AIR QUALITY RESEARCH PROGRAM

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

Quarterly Report

September 1, 2020 – November 30, 2020

Submitted to

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Texas Air Quality Research Program

Quarterly Report

September 1, 2020 – November 30, 2020

OVERVIEW

The goals of the State of Texas Air Quality Research Program (AQRP) are:

(i) to support scientific research related to Texas air quality, in the areas of emissions inventory development, atmospheric chemistry, meteorology and air quality modeling,

(ii) to integrate AQRP research with the work of other organizations, and

(iii) to communicate the results of AQRP research to air quality decision-makers and stakeholders.

PROGRAM ACTIVITIES FOR THE YEAR

Between September 1, 2020 and November 30, 2020, the AQRP Project Administration efforts focused primarily on individual project audits of Financial Status Reports (FSR), internal UT account audits and monthly FSR preparations, Project Management Monthly Technical Report (MTR) reviews and discussions, completion of transfer of FY18-19 Carry Forward funds from both Administration and Contractual funds into FY 2020 UT funds, coordinating project amendments, Annual (Sept. 2019-Aug. 2020) and Quarterly (Sept. 2020-Nov. 2020) AQRP Reports, and determining the status of budget updates due to COVID-19 related travel restrictions and delays.

Due to COVID-19 travel restrictions, the TCEQ recommended that the AQRP allow Principal Investigators (PIs) to re-budget any travel funds 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. As of November 30, 2020, no projects have requested to re-budget their travel funds. The Project Managers will continue to work with PIs through December 2020 and January 2021 to evaluate travel budget modification requests. Any projects that re-budget travel funds will be noted in subsequent quarterly reports.

The AQRP Workshop, which was originally planned to be held in Austin, TX in August 2021, will now be conducted entirely virtually due to COVID-19 travel and health related concerns. All project PIs were notified of this change on November 6, 2020 via email from their assigned Project Manager at UT Austin.

Two projects in the 2020-2021 fiscal year (20-003 and 20-004) conducted discussions with the AQRP regarding contract amendments to approve modifications to their Scope of Work (SoW), Quality Assurance Project Plan (QAPP), and Budget to reflect changes that were unavoidable due to COVID-19 related delays:

> Project 20-003 (Lead PI: Robert Griffin, Institution: Rice University, "Characterization of Corpus Christi and San Antonio Air Quality During the 2020 Ozone Season") fully executed a Task Order amendment on November 1, 2020 that will modify the timeline of the project. Due to COVID-19 related delays, the researchers requested to conduct their field work in Spring 2021, instead of the originally approved Summer 2020. The AQRP Advisory Council, ITAC, and TCEQ provided feedback regarding the requested timeline modification; no objections were presented. The amended Task Order includes an updated SoW and QAPP for all entities in the project (Rice University, Baylor University, and the University of Houston). The updated SoW and QAPP are expected to be updated to the AQRP website in December 2020.
>
> Project 20-004 (Lead PI: James Flynn, Institution: University of Houston, "Galveston Offshore Ozone Observation (GO3)") began discussions of an amendment for an alternate schedule, due to travel delays caused by COVID-19, as well as a budget increase adjustment to incorporate modified data collection and analysis. The budget increase amount is $13,000 which includes the cost of additional instrumentation, personnel effort, and Indirect Costs. By November 6, 2020, the revised SoW and Budget increase were approved by the Independent Technical Council (ITAC) and the Advisory Council. As of November 30, 2020, UT is awaiting the revised SoW, QAPP, and Budget/Budget Justification documents from Dr. Flynn. A Task Order amendment will be issued by UT when all pending documents are received and approved by the AQRP QAPP reviewer and the TCEQ. Additional information regarding this pending amendment will be included in subsequent quarterly reports. Budget updates will also be reflected in the project's Research Project section and Appendix A of subsequent reports.

A full list of the funded projects for FY 2020-2021 is provided in Appendix A, as well as the projects selected for funding if the initially approved projects could not be performed (contingency projects). A full list of all proposals submitted to the AQRP FY 2020-2021 biennium Request for Proposals is provided in Appendix B. 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 August 2021 at UT Austin. Approval was granted by the TCEQ to extend the Quarterly Report deadline to December 17, 2020 to accommodate a shifted financial closure time-period that UT Austin has adopted during the implemented work-from-home period. 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.

COVID-19 related delays caused research contractual processing delays to subawards, UT Austin financial deadline adjustments, PPE budget adjustment requests, and travel delays that resulted in Task Order amendments for modified timelines and/or budgets, as described above, for projects 20-003 and 20-004.

Program activities in the following quarter will focus on completing the Task Order amendment for Project 20-004, 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 and conducting the AQRP Workshop virtually, 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.

Independent Technical Advisory Committee (ITAC)

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

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

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

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

Table 1. Independent Technical Advisory Committee Members

Name	Title	Organization
David Allen	Gertz Regents Professor in Chemical Engineering, Professor and Director, AQRP	The University of Texas at Austin
William Carter	Emeritus Research Chemist, Center for Environmental Research and Technology	University of California Riverside
Don Collins	Professor, Department of Chemical and Environmental Engineering	University of California Riverside
James Crawford	Research Scientist, Chemistry & Dynamics Science Directorate	NASA
Joost de Gouw	Professor, Cooperative Institute for Research in Environmental Sciences (CIRES) /Dept of Chemistry	University of Colorado
Robert Griffin	Professor, Civil and Environmental Engineering	Rice University
Tho Ching (Thomas) Ho	Aldredge Endowed Chair, Regent's Professor and Chair, Dan F. Smith Department of Chemical Engineering; Director, Texas Air Research Center	Lamar University
Golam Sarwar	Research Scientist	EPA ORD
Stephanie Shirley	Senior Technical Specialist	Texas Commission on Environmental Quality (TCEQ)
Christine Wiedinmyer	Associate Director for Science, Cooperative Institute for Research in Environmental Sciences (CIRES)	University of Colorado
Greg Yarwood	Principal	Ramboll

TCEQ Relevancy Review

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

Advisory Council

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

Table 2. Advisory Council Members

Name	Title	Organization
Daniel Baker	Senior Consultant in Air Quality	Shell Global Solutions
Laurie Barker	Special Council	Texas Commission on Environmental Quality (TCEQ)
Chris Klaus	Senior Program Manager	North Central Texas Council on Governments
Ralph Marquez	Proprietor	Environmental Strategies and Policy
Chris Rabideau	Environmental Scientist	Chevron
Cyrus Reed	Conservation Director	Sierra Club
Chris Owen	Senior Technical Specialist	Texas Commission on Environmental Quality (TCEQ)

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 in this period was related to Task #1, campaign preparation.

The team has continued training of new graduate students and research staff and preparation of instrumentation and the mobile air quality laboratory. Specifically, the Baylor team has begun planning for the required mobile facility suspension retrofit. All instruments continue to undergo checks, maintenance and calibration. The Rice team has begun collection of a test data set outside their laboratory in Houston to allow new staff to learn data analysis procedures.

Task #1 effort also included returning the "MAQL2" to Waco from the field to allow its preparation for the planned spring 2021 campaign. This included reconfiguring the floor plan to accommodate all instrumentation (while taking input from multiple investigators into account), updated plans for air conditioning, inlets, and power, and worked with tower vendors to develop a plan for improved stationary measurements. Purchased supplies for these efforts have begun. With regard to specific instrumentation, the cooler unit for the proton-transfer-reaction mass spectrometer needed to be replaced, so a new one has been purchased. For the aerosol mass spectrometer, evaluation of the 'servo' which blocks the sample beam to allow particle sizing and a baseline measurement is underway after tests indicated that it likely needs to be replaced, and a new computer is expected to arrive in December. Other gas-phase instruments have begun to be placed into racks for deployment into the MAQL2 early in 2021. Shock mounting for these racks was constructed. Training of staff and graduate students on all of these instruments continues. In addition, the team secured recreational vehicle spaces for the MAQL near Corpus Christi and San Antonio, and housing for team scientists was reserved in both cities, for the duration of the campaign.

Additional work was performed for Task #3, data analysis, which includes three-dimensional modeling. This includes implementing use 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. The University of Houston modeling team set up the WRF-GC model at a 9 km x 9 km resolution (**Figure 20-003-1**) that will serve as the outmost model domain and provide boundary conditions for the planned 1 km x 1 km resolution simulation over the field campaign region (e.g., Corpus Christi). Model physics options tested in this reporting period are listed in **Table 20-003-1**.

Figure 20-003- 1. The outmost WRF-GC modeling domain at 9 km x 9 km.

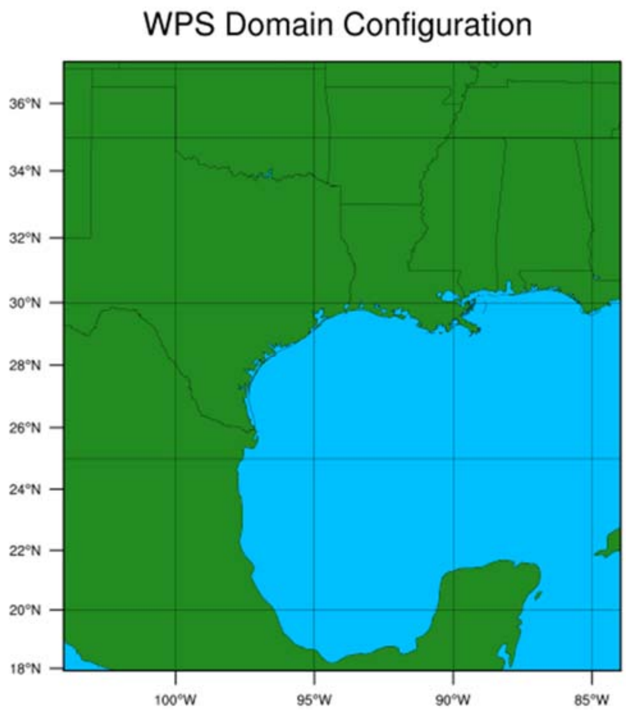


Table 20-003-1. WRF-GC configuration tested in this reporting period.

Configuration	Setting	Scheme
PBL scheme	bl_pbl_physics = 1	YSU
Surface layer	sf_sfclay_physics = 1	Monin-Obukhov Similarity
Land surface	sf_surface_physics = 4	Noah-MP (Multi-physics) Land Surface Model
Microphysics	mp_physics = 10	Morrison 2-moment
Shortwave radiation	ra_sw_physics = 4	RRTMG
Longwave radiation	ra_lw_physics = 4	RRTMG
Cumulus parametrization	cu_physics = 16	New Tiedtke
Initial & boundary conditions	MOZART	
Resolution	9km * 9 km	
Model version	Alpha	

Initial and boundary conditions (IC/BC) for the outmost WRF-GC domain can be provided by the MOZART global model (default) or the GEOS-Chem global model. We used the default MOZART boundary conditions in this reporting period. **Figure 20-003-2** shows hourly results of surface ozone of April 27, 2017 simulated by WRF-GC after a 2-day spin-up (April 25 and 26, 2017). 2017 is the latest year of available MOZART boundary conditions. The simulation day was randomly chosen. We were surprised by high ozone over the Gulf of Mexico predicted by the model. Upon checking, we found the high ozone originated from the MOZART IC/BC conditions. We suspect the high ozone in the MOZART model was caused by Central American fire emissions, which peak in April and May each year. We will test GEOS-Chem boundary conditions in the next reporting period and check whether the high ozone is model dependent.

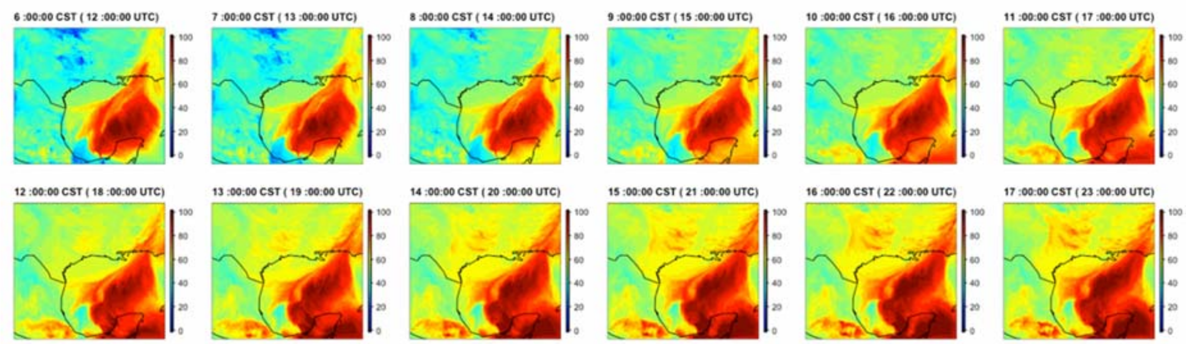


Figure 20-003-2. Hourly model outputs of surface ozone on April 27, 2017.

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

Field Goals: Continue preparation of mobile air quality laboratory, continue assessment of equipment maintenance needs, continue training of researchers on equipment usage (including generation of HR-ToF-AMS test data for training), and continue assessment of locations for deployment (in light of the new statement of work) and travel planning.

Identified Issues: 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.

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 – 07/17/20-08/31/21**

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

Funded Amount: $201,754.00 *[Pending additional $13,000 to U of Houston budget]*
(U of Houston: $133,494.00; St. Ed'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 NO2 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 one of the vessels to measure boundary layer height over the water, 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:
During this period, the team had an online meeting with AQRP, TCEQ, and project teams to discuss changes to deployment timeline and scope of work. Research teams received reupholstered seat cushions and reinstalled them on the pontoon boat. Researchers tested communication between navigation chart plotter and VHF communication radio to display commercial ship location and movement for pontoon boat safety. Secured indoor storage location for the UH pontoon boat to preserve the investment that has been made so that it can more easily be available for future research projects was secured. The UH team began taking online boater safety courses. Researchers finished fabrication on package for Gulf of Mexico boat and delivered it to UH for programming and lab testing. Work with Larry Willis on liability issues for installing research equipment on his shrimp boat for Galveston Bay measurements took place. PIs discussed with Larry Willis about delaying measurements into 2021 and confirmed he was still available and willing to work with us. Researchers received CL-51 ceilometer for installation on Larry Willis's shrimp boat.

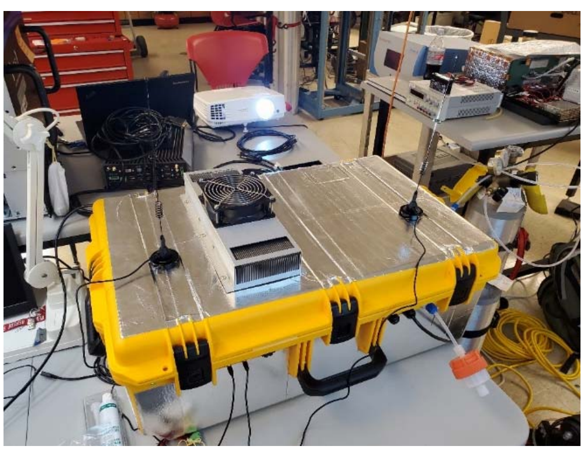



Figure 20-004-1. Offshore sampling package closed with cellular antennas on lid (left). Sampling package lid opened during testing at UH (right).

The team worked with AQRP, TCEQ and project team to discuss implications of adding a NO_2 photocell to the sampling packages. Teams began testing the pontoon boat on a local lake to gain experience with handling and operation prior to beginning tests of science operations. The galvanized trailer on the Pontoon boat was switched. The UH team continued taking online boater safety courses. Teams sent a partially executed liability waiver to Larry Willis for execution before installing research equipment on his shrimp boat for Galveston Bay measurements. The PIs coordinated the new deployment schedule with Ryan Marine Services for operations in the Gulf of Mexico.

Data Collected: Lab testing of the first system showed expected performance. The ozone monitor calibrated with a sensitivity near 1 ppb and the charcoal zero filter also worked well and was consistent with zero air challenges.

Initial field test of the first instrument package was conducted between October 10 and 17 at the Moody Tower. The system was placed on the roof deck of a lab trailer ~7-8 m from the main sample inlet and about 4 m lower. The sampling system, mast with weather sensor, filter, and rain guard can be seen in the photo below. Time series data are also presented below.

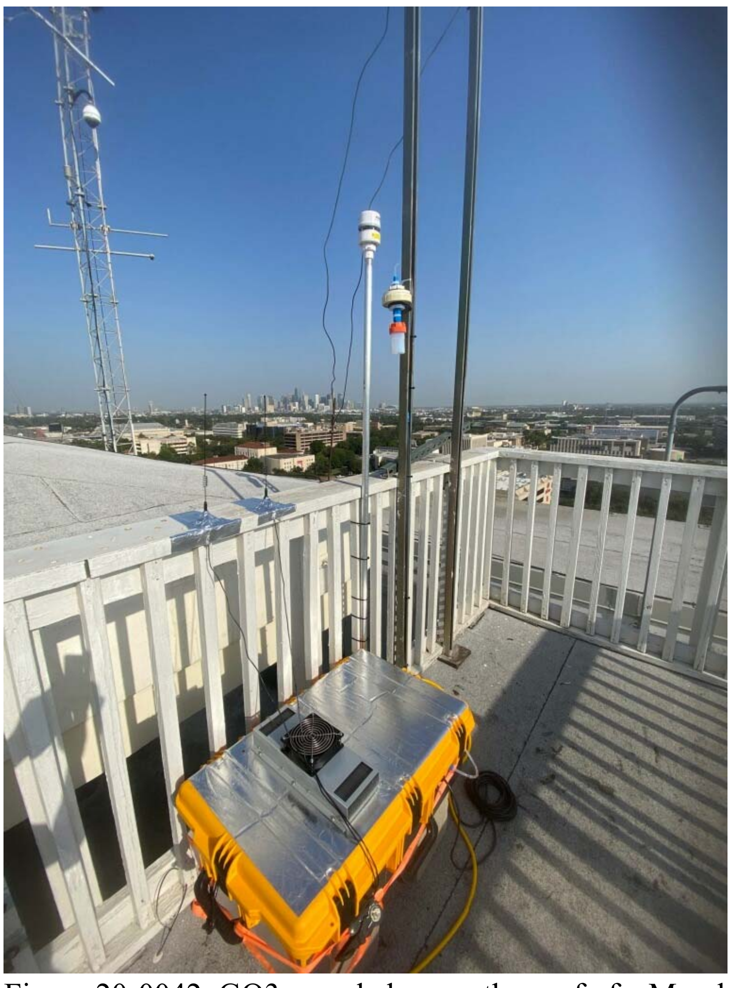


Figure 20-0042. GO3 sample box on the roof of a Moody Tower lab trailer with met sensor and inlet. The main Moody Tower (C695) sample mast is in the background where O_3 and met parameters are measured for C695.

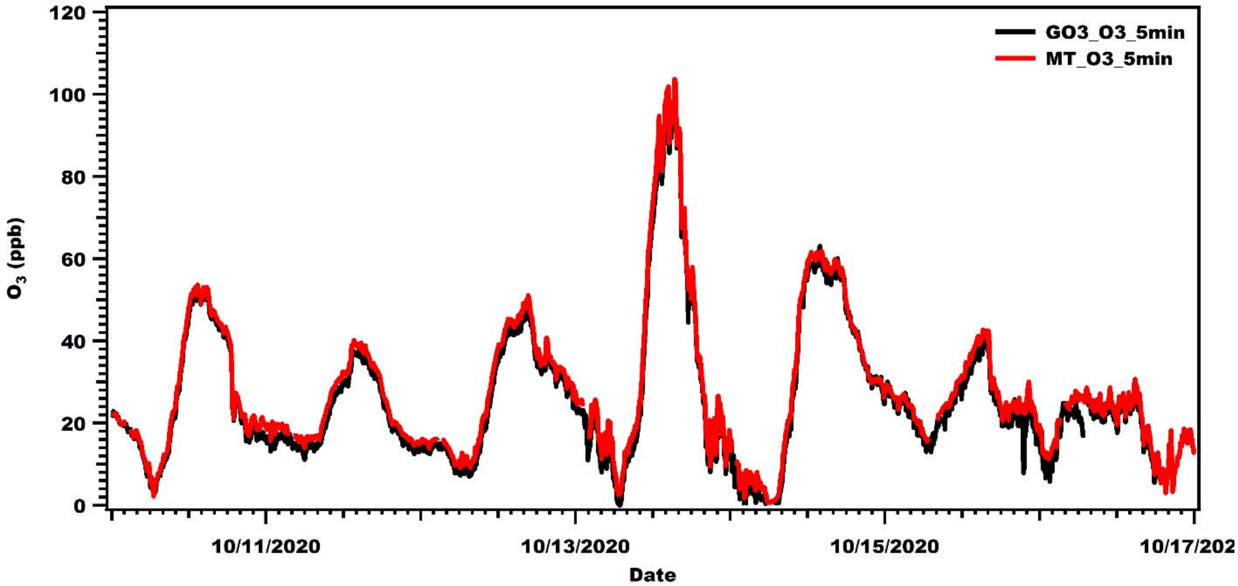


Figure 20-004-3. Time series of O_3 from the GO3 and Moody Tower systems.

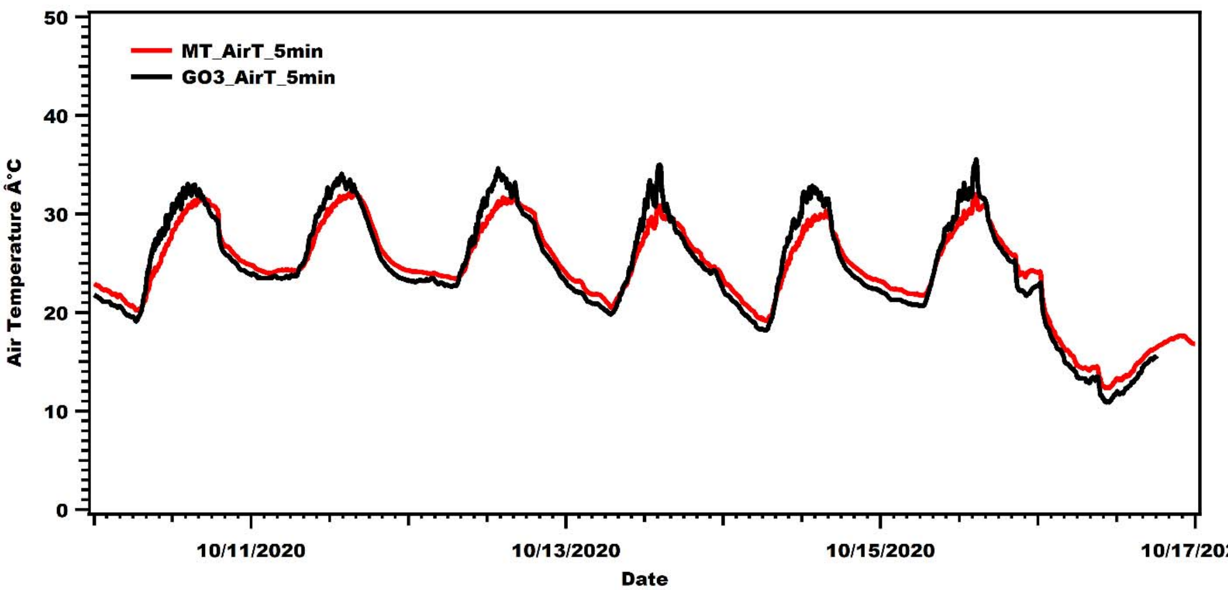


Figure 20-004-4. Time series of air temperature from the GO3 and Moody Tower systems.

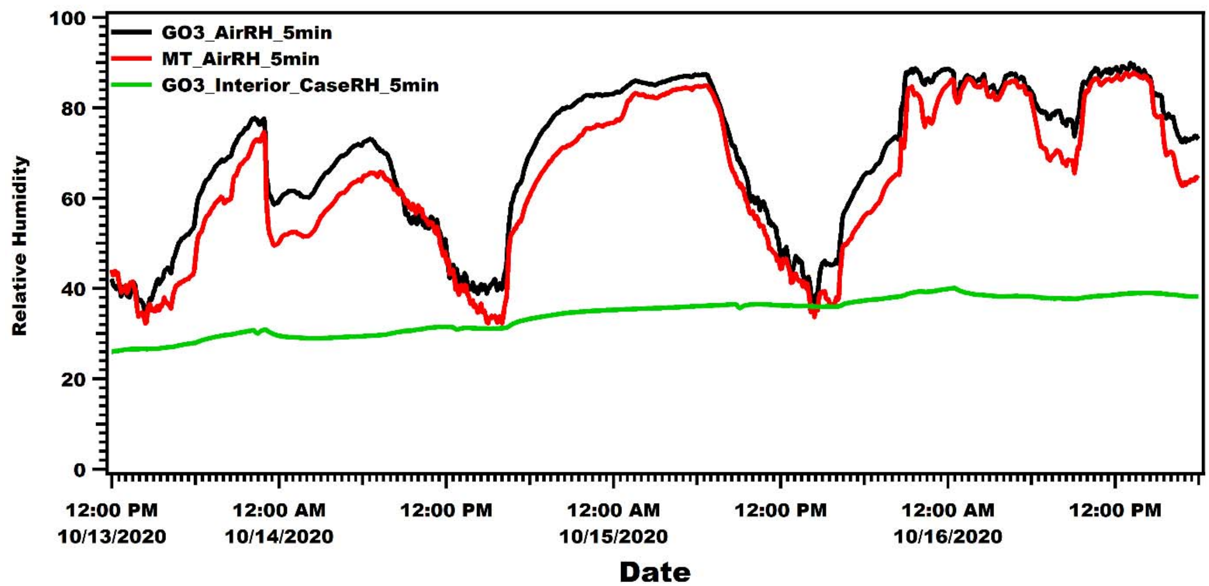


Figure 20-004-5. Time series of relative humidity from the GO3 and Moody Tower systems. The interior RH for the case is for housekeeping purposes and the progressive increase over time is addressed in more detail below.

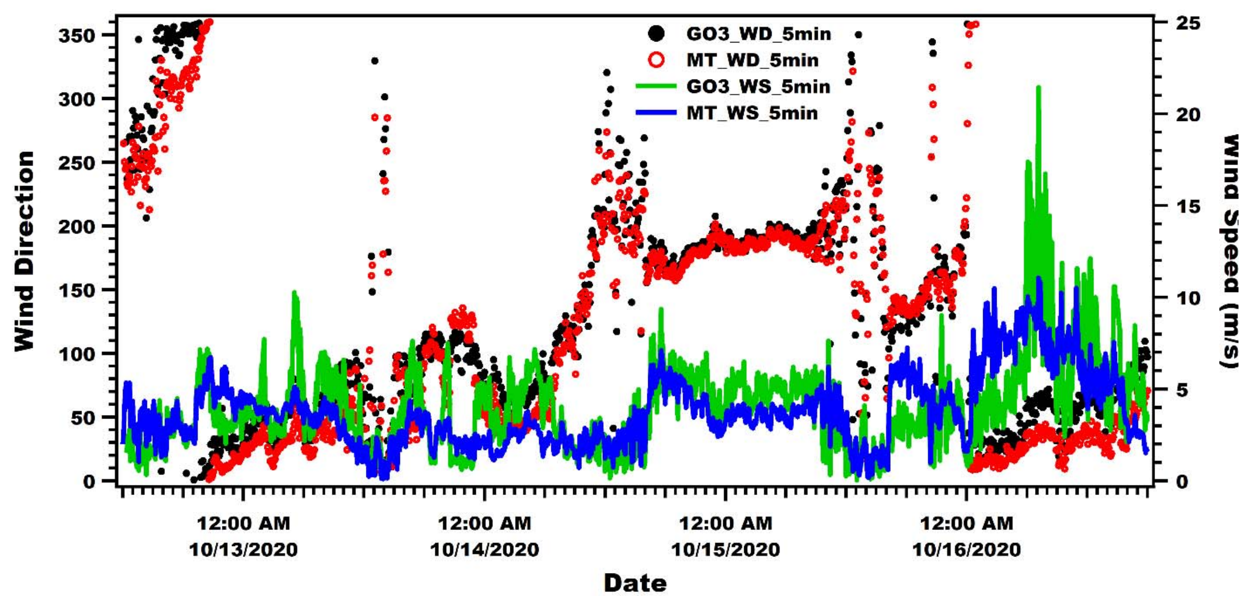


Figure 20-004-6. Time series of wind speed and wind direction from the GO3 and Moody Tower systems. It should be noted that the Moody Tower uses a propeller and vane anemometer and the GO3 uses a compact integrated met sensor with 2-D sonic anemometer.

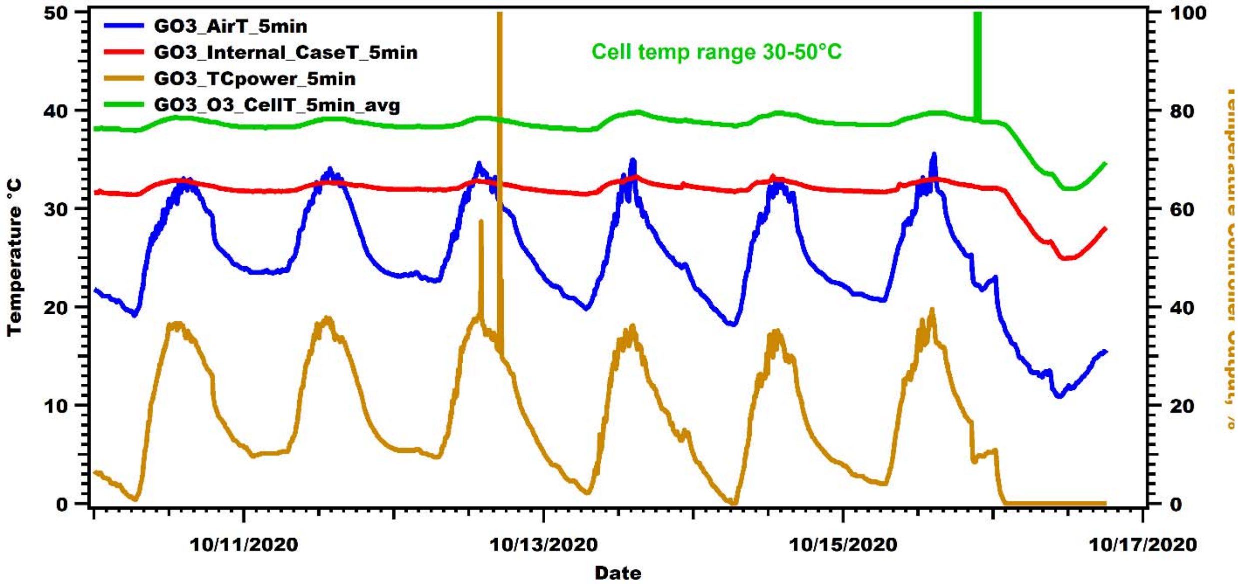
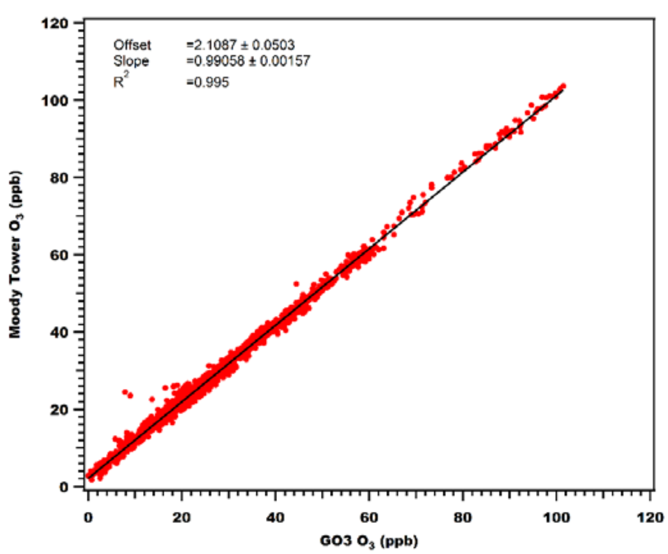


Figure 20-004-7. Time series of temperatures and thermoelectric cooler power output from the GO3 system. The cooling system power output did not exceed 40% other than two transient events. A cold front near the end of the test dropped temperatures below the threshold for active cooling however, the O_3 instrument remained within its operational range of 30-50 ˚C. It is not anticipated that temperatures as cool as these will be experienced for significant periods during the operational period which will begin April 1, 2021.

Preliminary Analysis: Preliminary analysis of the initial field test of the first instrument system which is intended for the crew boat in the Gulf of Mexico showed excellent agreement with the O_3 monitor at Moody Tower (C695). The GO3 package agrees with Moody Tower within a couple of percent and has a high degree of correlation ($r^2 = 0.995$).



Identified Issues: In the last report the deployment schedule was identified as a potential problem. During the meeting with the project team, AQRP, and TCEQ in September, Doug Boyer suggested we hold off deploying this calendar year and focus efforts on the spring and suggested we further explore the possibility of adding a photolytic NO_2 converter to the package to allow for estimates of NO_2 over the water in addition to O_3.

An issue with Larry Willis' requested a liability waiver has been approved by all parties and a fully executed copy was picked up from Mr. Willis in November when the UH sampling trailer at Smith Point is shut down for the O_3 season. UH Office of Contracts and Grants shared a modified boat rental agreement as an example for his attorney to follow when requesting a liability waiver. All parties hope to have this resolved in the coming weeks.

As seen in Figure 4 the relative humidity inside the case was increasing over time. We believe that this is due to outside humid air being drawn into the case by the O_3 sample pump. From the factory the 2B Tech instrument does not have an exhaust port, air is simply exhausted inside the instrument. The sample case does have a factory pressure valve to relieve the increase in pressure from the sample exhaust, however over time the addition of ~2 liters per minute of ambient air was introducing more humidity into the case, gradually exceeding the capacity of the desiccant bags. To address this an exhaust port is being added to the O_3 monitors, which will then allow us to exhaust the humid sample back out of the case. Operationally the desiccant bags will be changed once per month when the inlet filter is changed, or any time the case is opened for maintenance. The case internal temperature is held relatively warm to avoid condensation issues. The coldest point in the system is the cold plate of the thermoelectric cooler which is held to 26.7 ˚C, or 80 ˚F and should be well above the dew point while still keeping the equipment within normal operating temperatures. This humidity measurement is a housekeeping parameter and intended to help identify potential leaks in the case and avoid excessive moisture rather than a reportable measurement.

The computer in the completed package experienced a couple of minor power issues. First, the 12V battery circuitry was unable to support the computer when taxed at full load. This led the computer to being moved to the main 24V power supply. This allowed for programming however once the cooling system was activated the computer would shutdown randomly. After troubleshooting it is suspected that the thermoelectric cooling system may be inducing transient power spikes in the system which are causing the computer to shut down. The interim solution to continue lab testing was to operate the computer from a separate power supply while blocking diodes are installed in the power system to prevent back feeding power spikes to other components. An alternate 12V or 24V battery system is being investigated to act as a UPS for the computer as initially intended.

Goals for the Succeeding Period: Finalize change in scope of work with AQRP and TCEQ. Make adjustments to GO3 sampling package and retest at UH Moody Tower before finalizing the build plan for the second system. Test CL-51 ceilometer at the UH Launch Trailer.

Complete preparations and continue testing of pontoon boat. Conduct test launch of ozonesonde from pontoon boat to identify issues to be addressed prior to deployment in Galveston Bay.

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: *Task 1.* We continued quantifying the overlap of the three smoke products (HMS, GOES, UVAI) in the Texas/Gulf of Mexico region from January through July 2020. However, as noted in the original project plan, simple comparisons of the three smoke products will only allow us to assess their consistency; none of the products provide a "truth" dataset to use as a reference. For our "truth" datasets, we refer to estimates of brown carbon from observations of OMI Aerosol Optical Depth (AOD) as well as the ratio of total column ammonia (NH_3) to carbon monoxide (CO). The results of this analysis are summarized in Figure 1 for a test day on May 22, 2020. We explore the implications of these results in the Preliminary Analysis section.

Task 2. We have begun Task 2 by collecting AOD information associated with GOES smoke pixels. The AOD has been compared to a recently published relationship between MAIAC plume height estimates and AOD measurements.

Preliminary Analysis: Consistent with the previous reporting period and the quarterly report, we continue to illustrate our progress with the May 22, 2020 example date. Figure 20-005-1 summarizes the main components of Task 1, where the three smoke products are shown along with BrC estimates and NH_3/CO ratios for the Texas/Gulf of Mexico region. Based on a literature review, we found that typical total column NH_3/CO ratios for cropland biomass burning can range from 0.01 to 0.04; in general, cropland biomass burning NH_3/CO ratios are skewed lower than those of other fire types. Figure 20-005-1 (bottom panel) supports the expectation of heavy agricultural fire influence in the region on May 22, 2020. We again note the variability and inconsistency among the three smoke products. However, Southern Mexico towards the Yucatán is the notable exception with consistent overlap among all three smoke products (southern Mexico, indicated by the medium-to-dense region on the HMS map). This region of smoke consistency is further supported by the presence of BrC-dominant aerosols in the same region (Figure 20-005-1, top panel) and NH_3/CO ratios indicative of agricultural biomass burning (Figure 20-005-1, bottom panel). We continue to process data for multiple days from January 2020 through July 2020 to provide robust statistics on not only overlap among the three smoke products but importantly their comparison with independent validation products such as BrC proxies and NH_3/CO ratios.

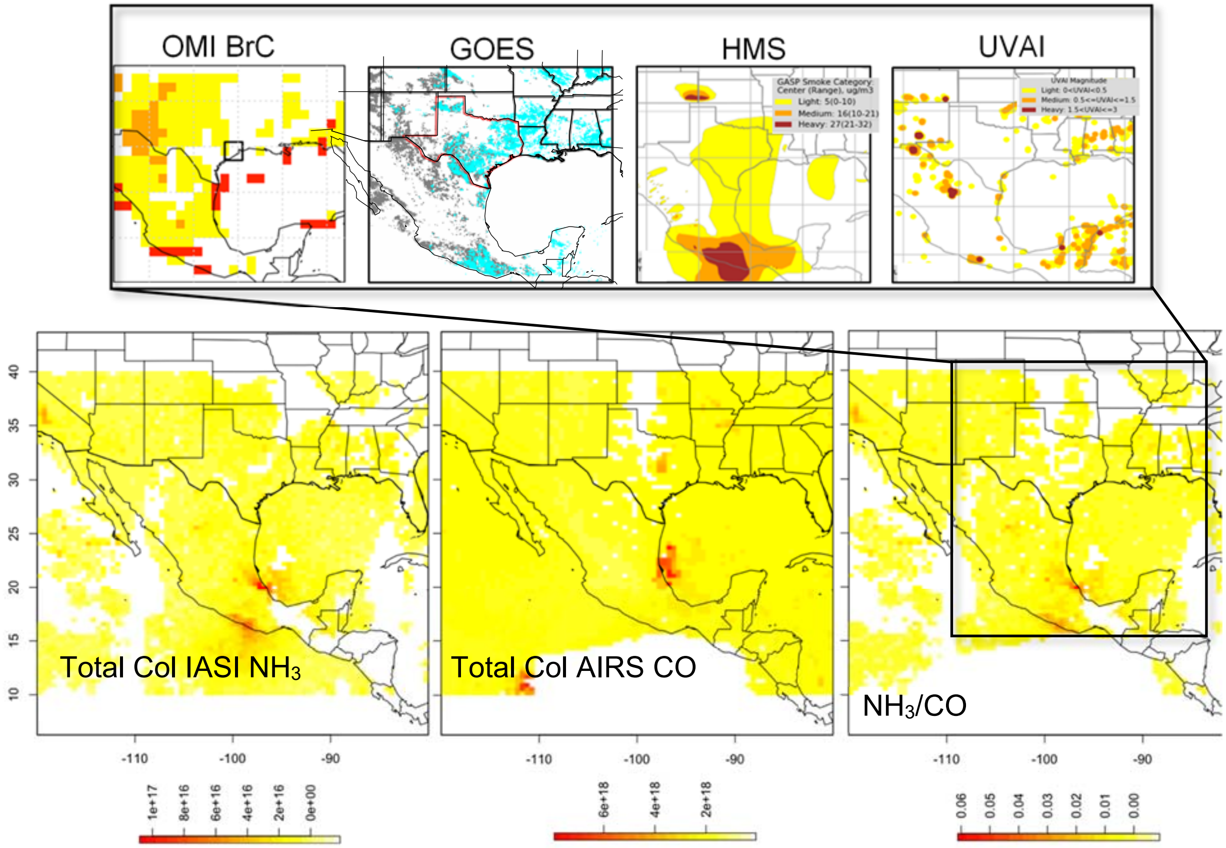


Figure 20-005-1. Summary of Task 1 products and results for a sample date on May 22 2020. Bottom panel (left to right): Total column IASI NH3; AIRS CO; and their ratio as NH_3/CO. Top panel (left to right): 48-h averaged brown carbon estimates from OMI, with yellow and red indicating light and heavy BrC mixtures respectively, and orange indicating no BrC; GOES smoke product at 1300 UTC with high quality smoke pixels colored in cyan; HMS daily aggregated smoke product, colored from light to heavy; TROPOMI UVAI daily smoke estimate colored from light to heavy.

For our Task 2 analysis, we began exploring the MAIAC twice-daily Terra/Aqua plume heights associated with suspected smoke events. A recent study by Cheeseman et al., 2020 (https://doi.org/10.1029/2020GL088949) evaluated the correlation of MAIAC plume height with AOD across the United States. In our analysis, we obtain high-quality GOES AOD and subset the AOD further to correspond to the high-quality filtered GOES smoke data. The resulting AOD dataset therefore reflects AOD associated with smoke pixels (filtered for high-quality). This process is displayed in Figure 20-005-2 for a sample hour on May 22 2020 at 1300 UTC. These smoke-related AOD values are then binned and compared to the relationship with plume height suggested in Cheeseman et al., 2020. The results of this preliminary plume height analysis are summarized in Figure 20-005-3 below. For reference, we provide the relevant figure from Cheeseman et al., 2020 displaying the plume height/AOD relationship. The average AOD for the 1300 UTC time slice was 0.48 (SD: 0.32). Based on the inset from Cheeseman et al., 2020 a preliminary assessment suggests that these smoke-related AOD values correspond to plume heights of 500-600m.

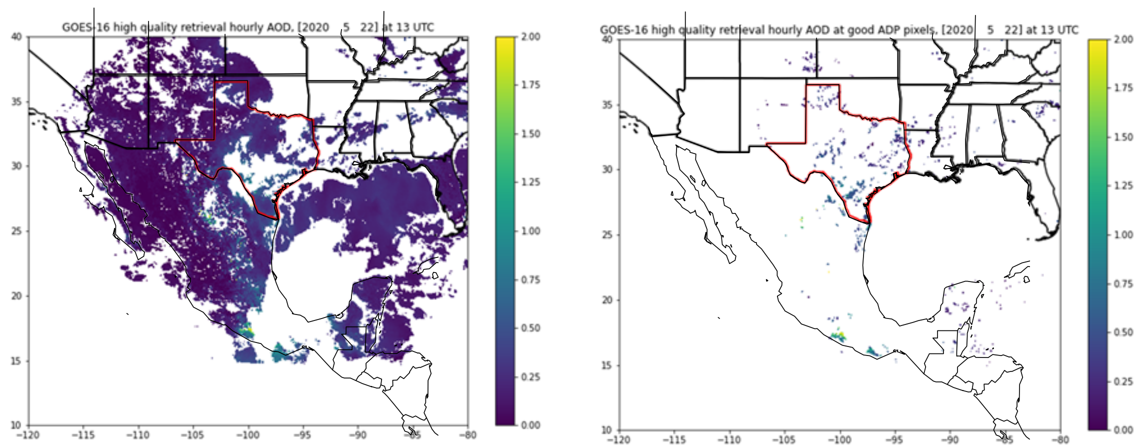


Figure 20-005-2. Hourly Averaged good quality GOES AOD at 1300UTC on May 22, 2020. (Left): Not filtered for smoke pixels. (Right): high quality AOD values corresponding to high quality smoke pixels only.

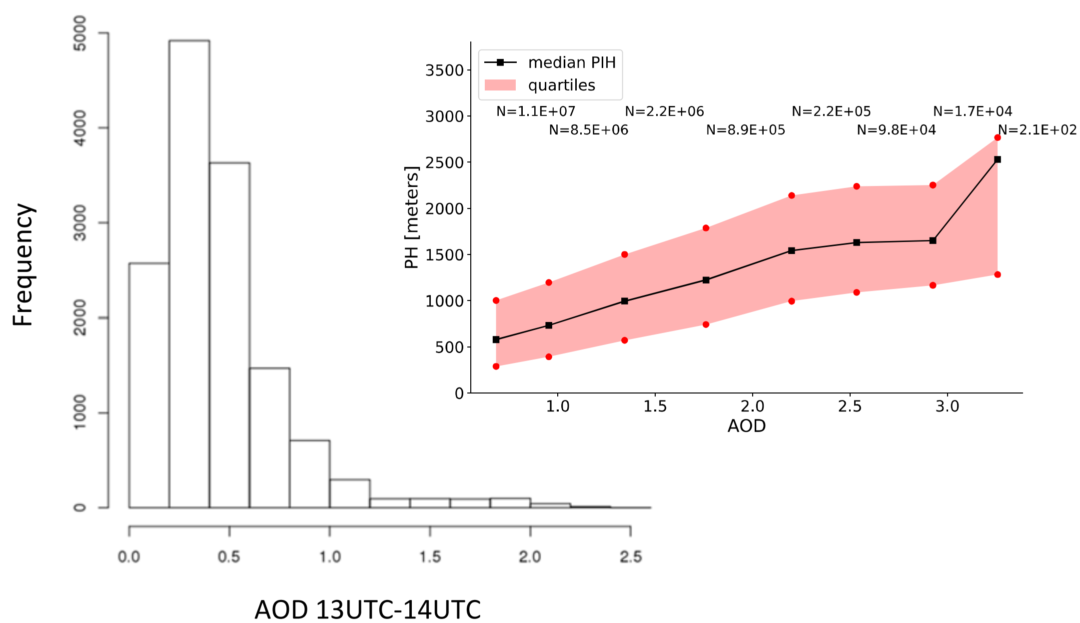


Figure 20-005-3. Histogram of high-quality GOES AOD values corresponding to high-quality GOES smoke pixels. Inset figure is from Cheeseman et al., 2020 displaying the relationship of MAIAC Plume Height and MAIAC AOD.

Data Collected: We are gathering NH_3 and CO data for the remainder of the 93-day analysis time period.

Goals for Succeeding Period: We will provide summary statistics for Task 1 for suspected smoke dates in the Texas/Gulf of Mexico region spanning January 2020-July 2020. We will finalize our comparison methodology both across smoke products and relative to BrC and NH_3/CO measurements. We will provide an assessment of key features associated with consistency among smoke products as well as an assessment of relationship with individual smoke products and smoke presence suggested by BrC presence and NH_3/CO measurements.

For Task 2, we will continue to examine the relationship of MAIAC plume heights with AOD for the full date range addressed in Task 1. We will also begin our analysis of plume windspeed and direction.

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 are completing and refining our comparisons of three different smoke products, the first milestone of Task 1 from the task order. We will also incorporate time of measurement to further refine our comparisons.
- We have begun our comparison with OMI brown carbon estimates derived from AOD and AAOD measurements.
- We have also begun our comparison with AIRS CO and IASI total column NH_3 data.
- We have begun our analysis of plume heights associated with smoke pixels from GOES; we are using a published relationship of MAIAC plume heights and aerosol optical depth associated with GOES smoke pixels.

Publications, Presentations related to the project:
1. Identifying Smoke-Impacted Regions using the Optical Properties of Brown Carbon Aerosol, accepted for poster at AGU Fall Meeting

2. Identifying Smoke-Impacted Regions using the Optical Properties of Brown Carbon Aerosol, accepted as oral presentation at the CMAS Fall Meeting

Personnel changes: We added AER Sr. Research Associate Qiang Sun to the project to help gather and process data for Task 1.

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 1: High Resolution (8-day, 10-m) LAI and Vegetation Cover Fraction for Urban Texas

No work was performed on Task 1 during the reporting period.

Task 2. BVOC Emitting Tree Distributions for Three Major Texas Urban Areas
Completed development of tree key for Texas trees. Completed iTree assessment of tree cover fraction distributions. Completed training sample database for Austin, Houston and San Antonio. Assessed approach by comparison with city average FIA data.

Task 3. MEGAN and BEIS input data, processors and results
Downloaded 2019 MODIS Leaf Area Index (LAI) and fraction of photosynthetically active radiation absorbed by the canopy (fPAR) data developed by TCEQ and performed quality checking of the data.

Project 20-009	STATUS: Active – 07/27/20-08/31/21

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 Clear 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 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.

As of this writing, we are in negotiations with UNEP, two platform operating companies as well as Texas A&M – Galveston regarding the timing and logistics of this project. All parties are committed to a successful deployment, but we do not have a guarantee on the exact timing of the project. Because the proposed work here is contingent on the other project, we do not yet have confirmed dates.

Project Update: The reporting schedule for this project has changed, and the new dates have been noted.

In the past reporting period, the unrelated Aerodyne Mobile Laboratory campaign was delayed indefinitely. The ozone instrument remains installed in the Mobile Lab and is measuring ambient signal in the Aerodyne parking lot. The data looks acceptable.

In September, we met remotely with a representative of the Gulf Offshore Research Institute, a non-profit organization that has leased two decommissioned platforms from an oil and gas company and is setting them up to operate as research stations for air quality, meteorological, wind energy, and fisheries research projects. They will be able to provide platform access for the central tracer-release portion of the UNEP campaign. There are two platforms available.

The first is 55 km east of Port Mansfield, Texas, (south of Corpus Christi). The second is 160 km south of Cameron, Louisiana (south-east of Galveston). The choice of platform will be made after consideration of logistical issues like transportation of release gases, and after consultation with the vessel operator.

We have also had a call with the vessel operator and one of its captains to discuss timing, logistics and COVID-19 related safety procedures. There is some additional flexibility in vessel timing for the spring, but other significant logistical concerns have been raised, and are discussed below.

In November, we have continued communication with vessel and platform operators this past month related to logistical concerns. Significant logistical problems have cropped up related to the safety of transferring equipment and personnel to the platform by boat. Pandemic-related safety issues also remain and are discussed in the following section.

Identified Issues: Finding an offshore platform is no longer the limiting factor for the success of this campaign.

However, there is increasing uncertainty about whether this project can be accomplished before the August 31, 2021 project deadline due to two main issues.

The first issue is related to COVID-19 safety and has been raised in Monthly Technical Reports. In November, we reviewed mission procedures put in place NOAA's aircraft operation division, which mandates a 7 day or longer shelter-in-place with symptom screening for all personnel working aircraft missions, along with several other policies. Additionally, Aerodyne Research, Inc. has come up with a separate travel policy during the pandemic, which also includes quarantine and testing. Thus, we continue to pursue some combination of testing and quarantining prior to boarding the vessel. Close quarters on the vessel (including bunk rooms) will make alternative risk mitigation steps ineffective. We will have an answer this coming month as to whether the vessel operators are able to complete a pre-mission quarantine and test, and whether the current UN project budget can support the extra incurred costs.

The second logistical issue is related to equipment and personnel transfer to the offshore platform. We have learned that docking at the platform is a difficult endeavor and can only be attempted under a very narrow set of meteorological conditions (calm seas). Supply vessels will not attempt a resupply unless the weather forecast is favorable. Since the offshore platform in question does not yet have accommodations, the tracer release technician would need to be evacuated at the end of each release day. This presents a very real barrier to doing the tracer-release experiment that is at the center of the UN-funded campaign. We will bring up this limitation with the UN sponsor and determine whether any solutions are feasible, for example, bringing in a 3rd project participant able to help with transport to/from the platform via helicopter and/or providing temporary overnight accommodations on the platform.

Goals for the Succeeding Period: In the next reporting period, we will continue work on solving the two central logistical issues of the UN-funded project. We will propose a meeting with the AQRP project manager to discuss the project progress.

Detailed Analysis of the Progress of the Task Order to Date: Progress has suffered some setbacks due to unforeseen logistical constraints. Progress (and spending) on this specific AQRP-funded sub-project to measure ozone offshore will still be focused on the weeks immediately surrounding the measurement campaign.

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:

<u>Task 1: Review Current CAMx WBDUST Estimates</u>

This task was completed in September 2020.

<u>Task 2: Review Alternative Methods and Datasets</u>

Completed documenting alternative WBD formulations and contrasting to the current

WBDUST method. Submitted the Task 2.1 Technical Memorandum to AQRP and the TCEQ liaison on November 25.

Task 3: Update the WBDUST Model and Evaluate Impacts in CAMx MP
No activities during the reporting period.

Task 4: Project Reporting and Presentation
Developed monthly MTRs and FSRs and submitted to AQRP.

Preliminary Analysis: We performed a qualitative assessment of WBDUST updates, which were based on selected formulations from the CMAQ WBD approach, by conducting single-day process-level testing for a few documented high-wind dust episodes that occurred during 2014 in the southwest and south-central US. Meteorological inputs were taken from the 2014 Western Air Quality Study modeling database. Whereas the original WBDUST model generated hardly any emissions, the formulation improvements resulted in reasonable emission rates and patterns (see the Task 2.1 Technical Memorandum for details). Under Task 3, Ramboll will refine these updates and conduct more in-depth testing with CAMx by evaluating PM concentrations against IMPROVE PM measurements throughout the south-central US.

Goals for the Succeeding Period: Begin Task 2.2 review of alternative landcover and agricultural datasets that can be used in the WBDUST model to define locally specific time/space-varying emissive land patterns. Continue formalized model testing of WBDUST updates using the CAMx model. No anticipated issues for the succeeding reporting period.

This project initiated on July 28 with the execution of the AQRP Task Order. All tasks remain on budget and on schedule for completion 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

Ramboll US Corporation – Dr. Jeremiah Johnson

AQRP Project Manager – Elena McDonald-Buller

TCEQ Project Liaison – Mark Muldoon

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

Abstract:
This study 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 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: *Task 1: Simulate NO_2 and SO_2 amounts with the high-resolution WRF-CAMx model*
The Ramboll modeling team completed CAMx modeling for the entire 2019 modeling period and provided all 3-D CAMx outputs to the UW-Madison team.

The UW-Madison team has secured data storage for all files related to this project and has begun transferring CAMx output from Ramboll.

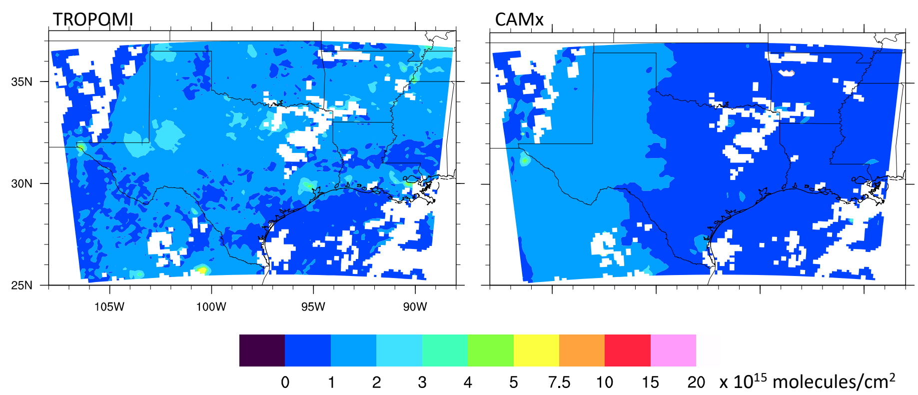
Task 2. Compare model simulations with TROPOMI and near-surface observations
The Ramboll modeling team continued evaluation of WRF-CAMx results against TCEQ observations.

The UW-Madison is continuing with processing of TROPOMI NO_2 with WHIPS on the 12km domain and has begun processing CAMx column amounts with the TROPOMI averaging kernel. The UW-Madison team has finished updating WHIPS to work with TROPOMI SO_2. To support faster gridding of TROPOMI data, the UW-Madison team has now begun to update WHIPS with a more recent version of Python.

Task 3. Compare satellite data and emissions for power plants and urban areas
The Ramboll modeling team provided hourly gridded emissions for the EGU sector to the UW-Madison team and to Dan Goldberg. In addition, Ramboll provided CEM NOx and SO_2 data for the 5 power plants to be analyzed in this project.

Task 4. Evaluate mobile emissions assessments performed with and without model
The Ramboll modeling team provided hourly gridded emissions for on-road mobile sources and all sources.

Preliminary Analysis: The UW-Madison team has begun analyses to support quality control of WHIPS gridding of TROPOMI NO_2, and to support comparison of TROPOMI NO_2 with CAMx output. An example of the latter is shown below using one day of TROPOMI and CAMx data.



July 1, 2019 column NO_2

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.

UW-Madison will continue gridding TROPOMI NO_2 to the 12km model domain via WHIPS and commence gridding TROPOMI NO_2 to the 4km model domain. 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: Task 1: In total, 18 cases – both 9 cases with NCEP FNL and ECWMF reanalysis are finished and archived. We generated the met and wrfinput as well as wrfbdy from NAM reanalysis data. In November, all 27 cases simulations are finished running. We examined the performance of all WRF cases.

Task 2: We downloaded the COSP package (the latest version) and we examined and prepared the inputs for COSP package. The inputs are generated from the WRF output. We are preparing the inputs for COSP package.

Preliminary Analysis: Preliminary results demonstrate that the microphysics scheme plays a more important role than reanalysis inputs in terms of simulating cloud radiative effect. The Morrison scheme predicts more reflective clouds than the other two microphysical schemes. PBL scheme selection is important during June and July, while the Microphysics scheme is more important during the rest of the 2018 year.

Data Collected:
1. 27 cases simulation results archived
2. COSP input/output files from WRF outputs.

Goals for the Succeeding Period: Complete running COSP simulations.

Detailed Analysis of the Progress of the Task Order to date: Task 1 finished and in the middle of Task 2.

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 either in September 2020, or need be postponed to Spring 2021 because of the COVID-19 pandemic. 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 part of this task conducted during the reporting period was continued training of graduate student Alexa Rhoads to use the ECHAMP peroxy radical sensor. She has worked with 4th year graduate student Andrew to get up to speed using the software tools required to analyze the ECHAMP data (Matlab) and the procedures for calibrating the instrument.

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.

Goals for the Succeeding Period: Alex Rhoads will continue her training to use the ECHAMP peroxy radical sensor and the required analytical software tools. Our plan is for her to conduct calibrations of the instrument using both of the two calibration methods we use (the water vapor photolysis method and the methyl iodide calibration method). This will be conducted with guidance from Andrew Lindsay (graduate student) and PI Ezra Wood.

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.

In September 2020, all remaining balances in the FY 2018-2019 Program Administration funds were carried forward into the FY 2020-2021 research contractual hold funds. The Carry Forward from FY2018-2019 to FY2020-2021 was approved in Amendment 4 of the AQRP contract with the TCEQ.

During the year, 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	$52,688.69	$52,575.03
Fringe Benefits	$15,279.91	$12,930.00	$28,209.91	$15,755.64	$12,454.27
Travel					
Supplies	$3,000.00	$3,000.00	$6,000.00	$828.52	$5,171.48
Equipment					
Other					
Contractual					
Total Direct Costs	$69,843.63	$69,630.00	$139,473.63	$69,272.85	$70,200.78
Authorized Indirect Costs *(10% of Salaries and Wages)*	$5,156.37	$5,370.00	$10,526.37	$5,268.86	$5,257.51
Total Costs	**$75,000.00**	**$75,000.00**	**$150,000.00**	**$74,541.71**	**$75,458.29**

**Expenses as of November 2020*

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.

In September 2020, all remaining balances in the FY 2018-2019 ITAC funds were carried forward into the FY 2020-2021 research contractual hold funds. The Carry Forward from FY2018-2019 to FY2020-2021 was approved in Amendment 4 of the AQRP contract with the TCEQ.

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.

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 November 2020*

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.

In September 2020, all remaining balances in the FY 2018-2019 Project Management funds were carried forward into the FY 2020 research contractual hold funds. The Carry Forward from FY2018-2019 to FY2020 was approved in Amendment 4 of the AQRP contract with the TCEQ.

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	$25,597.82	$47,363.56
Fringe Benefits	$10,871.25	$10,871.25	$21,742.50	$7,657.26	$14,085.24
Travel					
Supplies	$1,000.00	$1,000.00	$2,000.00	$1,033.67	$966.33
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	$34,288.75	$67,405.20
Authorized Indirect Costs *(10% of Salaries and Wages)*	$3,648.06	$3,648.06	$7,296.12	$2,559.79	$4,736.33
Total Costs	**$54,490.07**	**$54,500.00**	**$108,990.07**	**$36,848.54**	**$72,141.53**

**Expenses as of November 2020*

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 C 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. 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	$8,314.55	$62,646.45
20-003	Rice University (PPE)	$2,300.00	$0.00	$2,300.00
20-003	University of Houston	$115,668.00	$33,800.92	$81,867.08
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	$14,391.28	$16,718.07
20-005	AER	$173,692.00	$93,371.00	$80,321.00
20-007	Ramboll	$6,311.68	$6,311.68	$0.00
20-007	Wildland Solutions	$8,244.06	$8,244.06	$0.00
20-009	Aerodyne Research, Inc.	$12,989.00	$0.00	$12,989.00
20-011	Ramboll	$28,403.75	$27,976.99	$426.76
20-020	University of Wisconsin-Madison	$26,785.71	$20,761.08	$6,024.63
20-020	Ramboll	$20,928.65	$20,928.65	$0.00
20-028	Drexel University	$17,842.15	$5,078.12	$12,764.03
FY 20 Total Contractual Funding Awarded		$678,327.82		
FY 20 Contractual Funds Expended (Init. Projects)			$302,472.80	
FY 20 Contractual Funds Remaining to be Spent				$375,855.02
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	$70,199.53	$13,414.78	$56,784.75
20-004	St. Edward's University	$37,150.65	$0.00	$37,150.65
20-007	Ramboll	$43,965.32	$4,202.62	$39,762.70
20-007	Wildland Solutions	$11,478.94	$10,485.94	$993.00
20-011	Ramboll	$85,211.25	$0.00	$85,211.25
20-020	University of Wisconsin-Madison	$98,214.29	$0.00	$98,214.29
20-020	Ramboll	$76,748.35	$11,259.76	$65,488.59
20-026	Texas A&M University	$98,427.00	$16,559.86	$81,867.14
20-028	Drexel University	$53,526.45	$0.00	$53,526.45
FY 21 Total Contractual Funding Awarded		$574,921.78		
FY 21 Contractual Funds Expended (Init. Projects)			$38,305.56	
FY 21 Contractual Funds Remaining to be Spent				$576,319.44
Total Contractual Funding		$1,292,952.82		
Total Contractual Funding Awarded		$1,253,249.60		
Total Contractual Funding Remaining to be Awarded		$39,703.22		
Total Contractual Funds Expended to Date			$340,778.36	
Total Contractual Funds Remaining to be Spent				$952,174.46

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)	$ 133,494.00	Flynn, James	Wang, Yuxuan	University of Houston (Prime Sub)	$ 201,754.00
		$ 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 2020-2021 Submitted Proposals and Contingency Abstracts

Proposal #	Title	Total Budget	PI	Institution
20-001	Changing Precipitation Dynamics in Southeastern Texas over the Past Three Decades: Amount, Intensity, Duration, and Storm Type	$ 105,845.00	Talbot, Robert	University of Houston
20-002	Measurements of Pollutant transportation into San Antonio during 2020	$ 180,995.00	Thompson, Jon	Texas Tech University
20-003 (funded)	Characterization of Corpus Christi and San Antonio Air Quality During the 2020 Ozone Season	$ 286,427.00	Griffin, Robert	Rice University
20-004 (funded)	Galveston Offshore Ozone Observation (GO3)	$ 201,754.00	Flynn, James	University of Houston
20-005 (funded)	Using Satellite Observations to Quantify Surface PM2.5 Impacts from Biomass Burning Smoke	$ 173,692.00	Alvarado, Matthew	Atmospheric and Environmental Research, Inc. (AER)
20-006	Unprecedented Air Quality Measurements in Austin, Texas: Understanding the Sources and Formation of Ozone Particulate Matter	$ 245,409.00	Hildebrandt Ruiz, Lea	University of Texas at Austin
20-007 (funded)	Texas urban vegetation BVOC emission source inventory	$ 130,931.00	Shah, Tejas	Ramboll US Corporation
20-008	Central Texas Air Quality: Corpus Christi, Austin, San Antonio Field Study	$ 249,969.00	Yacovitch, Tara	Aerodyne Research, Inc.
20-009 (funded)	Ozone Measurements and Platform Emission Factors in the Gulf of Mexico	$ 12,990.00	Yacovitch, Tara	Aerodyne Research, Inc.
20-010 (contingency)	Using remote-sensing smoke products to quantify the impact of biomass burning smokes on ground-level particulate matter concentrations in Texas	$ 188,322.00	Wang, Yuxuan	University of Houston
20-011 (funded)	Improving Estimates of Wind-Blown Dust from Natural and Agricultural Sources	$ 113,615.00	Emery, Chris	Ramboll US Corporation
20-012	Computationally Efficient Deep Learning Model to Improve Meteorological Models over Texas: AI-Powered Data Assimilation, Bias-Correction, and Sensitivity Analysis	$ 175,644.00	Choi, Yunsoo	University of Houston
20-013	Deep Learning and chemical Transport Models Integration with In Situ and Remote Sensing Data to Accurately Estimate Emissions within Texas and Surrounding States	$ 187,759.00	Choi, Yunsoo	University of Houston
20-014 (contingency)	Utilization of Remote Sensing Data to Improve Meteorological Fields for Air Quality Simulations	$ 161,753.00	Pour-Biazar, Arastoo	University of Alabama at Huntsville

Appendix B (continued)

20-015	Baseline Air Quality Measurements in Taft, Texas, Analysis of Available Data & An Assessment of the Use of Unmanned Aerial Vehicles Using Low Cost Sensors for Selective Air Monitoring Applications	$ 334,758.00	Torres, Vincent	University of Texas at Austin
20-016	Optimized WRF Configurations for Texas Air Quality Simulations	$ 148,745.00	Hegarty, Jennifer	Atmospheric and Environmental Research, Inc. (AER)
20-017	Novel methods for estimating particulate matter air quality impacts of smoke from biomass burning using Geostationary satellites	$ 200,725.00	Nair, Udaysankar	University of Alabama at Huntsville
20-018	Air-quality Conscious and Cost-effective Industrial Emission Control for Texas Air-quality Improvement	$ 201,184.00	Xu, Qiang	Lamar University
20-019	Reduced Combustion Mechanisms for the Ammonia/Natural Gas/Air System and CFD Simulations for Turbine/Internal Combustion Engine Emissions	$ 150,000.00	Chen, Daniel H.	Lamar University
20-020 (funded)	New Satellite Tools to Evaluate Emission Inventories: Is a 3-D Model Necessary?	$ 222,677.00	Holloway, Tracy	University of Wisconsin-Madison
20-021	A critical evaluation of soil layers in land surface models for improving simulations of dust emissions	$ 194,686.00	Wu, Yu-Ling	Earth System Science Center
20-022	Implementing Dust Speciation for Improved Representation of Dust Impacts on Chemistry	$ 119,198.00	Liu, Xiaohong	Texas A&M University
20-023	Ozone Measurements in Galveston Bay and the Gulf of Mexico in support of air quality modeling	$ 232,701.00	Ying, Qi	Texas A&M University
20-024	Improving biogenic emissions in urban areas and evaluating their impact on ozone and secondary organic aerosol	$ 186,494.00	Ying, Qi	Texas A&M University
20-025	Near-Real-Time Application of Remote Sensing Tools to Verify, Validate and Improve Emissions of NO2 and SO2 for Texas Air Quality Modeling	$ 186,979.00	Pavlovic, Nathan	Sonoma Technology, Inc.
20-026 (funded)	Improve Cloud Modeled by WRF using COSP and Generative Adversarial Network	$ 98,427.00	Lu, Zheng	Texas A&M University
20-027	Austin 2020 Air Quality Field Study	$ 223,260.00	Walter, Paul	St. Edward's University
20-028 (funded)	Quantification and Characterization of Ozone Formation in Central San Antonio	$ 71,368.60	Wood, Ezra	Drexel University
20-029	Evaluating Opportunities to Improve County-level Emissions of Oxides of Nitrogen Using Satellite-based Observations	$ 185,509.00	Capps, Shannon	Drexel University

Project 20-010 **STATUS: CONTINGENCY**

Using remote-sensing smoke products to quantify the impact of biomass burning smokes on grand-level particulate matter concentrations in Texas

University of Houston – Dr. Yuxuan Wang AQRP Project Manager – n/a

Baylor University – Dr. Sascha Usenko TCEQ Project Liaison – n/a

Proposed Amount: $188,322.00

Abstract:
Due to its geography, Texas is susceptible to smokes from both in-state and out-of-state fires. While current satellites can provide routine products of fire and smoke locations, the spatiotemporal information of fire plumes seen from above by the satellites may not correlate well with air quality impacts at the ground due to complex vertical structures and chemical heterogeneity of fire plumes, both of which are challenging for satellites to observe. Previous studies used either statistical methods or numerical models to estimate surface air quality impacts of fire emissions from satellites, but these approaches have inherent drawbacks, including computational expenses and small signal to noise ratios to quantify individual transport events.

To address the shortcomings of the existing approaches, we propose here a new hybrid method that integrates recent advances in aerosol reanalysis model, machine learning, and surface observation of biomass burning indicators and develop an automatable system for real-time detection of individual events of biomass burning smokes in Texas and quantification of the associated surface impacts. First, we will build a machine-learning emulator for a state-of-the-science aerosol reanalysis model (Navy Aerosol Analysis and Prediction System, NAAPS), which provides mechanistic relationships between smoke aerosol optical depth (AOD), surface smoke concentrations, and smoke height for numerous past events of fire emissions transport to Texas. As the NAAPS aerosol reanalysis outputs already assimilated satellite AOD, smoke AOD from NAAPS is consistent with satellite products, a major strength compared to other free-running aerosol models. Second, the trained emulator will apply to satellite fire and smoke products to generate mechanistic-based quantitative hindcast predictions of smoke height and ground level impacts of fire smoke in Texas. Third, the emulator-predicted smoke impacts will be compared with and validated by independent, ground-based measurements of smoke indicators, including aerosol optical properties (e.g. (BC)2 2019 in El Paso, and potentially (BC)2 2020 at three sites in Houston and again in El Paso) for validation and confirmation of individual events across Houston and between Houston and El Paso and chemical speciation (e.g. West Liberty site) for confirmation of longer-term trends (i.e. identification of peak seasons). Finally, we will demonstrate the end product, which is an automatable system that can translate incoming fire and smoke products from satellites into ground-level smoke concentrations and smoke height over Texas and validate the prediction with surface-based optical measurements in near-real-time.

The proposed project specifically targets the AQRP Priority Research Area FY2020-2021:

Estimate Impacts of Smoke from Biomass Burning. The proposed emulator-prediction approach will be computationally lean yet mechanistically based. It leverages on and links to previous and ongoing ground-level measurements of smoke indicators funded by the state. Furthermore, the emulator approach is adaptable and can be readily updated to fit improved versions of mechanistic models that incorporate new scientific understandings on fire emissions, chemistry, and transport.

Project Update: n/a

Project 20-014 **STATUS: CONTINGENCY**

Utilization of Remote Sensing Data to Improve Meteorological Fields for Air Quality Simulations

University of Alabama at Huntsville – Dr. Arastoo Pour-Biazar

AQRP Project Manager – n/a

TCEQ Project Liaison – n/a

Proposed Amount: $161,753.00

Abstract:

This proposal is in response to the call by the State of Texas Air Quality Research Program (AQRP) seeking studies to support Texas Air Quality research priorities. The work proposed here addresses priority areas with respect to meteorological modeling. In particular, the project focuses on enhancing the meteorological input for air quality simulations by assimilating satellite-observed cloud fields in an optimized Weather Research and Forecasting (WRF) model configuration for Texas. While this work specifically addresses meteorological priority areas, the project also contributes to several other priority areas as the improvements in cloud field improves vertical transport of pollutants, affects radiation, and influences the biogenic emissions. The improvements in cloud simulation will be enhancing the overall photochemical simulation and lead to better understanding of ozone and PM formation over Texas.

With the support of the TCEQ, either directly or through AQRP, the University of Alabama in Huntsville (UAH) has been developing techniques to improve the realization of clouds in air quality simulations. These efforts started with using satellite observations to correct for the radiative impact of clouds in both the CMAQ and the CAMx models. While these techniques significantly improved air quality simulations, it introduced a physical inconsistency in the modeling system as the insolation and photolysis fields did not agree with the other attributes of the model (such as precipitation, vertical transport, heterogeneous chemistry, wet deposition, etc.) Currently, both CMAQ and CAMx use ancillary information from the meteorological model to diagnose cloud attributes that are critical to air quality simulations (such as convective parameterization or photolysis rate calculation). Therefore, any error emanating from the meteorological model will propagate to the photochemical model. Assimilating observed clouds in the meteorological model will eliminate such inconsistencies.

With partial support from TCEQ, UAH has developed a cloud assimilation system (CAS) that dynamically corrects model clouds in the meteorological model based on the satellite observations (Pour-Biazar et al., 2015). CAS is particularly suitable for retrospective regulatory applications as it utilizes satellite observation. CAS has been evaluated for air quality simulations over the summer of 2006 and the summer of 2013. Both these studies indicated significant improvements in model cloud and radiation fields over the contiguous United States. Subsequent air quality simulations substantially improved due to correction in biogenic hydrocarbon emissions and photolysis rates. Yet, the improvements are not uniform over all the regions, and the system's dependency on model configuration has not been thoroughly tested.

We are proposing to conduct a study to investigate the performance of CAS over Texas. Furthermore, the study will attempt to improve and fine-tune the CAS for Texas air quality studies. The proposed study will investigate the use of additional observed information, such as lightning activity data and satellite-observed total precipitable water, to improve the initiation of convection and perform moisture adjustment where needed. The study will also investigate the influence of different WRF configurations on the performance of the CAS over Texas and will recommend an optimized configuration.

The Weather Research and Forecasting (WRF) model will be used for simulations over the summer of 2016. WRF simulations will take advantage of improved cloud simulation by applying a technique developed at UAH under a previous TCEQ funded project. The technique uses GOES cloud observations to dynamically correct cloud fields in WRF.

The project will leverage resources from a current NASA activity for acquiring the data needed for this study. Arastoo Pour-Biazar and Andrew White will be responsible for model simulations and refinements to CAS. Richard McNider will be helping in the evaluation of the results. A research associate will assist the team in model simulations and evaluation of results.

Project Update: n/a

Appendix C
FY 2018-2019 Research Projects

Project No.	Project Title / *Lead Institution*	Start Date / *PI*	End Date	Funding Awarded	Total Project Expenditures*	Funding to be Carried Forward to 20-21
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**