AIR QUALITY RESEARCH PROGRAM

Texas Commission on Environmental Quality
Contract Number 582-10-94300
Awarded to The University of Texas at Austin

Annual Report

September 1, 2013 through August 31, 2014

Submitted to

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Texas Air Quality Research Program

Annual Report

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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.

On April 30, 2010, the Texas Commission on Environmental Quality (TCEQ) contracted with the University of Texas at Austin to administer the AQRP. For the 2010-2011 biennium, the AQRP had approximately $4.9 million in funding available. Following discussions with the TCEQ and an Independent Technical Advisory Committee (ITAC) concerning research priorities, the AQRP released its first request for proposals in May, 2010. Forty-five proposals, requesting $12.9 million in research funding were received. After review by the ITAC for technical merit, and by the TCEQ for relevancy to the State's air quality research needs, the results of the reviews were forwarded to the AQRP's Advisory Council, which made final funding decisions in late August, 2010. A total of 15 proposals were selected for funding. As of November 30, 2011, all projects have been completed. Final reports have been posted to the AQRP website.

In June 2011, the TCEQ renewed the AQRP for the 2012-2013 biennium. Funding of $1,000,000 for the FY 2012 period was awarded in February 2012. An additional $1,000,000 for the FY 2013 period was awarded in June 2012. At the same time an additional $160,000 was awarded for FY 2012, to support funding for two specific air quality projects recommended by the TCEQ. A call for proposals was released in May 2012. Thirty-two proposals, requesting $5 million in research funding were received. The proposals were reviewed by the ITAC and the TCEQ. The Advisory Council selected 14 projects for funding.

In June 2013, the TCEQ issued Amendment 9 to the AQRP grant. This amendment had two purposes, 1) it renewed the AQRP for the 2014-2015 biennium (but did not award any funding for that biennium), and 2) it awarded an additional $2,500,000 in FY 2013 funds. Ten percent (10%) of these funds were allocated for Project Administration, and the remaining funds were allocated to the Research program per the terms of the AQRP grant. A portion of the research funds were awarded to the 2012-2013 Discover-AQ Ground Sites Infrastructure Support project, in order to expand logistical support for the Discover-AQ study, at the request of TCEQ and with the Advisory Council's approval.

All 2012 – 2013 research projects were completed by November 30, 2013. The final reports for the projects have been posted to the AQRP website. All FY 2012 funds were fully expended and the remaining FY 2013 funds were held for use on future projects.

After the TCEQ issued Amendment 9 to renew the grant, the AQRP developed the FY 2014/2015 research priorities and submitted them to the ITAC for input and to the TCEQ for review. Funding of $1,000,000 for FY 2014 and $1,000,000 for FY 2015 was awarded via Amendment 10 in October 2013. A call for proposals was released and by the November 22, 2013 due date, 31 proposals requesting $5.8 million in research funding were received. In December and January the ITAC and the TCEQ reviewed the proposals. On February 21, the Advisory Council selected 15 projects for funding, with one project on hold while TCEQ completed their review. These projects were funded with a combination of FY 2013, 2014, and 2015 funds.

In early March, project Principal Investigators (PIs) were notified of the decision of the Advisory Council. AQRP Project Managers and TCEQ Project Liaisons were assigned to each project. A kick-off call was held with the project teams to discuss the development of the Work Plans which consist of the project scope of work, budget and justification, and quality assurance project plan (QAPP). The TCEQ completed their review of the final projects to be recommended for funding and the Council approved the final project on April 2, 2014.

During the spring and summer, project administration staff focused on putting contracts in place with each entity involved in the research projects. Project Managers worked with the project teams to complete and approve the Work Plans. As of August 31, 2014, all project Work Plans were approved, one project entity was still negotiating the Master Agreement with UT, and all other projects had begun work. An update of the status of each project is listed in the Research Projects section of this report.

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 April 30, 2010 for the 2010-2011 biennium, and was renewed in June 2011 for the 2012-2013 biennium and in June 2013 for the 2014-2015 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 being 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, 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 a Project Manager at UT-Austin and a Project Liaison at TCEQ. The project manager at UT-Austin 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 Project Manager has responsibility for documenting progress toward project measures of success for each project. The Project Manager works with the researchers, and the TCEQ, to create an approved work plan for the project.

   The 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 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 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.

Steps 1 – 9 have all been completed for both the 2010-2011 and 2012 - 2013 biennia. For the 2014-2015 biennium Steps 1 through 6 have been completed. Steps 7 and 8 are in progress.

Independent Technical Advisory Committee (ITAC)

The AQRP funding is used primarily for research projects, and one of three groups responsible for selecting the projects is the Independent Technical Advisory Committee (ITAC). The ITAC, composed of up to 15 individuals with scientific expertise relevant to the Program, is charged with recommending technical approaches, and establishing research priorities. Initially, the ITAC was to meet at least twice per year at locations rotating between Austin, Dallas and Houston. As the Program proceeded, it was more efficient for the ITAC to meet once in Austin and as needed via conference call/webinar. Generally, the meetings in Austin are dedicated to new project review, reviewing progress on funded projects, and reviewing the Program's strategic plan.

Members of the ITAC consist of the TCEQ Project Director (or designee), representatives with air quality expertise from research institutions with extensive expertise in air quality research in Texas. 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 members of the ITAC are listed in Table 1.

As 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 requires that the AQRP shall 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 conflict of interest and confidentiality provisions prior to participating in the review of proposals.

Table 1: Members of the Independent Technical Advisory Committee

Name	Title	Organization
David Allen	Gertz Regents Professor in Chemical Engineering	The University of Texas at Austin
Peter Daum	Head, Atmospheric Science Division	Brookhaven National Lab
Mark Estes	Senior Air Quality Scientist Air Modeling and Data Analysis Section	Texas Commission on Environmental Quality
Fred Fehsenfeld	Senior Scientist, Cooperative Institute for Research in Environmental Sciences	University of Colorado - Boulder
Sarwar Golam	Research Physical Scientist, Atmospheric Modeling and Analysis Division, Office of Research and Development	U.S. Environmental Protection Agency
Robert Griffin	Associate Professor, Civil and Environmental Engineering	Rice University
Tho (Thomas) Ching Ho	Chairman, Dan F. Smith Dept. of Chemical Engineering	Lamar University
Kuruvilla John	Professor of Mechanical and Energy Engineering Associate Dean for Research and Graduate Studies	University of North Texas
Barry Lefer	Associate Professor, Department of Earth and Atmospheric Sciences	The University of Houston
John Nielsen-Gammon	Professor and Texas State Climatologist Center for Atmospheric Chemistry and the Environment	Texas A&M University
David Parrish	Program Lead, Tropospheric Chemistry, NOAA/ESRL/Chemical Sciences Division	National Oceanic and Atmospheric Administration
Jay Turner	Associate Professor of Energy, Environmental and Chemical Engineering	Washington University in St. Louis
William Vizuete	Associate Professor, Gillings School of Global Public Health	The University of North Carolina at Chapel Hill
Christine Wiedinmyer	Scientist II, Atmospheric Chemistry Division	Nation Center for Atmospheric Research
Greg Yarwood	Principal	Environ

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 up to 11 members, all residents of the State of Texas. 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 include government officials from Texas Near-Non-Attainment Areas active in air quality management. The purpose of the Council is to give final approval to projects recommended by the ITAC and TCEQ, and to provide guidance on the Strategic Plan. At least one meeting in Austin is dedicated to new project selection. Additional meetings, either in person or via webinar, and email updates are dedicated to providing summaries of on-going projects and review of the strategic plan.

Table 2: Members of the Advisory Council

Name	Title	Organization
Ramon Alvarez	Senior Scientist	Environmental Defense Fund
Daniel Baker	Senior Consultant in Air Quality	Shell Global Solutions
Sam Biscoe	County Judge	Travis County
Jeff Branick	County Judge	Jefferson County
Edward M. Emmett	County Judge	Harris County
Ralph B. Marquez	Former TCEQ Commissioner	Environmental Strategies and Policy
Keith Self	County Judge	Collin County
Kim Herndon	Assistant Director Air Quality Division	Texas Commission on Environmental Quality
TCEQ 2	Pending appointment by TCEQ	

PROJECT TIMELINE

During the project period covered by this report (September 1, 2013-August 31, 2014), five primary activities took place:

- FY 2012-2013 projects completed
- Data Workshop
- New funding for FY 2014-2015
- A Request for proposals (RFP) issued for FY 2014-2015
- FY 2014-2015 projects selected/funded

September 2013 – November 2013

At the beginning of fiscal year 2013-2014, the FY 2012-2013 projects were still active. The Discover-AQ activities (see description under Research Projects) took place in September. On November 14, 2013, the AQRP hosted a Data Workshop at The University of Texas at Austin's Pickle Research Campus. A representative from each project presented a report on research project findings and recommendations to the TCEQ, AQRP, and to the other AQRP researchers. All FY 2012-2013 projects ended on November 30, 2013, and final reports were submitted to the Project Managers for review.

Funding of $1,000,000 for FY 2014 and $1,000,000 for FY 2015 was awarded via Amendment 10 in October 2013. A call for proposals was released and by the November 22, 2013 due date, 31 proposals requesting $5.8 million in research funding were received.

Program Administration during this period focused on the payment of monthly invoices for projects, reporting activities, the planning and execution of the Data Workshop, and the issuance of the RFP.

Table 3 under Research Projects, page 13, lists all FY 2012-2013 Research Projects, the amount they were funded, the amount they expended, and the amount they returned to the AQRP.

December 2013 – Feb 2014

During the second quarter of FY 2013-2014, Program Administration focused on the close-out and final payment of invoices for projects, as well as the completion of reporting activities. Project Managers and TCEQ Liaisons completed the review of the Final Reports.

Once all reviews were completed, the Final Report for each project was posted on the AQRP website at http://aqrp.ceer.utexas.edu/projects.cfm. All Final Reports have been posted to the website. Principal Investigators notified Project Managers and TCEQ Liaisons of impending publications developed from the AQRP Projects. A reference list of the publications from all AQRP projects can be found in Appendix D.

The ITAC conducted the scientific and technical review of the proposals received under the FY 2014-2015 RFP via a conference call on December 17, 2013 and in a meeting held in Austin, Texas, on January 10, 2014. Seven proposals were highly recommended for funding; seven

proposals were recommended for funding; five proposals were recommended for funding, if additional funds were available; and twelve proposals were not recommended for funding.

On January 13, 2014, the project proposals and ITAC recommendations were forwarded to TCEQ. The TCEQ evaluated the project recommendations from the ITAC and provided comment on the relevancy of the projects to the State's air quality research needs. The TCEQ recommended for funding thirteen (13) of the fourteen (14) proposals that the ITAC either highly recommended or recommended, and two (2) of the five (5) proposals that the ITAC recommended if funding was available. While it was ultimately recommended, the TCEQ took additional time to review one of the proposals that was recommended by the ITAC until after the initial Advisory Council meeting, held on February 21, 2014. On this date, the Advisory Council selected 15 projects for funding.

March 2014 – May 2014

In early March, project Principal Investigators (PIs) were notified of the decision of the Advisory Council. AQRP Project Managers and TCEQ Project Liaisons were assigned to each project. A kick-off call was held with the project teams to discuss the development of the Work Plans which consist of the project scope of work, budget and justification, and quality assurance project plan (QAPP). The TCEQ completed their review of the final project to be recommended for funding and the Council approved the sixteenth project on April 2, 2014.

Throughout March, April, and May, project administration staff focused on putting contracts in place with each entity involved in the research projects. Project Managers worked with the project teams to complete and approve the Work Plans. Several of the proposals that were selected for funding came from institutions that had received AQRP funding in the prior biennia. Because Master Agreements were already in place with these organizations, the AQRP was able to issue amendments, decreasing the amount of time spent on contract negotiations. For those organizations that were new to the AQRP, new Master Agreements were negotiated. At the end of this quarter, all of the amendments to the Master Agreements were in place. All sixteen (16) of the projects had submitted Work Plans for review and seven (7) of the sixteen (16) Work Plans were approved. (The Work Plan consists of the Project Plan, Budget and Justification, and Quality Assurance Project Plan (QAPP).)

June 2014 – August 2014

During this period, all project work plans were approved, and contracts were finalized for all but two projects. Work either began or continued for the remaining projects. Projects were assigned funding from fiscal year 2013, 2014, or 2015 with multiple projects assigned partial funding from multiple fiscal years. This allowed the AQRP to fully expend all FY 2013 Research funds before they expired, and allow projects to continue through June 2015.

Project managers continued to work with principal investigators to ensure that all project goals were met, as well as all reporting and invoicing requirements. In August, the AQRP was notified that two projects were undergoing significant changes:

Project 14-026, led by Environ International, was authorized to begin work even though contract negotiations were still on-going with the project partner, the California Institute of Technology (Cal Tech). In August, Environ notified AQRP that Cal Tech wanted to terminate contract negotiations with the AQRP and would no longer be involved with the project. Cal Tech's contract negotiations office confirmed this with AQRP's contract negotiations office. Environ submitted a revised Work Plan to the AQRP to modify the scope and budget of the project in light of the change in participants. The change included bringing on David Parrish as a consultant. The revised Work Plan will be reviewed by the AQRP Review Panel in September.

Project 14-023, led by The University of Texas at Austin, began work in May. In July, the host of the site where the work was to be performed notified the PI that the company was being sold, and the new owners would not allow the project to take place on that site. The PI tried to locate an alternate site for the project, but was unable to find a host. In August, the PI officially notified the AQRP that the project could not be completed. At this point the project was ended and all unspent funds were returned to the AQRP Research Projects fund.

At this time, the AQRP is working with the TCEQ to identify alternate projects for funding. This will be further discussed by the Review Panel during their call in September.

An update of the status of each project is listed in the Research Projects section of this report.

RESEARCH PROJECTS

Research projects for FY 2010-2011 are complete. The FY 2012-2013 research projects were completed in November 2013. All projects have submitted final invoices and those invoices have been paid. The Final Report for each project is posted on the AQRP website at http://aqrp.ceer.utexas.edu/projects.cfm.

A final summary of the FY 2012-2013 projects is shown in Table 3 below. It is followed by a description of the new projects approved for funding for FY 2014-2015. A list of publications resulting from all research projects to date is provided in Appendix D and can also be found on the AQRP website.

FY 2012 – 2013 Projects

Discover AQ

In September of 2013, the DISCOVER-AQ (Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality) program deployed NASA aircraft to make a series of flights with scientific instruments on board to measure gaseous and particulate pollution in the Houston, Texas area. The purpose, for NASA, of this campaign was to better understand how satellites could be used to monitor air quality for public health and environmental benefit.

To complement the NASA flight-based measurements, and to leverage the extensive measurements being funded by NASA to better understand factors that control air quality in Texas, ground-based air quality measurements were made simultaneously by researchers from collaborating organizations, including research scientists and engineers funded wholly or in part by the AQRP and the TCEQ. Because of the opportunity to leverage NASA measurements, projects related to DISCOVER-AQ were a high priority for the 2012-2013 biennium.

Table 3: FY 2012-2013 Funded Research Projects

AQRP Project Number	Title	Start Date	End Date	Total Project Funding Awarded	Total Project Expenditures	Funding Returned to AQRP
	Institution (*Institution = Lead Institution and PI)	Principal Investigator		Project Funding Awarded to Institution	Institution Project Expenditures	Institution Funding Returned to AQRP
12-004	**DISCOVER-AQ Ground Sites Infrastructure Support**	**3/1/2013**	**11/30/2013**	**$1,691,944**	**$941,402.05**	**$750,541.95**
	*The University of Texas at Austin	Vincent Torres				
13-005	**Quantification of industrial emissions of VOCs, NO2 and SO2 by SOF and mobile DOAS during DISCOVER AQ**	**1/15/2013**	**11/30/2013**	**$177,553.00**	**$173,975.24**	**$3,577.76**
	*Chalmers University of Technology	Johan Mellqvist		$129,047.00	$129,047.00	$0.00
	University of Houston	Barry Lefer		$48,506.00	$44,928.24	$3,577.76
12-006	**Environmental chamber experiments and CMAQ modeling to improve mechanisms to model ozone formation from HRVOCs**	**2/8/2013**	**11/30/2013**	**$146,259.00**	**$143,899.22**	**$2,359.78**
	*University of California - Riverside	Gookyoung Heo		$101,765.00	$101,765.00	$0.00
	Texas A&M University	Qi Ying		$44,494.00	$42,134.22	$2,359.78
12-011	**Investigation of Global Modeling and Lightning NOx Emissions as Sources of Regional Background Ozone in Texas**	**1/17/2013**	**11/30/2013**	**$77,420.00**	**$77,410.16**	**$9.84**
	*ENVIRON International	Chris Emery				
12-012	**Interactions Between Organic Aerosol and NOy: Influence on Oxidant Production**	**12/19/2012**	**11/30/2013**	**$148,837.00**	**$148,546.58**	**$290.42**
	*The University of Texas at Austin	Lea Hildebrandt Ruiz		$79,463.00	$79,173.94	$289.06
	ENVIRON International	Greg Yarwood		$69,374.00	$69,372.64	$1.36

AQRP Project Number	Title	Start Date	End Date	Total Project Funding Awarded	Total Project Expenditures	Funding Returned to AQRP
	Institution (*Institution = Lead Institution and PI)	Principal Investigator		Project Funding Awarded to Institution	Institution Project Expenditures	Institution Funding Returned to AQRP
12-013	**Development of Transformation Rate of SO2 to Sulfate for the Houston Ship Channel using the TexAQS 2006 Field Study Data**	**12/14/2012**	**11/30/2013**	**$59,974**	**$59,960.93**	**$13.07**
	* ENVIRON International	Ralph Morris				
13-016	**Ozonesonde launches from the University of Houston and Smith Point, Texas in Support of DISCOVER AQ**	**11/20/2012**	**11/30/2013**	**$86,667.00**	**$80,922.40**	**$5,744.60**
	*Valparaiso University	Gary Morris		$66,821.00	$66,821.00	$0.00
	University of Houston	Barry Lefer		$19,846.00	$14,101.40	$5,744.60
12-018	**The Effects of Uncertainties in Fire Emissions Estimates on Predictions of Texas Air Quality**	**1/8/2013**	**11/30/2013**	**$106,970.00**	**$106,884.06**	**$85.94**
	*The University of Texas at Austin	Elena McDonald-Buller		$85,282.00	$85,197.80	$84.20
	ENVIRON International	Chris Emery		$21,688.00	$21,686.26	$1.74
13-022	**Surface Measurements of PM, VOCs, and Photochemically Relevant Gases in Support of DISCOVER-AQ**	**1/29/2013**	**11/30/2013**	**$206,815.00**	**$192,004.33**	**$14,810.67**
	*Rice University	Robert Griffin		$89,912.00	$75,881.86	$14,030.14
	University of Houston	Barry Lefer		$116,903.00	$116,122.47	$780.53
13-024	**Surface Measurement of Trace Gases in Support of DISCOVER-AQ in Houston in Summer 2013**	**2/20/2013**	**11/30/2013**	**$90,444.00**	**$89,658.88**	**$785.12**
	*University of Maryland	Xinrong Ren				

AQRP Project Number	Title	Start Date	End Date	Total Project Funding Awarded	Total Project Expenditures	Funding Returned to AQRP
	Institution (*Institution = Lead Institution and PI)	Principal Investigator		Project Funding Awarded to Institution	Institution Project Expenditures	Institution Funding Returned to AQRP
12-028	**Implementation and evaluation of new HONO mechanisms in a 3-D Chemical Transport Model for Spring 2009 in Houston**	**1/29/2013**	**11/30/2013**	**$117,269.00**	**$114,022.02**	**$3,246.98**
	*University of Houston	Barry Lefer		$19,599.00	$16,586.51	$3,012.49
	University of California - Los Angeles	Jochen Stutz		$17,944.00	$17,709.51	$234.49
	ENVIRON International	Greg Yarwood		$44,496.00	$44,496.00	$0.00
	University of North Carolina – Chapel Hill	Will Vizuette		$35,230.00	$35,230.00	$0.00
12-032	**Collect, Analyze, and Archive Filters at two DISCOVER-AQ Houston Focus Areas: Initial Characterization of PM Formation and Emission Environmental Chamber Experiments to Evaluate NOx Sinks and Recycling in Atmospheric Chemical Mechanisms**	**1/25/2013**	**11/30/2013**	**$45,972.00**	**$43,642.21**	**$2,329.79**
	*Baylor University	Rebecca Sheesley				
12-TN1	**Investigation of surface layer parameterization of the WRF model and its impact on the observed nocturnal wind speed bias**	**2/21/2013**	**11/30/2013**	**$64,994.00**	**$64,537.12**	**$456.88**
	*University of Maryland	Daniel Tong / Pius Lee				
12-TN2	**Development of IDL-based geospatial data processing framework for meteorology and air quality modeling**	**2/21/2013**	**11/30/3013**	**$69,985.00**	**$68,362.27**	**$1,622.73**
	*University of Maryland	Daniel Tong / HyunCheol Kim				
Notes:	A total of $785,875.53 was returned to the AQRP by the Projects as FY 2013 funds. An additional $822,500 of FY 2013 funds were never allocated to any specific projects. All of these funds were carried over and used to fund FY 2014-2015 projects.					

FY 2014 – 2015 Projects

Project 14-002 **STATUS: Work Plan Approved**
Master Agreement Negotiations Pending

Analysis of Airborne Formaldehyde Data Over Houston Texas Acquired During the 2013 DISCOVER-AQ and SEAC4RS Campaigns

University of Colorado - Boulder – Alan Fried
University of Maryland – Christopher Loughner

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Jim Smith

Funding Amount: $199,895

($150,508 UC-Boulder, $49,387 U of Maryland)

Executive Summary

During summer months the greater Houston-Galveston-Brazoria Metropolitan Area (HGBMA) often experiences elevated levels of ozone exceeding federal standards, particularly during hot and stagnant wind conditions. Although significant progress has been achieved understanding the major causes of these events over the past 10 years, there are still major unanswered questions related to sources of ozone from highly reactive volatile organic compounds (HRVOC's) emitted by large petrochemical facilities throughout the HGBMA. The toxic trace gas formaldehyde (CH_2O) is produced as an intermediate when these HRVOC's breakdown in the atmosphere, and ozone and radicals are formed when CH_2O further breaks down. Therefore a comprehensive understanding of CH_2O emissions, photochemical production rates, and transport processes is needed. Unfortunately, despite extensive efforts and advances from past studies, there are still major gaps in understanding related to the importance of directly emitted CH_2O from sources such as petrochemical flaring operations and automotive emissions relative to secondarily produced CH_2O from HRVOC's produced downwind, affecting large geographic areas far removed from the petrochemical facilities. Updating the emission inventories and temporal trends for CH_2O and its HRVOC precursors are two additional areas requiring attention.

To address these issues, a collaborative team, comprised of scientists from the University of Colorado, the University of Maryland, and the NASA Goddard Space Flight Facility, will analyze ambient measurements of CH_2O they acquired on the NASA P3 and DC-8 aircraft during the 2013 DISCOVER-AQ (Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality) and 2013 SEAC^{4}RS (Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys) studies, respectively.

The analysis will rely on the Community Multiscale Air Quality (CMAQ) model with Process Analysis, in very high-resolution mode (1 km resolution), driven by the WRF (Weather Research and Forecasting) meteorological model. The analysis will begin by identifying favorable time periods, such as Sept. 25, 2013, when sampling large petrochemical and refinery plumes under favorable meteorological conditions as well as other clearly identifiable sources (e.g., ship plumes, etc.) close to their source and downwind. The high resolution WRF-CMAQ model

results will be compared with observations downwind at various times to arrive at updated emission rates for CH_2O and to help in validating the model meteorology and chemistry. The CMAQ model will be run in the Process Analysis Mode to quantify the relative importance of the major CH_2O sources. The analysis will conclude with an effort to compare select airborne CH_2O measurements with 24-hour averaged cartridge measurements acquired by The Texas Commission on Environmental Quality (TCEQ) every 6^{th} day at the Clinton, Deer Park and Channelview sites as a means to further validate and/or provide error bounds, for such long-term CH_2O data in the greater HGBMA.

Project Update

The Work Plan for Project 14-002 was approved on June 5, 2014. Contract negotiations are still on-going between the University of Colorado-Boulder and UT Austin. Final terms are very close to completion and the project is expected to begin in September. The project start date will be the date the project Work Plan was approved.

Project 14-003 **STATUS: Active – May 28, 2014**

Update and evaluation of model algorithms needed to predict Particulate Matter from Isoprene

University of North Carolina – Chapel Hill – William Vizuete

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

Funding Amount: $200,000

Executive Summary

Terrestrial vegetation emits into the atmosphere large quantities (~500 teragrams C) of the reactive di-olefin isoprene (C_5H_8). Isoprene emissions in eastern Texas and northern Louisiana are some of the largest in the United States. Photochemical oxidation of isoprene leads to significant yields of gas-phase intermediates that contribute to fine particulate matter (PM2.5). The production of isoprene-derived PM2.5 is enhanced when mixed with anthropogenic emissions from urban areas like those found in Houston. To predict PM production from isoprene requires fundamental parameters needed to describe the efficiency with which gas phase intermediates react on the surface of atmospheric particles. Recently, EPA updated a regulatory chemical mechanism to include the formation of these new gas-phase isoprene-derived intermediates. Furthermore, the project investigators recently collaborated with the EPA to update the CMAQ model to predict isoprene-derived PM explicitly across the eastern US. This updated gas- and aerosol-phase framework found in CMAQ remains to be validated against systematically conducted chamber experiments. Thus, we first propose to conduct a series of new experiments at UNC to quantitatively measure the reactive uptake of the two predominant isoprene-derived gas phase intermediates to PM of different inorganic compositions. By providing these new fundamental measurements, we will be able to more directly evaluate the aerosol-phase processes added to the model. This work will produce a model evaluation of isoprene SOA formation against existing UNC outdoor smog chamber experiments. This project will also deliver performance data needed to bound uncertainties in key parameters used by CAMx to predict isoprene derived PM. This work directly addresses the stated priority area of investigating the transformation of gas-phase pollutants to particulate matter that impact Texas air quality.

Project Update

Progress on Project 14-003 is summarized below by Task:

Task 1. Integration of Gas-Phase Epoxide Formation and Subsequent SOA Formation into UNC MORPHO Box Model

Thus far the integration and simulations using the updated SAPRAC07TC chemical mechanism are complete. These simulations include characterization experiments using wall reaction rate constants. Implementation of the multiphase chemistry of isoprene derived epoxides continues. In the past month the team has been debugging and refining the box model which simulates the uptake of gaseous IEPOX onto an aerosol of variable acidity,

temperature, and relative humidity. In particular, a time stepping algorithm has been implemented that finds a time step that is small enough to keep the solution error within a particular tolerance while keeping it large enough so that the solution is found within a reasonable amount of computing time. Additionally, errors in the code related to wall loss calculations have been corrected. The team intends to complete implementation and begin simulations of existing experiments in the next quarter.

Task 2. Synthesis of Isoprene-derived Epoxides and Known SOA Tracers

Discussions with Dr. Avram Gold concerning synthesis protocols are complete. As a result of these meetings, the synthesis protocols for SOA constituents are now finalized and scheduled for his lab. Starting materials for synthesis of the SOA constituents have been ordered.

Task 3. Indoor Chamber Experiments Generating SOA Formation Directly from Isoprene Derived Epoxides

Preparation of the UNC indoor 10---m3 flexible Teflon chamber for use in this project. The team also trained students, prepared teflon filters, and calibrated GC/MS, IC, CIMS, and LC/DAD---ESI---QTOFMS instruments. Finally, an experimental plan has been proposed and experiments placed on the calendar. The next 2---3 months will yield enough experimental data to evaluate by the model. These will include wall---loss experiments (including for IEPOX and MAE), as well as actual experiments outlined in the work plan.

Task 4. Modeling of Isoprene-derived SOA Formation From Environmental Simulation Chambers

Work on this task has not yet begun.

All funds allocated to the project are intended to be utilized by June 30, 2015.

Project 14-004 **STATUS: Active – June 20, 2014**

Emission Source region contributions to a high surface ozone episode during DISCOVER-AQ

University of Maryland – Christopher Loughner
Morgan State University – Melanie Follette-Cook
AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Doug Boyer

Funding Amount: $109,111
($55,056 Univ. of Maryland, $54,055 Morgan State Univ.)

Executive Summary

The highest ozone air pollution episode in the Houston, TX region in 2013 occurred September 24-26, which coincided with the DISCOVER-AQ (Deriving Information on Surface Conditions and Vertically Resolved Observations Relevant to Air Quality) field campaign. The maximum 8-hour average ozone peaked on September 25 at LaPorte Sylvan Beach reaching 124 ppbv. We propose to analyze this air pollution episode to quantify how emissions from various source regions (i.e., Houston, Dallas, Beaumont/Port Arthur, Lake Charles, LA, Oklahoma, etc.) contributed to Houston's poor air quality. This work will examine the importance of regional emissions and transport on local air quality.

The investigators will use a combination of model simulations and space-, aircraft-, and ground-based observations to investigate the roles of both regional transport and local emissions on air quality in Houston, TX for this event. This work will improve understanding of ozone formation and accumulation by examining the spatial patterns of emissions within and outside of Texas and the transport processes that contributed to high ozone in Houston.

The investigators will use Weather Research and Forecasting (WRF) and Community Multi-scale Air quality (CMAQ) model output along with ground- and aircraft-based observations obtained during the DISCOVER-AQ field campaign to identify plumes that entered the Houston metropolitan area and contributed to high surface ozone concentrations. The investigators will identify the origins of plumes by calculating back trajectories from the WRF simulation. CMAQ simulations performed with source apportionment will be analyzed to determine the contributions of various source regions on surface ozone concentrations in the Houston metropolitan area. In addition, satellite observations (Ozone Monitoring Instrument (OMI) tropospheric nitrogen dioxide, OMI ozone profiles, Measurement Of Pollution In The Troposphere (MOPITT) carbon monoxide, and Moderate Resolution Imaging Spectrometer (MODIS) and Visible Infrared Imaging Radiometer Suite (VIIRS) aerosol optical depth) will be analyzed to determine if they were able to detect the regional transport of air pollution and subsequent buildup in the Houston metropolitan area.

Project Update

The contracts with the University of Maryland and Morgan State University are in place and the Work Plan and QAPP are approved. During this quarter, the team reviewed the Work Plan and QAPP. The team developed a plan to accomplish the project tasks. The team will begin by processing WRF model output to prepare input files for the RIP (Read/Interpolate/Plot) program for calculating back trajectories, run RIP, create CMAQ input files, and perform CMAQ model simulations.

Project 14-006 **STATUS: Active – June 12, 2014**

Characterization of Boundary-Layer Meteorology during DISCOVER-AQ Using Radar Wind Profiler and Balloon Sounding Measurements

Sonoma Technology, Inc. – Clinton MacDonald
Valparaiso University – Gary Morris
AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Dave Westenbarger

Funding Amount: $65,588
($49,979 Sonoma Technology, $15,609 Valparaiso)

Executive Summary

As part of the DISCOVER-AQ (Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality) program in August and September 2013, Sonoma Technology, Inc. and the National Oceanic and Atmospheric Administration, with support from the AQRP, operated radar wind profilers (RWPs) at four sites in the greater Houston area to collect boundary layer wind data. In addition, a permanent network of three RWPs also provided data during this study. Also, Pennsylvania State University and the Valparaiso University/University of Houston team conducted daily meteorological and ozone soundings on most days during DISCOVER-AQ. The combination of these data offers a rich source of boundary layer meteorological data and can be used to provide insight into the processes that influence the air quality in Houston.

To address questions about meteorological conditions during the DISCOVER-AQ study and to provide useful information to other researchers, this project will (1) characterize boundary layer meteorological processes on all aircraft flight days and high ozone days during the DISCOVER-AQ study period; (2) provide context to the DISCOVER-AQ boundary layer characteristics by comparing them to characteristics observed on high ozone days during the TexAQS-II project in 2005 and 2006 and over the past 10 years for the month of September; and (3) provide continuous daytime boundary layer height data at the seven RWP sites for the entire study period. The results from this project will be documented in a final report, distributed to other researchers, and presented at an end-of-project meeting in Austin in June 2015.

Project Update

During June, July, and August, 2014, the project team held internal project progress meetings to discuss project roles, assignments, and deadlines; began gathering relevant meteorological and air quality data from the DISCOVER-AQ program necessary to complete the project; calculated mixing heights from radar wind profilers and ozonesondes operated in the Houston area during DISCOVER-AQ, and performed an initial assessment of meteorological and air quality conditions on DISCOVER-AQ flight days and other days with high ozone levels in the Houston area.

Data gathered for this project during the June-August 2014 period included surface and upper-level meteorological plots, ozonesonde data from the three Houston-area launch sites, radar wind profiler data from the seven Houston-area profilers, surface ozone data, and radar and satellite imagery. The bulk of the work performed during this time period involved calculating mixing

heights (Task 3 of this project), as these data will be necessary for the comprehensive characterization of weather and air quality conditions in the Houston-area during the DISCOVER-AQ program (Task 1) and the comparison of the results from Task 1 to weather and air quality conditions observed during the 2006 TexAQS program (Task 2).

Over the next quarter, work will focus on concluding the calculation of mixing heights (Task 3), completing the characterization of weather and air quality conditions in the Houston-area during the DISCOVER-AQ program (Task 1), and comparing the results found in Task 1 to weather and air quality conditions observed during the 2006 TexAQS program (Task 2), with the anticipation of completing a draft final report by November 30, 2014.

Project 14-007 **STATUS: Active – June 23, 2014**

Improved Analysis of VOC, NO2, SO2 and HCHO data from SOF, mobile DOAS and MW-DOAS during DISCOVER-AQ

Chalmers University – Johan Mellqvist
University of Houston – Barry Lefer

AQRP Project Manager – David Sullivan
TCEQ Project Liaison – John Jolly

Funding Amount: $97,260
($74,179 Chalmers, $23,081 UH)

Executive Summary

Mobile optical remote sensing measurements by the SOF and mobile DOAS techniques were carried out in the Houston area during September 2013 as part of the NASA Discover Air Quality experiment. Atmospheric gas column measurements of SO_2, NO_2, HCHO and VOCs were carried out in a box around the Houston Ship channel, in parallel with flights by two aircraft from NASA. In this project the collected optical remote sensing data will be reanalyzed, improved and compared to other data. In particular, the investigators will work with radiative transfer modeling to minimize cloud effects.

In addition, during the 2013 field campaign a new VOC sensor was used to map ratios of the ground concentrations of alkanes and aromatic VOCs downwind of various industries. In this project the investigators will refine the spectral analysis for measurements of the aromatic VOCs from this sensor and compare the data to parallel measurements with other techniques and write a scientific paper.

This project will support the AQRP priority research area: "Improving the understanding of ozone and particulate matter (PM) formation, and quantifying the characteristics of emissions in Texas through analysis of data collected during the DISCOVER-AQ and SEAC4RS campaigns."

Project Update

During the period June 21 to August 31 the following tasks have been carried out in collaboration between Chalmers University of technology and University of Houston:

a) A retrieval scheme and automatic retrieval algorithm has been developed for multiple angle measurements by DOAS.

b) A radiative transfer model named Sciatran has been installed and compiled on a computer with the objective to improve the column measurements from DOAS. Various test cases have been run and appropriate input data from the NASA discover database has been compiled (partly).

c) Comparative data from ground sites and the two airplanes within NASA DISCOVER-AQ has been compiled (partly).

Project 14-008 **STATUS: Active – April 17, 2014**

Investigation of Input Parameters for Biogenic Emissions Modeling in Texas during Drought Years

The University of Texas at Austin – Elena McDonald-Buller

AQRP Project Manager – David Sullivan
TCEQ Project Liaison – Barry Exum

Funding Amount: $175,000

Executive Summary

The role of isoprene and other biogenic volatile organic compounds (BVOCs) in the formation of tropospheric ozone has been recognized as critical for air quality planning in Texas. In the southwestern United States, drought is a recurring phenomenon and, in addition to other extreme weather events, can impose profound and complex effects on human populations and the environment. Understanding these effects on vegetation and biogenic emissions is important as Texas concurrently faces requirements to achieve and maintain attainment with the National Ambient Air Quality Standard (NAAQS) for ozone in several large metropolitan areas. Previous research has indicated that biogenic emissions estimates are influenced by potentially competing effects in model input parameters during drought and that uncertainties surrounding several key input parameters remain high. The primary objective of the project is to evaluate and inform improvements in the representation of one of these key input parameters, soil moisture, through the use of simulated and observational datasets. The Model of Emissions of Gases and Aerosols from Nature (MEGAN) will be used to explore the sensitivity of biogenic emission estimates to alternative soil moisture representations.

Project Update

Progress on Project 14-008 is summarized below by Task:

Task 1. Investigation and Evaluation of Soil Moisture Datasets

Work during this quarter has focused on identifying and describing the networks [West Texas Mesonet, Climate Research Network (CRN), Soil Climate Analysis Network (SCAN), Cosmic Ray Soil Moisture Observing System (COSMOS)] that operate soil moisture observation stations in Texas as well as an analysis of data collected during 2006-2013 at selected stations (including two in the Oklahoma Mesonet representative of soil moisture conditions for northeast Texas).

Seven soil types are found in Texas, including Alfisols, Aridsols, Entisols, Inceptisols, Mollisols, Ultisols, and Vertisols; their spatial distribution is shown in Figure 1. The Soil Survey Geographic Data Base (SSURGO), which was created using field methods and aerial photos, provides the most detailed level of soil information. The detailed SSURGO soil survey maps, or if unavailable data on geology, topography, vegetation, and climate together with satellite images, have been generalized to create the State Soil Geographic Data Base

(STATSGO). STATSGO is mapped on USGS 1:250,000-scale topographic quadrangle series and is the source of the USDA soil taxonomy classification (order) mapping shown in Figure 1.

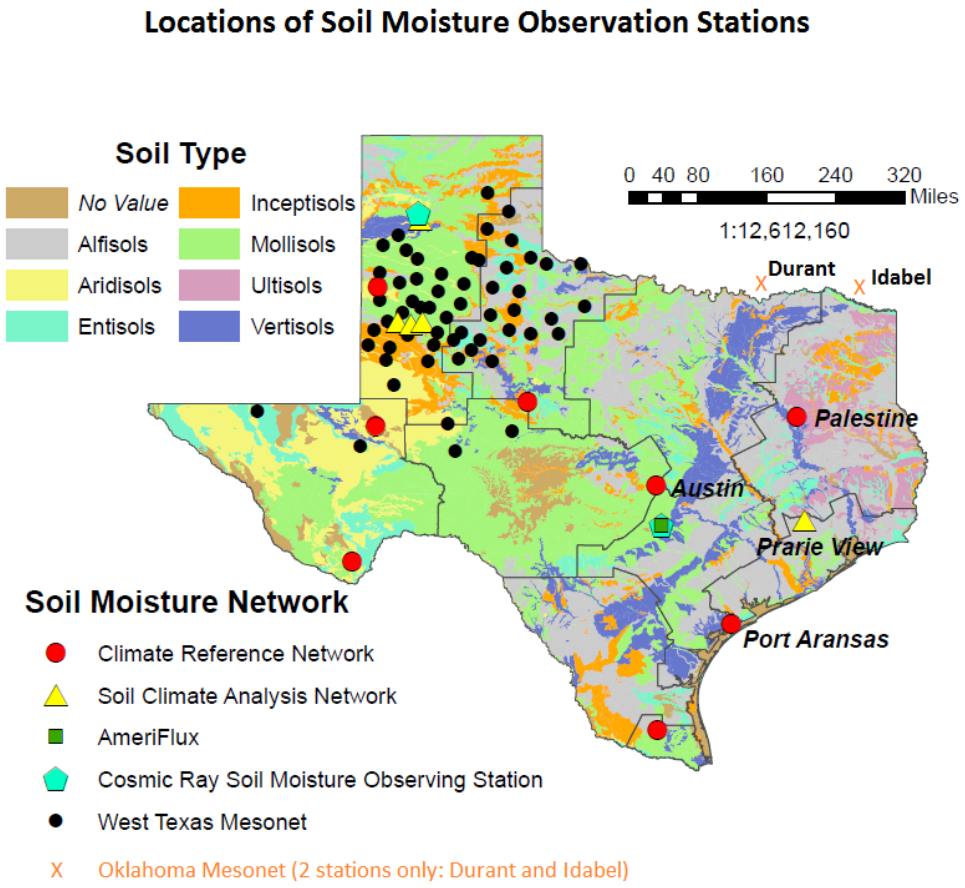

Figure 1. Locations of soil moisture observation stations in Texas overlain on a soils type map. The boundaries show the ten Texas climate divisions. Measurement data collected at the labeled sites in eastern Texas and southeastern Oklahoma during 2006-2013 are currently being investigated.

Initial analyses of observational soil moisture data are focusing on the four labeled sites in Texas in Figure 1 (i.e., “Palestine”, “Austin”, “Prairie View”, “Port Aransas”) in addition to two Oklahoma Mesonet stations (representative of conditions in northeastern Texas) adjacent to the Red River in southeastern Oklahoma (“Durant” and “Idabel”). The hourly data for Texas stations were retrieved directly from the SCAN and CRN websites; summary daily data for the Oklahoma Mesonet stations were accessed via the North American Soil Moisture Database (NASMD) and were only available (at this time) through September 2012.

A completeness criteria of 70% for individual annual seasons was applied. (For our purposes: winter=Dec/Jan/Feb, spring=Mar/Apr/May, summer=Jun/Jul/Aug, fall=Sep/Oct/Nov). On average across all years, seasonal soil moisture increases with increasing depth All depths show a similar seasonality with lowest soil moisture values during summer and fall and relatively higher values during spring and, especially, winter; this seasonal trend was observed across all locations. Results at each available location at 100 cm show strong seasonality (though with less consistency) and increased soil moisture compared to 5 cm; values at Port Aransas are substantially lower compared to the other locations. The investigation of observed soil moisture at these stations (hourly, daily, and seasonal), including an analysis of inter-annual variability with particular attention to drought year 2011, is on-going.

Task 2. Comparison of Simulated and Observed Soil Moisture

The North American Land Data Assimilation System Phase 2 (NLDAS-2) provides high-resolution simulations of land surface variables, including soil moisture. This dataset cover the period from Jan 1979 up to present. NLDAS-2 (Mitchell et al., 2004; Xia et al., 2012) integrates a large quantity of observation-based and model reanalysis data to drive land-surface models, and executes at 1/8th-degree grid spacing over central North America. Three land-surface models are included in NLDAS-2: NASA's Mosaic, NOAA's Noah, and Princeton's VIC. Mosaic was developed by Koster and Suarez (1994, 1996) to account for subgrid vegetation variability. Analysis of the Mosaic and Noah dataset and comparisons with in-situ measurements at the four sites of Prairie View, Port Aransas, Austin and Palestine are being conducted for the time period of 2006-2013.

Task 3. Preparation of MEGAN Simulations

This task has not yet been initiated.

Task 4. Sensitivity of Biogenic Emission Estimates to Soil Moisture

This task has not yet been initiated.

All funds allocated to the project are intended to be utilized by June 30, 2015.

Project 14-009 **STATUS: Active – July 1, 2014**

Analysis of Surface Particulate Matter and Trace Gas Data Generated during the Houston Operations of DISCOVER-AQ

Rice University – Robert Griffin
University of Houston – Barry Lefer

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Shantha Daniel

Funding Amount: $219,232
($109,867 Rice, $109,365 UH)

Executive Summary

In recent years, the National Aeronautics and Space Administration (NASA) has placed considerable emphasis on the use of satellite remote sensing in the measurement of species such as O_3 and PM that constitute air pollution. However, additional data are needed to aid in the development of methods to distinguish between low- and high-level pollution in these measurements. To that end, NASA established a program titled Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ). DISCOVER-AQ began in summer 2011 with work in the Mid-Atlantic Coast that featured satellite, airborne, and ground-based sampling. The DISCOVER-AQ program conducted operations in and near Houston in September 2013.

During the Houston operations of DISCOVER-AQ, there was a need for ground-based measurement support. The predecessor to this project filled that need by providing quantitative measurements of sub-micron particle size and composition and mixing ratios of volatile organic compounds (VOCs) and other photochemically relevant gases such as O_3 and oxides of nitrogen (NO_x = nitric oxide (NO) plus nitrogen dioxide (NO_2)). The instrumentation for these measurements was deployed using the University of Houston (UH) mobile laboratory. The current project focuses on the analysis of data generated during the mobile laboratory operations during DISCOVER-AQ. To date, work has focused simply on contracting issues and development of a work plan and a quality assurance plan.

Project Update

During June 2014, most effort related to Project 14 was focused on development of a Work Plan and Quality Assurance Project Plan. These documents were approved late in the month, and the Project commenced officially at the beginning of July.

During July and August 2014, significant effort was placed on determination of particle emission factors as a function of size (if possible) when mobile laboratory sampling was obviously occurring within a specific plume from gasoline-fueled motor vehicles. Generally this occurred while the mobile laboratory was on-road. As such, determination of emissions factors predominantly is focused on organic aerosol of particle diameter smaller than one micron. A protocol for determination of these emission factors has been developed. A ratio of enhancements in organic aerosol to enhancements in either carbon monoxide (CO) or nitric oxide (NO) is being compared to known emission factors for CO or NO (taken from Environmental Protection Agency (EPA) modeling). Enhancements are defined relative to the

background immediately before and after the plume sampling. Plumes of organic aerosol while the mobile laboratory was on-road have been identified for the DISCOVER-AQ period, and the corresponding enhancements in organic aerosol have been calculated. Eight specific episodes have been identified; enhancements in sub-micron organic aerosol ranged from 14 to 215 micrograms per cubic meter. Current efforts are focused on calculating the ratio of these values to appropriate values of CO or NO. With the high-definition cameras available on the mobile laboratory, the type of vehicle is being identified for each on-road event. Therefore, multiple points will be combined to provide data across vehicle type. An additional approach is to combine points across location type. The appropriate emission factor for vehicle type or location is being determined by regression between the enhancement ratios and the EPA estimates.

Other large aerosol enhancements (beyond those from gasoline-powered motor vehicles) also are being characterized as part of these analysis activities. The time series generated during the periods of operation of the mobile laboratory were examined, and the emission sources associated with these peak events were identified based on field observations and thorough analysis of video footage obtained from the four different cameras installed in the mobile laboratory. The continuous operation of these video cameras allowed capture of a peripheral view of the different events occurring while the mobile laboratory was in transit. For consistency purposes, short-term increases in concentrations of sub-micron PM were classified as peak events when the average PM background concentration for the specific time interval and location was exceeded by at least three standard deviations. Twenty-six peak events (in addition to those described above) associated with both mobile and point sources were identified during the period of monitoring. Mobile sources including heavy and light duty diesel vehicles and a tanker ship transporting bulk-liquid chemicals were identified as the responsible sources for the PM concentration peaks in twelve events. Point sources corresponding to petrochemical facilities (e.g., storage tanks, stack emissions, and gas flares) and biomass burning activities were associated with nine and five of the observed peak events, respectively. Significant increases in the organic fraction of PM were primarily detected in the peak events attributed to mobile sources and biomass burning, while sulfate was generally the largest component observed in the peak events attributed to emissions from petrochemical facilities. Concentrations of PM with maximum levels between 15 and 100 micrograms per cubic meter were observed in events related to mobile sources and biomass burning activities, while more moderate increases were detected for PM concentration peaks associated with operations in petrochemical facilities (maximum concentration between 4 and 30 micrograms per cubic meter). Analysis of the mass spectra of the observed peak events is being conducted in order to gain further insight into the chemical characteristics of the associated source profiles. Analysis of mass spectra in conjunction with aerosol size distributions corresponding to each observed PM peak event is being conducted currently as well to investigate how chemical characteristics of PM vary with particle size.

Work has begun to characterize the oxidized nature of the PM as well, which provides insight into whether the particle was emitted from a primary source or formed directly in the atmosphere. This is first being approached via the application of factor analysis by positive matrix factorization (PMF) for identification of aerosol components (e.g., hydrocarbon-like organic aerosol and various forms of oxidized organic aerosol). In addition, the feasibility of conducting a three-dimensional (3D) factorization technique, specifically called parallel factor

analysis (PARAFAC), is being evaluated. The extension of the two-dimensional analysis (PMF) to a 3-D analysis of size resolved organic composition data set has been reported recently, but only a few studies have employed this technique for analysis of HR-AMS data sets. Application of PARAFAC (sometimes referred as PMF3) on the HR data set generated during DISCOVER-AQ likely will allow the identification of additional aerosol components and provide more robust information on their size distribution. The necessary formatting of the data set is being conducted currently, and preliminary PARAFAC application will be performed once the formatting is complete.

Lastly, significant effort was made to have all promised data in a form that will be readily shared with other AQRP investigators. It is expected that all data for sharing will be provided to collaborators during September 2014.

Project 14-011 **STATUS: Active – June 23, 2014**

Targeted Improvements in the Fire Inventory from NCAR (FINN) Model for Texas Air Quality Planning

The University of Texas at Austin – Elena McDonald-Buller
Environ – Christopher Emery

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

Funding Amount: $179,586
($151,167 UT-Austin, $28,419 Environ)

Executive Summary

Wildland fires and open burning can be substantial sources of ozone precursors and particulate matter. The influence of fire events on air quality in Texas has been well documented by observational studies. During the 2012-2013 fiscal year of the Air Quality Research Program (AQRP), Dr. Elena McDonald-Buller, Dr. Christine Wiedinmyer, and Mr. Chris Emery led a project (#12-018) that evaluated the sensitivity of emissions estimates from the Fire INventory from NCAR (FINNv1; Wiedinmyer et al. 2011) to the variability in input parameters and the effects on modeled air quality using the Comprehensive Air Quality Model with Extensions (CAMx; ENVIRON, 2011). The project included an analysis of the climatology of fires in Texas and neighboring regions, comparisons of fire emission estimates between the FINN and BlueSky/SmartFire (Larkin 2009; Chinkin et al., 2009) modeling frameworks, evaluation of the sensitivity of FINN emissions estimates to key input parameters and data sources, and assessment of the effects of FINN sensitivities on Texas air quality. Among the many findings of the study were the needs for targeted improvements in land cover characterization, burned area estimation, fuel loadings, and emissions factors. These needs were particularly pronounced in areas with agricultural burning. This project addresses specific improvements in FINN that will support fire emissions estimates for Texas and the next public release of the FINN model. Fire emissions and air quality modeling will focus on 2012 to support TCEQ's air quality planning efforts.

Project Update

Progress on Project 14-011 is summarized below by Task:

Task 1. Regional Land Cover Characterization

Task 1 of this work is applying land cover data specific to Texas, as an alternative to global scale land cover mapping from the MODIS Land Cover Type (LCT) product, which is the FINN default. In addition, a mapping of crop types will be developed for incorporation in the FINN land cover database that focuses on Texas and surrounding states. The team is using a land use/land cover database for Texas and surrounding states developed by Popescu et al. (2011; *http://m.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/oth/5820564593FY0925-20110419-tamu-expension_tx_lulc_arboreal_vegetation.pdf*). For the

characterization of croplands, the team has selected the following: *U.S. Department of Agriculture (USDA), National Agricultural Statistical Service (NASS) Cropland Data Layer (CDL):* *http://nassgeodata.gmu.edu/CropScape/*.

Task 2. Mapping of Croplands

A mapping and cross-tabulation of land cover classifications associated with agricultural operations between the 2012 NASS and Popescu et al. (2011) databases is being developed for Texas using the spatial analyst package in ArcGIS for this task.

Task 3. Estimation of Burned Area

This task has not yet been initiated.

Task 4. Sub-grid scale Partitioning of NO_x Emissions to NO_z in Fire Plumes

This task has not yet been initiated.

Task 5. CAMx Sensitivity Studies

This task has not yet been initiated.

All funds allocated to the project are intended to be utilized by June 30, 2015.

Project 14-016 **STATUS: Active – June 4, 2014**

Improved Land Cover and Emission Factor Inputs for Estimating Biogenic Isoprene and Monoterpene Emissions for Texas Air Quality Simulations

Environ – Greg Yarwood

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Mark Estes

Funding Amount: $271,911

Executive Summary

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. Accurate quantification of emission fluxes is a necessary step in developing air pollution control strategies. In some cases emissions can be directly measured (e.g., point sources with continuous emission monitors) or can be estimated with reasonable confidence (e.g., point sources that have well-defined operating parameters). In contrast, large uncertainties are associated with area sources including emissions from vegetation, and in particular, emissions of biogenic volatile organic compounds (BVOCs). Vegetation is the largest source of VOC emissions to the global atmosphere. The oxidation of BVOCs in the atmosphere affects ozone, aerosol and acid deposition. Current BVOC emission estimates are based on measurements for individual plants that must be scaled up to represent landscapes and adjusted for environmental conditions. There is a critical need for independent BVOC emission inputs for air quality models.

AQRP Project 14-016 will use aircraft observations from the 2013 Southeast Atmosphere Study (SAS) and the 2006 Texas Air Quality Study (TexAQS) to assess and reduce uncertainties associated with a widely-used BVOC emissions model, namely the Model of Emissions of Gases and Aerosol from Nature version (MEGAN). The eddy covariance technique will be used to directly quantify BVOC emission fluxes for all suitable aircraft observations from the SAS study. Using the relationship between BVOC fluxes and concentrations derived from this subset of SAS aircraft data, BVOC emission fluxes will be estimated for 2013 SAS and 2006 TexAQS flights in the southeastern U.S. and Texas, respectively. In addition, the investigators will improve the land cover and emission factor input data sets that are considered the major uncertainties associated with BVOC emission estimates. The overall benefit of this project will be more accurate BVOC emission estimates that can be used in Texas air quality simulations that are critical for scientific understanding and the development of effective regulatory control strategies that will enhance efforts to improve and maintain clean air.

Project Update

This AQRP project is being performed by ENVIRON International Corporation (ENVIRON) as prime contractor, and NOAA and Battelle/Pacific Northwest National Laboratory as sub-contractors. A summary of activities for the period June 1, 2014 through August 31, 2014 is presented below.

Task 4: Development of MEGAN Biogenic Emission Inventories and Inventory Evaluation using Regional Photochemical Modeling

ENVIRON carried out mesoscale meteorological modeling of the period June 1-July 15, 2013 with the Weather Research and Forecast (WRF) Model (Skamarock et al. 2008). ENVIRON developed model inputs and ran the model on the nested 36/12 km modeling grids that encompass the NOAA/NCAR aircraft flight tracks to be used to develop biogenic emissions. ENVIRON began evaluation of WRF output fields against CAMS station wind and temperature data within Texas and ds472 airport meteorological data within and outside of Texas.

ENVIRON prepared a biogenic emission inventory for June 1-July 15, 2013 using the Model of Emissions of Gases and Aerosols from Nature (MEGAN) (Guenther et al., 2012). In the past, ENVIRON has used MEGAN input data available in ArcGIS format, but the developers of MEGAN plan to release future MEGAN inputs (including inputs for this project) in NetCDF format. ENVIRON developed software that takes MEGAN input data in NetCDF format and reformats the data into the ASCII format used by MEGAN. Using the WRF output from the initial model run to generate weather data for MEGAN, we ran MEGAN for the June 1-July 15, 2013 episode with default landcover and emission factor inputs. Episode average isoprene and monoterpene emissions on the 12 km modeling domain are shown in Figure 1. We verified that the NetCDF reformatting tool and MEGAN modeling system are functioning properly by comparing the magnitude and spatial patterns of episode average isoprene and terpenes across the 36 km and 12 km grids with July episode average maps from the biogenic emission inventory prepared for the Western Governors Association by ENVIRON and Dr. Guenther (Sakulyanontvittaya et al., 2012). If no further WRF runs are needed, this MEGAN emission inventory will serve as the base case default biogenic emission inventory against which we will compare MEGAN inventories developed with new inputs developed in Tasks 1-3.

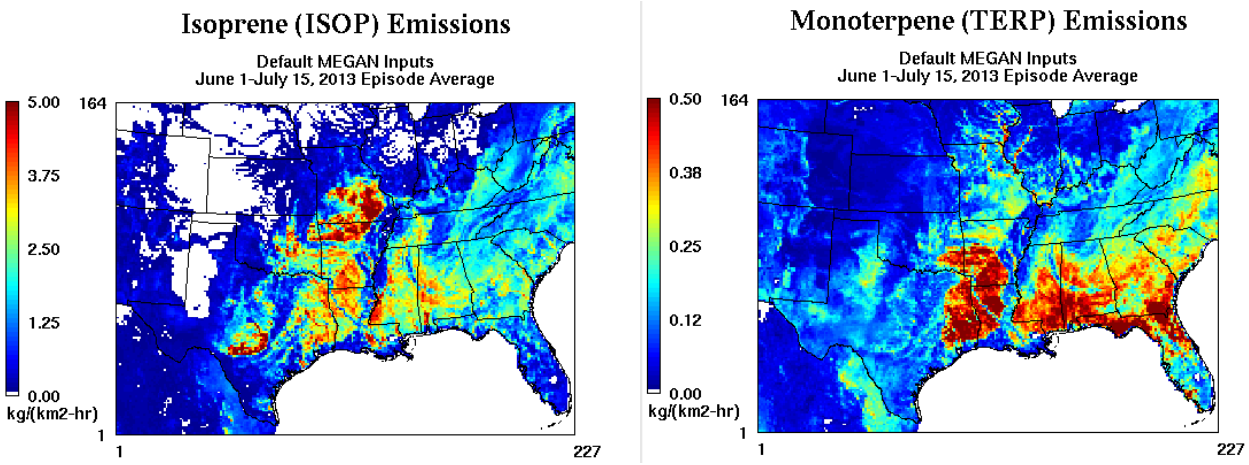

Figure 1. June 1-July 15, 2013 episode average MEGAN isoprene (left panel) and monoterpene (right panel) emissions developed using default land cover and emission factor assumptions.

Task 5: Project Management

ENVIRON, NOAA and PNNL/Battelle developed subcontracting agreements for NOAA and PNNL/Battelle for work to be done under Tasks 1-3.

The development of subcontracting agreements has progressed more slowly than expected. We expect that the schedule for Tasks 1-3 will be extended by 3-4 months. However, sufficient progress on Task 4 has been made that the project remains on schedule for completion with delivery of the final AQRP-reviewed report by June 30, 2015.

We intend to use all funds allocated to the project by 06/30/2015.

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Skamarock, W. C., J. B. Klemp, J. Dudhia, D. O. Gill, D. M. Barker, W. Wang, and J. G. Powers, 2008. A description of the Advanced Research WRF Version 3. NCAR Tech Notes-475+STR. http://www.mmm.ucar.edu/wrf/users/docs/arw_v3.pdf.

Project 14-017 **STATUS: Active – July 8, 2014**

Incorporating Space-borne Observations to Improve Biogenic Emission Estimates in Texas

University of Alabama - Huntsville – Arastoo Pour Biazar
Rice University – Daniel Cohan

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Mark Estes

Funding Amount: $199,982
($137,003 UAH, $62,979 Rice)

Executive Summary

One of the challenges in understanding the Texas air quality has been the uncertainties in estimating the biogenic hydrocarbon emissions. Biogenic volatile organic compounds, BVOCs, play a critical role in atmospheric chemistry, particularly in ozone and particulate matter (PM) formation. In southeast Texas, BVOCs (mostly as isoprene) are the dominant summertime source of reactive hydrocarbon. Despite significant efforts by the State of Texas in improving BVOC estimates, the errors in emission inventories remain a concern. This is partly due to the diversity of the land use/land cover (LU/LC) over southeast Texas coupled with a complex weather pattern, and partly due to the fact that isoprene is highly reactive and relating atmospheric observations of isoprene to the emissions source (vegetation) relies on many meteorological factors that control the emission, chemistry, and atmospheric transport.

BVOC estimates depend on the amount of radiation reaching the canopy (Photosynthetically Active Radiation, PAR), and temperature. However, the treatment of temperature and PAR is not uniform across emissions models and still poses a problem when evaluating the inventories. Recent studies show that the largest uncertainty comes from the model solar radiation estimates and that using satellite-based PAR would be preferable. Emissions from soils also remain as one of the poorly quantified sources of NOx (nitrogen oxides) in most air quality models. Soils can be the largest source of NOx in rural regions where low-NOx conditions make ozone production efficiency especially high, contributing to background ozone levels.

The overall objective of the current activity is to advance our understanding of Texas Air Quality by utilizing satellite observations and the new advances in biogenic emissions modeling to improve biogenic emission estimates. This work specifically addresses a priority area in Texas AQ studies by improving biogenic emission estimates. In particular, the objectives are:

(1) To provide satellite-based PAR estimates for Texas during selected periods of 2006 and the Discover-AQ period (September, 2013).

(2) To produce an improved biogenic emission estimate for Texas and help in the evaluation of biogenic emission inventories over Texas by providing the best model representation of the atmospheric condition during the observations used for evaluation.

(3) To prepare and use a new soil NOx scheme that provides more mechanistic representation of how emissions respond to nitrogen deposition, fertilizer application, and changing meteorology.

The University of Alabama in Huntsville (UAH) currently generates a set of products from the Geostationary Operational Environmental Satellite (GOES) that includes surface incident short-wave radiation as well as cloud albedo and cloud top temperature. Under this activity, UAH will produce the Photosynthetically Active Radiation (PAR) needed in the estimation of biogenic hydrocarbon emissions. Satellite-derived PAR will be evaluated against previous satellite-based products as well as surface observations for the summer of 2006 and also during Texas Discover-AQ campaign. Furthermore, the new PAR retrievals will be used in MEGAN (the Model of Emissions of Gases and Aerosols from Nature) to generate BVOC emissions.

The new soil NOx scheme to be used is an implementation of the Berkeley-Dalhousie Soil NOx Parameterization (BDSNP) within MEGAN. A series of sensitivity simulations will be performed and evaluated against Discover-AQ observations to test the impact of satellite-derived PAR and the new soil NOx emission model on air quality simulations.

Project Update

Contract negotiations were completed on August 22, 2014, and the project start date was back dated to July 8, 2014, when the Work Plan was approved. Project activities to date have been limited, but are expected to proceed in the coming months.

Project 14-023 **STATUS: Active – May 23, 2014**

Assessment of Two Remote Sensing Technologies to Control Flare Performance

The University of Texas at Austin – Vincent Torres
Aerodyne Research, Inc. – Scott Herndon
Leak Surveys, Inc. – Joshua Furry
Providence Photonics, LLC – Yongshen Zeng

AQRP Project Manager – David Sullivan
TCEQ Project Liaison – Russell Nettles

Funding Amount: $480,741
($239,773 UT-Austin, $157,066 Aerodyne, $26,716 Leak Survey, $57,186 Providence Photonics)

Executive Summary
Industrial flares are devices used at industrial facilities to safely dispose of relief gases in an environmentally compliant manner through the use of combustion. Recent studies of industrial air- and steam-assisted flares have shown that merely complying with federal regulations like the Environmental Protection Agency's 40CFR § 60.18 and 40CFR § 63.11, do not ensure the flare will operate with at high combustion efficiency when combusting hydrocarbons over the entire range of operating scenarios for dual service flares. For vent gas streams containing hydrocarbons, the combustion efficiency (CE) is the percentage of the total hydrocarbon stream entering the flare that burns completely to form only carbon dioxide and water. It is desirable to have high combustion efficiency at all times to maximize flare performance.

The purpose of the proposed project is to conduct a series of field tests using an operational, full-scale industrial flare at a Petrologistics, LLC plant in Houston, Texas, to determine the technical, economic and operational feasibility of two approaches designed to maximize flare performance. These approaches continuously measure or determine the flare's combustion efficiency and would use this information to adjust the steam assist to the flare to adjust the flare's performance. To assess the technical performance of the approaches, the combustion efficiency measurements of each approach will be compared to an independent direct sampling measurement (the reference measurement) of the flare's combustion efficiency to determine the accuracy and completeness of the measurements obtained from the two approaches. For the field tests, the performance of the flare will not be controlled by either of the two approaches so that the prescribed test plan can be conducted with the flare. After the test series, the economic and operational feasibility will be evaluated based on the operational and safety characteristics observed during the tests and the estimated cost to implement each approach.

Project Update
An initial site visit to the Petrolgistics, LLC plant was conducted on June 12. The project team spent most of the morning reviewing, understanding and discussing the process flows, typical compositions of the vent gas and plant fuel gas (C2s and lighter), ability of the plant to vary these flows and compositions, and other information required to update the QAPP and develop the field test plan. Agreements were made on how the sampling would be conducted and a date (December 1-5, 2014) for the field tests was selected.

On June 26, 2014, the flare site contact for Petrologistics, Vance Darr, notified the Principal Investigator that the representative from Flint Hills Resources (FHR), who was present during the planning meeting on June 12, informed Petrologistics that FHR will not continue participation in the study after the acquisition of Petrologistics is complete. FHR is in the process of purchasing Petrologisitics and this acquisition will be concluded before the study can be completed. Mr. Darr reviewed the purpose and scope of the study with FHR, and Petrologisitcs involvement with the TCEQ and EPA. Nonetheless, FHR has elected not to participate in this study.

From June 26 until August 12, the project team, along with the project's Industry Advisory Committee, attempted to find another host site for the project. We were unable to find one and made the decision to terminate the project as time to locate another host site had expired. Therefore, on August 15, 2014, notice was sent to the AQRP Project Manager that the project would need to be terminated and all unspent funds returned to the AQRP.

No further work will be performed or costs incurred on this project.

Sources of Organic Particulate Matter in Houston: Evidence from DISCOVER-AQ Data, Modeling and Experiments

The University of Texas at Austin – Lea Hildebrandt Ruiz
Environ – Greg Yarwood
University of California – Riverside – Gookyoung Heo

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Shantha Daniel

Funding Amount: $300,000
($163,282 UT-Austin, $101,404 Environ, $35,314 UC – Riverside)

Executive Summary

The United States Environmental Protection Agency recently lowered the annual National Ambient Air Quality Standard (NAAQS) for particulate matter smaller than 2.5 μm in diameter ($PM_{2.5}$) from 15 to 12 μg m^{-3}. This new annual standard brings the Houston region near to non-attainment for $PM_{2.5}$, underlining the importance of understanding the composition and sources of $PM_{2.5}$ in Houston. Recent measurements made during the month of September indicate that a majority of $PM_{2.5}$ in the Houston region is composed of organic material. An improved understanding of Houston organic aerosol is therefore essential and will directly benefit the Texas Commission on Environmental Quality (TCEQ) in understanding how to manage Houston's air quality.

Project 14-024 will focus on improving our understanding of the contributions of intermediate volatility organic compounds (IVOC) to formation of secondary organic aerosol (SOA). IVOCs, specifically large alkanes and polycyclic aromatic hydrocarbons, are largely excluded from current emission inventories because these compounds fall between the definitions of volatile organic compounds (VOC) and primary organic $PM_{2.5}$. Emissions of IVOC are expected to be high in Houston, due to the combination of petrochemical industry and mobile source emissions, and the contributions of IVOC to SOA appear to be important but underestimated. Work will include analysis of recently collected ambient data during DISCOVER-AQ on PM concentration and composition, new environmental chamber experiments on the SOA formation potential of IVOC, and photochemical modeling of the Houston region. Modeling of the formation of SOA from VOC and IVOC precursors will use a new state of the art approach based on the Volatility Basis Set (VBS) that has recently been implemented in the Comprehensive Air-quality Model with extensions (CAMx).

Project Update

In this quarter the team conducted a literature review to identify the most recent emission estimates for intermediate volatility organic compounds (IVOCs). Early modeling studies estimated IVOC by scaling from primary organic aerosol (POA) emissions. A limitation of this approach is that the ratio of IVOC to POA emissions would depend on gas-particle partitioning of POA at the measurement condition. A more recent approach estimates IVOC from the un-speciated fraction of total non-methane organic gas (NMOG) emissions. Recently published

chamber data provide source-specific un-speciated fractions of NMOG (i.e., approximate IVOC-to-NMOG ratios) for on-road gasoline and diesel vehicle emissions and biomass burning emissions.

The team also conducted a literature review to identify previous studies on mass yields of SOA formed from oxidation of IVOCs. This effort resulted in the creation of a preliminary list of IVOCs to study in chamber experiments. The team also designed and ordered the heated injector, which will be used to inject low-volatility IVOCs into the laboratory chamber and the thermodenuder, which will be used to measure the volatility of the organic aerosol formed. DISCOVER-AQ data has been shared with investigators of AQRP projects 14-009 and 14-029.

All funds allocated to the project are expected to be used by June 30, 2015.

Project 14-025 **STATUS: Active – May 21, 2014**

Development and Evaluation of an Interactive Sub-Grid Cloud Framework for the CAMx Photochemical Model

Environ – Christopher Emery
Texas A&M University – John Nielson-Gammon
AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Khalid Al-Wali

Funding Amount: $256,261
($135,735 Environ, $120,526 TAMU)

Executive Summary

The US Environmental Protection Agency (EPA) requires the use of photochemical models to demonstrate that emission control plans will achieve the federal standard for ground-level ozone (EPA, 2007). The TCEQ uses the Comprehensive Air quality Model with extensions (CAMx) for research and regulatory photochemical modeling. Previous research conducted for the TCEQ has concluded that improvements to the CAMx modeling system, including a sub-grid cloud convection treatment, are necessary to reduce model under prediction biases in oxidized nitrogen compounds in the upper troposphere. Cloud convection at sub-grid scales is an important mechanism for exchanging boundary layer air with the free troposphere and for chemical processing. The current sub-grid cloud approach within CAMx influences photolysis rates, scavenging by rainfall, and aqueous chemistry at grid scale, but does not explicitly treat these processes at cloud scale and does not include sub-grid convective transport.

Small-scale clouds are often widespread but they are not explicitly resolved by the grid scales employed in regional meteorological and photochemical modeling applications. The physical effects from these sub-grid clouds are difficult to characterize accurately, but they can substantially influence many different atmospheric processes, including: boundary layer mixing, ventilation, and deep vertical transport of heat, moisture, and chemical tracers; radiative transfer and surface heat budgets; spatio-temporal precipitation patterns, intensity and wet scavenging rates; chemistry via photolysis and aqueous reactions; and certain environmentally-sensitive emission sectors (e.g., biogenic). Cloud convection is also an important component for long-range transport of ozone, PM, and precursors. The effects of sub-grid clouds on vertical transport, chemistry, and wet scavenging are addressed to varying degrees in off-line photochemical models (i.e., models like CAMx that operate separately from meteorological models that supply environmental inputs). However, the spatio-temporal distributions of such clouds, and all the processes that occur within them, must be re-diagnosed because meteorological models do not export necessary information from their sub-grid cloud parameterizations. This leads to potentially large inconsistencies between the models.

Under this AQRP Project, ENVIRON and collaborators at the Texas A&M University (TAMU) will incorporate and extensively evaluate an explicit sub-grid cloud model within CAMx. The primary goal of this work is to introduce shallow and deep convective cloud mixing at sub-grid scales. Further, the investigators will develop an approach to improve interactions with chemistry and wet deposition to operate explicitly at sub-grid scales in tandem with the cloud mixing scheme. The approach will tie into recent updates implemented in the Weather Research and

Forecasting (WRF) model by researchers at EPA, whereby specific sub-grid cloud fields will be passed to CAMx to define their spatio-temporal distributions and mixing rates for the new sub-grid cloud algorithm. This will yield a more consistent cloud-mixing-chemistry system across the WRF and CAMx models. The new CAMx treatment will be tested for three convective episodes that occurred during the September 2013 Houston DISCOVER-AQ field study and the Spring 2008 START08 field study, particularly addressing tropospheric profiles of NOx, ozone, and other chemical tracers by comparing to in situ profiles from aircraft measurements. The new model will be provided to TCEQ to support future regulatory and research-oriented ozone and PM modeling.

Project Update

This AQRP project is being performed by ENVIRON International Corporation (ENVIRON) and the Texas A&M University. A summary of activities for the period June 1, 2014 through August 31, 2014 is presented below.

The team has commenced modeling database setup and measurement data acquisition. We have obtained the latest WRF model source code (v3.6) from NCAR, which includes EPA's updates to the Kain-Fritsch (K-F) sub-grid convection algorithm. We have discussed these updates via e-mail correspondence with EPA to define the specific variables available to support the CAMx cloud model framework. Additional updates to make the K-F parameterization applicable at small spatial scales (<10 km) are currently under development at EPA. This "scale-aware" version of WRF K-F is expected to be available from EPA this fall. From this information we have begun to refine details of the methodology to incorporate a sub-grid cloud model in CAMx.

The interactive sub-grid cloud framework in CAMx will address shallow mixing, deep convective transport, gas and aqueous chemistry, and wet scavenging. All processes will be driven by specific data obtained from output fields generated by the WRF K-F scheme. The CAMx sub-grid cloud model framework will operate separately from the normal grid processes in a manner similar to the Plume-in-Grid (PiG) model. This "cloud-in-grid" (CiG) approach will define at each hour the physical attributes of a multi-layer cloud "reactor" according to the hourly cloud data provided by WRF. Each CiG reactor configuration will be unique to each grid column (or entirely absent from it) and characterize a steady-state sub-grid cloud environment between each hourly meteorological update time. Fractions of pollutant vertical mass profiles from each host grid column will be allocated to each CiG reactor layer, which will then operate on that mass to include vertical transport, entrainment/ detrainment with the ambient grid column, chemistry, and wet removal.

The project team has conferred on the model design and implementation approach. The general approach and certain technical implementation issues to consider in the final design of the CAMx cloud treatment were discussed at length. Some of the most important issues included: need for additional variables to be output from the WRF K-F algorithm; addressing "layer collapsing" of WRF layers to the CAMx layer structure; use of hourly-instantaneous or averaged fields; approach to partition CAMx grid mass to the ambient and in-cloud environments; approach to integrate chemistry and wet scavenging; numerical solvers to employ for convective transport; and compatibility with and inclusion of Probing Tool tracers. To gain insight and perspective on how sub-grid cloud processes are handled in other models, we have reviewed literature on the K-F approach, the sub-grid cloud technique in CMAQ, and the techniques employed in two European air quality models (TOMCAT and CHIMERE). A detailed

implementation design has been developed that addresses all of these issues; it is documented in the August monthly progress report.

Establishment of an AQRP sub-contract with co-principal investigators at Texas A&M has been delayed. Once a contract is established with Texas A&M, collection of field study measurements from DISOVER-AQ and START08 will commence. Other than addressing technical details in the design and implementation of the sub-grid cloud system into CAMx, no major technical issues have been encountered during the course of this project.

We intend to use all funds allocated to the project by 6/30/2015.

Project 14-026 **STATUS: Active – May 21, 2014**

Quantifying ozone production from light alkenes using novel measurements of hydroxynitrate reaction products in Houston during the NASA SEAC4RS project

Environ – Thomas Ryerson AQRP Project Manager – Gary McGaughey
California Institute of Technology – Paul Wennberg TCEQ Project Liaison – Chris Kite

Funding Amount: $231,182
($135,782 Environ, $95,400 CalTech)

Executive Summary

The objective of this project is to improve and quantify our understanding of ozone (O_3) and formaldehyde (HCHO) production from industrial emissions of Highly Reactive Volatile Organic Compounds (HRVOCs) in the Houston area. Aircraft flights during the National Aeronautics and Space Administration (NASA) Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys ($SEAC^4RS$) project encountered plumes with enhanced O_3 downwind of petrochemical facilities in Houston. For example, on 25 September 2013, ground monitoring downwind of the Ship Channel showed 5-minute average O_3 values peaking at 165 ppb and are associated with elevated concentrations of the oxidation products of HRVOCs. HRVOCs, specifically ethene, propene, butenes and 1,3-butadiene, have been implicated in these types of high ozone events but quantifying the relative contributions of individual HRVOCs to O_3 formation has been difficult.

The project objective will be accomplished by a combination of data analysis and reactive plume modeling. Data taken aboard the NASA DC-8 research aircraft during the 2013 $SEAC^4RS$ project in Houston will be analyzed. Chemical compounds called β-hydroxynitrates are formed when HRVOCs react in the atmosphere in the presence of nitrogen oxides (NOx). Measurements of the C_2-C_4 hydroxynitrates aboard the DC-8 provide a novel means to link observed enhancements of O_3 and HCHO to reactions of specific HRVOCs. Analyzing the data will provide a robust first-order attribution of observed O_3 and HCHO enhancements to the oxidation of individual HRVOCs emitted from the Houston Ship Channel. The plumes of HRVOCs and O_3 that the DC-8 intercepted will be analyzed further to estimate what emissions of HRVOCs and NOx gave rise to each plume. A reactive plume model (SCICHEM) will be used to model these plumes and test chemical reaction mechanisms for individual HRVOCs. The model sensitivity to plume expansion rates will be evaluated to test how plume dilution influences chemical processing and therefore how grid model resolution can influence assessments for HRVOC sources. The benefits of this project to the TCEQ will be a data-driven assessment of the contributions of individual HRVOCs to O_3 and HCHO enhancements downwind of the Houston ship channel and improved modeling tools for assessing the air quality impacts of HRVOC emissions in the Texas State Implementation Plan (SIP).

Project Update

This AQRP project is being performed by ENVIRON International Corporation (ENVIRON), NOAA (under sub-contract to ENVIRON), and Caltech. A summary of activities for the period June 1, 2014 through August 31, 2014 is presented below.

Task 1: QA/QC Alkene Hydroxynitrate Measurements by the Caltech TOF-CIMS aboard the DC-8 during SEAC^{4}RS and Generate Final Data

This task is being conducted by Caltech. However, the contract between Caltech and AQRP has been delayed, and Caltech has not yet initiated work on this task.

Task 2: Analysis of DC-8 airborne data to quantify plume initial conditions, production rates, and yields of O_3 and HCHO from parent alkenes

This task is being conducted by NOAA with assistance from Caltech. Since it requires the products of Task 1 before it can be initiated, there has been no progress on this task in the reporting quarter.

Task 3: Photochemical plume modeling to assess effects of hydroxynitrate sinks and 2nd-generation reaction products on inferred plume ozone production

This task is being conducted by ENVIRON. As part of this task, ENVIRON began updating the chemical mechanisms in SCICHEM from CB05 to CB6r2. The remaining components of this task (updates to CB6r2 mechanism to include additional explicit reactions to represent hydroxynitrate production from individual HRVOCs; plume modeling) will require the products of Tasks 1 and 2 before the task can be completed.

Project Management

ENVIRON developed a subcontracting agreement for NOAA for work to be done under Task 2. Since the Caltech contract with AQRP has been delayed, ENVIRON submitted a revised Workplan and QAPP to AQRP on August 21, 2014 that takes this delay into account and provides a revised approach to accomplishing the objectives of this study on time. This approach includes removing Caltech from the project and bringing on David Parrish as a consultant.

The study has progressed more slowly than expected due to delays in the Caltech contract. We expect that the schedule for Tasks 1-2 will be extended by about 3 months. However, we expect the overall project to remain on schedule for completion with delivery of the final AQRP-reviewed report by June 30, 2015, as described in our revised workplan.

Project 14-029 **STATUS: Active – July 10, 2014**

Spatial and temporal resolution of primary and secondary particulate matter in Houston during DISCOVER-AQ

Baylor University – Rebecca Sheesley

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Shantha Daniel

Funding Amount: $178,679

Executive Summary

This projects builds on a previously-funded AQRP project tasked at the initial elemental carbon (EC), organic carbon (OC), and optical black carbon (BC) characterization of particulate matter (PM) at Moody Tower and Manvel Croix during DISCOVER-AQ Houston Texas 2013 (AQRP 12-032). Under the original framework of PIs Sheesley and Usenko's AQRP ECOC Project, samples were to be collected over the entire DISCOVER-AQ sampling period at two primary sites in Houston: Moody Tower (urban) and Manvel Croix (southern suburb). Collaborations developed during the early stages of this project increased the sampling intensity at the two primary sites and expanded PM sampling efforts to Conroe (far north suburb) and La Porte (urban industrial).

The overall goals of this project are to analyze the filter samples collected in the previous project and to quantify the strength of PM formation and PM emission sources, including shipping emissions, motor vehicle exhaust, biomass burning and biogenic emissions, across the Houston metropolitan area. This work builds on the strengths of DISCOVER-AQ, specifically the spatial and temporal sampling strategies (i.e. multiple ground-based sites sampled for approximately 28 days). These strategies allow for the examination of both regional and long-range transport as well as anthropogenic and biogenic influences on air quality. The project will characterize PM through the quantification of water-soluble OC, organic tracers, EC, OC, ^{14}C, select inorganic ions, and elemental tracers from PM filters collected from four DISCOVER-AQ anchor sites including Moody Tower, Manvel Croix, Conroe, and La Porte. The PIs will apply a combination of radiocarbon source apportionment of organic and elemental carbon with source-specific organic and inorganic molecular tracers to tightly constrain urban and regional, fossil and biomass burning/biogenic sources.

Progress Report

In July and August, 2014 research efforts focused on training students and method optimization. Specifically, students were trained in quality assurance and quality control protocols. In addition, students performed a reproducibility study to ensure the ability of each analyst participating in the study. Research efforts focused on tasks outlined in the project timeline specifically water-soluble organic carbon (WSOC) and organic tracer analysis. The initial WSOC analysis focused on airborne particulate matter samples collected from Manvel Croix, TX. PI Sheesley and PI Usenko participated in a conference call with the AQRP program officer and DISCOVER-AQ aerosol focus group collaborators (grants 14-024 and 14-009). The WSOC is on target to be completed and shared with Dr. Hildebrandt-Ruiz by the end of September. An analytical method capable of measuring all of the necessary organic tracers was optimized for airborne particulate

matter samples collected in Houston, TX. A manuscript describing this method and its optimization is currently underway with an anticipated submission date of Dec 2014. Laboratory consumables were purchased for both analyses.

Two abstracts were submitted to the national conference of the American Geophysical Union covering the DISCOVER-AQ analysis under 14-029:

“Spatial trends in surface-based carbonaceous aerosol, including organic, water-soluble and elemental carbon, during DISCOVER-AQ in Houston, TX”

“The application of a novel pressurized liquid extraction method to quantify organic tracers combined with historic and novel organic contaminants for the DISCOVER-AQ Houston field experiment”

No data is ready to be shared at this point.

Water blank issues arose during August for the WSOC analysis, but have since been resolved. This caused a small delay, but time had been included within the timeline for analysis issues and there will be no delay in the WSOC data sharing.

Supplies and salary expenses for August 2014 were reported by Phyllis Doughty of Baylor University. Supply expenses were associated with WSOC and organic tracer analysis. Salary expenses for August were associated with PI Sheesley.

Project 14-030 **STATUS: Active – June 25, 2014**

Improving Modeled Biogenic Isoprene Emissions under Drought Conditions and Evaluating Their Impact on Ozone Formation

Texas A&M University – Qi Ying

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Mark Estes

Funding Amount: $176,109

Executive Summary

Isoprene emitted from biogenic sources plays an important role in atmospheric chemistry that leads to the formation of ozone and secondary particulate matter (PM). Although drought has been thought to affect biogenic emissions, the capability of the current drought parameterization to adjust the impact of soil moisture on isoprene emissions has not been critically evaluated, especially under severe drought conditions in Texas. The impact of this change in isoprene emissions on regional ozone concentrations is also unclear. In this study, biogenic isoprene emissions during two seven-month episodes, one representing a relatively wet year (2007) and one representing a severe drought year (2011) will be estimated using the most recent version of the MEGAN biogenic emission model (MEGAN v2.1). Emissions during the severe drought year 2011 will be estimated using several different soil moisture parameterization schemes, including one that will be developed in this study based on additional field and climate-controlled laboratory measurements of isoprene emissions at leaf-level for selected Texas tree species. The Community Multiscale Air Quality Model (CMAQ) will be used to simulate isoprene, isoprene oxidation products and ozone concentrations during the dry and wet episodes. The predicted concentrations will be evaluated against all available measurements to evaluate the ability of different drought parameterization schemes and quantify the impact of drought on biogenic isoprene emission and ozone concentrations in Texas. Optimal configuration of the WRF model that is most appropriate for meteorology and soil moisture simulations during the drought seasons will also be investigated.

Project Update

Due to delays in project setting up, the project started on June 25. The current report generally covers the activities during the month of July and August, 2014. The following summarized the progress on each Task in the Work Plan.

Task 1: Meteorology simulation with WRF.

A base case WRF simulation for May – November 2007 and 2011 have been completed using the TACC supercomputer at UT Austin. The WRF domains followed the same domains used by the TCEQ (na_36km, sus_12km, tx_4km), as proposed in the Work Plan. The base case simulation uses the default MODIS land use/land cover. Initial and boundary conditions, including initial soil moisture, were taken from the 3-h resolution North American Regional Reanalysis (NARR) data. The MM5 land surface model was used in this simulation. Observation data from ~100 surface weather stations in the 4-km domain were downloaded from the National Climatic Data Center (NCDC), dataset ds463.3, and soil moisture data for

both 2007 and 2011 were downloaded from TAMU North American Soil Moisture Database. Model performance analysis is currently underway. Based on the results from the initial model performance analysis, we will repeat the WRF simulations using Noah Land Surface Model and initial soil moisture data from the North American Land Data Assimilation System (NLDAS) archive, according to the Work Plan. The National Land Cover Database (NLCD) 2011 land cover data has been downloaded and processed and a sensitivity run will also be conducted. Currently, we can run the WRF simulations using TACC at 2 wall-clock hours for one day and multiple runs can be issued at the same time. We expect to finish WRF simulation in September.

Task 2: Perform field and laboratory measurements on common Texas tree species.

In this quarter, the Schade group assessed the seeding mortality rates and began leaf-level physiology and isoprene emission baseline measurements. The tree seedlings grown for this study were being nurtured in the greenhouse but unfortunately, they were forced to switch greenhouses, which caused additional delays and further increased seedling mortality. Nevertheless, a watering schedule was established in July, the soil used for potting was physically and chemically analyzed, the soil moisture sensors to be used were calibrated in the soil mix, and first photosynthesis baseline measurements on tree seedling leaves were initiated in August. Consumables were acquired throughout July and August and testing of the Tenax VOC sampling cartridges intended for isoprene emissions quantification commences.

Task 5: Perform regional air quality simulations.

Emission inventory for 2007 based on the 2007v5 modeling platform was downloaded from ftp://ftp.epa.gov/EmisInventory/2007v5/; and emission inventory for 2011 based on 2011 NEIv1 modeling platform was download from ftp://ftp.epa.gov/EmisInventory/2011v6/v1platform/. Spatial allocation surrogates were prepared for the RPO 36-km, Texas 12-km, and 4-km domains. Anthropogenic emissions (except point sources) for 2007 and 2011 have been prepared.

FINANCIAL STATUS REPORT

Initial funding for fiscal year 2010 was established at $2,732,071.00. In late May 2010 an amendment was issued increasing the budget by $40,000. Funding for fiscal year 2011 was established at $2,106,071, for a total award of $4,878,142 for the FY 2010/2011 biennium. FY 2010 funds were fully expended in early 2012 and the FY 2011 funds expired on June 30, 2013 with a remaining balance of $0.11.

In February 2012, funding of $1,000,000 was awarded for FY 2012. In June 2012, an additional $160,000 was awarded in FY 2012 funds and $1,000,000 was awarded in FY 2013 funds, for a total of $2,160,000 in funding for the FY 2012/2013 biennium.

In April 2013, the grant was amended to reduce the FY 2012 funds by $133,693.60 and increase the FY 2011 funds by the same amount.

In June 2013, the grant was amended to increase the FY 2013 funds by $2,500,000.

In October 2013, the grant was amended to award FY 2014 funds of $1,000,000 and FY 2015 funds of $1,000,000. The budget for each fiscal year can be found in Appendix C.

FY 2012 funds were fully expended at the end of April 2014.

For each biennium (and fiscal year) 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, part time, in the administration of the AQRP. Dr. David Allen, Principal Investigator and AQRP Director, is responsible for the overall administration of the AQRP. James Thomas, AQRP Manager, is responsible for assisting

Dr. Allen in the program administration. Maria Stanzione, AQRP Grant Manager, with Rachael Bushn, Melanie Allbritton, and Susan McCoy each provided assistance with program organization and financial management. This included assisting with the contracting process. 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 22% of salaries and wages across the term of the project. It should be noted that this was an estimate, and actual fringe benefit expenses have been 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. At the end of the project, the overall total of fringe benefit expensed is expected to be at or below 22% of the total salaries and wages. Actual fringe benefit expenses to date are included in the spreadsheets above.

As discussed in previous Quarterly Reports, the AQRP Administration requested and received permission to utilize funds in future fiscal years. This is for all classes of funds including Administration, ITAC, Project Management, and Contractual. As of the writing of this report, the FY 2010, FY 2011, and FY 2012 funds have been fully expended. This same procedure will be followed for the FY 2013, FY 2014, and FY 2015 funds.

In May 2014, UT-Austin received a Contract Extension for the AQRP. This extension will continue the program through April 27, 2016.

Table 1: AQRP Administration Budget

Administration Budget (includes Council Expenses)
FY 2010/2011

Budget Category		FY10 Budget	FY11 Budget	Total	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$202,816.67	$172,702.06	$375,518.73	$375,518.73	$0.00	$0.00
Fringe Benefits		$38,665.65	$33,902.95	$72,568.60	$72,568.60	$0.00	$0.00
Travel		$346.85	$0	$346.85	$346.85	$0.00	$0.00
Supplies		$15,096.14	$101.25	$15,197.39	$15,197.39	$0.00	$0.00
Equipment		$0	$0	$0			$0.00
Total Direct Costs		$256,925.31	$206,706.26	$463,631.57	$463,631.57	$0.00	$0.00
Authorized Indirect Costs		$20,281.69	$17,270.20	$37,551.89	$37,551.89	$0.00	$0.00
10% of Salaries and Wages							
Total Costs		**$277,207.00**	**$223,976.46**	**$501,183.46**	**$501,183.46**	**$0.00**	**$0.00**
Fringe Rate		22%	22%		19%		

Administration Budget (includes Council Expenses)
FY 2012/2013

Budget Category		FY12 Budget	FY13 Budget	Total	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$74,238.65	$265,040.00	$339,278.65	$226,107.70	$0.00	$113,170.95
Fringe Benefits		$17,068.38	$47,706.00	$64,774.38	$51,188.43	$0.00	$13,585.95
Travel		$339.13	$750	$1,089.13	$339.13		$750.00
Supplies		$3,560.62	$10,000	$13,560.62	$9,731.07	$0.00	$3,829.55
Equipment		$0.00	$0	$0			$0
Total Direct Costs		$95,206.78	$323,496.00	$418,702.78	$287,366.33	$0.00	$131,336.45
Authorized Indirect Costs		$7,423.86	$26,504.00	$33,927.86	$22,610.76	$0.00	$11,317.10
10% of Salaries and Wages							
Total Costs		**$102,630.64**	**$350,000.00**	**$452,630.64**	**$309,977.09**	**$0.00**	**$142,653.55**
Fringe Rate		22%	22%		23%		

Administration Budget (includes Council Expenses)
FY 2014/2015

Budget Category		FY14 Budget	FY15 Budget	Total	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$70,000.00	$70,000.00	$140,000.00	$0.00	$0.00	$140,000.00
Fringe Benefits		$15,150.00	$15,150.00	$30,300.00	$0.00	$0.00	$30,300.00
Travel		$350.00	$350.00	$700.00	$0.00	$0.00	$700.00
Supplies		$7,500.00	$7,500.00	$15,000.00	$0.00	$0.00	$15,000.00
Equipment							
Total Direct Costs		$93,000.00	$93,000.00	$186,000.00	$0.00	$0.00	$186,000.00
Authorized Indirect Costs		$7,000.00	$7,000.00	$14,000.00	$0.00	$0.00	$14,000.00
10% of Salaries and Wages							
Total Costs		**$100,000.00**	**$100,000.00**	**$200,000.00**	**$0.00**	**$0.00**	**$200,000.00**
Fringe Rate		22%	22%		0%		

ITAC

During December 2013and January 2014 the ITAC conducted their review of the proposals submitted in response to the 2014 – 2015 Request for Proposals. In November 2013 each proposal was assigned to 3 different ITAC members for review. On December 17, 2013, the individual reviews were submitted to AQRP and a conference call was held to perform an initial discussion and ranking of the proposals. On January 10, 2014, the ITAC met for a full day to review the proposals for technical merit and provide a ranking to the TCEQ and the Advisory Council. Expenses during this period were for travel for the ITAC members to attend the meeting and lunch provided during the meeting.

All remaining FY 2012 and FY 2013 ITAC funds were transferred to Research Projects/Contractual, as they were no longer needed for ITAC expenses and could be better utilized as additional research funding.

Table 2: ITAC Budget

ITAC Budget
FY 2010/2011

Budget Category		FY10 Budget	FY11 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary							
Fringe Benefits							
Travel		$16,378.86	$6,292.97	$22,671.83	$22,671.83	$0.00	$0
Supplies		$1,039.95	$284.67	$1,324.62	$1,324.62	$0.00	0
Total Direct Costs		$17,418.81	$6,577.64	$23,996.45	$23,996.45	$0.00	$0
Authorized Indirect Costs							
10% of Salaries and Wages							
Total Costs		**$17,418.81**	**$6,577.64**	**$23,996.45**	**$23,996.45**	**$0.00**	**$0**

ITAC Budget
FY 2012/2013

Budget Category		FY12 Budget	FY13 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary							
Fringe Benefits							
Travel		$5,323.31	$0.00	$5,323.31	$5,323.31	$0	$0.00
Supplies		$231.86	$0.00	$231.86	$231.86		$0.00
Total Direct Costs		$5,555.17	$0.00	$5,555.17	$5,555.17	$0	$0.00
Authorized Indirect Costs							
10% of Salaries and Wages							
Total Costs		**$5,555.17**	**$0.00**	**$5,555.17**	**$5,555.17**	**$0**	**$0.00**

ITAC Budget
FY 2014/2015

Budget Category		FY14 Budget	FY15 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary							
Fringe Benefits							
Travel		$7,000.00	$7,000.00	$14,000.00	$0.00	$0.00	$14,000.00
Supplies		$500.00	$500.00	$1,000.00	$0.00	$0.00	$1,000.00
Total Direct Costs		$7,500.00	$7,500.00	$15,000.00	$0.00	$0.00	$15,000.00
Authorized Indirect Costs							
10% of Salaries and Wages							
Total Costs		**$7,500.00**	**$7,500.00**	**$15,000.00**	**$0.00**	**$0.00**	**$15,000.00**

Project Management

During the first quarter of FY 2013-2014, Project Managers assisted with project questions, reporting requirements, and budget amendment requests as projects drew to a close. They also reviewed draft final reports and provided feedback. This transitioned to reviewing final project reports for the FY 2012-2013 research cycle as projects closed at the end of November 2013. This included a thorough review of each project against its Quality Assurance Project Plan (QAPP). Final reports were approved for all projects and are now available on the AQRP web page.

During third quarter, Project Managers worked with the project teams to complete the project Work Plans and begin work on the projects. As these were approved and projects became active, Project Managers focused on making sure all reporting requirements were met and projects were moving forward as described in the Work Plans.

Table 3: Project Management Budget

Project Management Budget
FY 2010/2011

Budget Category		FY10 Budget	FY11 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$145,337.70	$121,326.64	$266,664.34	$266,664.34	$0	$0
Fringe Benefits		$28,967.49	$23,102.60	$52,070.09	$52,070.26	$0	($0.17)
Travel		$0	$0	$0	$0		$0
Supplies		$778.30	$207.98	$986.28	$986.22	$0	$0.06
Total Direct Costs		$175,083.49	$144,637.22	$319,720.71	$319,720.82	$0	($0.11)
Authorized Indirect Costs		$14,533.77	$12,132.66	$26,666.43	$26,666.32	$0	$0.11
10% of Salaries and Wages							
Total Costs		**$189,617.26**	**$156,769.88**	**$346,387.14**	**$346,387.14**	**$0**	**$0.00**

Project Management Budget
FY 2012/2013

Budget Category		FY12 Budget	FY13 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$53,384.46	$77,000.00	$130,333.63	$130,333.63	$0.00	$50.83
Fringe Benefits		$10,991.04	$13,500.00	$26,291.04	$25,496.30	$0.00	$794.74
Travel		$0.00	$0	$0.00	$0.00		$0.00
Supplies		$967.98	$6,000.00	$6,967.98	$1,452.52		$5,515.46
Total Direct Costs		$65,343.48	$98,300.00	$163,643.48	$157,282.45	$0.00	$6,361.03
Authorized Indirect Costs		$5,338.44	$7,700.00	$13,038.44	$13,033.36	$0.00	$5.08
10% of Salaries and Wages							
Total Costs		**$70,681.92**	**$106,000.00**	**$176,681.92**	**$170,315.81**	**$0.00**	**$6,366.11**

Project Management Budget
FY 2014/2015

Budget Category		FY14 Budget	FY15 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$52,000.00	$52,000.00	$104,000.00	$3,869.46	$0.00	$100,130.54
Fringe Benefits		$9,300.00	$9,300.00	$18,600.00	$785.46	$0.00	$17,814.54
Travel							
Supplies		$1,000.00	$1,000.00	$2,000.00	$0.00	$0.00	$2,000.00
Total Direct Costs		$62,300.00	$62,300.00	$124,600.00	$4,654.92	$0.00	$119,945.08
Authorized Indirect Costs		$5,200.00	$5,200.00	$10,400.00	$386.94	$0.00	$10,013.06
10% of Salaries and Wages							
Total Costs		**$67,500.00**	**$67,500.00**	**$135,000.00**	**$5,041.86**	**$0.00**	**$129,958.14**

Research Projects

FY 2010-2011

The FY 2010 Research/Contractual budget was originally funded at $2,286,000. After all transfers, it was increased by $1,827.93. The FY 2011 Research/Contractual budget was originally funded at $1,736,063. After all transfers, it was increased by $377.62, plus an additional $116,000 from FY 2012 funds that were changed to FY 2011 funds. This is an overall net increase of $13,205.55 to the Research/Contractual funds (and net reduction in Project Management/ITAC funds). ($105,000 in FY 2012 research funds were transferred to FY 2011, the remaining $11,000 were transfers from Project Management funds.)

All FY 2010 Research Project funding was fully expensed before the expiration of FY 2010 funds in June 2012. The FY 2011 Research Project funding that remained after all FY 2011 research projects were completed was allocated to FY 2012-2013 projects. This included the funds that were reallocated from FY 2012 to FY 2011. The funds were allocated to project 13-016 Valparaiso and project 13-004 Discover AQ Infrastructure. Both projects utilized their FY 2011 funds (project 13-004 $116,000 and project 13-016 $20,168.90) by June 30, 2013. A remaining balance of $0.11 was returned to TCEQ.

Table 4 on the following 2 pages illustrates the 2010-2011 Research Projects, including the funding awarded to each project and the total expenses reported on each project through the expiration of the FY 2011 funds on June 30, 2013.

FY 2012-2013

The FY 2012 Research/Contractual budget was originally funded at $815,000. Transfers to date have increased the budget by $32,438.67. These funds were fully expended as of April 2014. The FY 2013 Research Contractual budget was originally funded at $835,000. In June 2013, Amendment 9 increased this budget by $2,100,000. (The remaining $400,000 was allocated to Admin and Project Management.) Transfers to date have increased that by an additional $109,000 for a total FY 2013 Research Contractual budget of $3,044,000. This includes funds transferred from the FY 13 Project Management budget to the Research Projects budget, in order to fund as many research projects as possible.

Total FY 2013 research project expenditures are $1,321,620.01. Funds that were not expended by the FY 2012 – 2013 research projects totaling $1,716,844.99 have been allocated to projects from the FY 2014-2015 RFP.

Table 5 illustrates the 2012-2013 Research Projects, including the funding awarded to each project and the total expenses reported on each project as of August 31, 2014. FY 2013 funding will be fully expended by June 30, 2015.

FY 2014-2015

The FY 2014 and 2015 Research/Contractual budgets were originally funded at $825,000 each. Research projects have been awarded to FY 2013, 2014, and 2015 funds.

Table 4: 2010/2011 Contractual Expenses

Contractual Expenses

FY 10 Contractual Funding	$2,286,000
FY 10 Contractual Funding Transfers	$1,827.93
FY 10 Total Contractual Funding	**$2,287,827.93**

Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
10-008	Rice University	$128,851	$126,622.32	$2,228.68
10-008	Environ International	$49,945	$49,944.78	$0.22
10-009	UT-Austin	$591,332	$591,306.66	$25.34
10-021	UT-Austin	$248,786	$248,786.41	-$0.41
10-022	Lamar University	$150,000	$132,790.80	$17,209.20
10-032	University of Houston	$176,314	$176,314	$0
10-032	University of New Hampshire	$23,054	$18,850.65	$4,203.35
10-032	UCLA	$49,284	$47,171.32	$2,112.68
10-034	University of Houston	$195,054	$186,657.54	$8,396.46
10-042	Environ International	$237,481	$237,479.31	$1.69
10-045	UCLA	$149,773	$142,930.28	$6,842.72
10-045	UNC - Chapel Hill	$33,281	$33,281	$0
10-045	Aerodyne Research Inc.	$164,988	$164,988.10	-$0.10
10-045	Washington State University	$50,000	$50,000	$0
10-DFW	UT-Austin	$37,857	$37,689.42	$167.58
FY 10 Total Contractual Funding Awarded		$2,286,000		
FY 10 Contractual Funding Expended (Init. Projects)			$2,244,812.59	
FY 10 Contractual Funds Remaining Unspent after Project Completion				$41,187.41
FY 10 Additional Projects				
	Data Storage	$7,015.34	$7,015.34	$0
10-SOS	State of the Science	$36,000.00	$36,000.00	$0
FY 10 Contractual Funds Expended to Date*			$2,287,827.93	
FY 10 Contractual Funds Remaining to be Spent				$0

FY 11 Contractual Funding		$1,736,063.00		
FY 11 Contractual Funding Transfers		$116,377.62		
FY 11 Total Contractual Funding		**$1,852,440.62**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
10-006	Chalmers University of Tech	$262,179	$262,179	$0
10-006	University of Houston	$222,483	$217,949.11	$4,533.89
10-015	Environ International	$201,280	$201,278.63	$1.37
10-020	Environ International	$202,498	$202,493.48	$4.52
10-024	Rice University	$225,662	$223,769.99	$1,892.01
10-024	University of New Hampshire	$70,747	$70,719.78	$27.22
10-024	University of Michigan	$64,414	$60,597.51	$3,816.49
10-024	University of Houston	$98,134	$88,914.46	$9,219.54
10-029	Texas A&M University	$80,108	$78,276.97	$1,831.03
10-044	University of Houston	$279,642	$277,846.38	$1,795.62
11-DFW	UT-Austin	$50,952	$29,261.75	$21,690.25
FY 11 Total Contractual Funding Awarded		$1,758,099		
FY 11 Contractual Funds Expended (Init. Projects)			$1,713,287.06	
FY 11 Contractual Funds Remaining Unspent after Project Completion				$44,811.94
FY 11 Additional Projects				
	Data Storage	$2,984.66	$2,984.66	$0.00
	12-016 Valparaiso	$20,168.90	$0.00	$21,168.90
	12-004 Discover AQ Infrastructure	$116,000.00	$115,999.89	$0.11
FY 11 Contractual Funds Expended to Date*			$1,852,440.51	
FY 11 Contractual Funds Remaining to be Spent				$0.11
Total Contractual Funding		$4,022,063.00		
Total Contractual Funding Transfers		$118,205.55		
Total Contractual Funding Available		$4,140,268.55		
Total Contractual Funds Expended to Date			$4,140,268.44	
Total Contractual Funds Remaining				$0.11

Table 5. 2012/2013 Contractual Expenses

Contractual Expenses

FY 12 Contractual Funding	$815,000.00
FY 12 Contractual Funding Transfers	$32,438.67
FY 12 Total Contractual Funding	**$847,438.67**

Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
12-004	UT-Austin (Torres)	$20,174.10	$20,174.10	$0.00
12-006	UC-Riverside	$101,765.00	$101,765.00	$0.00
12-006	TAMU/TEES	$44,494.00	$42,134.22	$2,359.78
12-011	Environ International	$77,420.00	$77,410.16	$9.84
12-012	UT-Austin (Hildebrandt)	$79,463.00	$79,173.94	$289.06
12-012	Environ International	$69,374.00	$69,372.64	$1.36
12-013	Environ International	$59,974.00	$59,960.93	$13.07
12-018	UT-Austin (McDonald-Buller)	$85,282.00	$85,197.80	$84.20
12-018	Environ International	$21,688.00	$21,686.26	$1.74
12-028	University of Houston	$19,599.00	$16,586.51	$3,012.49
12-028	UCLA	$17,944.00	$17,709.51	$234.49
12-028	Environ International	$44,496.00	$44,496.00	$0.00
12-028	UNC - Chapel Hill	$35,230.00	$35,230.00	$0.00
12-032	Baylor	$45,972.00	$43,642.21	$2,329.79
12-TN1	Maryland	$64,994.00	$64,537.12	$456.88
12-TN2	Maryland	$69,985.00	$68,362.27	$1,622.73
FY 12 Total Contractual Funding Awarded		$847,438.67		
FY 12 Contractual Funds Expended to Date			$847,438.67	
FY 12 Contractual Funds Remaining to be Spent				$0.00

Note:
Project 12-004 on this page and Project 13-004 on the following page were the same project, with funding split across fiscal years. After all FY12 projects were completed and fully invoiced, the remaining FY12 funds were transferred to 12-004 and 13-004 was reduced by the same amount, so that the total project budget remained the same, but all FY12 funds could be expended.

FY 13 Contractual Funding		$835,000		
FY 13 Contractual Funding Transfers		$2,209,000		
FY 13 Total Contractual Funding		**$3,044,000**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
13-004	UT-Austin (Torres)	$1,555,770	$805,228.06	$750,541.84
13-005	Chalmers University of Tech	$129,047	$129,047.00	$0.00
13-005	University of Houston	$48,506	$44,928.24	$3,577.76
13-016	Valparaiso	$46,652	$46,652.10	$0.00
13-016	University of Houston	$19,846	$14,101.40	$5,744.60
13-022	Rice University	$89,912	$75,881.86	$14,030.14
13-022	University of Houston	$116,903	$116,122.47	$780.53
13-024	Maryland	$90,444	$89,658.88	$785.12
FY 13 Total Contractual Funding Awarded		$2,097,080		
FY 13 Contractual Funds Expended (Init. Projects)			$1,321,620.01	
FY 13 Contractual Funds Remaining Unspent				$1,722,379.99
FY 13 Additional Expenditures				
	DATA Storage	$5,535	$5,535	$0.00
FY 13 Contractual Funds Expended			$1,327,155.01	
FY 13 Contractual Funds Remaining Unspent				$1,716,844.99

Note:
After all FY13 projects were completed contractual funds in the amount of $1,716,844.99 remained. The funds will be utilized for FY14 projects and will be accounted for on the following page.

FY 13 Remaining Contractual Funding		**$1,716,844.99**		
Awarded to FY 2014-2015 Projects				
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
14-003	UNC Chapel Hill	$180,000.00	$0.00	$180,000.00
14-006	Sonoma Technology	$47,979.00	$1,886.50	$46,092.50
14-006	Valparaiso	$15,609.00	$0.00	$15,609.00
14-007	Chalmers Univ.	$15,233.00		$12,000.00
14-007	Univ. of Houston	$10,000.00		$10,000.00
14-008	UT-Austin (McDonald-Buller)	$175,000.00	$10,318.18	$164,681.82
14-011	UT-Austin (McDonald-Buller)	$131,166.00	$8,798.70	$122,367.30
14-011	Environ	$6,000.00	$492.51	$5,507.49
14-016	Environ	$240,000.00	$52,820.56	$187,179.44
14-017	University of Alabama - Huntsville	$25,000.00		$25,000.00
14-017	Rice University	$25,000.00		$25,000.00
14-023	UT-Austin (Torres)	$76,773.00	$17,233.89	$59,539.11
14-023	Aerodyne	$147,066.00		$147,066.00
14-024	UT-Austin (Hildebrandt Ruiz)	$143,282.00	$25,074.73	$118,207.27
14-024	Environ	$25,000.00	$5,855.68	$19,144.32
14-024	UC Riverside	$35,314.00	$0.00	$35,314.00
14-025	Environ	$40,000.00	$19,447.89	$20,552.11
14-025	TAMU	$20,000.00		$20,000.00
14-029	Baylor University	$150,000.00		$150,000.00
14-030	TEES	$132,227.43	$4,231.74	$127,995.69
FY 13 Total Remaining Contractual Funding Awarded		$1,640,649.43		
FY 13 Remaining Contractual Funds Expended			$146,160.38	
FY 13 Remaining Contractual Funds Unspent				$1,570,684.61

Total Contractual Funding	$3,891,439		
Total Contractual Funding Awarded	$3,815,243		
Total Contractual Funding Remaining to be Awarded	$76,196		
Total Contractual Funds Expended to Date		$2,320,754.06	
Total Contractual Funds Remaining to be Spent			$1,570,684.61

Table 6. 2014/2015 Contractual Expenses

Contractual Expenses

FY 14 Contractual Funding	**$825,000**
FY 14 Contractual Funding Transfers	**$0**
FY 14 Total Contractual Funding	**$825,000**

Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
14-002	CU - Boulder	$150,508.00		$150,508.00
14-002	Univ. of Maryland	$49,387.00		$49,387.00
14-003	UNC Chapel Hill	$20,000.00	$0.00	$20,000.00
14-004	Univ. of Maryland	$55,056.00		$55,056.00
14-004	Morgan State Univ.	$54,055.00		$54,055.00
14-009	Rice Univ.	$109,867.00		$109,867.00
14-009	Univ. of Houston	$109,635.00		$109,635.00
14-026	Environ	$135,782.00	$3,657.28	$132,124.72
14-030	TAMU/TEES	$43,881.57		$43,881.57
				$0.00
				$0.00
				$0.00
FY 14 Total Contractual Funding Awarded		$728,171.57		
FY 14 Contractual Funding Remaining to be Awarded		$96,828.43		
FY 14 Contractual Funds Expended to Date			$3,657.28	
FY 14 Contractual Funds Remaining to be Spent				$821,342.72

FY 15 Contractual Funding		**$825,000**		
FY 15 Contractual Funding Transfers		**$0**		
FY 15 Total Contractual Funding		**$825,000**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
14-006	Sonoma Technology	$2,000.00	$0.00	$2,000.00
14-007	Chalmers University	$58,946.00		$74,179.00
14-007	Univ. of Houston	$13,081.00		$23,081.00
14-011	Univ. of Texas - Austin	$20,001.00		$20,001.00
14-011	Environ	$22,419.00		$28,419.00
14-016	Environ	$31,911.00	$0.00	$31,911.00
14-017	Univ. of Alabama - Huntsville	$112,003.00		$112,003.00
14-017	Rice University	$37,979.00		$37,979.00
14-023	Aerodyne Research	$10,000.00	$0.00	$10,000.00
14-024	Univ. of Texas - Austin	$20,000.00	$0.00	$20,000.00
14-024	Environ	$76,404.00	$0.00	$101,404.00
14-025	Environ	$95,735.00	$0.00	$135,735.00
14-025	TAMU	$100,526.00		$100,526.00
14-029	Baylor University	$28,679.00		$28,679.00
FY 15 Total Contractual Funding Awarded		$629,684.00		
FY 15 Contractual Funding Remaining to be Awarded		$195,316.00		
FY 15 Contractual Funds Expended to Date			$0.00	
FY 15 Contractual Funds Remaining to be Spent				$825,000.00

Total Contractual Funding	$1,650,000		
Total Contractual Funding Awarded	$1,357,856		
Total Contractual Funding Remaining to be Awarded	$292,144		
Total Contractual Funds Expended to Date		$3,657.28	
Total Contractual Funds Remaining to be Spent			$1,646,343

Appendix A

Financial Reports by Fiscal Year

FY 10 and 11

(Expenditures reported as of August 31, 2014.)

Administration Budget (includes Council Expenses)

FY 2010

Budget Category		FY10 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$202,816.67	$202,816.67		$0
Fringe Benefits		$38,665.65	$38,665.65		$0
Travel		$346.85	$346.85		$0
Supplies		$15,096.14	$15,096.14		$0
Equipment		$0.00			$0
Other					
Contractual					
Total Direct Costs		$256,925.31	$256,925.31		$0
Authorized Indirect Costs		$20,281.69	$20,281.69		$0
10% of Salaries and Wages					
Total Costs		**$277,207.00**	**$277,207.00**	**$0**	**$0**

Administration Budget (includes Council Expenses)

FY 2011

Budget Category		FY11 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$172,702.06	$172,702.06	$0.00	$0.00
Fringe Benefits		$33,902.95	$33,902.95	$0.00	$0.00
Travel		$0.00		$0.00	$0.00
Supplies		$101.25	$101.25	$0.00	$0.00
Equipment					
Other		$0.00			$0.00
Contractual					
Total Direct Costs		$206,706.26	$206,706.26	$0.00	$0.00
Authorized Indirect Costs		$17,270.20	$17,270.20	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$223,976.46**	**$223,976.46**	**0.00**	**$0.00**

ITAC Budget

FY 2010

Budget Category		FY10 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$16,378.86	$16,378.86	$0	$0
Supplies		$1039.95	$1,039.95		$0
Equipment					
Other					
Total Direct Costs		$17,418.81	$17,418.81	$0	$0
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$17,418.81**	**$17,418.81**	**$0**	**$0**

ITAC Budget

FY 2011

Budget Category		FY11 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$6,292.97	$6,292.97	$0.00	$0
Supplies		$284.67	$284.67	$0.00	$0
Equipment					
Other					
Total Direct Costs		$6,577.64	$6,577.64	$0.00	$0
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$6,577.64**	**$6,577.64**	**$0.00**	**$0**

Project Management Budget

FY 2010

Budget Category		FY10 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$145,337.70	$145,337.70		$0
Fringe Benefits		$28,967.49	$28,967.49		$0
Travel		$0	$0		$0
Supplies		$778.30	$778.30		$0
Equipment					
Other					
Total Direct Costs		$175,083.49	$175,083.49	$0	$0
Authorized Indirect Costs		$14,533.77	$14,533.77		$0
10% of Salaries and Wages					
Total Costs		**$189,617.26**	**$189,617.26**	**$0**	**$0**

Project Management Budget

FY 2011

Budget Category		FY11 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$121,326.64	$121,326.64	$0	$0
Fringe Benefits		$23,102.60	$23,102.77	$0	($0.17)
Travel		$0			$0
Supplies		$207.98	$207.92	$0	$0.06
Equipment					
Other					
Total Direct Costs		$144,637.22	$144,637.33	$0	($0.11)
Authorized Indirect Costs		$12,132.66	$12,132.55	$0	$0.11
10% of Salaries and Wages					
Total Costs		**$156,769.88**	**$156,769.88**	**$0**	**$0.00**

AQRP Budget

FY 2010

Budget Category		FY10 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$202,816.67	$202,816.67	$0.00	$0.00
Fringe Benefits		$38,665.65	$38,665.65	$0.00	$0.00
Travel		$346.85	$346.85	$0.00	$0.00
Supplies		$15,096.14	$15,096.14	$0.00	$0.00
Equipment		$0	$0.00	$0.00	$0.00
Other		$0	$0.00	$0.00	$0.00
Contractual		$2,287,827.93	$2,287,827.93	$0.00	$0.00
ITAC		$17,418.81	$17,418.81	$0.00	$0.00
Project Management		$189,617.26	$189,617.26	$0.00	$0.00
Total Direct Costs		$2,751,789.31	$2,751,789.31	$0.00	$0.00
Authorized Indirect Costs		$20,281.69	$20,281.69	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$2,772,071.00**	**$2,772,071.00**	**$0.00**	**$0.00**

AQRP Budget

FY 2011

Budget Category		FY11 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$172,702.06	$172,702.06	$0.00	$0.00
Fringe Benefits		$33,902.95	$33,902.95	$0.00	$0.00
Travel		$0.00	$0.00	$0.00	$0.00
Supplies		$101.25	$101.25	$0.00	$0.00
Equipment		$0.00	$0.00	$0.00	$0.00
Other		$0.00	$0.00	$0.00	$0.00
Contractual		$1,852,440.62	$1,852,440.51	$0.00	$0.11
ITAC		$6,577.64	$6,577.64	$0.00	($0.00)
Project Management		$156,769.88	$156,769.88	$0.00	$0.00
Total Direct Costs		$2,222,494.40	$2,222,494.29	$0.00	$0.11
Authorized Indirect Costs		$17,270.20	$17,270.20	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$2,239,764.60**	**$2,239,764.49**	**$0.00**	**$0.11**

Appendix B

Financial Reports by Fiscal Year

FY 12 and 13

(Expenditures reported as of August 31, 2014.)

Administration Budget (includes Council Expenses)

FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$74,238.65	$74,238.65	$0.00	$0.00
Fringe Benefits		$17,068.38	$17,068.38	$0.00	$0.00
Travel		$339.13	$339.13		$0.00
Supplies		$3,560.62	$3,560.62	$0.00	$0.00
Equipment		$0.00			$0.00
Other					
Total Direct Costs		$95,206.78	$95,206.78	$0.00	$0.00
Authorized Indirect Costs		$7,423.86	$7,423.86	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$102,630.64**	**$102,630.64**	**$0.00**	**$0.00**

Administration Budget (includes Council Expenses)

FY 2013

Budget Category		FY13 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$265,040.00	$151,869.05		$113,170.95
Fringe Benefits		$47,706.00	$34,120.05		$13,585.95
Travel		$750.00	$0.00		$750.00
Supplies		$10,000.00	$6,170.45		$3,829.55
Equipment					
Other		$0.00			
Total Direct Costs		$323,496.00	$192,159.55	$0.00	$131,336.45
Authorized Indirect Costs		$26,504.00	$15,186.90		$11,317.10
10% of Salaries and Wages					
Total Costs		**$350,000.00**	**$207,346.45**	**$0.00**	**$142,653.55**

ITAC Budget

FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$5,323.31	$5,323.31		$0.00
Supplies		$231.86	$231.86		$0.00
Equipment					
Other					
Total Direct Costs		$5,555.17	$5,555.17	$0.00	$0.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$5,555.17**	**$5,555.17**	**$0.00**	**$0.00**

ITAC Budget

FY 2013

Budget Category		FY13 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$0.00	$0.00		$0.00
Supplies		$0.00	$0.00		$0.00
Equipment					
Other					
Total Direct Costs		$0.00	$0.00	$0.00	$0.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$0.00**	**$0.00**	**$0.00**	**$0.00**

Project Management Budget

FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$53,384.46	$53,384.46	$0.00	$0.00
Fringe Benefits		$10,991.04	$10,991.04	$0.00	$0.00
Travel		$0.00	$0.00		$0.00
Supplies		$967.98	$967.98		$0.00
Equipment					
Other					
Total Direct Costs		$65,343.48	$65,343.48	$0.00	$0.00
Authorized Indirect Costs		$5,338.44	$5,338.44	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$70,681.92**	**$70,681.92**	**$0.00**	**$0.00**

Project Management Budget

FY 2013

Budget Category		FY13 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$77,000.00	$76,949.17		$50.83
Fringe Benefits		$15,300.00	$14,505.26		$794.74
Travel					
Supplies		$6,000.00	$484.54		$5,515.46
Equipment					
Other					
Total Direct Costs		$98,300.00	$91,938.97	$0	$6,361.03
Authorized Indirect Costs		$7,700.00	$7,694.92		$5.08
10% of Salaries and Wages					
Total Costs		**$106,000.00**	**$99,633.89**	**$0.00**	**$6,366.11**

AQRP Budget

FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$74,238.65	$74,238.65	$0.00	$0.00
Fringe Benefits		$17,068.38	$17,068.38	$0.00	$0.00
Travel		$339.13	$339.13	$0.00	$0.00
Supplies		$3,560.62	$3,560.62	$0.00	$0.00
Equipment		$0.00	$0.00	$0.00	$0.00
Other		$0.00	$0.00	$0.00	$0.00
Contractual		$847,438.67	$847,438.67	$0.00	$0.00
ITAC		$5,555.17	$5,555.17	$0.00	$0.00
Project Management		$70,681.92	$70,681.92	$0.00	$0.00
Total Direct Costs		$1,018,882.54	$1,018,882.54	$0.00	$0.00
Authorized Indirect Costs		$7,423.86	$7,423.86	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$1,026,306.40**	**$1,026,306.40**	**$0.00**	**$0.00**

AQRP Budget

FY 2013

Budget Category		FY13 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$265,040.00	$151,869.05	$0.00	$113,170.95
Fringe Benefits		$47,706.00	$34,120.05	$0.00	$13,585.95
Travel		$750.00	$0.00	$0.00	$750.00
Supplies		$10,000.00	$6,170.45	$0.00	$3,829.55
Equipment		$0.00	$0.00	$0.00	$0.00
Other		$0.00	$0.00	$0.00	$0.00
Contractual		$3,044,000.00	$1,473,315.39	$0.00	$1,570,684.61
ITAC		$0.00	$0.00	$0.00	$0.00
Project Management		$106,000.00	$99,633.89	$0.00	$6,366.11
Total Direct Costs		$3,473,496.00	$1,765,108.83	$0.00	$1,708,387.17
Authorized Indirect Costs		$26,504.00	$15,186.90	$0.00	$11,317.10
10% of Salaries and Wages					
Total Costs		**$3,500,000.00**	**$1,780,295.73**	**$0.00**	**$1,719,704.27**

Appendix C

Financial Reports by Fiscal Year

FY 14 and 15

(Expenditures reported as of August 31, 2014.)

Administration Budget (includes Council Expenses)

FY 2014

Budget Category		FY14 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$70,000.00	$0.00	$0.00	$70,000.00
Fringe Benefits		$15,150.00	$0.00	$0.00	$15,150.00
Travel		$350.00	$0.00	$0.00	$350.00
Supplies		$7,500.00	$0.00	$0.00	$7,500.00
Equipment					
Other					
Total Direct Costs		$93,000.00	$0.00	$0.00	$93,000.00
Authorized Indirect Costs		$7,000.00	$0.00	$0.00	$7,000.00
10% of Salaries and Wages					
Total Costs		**$100,000.00**	**$0.00**	**$0.00**	**$100,000.00**

Administration Budget (includes Council Expenses)

FY 2015

Budget Category		FY15 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$70,000.00	$0.00	$0.00	$70,000.00
Fringe Benefits		$15,150.00	$0.00	$0.00	$15,150.00
Travel		$350.00	$0.00	$0.00	$350.00
Supplies		$7,500.00	$0.00	$0.00	$7,500.00
Equipment					
Other					
Total Direct Costs		$93,000.00	$0.00	$0.00	$93,000.00
Authorized Indirect Costs		$7,000.00	$0.00	$0.00	$7,000.00
10% of Salaries and Wages					
Total Costs		**$100,000.00**	**$0.00**	**$0.00**	**$100,000.00**

ITAC Budget

FY 2014

Budget Category		FY14 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$7,000.00	$0.00	$0.00	$7,000.00
Supplies		$500.00	$0.00	$0.00	$500.00
Equipment					
Other					
Total Direct Costs		$7,500.00	$0.00	$0.00	$7,500.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$7,500.00**	**$0.00**	**$0.00**	**$7,500.00**

ITAC Budget

FY 2015

Budget Category		FY15 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$7,000.00	$0.00	$0.00	$7,000.00
Supplies		$500.00	$0.00	$0.00	$500.00
Equipment					
Other					
Total Direct Costs		$7,500.00	$0.00	$0.00	$7,500.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$7,500.00**	**$0.00**	**$0.00**	**$7,500.00**

Project Management Budget

FY 2014

Budget Category		FY14 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$52,000.00	$3,869.46	$0.00	$48,130.54
Fringe Benefits		$9,300.00	$785.46	$0.00	$8,514.54
Travel		$0.00	$0.00	$0.00	$0.00
Supplies		$1,000.00	$0.00	$0.00	$1,000.00
Equipment					
Other					
Total Direct Costs		$62,300.00	$4,654.92	$0.00	$57,645.08
Authorized Indirect Costs		$5,200.00	$386.94	$0.00	$4,813.06
10% of Salaries and Wages					
Total Costs		**$67,500.00**	**5,041.86**	**$0.00**	**$62,458.14**

Project Management Budget

FY 2015

Budget Category		FY15 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$52,000.00	$0.00	$0.00	$52,000.00
Fringe Benefits		$9,300.00	$0.00	$0.00	$9,300.00
Travel		$0.00	$0.00	$0.00	$0.00
Supplies		$1,000.00	$0.00	$0.00	$1,000.00
Equipment					
Other					
Total Direct Costs		$62,300.00	$0.00	$0.00	$62,300.00
Authorized Indirect Costs		$5,200.00	$0.00	$0.00	$5,200.00
10% of Salaries and Wages					
Total Costs		**$67,500.00**	**$0.00**	**$0.00**	**$67,500.00**

AQRP Budget

FY 2014

Budget Category		FY14 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$70,000.00	$0.00	$0.00	$70,000.00
Fringe Benefits		$15,150.00	$0.00	$0.00	$15,150.00
Travel		$350.00	$0.00	$0.00	$350.00
Supplies		$7,500.00	$0.00	$0.00	$7,500.00
Equipment		$0.00	$0.00	$0.00	$0.00
Other		$0.00	$0.00	$0.00	$0.00
Contractual		$825,000.00	$3,657.28	$0.00	$821,342.72
ITAC		$7,500.00	$0.00	$0.00	$7,500.00
Project Management		$67,500.00	$5,041.86	$0.00	$62,458.14
Total Direct Costs		$993,000.00	$8,699.14	$0.00	$984,300.86
Authorized Indirect Costs		$7,000.00	$0.00	$0.00	$7,000.00
10% of Salaries and Wages					
Total Costs		**$1,000,000.00**	**$8,699.14**	**$0.00**	**$991,300.86**

AQRP Budget

FY 2015

Budget Category		FY15 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$70,000.00	$0.00	$0.00	$70,000.00
Fringe Benefits		$15,150.00	$0.00	$0.00	$15,150.00
Travel		$350.00	$0.00	$0.00	$350.00
Supplies		$7,500.00	$0.00	$0.00	$7,500.00
Equipment		$0.00	$0.00	$0.00	$0.00
Other		$0.00	$0.00	$0.00	$0.00
Contractual		$825,000.00	$0.00	$0.00	$825,000.00
ITAC		$7,500.00	$0.00	$0.00	$7,500.00
Project Management		$67,500.00	$0.00	$0.00	$67,500.00
Total Direct Costs		$993,000.00	$0.00	$0.00	$993,000.00
Authorized Indirect Costs		$7,000.00	$0.00	$0.00	$7,000.00
10% of Salaries and Wages					
Total Costs		**$1,000,000.00**	**$0.00**	**$0.00**	**$1,000,000.00**

Appendix D

AQRP Publications and Presentations

FY10-11

10-006

Johansson, J., Johan Mellqvist, Jerker Samuelsson, Brian Offerle, Jana Moldanova , Bernhard Rappenglück, Barry Lefer, and James Flynn (2014) , Formaldehyde Quantitative Measurements and Modeling of Industrial Formaldehyde Emissions in the Greater Houston Area during Campaigns in 2009 and 2011, Journal of Geophysical Research: Atmospheres, 119, DOI: 10.1002/2013JD020159

Johansson, J. K. E., J. Mellqvist, J. Samuelsson, B. Offerle, B. Lefer, B. Rappenglück, J. Flynn, and G. Yarwood(2014), Emission measurements of alkenes, alkanes, SO2, and NO2 from stationary sources in Southeast Texas over a 5 year period using SOF and mobile DOAS, J. Geophys. Res. Atmos., 119, doi:10.1002/2013JD020485.

10-008

Digar, A., D.S. Cohan, X. Xiao, K.M. Foley, B. Koo, and G. Yarwood (2013). Constraining ozone-precursor responsiveness using ambient measurements. *Journal of Geophysical Research*, 118(2), 1005-1019, doi:10.1029/2012JD018100.

10-009

The following papers were published in the journal Industrial & Engineering Chemistry Research in a Special Issue on Industrial Flaring:

Torres, V.M., Herndon, S., Wood, E., Al-Fadhli, F.M., Allen, D.T., Emissions of Nitrogen Oxides from Flares Operating at Low Flow Conditions, *Industrial & Engineering Chemistry Research,* 51, 12600-12605, DOI: 10.1021/ie300179x (2012)

Pavlovic, R.T., Al-Fadhli, Kimura, Y., Allen, D.T., and McDonald-Buller, E.C. Impacts of Emission Variability and Flare Combustion Efficiency on Ozone Formation in the Houston-Galveston-Brazoria Area, *Industrial & Engineering Chemistry Research,* 51, 12593-12599, DOI: 10.1021/ie203052w (2012).

Knighton, W.B., Herndon, S.C., Franklin, J.F., Wood, E.C., Wormhoudt, J., Brooks, W., Fortner, E.C., and Allen, D.T. Direct measurement of volatile organic compound emissions from industrial flares using real-time on-line techniques: Proton Transfer Reaction Mass Spectrometry and Tunable Infrared Laser Differential Absorption Spectroscopy, *Industrial & Engineering Chemistry Research,* 51, 12674-12684, DOI: 10.1021/ie202695v (2012)

Torres, V.M., Herndon, S., Kodesh, Z., Nettles, R., and Allen, D.T. "Industrial flare performance at low flow conditions: Part 1. Study Overview" *Industrial & Engineering Chemistry Research,* 51, 12559-12568, DOI: 10.1021/ie202674t (2012).
Torres, V.M., Herndon, S. and Allen, D.T. "Industrial flare performance at low flow conditions: Part 2. Air and Steam assisted flares" *Industrial & Engineering Chemistry Research,* 51, 12569-12576, DOI: 10.1021/ie202675f (2012)

Herndon, S.C., Nelson, D.D., Wood, E.C., Knighton, W.B., Kolb, C.E., Kodesh, Z., Torres, V.M., and Allen, D.T., Application of the carbon balance method to flare emissions characteristics, *Industrial & Engineering Chemistry Research,* 51, 12577-12585, DOI: 10.1021/ie202676b (2012)

Al-Fadhli, F.M., Kimura, Y., McDonald-Buller, E.C., and Allen, D.T. Impact of flare destruction efficiency and products of incomplete combustion on ozone formation in Houston, Texas, *Industrial & Engineering Chemistry Research,* 51, 12663-12673, DOI: 10.1021/ie201400z (2012).

The following presentations were given at the Air& Waste Management Association June 2012 Conference, and papers were published in the Conference Proceedings:

Torres, V.M., Allen, D.T., Herndon, S. and Kodesh, Z., Overview of the Texas Commission on Environmental Quality 2010 Flare Study, Air and Waste Association Annual Meeting, Extended Abstract 2012-A-437-AWMA, San Antonio, June, 2012.

Torres, V.M., Al-Fadhli, F.M., Allen, D.T., Herndon, S., and Wood, E., NOx Emissions from Industrial Flaring, Air and Waste Association Annual Meeting, Extended Abstract 2012-A-315-AWMA, San Antonio, June, 2012.

10-015
The following papers are currently under development:

Measurements of Nitryl Chloride in Several Metropolitan Areas and Comparison with Regional Models
J.M. Roberts, H. Osthoff, E.J. Williams, B. Lerner, J.A. Neuman, J.B. Nowak, S.B. Brown, W.P. Dube, N.L. Wagner, T.B. Ryerson, I.B. Pollack, J.S. Holloway, A. Middlebrook, R. Bahreini, B. Koo, G. Yarwood
In preparation for Journal of Geophysical Research

Hydrochloric acid at the Pasadena ground site during CalNex 2010 and its role as a source of aerosol chloride
J.M. Roberts, P.R. Veres, A.K. Cochran, C. Warneke, J. de Gouw, R. Weber, R. Ellis, T. Vandenboer, J. Murphy, B. Koo, G. Yarwood
In preparation for Journal of Geophysical Research

10-020
Brown, S. S., et al. (2012), Effects of NO_xcontrol and plume mixing on nighttime chemical processing of plumes from coal-fired power plants, J. Geophys. Res., 117, D07304, doi:10.1029/2011JD016954.

Brown, S. S., Dubé, W. P., Bahreini, R., Middlebrook, A. M., Brock, C. A., Warneke, C., de Gouw, J. A., Washenfelder, R. A., Atlas, E., Peischl, J., Ryerson, T. B., Holloway, J. S., Schwarz, J. P., Spackman, R., Trainer, M., Parrish, D. D., Fehshenfeld, F. C., and

Ravishankara, A. R.: Biogenic VOC oxidation and organic aerosol formation in an urban nocturnal boundary layer: aircraft vertical profiles in Houston, TX, Atmos. Chem. Phys., 13, 11317-11337, doi:10.5194/acp-13-11317-2013, 2013.

In preparation for Atmosphere:
Reactive Plume Modeling to Investigate NOx Reactions and Transport at Night
Prakash Karamchandani, Shu-Yun Chen, Greg Yarwood, Steven S. Brown, David Parrish

In preparation for Atmosphere:
Modeling Overnight Power Plant Plume Impacts on Next-Day Ozone Using a Plume-in-Grid Technique
Greg Yarwood, Chris Emery, Steven S. Brown, David Parrish

10-021

The Project Investigators presented findings from this project at the Air & Waste Management Association June 2012 Conference. The title of the submitted abstract was *Dry Deposition of Ozone to Built Environment Surfaces* and the authors are Yosuke Kimura, Dustin Poppendeck, Erin Darling, Elena McDonald-Buller, and Richard Corsi

10-022

Kanwar Devesh Singh, Tanaji Dabade, Hitesh Vaid, Preeti Gangadharan, Daniel Chen, Helen H. Lou, Xianchang Li, Kuyen Li, and Christopher B. Martin "Computational Fluid Dynamics Modeling of Industrial Flares Operated in Stand-By Model," *Industrial & Engineering Chemistry Research* **2012** *51* (39), 12611-12620

Kanwar Devesh Singh, Preeti Gangadharan, Daniel Chen, Helen H. Lou, Xianchang Li, P. Richmond, " Parametric Study of Ethylene Flare Operations and Validation of a Reduced Combustion Mechanism," Engineering Applications of Computational Fluid Mechanics, Vol. 8, No. 2, pp. 211–228 (2014).

Hitesh S. Vaid, Kanwar Devesh Singh, Helen H. Lou, Daniel Chen, Peyton Richmond, "A Run Time Combustion Zoning Technique towards the EDC Approach in Large-Scale CFD Simulations," International Journal of Numerical Methods for Heat and Fluid Flow, Vol. 24 No. 1, 2014, pp. 21-35.

K. Singh, T. Dabade, H. Vaid, P. Gangadharan, D. Chen, H. Lou, X. Li, K. Li, C. Martin, "Computational Fluid Dynamics Modeling of Industrial Flares Operated in Stand-By Mode," Industrial Flares special issue, Ind. & Eng. Chem. Research, 51 (39), 12611-12620, October, 2012.

H. Lou, D. Chen, C. Martin, X. Li, K. Li, H. Vaid, K. Singh, P. Gangadharan, "Optimal Reduction of the C1-C3 Combustion Mechanism for the Simulation of Flaring, " Industrial & Engineering Chemistry Research, Industrial flares special issue, 51 (39), 12697-12705, October, 2012.

H. Lou, C. Martin, D. Chen, X. Li, K. Li, H. Vaid, A. Tula, K. Singh,"Validation of a Reduced Combustion Mechanism for Light Hydrocarbons," Clean Technologies and Environmental Policy, Volume 14, Issue 4, pp 737-748, August 2012, DOI 10.1007/s10098-011-0441-6.

Helen H. Lou, Christopher B. Martin, Daniel Chen, Xianchang Li, Kyuen Li, Hitesh Vaid, Anjan Tula Kumar, Kanwar Devesh Singh, & Doyle P. Bean, "A reduced reaction mechanism for the simulation in ethylene flare combustion," Clean Technologies and Environmental Policy, Volume 14, Issue 2, pp 229-239, April 2012, doi:10.1007/s10098-011-0394-9.

10-024
The Project Investigators have submitted articles to the following journals:
J. Geophysical Research (in revision)
Atmospheric Environment (in review)

10-032
Ren, X., D. van Duin, M. Cazorla, S. Chen, J. Mao, L. Zhan, W. H. Brune, J. H. Flynn, N. Grossberg, B. L. Lefer, B. Rappengluck, K. W. Wong. C. Tsai, J. Stutz, J. E. Dibb, B. T. Jobson, W. T. Luke and P. Kelley (2013), Atmospheric oxidation chemistry and ozone production: Results from SHARP 2009 in Houston, Texas, *Journal of Geophysical Research-Atmospheres,118*,5770-5780,doi:10.1002/jgrd.50342.

10-042
Heo, G., McDonald-Buller, E.C., Carter, W.P.L., Yarwood, G., Whitten, G.Z. and Allen, D.T. "Modeling Ozone Formation from Alkene Reactions using the Carbon Bond Chemical Mechanism, *Atmospheric Environment*, 59, 141-150, DOI: 10.1016/j.atmosenv.2012.05.042 (2012).

Heo, G. Y. Kimura, E. McDonald-Buller, D. T. Allen, G. Yarwood, G. Z. Whitten Evaluation of a New Toluene Mechanism For Carbon Bond 05 Using Environmental Chamber Data and Ambient Data, Air and Waste Management Association Annual Meeting, Paper #154, Detroit, June 2009

In preparation for Atmospheric Environment: *Environmental chamber experiments to evaluate NOx removal and recycling represented in atmospheric mechanisms for air quality modeling*
Gookyoung Heo, William Carter, Greg Yarwood, Gary Z. Whitten, David T. Allen

In preparation for Atmospheric Environment: *Evaluation of mechanisms for modeling ozone formation from isoprene in SAPRC-07 and CB6 using environmental chamber data with low initial NOx*
Gookyoung Heo, William Carter, Greg Yarwood

10-045

Olga Pikelnaya, James H. Flynn, Catalina Tsai, and Jochen Stutz (2013), Imaging DOAS detection of primary formaldehyde and sulfur dioxide emissions from petrochemical flares, Journal of Geophysical Reserch, Volume 118, Issue 15, pages 8716–8728, 16 August 2013, DOI: 10.1002/jgrd.50643

The following papers were published in Industrial & Engineering Chemistry Research Special Issue on Industrial Flaring. The paper edition of this special edition came out in Fall 2012.

W. Berk Knighton, Scott C. Herndon, Ezra C. Wood, Edward C. Fortner, Timothy B. Onasch, Joda Wormhoudt, Charles E. Kolb, Ben H. Lee, Miguel Zavala, Luisa Molina, and Marvin Jones. "Detecting Fugitive Emissions of 1,3-Butadiene and Styrene from a Petrochemical Facility: An Application of a Mobile Laboratory and a Modified Proton Transfer Reaction Mass Spectrometer," *Industrial & Engineering Chemistry Research* 2012 *51* (39), 12706-12711

Ezra C. Wood, Scott C. Herndon, Ed C. Fortner, Timothy B. Onasch, Joda Wormhoudt, Charles E. Kolb, W. Berk Knighton, Ben H. Lee, Miguel Zavala, Luisa Molina, and Marvin Jones. "Combustion and Destruction/Removal Efficiencies of In-Use Chemical Flares in the Greater Houston Area," *Industrial & Engineering Chemistry Research* 2012 *51* (39), 12685-12696

Pikelnaya, O., J. H. Flynn, C. Tsai, and J. Stutz (2013), Imaging DOAS detection of primary formaldehyde and sulfur dioxide emissions from petrochemical flares, J. Geophys. Res. Atmos., 118,8716–8728, doi:10.1002/jgrd.50643.

This project has also resulted in the following publications:
Olga Pikelnaya, Jochen Stutz, Scott Herndon, Ezra Wood, Oluwayemisi Oluwole, George Mount, Elena Spinei, William Vizuete, Evan Couzo, "*Formaldehyde and Olefin from Large Industrial Sources (FLAIR) in Houston, TX – Campaign Overview"*, in preparation for Journal of Geophysical Research

Olga Pikelnaya, Scott Herndon, Ezra Wood, and Jochen Stutz, "*Observations of emissions from ships in the Houston Ship Channel during 2009 FLAIR campaign,"* under development.

FY12-13

12-006

Journal Papers:

Gookyoung Heo, Peng Wang, Qi Ying, Ron Thomas, William P.L. Carter. Using chemically detailed emissions data to test assumptions used in developing chemical mechanisms: a case study for southeast Texas, USA. [To be submitted to Atmospheric Environment in Summer 2014]

Peng Wang, Gookyoung Heo, William P.L. Carter, Qi Ying. Comparison of a detailed and a lumped version of SAPRC-11 photochemical mechanism during a summer ozone episode. [To be submitted to Atmospheric Environment in Summer 2014]

Gookyoung Heo, Chia-Li Chen, Ping Tang, William P.L. Carter. Evaluation of mechanisms for major terminal and internal alkenes with environmental chamber data. [To be submitted to Atmospheric Environment in Summer 2014]

Gookyoung Heo, Shunsuke Nakao, William P.L. Carter. Evaluation of mechanisms for 1,3-butadiene with environmental chamber data. [To be submitted to Atmospheric Environment in Summer 2014]

Conference Paper:
Heo, G., Carter, W.P.L., Wang, P., Ying, Q., Thomas, R. (2013). Evaluating and improving atmospheric chemical mechanisms used for modeling ozone formation from alkenes. Presented at the 12th Annual CMAS Conference, Chapel Hill, NC, October 28-30, 2013.

12-012
Conference presentations:
C. Faxon, J. Bean, L. Hildebrandt Ruiz. Evidence of atmospheric chlorine chemistry in Conroe, TX: Regional implications. American Chemical Society Southwest Regional Meeting, November 2013, Waco, TX.

J. Bean, C. Faxon, L. Hildebrandt Ruiz. Atmospheric processing of pollutants in the Houston Region: First insights from DISCOVER-AQ. American Chemical Society Southwest Regional Meeting, November 2013, Waco, TX.

L. Hildebrandt Ruiz, J. Bean, G. Yarwood, B. Koo, U. Nopmongcol. Formation and Gas-Particle Partitioning of Organic Nitrates: Influence on Ozone Production. American Association for Aerosol Research Annual Meeting, October 2013, Portland, OR.

Planned publications:
C. Faxon, J. Bean and L. Hildebrandt Ruiz. Preliminary title “Significant Inland Concentrations of ClNO2 Detected in Conroe TX during DISCOVER-AQ 2013”. Submission planned for August 2014.
J. Bean, C. Faxon and L. Hildebrandt Ruiz. Manuscript summarizing particle-phase measurements from DISCOVER-AQ. Submission planned for late 2014.

13-016
Gary Morris presented a poster entitled "Tropospheric Ozone Pollution Project (TOPP) Overview: A Context for DISCOVER-AQ Houston 2013" at the DISCOVER-AQ Science Team Meeting on February 27, 2014.

13-024
NASA AQAST meeting at Rice University in Houston, TX (Jan. 14-16, 2014), where Xinrong Ren gave a talk titled: "Measurements of trace gases at the Manvel Croix and Galveston sites during DISCOVER-AQ."

NASA DISCOVER-AQ science meeting at NASA Langley in Hampton, VA, where Winston Luke gave a talk titled: "NOAA/Air Resources Laboratory Surface Observations at Galveston and Manvel-Croix: Summary and Comparison with Aircraft Data."

A paper is in preparation with the intent to submit to Atmospheric Chemistry and Physics within about 3 months.

12-028

Implementation and Refinement of a Surface Model for HONO formation in a 3-D Chemical Transport Model. Prakash Karamchandani[1], Chris Emery[1], Greg Yarwood[1], Barry Lefer[2], Jochen Stutz[3], Evan Couzo[4], and William Vizuete[5]. ([1]ENVIRON, [2]University of Houston, [3]University of California-Los Angeles, [4]Massachusetts Institute of Technology, and [5]University of North Carolina.)

Impacts of heterogeneous HONO formation on radical sources and ozone chemistry in Houston, Texas. Evan Couzo[1], Barry Lefer[2], Jochen Stutz[3], Greg Yarwood[4], Prakash Karamchandani[4], Barron Henderson[5], and William Vizuete[1]. ([1]University of North Carolina (now at MIT), [2]University of Houston, [3]University of California-Los Angeles, [4]ENVIRON, [5]University of Florida.)

12-032

Poster at the American Geophysical Union national meeting (Dec 2013) *Initial characterization of surface-based carbonaceous aerosol during DISCOVER-AQ in Houston, TX* Rebecca J. Sheesley, Tate E. Barrett, Subin Yoon, Adelaide Clark and Sascha Usenko

Poster at the DISCOVER-AQ Science Working Group meeting (Feb 2014) *Initial characterization of surface-based carbonaceous aerosol during DISCOVER-AQ in Houston, TX* Rebecca J. Sheesley, Tate E. Barrett, Subin Yoon, Adelaide Clark and Sascha Usenko

Manuscript in preparation. Submission planned to Atmospheric Environment in summer 2014. Draft title: "*Initial characterization of surface-based carbonaceous aerosol during DISCOVER-AQ in Houston, TX*."

12-TN1

Presentation:

"A regional chemical reanalysis prototype" Pius Lee , Greg Carmichael, Tianfeng Chai, Rick Saylor, Li Pan, Hyuncheol Kim, Daniel Tong, and Ariel Stein

Poster:

"Preliminary analyses of flight measurements and CMAQ simulation during Southeast Nexus (SENEX) field experiment" Li Pan, Pius Lee , Hyun Cheol Kim, Daniel Tong ,Rick Saylor and Tianfeng Chai

Publication:
Pius Lee, Fantine Ngan, Hang Lei, Barry Baker, Bright Dornblaser, Gary McGauhey,and Daniel Tong. An Application for Improving Air Quality: a Houston Case Study, Earthzine 2014 [available at: http://www.earthzine.org/2014/03/29/an-application-for-improving-air-quality-a-houston-case-study/?shareadraft=baba698217_53330c8eab882]

12-TN2
The project team presented at the Community Modeling and Analysis System (CMAS) Conference in October 2013.

Presentations:
"HCHO and NO2 column comparisons between OMI, GOME-2 and CMAQ during 2013 SENEX campaign (21 slides)" Hyun Cheol Kim, Li Pan, Pius Lee, Rick Saylor, and Daniel Tong

Posters:
Fine-scale comparison of GOME-2, OMI and CMAQ NO2 columns over Southern California in 2008" Hyun Cheol Kim, Sang-Mi Lee, Fong Ngan, and Pius Lee