AIR QUALITY RESEARCH PROGRAM

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

Quarterly Report

March 1, 2021 – May 31, 2021

Submitted to

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Texas Air Quality Research Program

Quarterly Report

March 1, 2021 – May 31, 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 QUARTER

Between March 1, 2021 and May 31, 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 20-028 (Drexel), 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.

In March 2021, project 20-028 (Drexel University) conducted discussions with the AQRP regarding contract end-date occurring prior to field work being completed due to unavoidable travel and COVID-19 vaccination restrictions that Drexel University enforced due to COVID-19 health and safety internal policy. As a result, the Drexel University research team was unable to conduct travel to Texas to fulfill field research data collection. Project 20-028 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. The Amendment No. 1 to terminate the project as of 03/15/2021 was fully executed by Drexel University and The University of Texas at Austin on May 7, 2021.

In March 2021, project 20-003 (Baylor University) requested to deploy two (2) additional sample collection devices to collect additional data used in the project's overall findings. The deployment request did not require additional funds or modify the original Statement of Work. The request was approved by the AQRP Project Manager, Vincent Torres. The request did not require additional approvals from the ITAC or Council as no budget or Scope of Work modifications were needed.

In May 2021, project 20-003 (Baylor University) requested to rebudget $14,714 of previously approved Salaries and Fringes into Travel and Supplies. Due to an internal COVID-19 related

salary support policy implemented at Baylor University, the rebudgetted amount was credited back to the project account. The recouped salary and fringe funds were approved to be rebudgetted into Travel and Supplies by the Project Manager, Vincent Torres, and the AQRP Program Manager, RoseAnna Goewey, on May 6, 2021. No other COVID-19 related budget revisions were requested during this period.

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.

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.

Program activities in the next quarter will focus on 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 is focusing 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 #2, campaign performance. The Mobile Air Quality Laboratory 2 (MAQL2) was deployed to a coastal area near Corpus Christi on April 1, 2021. Stationary ambient sampling for all instruments was initiated by April 2, 2021. This stationary sampling continued through April 14, 2021. For the next seven-day period (April 15- 21, 2021), mobile sampling was performed downwind of Corpus Christi (toward

San Antonio), except on days when it rained sufficiently hard to make it less safe and less fruitful to drive.

Mobile sampling (avoiding freeways to the extent possible) occurred during the day, and the MAQL2 returned to the stationary location overnight. On April 22, the MAQL2 transitioned to San Antonio. From April 23-28, 2021, the MAQL2 sampled upwind of San Antonio (toward Corpus Christi). On April 29 and 30, 2021, the MAQL2 sampled in stationary mode near San Antonio. During this period, all instruments were maintained, zeroed, and calibrated as appropriate and as needed.

Additional work was performed for Task #3, data analysis. These analyses were focused on generation of first-pass time series to check instrumentation operation and perform initial comparison between observations. These data have not undergone rigorous QA/QC.

Task #3 also 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.

Identified Issues: As referenced in prior reports, delays in finalizing task orders and issues associated with the COVID 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. 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 worked 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 again worked hard to make up for that lost time. Baylor also experienced delays in receiving equipment and supplies: the most noticeable was the tower (3 weeks delay), TAPs (2 weeks delay), and PTR-MS heated sampling line (3 weeks delay). These delays were a result of COVID-related logistical hurdles (personnel communication with vendors). The team members worked extremely hard to be ready to deploy to the field as of April 1, which was done successfully.

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, initial modeling runs on April and May 2021 time periods.

Field: Finish field deployment and collection of data as of May 19, including post-campaign calibrations as needed. Begin more in-depth data analysis (QA/QC, initial time series, etc.).

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 field testing of the two packages a top of Moody Tower until 4/12/21. Both systems where then taken to our lab to fine-tune them and to wait for the delivery of the NO_2 photocells so they can be installed.
- Installed and tested GSPs with sampling systems.
- Placed order of an additional Vaisala Ceilometer. This ceilometer will be installed on the UH pontoon boat and used for measuring the height of the boundary layer over Galveston Bay.
- On April 19, the pontoon boat was deployed into Galveston Bay for a test of the handling characteristics and measurement systems as well as to begin training the graduate students who will pilot the boat on a regular basis. See figures 20-004-1–5 below.

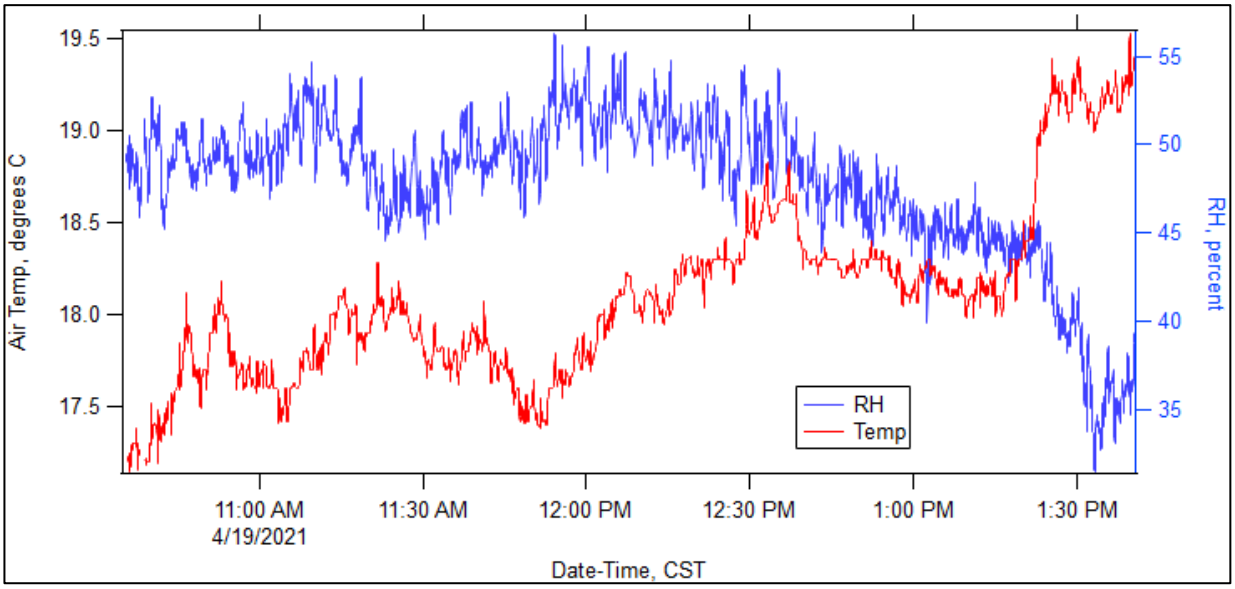

Figure 20-004-1: Time series of measured air temperature and relative humidity.

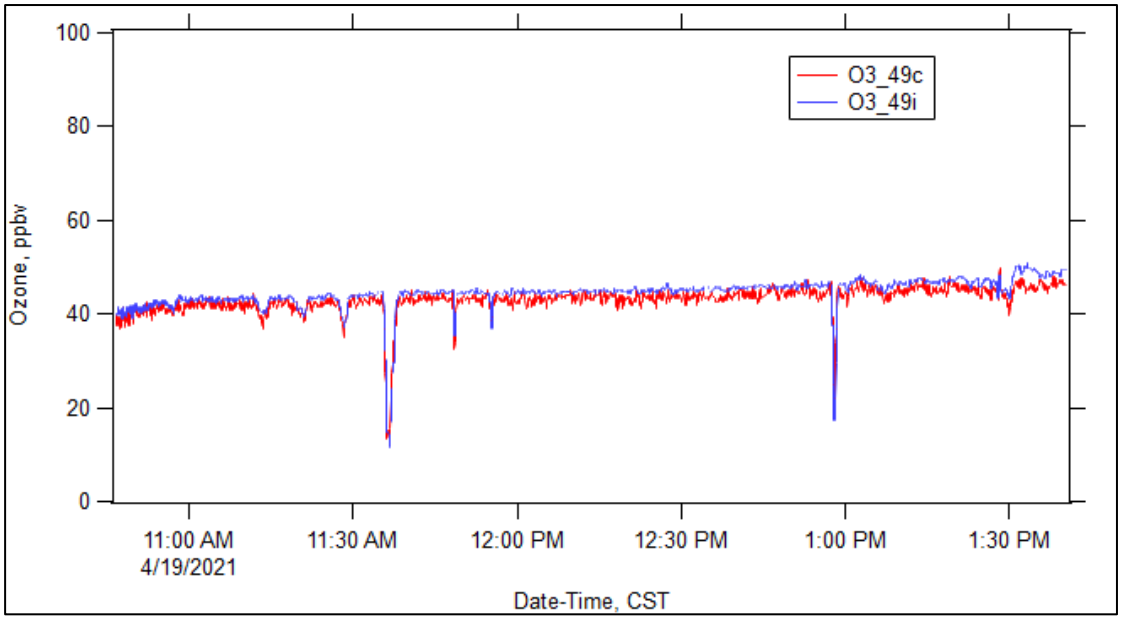

Figure 20-004-2: Time series of O3 from a Thermo 49c and 49i. The 49i will be used for the NO_2 measurement once the NO_2 photocell is installed.

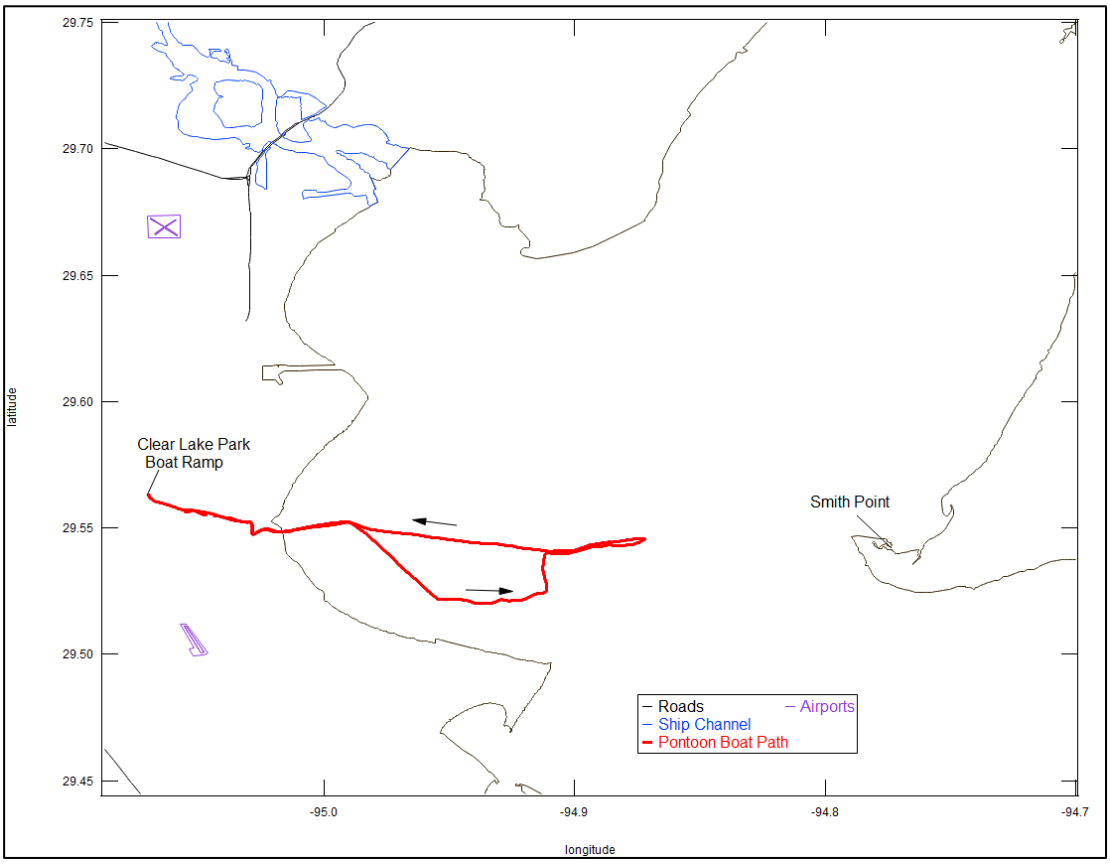

Figure 20-004-3: Spatial plot showing the course of the pontoon boat during 4/19/21 test. The crew practiced anchoring while in the center of the bay.

Figure 20-004-4: During ship channel crossing on 4/19/201.

Figure 20-004-5: During ship channel crossing on 4/19/201.

Identified Issues: Delivery of the photocells have been delayed due to winter weather in Colorado as well as COVID impacts on material providers. We have been in regular contact with the manufacturer and receiving updated delivery estimates.

Goals for the Succeeding Period:

- Receive and test new ceilometer. Install Vaisala license in package computer.
- Receive, install, and test NO_2 photocells in sampling packages.
- Begin operational measurement by the end of May.

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 began drafting the Final Report and finalizing associated deliverables. We also began work on Task 3, where we examine how well the surface PM2.5 impacts of smoke in Texas can be constrained using current remote sensing products. For reference, Figure 20-005-1 displays the 2020 annual average of PM2.5 using daily PM2.5 data from EPA's AirNow portal (https://www.epa.gov/outdoor-air-quality-data/download-daily-data). Daily measurements from the EPA AirNow portal will be used in conjunction with the data subset from Tasks 1 and 2 to derive PM2.5-AOD relationships at each station. The derived relation will then be applied to the data subset as a whole (i.e., where GOES AOD measurements are available). We will compare our findings with a recent paper by Zhang and Kondragunta (2021), which demonstrates a proof-of-concept for a near-real-time NOAA algorithm for surface PM2.5 estimates over CONUS. Zhang and Kondragunta (2021) emphasize the importance of dynamic PM2.5-AOD relationships in realistic air quality assessments rather than using traditional algorithms that rely on simplistic climatological PM2.5-AOD regression relationships. Figure 20-005-2 displays PM2.5 for an example study date (17 April 2020) along with relevant data from Tasks 1 and 2. Of note, observations indicate high PM2.5 air quality advisory in Southern Texas. Matching this up with our data analysis for the same day, we can see that our Smoke Confidence Index is "Low" for this region. However, while the three smoke products (HMS, GOES, UVAI) do not overlap in time at the southern Texas location (leading to the Low SCI), they all consistently suggest smoke presence at various times in the day. In other words, there is spatial correlation rather than temporal correlation suggesting that future versions of the SCI could be updated to reflect spatial ***and/or*** temporal overlap rather than simply spatial ***and*** temporal

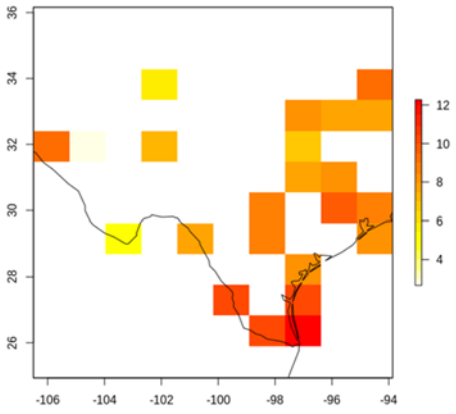

Figure 20-005-6: 2020 Annual Average PM2.5 derived from daily measurements at TCEQ/EPA Air Now monitoring stations. Units are mg/m^3.

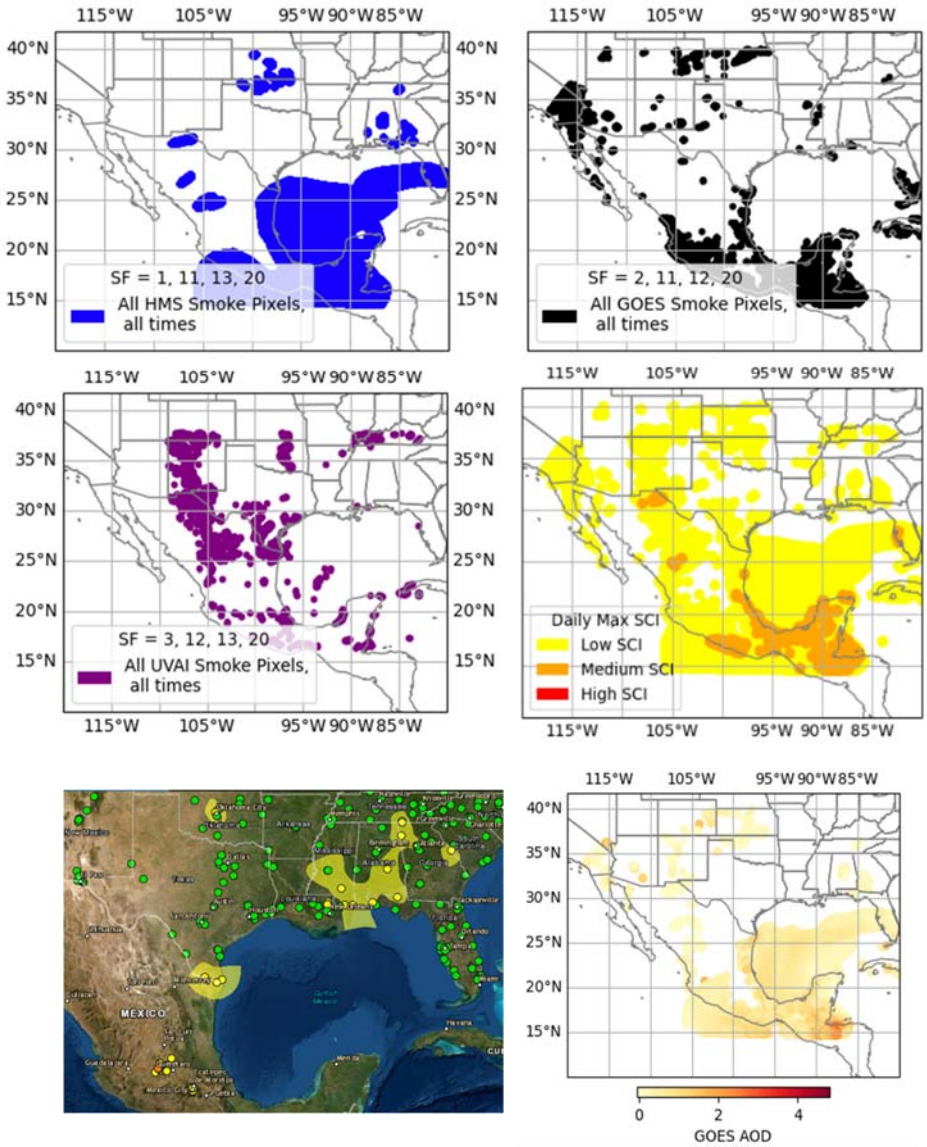

Figure 20-005-7. Synthesis of findings thus far using 17 April 2020 as an example date. Rows 1 and 2 provide smoke data from HMS, GOES, and TROPOMI UVAI along with the Smoke Confidence Index of spatiotemporal overlap. The last row (first column) displays PM2.5 Air Quality from the EPA AirNow interactive map; yellow indicates Moderate PM2.5 Air Quality advisories. The last row (second column) displays available GOES AOD measurements.

Researcher Qiang Sun resigned from AER at the beginning of February.

Data Collected: Daily PM2.5 data for the study period was downloaded from the EPA AirNow portal (https://www.epa.gov/outdoor-air-quality-data/download-daily-data).

Goals for the Succeeding Period: We will provide preliminary PM2.5-AOD regression results at EPA AirNow surface stations. We will include a comparison with findings from Zhang and Kondragunta (2021). The regression results will then be used to derive a PM2.5 variable associated with AOD measurements reported in the Task 1 and 2 data subset.

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 and Surface PM2.5 estimates (Task 2.2, Task 3)
- We have daily PM2.5 data from TCEQ (via EPA AirNow) surface stations.

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.
4. From OMI to TEMPO: Opportunities for enhanced identification of biomass burning using the optical properties of Brown Carbon aerosol, poster presentation at TEMPO June 2021 Science Team 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 worked on updating MEGAN source code to use CAMx meteorological data and add the option of using either monthly, 10 day or 8 day LAI data. We downloaded global LAI data

for 2019 from ESA's Copernicus Global Landcover database and transformed to 8 day LAI data. We also worked on programming new MEGAN emission factor processor approach.

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

Identified Issues: Due to personal reasons, Mr. Chris Geron is unable to work on updating BELD biogenic emissions landcover database. Ramboll and Dr. Guenther will work together to update the BELD landcover database.

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. Continue working on updating the MEGAN EFP and source code.

Project 20-009 **STATUS: ENDED – 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 had been funded by the United Nations 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 CO, CO_2 and NOx.

Figure 20-009-8: 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 ended on 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.

Funds Released to the AQRP: $11,701.87.

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 1: Review Current CAMx WBDUST Estimates

This task was completed in September 2020.

Task 2: Review Alternative Methods and Datasets
Task 2.1 was completed in November 2020.
Task 2.2 was completed in February 2021.

Task 3: Update the WBDUST Model and Evaluate Impacts in CAMx MP
Continued to apply CAMx with the 2016 EPA Modeling Platform to assess windblown dust estimates from the updated WBDUST model. Inert 2-month test runs were completed in April. Work for May involved running CAMx with the final WBDUST configuration in full-chemistry mode, with all emission sectors, and with dust elemental speciation, for the entirety of the 2016 modeling year. We are continuing to evaluate model results from this final run.

Task 4: Project Reporting and Presentation
Developed April MTR and FSR and submitted to AQRP on April 5 and 25, respectively. Continued assembling the project final report including results from Task 3.

Preliminary Analysis: We are continuing to evaluate model results from the full-chemistry model run and will report results in June.

Data Collected: n/a

Goals for the Succeeding Period: Complete analysis of the full-chemistry 2016 annual model run with the final WBDUST configuration. Continue to develop the project final report. No anticipated issues for the succeeding reporting period.

Detailed Analysis of the Progress of the Task Order to Date: This project initiated on July 28 with the execution of the AQRP Task Order. All remaining tasks remain on schedule and budget according to our work plan.

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 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 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: During this reporting period, work was carried out on Tasks 1 - 3.

Task 1: Simulate NO_2 and SO_2 amounts with the high-resolution WRF-CAMx model
The Ramboll modeling team prepared and completed additional CAMx sensitivity simulations, including adding lightning NO_X emissions.

Task 2. Compare model simulations with TROPOMI and near-surface observations
The UW-Madison has completed running WHIPS to grid NASA Standard Product OMI NO_2, as a cross-check between differing satellite instruments and retrievals. CAMx column amounts have been processed with and without the OMI averaging kernel for comparison with emissions data.

The UW-Madison team has been in regular contact with project collaborator Dr. Dan Goldberg to assure methodological consistency in calculating model column amounts for comparison with satellite observations. The UW-Madison team is documenting these different methodologies to provide guidance to the wider air quality modeling community in the use of satellite data for model evaluation, and for inclusion in a paper (not yet started) led by Dr. Dan Goldberg on the inter-comparison of satellite observations of NO_2, NO_X emissions, and the CAMx modeling conducted by Ramboll for this project.

Task 3. Compare satellite data and emissions for power plants and urban areas
The UW-Madison team is continuing work on the comparison of satellite observations of NO_2 with emissions and model column NO_2 amounts in urban areas and at power plant locations.

Preliminary Analysis: n/a

Goals for the Succeeding Period:
Ramboll will prepare and complete a final CAMx simulation that includes lightning NO_X emissions and potentially adjustments to mobile source NO_X emissions.

UW-Madison will add a correction for NO_2 contributions to the model column from lightning in the free troposphere (~3km and above), which were not included in the original CAMx simulations but may be estimated from *Silvern et al.* (2018; https://doi.org/10.1029/2018GL077728). UW-Madison will continue work on the analyses of column NO_2 for the 5 cities and 5 power plants of focus.

The Ramboll and UW-Madison teams, with Dr. Dan Goldberg, have discussed the vertical sensitivity of the TROPOMI retrieval, which the retrieval derives from a global model, and how well it may capture the emission plumes from power plants. We hope this will be clarified as we compare TROPOMI and OMI column amounts and the applications of the differing averaging kernels to the CAMx simulations.

We had planned to expand our analysis to SO_2 to a limited extent as resource and data integrity allow. Our NO_2 analysis has highlighted nuances in satellite retrieval algorithms and in processing model column estimates, and our team has agreed that expanding our analysis to include SO_2 would not be simple, and would require resources and time beyond what is available between now and the end of the grant period. As such, our focus will remain on the analysis of observed and modeled NO_2 with emissions.

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: Continued preparation of the image inputs for GAN training from GOSP outputs. We are generating grayscale figures of cloud fields (cloud fraction, cloud water path, cloud optical depth) outputted from COSP packages. We plan to train the GAN for individual fields as well as RGB-composed field from three variables. Previously, we use machine learning/deep learning tool Tensorflow; however, it turns out that this tool is unstable when sample size is very large because of our machine specs. The training crashes after a few epochs. We are now switching to another ML/DL tool Pytorch. The test cases run smoothly on our machine.

Preliminary Analysis: n/a

Data Collected: Figures of cloud fields from GOSP packages.

Goals for the Succeeding Period: Examining the performance of GAN training and tuning hyper-parameters of GANs including epoch number, learning rates, etc.

Detailed Analysis of the Progress of the Task Order to Date: 100% of Task 1& 2. 40% of Task 3.

Project 20-028 **STATUS: ENDED: 08/07/20-03/15/2021**

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

1. Prepare for the field deployment in San Antonio. This would 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 would occur in Spring 2021. Similar to the 2017 San Antonio Field Study, the Drexel team would deploy its "ECHAMP" sensor that quantifies concentrations of peroxy radicals.
3. Data Quality Assurance. The data from the field deployment would be quality assured and prepared for the subsequent analysis.
4. Preliminary Data Analysis. Using the collected measurements of peroxy radicals and nitric oxide, we would 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 was 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 testing out the peformance of the ECHAMP peroxy radical sensor at reduced pressure. Laboratory tests have shown that the sampling losses of HO_2 through the pressure-reducing orifice are greater than those from propyl peroxy radicals, but are low enough that we are optimistic that the new reduced pressure sampling method will work for the field deployment.

No work has been done on Task #2 (Field Deployment), Task #3 (Data Quality Assurance), or Task #4 (Data Analysis). Work for Task #5 (Project Reporting and Presentation) has focused on deciding whether to continue the project due to the continued lack of vaccination in the PI's research group and Drexel University's travel policy as described below.

Preliminary Analysis: Continued preliminary analysis of the laboratory characterization of ECHAMP at reduced pressure show that the sensitivity of the instrument was, as predicted, much less sensitive to ambient humidity, but the absolute sensitivity does not appear to have changed greatly. At the lowest pressures tested (~250 Torr), the absolute sensitivity decreases in fact. Additionally, use of larger diameter tubes shows superior results. We have begun testing the transmission of HO_2 and other organic peroxy radicals (RO_2) through the new pressure-dropping inlet and found that sampling losses of HO_2 are higher. These losses have been reduced with minor adjustments to the tubing, suggesting that continued adjustments will lead to acceptably low sampling losses.

Data Collected: No field data have been collected, though laboratory data have been collected related to the characterization of the ECHAMP peroxy radical sensor at reduced pressure as described in the "Preliminary Analysis" section.

Identified Issues: As of April 1, 2021, neither graduate student Alexa Rhoads nor PI Ezra Wood have been vaccinated, and Drexel University has not softened its prohibition on non-essential academic travel. As a result the project must be terminated as of March 15, 2021, the date at which no subsequent charges were made to the project.

Goals for the Succeeding Period: The only remaining goals are to continue the termination of the project and all associated reporting issues. The Project officially ended early on March 15, 2021 due to unavoidable COVID-19 related travel restrictions.

Detailed Analysis of the Progress of the Task Order to Date: Tasks 1 and 5 were in progress but have been halted. Tasks 2, 3, and 4 never started.

Funds Released to the AQRP: $57,070.13.

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 2020-2021 (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 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	$75,103.95	$30,159.77
Fringe Benefits	$15,494.82	$12,930.00	$28,424.82	$22,502.61	$5,922.21
Travel					
Supplies	$3,000.00	$3,000.00	$6,000.00	$1,906.07	$4,093.93
Equipment					
Other					
Contractual					
Total Direct Costs	$70,058.54	$69,630.00	$139,688.54	$99,512.63	$40,175.91
Authorized Indirect Costs *(10% of Salaries and Wages)*	$5,156.37	$5,370.00	$10,526.37	$7,510.38	$3,015.99
Total Costs	**$75,214.91**	**$75,000.00**	**$150,214.91**	**$107,023.01**	**$43,191.90**

**Expenses as of May 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.

As of May 2021, with the possibility of a State of Science project, the TCEQ has tentatively approved the use of unused ITAC funds for a possible State of the Science report, if awarded. More details regarding this possible rebudget will be included 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 May 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	$46,238.25	$26,723.13
Fringe Benefits	$10,871.25	$10,871.25	$21,742.50	$13,870.03	$7,872.47
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	$61,391.68	$40,302.27
Authorized Indirect Costs *(10% of Salaries and Wages)*	$3,648.06	$3,648.06	$7,296.12	$4,623.83	$2,672.29
Total Costs	**$54,490.07**	**$54,500.00**	**$108,990.07**	**$66,015.51**	**$42,974.56**

**Expenses as of May 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. 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. Residual FY 18-19 funds from 18-023 and 18-022 totaling $14.31, were discovered as not being fully carried forward. The $14.31 will be carried forward into FY 2020 Contractual funds in the subsequent quarter.

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 2020-2021 budget allocates $1,292,952.82 for research projects ($678,327.82 in FY 2020 and $614,625.00 in FY 2021, which includes $8,563.31 of reallocated ITAC and Other Supplies funds that will not be 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 are a result of COVID-19 related delays and cancellations may be distributed in the subsequent quarters to projects requesting amendments and a possible State of the Science report. All Contractual budget reallocations will receive review by the Advisory Council, ITAC, and TCEQ prior to approval.

Project 20-2004 (University of Houston) was awarded two additional increments of funding, for $13,000 and $35,000 that was distributed from unused Contractual funds due to COVID-19 related project delays, delayed travel, and early cancellation of projects. During this quarter, the internal UT transfer from the Research Holding account were processed to formalize the increased budget to the University of Houston's 20-004 subaward account number. University of Houston's total budget for Project 20-004 is $181,494.00.

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

FY 18-19 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	$34,617.29	$36,343.71
20-003	Rice University (PPE)	$2,300.00	$320.54	$1,979.46
20-003	University of Houston	$115,668.00	$48,858.06	$66,809.94
20-003	Baylor University	$99,798.00	$3,050.38	$96,747.62
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	$123,085.74	$50,606.26
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)			$409,141.98	
FY 20 Contractual Funds Remaining to be Spent				$269,185.84
FY 18-19 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	$29,581.16	$88,618.37
20-004	St. Edward's University	$37,150.65	$0.00	$37,150.65
20-007	Ramboll	$43,965.32	$28,502.53	$15,462.79
20-007	Wildland Solutions	$11,478.94	$10,815.94	$663.00
20-011	Ramboll	$85,211.25	$54,925.63	$30,285.62
20-020	University of Wisconsin-Madison	$98,214.29	$14,529.01	$83,685.28
20-020	Ramboll	$76,748.35	$65,874.41	$10,873.94
20-026	Texas A&M University	$98,427.00	$48,300.39	$50,126.61
20-028	Drexel University	$0.00	$0.00	$0.00
FY 21 Total Contractual Funding Awarded		$569,395.33		
FY 21 Contractual Funds Expended (Init. Projects)			$252,529.07	
FY 21 Contractual Funds Remaining to be Spent				$362,095.93
Total Contractual Funding		$1,292,952.82		
Total Contractual Funding Awarded		$1,232,478.00		
Total Contractual Funding Remaining to be Awarded		$60,474.82	*	
Total Contractual Funds Expended to Date			$661,671.05	
Total Contractual Funds Remaining to be Spent				$631,281.77

**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**