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, 2020 – February 27, 2022

Submitted to

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Texas Air Quality Research Program

Annual Report

September 1, 2020 – February 27, 2022

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

Between September 1, 2020 and February 27, 2022, the AQRP program efforts are reviewed on a quarterly basis below.

During the first quarter, September 2020-November 2020:

- AQRP Project Administration efforts focused primarily on individual project audits of Financial Status Reports (FSR), internal University of Texas at Austin (UT) account audits and monthly FSR preparations, Project Management Monthly Technical Report (MTR) reviews and discussions, completion of transfer of Fiscal Year 2018-2019 (FY 18-19) Carry Forward funds into FY 2020 UT funds, coordinating project amendments, Annual and Quarterly Reports preparation, and determining the status of budget updates due to coronavirus disease 2019 (COVID-19) related travel restrictions and delays.
- Principal Investigators (PIs) were allowed to re-budget any travel funds to any other budget category, except for increased Indirect Costs. PIs were notified of the budget transfer option.
- The AQRP Workshop was conducted entirely virtually due to COVID-19 travel and health related concerns.
- Projects 20-003 and 20-004 began discussions with the AQRP to address modifications to their Scope of Work (SOW), Quality Assurance Project Plan (QAPP), and Budget to reflect expenditure changes that were unavoidable due to COVID-19 related delays. The SOW, QAPP and Budget changes were approved.

In the second quarter, December 2020-February 2021:

- AQRP Project Administration efforts were similar to the first quarter, in addition to facilitating project amendments for 20-004, 20-009, and 20-028 due to COVID-19 related delays. Project 20-004 had Task Order Amendments executed to increase the supplies budget by $13,000, to increase the equipment budget by $35,000, and to extend the

project end-date to November 15, 2021. Project 20-009 notified the AQRP Project Manager in early January 2021 that the project will cease operations as of January 31, 2021 due to ongoing COVID-19 travel restrictions and delays. UT executed the amendment to end the project. Project 20-009 released of claims in the amount of $11,701.87. Project 20-028 notified the AQRP Project Manager that, due to COVID-19 travel restrictions, the Drexel research team was unable to conduct the field study in Summer 2020. Later in quarter 3, Drexel University halted all field preparation expenses on March 15, 2021 and requested that their project be cancelled due to the inability to travel to Texas, a requirement of their scope of work. Project 20-028 released of claims in the amount of $57,070.13.

- The following projects requested travel budget transfer in quarter two, due to COVID-19 related travel restrictions, to materials and supplies: 20-004, 20-007, 20-011, 20-020, and 20-026.

In quarter three, March 2021-May 2021:

- AQRP Project Administration coordinating project amendments for 20-028 and continued effort to work with project institutions to adjust travel budgets to other budget categories, due to ongoing COVID-19 travel restrictions. The following project requested travel budget transfer in quarter two, due to COVID-19 related travel restrictions, to materials and supplies: 20-003.
- Project 20-003 requested and was approved to deploy two (2) additional sample collection devices, with no additional funding or modification of the original SOW.

In the fourth quarter, June 2021-August 2021:

- AQRP Project Administration efforts were similar to prior quarters, as well as AQRP Workshop coordination, and the State of the Science (SOS) workplan submission to the TCEQ.
- UT submitted the SOS project workplan proposal to the TCEQ to encompass the 2016-2021 grant period and received approval by the TCEQ to commence the project as presented in the workplan. A copy of the approved SOS workplan may be requested by emailing AQRP@ceer.utexas.edu.
- Projects 20-003, 20-004, 20-007, and 20-028 were granted budget revisions to transfer funds between sub accounts to better accommodate their research project needs without modifying the SOW.
- The 2021 AQRP Workshop was held on August 18, 2021, remotely over Zoom, due to COVID-19 travel restrictions. The Workshop agenda and project presentations can be found at http://aqrp.ceer.utexas.edu/reports.cfm. The Workshop was recorded via Zoom web conferencing and will be available for download on an individually requested basis (please email the AQRP Program Manager for download link: r.goewey@ceer.utexas.edu).
- On August 20, 2021, after a review of the AQRP grant report deadlines with the TCEQ, it was determined that a Quarterly Report for June – August 2021 and a separate Annual Report, to encompass September 2020 – February 2022, would be preferrable to include all research projects and their associated completed financials.

In the fifth quarter, September 2021-November 2021:

- AQRP Project Administration efforts focused primarily on closing out subawards that fully completed their project and invoicing.
- Final Reports for all projects were posted to the AQRP website: http://aqrp.ceer.utexas.edu/projects.cfm. Final project data has been archived at UT's Texas Advanced Computing Center (TACC).

In quarter six, December 2021-February 2022:

- Project administration focused on continuing the close-out process of subawards. The SOS project continued submission and revisions. The final SOS report was accepted by the TCEQ on February 16, 2022. All projects were completed in this quarter. On January 24, 2022, project 20-003 (Baylor University) was approved to retroactively correct personnel charges from Summer 2021. However, due to internal policy issues at Baylor University, the correction was not approved prior to the AQRP grant expiration. Remaining project funds are listed in Table 6. Due to an FSR audit review conducted by the TCEQ, project 20-003 (Baylor University) may credit back $330.16 due to missing receipts. An annual report amendment will be submitted if this credit is processed, which will adjust the overall remaining funds to be released to the TCEQ. The AQRP 2016-2021 grant period expired February 27, 2022.

The AQRP Final Annual Report has been accepted by the TCEQ on April 22, 2022. Financial balances are detailed in the Financial Status Report section. A total of $12,800.39 of funds were not utilized, primarily from subaward contractual funds related to COVID-19 related travel delays and decreased personnel effort.

A full list of the funded projects for Fiscal Year 2020-2021 (FY 20-21) is provided in Appendix A. Project subaward budget balances are available in Table 6.

The FSR section of this report includes accounting from both FY 18-19 and FY 20-21. Remaining funds in FY 18-19 were approved by the TCEQ to be carried forward into FY 20-21.

Throughout the reporting period, the Program Administration communicated regularly with the TCEQ to ensure that all program requirements were being met, and to provide information regarding AQRP and individual project activities. The AQRP Program Manager provided detailed FSRs monthly, as required, and additional information as requested by the TCEQ.

BACKGROUND

Section 387.010 of House Bill (HB) 1796 (81st Legislative Session), directs the Texas Commission on Environmental Quality (TCEQ) to establish the Texas Air Quality Research Program (AQRP). 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 renewed for the 2020-2021 biennium and 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 Advisory 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 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 the 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 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 through 9.

Independent Technical Advisory Committee

The AQRP funding is to be used primarily for research projects, and one of three groups responsible for selecting the projects is the 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) and 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 the 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
Joost de Gouw	Professor, Cooperative Institute for Research in Environmental Sciences (CIRES) /Dept of Chemistry	University of Colorado
Robert Griffin	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
Golam Sarwar	Research Scientist	EPA ORD
Stephanie Shirley	Senior Technical Specialist	Texas Commission on Environmental Quality
Christine Wiedinmyer	Associate Director for Science, Cooperative Institute for Research in Environmental Sciences (CIRES)	University of Colorado
Greg Yarwood	Principal	Ramboll

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. 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
Daniel Baker	Senior Consultant in Air Quality	Shell Global Solutions
Laurie Barker	Special Counsel	Texas Commission on Environmental Quality
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
Chris Owen	Senior Technical Specialist	Texas Commission on Environmental Quality

RESEARCH PROJECTS: FY 2020-2021

Project 20-003: Characterization of Corpus Christi and San Antonio Air Quality During the 2020 Ozone Season

Rice University: Dr. Robert Griffin
University of Houston: Dr. James Flynn
Baylor University: Dr. Rebecca Sheesley

STATUS: COMPLETE
07/17/2020-08/31/2021

AQRP Project Manager – Vincent Torres

TCEQ Project Liaison – Erik Gribbin

Original Funded Amount: $286,427, **Amended Funded Amount:** $288,727
(Rice: $73,261.00; University of Houston: $115,668.00; Baylor: $99,798.00)

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

Project Update:
Research completed 08/31/2021. Final Report can be viewed at the AQRP website:
http://aqrp.ceer.utexas.edu/projects.cfm

Project 20-004: Galveston Offshore Ozone Observation (GO3)

University of Houston: Dr. James Flynn
St. Edward's University: Dr. Paul Walter

STATUS: COMPLETE
07/17/2020-11/15/2021

AQRP Project Manager: Vincent Torres

TCEQ Project Liaison: Doug Boyer

Original Funded Amount: $201,754.00; **Amended Funded Amount:** $249,754.00
(University of Houston: $181,494.00; St. Edward's University: $68,260.00)

Abstract:
This project addresses the 2020-2021 Texas Air Quality Research Program Priority Area of Monitoring Ozone in Galveston Bay and Offshore. The project deployed two small automated sampling systems on commercial boats operating in Galveston Bay (Larry Willis, commercial shrimper) and the offshore waters adjacent to Galveston Island (Ryan Marine Services, crew launch boat operator) to collect routine measurements of ozone (O_3), O_X ($O_X = O_3$ + nitrogen dioxide (NO_2)) and meteorology, including boundary layer height, during April-August 2021 through a collaboration with the University of Houston (UH) and St. Edward's University (SEU). A third boat, owned and operated by UH, was utilized for special studies in Galveston Bay as well as for launches of up to 20 ozonesondes to examine vertical profiles of O_3 and confirm ceilometer measurements of boundary layer height. Coupled with three-dimensional chemical transport modeling, this study shed light on the conditions and processes that may result in high O_3 over the water and subsequent impacts on the Houston-Galveston-Brazoria (HGB) urban area.

The study was designed to focus on the following primary science questions:

1. How frequently does high ozone reside over the water during the ozone season, and how does the observed frequency compared to that simulated by photochemical models?
2. How does O_3 and O_X over water compare with O_3 and O_X over adjacent land?
3. How is O_3 formation over the water impacted by local circulation patterns?
4. What are the characteristics of the boundary layer over the water during high O_3 events, and how do the observed boundary layer heights compare to model predicted heights?
5. How do small O_3, O_X, and meteorology sampling systems installed on commercial vessels help us better understand O_3 in Galveston Bay and the Gulf of Mexico?

The instrumentation packages included an O_3 monitor, ultraviolet-light emitting diode (UV-LED) NO_2 photocell, Global Positioning System (GPS) receiver, all-in-one weather station, and a ruggedized personal computer (PC) with a cellular data connection. The package operates autonomously when power is available. A ceilometer was installed on two of the vessels to measure boundary layer height over the water in Galveston Bay, which is often parameterized in photochemical models and can have a significant impact on model results. The data, which were logged locally, were sent to servers at UH when within cellular coverage.

Modeling activities utilized the Weather Research and Forecasting (WRF) driven Goddard Earth Observing System with Atmospheric Chemistry (GEOS-Chem) (WRF-GC) model. The model simulates ozone distributions in the HGB region during the measurement

periods with a focus on ozone over the water and land-water ozone gradient. WRF has a powerful and flexible grid system, including multiple nested grids and moving nested grids. The inner-most model domain of WRF-GC was set over the sampling areas as well as the area surrounding the bay which include the monitors used for comparisons at a resolution of 1 kilometer (km) x 1 km, allowing replications of fine-scale temporal and spatial dynamics specific to coastal regions such as sea/bay breeze. In addition to confirming the presence or absence of high O_3 over the water and the conditions which occur during high O_3 events, the results from this project are expected to provide more accurate parameterizations for future modeling studies and to identify partners and methodologies for additional studies.

Project Update:
Research completed 11/15/2021. Final Report can be viewed at the AQRP website: http://aqrp.ceer.utexas.edu/projects.cfm

Project 20-005: Using Satellite Observations to Quantify Surface $PM_{2.5}$ Impacts from Biomass Burning Smoke

Atmospheric and Environmental Research Inc.:
Dr. Matthew Alvarado

STATUS: COMPLETE
07/28/20-08/31/21

AQRP Project Manager: Elena McDonald-Buller

TCEQ Project Liaison: Fernando Mercado

Funded Amount: $173,692.00

Abstract:
Biomass burning smoke can have major impacts on surface $PM_{2.5}$ concentrations both near the fires and hundreds of miles downwind. These smoke impacts pose two challenges for air quality managers. First, they want to accurately report the potential smoke impacts in time for the public to take protective actions. Second, they need to estimate the recent impacts of smoke on $PM_{2.5}$ in order to determine which elevated $PM_{2.5}$ episodes may fall under the United States Environmental Protection Agency (US EPA) Exceptional Events Rule (EER). The EER determines the conditions under which the US EPA will forgo comparison of policy relevant air monitoring data to a relevant National Ambient Air Quality Standard (NAAQS).

The National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautic and Space Administration (NASA) satellite observations provide valuable information on the locations of fires and transport of smoke. Existing analysis products, such as the NOAA Hazard Mapping System (HMS) Fire and Smoke product, provide observed fire locations and identify regions that are being impacted by biomass burning smoke. However, there are multiple products that use different techniques to identify smoke plumes, and thus may disagree on the extent of the area covered by biomass burning smoke. In addition, as these products primarily use passive, single-angle geostationary and polar satellite observations (due to their greater spatial coverage), these products do not currently provide information on the height of the smoke plumes or estimates of the surface impacts of the observed smoke. An analysis of existing smoke products that increases our confidence in the identification of smoke and provides an estimate of smoke height and surface $PM_{2.5}$ impact would greatly help TCEQ air quality managers protect the public and properly enforce air quality standards.

In this project, we evaluated the ability of existing remote sensing smoke products to accurately and consistently identify regions impacted by smoke. We compared and evaluated the smoke products using additional polar satellite observations that are sensitive to smoke, specifically observations of carbon monoxide (CO) and ammonia (NH_3) from Cross-track Infrared Sounder (CrIS) and Atmospheric Infrared Sounder (AIRS) and aerosol absorption Angstrom exponent (a proxy for brown carbon) from the Ozone Monitoring Instrument (OMI). We evaluated two methods for estimating the height of the plumes detected by the HMS and other smoke products: the plume height estimates from the Moderate Resolution Imaging Spectroradiometer (MODIS) Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithm and a new method based on the observed transport direction of the smoke plumes. Finally, we tested different

statistical and model-based approaches to estimate the impact of the observed smoke on surface $PM_{2.5}$.

The objectives of this project were:

1. To compare different methods for identifying smoke plumes from NOAA and NASA remote sensing imagery;
2. To investigate different remote sensing techniques to estimate the height and vertical profiles of these smoke plumes; and
3. To investigate new statistical and machine learning methods to relate the smoke aerosol optical depth (AOD) observations to surface $PM_{2.5}$ concentrations.

This work directly responded to the AQRP priority research area *"Estimate Impacts of Smoke from Biomass Burning"* by investigating the question *"Is it possible to quantify ground level impacts of biomass burning (PM2.5) using remote sensing tools, such as the NOAA Hazard Mapping System (HMS) Fire and Smoke product?"*

Project Update:
Research completed 08/31/2021. Final Report can be viewed at the AQRP website: http://aqrp.ceer.utexas.edu/projects.cfm

Project 20-007: Texas urban vegetation BVOC emission source inventory

Ramboll US Corporation: Dr. Tejas Shah
Wildland Solutions: Alex Guenther

STATUS: COMPLETE
07/21/20-08/31/21

AQRP Project Manager: Elena McDonald-Buller

TCEQ Project Liaison: Miranda Kosty

Funded Amount: $70,000.00
(Ramboll: $50,277.00; Wildland Solutions: $19,723.00)

Abstract:
The overall goal of this project was to improve numerical predictions of regional ozone and aerosol distributions in Texas by using more accurate estimates of biogenic volatile organic compound (BVOC) emissions in Texas urban areas. Isoprene and other BVOC strongly influence atmospheric chemistry in Texas urban areas and can dominate the total volatile organic compound (VOC) reactivity of at least some Texas urban locations. Although there have been significant advancements in the models used to simulate BVOC emissions, there are still major uncertainties limiting predictability of Texas air quality simulations. Urban areas are the most challenging for BVOC emissions estimation, due to heterogeneity and a lack of vegetation information, and yet they continue to be the least studied. Recent ground surveys of urban tree inventories and increasingly higher resolution remote sensing data products have substantially improved the potential for characterizing the landcover inputs required for biogenic emission models. Therefore, we improved both the Model of Emissions of Gases and Aerosols from Nature (MEGAN, Guenther et al., 2012) and the Biogenic Emission Inventory System (BEIS, Geron et al. 1994) frameworks for estimating BVOC emissions in Texas urban areas. To accomplish this, we used urban tree inventories and aerial and satellite imagery to develop a high spatial resolution (~1 kilometer) gridded inventory of time-varying Leaf Area Index (LAI), total vegetation cover, and the relative abundance of high BVOC emitting trees (e.g., live oaks, deciduous oaks, sweetgum, palms, pines, and juniper) and other vegetation cover types for three Texas urban areas: Austin, Houston, and San Antonio.

The primary deliverable is more accurate landcover inputs for BVOC emission models for estimating BVOC emissions for the urban and suburban areas. Outcomes included improved biogenic emission estimates and a better understanding of the current uncertainties in urban biogenic emission model simulations. The overall benefit of this project is more accurate VOC 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:
Research completed 08/31/2021. Final Report can be viewed at the AQRP website: http://aqrp.ceer.utexas.edu/projects.cfm

Project 20-009: Ozone Measurements and Platform Emission Factor in the Gulf of Mexico

Aerodyne Research, Inc.: Dr. Tara Yacovitch

STATUS: ENDED
07/27/20-01/31/2021

AQRP Project Manager: Vincent Torres

TCEQ Project Liaison: Doug Boyer

Funded Amount: $12,989.00

Abstract:
A ship-based measurement campaign of offshore oil and gas rigs in the Gulf of Mexico had been funded by the United Nations (UN) through the Clean Air and Climate Coalition. This campaign was expected to occur in the late winter/spring of 2021, at the beginning of Houston's ozone season. This proposal aimed to supplement the instrument manifest with an ozone monitor, and to support the analysis of emission factors using existing measurements of methane, ethane, carbon monoxide (CO), carbon dioxide (CO_2) and nitrogen oxides (NO_x).

Figure 20-009-1: The proposed measurement vessel (left), the Research Vessel Trident, owned and operated by Texas A&M University out of Galveston. This vessel's laboratory space (right) is used to house measurement instrumentation.

Project Update: In January, we had a call with UN project sponsors to discuss the logistical challenges related to getting personnel on and off the offshore platform. We decided that we would have required an industry participant/partner to help with these logistics. This would significantly delay the project, and we therefore notified our AQRP project manager that we would no longer be able to complete this project before the AQRP deadline of August 31, 2021. The project ended on 01/31/2021. Aerodyne coordinated with UT to amend the project Task Order to formally end 01/31/2021 and completed a Release of Claims

Detailed Analysis of the Progress of the Task Order to Date: A small amount of labor was charged to this project to cover the work that had been done planning the project and reporting to the AQRP. The remainder was forfeited.

Funds Released to the AQRP: $11,701.87.

Project 20-011: Improving Estimates of Wind-Blown Dust from Natural and Agricultural Sources

Ramboll US Corporation: Dr. Chris Emery

STATUS: COMPLETE
07/28/20-08/31/21

AQRP Project Manager: Elena McDonald-Buller

TCEQ Project Liaison: Barry Exum

Funded Amount: $113,615.00

Abstract:
Ramboll critically evaluated current windblown dust (WBD) emission models and identified and adapted alternative landcover, soil and activity datasets with which to update Ramboll's existing WBD emissions modeling framework. Using the Comprehensive Air quality Model with extensions (CAMx), we assessed the effects of the WBD emission updates on speciated particulate matter (PM) concentrations at monitoring sites located in federally protected Class I Areas throughout the south-central US. Our project directly addresses an AQRP priority research area by focusing on improving speciated, size-resolved WBD emission estimates for air quality modeling, in particular to support the Texas Commission on Environmental Quality's (TCEQ) current visibility modeling for the federal Regional Haze Rule (RHR).

Visibility impairment is predominantly caused by PM in fine and coarse size ranges. Whereas fine PM commonly includes a multitude of primary and secondary inorganic and organic compounds from a variety of sources, including crustal (soil-derived) components, the majority of coarse PM derives from direct emissions of crustal material. Current TCEQ modeling exhibits especially large underestimates of coarse crustal PM concentrations, indicating a need to improve emission estimates from dust sources. Soil emissions are especially difficult to estimate given the variety of source mechanisms and environmental conditions that lead to high spatial and temporal variations. Improving dust emissions and modeled concentrations requires refined vegetative and soil datasets and emission parameterizations. Visibility simulations will benefit from enhanced WBD modeling and explicit treatment of elemental species (e.g., calcium (Ca), iron (Fe), and manganese (Mn)), which influence secondary PM chemistry (e.g., sulfate, nitrate) and enable more refined model evaluation because they are explicitly monitored. The CAMx WBD emission model provides an existing framework to efficiently test updated parameterizations and to incorporate enhanced and/or more locally specific landcover, soil and activity data. Computing dust emissions outside CAMx (in a preprocessor) is more flexible and transparent than implementing an "in-line" dust scheme inside CAMx.

Project Update:
Research completed 08/31/2021. Final Report can be viewed at the AQRP website:
http://aqrp.ceer.utexas.edu/projects.cfm

Project 20-020: New Satellite Tools to Evaluate Emission Inventories: Is a 3-D Model Necessary?

University of Wisconsin-Madison: Dr. Tracy Holloway
Ramboll US Corporation: Dr. Jeremiah Johnson

STATUS: COMPLETE
08/21/20-08/31/21

AQRP Project Manager: Elena McDonald-Buller

TCEQ Project Liaison: Mark Muldoon

Funded Amount: $222,677.00
(UW-Madison: $125,000.00; Ramboll: $97,677.00)

Abstract:
This study developed best-practice recommendations for the utilization of satellite data for emissions evaluation. Because of their radiative properties, nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) are among a small group of gas-phase air pollutants that may be reliably detected from space. These gases have short atmospheric lifetimes, such that satellite-based observations are useful as an indicator of fuel combustion. Although the characterization of gas-phase emissions has emerged as one of the leading areas for air quality utilization of satellite data, multiple atmospheric processes affect the relationship between satellite-derived column abundance and near surface abundance. We evaluated two different methods to compare satellite NO_2 with emission inventories developed by the Texas Commission on Environmental Quality (TCEQ).

Our work responds to two Priority Research Areas for the Air Quality Research Program (AQRP): the use of remote sensing for (1) point source and (2) county-level emissions. We developed methods to leverage remote sensing capabilities to improve emission inventories, without undermining the process-based nature of the inventories, essential for their use in air quality management.

These methods include:
1) Comparison of satellite-derived NO_2 from the TROPOspheric Monitoring Instrument (TROPOMI) for summer 2019 with model simulations from a Weather Research and Forecasting- Comprehensive Air quality Model with extensions (WRF-CAMx) modeling system developed for the TCEQ;
2) Simpler approaches to comparing nitrogen oxides (NO_X) emissions and TROPOMI data that don't require a photochemical grid model, especially the Exponentially Modified Gaussian (EMG) approach.

This analysis evaluated methods by which high-resolution satellite data may be compared with emissions inventories and assessed the necessity of computationally intensive modeling approaches. Study goals included the validation of the TCEQ 2020 inventory (including the value of alternate methods to calculate on-road mobile emissions), as well as recommendations and software to support future TCEQ utilization of satellite data for emission evaluation.

Project Update:

Research completed 08/31/2021. Final Report can be viewed at the AQRP website: http://aqrp.ceer.utexas.edu/projects.cfm

Project 20-026: Improve Cloud Modeled by WRF using COSP and Generative Adversarial Network

Texas A&M University: Dr. Zheng Lu

STATUS: COMPLETE
08/24/20-12/31/21

AQRP Project Manager: Elena McDonald-Buller

TCEQ Project Liaison: Bright Dornblaser

Funded Amount: $98,427.00

Abstract:
The cloud fields modeled by meso-scale models play an important role in the application of predicting local air quality. The cloud fields can strongly affect the formation, transport, as well as deposition of many gaseous and particulate species, through regulating radiative transfer, influencing aqueous chemistry, and altering precipitation. However, it is very challenging to accurately predict the microphysical and macrophysical properties of cloud fields.

We ran the weather research and forecasting (WRF) model with Texas in the center of model domain. Modeled cloud fields were fed into the Cloud Feedback Intercomparison Project (CFMIP) Observation Simulator Package (COSP), so that modeled clouds could be directly compared to satellite observations. The objective was to select an optimal combination of initiation state (the selection of reanalysis data) and physical packages (namely microphysics, cumulus parameterization, planetary boundary layer scheme) for the cloud simulation.

With modeled and observed cloud fields, we trained a Generative Adversarial Network (GAN), a type of deep learning technique. We performed super-resolution and image-to-image translation applications to modeled cloud microphysical fields over Texas, so that they gain detailed fine features, and become more accurate compared to observed cloud fields. Improved cloud fields can improve Texas air quality prediction.

Project Update:
Research completed 08/31/2021. Final Report can be viewed at the AQRP website: http://aqrp.ceer.utexas.edu/projects.cfm. No-cost-extension through 12/31/2021 for the purpose of shipping project data to the AQRP was approved; data was received by UT, archived at TACC, and project closed-out.

Project 20-028: Quantification and Characterization of Ozone Formation in Central San Antonio

Drexel University: Dr. Ezra Wood

STATUS: ENDED
08/07/20-03/15/2021

AQRP Project Manager: Vincent Torres

TCEQ Project Liaison: Erik Gribbin

Funded Amount: $71,369.00

Abstract:
In 2017, during the San Antonio Field Study, a team of researchers conducted a field study focused on ozone air pollution in the greater San Antonio area. Included in the study were measurements of the concentration of total peroxy radicals which allow for the instantaneous gross ozone formation rate to be directly calculated. As a result of the analysis of the data collected, the team concluded that in Floresville (usually upwind of San Antonio during the most common wind patterns) and at the University of Texas at San Antonio (usually downwind), ozone formation was limited by the emissions of nitrogen oxides and that biogenic volatile organic compounds accounted for a large (almost half) of the hydroxyl radical (OH) reactivity. These results strongly suggest that controls on volatile organic compound emissions were unlikely to be effective in mitigating high ozone events.

Measurements of total peroxy radicals were not collected in the central urban core of San Antonio, where nitrogen oxide concentrations were measured to be much greater at times than those at the upwind and downwind sites. As a result, there is considerable uncertainty regarding how much ozone is formed in central San Antonio and how sensitive ozone concentrations might be to emissions of nitrogen oxides and volatile organic compounds. To address these knowledge gaps, the research team planned to participate in a field deployment to central San Antonio. Because of limits on travel imposed by Drexel University due to COVID-19, the researchers were unable to participate in the field measurements and the project was ended.

Project Update:
Project cancelled 03/15/2021 due to unavoidable COVID-19 related delays.

Funds Released to the AQRP: $57,070.13.

Project 21-SOS: State of the Science: 2016-2021

The University of Texas at Austin: David Allen

STATUS: COMPLETE
07/30/21-12/31/21

AQRP Project Manager: Vincent Torres

TCEQ Project Liaison: Daphne McMurrer and Stephanie Shirley

Funded Amount: $70,798.00

Purpose:
A State of the Science (SOS) assessment (the Assessment) was prepared for the Air Quality Research Program (AQRP) for the current grant period, 2016-2021. The Assessment consisted of 3 parts: (i) an overview of the current understanding of key scientific and technical issues, relevant to Texas, in emissions inventory development, atmospheric chemistry, meteorology, and air quality modeling; (ii) a summary of AQRP activities in the 2016-2021 grant period and how those activities improved the understand of key scientific and technical issues; and (iii) identification of a set of high priority scientific and technical issues that should be addressed in the future. The Assessment serves as a resource for developing future AQRP research priorities and as a resource for researchers responding to future AQRP requests for proposals.

The final Assessment included a synthesis of the final research projects from the 2020-2021 grant period. Completed in February 2022, the final Assessment is publicly posted on the AQRP website. While not intended to be submitted to an academic journal, a portion of this document may be suitable for publication.

Project Update:
Research completed 12/31/2021. Final Report can be viewed at the AQRP website: http://aqrp.ceer.utexas.edu/projects.cfm

FINANCIAL STATUS REPORT

The AQRP contract was renewed for the FY 18-19 biennium and additional funding of $750,000 per year was awarded. For the FY 20-21, the AQRP was renewed for additional funding of $750,000 per year. For each year in FY 18-19 and FY 20-21, the funds were distributed across several different reporting categories as required under the contract with TCEQ. The reporting categories are listed below in detail:

Program Administration – limited to 10% of the overall funding (per FY). 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 were 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 was assigned a Project Manager to ensure that project objectives were achieved in a timely manner and that effective communication was maintained among investigators in multi-institution projects. These funds were to support the staffing and performance of project management.

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

Program Administration

Program Administration included salaries and fringe benefits for those overseeing the program, as well as materials and supplies, travel, equipment, and other expenses. This category allowed indirect costs in the amount of 10% of salaries and wages. Remaining funds from FY 18-19 Administration budget in the amount of $214.91 was approved by the TCEQ to carry forward into the FY 20-21 Administration budget.

During the 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, was responsible for the overall administration of the AQRP. RoseAnna Goewey, AQRP Program Manager, assisted Dr. Allen with program and grant/subaward management. Nohemi Cazares assisted with program administration as AQRP is hosted at the Center for Energy and Environmental Resources (CEER) at The University of Texas at Austin. Randy George was responsible for the AQRP Web Page development and project data management.

In FY 20-21 (09/01/2020-08/31/2021), the federally negotiated fringe rates are listed below. Fringe rates are estimated to have a 0.50% increase in Full-time, Part-time/Benefits Eligible category for subsequent years and a decrease to 5.68% in Part-time/Non-benefits Eligible category for all subsequent year:

Full-time, Part-Time/Benefits Eligible (including Graduate Students)	30.1%
Part-time/Non-benefits Eligible	5.68%

Table 3: Administration Budgets

Administration Budget (includes Council expenses)
FY 18-19

Budget Category	FY 18 Budget	FY 19 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary	$54,327.32	$55,069.42	$109,396.74	$109,396.74	$0.00
Fringe Benefits	$13,751.44	$13,980.40	$27,731.84	$27,516.93	$214.91
Travel					
Supplies	$1,488.50	$443.22	$1,931.72	$1,931.72	$0.00
Equipment					
Other					
Contractual					
Total Direct Costs	$69,567.26	$69,493.04	$139,060.30	$138,845.39	$214.91
Authorized Indirect Costs *(10% of Salaries and Wages)*	$5,432.74	$5,506.90	$10,939.70	$10,939.70	$0.00
Total Costs	**$75,000.00**	**$75,000.00**	**$150,000.00**	**$149,785.09**	**$214.91**

**Expenses as of August 2020*

Administration Budget (includes Council expenses)
FY 20-21

Budget Category	FY20 Budget	FY21 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary	$52,008.33	$52,869.78	$104,878.11	$104,878.11	$0.00
Fringe Benefits	$15,558.69	$15,841.10	$31,399.79	$31,399.12	$0.67
Travel					
Supplies	$2,447.05	$1,002.17	$3,449.22	$3,445.88	$3.34
Equipment					
Other					
Contractual					
Total Direct Costs	$70,014.07	$69,713.05	$139,727.12	$139,723.11	$4.01
Authorized Indirect Costs *(10% of Salaries and Wages)*	$5,200.85	$5,286.94	$10,487.79	$10,487.79	$0.00
Total Costs	**$75,214.92**	**$74,999.99**	**$150,214.91**	**$150,210.90**	**$4.01**

**Expenses as of Feb. 2022*

ITAC

ITAC expenditures were incurred in FY 18-19 and were only charged against 2018 funding. ITAC expenditures in FY 2020 consisted of the February 2020 ITAC meeting travel expenses. Future costs for ITAC in FY 2021 are not expected at this time.

Due to COVID-19 travel restrictions, ITAC related travel and expense funds in FY 2020 and 2021 were rebudgetted to contractual subaward funds. The TCEQ approved the ITAC budget reduction by $3,125 in both 2020 and 2021 FYs, crediting the amount to the subawards budget category for use by research contractual subawards in FY 2020 and FY 2021.

Table 4: ITAC Budgets

ITAC Budget
FY 18-19

Budget Category	FY 18 Budget	FY 19 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
Equipment					
Other					
Contractual					
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)*	$0.00	$0.00	$0.00	$0.00	$0.00
Total Costs	**$9,000.00**	**$9,000.00**	**$18,000.00**	**$4,669.09**	**$13,330.91**

**Expenses as of August 2020*

ITAC Budget
FY 20-21

Budget Category	FY20 Budget	FY21 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel	$3,481.62	$0.00	$3,481.62	$3,481.62	$0.00
Supplies	$90.00	$0.00	$90.00	$90.00	$0.00
Equipment					
Other					
Contractual					
Total Direct Costs	$3,571.62	$0.00	$3,571.62	$3,571.62	$0.00
Authorized Indirect Costs *(10% of Salaries and Wages)*	$0.00	$0.00	$0.00	$0.00	$0.00
Total Costs	**$3,571.62**	**$0.00**	**$3,571.62**	**$3,571.62**	**$0.00**

**Expenses as of Feb. 2022*

Project Management

Project Management funds in FY 18-19 were expended on salaries, fringe benefits, and required materials and supplies for the AQRP Program Managers and QAPP reviewer. At the close of the FY 18-19 Project Management accounts on 02/29/20, $32,446.01 remained to be carried forward into FY 20-21 project research Contractual funds. Project management was utilized in the same manner in FY 20-21. Total Program Management expenses for FY 20-21 to date are listed in the table below.

Table 5: Project Management Budgets

Project Management Budget
FY 18-19

Budget Category	FY 20 Budget	FY 21 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel	$3,481.62	$0.00	$3,481.62	$3,481.62	$0.00
Supplies	$90.00	$0.00	$90.00	$90.00	$0.00
Equipment					
Other					
Contractual					
Total Direct Costs	$3,571.62	$0.00	$3,571.62	$3,571.62	$0.00
Authorized Indirect Costs *(10% of Salaries and Wages)*	$0.00	$0.00	$0.00	$0.00	$0.00
Total Costs	**$3,571.62**	**$0.00**	**$3,571.62**	**$3,571.62**	**$0.00**

**Expenses as of Nov. 2021*

Project Management
FY 20-21

Budget Category	FY 20 Budget	FY 21 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary	$36,436.24	$36,480.69	$72,916.93	$72,731.23	$185.70
Fringe Benefits	$10,920.14	$10,871.25	$21,791.39	$21,977.02	($185.63)
Travel					
Supplies	$1,000.00	$1,000.00	$2,000.00	$1,971.21	$28.79
Equipment					
Other	$0.00	$0.00	$0.00	$0.00	$0.00
Contractual					
Total Direct Costs	$48,356.38	$48,351.94	$96,708.32	$96,679.46	$28.86
Authorized Indirect Costs *(10% of Salaries and Wages)*	$3,643.62	$3,648.06	$7,291.68	$7,273.13	$18.55
Total Costs	**$52,000.00**	**$52,000.00**	**$104,000.00**	**$103,952.59**	**$47.41**

**Expenses as of Feb. 2022*

RESEARCH PROJECTS

In FY 18-19, there were eight projects requesting $1,223,541.60 in funding, that were selected out of forty (40) proposals submitted to the AQRP request for proposal (RFP) for the biennium. Table 6 on the following page shows the distribution of the projects across the fiscal years for FY 18-19. Funds remaining to be spent in the Contractual budget form FY 18-19 were approved by the TCEQ to carry forward into FY 20-21 Contractual funding. Total carry forward of FY 18-19 funds totaled $61,389.51, which included residual funds in the Contractual budget, including research project budget, project management budget, and ITAC budget. These funds were carried forward into the UT internal FY 2020 account.

Nine projects were selected for 2020-2021, two projects (20-009 and 20-028) were cancelled early due to unavoidable COVID-19 related travel delays. Table 6 on the following page shows the distribution of FY 20-21 projects across fiscal years.

The FY 20-21 budget allocates $1,292,952.82 for research projects ($678,327.82 in FY 2020 and $614,625.00 in FY 20-21, which includes $8,563.31 of reallocated ITAC and Other Supplies funds that were not utilized on expenses due to COVID-19 travel restrictions). The reallocation of ITAC budget funds was approved by the TCEQ in August 2020.

Unused Contractual funds that were a result of COVID-19 related delays and cancellations were distributed for use on the approved SOS report, in the amount of $70,798. All Contractual budget reallocations received review by the Advisory Council, ITAC, and the TCEQ prior to approval.

The AQRP grant expired on February 27, 2022. The estimated release of claims of unused contractual research funds is $12,418.78. If necessary, this figure will be updated in an amendment to the report when the final FSR is submitted and approved by the TCEQ, expected in late March 2022.

Table 6: FY 18-19 and FY 20-21 Contractual/Research Project Budgets

FY 18-19 Contractual Budget

FY 18 Contractual Funding		**$611,500**		
FY 18 Contractual Funding Transfers		**$0**		
FY 18 Total Contractual Funding		**$611,500**		
Project Number	**Institution**	**Amount Awarded (Budget)**	**Cumulative Expenditures**	**Remaining Balance**
18-005	UC - Irvine	$ 139,193.00	$ 130,718.77	$ 8,474.23
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)			**$ 599,801.45**	
FY 18 Contractual Funds Remaining to be Spent				**$ 11,698.55**
FY 19 Contractual Funding		**$ 611,500.00**		
FY 19 Contractual Funding Transfers		**$ 782.00**		
FY 19 Total Contractual Funding		**$ 612,282.00**		
Project Number	**Institution**	**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	$ 97,825.82	$ 261.18
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)			**$ 608,353.65**	
FY 19 Contractual Funds Remaining to be Spent				**$ 3,928.35**
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			**$ 1,208,155.10**	
Total Contractual Funds Remaining to be Spent				**$ 15,626.90**

FY 20-21 Contractual Budget

FY 18-19	**Contractual Funds Carry Forward**	**$61,389.51**		
FY 20	**Contractual Funding**	**$611,500.00**		
FY 20	**Contractual Funding Transfers**	**$5,452.62**		
FY 20	**Total Contractual Funding**	**$665,923.35**		
Project	**Institution**	**Amount Awarded**	**Cumulative Expenditures**	**Remaining Balance**
20-003	Rice University	$72,940.46	$72,832.39	$108.07
20-003	Rice University (PPE)	$320.54	$320.54	$0.00
20-003	University of Houston	$115,668.00	$115,566.23	$101.77
20-003	Baylor University	$99,798.00	$90,111.10	$9,686.90
20-004	University of Houston	$63,294.47	$63,294.47	$0.00
20-004	St. Edward's University	$31,109.35	$31,109.35	$0.00
20-005	AER	$173,692.00	$173,692.00	$0.00
20-007	Ramboll	$6,311.68	$6,311.68	$0.00
20-007	Wildland Solutions	$8,244.06	$8,244.06	$0.00
20-009	Aerodyne Research, Inc.	$1,287.13	$1,287.13	$0.00
20-011	Ramboll	$28,403.75	$28,403.75	$0.00
20-020	University of Wisconsin-Madison	$26,785.71	$26,785.71	$0.00
20-020	Ramboll	$20,928.65	$20,928.65	$0.00
20-028	Drexel University	$14,298.87	$14,298.87	$0.00
FY 20	**Total Contractual Funding Awarded**	$663,082.67		
FY 20	**Contractual Funds Expended (Init. Projects)**		$653,185.93	
FY 20	**Contractual Funds Remaining to be Spent**			**$12,737.42**
FY 18-19	**Contractual Funding Carry Forward**	**$0.00**		
FY 21	**Contractual Funding**	**$611,500.00**		
FY 21	**Contractual Funding Transfers**	**$13,990.07**		
FY 21	**Total Contractual Funding**	**$637,908.85**		
Project	**Institution**	**Amount Awarded**	**Cumulative Expenditures**	**Remaining Balance**
20-004	University of Houston	$118,199.53	$117,267.71	$931.82
20-004	St. Edward's University	$37,150.65	$37,085.86	$64.79
20-007	Ramboll	$43,965.32	$43,951.32	$14.00
20-007	Wildland Solutions	$11,478.94	$11,478.94	$0.00
20-011	Ramboll	$85,211.25	$85,192.09	$19.16
20-020	University of Wisconsin-Madison	$98,214.29	$98,214.29	$0.00
20-020	Ramboll	$76,748.35	$76,748.35	$0.00
20-026	Texas A&M University	$98,427.00	$97,188.21	$1,238.79
20-028	Drexel University	$0.00	$0.00	$0.00
21-SOS	The University of Texas at Austin	$70,798.00	$70,770.53	$27.47
FY 21	**Total Contractual Funding Awarded**	$640,193.33		
FY 21	**Contractual Funds Expended (Init. Projects)**		$637,897.30	
FY 21	**Contractual Funds Remaining to be Spent**			**$11.55**
Total	**Contractual Funding**	$1,303,832.20		
Total	**Contractual Funding Awarded**	$1,303,276.00		
Total	**Contractual Funding Remaining to be Awarded**	$556.20		
Total	**Contractual Funds Expended to Date**		$1,291,083.23	
Total	**Contractual Funds Remaining to be Spent**			**$12,748.97**

APPENDIX A: FY 20-21 FUNDED PROJECTS

Prop. #	Title	Budget	PI	Co-PI	Institution	Total Budget Approved
20-003	Characterization of Corpus Christi and San Antonio Air Quality During the 2020 Ozone Season	$ 70,961.00	Griffin, Robert	n/a	Rice University (Prime Sub)	$ 288,727.00
		$ 2,300.000	Griffin, Robert	n/a	Rice University - PPE	
		$ 115,668.00	Flynn, James	Wang, Yuxuan	University of Houston	
		$ 99,798.00	Usenko, Sascha	Sheesley, Rebecca	Baylor University	
20-004	Galveston Offshore Ozone Observation (GO3)	$ 181,494.00	Flynn, James	Wang, Yuxuan	University of Houston (Prime Sub)	$ 249,754.00
		$ 68,260.00	Walter, Paul	Morris, Gary	St. Edward's University	
20-005	Using Satellite Observations to Quantify Surface $PM_{2.5}$ Impacts from Biomass Burning Smoke	$ 173,692.00	Alvarado, Matthew	n/a	Atmospheric and Environmental Research, Inc. (AER)	$ 173,692.00
20-007	Texas urban vegetation BVOC emission source inventory	$ 50,277.00	Shah, Tejas	n/a	Ramboll US Corporation (Prime Sub)	$ 70,000.00
		$ 19,723.00	Wildland Solutions	n/a	Wildland Solutions	
20-009	Ozone Measurements and Platform Emission Factors in the Gulf of Mexico	$ 12,989.00	Yacovitch, Tara	n/a	Aerodyne Research, Inc.	$ 12,989.00
20-011	Improving Estimates of Wind-Blown Dust from Natural and Agricultural Sources	$ 113,615.00	Emery, Chris	n/a	Ramboll US Corporation	$ 113,615.00
20-020	New Satellite Tools to Evaluate Emission Inventories: Is a 3-D Model Necessary?	$ 125,000.00	Holloway, Tracy	n/a	University of Wisconsin-Madison (Prime Sub)	$ 222,677.00
		$ 97,677.00	Johnson, Jeremiah	n/a	Ramboll US Corporation	
20-026	Improve Cloud Modeled by WRF using COSP and Generative Adversarial Network	$ 98,427.00	Lu, Zheng	n/a	Texas A&M University	$ 98,427.00
20-028	Quantification and Characterization of Ozone Formation in Central San Antonio	$ 71,368.60	Wood, Ezra	n/a	Drexel University	$ 71,368.60
21-SOS	State of the Science of Air Quality in Texas: 2016-2021	$ 70,798.00	Allen, David	n/a	The University of Texas at Austin	$ 70,798

APPENDIX B: FY 18-19 RESEARCH PROJECTS

Project No.	Project Title	Start Date	End Date	Funding Awarded	Total Project Expenditures*	Funding to be Carried Forward to 20-21
	Lead Institution	***PI***				
18-005	Next steps for improving Texas biogenic VOC and NO emission estimates	10/31/2018	8/31/2019	$168,146.00	$159,669.00	$8,477.00
	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	$150,749.61	$150,736.65	$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	$127,630.78	$3,663.22
	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 May 2020**			**TOTALS**	**$1,223,541.61**	**$1,208,155.10**	**$15,386.51**
			CONTRACTUAL FUNDS NOT AWARDED	**n/a**	**n/a**	**$240.39**
			TO BE CARRIED FORWARD TO 20-21	**n/a**	**n/a**	**$15,626.90**