AIR QUALITY RESEARCH PROGRAM

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

Quarterly Report

December 1, 2020 – February 28, 2021

Submitted to

Donna Huff
Texas Commission on Environmental Quality
12100 Park 35 Circle
Austin, TX 78753

Prepared by

David T. Allen, Principal Investigator
The University of Texas at Austin
10100 Burnet Rd. MC R7100
Austin, TX 78758

March 22, 2021

The preparation of this report was financed through a grant from the Texas Commission on Environmental Quality (TCEQ), administered by The University of Texas at Austin through the Air Quality Research Program (AQRP). The contents, findings, opinions, and conclusions are the work of the author(s) and do not necessarily represent findings, opinions, or conclusions of the TCEQ.

Texas Air Quality Research Program

Quarterly Report

December 1, 2020 – February 28, 2021

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 December 1, 2020 and February 28, 2021, the AQRP Project Administration efforts focused primarily on individual project audits of Financial Status Reports (FSR), internal UT account audits and monthly FSR preparations (UT submissions to the TCEQ), Project Management Monthly Technical Report (MTR) reviews and discussions, coordinating project amendments for 20-004, 20-009, and 20-028, continued effort to work with project institutions to adjust travel budgets to other budget categories, Quarterly AQRP Report preparation, and determining the status of internal and subaward project budgets due to COVID-19 related travel restrictions and delays.

Three projects in the 2020-2021 fiscal year (20-004, 20-009, and 20-028) conducted discussions with the AQRP regarding contract amendments for modifications to their Scope of Work (SOW), Quality Assurance Project Plan (QAPP), and/or Budget to reflect changes that were unavoidable due to COVID-19 related delays:

> Project 20-004 (Galveston Offshore Ozone Observation (GO3) – Univ. of Houston lead) coordinated two separate Task Order Amendments during this quarter. Amendment No. 1 adjusted the field work timeline to April through August 2021 as well as to increase the supplies budget by $13,000 for the purchase of photocells and associated shipping and indirect costs. The amendment details were approved by the AQRP Independent Technical Advisory Committee (ITAC), the AQRP Council, TCEQ, and the QAPP Manager. Amendment No. 1 was fully executed on January 15, 2021. Amendment No. 2 was sent to the Council and TCEQ for approval to increase the equipment budget for The University of Houston by $35,000 for the purchase of a ceilometer, as well as associated indirect costs, and to extend the project end-date to November 15, 2021. The Council and TCEQ approved the amendment request, which was fully executed by UT and Univ. of Houston on March 10, 2021.

Project 20-009 (Ozone Measurements and Platform Emission Factors in the Gulf of Mexico – Aerodyne Research, Inc.) notified the AQRP in early January 2021 that their project will cease operations as of January 31, 2021 due to ongoing COVID-19 travel restrictions and delays. UT and Aerodyne fully executed the amendment to adjust the project end date on February 2, 2021. The Aerodyne release of claims is in process. The remaining balance returned to the AQRP will be presented in detail in a subsequent quarterly report.

Project 20-028 (Quantification and Characterization of Ozone Formation in Central San Antonio – Drexel University) notified the AQRP Project Manager of a proposed timeline modification of field work to be conducted in Summer 2021. Due to COVID-19 travel restrictions, the Drexel research team was unable to conduct the field study in Summer 2020. The amendment timeline details were presented to and approved by the Council and TCEQ in February 2021. Dr. Ezra Wood is updating the proposed SOW timeline. Once received and approved by the AQRP QAPP Manager and the TCEQ, UT will issue the amendment to Drexel Univ. to approve the new research timeline. An additional amendment may be presented to the Council and TCEQ in the following quarter to address continuing out-of-state travel COVID-19 restrictions that Drexel University has imposed on all non-essential research. As of March 15, 2021, Drexel Univ. has been informed to hold all expenses until April 1, 2021. Dr. Wood will notify the AQRP no later than April 1, 2021 if the research team will be allowed to travel to Texas to conduct research. Details regarding this possible second amendment will be presented in a subsequent quarterly report.

Due to COVID-19 travel restrictions, the TCEQ recommended that the AQRP allow Principal Investigators (PIs) to re-budget any travel funds associated with travel to conferences, AQRP meetings or other meetings now being held virtually, to any other budget category, except for increased Indirect Costs. The AQRP Director, Dr. David Allen, agreed with the recommendation and informed the Project Managers to notify project PIs of the re-budget option. The AQRP Project Managers notified project PIs on November 6, 2020 that the option to rebudget Travel funds was available. The Project Managers worked with PIs in December 2020 and January 2021 to evaluate travel budget modification requests. The following projects requested and were approved for a Travel budget modification:

Projects 20-004 (University of Houston), 20-007 (Ramboll), 20-011 (Ramboll), 20-020 (University of Wisconsin), and 20-026 (Texas A&M University) requested to reallocate all travel to the materials and supplies budget category.

A full list of the funded projects for FY 2020-2021 is provided in Appendix A. The Scopes of Work are included in this report for all FY 2020-2021 funded projects.

The Financial Status Report section of this report includes accounting from both FY 2018-2019 and FY 2020-2021. Remaining funds in FY 2018-2019 have been approved by the TCEQ to be carried forward into FY 2020-2021. On December 18, 2020, UT finalized the FY18-19 Carry Forward of Administrative budget into the FY 2020 Administrative salaries and fringe budget categories.

Due to COVID-19 health-safety concerns, work-from-home status was implemented across UT Austin and the TCEQ in March 2020. It is anticipated that this status will continue through September 2021 at UT Austin. Approval was granted by TCEQ to submit monthly FSRs, Quarterly Reports, and Annual Reports as a single PDF instead of the hardcopies that have previously been required. Hardcopies of all documents will be delivered to TCEQ if required at a later date. On March 12, 2021, the AQRP requested to shift the December 2020 – February 2021 Quarterly Report due date to March 22, 2021 to allow for project FSRs to be included in the Financial section. Due to the dates overlapping, the AQRP requested more time to incorporate project FSR data. The request was approved.

Program activities in the next quarter will focus on completing the Task Order amendments for Project 20-004, 20-009, and 20-028, auditing individual project monthly Financial Status Reports (FSR), Project Manager reviews of Monthly Technical Reports, budget revision discussions and planning due to COVID-19 travel restrictions, Project Manager reviews of project Quarterly Reports, UT Austin monthly FSR reconciliations, accounts payable to subaward institutions, and UT Austin internal subaward account reconciliations.

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). 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 Council and the TCEQ, develop research priorities; the research priorities are released along with a Request for Proposals.
2) Project proposals relevant to the research priorities are solicited. The Request for Proposals can be found at http://aqrp.ceer.utexas.edu/ .
3) The Independent Technical Advisory Committee (ITAC) performs a scientific and technical evaluation of the proposals.
4) The project proposals and ITAC recommendations are forwarded to the TCEQ. The TCEQ evaluates the project recommendations from the ITAC and comments on the relevancy of the projects to the State's air quality research needs.
5) The recommendations from the ITAC and the TCEQ are presented to the Council and the Council selects the proposals to be funded. The Council also provides comments on the strategic research priorities.
6) All Investigators are notified of the status of their proposals, either funded, not funded, or not funded at this time, but being held for possible reconsideration if funding becomes available.
7) Funded projects are assigned an AQRP Project Manager at UT-Austin and a Project Liaison at TCEQ. The AQRP Project Manager is responsible for ensuring that project objectives are achieved in a timely manner and that effective communication is maintained among investigators involved in multi-institution projects. The AQRP Project Manager has responsibility for documenting progress toward project measures of success for each project. The AQRP Project Manager works with the researchers, and the TCEQ, to create an approved work plan for the project.

   The AQRP Project Manager also works with the researchers, TCEQ and the Program's Quality Assurance officer to develop an approved Quality Assurance Project Plan (QAPP) for each project. The AQRP Project Manager reviews monthly, annual and final reports from the researchers and works with the researchers to address deficiencies.
8) The AQRP Director and the AQRP Project Manager for each project describe progress on the project in the ITAC and Council meetings dedicated to on-going project review.
9) The project findings are communicated through multiple mechanisms. Final reports are posted to the Program web site; research briefings are developed for the public and air quality decision makers; and a bi-annual research conference/data workshop is held.

During this reporting period, program activity concentrated on Steps 7 and 8 for FY 2020-2021 projects.

RESEARCH PROJECTS
FY 2020-2021 Projects

Project 20-003 **STATUS: Active – 07/17/20-08/31/21**

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

AQRP Project Manager – Vincent Torres
TCEQ Project Liaison – Erik Gribbin

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

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

Project Update:
Work performed was related to Task #1, campaign preparation. Expendable supply purchases continued, as did training of staff and graduate students on all instruments. The work for the reporting period also included on-going effort toward upgrading and modifying the Baylor trailer for deployment during the upcoming campaign. With respect to specific instrumentation, the electronic control box for the particle sizing region of the aerosol mass

spectrometer was repaired, and this instrument was tested using laboratory air. Its calibrations are underway. Other preparations focused on the inlet for the sampling, including installation of an reactive nitrogen converter (including the heater and associated temperature controller), a pressure sensor, labjack, and valves; all relevant parameters for the inlet box were added to the data acquisition system (including an appropriate KVM switch). Meteorological measurements (wind direction/speed, relative humidity, radiometer) and a sky camera were added next to the inlet box. For other gas-phase instruments, work focused on testing with zero air and automating calibration sequences. Drive planning for week 3 (mobile measurements based in Corpus Christi after the initial 2-week stationary period) commenced; these drives will focus on characterization of both local emissions and downwind transformations.

Additional work was performed for Task #3, data analysis, which includes three-dimensional modeling. This includes continued implementation of larger-scale GEOS-Chem outputs as boundary conditions to drive the WRF-GC model and preparing emission files for the fine resolution WRF-GC runs to be performed as part of this project. This work is a continuation of that reported last month. In addition, the team began testing WRF-GC v2.0 (released in February 2021, https://github.com/jimmielin/wrf-gc-release). New features of WRF-GC v2.0 that will benefit the project include its nested-domain functionality and its simulations of aerosol radiation interactions and aerosol-cloud interactions

Identified Issues: As referenced in Monthly Technical Reports, delays in finalizing task orders and issues associated with the COVID-19 pandemic have necessitated shifting the field work from fall 2020 to spring 2021. With approval from the AQRP, we have adjusted and added to the scientific questions to be addressed using our field data analysis and modeling. We currently are planning precautions needed to successfully perform this campaign during spring 2021, despite the continued pandemic. Note that a few individuals from the Baylor group were forced to quarantine due to potential exposure to COVID-19. This has resulted in some delays, but the group is working diligently to catch up. There also were delays caused by the winter storm that hit Texas in mid-February, preventing access to laboratories for essentially a week. The teams are working hard to make up for that lost time.

Goals for the Succeeding Period:
Model: Continue generation of appropriate input files for three-dimensional modeling efforts, continued training of researchers on use of the three-dimensional model

Field: Continue preparation of mobile air quality laboratory, continue assessment of equipment maintenance needs, and continue training of researchers on equipment usage. We plan to be ready for deployment as of April 1.

Detailed Analysis of the Progress of the Task Order to Date: Given the late start and the approved change in project field work, we believe that our progress on the project has been appropriate.

Project 20-004 **STATUS: Active – 07/17/20-11/15/2021**

Galveston Offshore Ozone Observation (GO3)

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

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 aims to deploy 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 O_3, O_X ($O_X = O_3 + NO_2$) 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, will be 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 3-D chemical transport modeling, this study will shed light on the conditions and processes that may result in high O_3 over the water and subsequent impacts on the HGB urban area.

The study is 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 ($O_X = O_3 + NO_2$) 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 proposed instrumentation packages will include an O3 monitor, UV-LED NO_2 photocell, Global Positioning System (GPS) receiver, all-in-one weather station, and a ruggedized PC with a cellular data connection. The package will operate autonomously when power is available. A ceilometer will be 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 are logged locally, will be sent to servers at UH when within cellular coverage.

Modeling activities will utilize the Weather Research and Forecasting (WRF) driven GEOS-Chem (WRF-GC). The model will simulate 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. For the proposed work, the inner-most model domain of WRF-GC will be set over the sampling areas as well as the area surrounding the bay which will include the monitors used for comparisons at a resolution of 1 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:

- Continued testing first sampling packages.
- Began testing of the second sampling system.
- Continued testing the Ceilometer CL-51 at the UH Launch Trailer site.
- Field test of the omnidirectional antenna was carried out. One telemetry setup using the omnidirectional antenna and one separate telemetry setup using a Yagi directional antenna were used to compare performance. The omnidirectional antenna mounted on a tripod is shown in Figure 20-004-1.

  Both setups used an RSPdx SDRplay receiver. It was found that both telemetry setups tracked the flight well throughout the troposphere during the ascent (Figure 20-004-2) with the omnidirectional antenna typically receiving a better signal.

Figure 20-004-1: The Harsh/Synergetics 14A-N omnidirectional antenna mounted on a tripod.

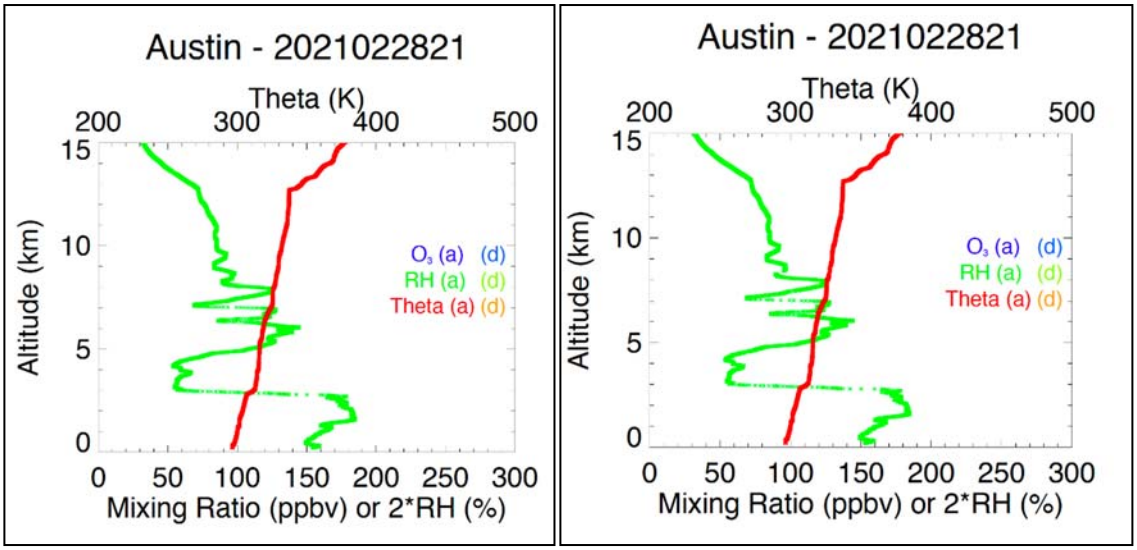

Figure 20-004-2: Left: Radiosonde tropospheric profile using omnidirectional antenna. Right: Same radiosonde tropospheric profile using Yagi antenna.

During the descent after the balloon burst, the omnidirectional antenna tracked the signal longer (Figure 20-004-3). The omnidirectional antenna continued to receive a signal until the radiosonde was 141 km away (approximately 10 km further than the Yagi antenna). The performance of the telemetry setup using the omnidirectional antenna was more than sufficient to meet the needs during the upcoming field campaign. The omnidirectional antenna will be mounted onto the pontoon boat used for ozonesonde launches in Galveston Bay. The omnidirectional antenna has the advantage that it is much smaller than the Yagi antenna and likely will not need to be repositioned as the pontoon boat is moving.

When the signal was weak during the descent, we may have observed some directional dependence when rotating the omnidirectional antenna. We will monitor signs of directional dependence affecting the signal strength during the field campaign.

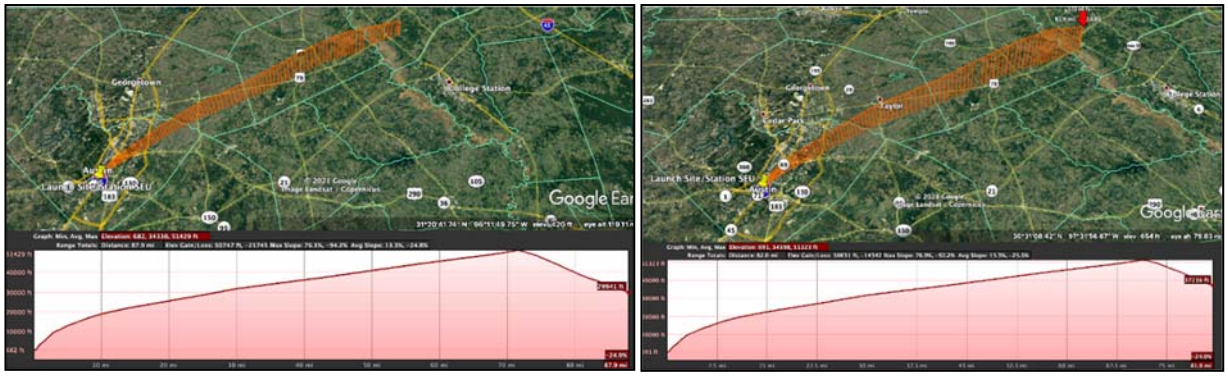

Figure 20-004-3: Left: Omnidirectional antenna tracking of the radiosonde flight path. Right: Yagi directional antenna tracking of the radiosonde flight path.

Goals for the Succeeding Period:

- Test both sampling system next to each other out in the field for comparison.
- Testing GSPs with the sampling systems.
- Work with Vaisala to get be able to switch license from instrument laptop to sampling system.
- Continue to prepare for deployment of sampling packages to be ready in April start of O_3 (ozone) season. Deployment schedule is dependent on receipt and successful testing of the GSP.

Detailed Analysis of the Progress of the Task Order to Date: The project is moving forward quite well with respect to the Task Order issue date. With the request from AQRP and TCEQ to delay deployment into the 2021 O_3 season the timeline has shifted which will allow more time for preparation and coordination.

Project 20-005 **STATUS: Active – 07/28/20/08/31/21**

Using Satellite Observations to Quantify Surface PM2.5 Impacts from Biomass Burning Smoke

Atmospheric and Environmental Research Inc.
Dr. Matthew Alvarado

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 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).

NOAA and 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 will evaluate the ability of these existing remote sensing smoke products to accurately and consistently identify regions impacted by smoke. We will compare and evaluate the smoke products using additional polar satellite observations that are sensitive to smoke, specifically observations of CO and NH_3 from CrIS and AIRS and aerosol absorption Angstrom exponent (a proxy for brown carbon) from OMI. We will evaluate two methods for estimating the height of the plumes detected by the HMS and other smoke products: the plume height estimates from the MODIS MAIAC algorithm and a new method based on the observed transport direction of the smoke plumes. Finally, we will test different statistical and model-based approaches to estimate the impact of the observed smoke on surface $PM_{2.5}$.
The objectives of this project are thus:

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 AOD observations to surface $PM_{2.5}$ concentrations.

This work directly responds 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 ($PM_{2.5}$) using remote sensing tools, such as the NOAA Hazard Mapping System (HMS) Fire and Smoke product?*".

Project Update: We continued refining the sections of the User's Guide/Documentation pertaining to Tasks 1 and 2.1. In addition, we began an outline for a journal article synthesizing the results of this project, including incorporating anticipated results from Tasks 2.1 and 3. As part of our goal to submit a journal article on the results of this project, we are considering refining our Smoke Confidence Index (SCI) such that it is more reflective of our findings.

Preliminary Analysis: As detailed in Monthly Technical Reports, our findings suggest that the GOES smoke product has higher correlation with smoke-relevant indicators than the NOAA HMS or TROPOMI UVAI products taken alone. When combined with the NOAA HMS product, the smoke prediction ability increases further. Based on our preliminary analysis of the simple SCI, the TROPOMI UVAI product does not appear to provide added value to assessments of smoke presence. As part of a publication-ready analysis, we are therefore considering revising the current SCI. Our revisions to the SCI may include some combination of the following, which better incorporates our analysis to date: (1) elimination, appropriate weighting, or selection criteria refinement of the UVAI; (2) weighting of the GOES and NOAA HMS products; (3) incorporation of the auxiliary smoke variables (brown carbon, ammonia, carbon monoxide, and aerosol optical depth).

Goals for the Succeeding Period: Over the next months, we will begin the HYSPLIT plume analysis on the Task 2.2 subset data. We will also begin Task 3, where we examine the ability of our smoke product (including AOD and the value of the SCI) to predict surface PM2.5, regressed against surface PM2.5 observations.

Detailed Analysis of the Progress of the Task Order to Date: We have selected 93 dates between January and July 2020 with suspected smoke intrusions in the Texas area. For these dates:

- We have merged all the Task 1 and 2 components thus far and placed them on a common grid.
- We have performed aggregate, seasonal, and daily analysis of the 93-day smoke data set, incorporating multiple auxiliary products (NH_3, CO, OMI BrC, AOD, PH) where relevant.
- We have developed a Smoke Confidence Index within a standalone data set that enables a user to perform multiple calculations including FMS, PH, etc.

- We have calculated PH from AOD bins based on Cheeseman et al. (2020) MAIAC PH/AOD relation.
- We have performed FMS analyses, aggregated over all times as well as broken down by day and measurement hour.
- We have developed a python-based GUI to visualize daily results from a user-selected date.
- We have subset relevant data for HYSPLIT Plume Analysis (Task 2.2)

Publications, Presentations related to the project:

1. Identification and evaluation of biomass burning events: a data assimilation approach over Texas, Journal of the Air and Waste Management Association.
2. Identifying Smoke-Impacted Regions using the Optical Properties of Brown Carbon Aerosol, accepted for poster at AGU Fall Meeting
3. Identifying Smoke-Impacted Regions using the Optical Properties of Brown Carbon Aerosol, accepted as oral presentation at the CMAS Fall Meeting.

Project 20-007 **STATUS: Active 07/21/20-08/31/21**

Texas urban vegetation BVOC emission source inventory

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

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 is 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 VOC reactivity of at least some Texas urban locations (Anderson et al. 2019). 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 propose to improve 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 will use urban tree inventories and aerial and satellite imagery to develop a high spatial resolution (~1 km) 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, juniper) and other vegetation cover types for three Texas urban areas: Austin, Houston, San Antonio.

The primary deliverable will be more accurate landcover inputs for biogenic VOC emission models for estimating BVOC emissions for the urban and suburban areas. Outcomes will include improved biogenic emission estimates and a better understanding of the current uncertainties in urban biogenic emission model simulations. The overall benefit of this project will be 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:
Task 3. MEGAN and BEIS input data, processors and results: Ramboll updated WRFCAMx preprocessor to output meteorological data for MEGAN processing to simplify application of MEGAN to support CAMx. This will avoid need for running MCIP preprocessor for CAMx modeling applications.

Task 4: Project Reporting and Presentation: Developed January MTR and FSR and submitted to AQRP.

Goals for the Succeeding Period: Continue developing the relative abundance of high BVOC-emitting trees and other vegetation cover types for three Texas urban areas: San Antonio, Austin and Houston. Continue working on integrating urban vegetation cover data in an appropriate format for input to the MEGAN and BEIS biogenic emission models.

Project 20-009 **STATUS: Active – 07/27/20-01/31/2021**

Ozone Measurements and Platform Emission Factor in the Gulf of Mexico

Aerodyne Research, Inc. – Dr. Tara Yacovitch

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 has been funded by the United Nations through the Clean Air and Climate Coalition. This campaign is expected to occur in the late winter/spring of 2021, at the beginning of Houston's ozone season. This proposal aims to supplement the instrument manifest with an ozone monitor, and to support the analysis of emission factors using existing measurements of methane, ethane CO, CO_2 and NOx.

Figure 20-009-4: 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 have decided that we require an industry participant/partner to help with these logistics. This will significantly delay the project, and we have therefore notified our AQRP project manager that we will no longer be able to complete this project before the AQRP deadline of August 31, 2021. The project will end 01/31/2021. Aerodyne coordinated with UT to amend the project Task Order to formally end 01/31/2021 and complete a Release of Claims.

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

Anticipated Funds Released to the AQRP: $11,574.00

Project 20-011 **STATUS: Active – 07/28/20-08/31/21**

Improving Estimates of Wind-Blown Dust from Natural and Agricultural Sources

Ramboll US Corporation – Dr. Chris Emery

AQRP Project Manager – Elena McDonald-Buller

TCEQ Project Liaison – Barry Exum

Funded Amount: $113,615.00

Abstract:
Ramboll will critically evaluate current windblown dust (WBD) emission models and identify and adapt 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 will assess 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., Ca, Fe, 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: Task 3: Update the WBDUST Model and Evaluate Impacts in CAMx MP: Continued to apply CAMx with the 2016 EPA Modeling Platform to assess alternative windblown dust estimates from previous and updated (from Task 2.1) versions of the WBDUST model. We expect to report initial results to the AQRP and TCEQ in February.

Task 4: Project Reporting and Presentation: Developed December MTR and FSR and submitted to AQRP on January 5 and 14, respectively.

Preliminary Analysis: Ramboll reviewed available Texas and US vegetative and cropland activity datasets as viable sources of information that can be used to further improve the spatial and temporal characterization of WBD from the agricultural lands. Agricultural tilling exposes land tracts to seasonal wind erosion. WBDUST does not specifically resolve this type of dust source temporally and spatially. Therefore, high-resolution crop activity information provides a way of characterizing sub-grid patterns of emissive lands.

We have chosen a US database called "CropScape", derived from the National Agricultural Statistics Service (NASS). CropScape provides detailed vegetative coverage of hundreds of crop types and other non-agricultural landcover types at 30 meter resolution over the 48 conterminous States. Additionally, from our review under Task 2.1, we found a State-level "crop calendar" that EPA employs in the in-line WBD emissions module within the Community Multiscale Air Quality (CMAQ) model. The crop calendar provides tilling, seeding, and harvesting dates for 18 major crop types. We are developing a methodology to use the CropScape and calendar datasets in WBDUST to improve the characterization of agricultural land cover types and particularly the specific areas and times that croplands are exposed to wind erosion.

Data Collected: We downloaded the 2016 30-m CropScape dataset (14 Gb) from NASS.

Goals for the Succeeding Period: Complete Task 2.2 technical memorandum documenting our choice for alternative landcover and agricultural datasets for use in the WBDUST model. Continue model testing of WBDUST updates using the CAMx model. Model results using original and alternative windblown dust estimates will be evaluated against those same ambient measurements. No anticipated issues for the succeeding reporting period.

Project 20-020 **STATUS: Active – 08/21/20-08/31/21**

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

University of Wisconsin-Madison – Dr. Tracy Holloway

AQRP Project Manager – Elena McDonald-Buller

Ramboll US Corporation – Dr. Jeremiah Johnson

TCEQ Project Liaison – Mark Muldoon

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

Abstract:
This study will develop 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 of 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 a useful 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 will evaluate two different methods to compare satellite NO_2, and to a limited extent SO_2, with emission inventories developed by the Texas Commission on Environmental Quality (TCEQ).

Our proposal directly 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 will develop 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 and SO_2 from TROPOMI for summer 2019 with model simulations from a WRF-CAMx modeling system developed for the TCEQ;

2) Simpler approaches to comparing NO_X emissions and TROPOMI data that don't require a photochemical grid model, especially the Exponentially Modified Gaussian (EMG) approach. These simpler methods will be extended to SO_2 as resources and data integrity allow.

This analysis will evaluate methods by which high-resolution satellite may be compared with emissions inventories, and to assess the necessity of computationally intensive modeling approaches. Study goals include 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. Results emerging from the proposed study will be submitted as a manuscript for peer-reviewed publication.

Project Update: Work was carried out on Task 1 and Task 2:

Task 1: Simulated NO_2 and SO_2 amounts with the high-resolution WRF-CAMx model The Ramboll modeling team prepared and completed two CAMx sensitivity simulations that modify the MEGAN biogenic emissions and are designed to help improve NO2 and ozone model performance.

Task 2. Compared model simulations with TROPOMI and near-surface observations The Ramboll modeling team completed evaluation of WRF-CAMx results against TCEQ observations for the base simulation and two sensitivity simulations. The UW-Madison is continuing with processing of TROPOMI NO_2 with WHIPS on the 12km domain and processing of CAMx column amounts with the TROPOMI averaging kernel. The UW-Madison team completed updating WHIPS to a newer version of Python, has installed WHIPS on an additional machine for faster processing, and has commenced gridding of TROPOMI NO_2 to the 4km domain.

Goals for the Succeeding Period: Ramboll will complete the model performance evaluation and assist UW-Madison with comparison of satellite data with emissions from power plants and mobile sources.

Preliminary Analysis: The UW-Madison team is continuing analyses to support comparison of TROPOMI NO2 with CAMx output. An example of the latter is shown below using one month of TROPOMI and CAMx data (Figure 20-020-1):

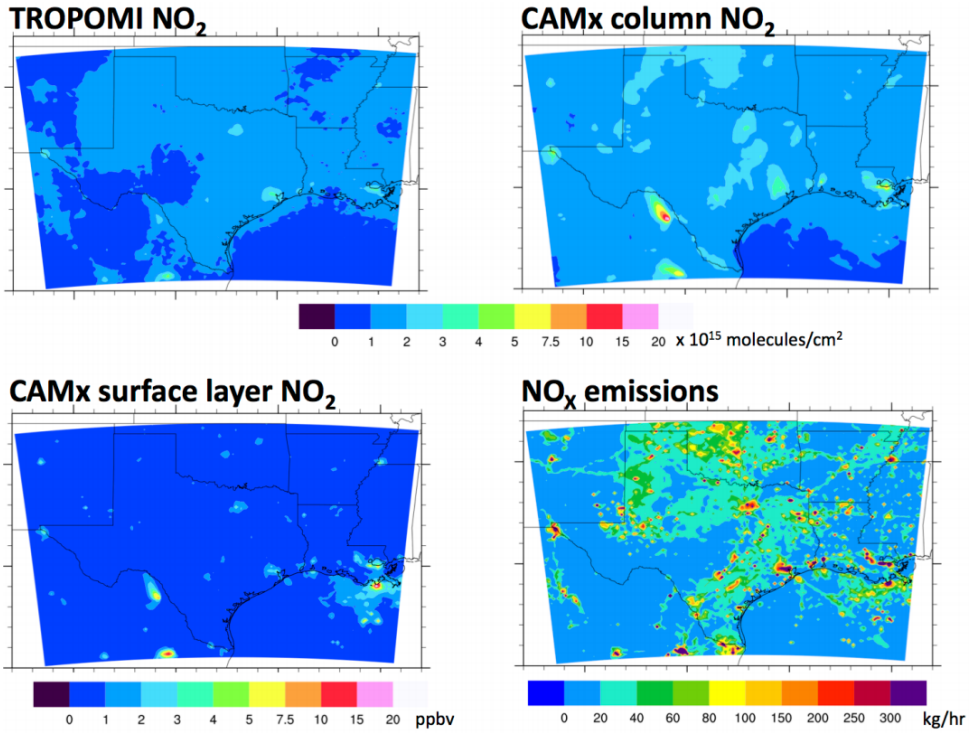

Figure 20-020-1: July 2019 average TROPOMI and CAMx NO_2 column amounts (top left and right, respectively), CAMx surface layer NO_2 (bottom left) and total NOX emissions (bottom right).

Goals for the Succeeding Period: Ramboll will perform additional sensitivity simulations, pending evaluation against observations. In addition, Ramboll will assist UW-Madison with

comparison of satellite data with emissions from power plants and mobile sources. UW-Madison will continue gridding TROPOMI NO_2 to the 12km and 4 km model domains via WHIPS. As more gridded TROPOMI are available, the UW-Madison team will continue comparison of model and satellite column NO_2.

Project 20-026 **STATUS: Active – 08/24/20-08/31/21**

Improve Cloud Modeled by WRF using COSP and Generative Adversarial Network

Texas A&M University – Dr. Zheng Lu

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, transportation, 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.

In this proposal, we plan to run **WRF** model with Texas in the center of model domain. Modeled cloud fields are feed into Cloud Feedback Intercomparison Project (CFMIP) Observation Simulator Package (**COSP**), so that modeled cloud can be directly compared to satellite observations. The objective is 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 train a **GAN** (Generative Adversarial Network), a type of deep learning technique. We will perform super-resolution and image-to-image translation applications to modeled cloud microphysical fields over Texas, so that they can gain detailed fine features, and become more accurate compared to observed cloud fields. Improved cloud fields can improve Texas air quality prediction.

Project Update: The major effort of the team during this period is to develop a framework of scripts that automatically converts daily WRF outputs of 27 cases into COSP inputs, runs COSP package, and archives the COSP outputs; therefore, the team can greatly shorten the processing time for both Task 2 and Task 3. The team has successfully finished processing all 27 cases. Currently the COSP outputs are evaluated against MODIS observations using the statistical metrics. The model evaluation and long-period (parallel) simulation will be finished by the end of Feb.

We also spent much effort in testing the assumptions in cloud properties calculation that are needed as the COSP inputs, especially for the Thompson and WSM6 schemes. This is because these two schemes do not output number concentration of cloud ice particles. The ways of effective radius of cloud droplet and ice are also different in three schemes. We are also testing different assumption about calculations of cloud emissivity, cloud hydrometeor production rate, etc.

Preliminary Analysis: We are calculating the statistical metrics of simulated and MODIS cloud properties. This is a still on-going work.

Data Collected: COSP outputs of all 27 cases.

Goals for the Succeeding Period: We plan to finish long-term WRF simulation in the next reporting period.

Detailed Analysis of the Progress of the Task Order to Date: 90% of Task 1& 2 completed. 15% of Task 3 completed.

Project 20-028 **STATUS: 08/07/20-08/31/21**

Quantification and Characterization of Ozone Formation in Central San Antonio

Drexel University – Dr. Ezra Wood

AQRP Project Manager – Vincent Torres

TCEQ Project Liaison – Erik Gribbin

Funded Amount: $71,369.00

Abstract:
Ozone concentrations in Bexar county have exceeded the Environmental Protection Agency's Air Quality Standard. To develop and implement ozone mitigation strategies, regulators and air quality planners require information regarding the mechanisms by which ozone is formed in San Antonio, including information on its dependence on the emissions of nitrogen oxides and volatile organic compounds.

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 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 will participate in a field deployment to central San Antonio. This project entails four research tasks:

1. Prepare for the field deployment in San Antonio. This will consist of logistical planning with the other participants in the study (Rice University, Baylor University, and the University of Houston) and improvements to our analytical methods in the laboratory.
2. Field deployment in San Antonio. This will occur in Spring 2021. Similar to the 2017 San Antonio Field Study, the Drexel team will deploy its "ECHAMP" sensor that quantifies concentrations of peroxy radicals.
3. Data Quality Assurance. The data from the field deployment will be quality assured and prepared for the subsequent analysis.
4. Preliminary Data Analysis. Using the collected measurements of peroxy radicals and nitric oxide, we will calculate the instantaneous ozone formation rates and characterize their dependence on concentrations of nitrogen oxides and volatile organic compounds.

Project Update: The goal of Task #1 is to prepare for the field deployment to San Antonio which is currently scheduled for the first two weeks of May 2021. The main activities conducted during the reporting period as part of this task were continued training of graduate student Alexa Rhoads to use the ECHAMP peroxy radical sensor and initial testing of the instrument with the reaction chambers held at reduced pressure. Preliminary data suggest that at ~0.5 atm, the amplification factor (and instrument sensitivity) was comparable to that at 1 atm under dry conditions, but that the amplification factor did not decrease with increasing relative humidity as it does at 1 atm, roughly in agreement with predictions. We have begun the preliminary characterization of the optimum settings (flow rates for ethane and nitric oxide) for use at reduced pressure.

No work has been done on Task #2 (Field Deployment), Task #3 (Data Quality Assurance), or Task #4 (Data Analysis). Limited work has been done for Task #5 (Project Reporting and Presentation) including this report.

Preliminary Analysis: No preliminary analysis has been conducted with the exception for the preliminary analysis of laboratory data as described above.

Data Collected: No field data have been collected but as described above we have collected laboratory data.

Identified Issues: There were no formal problems encountered during the reporting period but we have moved our lab within the same building. Several days of work have been spent setting things up in the new lab during which we did not focus on instrument preparation.

There are no delays beyond the relocation of our laboratory as mentioned earlier. This will lead to dividends in the near-future as in our new laboratory we will not have the stringent occupancy requirements that we had in the old lab.

Possible travel delays are being discussed with the AQRP due to Drexel University travel restrictions imposed on all non-essential research during the COVID-19 pandemic. The project team will have an update on travel status on April 1, 2021.

Goals for the Succeeding Period: Alex Rhoads will continue her training to use the ECHAMP peroxy radical sensor and the required analytical software tools. We will continue to characterize the performance of the ECHAMP sensor at reduce pressure.

Detailed Analysis of the Progress of the Task Order to Date: Tasks 1 and 5 are in progress. Tasks 2, 3, and 4 have not started.

FINANCIAL STATUS REPORT

The AQRP contract was renewed for the FY 2018-2019 biennium and additional funding of $750,000 per year was awarded. For the FY 2020-2021, the AQRP was renewed for additional funding of $750,000 per year. For each year in FY 2018-2019 and FY 2020-2021, 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 Fiscal Year). This category includes all staffing, materials and supplies, and equipment needed to administer the overall AQRP. It also includes the costs for the Council meetings.

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

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

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

Program Administration

Program Administration includes salaries and fringe benefits for those overseeing the program as a whole, as well as materials and supplies, travel, equipment, and other expenses. This category allows indirect costs in the amount of 10% of salaries and wages. Remaining funds from FY 2018-2019 Administration budget in the amount of $214.91 was approved by the TCEQ to carry forward into the FY 2020-2021 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, is responsible for the overall administration of the AQRP. RoseAnna Goewey, AQRP Program Manager, assisted Dr. Allen with program management. Susan McCoy and 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. Denzil Smith was responsible for the AQRP Web Page development and for data management.

In FY 2019-2020 (09/01/2019-08/31/2020), 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)	29.8%

Part-time/Non-benefits Eligible 5.10%

Table 3: Administration Budgets

Administration Budget (includes Council expenses)
FY 2018-2019

Budget Category	FY18 Budget	FY19 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 2020-2021

Budget Category	FY20 Budget	FY21 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary	$51,563.72	$53,700.00	$105,263.72	$64,283.58	$40,980.14
Fringe Benefits	$15,494.82	$12,930.00	$28,424.82	$19,245.69	$9,179.13
Travel					
Supplies	$3,000.00	$3,000.00	$6,000.00	$1,424.15	$4,575.85
Equipment					
Other					
Contractual					
Total Direct Costs	$70,058.54	$69,630.00	$139,688.54	$84,953.42	$54,735.12
Authorized Indirect Costs *(10% of Salaries and Wages)*	$5,156.37	$5,370.00	$10,526.37	$6,897.16	$3,629.21
Total Costs	**$75,214.91**	**$75,000.00**	**$150,214.91**	**$91,850.58**	**$58,364.33**

**Expenses as of February 2021*

ITAC

ITAC expenditures were incurred in FY 2018-2019 and were only charges against 2018 funding. ITAC expenditures in FY 2020 consist 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 to have the ITAC budget reduced by $3,125 in both 2020 and 2021 fiscal years, crediting the amount to the subawards budget category for use by research contractual subawards in FY2020 and FY2021. Additional FY2020-2021 ITAC funds may be rebudgetted in the future due to unused funds related to continuing COVID-19 restrictions, with approval from the TCEQ.

The AQRP and the TCEQ are in discussions to further utilize unspent ITAC funds (due to COVID-19 related travel restrictions) for Contractual Project expansions. Additional details regarding this possibility will be detailed in the subsequent quarterly report.

Table 4: ITAC Budgets

ITAC Budget
FY 2018-2019

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
Equipment					
Other					
Contractual					
Total Direct Costs	$9,000.00	$9,000.00	$18,000.00	$4,669.09	$13,330.91
Authorized Indirect Costs	$0.00	$0.00	$0.00	$0.00	$0.00
(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 August 2020*

ITAC Budget
FY 2020-2021

Budget Category	FY20 Budget	FY21 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel	$3,481.62	$4,375.00	$7,856.62	$3,481.62	$4,375.00
Supplies	$90.00	$1,500.00	$1,590.00	$90.00	$1,500.00
Equipment					
Other					
Contractual					
Total Direct Costs	$3,571.62	$5,875.00	$9,446.62	$3,571.62	$5,875.00
Authorized Indirect Costs *(10% of Salaries and Wages)*	$0.00	$0.00	$0.00	$0.00	$0.00
Total Costs	**$3,571.62**	**$5,875.00**	**$9,446.62**	**$3,571.62**	**$5,875.00**

**Expenses as of February 2021*

Project Management

Project Management funds in FY 2018-2019 were expended on salaries, fringe benefits, and required materials and supplies for the AQRP Program Managers and QAPP reviewer. At the close of the FY 2018-2019 Project Management accounts on 02/29/20, $32,446.01 remained to be carried forward into FY 2020-2021 project research Contractual funds. Project management will be utilized in the same manner in FY 2020-2021. Total Program Management expenses for FY 2020-2021 to date are listed in the table below.

Table 5: Project Management Budgets

Project Management Budget
FY 2018-2019

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
Travel					
Supplies	$142.50	$1,000.00	$1,142.50	$142.50	$1,000.00
Equipment					
Other	$1,861.28	$1,718.00	$3,579.28	$0.00	$3,579.28
Contractual					
Total Direct Costs	$50,721.99	$49,912.00	$100,633.99	$70,207.77	$30,426.22
Authorized Indirect Costs	$3,778.01	$3,806.00	$7,584.01	$5,564.22	$2,019.79
10% of Salaries and Wages					
Total Costs	**$54,500.00**	**$53,718.00**	**$108,218.00**	**$75,771.99**	**$32,446.01**

**Expenses as of August 2020*

Project Management
FY 2020-2021

Budget Category	FY20 Budget	FY21 Budget	Total Budget	Expenses*	Remaining Balance
Personnel/Salary	$36,480.69	$36,480.69	$72,961.38	$36,573.15	$36,388.23
Fringe Benefits	$10,871.25	$10,871.25	$21,742.50	$10,960.83	$10,781.67
Travel					
Supplies	$1,000.00	$1,000.00	$2,000.00	$1,283.40	$716.60
Equipment					
Other	$2,490.07	$2,500.00	$4,990.07	$0.00	$4,990.07
Contractual					
Total Direct Costs	$50,842.01	$50,851.94	$101,693.95	$48,817.38	$52,876.57
Authorized Indirect Costs *(10% of Salaries and Wages)*	$3,648.06	$3,648.06	$7,296.12	$3,657.35	$3,638.77
Total Costs	**$54,490.07**	**$54,500.00**	**$108,990.07**	**$52,474.73**	**$56,515.34**

**Expenses as of February 2021*

Research Projects

In FY 2018-2019, there were eight projects requesting $1,223,541.60 in funding, that were selected out of forty (40) proposals submitted to the AQRP RFP for the biennium. Table 6 on the following page shows the distribution of the projects across the fiscal years for FY 2018-2019. Funds remaining to be spent in the Contractual budget form FY 2018-2019 have been approved by the TCEQ to carry forward into FY 2020-2021 Contractual funding.

Projects for FY 2020-2021 have been selected. Nine projects were selected for funding and are having Work Plans, QAPP, and Budgets reviewed by Project Managers, the TCEQ, and the UT AQRP Program Manager. Table 6 on the following page shows the distribution of FY 2020-2021 projects across fiscal years.

The FY 2018 – 2019 budget allocated $1,223,000.00 for research projects ($750,000 per fiscal year). After all FY 2016 – 2017 research projects and program activities were complete, $7,559.39 in FY 2017 funds remained ($1,558,35 in Research/Contractual and $6,001.04 in Project Management). These funds were all transferred to the Research/Contractual category, and then assigned to partially fund project 19-023. These funds were expended first, so that all FY 2017 funds will be spent by Spring of 2019. That left a shortage of $541.61 in Research/Contractual funding. In order to fully fund all research projects, $782 will be transferred from the FY 2019 ITAC funds to the FY 2019 Research/Contractual category. Even though the total shortfall is $542, the FY 2018 projects do not use all of the funds allocated to them. The AQRP is not permitted to move funds between fiscal years. Therefore, the FY 2019 shortfall is $782.

The AQRP has submitted to the TCEQ that the final approved FY 2018-2019 invoices will result in $15,626.90 of research contractual funds to be carried forward into the FY 2020-2021 biennium contractual funding. Table 6 and Appendix B reflect actual invoiced amounts that have been approved and paid from AQRP FY 2018-2019.

The FY 2020-2021 budget allocates $1,253,250.00 for research projects ($753,125 per fiscal year, which includes a $3,125 per fiscal year of reallocated ITAC funds that will not be utilized on travel expenses due to COVID-19 travel restrictions). The reallocation of ITAC budget funds was approved by the TCEQ in August 2020. Personal Protective Equipment (PPE) additional funding was awarded to Project 20-003 in the amount of $2,300.00. No other sub-awardees requested PPE funding. Remaining Contractual funds may be distributed in the subsequent quarters to projects requesting amendments due to unavoidable COVID-19 delays. All Contractual budget reallocations will receive review by the Advisory Council, ITAC, and TCEQ prior to approval.

Table 6: FY 2018-2019 and FY 2020-2021 Contractual/Research Project Budgets

FY 2018-2019 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 2020-2021 Contractual Budget

FY18-19 Contractual Funds Carry Forward		**$61,389.51**		
FY 20 Contractual Funding		**$611,500.00**		
FY 20 Contractual Funding Transfers		**$5,438.31**		
FY 20 Total Contractual Funding		**$678,327.82**		
Project Number	**Institution**	**Amount Awarded**	**Cumulative Expenditures**	**Remaining Balance**
20-003	Rice University	$70,961.00	$18,542.66	$52,418.34
20-003	Rice University (PPE)	$2,300.00	$0.00	$2,300.00
20-003	University of Houston	$115,668.00	$48,858.06	$66,809.94
20-003	Baylor University	$99,798.00	$0.00	$99,798.00
20-004	University of Houston	$63,294.47	$63,294.47	$0.00
20-004	St. Edward's University	$31,109.35	$29,655.65	$1,453.70
20-005	AER	$173,692.00	$124,572.80	$49,119.20
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.	$12,989.00	$0.00	$12,989.00
20-011	Ramboll	$28,403.75	$28,403.75	$0.00
20-020	University of Wisconsin-Madison	$26,785.71	$26,478.07	$307.64
20-020	Ramboll	$20,928.65	$20,928.65	$0.00
20-028	Drexel University	$17,842.15	$5,092.30	$12,749.85
FY 20 Total Contractual Funding Awarded		$678,327.82		
FY 20 Contractual Funds Expended (Init. Projects)			$380,382.15	
FY 20 Contractual Funds Remaining to be Spent				$297,945.67
FY19 Contractual Funding Carry Forward		**$0.00**		
FY 21 Contractual Funding		**$611,500.00**		
FY 21 Contractual Funding Transfers		**$3,125.00**		
FY 21 Total Contractual Funding		**$614,625.00**		
Project Number	**Institution**	**Amount Awarded**	**Cumulative Expenditures**	**Remaining Balance**
20-004	University of Houston	$118,199.53	$28,391.15	$89,808.38
20-004	St. Edward's University	$37,150.65	$0.00	$37,150.65
20-007	Ramboll	$43,965.32	$18,639.15	$25,326.17
20-007	Wildland Solutions	$11,478.94	$10,815.94	$663.00
20-011	Ramboll	$85,211.25	$19,434.88	$65,776.37
20-020	University of Wisconsin-Madison	$98,214.29	$3,161.76	$95,052.53
20-020	Ramboll	$76,748.35	$49,500.47	$27,247.88
20-026	Texas A&M University	$98,427.00	$35,825.86	$62,601.14
20-028	Drexel University	$53,526.45	$0.00	$53,526.45
FY 21 Total Contractual Funding Awarded		$622,921.78		
FY 21 Contractual Funds Expended (Init. Projects)			$165,769.21	
FY 21 Contractual Funds Remaining to be Spent				$448,855.79
Total Contractual Funding		$1,292,952.82		
Total Contractual Funding Awarded		$1,301,249.60		
Total Contractual Funding Remaining to be Awarded		-$8,296.78	*	
Total Contractual Funds Expended to Date			$546,151.36	
Total Contractual Funds Remaining to be Spent				$746,801.46

**Pending Transfer of unused ITAC and AQRP Supplies budget will be added to Contractual Funding; Currently in-progress*

Appendix A
FY 2020-2021 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 PM2.5 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

Appendix B
FY 2018-2019 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**