checks on the instruments and gas cylinder pressures. Baylor and UH oversaw UTEP students paid to conduct weekly site checks and filter changes on the TAP. Baylor students did site visits in April and May to train UTEP students and to do routine maintenance.

Project 19-040 **STATUS: Active – September 18, 2018**
Complete – September 30, 2019

Analysis of Ozone Production Data from the San Antonio Field Study

Drexel University – Ezra Wood

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Mark Estes

Funded Amount: $130,264

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 analyzed many aspects of the data in order to address the above goals. This research consisted 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 Update
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 completed the modeling at the UTSA, Corpus Christi, Floresville, and Traveler's World measurement sites. The first three sites utilized the Aerodyne Mobile Laboratory data, and we were able to compare the peroxy radical concentrations (and ozone production rates) predicted by the models with the measured values. For Traveler's World, which is a more centrally located site subject to higher NOx concentrations, we used the combined Baylor U. / Rice U. / U. of Houston dataset. The Master Chemical Mechanism, which is the most explicit of all the

mechanisms used, produced the highest ozone formation rates. This agrees with separate modeling work conducted by the Rice University / U. Houston / Baylor University team, which utilized the NASA – Langley 0-D model.

We completed 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). The comparison of the NOx concentrations predicted by CMAQ and those measured at the TCEQ monitoring sites across the site was complicated by the fact that many of the monitoring sites are located near-roadways, whereas CMAQ does not have the spatial resolution to accurately predict concentrations near emission sources. Additionally, the measurements at the monitoring sites were made with the standard chemiluminescence method, which uses a molybdenum converter to convert NO_2 into NO prior to detection. This conversion method is not specific to NO_2, however, as "higher" nitrogen oxides such as peroxyacetyl nitrate (PAN) and alkyl nitrates are also converted into NO_2. We compared the modeled quantity ([NO] + [NO_2] + [organic nitrates]) to the measured NOx to address this.

We found that reducing NOx emissions into CMAQ by 30% led to better agreement with the measurements, which is in rough agreement with other studies assessment of urban NOx emissions in the National Emission Inventory. Additionally, we "ran" CMAQ several times with different NOx emissions inputs to simulate the possible impact of future NOx emission reductions. In all cases the NOx emissions led to decreases in O_3, though sometimes by small amounts (i.e., less than 10%). These findings are more fully described in the draft final report which we submitted in early August, and the revised final report was submitted September 3, 2019.

FINANCIAL STATUS REPORT

The AQRP contract was renewed for the FY 2018-2019 biennium and additional funding of $750,000 per year was awarded. For the FY 2020-2021, the AQRP was renewed for additional funding of $750,000 per year. 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 is 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 first quarter, 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. RoseAnna Goewey, AQRP Program Manager, assisted Dr. Allen in the program administration, Susan McCoy and Nohemi Cazares provided assistance with program organization as it is hosted at the Center for Energy and Environmental Resources (CEER) at The University of Texas at Austin. Denzil Smith was responsible for the AQRP Web Page development and for data management, particularly with the archival of data deliverables when the FY 18-19 projects came to a close.

Beginning September 1, 2018, The University of Texas at Austin moved to a federally negotiated fringe benefits rate. Starting FY 2018-2019, fringe rates are estimated to increase by 0.5% each subsequent fiscal year. In FY 2019-2020 (09/01/2019-08/31/2020), the federally negotiated fringe rates are listed below:

Full-time, Part-Time/Benefits Eligible (including Graduate Students)	29.80%
Part-time/Non-benefits Eligible	5.10%

Table 1: Administration Budgets

Administration Budget (includes Council Expenses)
FY 2018-2019

Budget Category	FY18 Budget	FY19 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary	$53,800.00	$53,700.00	$107,500.00	$97,536.63	$9,963.37
Fringe Benefits	$14,320.00	$12,930.00	$27,250.00	$24,457.01	$2,792.99
Supplies	$1,500.00	$3,000.00	$4,500.00	$1,775.36	$2,724.64
Total Direct Costs	$69,620.00	$69,630.00	$139,250.00	$123,769.00	$15,481.00
Authorized Indirect Costs *10% of Salaries and Wages*	$5,380.00	$5,370.00	$10,750.00	$9,753.68	$996.32
Total Costs	**$75,000.00**	**$75,000.00**	**$150,000.00**	**$133,522.68**	**$16,477.32**

**Expenses as of November 2019*

Administration Budget (includes Council Expenses)
FY 2020-2021

Budget Category	FY20 Budget	FY21 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary	$53,700.00	$53,700.00	$107,400.00	$0.00	$107,400.00
Fringe Benefits	$12,930.00	$12,930.00	$25,860.00	$0.00	$25,860.00
Supplies	$3,000.00	$3,000.00	$6,000.00	$0.00	$6,000.00
Total Direct Costs	$69,630.00	$69,630.00	$139,260.00	$0.00	$139,260.00
Authorized Indirect Costs *10% of Salaries and Wages*	$5,370.00	$5,370.00	$10,740.00	$0.00	$10,740.00
Total Costs	**$75,000.00**	**$75,000.00**	**$150,000.00**	**$0.00**	**$150,000.00**

**Expenses as of November 30, 2019*

ITAC

ITAC expenditures were incurred in FY2018-2019 and were only charges against 2018 funding. ITAC funds were not expended in 2019. Plans for ITAC funds use in FY 2020-2021 are planned for use in the 2nd quarter.

Table 2: ITAC Budgets

ITAC Budget
FY2018-2019

Budget Category	FY18 Budget	FY19 Budget	Total Budget	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**

**Expenses as of November 2019*

ITAC Budget
FY 2020-2021

Budget Category	FY 20 Budget	FY 21 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel	$7,500.00	$7,500.00	$15,000.00	$0.00	$15,000.00
Supplies	$1,500.00	$1,500.00	$3,000.00	$0.00	$3,000.00
Total Direct Costs	$9,000.00	$9,000.00	$18,000.00	$0.00	$18,000.00
Authorized Indirect Costs *10% of Salaries and Wages*	$0.00	$0.00	$0.00	$0.00	$0.00
Total Costs	**$9,000.00**	**$9,000.00**	**$18,000.00**	**$0.00**	**$18,000.00**

**Expenses as of November 30, 2019*

Project Management

Project Management funds in FY 2018-2019 were expended on salaries, fringe benefits, and required materials and supplies for the AQRP Program Managers and QAPP reviewer. Project management will be utilized in the same manner in FY 2020-2021. Program Management expenses for FY 2020-2021 are expected to begin use in the 2nd quarter.

Table 3: Project Management Budgets

Project Management Budget
FY2018-2019

Budget Category	FY18 Budget	FY19 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary	$37,780.06	$38,060.00	$75,840.06	$55,642.15	$20,197.91
Fringe Benefits	$10,938.15	$9,134.00	$20,072.15	$14,423.12	$5,649.03
Supplies	$142.50	$1,000.00	$1,142.50	$142.50	$1,000.00
Other	$1,861.28	$1,718.00	$3,579.28	$0.00	$3,579.28
Total Direct Costs	$50,721.99	$49,912.00	$100,633.99	$70,207.77	$30,426.22
Authorized Indirect Costs *10% of Salaries and Wages*	$3,778.01	$3,806.00	$7,584.01	$5,564.22	$2,019.79
Total Costs	**$54,500.00**	**$53,718.00**	**$108,218.00**	**$75,771.99**	**$32,446.01**

**Expenses as of November 2019*

Project Management Budget
FY 2020-2021

Budget Category	FY 20 Budget	FY 21 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary	$36,480.69	$36,480.69	$72,961.38	$0.00	$72,961.38
Fringe Benefits	$10,871.25	$10,871.25	$21,742.50	$0.00	$21,742.50
Supplies	$1,000.00	$1,000.00	$2,000.00	$0.00	$2,000.00
Other	$2,500.00	$2,500.00	$5,000.00	$0.00	$5,000.00
Total Direct Costs	$50,851.94	$50,851.94	$101,703.88	$0.00	$101,703.88
Authorized Indirect Costs *10% of Salaries and Wages*	$3,648.06	$3,648.06	$7,296.12	$0.00	$7,296.12
Total Costs	**$54,500.00**	**$54,500.00**	**$109,000.00**	**$0.00**	**$109,000.00**

**Expenses as of November 30, 2019*

Research Projects

In FY 2018-2019, there were eight (8) projects requesting $1,231,101 in funding, that were selected out of forty (40) proposals submitted to the AQRP RFP for the biennium. Table 4 on the following page shows the distribution of the projects across the fiscal years for FY 2018-2019. Projects for FY 2020-2021 have not been selected as of the 1st quarter. Selection of FY 2020-2021 projects is expected to be finalized late in the 2nd quarter or early in the 3rd quarter. Future quarterly reports will reflect updated Research Project budget tables as well as an updated Appendix A with FY 2020-2021 information.

The 2018 – 2019 budget allocates $1,223,000.00 for research projects ($750,000 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. These funds were expended first, so that all FY 2017 funds will be spent by Spring of 2019. That will leave a shortage of $541.61 in Research/Contractual funding. In order to fully fund all research projects, $782 will be 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.

In the 1st quarter, the focus was on completing projects and invoices in the FY 2018-2019 biennium research projects. At the close of the 1st quarter, project 18-005 and 19-031 had pending final invoice payments from AQRP funds. The AQRP estimates that their final approved invoice will reduce their balance to be returned to the TCEQ to $8,474.23. Table 4 and Appendix A only reflect actual invoiced amounts that have been approved and paid from AQRP funds at the close of the 1st quarter (November 30, 2019).

Table 4: Contractual/Research Project Budget

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	$ 139,193.00	$ 103,018.04	$ 36,174.96
18-005	Ramboll	$ 28,953.00	$ 28,950.23	$ 2.77
18-007	Ramboll	$ 150,000.00	$ 150,000.00	$ -
18-010	TAMU	$ 121,000.00	$ 118,019.80	$ 2,980.20
18-022	UT Austin	$ 85,768.00	$ 85,766.65	$ 1.35
18-022	Sonoma Tech, Inc.	$ 86,346.00	$ 86,346.00	$ -
FY 18 Total Contractual Funding Awarded		$ 611,260.00		
FY 18 Contractual Funds Expended (Init. Projects)			$ 572,100.72	
FY 18 Contractual Funds Remaining to be Spent				$ 39,399.28
FY 19 Contractual Funding		**$ 611,500.00**		
FY 19 Contractual Funding Transfers		**$ 782.00**		
FY 19 Total Contractual Funding		**$ 612,282.00**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
19-023	UT Austin	$ 85,736.61	$ 85,723.65	$ 12.96
19-023	Ramboll	$ 65,013.00	$ 65,013.00	$ -
19-025	Aerodyne Research, Inc.	$ 199,974.00	$ 199,722.22	$ 251.78
19-031	Baylor University	$ 98,087.00	$ 90,093.43	$ 7,993.57
19-031	University of Houston	$ 33,207.00	$ 29,804.96	$ 3,402.04
19-040	Drexel University	$ 130,264.00	$ 130,264.00	$ -
FY 19 Total Contractual Funding Awarded		$ 612,281.61		
FY 19 Contractual Funding Expended (Init. Projects)			$ 600,621.26	
FY 19 Contractual Funds Remaining to be Spent				$ 11,660.74
Total Contractual Funding		$ 1,223,782.00		
Total Contractual Funding Awarded		$ 1,223,541.61		
Total Contractual Funding Remaining to be Awarded		$ 240.39		
Total Contractual Funds Expended to Date			$ 1,172,721.98	
Total Contractual Funds Remaining to be Spent				$ 51,060.02

Appendix A

FY 2018-2019 Research Projects

Project No.	Project Title	Start Date	End Date	Total Project Funding Awarded	Total Project Expenditures*	Funding to be Returned to AQRP*
	Lead Institution	***Principal Investigator***				
18-005	Next steps for improving Texas biogenic VOC and NO emission estimates	10/31/2018	8/31/2019	$168,146.00	$131,968.27	$36,177.73
	University of California - Irvine	*Alex Guenther*				
18-007	DDM Enhancements in CAMx: Local Chemistry Sensitivity and Deposition Sensitivity	10/16/2018	8/31/2019	$150,000.00	$150,000.00	$0.00
	Ramboll	*Greg Yarwood*				
18-010	A synthesis study of the role of mesoscale and synoptic-scale wind on the concentrations of ozone and its precursors in Houston	10/26/2018	8/31/2019	$121,000.00	$118,019.80	$2,980.20
	Texas A&M University	*Qi Ying*				
18-022	Development and Evaluation of the FINN v.2 Global Model Application and Fire Emissions Estimates for the Expanded Texas Air Quality Modeling Domain	9/1/2018	8/31/2019	$172,114.00	$172,112.65	$1.35
	The University of Texas at Austin	*Elena McDonald-Buller*				
19-023	Emission Inventory Development and Projections for the Transforming Mexican Energy Sector	9/18/2018	8/31/2019	$158,309.00	$158,296.04	$12.96
	The University of Texas at Austin	*Elena McDonald-Buller*				
19-025	Apportioning the Sources of Ozone Production during the San Antonio Field Study	10/16/2018	9/30/2019	$199,974.00	$199,722.22	$251.78
	Aerodyne Research, Inc.	*Tara Yacovitch*				
19-031	Detecting events and seasonal trends in biomass burning plumes using black and brown carbon: (BC)2 El Paso	10/26/2018	9/30/2019	$131,294.00	$119,898.39	$11,395.61
	Baylor University	*Rebecca Sheesley*				
19-040	Analysis of Ozone Production Data from the San Antonio Field Study	9/18/2019	9/30/2019	$130,264.00	$130,264.00	$0.00
	Drexel University	*Ezra Wood*				

**Funding as of November 30 2019*