AIR QUALITY RESEARCH PROGRAM

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

Annual Report

September 1, 2018 through August 31, 2019

Submitted to

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Texas Air Quality Research Program

Annual Report

September 1, 2018 – August 31, 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 YEAR

As the 2018-2019 fiscal year began, the research projects awarded in 2018-2019 were being fully executed at The University of Texas at Austin - AQRP. Master Agreement Contracts, which describe the terms and conditions of the institutions contracting with The University of Texas at Austin, were negotiated. While Master Agreements were being processed at awardee institutions, AQRP Project Managers were working with Principal Investigators to complete the development of the Statements of Work, Budgets and Budget Justifications, and Quality Assurance Project Plans (QAPPs). These documents, in total, are referred to as the Work Plans. Project performance periods ranged from start dates of 09/01/2018 to 10/31/2018. All projects were fully negotiated and awarded within the first quarter. Program activities centered primarily on the full execution of project subaward contracts between The University of Texas at Austin – AQRP and the individual project institutions, review of the monthly technical reports of the eight research projects that would expire between August 31, 2019 and October 31, 2019, reviewed by AQRP Project Managers. Monthly invoice review by the AQRP Program Manager was conducted thoroughly throughout the year for prompt payment of allowable expenses. By the end of the first quarter of the 2018-2019 fiscal year, eight funded projects were fully executed subcontracts, communicating technical reports and research progress to the AQRP Project Managers. A full list of the awarded projects are listed in Appendix A.

In the 2nd and 3rd quarters of the year, work progression on projects continued. Monthly reports and invoices were communicated to AQRP Project and Program Managers. Projects began invoicing as early as the 1st quarter. All projects involving field studies required extensive invoice review to ensure all expenses were allowable.

In June 2019, the existing AQRP Program Manager resigned from their position and was replaced by another UT staff member to assume administrative duties required by AQRP.

The AQRP Workshop was held on August 22, 2019. During the Workshop, each Investigator presented a summary of his or her project activities and research findings. Attendees included

Investigators from each of the projects, AQRP Program Administration members, Project Managers, Independent Technical Advisory Committee members, an Advisory Committee member, the TCEQ Liaisons, and other interested parties from the TCEQ. A copy of each presentation has been made available on the AQRP website (http://aqrp.ceer.utexas.edu/reports.cfm).

The final 2018-2019 research project ended on October 31, 2019. By the end of November 2019, all final reports were completed by researchers and accepted by the TCEQ, all project data was received, and all final invoices, with the exception of the University of California-Irvine, were paid by the end of December 2019. Complete project information was posted on the AQRP website (http://aqrp.ceer.utexas.edu/projects.cfm) under FY 2018-2019 Projects.

Throughout the year, the Program Administration communicated regularly with the TCEQ to ensure that all program requirements were being met, and to provide information on the Program and individual project activities. The AQRP Program Manager provided detailed Financial Status Reports monthly, as required, and additional information whenever requested.

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 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 program year, the AQRP performed Steps 7-9.

Independent Technical Advisory Committee (ITAC)

The AQRP funding is to be used primarily for research projects, and one of three groups responsible for selecting the projects is the Independent Technical Advisory Committee (ITAC). The ITAC is composed of between 9 and 15 individuals with scientific expertise relevant to the Program. The ITAC is charged with recommending technical approaches, establishing research priorities, and reviewing, commenting, and advising on all projects to ensure that the projects facilitate air quality improvement in Texas. Members of the ITAC consist of the TCEQ Project Director (or designee), representatives with air quality expertise from research institutions with extensive expertise in air quality research in Texas. The members of the ITAC are listed in Table 1. The members of the ITAC are drawn from Texas universities active in air quality research, national laboratories that have participated in air quality studies in Texas, and institutions that have expertise not available in Texas and that have participated in air quality studies in Texas.

The ITAC membership is intentionally drawn from air quality researchers who have experience in Texas. These researchers and their colleagues will likely have interest in responding to the requests for research proposals issued by the AQRP. This raises potential confidentiality and conflict of interest issues, and the contract between TCEQ and the University of Texas at Austin requires that the AQRP maintain and implement an appropriate written policy on conflict of interest. Specifically for the ITAC, all members are required to certify:

> *Confidentiality:* As a member of ITAC I understand that I will have access to proposals submitted to the Air Quality Research Program. Subject to any legal requirements, I agree to keep the information in these proposals confidential until the selection process is completed and it is appropriate to release information to the public. I understand that there may be certain information that comes to me in my role as a member of ITAC that retains its confidential nature even after the process is concluded. I also understand that I will review said proposals and may have access to the reviews made by other ITAC members. I agree to keep these reviews and the identity of the reviewers confidential until such time as this information is released to the public. (NOTE: For the reviews and reviewers, this information may never be released.)
>
> *Conflict of Interest:* As a member of ITAC, I agree that I will not evaluate, comment on, or vote on proposals in which I or my home institution is involved, including but not limited to, any financial interest, or in which I have another form of conflict of interest. I understand that ITAC members with conflicts of interest must leave the meeting room or the conference line when a proposal with which they have a conflict is discussed, voted on or otherwise being considered. I understand that I must recuse myself from participating in or attempting to influence at any time the ITAC's or the AQRP Council's consideration or decision concerning such proposals. I agree to bring any issues concerning a possible conflict of interest to the attention of the Director of the Air Quality Research Program or the TCEQ Project Director. If there is a question of interpretation regarding whether a conflict of interest exists, I agree that the decision regarding whether a conflict of interest exists will be made by the Director of the Air Quality Research Program or the TCEQ Project Director.

All members of the ITAC agreed to abide by these conflicts of interest and confidentiality provisions prior to participating in the review of proposals.

Table 1. Independent Technical Advisory Committee Members

Name	Title	Organization
David Allen	Gertz Regents Professor in Chemical Engineering, Professor and Director, AQRP	The University of Texas at Austin
William Carter	Emeritus Research Chemist, Center for Environmental Research and Technology	University of California - Riverside
Don Collins	Professor, Department of Chemical and Environmental Engineering	University of California - Riverside
James Crawford	Research Scientist, Chemistry & Dynamics Science Directorate	NASA
Peter Daum	Head, Atmospheric Science Division	Brookhaven National Lab (Retired)(Resigned May 2018)
Mark Estes	Senior Air Quality Scientist Air Modeling and Data Analysis Section	Texas Commission on Environmental Quality
Fred Fehsenfeld	Senior Scientist, Cooperative Institute for Research in Environmental Sciences	University of Colorado – Boulder (Retired)
Joost de Gouw	Research Physicist, Earth System Research Lab	NOAA
Robert Griffin	Associate Professor, Civil and Environmental Engineering	Rice University
Tho Ching (Thomas) Ho	Aldredge Endowed Chair, Regent's Professor and Chair, Dan F. Smith Department of Chemical Engineering; Director, Texas Air Research Center	Lamar University
Bryan Lambeth	Senior Meteorologist (Retired)	TCEQ (Retired) (Resigned October 2017)
Golam Sarwar	Research Scientist	EPA ORD
Christine Wiedinmyer	Scientist III, Atmospheric Chemistry Division	Nation Center for Atmospheric Research
Greg Yarwood	Principal	Ramboll Environ, Inc.

TCEQ Relevancy Review

Once the ITAC has reviewed and ranked research project proposals according to technical merit, they are submitted to the TCEQ for a relevancy review. The TCEQ reviews proposals for relevancy to the State's air quality research needs. TCEQ approval is required for a project to receive funding from the Program.

Advisory Council

The final group responsible for selecting AQRP research projects is the Advisory Council. The Council consists of between 7 and 11 members, all residents of the State of Texas. Two Council members with relevant scientific expertise are nominated by the TCEQ. As defined in the AQRP contract, up to four members of the Council can be county judges from the Houston-Galveston-Brazoria (HGB) and Dallas-Fort Worth (DFW) non-attainment counties. Additional members should have a general background in air quality and business practices, and can include elected officials, business community representatives, environmental group representatives, and members of the general public. The Council's responsibilities are to attend meetings with TCEQ Management and the AQRP to understand the statewide project goals for the funding period, to select for funding the projects reviewed by the ITAC and ranked by the TCEQ, and to assist with the presentation of project final results at locations throughout the state.

Table 2. Advisory Council Members

Name	Title	Organization
Ramon Alvarez	Senior Scientist	Environmental Defense Fund
Daniel Baker	Senior Consultant in Air Quality	Shell Global Solutions
Omar Garcia	President & CEO	South Texas Energy & Economic Roundtable
Chris Klaus	Senior Program Manager	North Central Texas Council on Governments
Ralph Marquez	Proprietor	Environmental Strategies and Policy
Chris Rabideau	Environmental Scientist	Chevron
Cyrus Reed	Conservation Director	Sierra Club
Kim Herndon	Assistant Director Air Quality Division	Texas Commission on Environmental Quality
Keith Sheedy	Technical Advisor to the Deputy Director for the Office of Air	Texas Commission on Environmental Quality

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 improves 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, are 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 – August 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 December 10, 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 – August 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 analysis were performed using WRF predicted wind fields using different boundary layer parameterization 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 results 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.

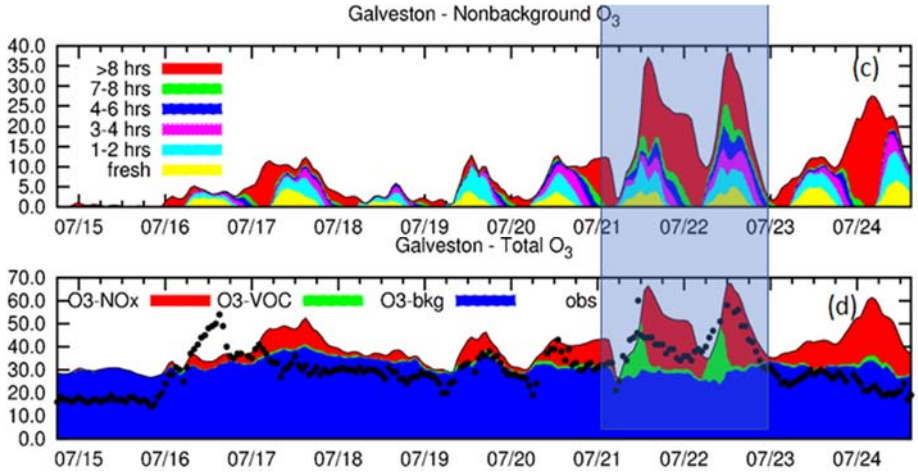

Figure 1: Predicted atmospheric age distribution of non-background ozone (i.e. ozone attributed to NOx and VOCs) at Galveston (c) and the breakdown of predicted total ozone to NOx, VOC and background contributions (d) from July 15 to July 24, 2016. Observed and predicted concentrations are in units of 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 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 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 – August 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.

During the fourth quarter, progress has been made for all of these tasks. 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, with draft final data to be submitted September 1st. 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.

Regular project-wide meetings as well as smaller focused scientific discussions have been crucial in pushing these tasks forward. The next quarter will have us amending the draft report and making small advances in data analysis in response to reviewer comments.

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 campaign (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 the last quarterly update in 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 and have been running continuously since that time. 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
During the quarter ending 8/31/2019, the project team members focused on completing all remaining aspects of tasks 2 and 3 though most of the work was dedicated to task 3.

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. As noted in the last quarterly report, 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

On September 4, 2017, the AQRP was renewed for the 2018-2019 biennium, and funding of $750,000 per year was awarded, for a total of $1,500,000. The funds were distributed across several different reporting categories as required under the contract with TCEQ. The financial status reported here is still preliminary. Updates will be made in quarterly reports. 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 and supplies expenses, for the ITAC meetings during the proposal review stage.

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.

On August 31, 2018, $7,559.39 remained in FY 2017 funding ($1,558.35 in Research Projects, $6,001.04 in Project Management). These funds were transferred to Research Project funding and were assigned to a FY 2018-2019 project with the expectation that they will be spent first. Due to the carry forward of $7,559.39 of FY 2016-2017 funds to FY 2018-2019, additional tables below will include the FY 2016-2017 balances in the 2018-2019 budget.

Program Administration

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

During the reporting period, several AQRP staff members were involved, at various levels of effort, in the administration of the AQRP. Dr. David Allen, AQRP Director, was responsible for the overall administration of the AQRP. Maria Stanzione and RoseAnna Goewey, AQRP Program Managers, assisted Dr. Allen in the program administration, while Terri Mulvey, Maeve Cooney, and Susan McCoy each provided assistance with program organization and financial management. Maria Stanzione and RoseAnna Goewey were not employed in any overlapping time-period. Ms. Stanzione resigned from the position in late June 2019. After her departure, Ms. Goewey was hired to fill the AQRP Program Manger duties. Denzil Smith was responsible for the AQRP Web Page development and for data management. Gina Palacios provided assistance with the website redesign.

Fringe benefits for the administration of the AQRP were initially budgeted to be 24% of salaries and wages across the term of the project. It should be noted that this was an estimate, and actual

fringe benefit expenses were reported for each month. The fringe benefit amount and percentage fluctuated each month depending on the individuals being paid from the account, their salary, their FTE percentage, the selected benefit package, and other variables. For example, the amount of fringe benefits was greater for a person with family medical insurance versus a person with individual medical insurance. Actual fringe benefit expenses to date are included in Tables 3, 4, and 5 below. Financial information from FY 2016-2017 are included to show the remaining balances that were carried forward into FY 2018-2019. AQRP will plan to carry forward remaining Administration (including Council expenses) into the FY 2020-2021 biennium. Carry forward budget line items are yet to be determined.

Beginning September 1, 2018, The University of Texas at Austin switched to a federally negotiated fringe benefit rate. Starting fiscal year 2018-2019, fringe rates are estimated to increase by 0.5% each fiscal year. For FY 2018-2019 (09/01/2018-08/31/2019), the fringe rates were:

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

For FY 2019-2020 (09/01/2019-08/31/2020), the federally negotiated fringe rates are:

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

Table 3: Administration Budget

Administration Budget (includes Council Expenses)
FY 2016-2017

Budget Category	FY16 Budget	FY17 Budget	Total Budget	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 *10% of Salaries and Wages*	$7,437.70	$7,302.73	$14,740.43	$14,740.43	$0.00
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 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*

ITAC

ITAC expenditures budgeted in FY 2018-2019 and were charged against the 2018 funds to accommodate initial travel required for the proposal review process. No ITAC budgeted funds were expended in 2019. The remainder of unused ITAC funds were not rebudgetted in FY 2018-2019. AQRP will plan to carry forward remaining ITAC funds into the FY 2020-2021 biennium. Carry forward budget line items are yet to be determined.

Table 4: ITAC Budget

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
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*

Project Management

Project Management funds were budgeting in FY 2018-2019 to accommodate the salaries, fringe benefits, and necessary materials and supplies required by the AQRP Project Managers and QAPP reviewer. In FY 2018-2019, AQRP employed two Project Managers and QAPP reviewer for 5-15% of their time on an equivalent full-time employment appointment, dependent on the period of effort. AQRP will plan to carry forward remaining Project Management Budget funds into the FY 2020-2021 biennium. Carry forward budget line items are yet to be determined.

Table 5: Project Management Budget

Project Management Budget
FY 2016-2017

Budget Category	FY16 Budget	FY17 Budget	Total	Expenses	Remaining Balance
Personnel/Salary	$53,470.31	$51,912.00	$105,382.31	$105,197.89	$184.42
Fringe Benefits	$11,337.19	$12,535.00	$23,872.19	$23,573.81	$298.38
Supplies	$176.36	$500.00	$676.36	$176.36	$500.00
Other	$0.00	$5,000.00	$5,000.00	$0.00	$5,000.00
Total Direct Costs	$64,983.86	$69,947.00	$134,930.86	$28,948.06	$5,982.80
Authorized Indirect Costs *10% of Salaries and Wages*	$5,347.03	$5,191.00	$10,538.03	$10,519.79	$18.24
Total Costs	**$70,330.89**	**$75,138.00**	**$145,468.89**	**$139,467.85**	**$6,001.04**

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*

Research Projects

Research projects awarded in FY2018-2019 began as early as September 1, 2018. The total contractual budget for FY2018-2019 contractual awards is $1,223,782, with $1,223,541.61 awarded to eight (8) projects selected out of forty proposals submitted to the AQRP RFP for the 2018-2019 biennium. Remaining contractual budget after the awards were selected was $240.39. These remaining funds have not been rebudgetted. During FY 2018-2019, two projects formally requested, and were granted, contract extensions to complete their research and reporting. Aerodyne Research (project number 19-025, "*Apportioning the Sources of Ozone Production during the San Antonio Field Study"*) requested a two-week extension to complete reporting. Baylor University (project number 19-031, *"Detecting events and seasonal trends in biomass burning plumes using black and brown carbon: (BC)2 El Paso"*) requested a one-month extension to complete the draft and final reports. As of December 10, 2019, all projects have submitted their final invoices, with the exception of an invoice amendment pending from the University of California – Irvine (project number 18-005, "*Next steps for improving Texas biogenic VOC and NO emission estimates"*). UCI's final invoice figures will be reflected in the upcoming quarterly report.

Table 6 on the following pages shows the distribution of the projects across the fiscal years and the cumulative expenditures to date.

Table 6: Research Project Expenditures*

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	$ 81,666.75	$ 4,679.25
FY 18 Total Contractual Funding Awarded		$ 611,260.00		
FY 18 Contractual Funds Expended (Init. Projects)			$ 567,421.47	
FY 18 Contractual Funds Remaining to be Spent				$ 44,078.53
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			$ 1,168,042.73	
Total Contractual Funds Remaining to be Spent				$ 55,739.27

**Expenses as of November 2019*

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	$167,433.40	$4,680.60
	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*	9/18/2018	9/30/2019	$130,264.00	$130,264.00	$0.00
	Drexel University	*Ezra Wood*				

**Funding as of November 2019*