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, 2016 through November 30, 2016

Submitted to

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Texas Air Quality Research Program

Quarterly Report

September 1, 2016 – November 30, 2016

OVERVIEW

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

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

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

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

PROGRAM ACTIVITIES FOR THE QUARTER

Between September 1, 2016 and November 30, 2016, the AQRP Project Administration efforts focused primarily on executing contractual agreements with the entities performing research projects, while the Project Managers worked with the Investigators to complete project Work Plans.

A Master Agreement, which describes the general terms and conditions of contracting with The University of Texas at Austin under the AQRP, was executed with each of the universities and business that were awarded research projects. The Master Agreements were negotiated in parallel with the development, by the project investigators, of the project Statement of Work, Budget and Budget Justification, and Quality Assurance Project Plan (QAPP), in total referred to as the project Work Plan. At the end of November, 8 of the 10 research projects' Work Plans were approved by its AQRP Project Manager and recommended to move forward by its TCEQ Liaison. Of the two remaining projects, one Work Plan was under final review by the TCEQ Liaison and the project investigator of the other project was completing edits to the QAPP.

Once Work Plans were approved, a Task Order was issued to the entity performing each of the research projects. The Task Order is a project specific contractual document that outlines the period of performance, budget, and scope of work to be performed. At the end of November, Task Orders were fully executed for 6 of the projects. The remaining two Task Orders were submitted to the performing party, but have not yet been signed. All 8 projects were authorized to begin work.

BACKGROUND

Section 387.010 of HB 1796 (81st Legislative Session), directs the Texas Commission on Environmental Quality (TCEQ, Commission) to establish the Texas Air Quality Research Program (AQRP).

> Sec. 387.010. AIR QUALITY RESEARCH. (a) The commission shall contract with a nonprofit organization or institution of higher education to establish and administer a program to support research related to air quality.
>
> (b) The board of directors of a nonprofit organization establishing and administering the research program related to air quality under this section may not have more than 11 members, must include two persons with relevant scientific expertise to be nominated by the commission, and may not include more than four county judges selected from counties in the Houston-Galveston-Brazoria and Dallas-Fort Worth nonattainment areas. The two persons with relevant scientific expertise to be nominated by the commission may be employees or officers of the commission, provided that they do not participate in funding decisions affecting the granting of funds by the commission to a nonprofit organization on whose board they serve.
>
> (c) The commission shall provide oversight as appropriate for grants provided under the program established under this section.
>
> (d) A nonprofit organization or institution of higher education shall submit to the commission for approval a budget for the disposition of funds granted under the program established under this section.
>
> (e) A nonprofit organization or institution of higher education shall be reimbursed for costs incurred in establishing and administering the research program related to air quality under this section. Reimbursable administrative costs of a nonprofit organization or institution of higher education may not exceed 10 percent of the program budget.
>
> (f) A nonprofit organization that receives grants from the commission under this section is subject to Chapters 551 and 552, Government Code.

The University of Texas at Austin was selected by the TCEQ to administer the program. A contract for the administration of the AQRP was established between the TCEQ and the University of Texas at Austin on July 29, 2015 for the 2016-2017 biennium. Consistent with the provisions in HB 1796, up to 10% of the available funding is to be used for program administration; the remainder (90%) of the available funding is to be used for research projects, individual project management activities, and meeting expenses associated with an Independent Technical Advisory Committee (ITAC).

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.

Step 7 is in progress for the quarter being reported.

RESEARCH PROJECTS

FY 2016 – 2017 Projects

Final funding amount for each project to be reported after Work Plan approval.

Project 16-008 **STATUS: Active – Sept. 22, 2016**

High Background Ozone Events in the Houston-Galveston-Brazoria Area: Causes, Effects, and Case Studies of Central American Fires

University of Houston – Yuxuan Wang

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Doug Boyer

Funded Amount: $191,366

Abstract

A significant fraction of surface ozone in Texas comes from regional background originating from outside the state. Background ozone is particularly variable over the Houston-Galveston-Brazoria (HGB) region due to its unique geographical location and meteorology. Prior analyses of the HGB background ozone have focused predominantly upon averages, not high concentration days or exceptional events. To bridge this gap, the objectives of this project are to identify high background ozone events across the HGB area over the past 16 years (2000-2015), characterize meteorological conditions and anomalous emissions that cause these events, and understand their effects on ozone exceedances. With regard to emission anomalies, the focus will be on fire events from Mexico and Central America, a large fire region globally of unique importance to Texas air quality in springtime and summer whose impact on Texas background ozone has not been quantified.

Integrated analyses of observations and modeling will be conducted to achieve the project objectives. Daily HGB background ozone estimated by researchers at the Texas Commission on Environmental Quality (TCEQ) will be used as the data source to identify high background ozone days. Different types of meteorological events which may be potentially associated with high background ozone (e.g., cold fronts and thunderstorms) or high local photochemical production (e.g., heat waves and stagnation) will be identified based on the analysis of meteorology data. The relationship between high background ozone days and the meteorological 'event days' will be characterized, e.g., in terms of their overlapping (or the lack of it), and background ozone difference between meteorological 'event days' and 'non-event days' will be evaluated. Anomalies in fire emissions leading to high background ozone will be mapped through spatiotemporal sampling of the Fire INventory from NCAR (FINN) along background trajectories of air masses affecting the HGB area prior to and during the selected high background ozone days. The GEOS-Chem global chemistry transport model, with the FINN inventory implemented, will be used to simulate a number of case studies of large Central American fires and estimate the perturbations caused by ozone precursor emissions from those fires on background ozone concentrations in Texas and the HGB area. Finally, we will develop a quantitative estimate of the effects of background ozone versus local production on ozone exceedance cases in the HGB area and the dependence of such effects on meteorology and Central America fire emissions.

Project Update

During this quarter the project team completed the project Work Plan (Scope of Work, Quality Assurance Project Plan, and Budget and Justification) and received notification from the AQRP Project Manager to begin work.

The following progress has been made towards project goals:

Task 1: The following datasets have been collected and processed: (1) Daily maximum 8 h average (MDA8) ozone concentrations during the ozone season (April- October) from 2000 to 2015 measured at Continuous Ambient Monitoring Stations (CAMS); (2) Regional background ozone over the Houston−Galveston−Brazoria (HGB) area during the same period; (3) National Centers for Environmental Prediction (NCEP) North American Regional Reanalysis (NARR) products from 1979 to 2015.

Meteorological parameters over HGB have been extracted from the NARR dataset. The occurrences of two extreme weather events, heat wave and stagnation, have been identified based on the meteorological parameters. The analysis of the extreme weather events is ongoing. Preliminary results include time series of MDA8, background ozone concentrations and the list of high ozone days and extreme weather days.

Task 3: Emissions and burning areas of Central American fires were collected and processed from the Fire Inventory from NCAR (FINN) v1.5. Through the use of 3-day back trajectories and cluster analysis, the days with potential impacts from Central American fires have been identified and categorized for April and May during 2000 – 2015. Preliminary modeling analyses were conducted to investigate the impacts of Central America fire events during April and May 2011 on HGB ozone.

There are no delays or other issues to report at this time.

Project 16-010 **STATUS: Active – Oct. 20, 2016**

MOVES-Based NOx Analyses for Urban Case Studies in Texas

Sonoma Technology, Inc. – Stephen Reid

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Chris Kite

Funded Amount: $69,075

Abstract
Emissions inventories are an important component of air quality planning and a key input to photochemical grid models that support air quality assessments. Findings from recent studies suggest that nitrogen oxides (NOx) emissions may be overestimated in the U.S. Environmental Protection Agency's (EPA) National Emissions Inventory (NEI), perhaps by as much as a factor of two. This overestimate has generally been attributed to the mobile source sector (e.g., on-road motor vehicles), for which emission estimates are prepared using EPA's MOVES model. A number of potential issues have been identified with MOVES, including reliance on the model's default input data rather than more representative local inputs.

The overall goals of this project are to examine MOVES emission estimates at the local scale and identify which input parameters have the greatest influence on NOx emission estimates. Specifically, we will use a well-established emissions reconciliation technique to quantitatively compare MOVES emission results with ambient near-road monitoring data. These analyses will be performed for case studies in three Texas metropolitan areas: Dallas-Fort Worth, Houston, and El Paso. In addition, we will perform sensitivity analyses comparing MOVES emission results using default vs. local data to identify key parameters that have substantial influence on NOx emissions. The results of this work will support emissions inventory development and air quality management efforts in Texas by providing information on the accuracy of current MOVES emission estimates and MOVES input parameters, for which local data are critical.

Project Update
Over this quarter (September to November, 2016), the project team completed the project planning documents (Scope of Work, Quality Assurance Project Plan, and Budget and Justification) and received notification from the AQRP project manager to begin work. The project team held internal project progress meetings to discuss tasks and schedules. The project team also began the planned task of emissions reconciliation analysis by collecting and processing the 2014-2015 near-road and background CO and NO_x monitoring data from the selected sites in Fort Worth, Houston, and El Paso.

Over the next quarter, work will focus on continuing the emissions reconciliation analysis with processing monitoring air quality data from the selected near-road and background sites, collecting meteorological data (e.g., wind speed and wind direction), and calculating ambient-based pollutant ratios.

There were no delays or issues related to the project during this reporting time period. The project team intends to use all funds allocated to the project by 8/31/2017 to complete the planned work tasks.

Project 16-011 **STATUS: Active – Oct. 6, 2016**

A Next Generation Modeling System for Estimating Texas Biogenic VOC Emissions

Ramboll Environ US Corporation – Gregory Yarwood

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Doug Boyer

Funded Amount: $158,134

Abstract
The exchange of gases and aerosols between the Earth's surface and the atmosphere is an important factor in determining atmospheric composition and regional air quality. Emissions of reactive gases from the earth's surface drive the production of ozone and aerosol and other atmospheric constituents relevant for regional air quality. Emissions of some compounds, including biogenic volatile organic compounds (BVOCs), are highly variable and can vary more than an order of magnitude over spatial scales of a few kilometers and time scales of less than a day. This makes estimation of these emissions especially challenging and yet accurate quantification and simulation of these fluxes is a necessary step towards developing air pollution control strategies and for attributing observed atmospheric composition changes to their causes.

The overall goal of Project 16-011 is to improve numerical model predictions of regional ozone and aerosol distributions in Texas by reducing uncertainties associated with quantitative estimates of BVOC emissions from Texas and the surrounding region. Although there have been significant advancements in the procedures used to simulate BVOC emissions, there are still major uncertainties that affect the reliability of Texas air quality simulations. This includes significant gaps in our understanding of BVOC emissions and their implementation in numerical models including 1) isoprene emission factors, 2) missing compounds, and 3) and unrepresented processes including canopy heterogeneity and stress induced emissions. In this project, we will develop new emission factors and incorporate missing BVOC compounds and unrepresented BVOC emission processes into the Model of Emissions of Gases and Aerosols from Nature (MEGAN) framework. To accomplish this, we will develop a transparent and comprehensive approach to assigning isoprene and monoterpene emission factors and will update MEGAN to include additional BVOC and processes including stress induced emissions and canopy heterogeneity. We will evaluate MEGAN BVOC emission inventories for Texas and surrounding regions using surface and aircraft observations and a photochemical model.

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
During the September-November 2016 quarter, Project 16-011 was initiated and work was carried out on Task 1 and Task 3.

Task 1: Development and Application of a Transparent Approach for Estimating BVOC Emission Factor Distributions

Alex Guenther and the Ramboll Environ held a project kickoff call on November 2, 2016 to coordinate efforts on Tasks 1-3. During November, model framework for calculating BVOC emission factors was completed (Figure 1). The format of the input databases (emission measurements, specific leaf mass measurements, landcover data, and literature references) has been defined and the measurement databases have been populated with observations from the available literature. This prototype framework was developed using Microsoft Access and will be converted to an open source code during the upcoming quarter.

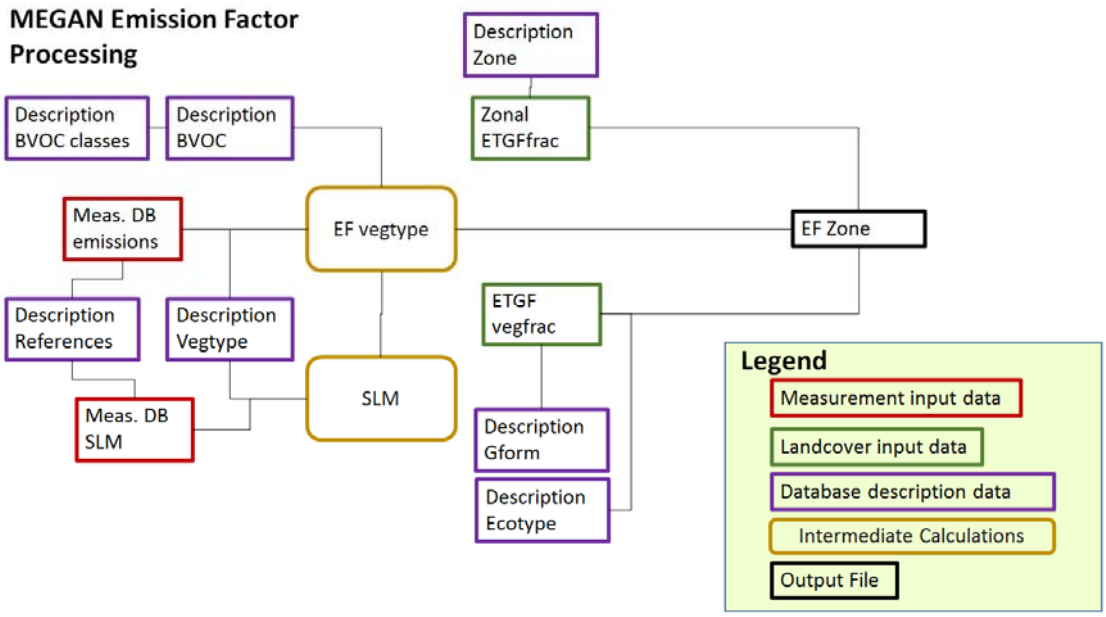

Figure 1. Schematic of MEGAN emission factor processing.

Task 2: Emission Factor Development

Task 2 has not yet been initiated.

Task 3: Development of MEGAN3

The MEGAN emission category approach was updated by adding additional compounds and by revising the emission categorization. The scheme has been integrated into the emission factor processor developed for Task 1.

Task 4: MEGAN Evaluation and Sensitivity Study

Task 4 has not yet been initiated.

Task 5: Project Management and Reporting

This task is ongoing.

The project team anticipates that all funds allocated for the project will be utilized by August 31, 2017.

Project 16-019 **STATUS: Active – Sept. 30, 2016**

The Influence of Alkyl Nitrates from Anthropogenic and Biogenic Precursors on Regional Air Quality in Eastern Texas

University of Texas at Austin – Elena McDonald-Buller
Ramboll Environ US Corporation – Gregory Yarwood

AQRP Project Manager – David Sullivan
TCEQ Project Liaison – Jim Smith

Funded Amount: $180,641
($118,019 UT Austin, $62,622 Ramboll Environ)

Abstract
Mono and multifunctional alkyl nitrates (ANs) are formed from the oxidation of biogenic or anthropogenic volatile organic compound (VOC) precursors and serve as a reservoir or sink of nitrogen oxides (NO_x). Alkyl nitrates have sufficiently long atmospheric chemical lifetimes (hours to days), such that they can influence tropospheric ozone and secondary organic aerosol (SOA) formation over regional to global spatial scales. Their functionalities, yields, and fates are known to depend upon the size and structure of the VOC. Depending on their structure, ANs can be transported, chemically processed, removed by deposition to vegetation and other surfaces, or undergo partitioning to and from the aerosol phase where hydrolysis is thought to be a loss mechanism. Although knowledge gaps still exist, recent laboratory and field studies have provided new insights on these processes for ANs formed from biogenic and anthropogenic hydrocarbon precursors. An ongoing need will be to incorporate these findings into the chemical mechanisms of photochemical models used to assess regional air quality. The objectives of this work are to apply the findings of ongoing experimental studies examining alkyl nitrates formed from the OH-initiated oxidation of C8-C11 alkanes at the University of Texas at Austin in addition to those of new publications that have focused on other hydrocarbon precursor classes relevant to Texas emissions inventories to improve how ANs are represented in the version 6 of the Carbon Bond mechanism (CB6). Revision 4 of CB6 (CB6r4) will soon be available in version 6.32 of the Comprehensive Air quality Model with extensions (CAMx v6.32). Sensitivity tests with CAMx will evaluate the formation and fate of ANs in central and southeastern Texas, the influence of ANs on regional ozone by recycling NO_x, and dependencies on organic aerosol concentrations.

Project Update
The project consists of three tasks: (1) develop modifications to the CB6r4 mechanism in CAMx, (2) evaluate the CB6r4 updates in CAMx modeling during the time period of the DISCOVER-AQ campaign through sensitivity studies that evaluate the formation and fate of ANs in central and southeastern Texas, the influence of ANs on regional ozone by recycling NO_x, and dependencies on organic aerosol concentrations, and (3) disseminate results through reporting, publications, and presentations. Project activities began in October 2016. Progress to date is described below. We anticipate that all funds allocated for the project will be utilized by August 31, 2017.

Task 1: Refinements to the CB6r4 Mechanism in CAMx

The University of Texas at Austin and Ramboll Environ teams held an initial conference call on October 26, 2016. The discussion included an update about on-going chamber experiments that are being conducted by Dr. Hildebrandt Ruiz's research group under the sponsorship of the Texas Air Research Center (TARC) to examine gas-particle partitioning and particle-phase hydrolysis rates of alkyl nitrates from straight-chained and branched alkane precursors. These experiments are expected to be important to the refinements that will be made to the CB6r4 mechanism. A literature review is ongoing and has focused to date on alkyl nitrates formed from nitrate radical oxidized monoterpenes. Ramboll Environ transferred the CAMx data to the University of Texas at Austin team, which is currently installing it at the Texas Advanced Computing Center (TACC).

Task 2. Evaluating CB6r4 Updates in CAMx Modeling for DISCOVER-AQ
Not yet initiated.

Task 3. Project Reporting and Presentation
On-going per requirements.

Project 16-031 **STATUS: Active – Oct. 18, 2016**

Condensed Chemical Mechanisms for Ozone and Particulate Matter Incorporating the Latest in Isoprene Chemistry

University of North Carolina – Chapel Hill – William Vizuete

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Jim Price

Funded Amount: $225,000

Abstract
Isoprene, the most emitted non-methane hydrocarbon on the planet, is known to influence ozone (O_3) formation in Houston, Texas. Eastern Texas and northern Louisiana feature some of the largest biogenic emission sources of isoprene in the United States. It is also now known that the photochemical oxidation of isoprene, when mixed with anthropogenic emissions from urban areas like those found in Houston, can produce significant yields of fine particulate matter ($PM_{2.5}$) through acid-catalyzed multiphase chemistry of isoprene epoxydiols (IEPOX) that leads to secondary organic aerosol (SOA) formation. Next-generation regulatory models in Houston will attempt to capture this recent discovery even though there exists great uncertainty in both gas-phase isoprene oxidation and SOA formation chemistry. This work will produce a fully updated condensed gas-phase mechanism based on SAPRC-07 and PM formation parameters suitable for use in a regulatory air quality model. The updated parameters will be evaluated against an archive of UNC smog chamber experiments, including new isoprene SOA experiments that investigate the effect of organic coatings/mixtures on the acid-catalyzed multiphase chemistry of IEPOX.

Our previously funded Air Quality Research Program (AQRP) work has directly derived the multiphase kinetics of IEPOX only on pure inorganic aerosols. In the atmosphere, however, IEPOX will more likely encounter mixed particles containing both pre-existing organics and acidic sulfate. As a result, there is a need to constrain the impact of pre-existing organics within acidic sulfate aerosol on the kinetics of IEPOX multiphase chemistry. We will also produce a regulatory air quality modeling episode focused on Houston to test these new updates in a simulated urban environment. This work directly addresses the stated priority area of improving the understanding of O_3 and PM formation and the interaction with PM precursors. Further, the regulatory air quality modeling system developed by this work can begin to address the stated priority of quantifying the impacts of uncertainty due to the treatment of atmospheric chemical processes by condensed models.

Project Update
During this quarter the project team completed the project Work Plan (Scope of Work, Quality Assurance Project Plan, and Budget and Justification) and received notification from the AQRP Project Manager to begin work.

The following progress has been made towards project goals:

Task 1 Updated SAPRC-07 and Aerosol Module for Isoprene Oxidation

Data Collected

The project team began collecting archived digital files of the experimental data needed for the evaluation of updates in the SAPRC-07 mechanism. The GRA began the training on the software needed to complete the task. The GRA also conducted literature reviews of any relevant publications and attended the recent 2016 Community Modeling and Analysis System annual conference in Chapel Hill, NC. This conference provided an opportunity to view the latest gas phase changes that maybe relevant for the project.

Goals and Anticipated Issues for the Succeeding Reporting Period

The team will continue with training on the modeling software such that the GRA is able to successfully replicate past UNC modeling applications. This will ensure the installation of the software and training. The next step will be training on the software needed to visualize the modeling results to provide meaningful analysis.

Detailed Analysis of the Progress of the Task Order to Date

The team is currently in the startup phase of this task and have begun gathering relevant data and information and training of the GRA on the tools needed for the task. The progress on the task is on schedule.

Task 2 Chamber Experiments: Interplay of Particle-Phase Composition, Phase, and Viscosity on IEPOX Multiphase Chemistry

Preliminary Analysis

The team obtained and analyzed the synthesized organic materials needed for the indoor chamber experiments. Based on this they have determined they can begin the first round of indoor chamber experiments.

Data Collected

From the first round of indoor chamber experiments the team has obtained particle concentration time profiles and size distributions. This data was collected for all three types of particles in the experiments: acidified ammonium sulfate seed particle, seed particle coated by **α**-pinene ozonolysis products (AP SOA), and IEPOX-AP SOA. Both online and offline instrumentation was used to collect data as detailed below.

Online: particle number, surface, volume concentrations and size distribution measured by Differential Mobility Analyzer; IEPOX concentrations measured by Chemical Ionization Mass Spectrometer; real time particle bulk composition measurement by Aerosol Chemical Speciation Monitor; real time ozone concentration; real time relative humidity and temperature.

Offline: two filters of 50 μg submicron particles each for each experiment for chemical characterization of particulate tracers in molecular level by GC/MS, LC/MS and UV-Vis Spectrophotometer.

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments

Issue: **α**-pinene ozonolysis products tend to nucleate instead of condensing onto inorganic seed particles

Adjustments: reduce volume of each **α**-pinene injection, use higher injection flow rate to avoid localized high concentration and wait for longer time for reaction to finish before next injection.

Goals and Anticipated Issues for the Succeeding Reporting Period
The team will finish processing all obtained data from various instruments during this first round of indoor chamber experiments. Once processed, the resulting observational data set will be analyzed and a determination will be made on whether to proceed with chamber modeling.

Detailed Analysis of the Progress of the Task Order to Date
The team has completed 3 sets of indoor chamber experiments. Each set includes an experiment with IEPOX uptake onto acidified ammonium sulfate particles coated with organic products from **α**-pinene ozonolysis and a control experiment with IEPOX uptake onto acidified ammonium sulfate. Three coating experiments were done with incremental **α**-pinene injections and hence increased particulate organic matter/organic coating thickness prior to IEPOX uptake. An acidified ammonium sulfate particle only experiment and a IEPOX only experiment were conducted to characterize the loss rates of particles and gaseous IEPOX to the chamber wall. The progress on the task is on schedule.

Task 3 Implementation in a regulatory air quality model
Data Collected
In collaboration with EPA scientists the team has obtained a regulatory CMAQ modeling episode developed to explore isoprene oxidation chemistry. EPA developed the CMAQ modeling episode for a 12 km grid resolution and spans May through June 2013. This CMAQ source code and all relevant input files have been transferred to UNC computing. Further, modeling output from EPA was also obtained for QA/QC of our installation. The team has also obtained SOAS2013 data needed for evaluation of results.

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments
There were several technical issues in compiling the CMAQ source code onto the UNC computing cluster. To overcome this the team relied on internal expertise to debug the issue and compile a version of CMAQ on the cluster. The data transfer of input files for CMAQ from EPA resulted in a flattened directory structure. Time was spent rebuilding the file structure. Currently, the team is dealing with run time bugs due to inconsistent input data structure and missing files. The team is working with EPA to identify these missing files.

Goals and Anticipated Issues for the Succeeding Reporting Period
The team will continue to debug the run time issues and will produce a base simulation run. Then the team will QA/QC this base run by comparing to EPA simulation output produced by the EPA computing clusters. The team will also begin to compile observational PM data relevant to Houston.

Detailed Analysis of the Progress of the Task Order to Date
The team has spent time training the GRA on the CMAQ modeling system. The GRA is also being familiarized with both explicit and CMAQ model representations of isoprene to PM reaction pathways. In parallel with these efforts the team has successfully compiled CMAQ 5.2 onto the UNC computing cluster.

Project 17-007 **STATUS: Active – Nov. 3, 2016**

Evaluating Methods for Determining the Vapor Pressure of Heavy Refinery Liquids

University of Texas at Austin – Vincent Torres

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Russell Nettles

Funded Amount: $205,500

Abstract
During the last five years, crude oil and natural gas production and petroleum refinery operations have seen an increased focus on their emissions of volatile organic compounds (VOCs), hazardous air pollutants (HAPS) and greenhouse gases (GHGs), especially those from storage tanks. These actions have been taken by the United States Environmental Protection Agency (US EPA) "because EPA and state investigations have identified Clean Air Act compliance concerns regarding significant emissions from storage vessels, such as tanks or containers at onshore oil and natural gas production facilities" and to "collect information on processing characteristics, crude slate, emission inventories, and limited source testing to fill information gaps". State and federal laws require certain facilities to design, install, operate and maintain effective pollution control measures to minimize the emissions of VOCs and HAPs. For example, the federal New Source Performance Standards for Crude Oil and Natural Gas Production "requires that new, reconstructed or modified storage vessels with the potential for VOC emissions of equal to or greater than six tons per year reduce VOC emissions by at least 95%." The Texas Commission on Environmental Quality (TCEQ) funded two projects recently to better understand the composition and properties of heavy refinery liquids and the most appropriate method of determining their true vapor pressure (TVP).

The purpose of this research is to improve the estimates of VOC emissions from storage tanks holding heavy refinery liquids. These tanks are found at storage terminals and refineries and are frequently heated in order to reduce the viscosity of their contents and make them pumpable. Evidence is mounting that the emissions from these tanks are underreported and may explain some of the VOC inventory gap in parts of Texas.

During the course of this project, the most accurate, reliable, convenient, and reasonably priced means of measuring the TVP of heavy refinery liquids stored in tanks will be identified. Identifying an appropriate means of measuring the TVP of these heavy refinery liquids is important because direct measurement of VOC emissions from storage tanks is inherently inexact and expensive, so equations are used to estimate emissions from storage tanks. The value used for the TVP in these equations has a profound impact on the results. The results of this research will facilitate efforts being made by the US EPA, TCEQ, and agencies in other states to better understand, more accurately estimate, and manage emissions from tanks holding heavy refinery liquids.

Project Update
Project 17-007 was issued a start date of November 3, 2016. In the past three weeks since then, project personnel made progress on the following activities:

- Initiating and holding weekly project team calls

- Seeking and obtaining approval to constitute a Technical Advisory Committee, subject to parameters established by AQRP
- Beginning work on identifying sources for the materials that will be used as vapor pressure test samples of heavy refinery liquids for the project
- Contacted EPA about being a potential source for material for test samples of heavy refinery liquids. Learned that they will not be able to do so.
- Contacted John McDonald about providing material for test samples of heavy refinery liquids
- Contacted Peter Weaver about sourcing material for test samples of heavy refinery liquids
- Contacted John Molloy at NIST about where the vapor pressure data on the safety data sheet for their No. 6 oil standards came from and about sourcing samples; they sent us some No. 6 oil and he put the project team in touch with the NIST lead on vapor pressure measurements
- Prepared a list of questions for Traci Johnson at IMTT, talked to her and exchanged emails about sourcing material for tests samples of heavy refinery liquids, her experience with using the Grabner and an Eralytics instruments to measure the vapor pressure of heavy refinery liquids, her experience with heated sampling pistons, etc.
- Obtained initial samples (1 liter) of No. 6 oil and asphalt to use to "test" the ability of the Grabner instrument before proceeding with its purchase
- Obtained access to a flammable storage refrigerator for samples
- Arranged for an on-site demonstration of the Grabner minivap instrument using the No. 6 and asphalt samples for December 14 and cleared space in a lab walk-in hood for possible demo test location.
- Contacted Arash Kiani of Eralytics to arrange on-site demo of their instrumentation
- Initiated development of a sample preparation standard operating procedure (SOP) for the heavy refinery liquids
- Initiated development of a procedure to prepare a mixture with a "known" vapor pressure similar to the storage vapor pressure of No. 6 oil and liquid asphalt
- Initiated development of a spreadsheet version of the NIST-modified UNIFAC model to identify any non idealities in our "known" vapor pressure mixture and also to assess the viability of using GC-MS to quantify the lighter ends in heavy refinery liquids along with Raoult's Law in order to estimate the vapor pressure of these liquids
- Prepared a work plan that combines elements of the project SOW with elements of the QAPP and contacted six people (a mix of industry, regulatory personnel, and scientists) to ask them if they would be willing to review the work plan
- Developed more accurate estimates for the minimum amount of material of the heavy refinery liquids that will be need for each type of material sample
- Studied CARB Method 310 (an adjunct to D2879), centering on the de-gassing step, and investigated equipment needed to use CARB 310/ASTM D2879
- Contacted Castrol and Radco about the provenance of their vapor pressure data

- Researched viable sources/databases, including the accreditation agency which does not have a search-by-method feature, to identify labs accredited for ASTM methods D2879, D323, and E1719 for vapor pressure measurements
- Investigated use of the center's environmental chamber for its potential use as a testing site for the minivap technique

The project team did not have any delays or issues related to the project during the reporting period.

Project 17-024 **STATUS: Active – Oct. 17, 2016**

Improving the Modeling of Wildfire Impacts on Ozone and Particulate Matter for Texas Air Quality Planning

Atmospheric and Environmental Research, Inc. – Matthew Alvarado

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Erik Gribbin

Funded Amount: $170,039

Abstract
Fires can have a large impact on ozone and particulate matter concentrations, and thus air quality, in Texas. Current air quality models (also called chemical transport models) take estimates of the primary emissions from biomass burning (such as forest and grass fires) and unphysically dilute them, which can lead to incorrect estimates of the impact of biomass burning on air quality. Smaller scale models like AER's Aerosol Simulation Program allow us to examine the chemical and physical transformations of trace gases and aerosols within biomass burning plumes and to develop new methods for accurately including this aging process in standard air quality models. In this project, we will improve our understanding of the impacts of local and out-of-state fires on air quality in Texas by implementing an improved approach for modeling the near-source chemistry of biomass burning plumes into the CAMx (Comprehensive Air Quality Model with Extensions) model used in Texas air quality planning. This improved approach will allow CAMx to better represent the impact of forest and grass fires on air pollutants such as ozone and fine particulate matter ($PM_{2.5}$). We will also investigate the impact that long-range transport of wildfire smoke has on air quality in Texas. This project thus addresses two strategic topics of the Texas Air Quality Research Program: "Improving the understanding of ozone and particulate matter (PM) formation [and] the interactions of ozone and PM precursors" and "Investigating global, international, and regional transport of pollutants using data and modeling analyses."

Project Update
The overarching goal of this project is to use an advanced smoke plume chemistry model (AER's Aerosol Simulation Program, or ASP) to improve understanding of the formation of O_3 and $PM_{2.5}$ in biomass burning (BB) plumes, and improve estimates of the impacts of in-state and out-of-state biomass burning on Texas air quality. The project is split into the following two tasks:

- To develop and evaluate an improved sub-grid scale parameterization of biomass burning for CAMx based on ASP coupled with the large eddy simulation model SAM (SAM-ASP) and an analysis of O_3 and SOA production in fire plumes observed during BBOP.

- To explore the impact of BB plumes on the boundary conditions used for CAMx and the resulting impact on Texas air quality with ASP coupled with the Lagrangian particle dispersion model STILT (STILT-ASP).

The project began on October 17th in this reporting period. The progress to date and challenges encountered for each task are discussed below. The current estimate is that all of the funds allocated to this project will be used by 08/31/2017.

Task 1: Develop improved parameterization and assess the impact on Texas air quality

Preliminary runs of the coupled SAM-ASP model were performed and the formation of O_3 and other pollutants in these simulations were evaluated against the box model simulations of the Williams fire performed by Alvarado et al. (2015). These initial evaluations uncovered errors in the simulations due to incorrect photolysis inputs, which were then fixed during the reporting period. However, the coupled model appears to be underestimating the horizontal diffusion of the plume for this case, leading to an overestimate of CO concentration downwind. The causes for this are currently being investigated.

Task 2: Investigate the impact of long-range transport of BB pollution on Texas air quality

The CO mixing ratios along the outer boundary of the TCEQ 2012 modeling episode are being investigated for areas where the concentrations are above 120 ppb on the western and southern borders, indicating potential long-range transport of biomass burning pollution. Satellite observations of fire locations, CO, and aerosol optical depth over Asia and the Pacific are also being used to investigate potential areas of long-range BB transport. Once these areas are identified, they will be simulated with STILT-ASP to determine how this "Lagrangian" estimate of the impact of fires on the boundary conditions for CO, O_3, NO_y species, OA, etc., differs from the "Eulerian" estimate from GEOS-Chem. Sensitivity runs of CAMx where the boundary concentrations attributable to biomass burning are perturbed by 20% will also be performed to investigate the impacts of long-range biomass burning transport on Texas air quality.

Alvarado, M. J., C. R. Lonsdale, R. J. Yokelson, S. K. Akagi, H. Coe, J. S. Craven, E. V. Fischer, G. R. McMeeking, J. H. Seinfeld, T. Soni, J. W. Taylor, D. R. Weise, and C. E. Wold (2015), Investigating the Links Between Ozone and Organic Aerosol Chemistry in a Biomass Burning Plume from a Prescribed Fire in California Chaparral, *Atmos. Chem. Phys.*, 15, 6667–6688, doi:10.5194/acp-15-6667-2015.

Project 17-032 **STATUS: Work Plan Under Review**

Spatial Mapping of Ozone Formation near San Antonio

Drexel University – Ezra Wood

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Mark Estes

Funded Amount: $59,000

Abstract
Ozone (O_3) is the main component of smog and causes adverse effects on human health, especially to sensitive groups such as children and the elderly. Unlike "primary" pollutants which are emitted directly from vehicles and industrial processes, ozone is formed in the atmosphere from photochemical reactions involving volatile organic compounds (VOCs) and nitrogen oxides ("NO_x"). In order for San Antonio to comply with the new National Ambient Air Quality Standard for ozone of 70 ppb, regulators will need to make science-based decisions on effective mitigation strategies, including emission reduction programs. Such decisions will require knowledge of the amount of ozone that is transported into the city from upwind regions (usually located southeast of San Antonio), the absolute rates of ozone formation in and around San Antonio, the relative importance and interaction of emissions from various sources (e.g., upwind oil and gas activity and urban emissions from the city itself), and when and where ozone formation occurs under "NO_x-limited" or "VOC-limited" conditions. In contrast to Houston and Dallas, little is known about ozone formation in San Antonio. This research project will address this major shortcoming and elucidate the mechanisms and rates of ozone formation that affect air quality in San Antonio using novel measurements of peroxy radicals aboard a mobile supersite during a 3-week field project during late spring of 2017. Instantaneous ozone production rates $P(O_3)$ will be quantified aboard the Aerodyne Mobile Laboratory using new but tested measurements of total peroxy radicals. These measurements will be used to "map" the rate of ozone formation upwind, downwind, and inside of the urban core of San Antonio. Measurements of organic nitrates will also be used to investigate the role of alkanes and organic nitrate formation as a terminator of ozone chemistry.

The main goals of the project are to quantify how much ozone is produced inside the city compared to upwind, and to quantify the role of alkanes in ozone formation.

Project Update
When the AQRP notified the investigator that this project was selected for funding, the investigator informed the AQRP that he had moved from the University of Massachusetts – Amherst (UMass), from which the project had been submitted, to Drexel University. Initial activities concerned the transfer of the proposal and award from UMass to Drexel. Once that was complete, project activities focused on the development of the Work Plan. At this time the AQRP has submitted the Work Plan to the TCEQ Liaison for final review.

Project 17-039 **STATUS: Active – Nov. 16, 2016**

Use of Satellite Data to Improve Specifications of Land Surface Parameters

University of Alabama - Huntsville – Richard McNider

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Bright Dornblaser

Funded Amount: $149,227

Abstract
It is the purpose of this proposal to continue a process to evaluate and improve the performance of the land surface models used in WRF by the use of satellite skin temperatures to better specify physical parameters associated with land use classes. Improved temperature performance impacts biogenic emissions, thermal decomposition (chemical chain lengths and slopes of ozone/NOy curves) and thermally driven winds. Also, land surface parameters control surface deposition which impacts the efficacy of long-range transport. Physical parameters such as heat capacity, thermal resistance, roughness, surface moisture availability, albedo etc. associated with a land use class are actually used in the land surface model. Many of the land use class associated parameters such as surface moisture availability are dynamic and ill-observed depending on antecedent precipitation and evaporation, soil transport, the phenological state of the vegetation, irrigation applications etc. Other parameters such as heat capacity, thermal resistance or deep soil temperature are not only difficult to observe they are often unknowable *a priori*. Despite the difficulty in specifying these parameters they are incredibly important to model predictions of turbulence, temperature, boundary layer heights and winds.

This proposal is directed toward the Meteorology and Air Quality Modeling and Biogenic Emissions Priority. Biogenic emissions are highly sensitive to temperature. Improvement in temperature predictions in conjunction with improved radiation inputs into biogenic emission model (MEGAN or BEIS) should increase the quality of biogenic emissions. The proposal is responsive to three areas in the Meteorology and Air Quality Modeling Priority- (1) boundary layer performance can impact local circulations driven by thermal gradients and the strength of low level jets is controlled by nighttime surface cooling rates; (2) boundary layers can impact clouds both boundary layer topped cumulus and clouds in sea breeze convergence zones; (3) dry deposition of ozone and nitrogen species is often controlled by stomatal uptake which depends on soil moisture.

The proposal will continue and expand activities under a 2015 funded AQRP project using satellite observed skin temperatures. That project was a late selected reduced scope project. Despite some initial issues with a NOAA skin temperature data set, the project ended up showing improvement in model performance for skin temperatures and in wind performance. However, the improvements were not as large as in previous uses of skin temperature data. Part of this may be due to following the Pleim-Xiu air temperature approach in the project, in which absolute differences between model and observed skin temperatures were used rather than skin temperature tendencies. Differences between the model and satellite skin temperatures not related to the boundary layer parameters such as emissivity or atmospheric correction in the satellite product might be an issue. Under this activity skin temperature tendencies will be tested

instead which avoids such problems. The DISCOVER AQ period of 2013 was an unusually cloudy and windy period over most of the Eastern U.S. and not characteristic of the conditions usually associated with ozone episodes in Texas. While significant effort went into QA for the skin temperature data set, cloud contamination in the skin temperatures may still be an issue. Under the current activity alternative skin temperature products such as MODIS data will used in conjunction with the tendency method that may reduce cloud contamination issues. Also, in consultation with TCEQ additional periods such as TEXAQS 2006 or the 2012 SIP period will be examined. Finally, the work on the previous project included emphasis on the large 12-km domain. Under this activity a greater emphasis will be given to fine scale model performance around Houston and Dallas. Particular attention will be given to wind changes due to changes in boundary layer parameters including changes in sea breezes and low level jets.

Project Update

During the quarter being reported, the project team completed the Work Plan, and received approval to begin work on November 16, 2016. The progress to date and challenges encountered for each task are discussed below. The current estimate is that all of the funds allocated to this project will be used by 08/31/2017.

(1) *Additional Model Test Period:* As noted in the proposal for this project, the Discover AQ period was not a particularly representative period for air quality concerns. Many active fronts and pervasive cloudiness dominated the period. Thus, as part of this year's effort an additional modeling period was to be chosen in conjunction with TCEQ. After discussion with TCEQ it was decided that the period July 1, 2012 – August 31, 2012 would be the new period. The drier 2012 year is a contrast to the 2013 Discover AQ period. This period may coincide with potential SIP work in in Texas.

(2) *Sources of Skin Temperature Data:* In last's years project for the Discover AQ 2013 period it was found that the NOAA operational skin temperature product (GSIP) had unrealistic values (too warm) especially in the Western U.S. when compared to both MODIS and two other geostationary skin temperature products. In order to have more realistic skin temperatures another NOAA product was obtained for the Discovery AQ period. However, this required special processing by NOAA. In order to be able to provide skin temperature data for other periods such as 2012 period (see above), NOAA has provided their processing code. This code has been installed at UAH and preliminary tests run. This system will be used to process data for the 2012 period and provide 24 hour skin temperature data. Additional cloud mask/detection algorithms developed by UAH will be added to the processing step. It is anticipated that the 2012 data can be processed by January 30, 2017.

(3) *Time Scales for Skin Temperature Assimilation:* In last year's project morning satellite skin temperature was used to adjust surface moisture and late afternoon skin temperature was used to adjust surface heat capacity. As part of this year's activity several sensitivity runs have been made using different periods for data assimilation, e.g 7:00AM – 10:00AM or 7:00AM – 12:00Noon. Based on performance statistics an optimal period will be chosen.

Project 17-053 **STATUS: Work Plan Under Review**

Identifying and Apportioning Ozone Producing VOCs in Central American Fires

Aerodyne Research, Inc. – Scott Herndon

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Mark Estes

Funding Amount Approved by Advisory Council: $185,193

Abstract
Aerodyne Research, Inc. will conduct measurements using a mobile laboratory as a portable photochemistry super site to study ozone production and the emission sources that ultimately impact air quality in central Texas. Work will be done at locations upwind, downwind and lateral to San Antonio. The suite of instrumentation has been selected to quantify key oxygenated volatile organic carbon species (OVOC) and nitrogen containing species (e.g. alkyl nitrates) to pinpoint and apportion ozone within broad categories of VOC emission sectors. The instrument payload will also directly quantify the instantaneous production rate of ozone to determine whether the chemical regime is NOx limited or VOC limited. An additional component of this research project will be to characterize emission sources associated with oil and natural gas production in the Eagle Ford Shale play, including active medium to large processing flares, as well as oil and condensate tanks at wellpads.

The project will provide scientific insight into the VOCs that are contributing to the ozone in central Texas. The effectiveness of mitigation strategies will be informed by these results. This work will isolate ozone production due to VOC oxidation from biogenic sources, refinery emissions, emissions from oil producing well pads and emissions from natural gas production. The dataset will inherently contain regional transport of emissions and processed air. The project will quantify local ozone production rates and evaluate the ozone sensitivity regime.

Project Update
There was a delay in the initial submission of the Work Plan for this project, and it was not received until mid-October. As the project activities are not scheduled to begin until 2017, the delay does not present any complications in the completion of the activities. The Work Plan has undergone review and the investigator is currently completing requested edits to the QAPP. This is the final set of edits before submission to the TCEQ Liaison.

FINANCIAL STATUS REPORT

Initial funding for fiscal years 2016 and 2017 was established at $1,000,000 each, for a total award of $2,000,000 for the FY 2016/2017 biennium. The funds were distributed across several different reporting categories as required under the contract with TCEQ. The reporting categories are:

Program Administration – limited to 10% of the overall funding (per Fiscal Year)
This category includes all staffing, materials and supplies, and equipment needed to administer the overall AQRP. It also includes the costs for the Council meetings.

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

Project Management – limited to 8.5% of the funds allocated for Research Projects
Each research project will be 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.

During the reporting period 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. Maria Stanzione, AQRP Program Manager, with Terri Mulvey Melanie Allbritton, and Susan McCoy each provided assistance with program organization and financial management. Denzil Smith is responsible for the AQRP Web Page development and for data management.

Fringe benefits for the administration of the AQRP were initially budgeted to be 24% of salaries and wages across the term of the project. It should be noted that this was an estimate, and actual fringe benefit expenses are reported for each month. The fringe benefit amount and percentage fluctuate each month depending on the individuals being paid from the account, their salary, their FTE percentage, the selected benefit package, and other variables. For example, the amount of fringe benefits is greater for a person with family medical insurance versus a person with individual medical insurance. Actual fringe benefit expenses to date are included in the spreadsheets below.

Table 3: Administration Budget

Administration Budget (includes Council Expenses)
FY 2016/2017

Budget Category		FY16 Budget	FY17 Budget	Total	Expenses	Remaining Balance
Personnel/Salary		$70,040.00	$70,040.00	$140,080.00	$66,420.95	$73,659.05
Fringe Benefits		$16,806.00	$16,806.00	$33,612.00	$15,970.85	$17,641.15
Travel		$150.00	$150.00	$300.00	$34.00	$266.00
Supplies		$6,000.00	$6,000.00	$12,000.00	$57.49	$11,942.51
Equipment						
Total Direct Costs		$92,996.00	$92,996.00	$185,992.00	$82,483.29	$103,508.71
Authorized Indirect Costs		$7,004.00	$7,004.00	$14,008.00	$6,642.10	$7,365.90
10% of Salaries and Wages						
Total Costs		**$100,000.00**	**$100,000.00**	**$200,000.00**	**$89,125.39**	**$110,874.61**

ITAC

All ITAC expenses for FY 2016 were accounted for by the end of September. Since the remaining funds would not be utilized under this category, $6,216 was transferred to the Contractual/Research Project category to increase the FY 2016 funds available to the Research Projects and $2,784 was transferred to Project Management.

Table 4: ITAC Budget

ITAC Budget
FY 2016/2017

Budget Category		FY16 Budget	FY17 Budget	Total	Expenses	Remaining Balance
Personnel/Salary						
Fringe Benefits						
Travel		$4,900.00	$10,000.00	$14,900.00	$4,076.57	$10,823.43
Supplies		$1,100.00	$5,000.00	$6,100.00	$1,079.20	$5,020.80
Total Direct Costs		$6,000.00	$15,000.00	$21,000.00	$5,155.77	$15,844.23
Authorized Indirect Costs						
10% of Salaries and Wages						
Total Costs		**$6,000.00**	**$15,000.00**	**$21,000.00**	**$5,155.77**	**$15,844.23**

Project Management

Project Management funds were increased by $2,784 from the reduction in ITAC funds. The funds were distributed across the salary, fringe benefit, and IDC categories. In addition, the funds budgeted in the Other category, which are reported under the Project Management table, were reduced by $3,000 and moved to Contractual/Research Projects, as estimated costs for data storage (to be paid from the Other category) have decreased significantly. Currently, Project Management funds are budgeted at 8.22% of Contractual/Research Project funds, below the 8.5% threshold.

Table 5: Project Management Budget

Project Management Budget
FY 2016/2017

Budget Category		FY16 Budget	FY17 Budget	Total	Expenses	Remaining Balance
Personnel/Salary		$46,078.00	$44,000.00	$90,078.00	$34,918.31	$55,159.69
Fringe Benefits		$11,098.00	$10,600.00	$21,698.00	$7,402.15	$14,295.85
Travel		$500.00	$500.00	$1,000.00	$0.00	$1,000.00
Supplies		$5,500.00	$5,500.00	$11,000.00	$0.00	$11,000.00
Other		$2,000.00	$5,000.00	$7,000.00	$0.00	$7,000.00
Total Direct Costs		$65,176.00	$65,600.00	$130,776.00	$42,320.46	$88,455.54
Authorized Indirect Costs		$4,608.00	$4,400.00	$9,008.00	$3,491.83	$5,516.17
10% of Salaries and Wages						
Total Costs		**$69,784.00**	**$70,000.00**	**$139,784.00**	**$45,812.29**	**$93,971.71**

Research Projects

A total of $1,630,000.00 was originally budgeted for research projects. During this quarter those funds were increased by $9,216, due to the reduction in funds allocated to Other and ITAC, as described above. A total of ten (10) projects were selected for funding out of fifty four (54) proposals submitted to the AQRP RFP for the 2016-2017 biennium. It is anticipated that $1,593,175.00 will be allocated to the 2016-2017 projects, pending final approval of project budgets. Table 6 on the following page shows the distribution of the projects across the fiscal years and the cumulative expenditures to date.

Table 6: Contractual/Research Project Budget

Contractual Expenses				
FY 16 Contractual Funding		**$815,000**		
FY 16 Contractual Funding Transfers		**$9,216**		
FY 16 Total Contractual Funding		**$824,216**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
16-008	University of Houston	$191,366	$0.00	$191,366.00
16-010	Sonoma Technology, Inc.	$69,075	$0.00	$69,075.00
16-011	Ramboll Environ	$158,134	$0.00	$158,134.00
16-019	Univ. of Texas - Austin	$118,019	$20,408.91	$97,610.09
16-019	Ramboll Environ	$62,622	$0.00	$62,622.00
16-031	UNC - Chapel Hill	$225,000	$0.00	$225,000.00
FY 16 Total Contractual Funding Awarded		$824,216		
FY 16 Contractual Funds Expended (Init. Projects)			$20,408.91	
FY 16 Contractual Funds Remaining to be Spent				$803,807.09
FY 17 Contractual Funding		**$815,000**		
FY 17 Contractual Funding Transfers		**$0**		
FY 17 Total Contractual Funding		**$815,000**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
17-007	Univ. of Texas - Austin	$205,500	$5,825.14	$199,674.86
17-024	Atmospheric and Environmental Research, Inc.	$170,039	$9,303.56	$160,735.44
17-032	Drexel University		$0.00	$0.00
17-039	Univ. of Alabama - Huntsville	$149,227	$0.00	$149,227.00
17-053	Aerodyne Research, Inc.		$0.00	$0.00
FY 17 Total Contractual Funding Awarded		$524,766		
FY 17 Contractual Funding Expended (Init. Projects)			$15,128.70	
FY 17 Contractual Funds Remaining to be Spent				$799,871.30
Total Contractual Funding		$1,639,216		
Total Contractual Funding Awarded		$1,348,982		
Total Contractual Funding Remaining to be Awarded		$290,234		
Total Contractual Funds Expended to Date			$35,537.61	
Total Contractual Funds Remaining to be Spent				$1,603,678