AIR QUALITY RESEARCH PROGRAM

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

Quarterly Report

September 1, 2013 through November 30, 2013

Submitted to

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December 10, 2013

Texas Air Quality Research Program

Annual Report

September 1, 2013 – November 30, 2013

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 on all but one project 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. The 2012 – 2013 research projects were completed on November 30, 2013, and the final reports are currently being reviewed.

In June 2013, the TCEQ renewed the AQRP for the 2014-2015 biennium via Amendment 9 of the Grant. At this time the TCEQ also awarded an additional $2,500,000 in FY 2013 funds to the AQRP. 10 % of these funds were allocated for Project Administration, and the remaining funds were allocated to the Research program. Initiated by the renewal, 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.

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 the initial (2010-2011) biennium. Steps 1 – 8 have been completed for the 2012 – 2013 biennium, and step 9 is in progress. A research conference/data workshop was held on November 14, 2013. For the 2014 – 2015 biennium Steps 1 and 2 have been completed.

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.

RESEARCH PROJECTS

Research Projects for FY 2010-2011 are now completed. All projects have submitted final invoices and those invoices have been paid. The Final Report for each project, with the exception of one, is posted on the AQRP website at http://aqrp.ceer.utexas.edu/projects.cfm.

A summary of the projects approved for funding for FY 2012-2013 follows.

Project 12-004	**STATUS: Active - March 1, 2013**

DISCOVER-AQ Ground Sites Infrastructure Support

University of Texas at Austin – Vincent Torres

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Raj Nadkarni

Funding Amount: $1,691,944

Executive Summary

In the summer 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 of this campaign, for NASA, was to improve the use of satellites 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. Multiple ground sites were expanded or established to accommodate the instrumentation brought to Houston by research collaborators. This project centralized and coordinated the site infrastructure preparation for the ground sites identified for expansion to support DISCOVER-AQ Houston 2013.

The scope of work for this project began with meeting with and/or contacting appropriate DISCOVER-AQ and TCEQ personnel and determining how many and which ground sites will be used for the study. Once sites were determined, assignment of instrumentation to each site followed. Next, to accommodate the instrumentation and the associated support equipment and supplies that were located at the selected ground sites, site improvements were made; site access/use agreements, ground (site pad) preparation, installation of utilities (electrical and communication) and security fencing, and rental of temporary buildings to accommodate instrumentation that must be located in conditioned space were all performed. During the intensive measurements period of the campaign, some limited support was required by the ground-based researchers should problems arise with the site accommodations. At the end of the campaign, each of these sites will be decommissioned and restored to their original condition or a condition required by the property owner.

Project Update

In early September, the logistics team ensured that all researcher's infrastructure needs were as requested and operational when the researchers started full data collection. During the data collection period, the logistics team was on stand-by should any logistics support problems arise. None did.

Once the data collection period ended at the end of September, plans were made and executed to begin decommissioning of the sites and restoration of the sites to pre-study conditions. Removal of all equipment and infrastructure installed for the study and restoration of all sites was completed by the end of November.

Work to be performed in the next quarter will focus on paying and reconciling invoices for services and utilities that will arrive in December and possibly as late as early January.

Project 13-005	STATUS: Active – January 15, 2013

Quantification of industrial emissions of VOCs, NO_2 and SO_2 by SOF and mobile DOAS during DISCOVER AQ

Chalmers University – Johan Mellqvist
University of Houston – Barry Lefer

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

Funding Amount: $177,553
($129,047 Chalmers, $48,506 UH)

Executive Summary
Mobile remote sensing by SOF and mobile DOAS will be carried out in the Houston ship channel (HSC) area during September 2013. In this manner vertical columns will be obtained of VOCs (alkanes, alkenes), NH_3, NO_2, SO_2, HCHO and particles as inferred from aerosol optical depth. The optical remote data will be complemented by wind profile measurements. The data collected will have great value of its own to be applied for future ozone modeling since a good understanding of the emission variability and changes in the total emissions in the HSC will be obtained by comparison to similar studies in 2006, 2009 and 2011 [Mellqvist 2007; 2009; 2010 and Rivera 2010]. The emission data will be compared to available emission inventories and categorized in various industrial types.

Equally important, the measurements will complement the NASA Discover AQ campaign which will run in the HSC area during the targeted month. NASA will then fly a high altitude aircraft (B200) equipped with optical sensors measuring columns of SO_2, NO_2, HCHO and aerosol profiles (LIDAR). They will utilize a low flying airplane (P-3) that will make spirals in the vicinity of two ground stations in the HSC, to validate the high altitude measurements.

The spatial column data of NO_2, SO_2, and HCHO from the mobile DOAS will be directly comparable to the column data measured by the high altitude NASA aircraft, hence providing a performance evaluation data set across the whole ship channel. Secondly, by carrying out emission measurements of VOCs, NO_2, SO_2 and HCHO around the HSC, especially upwind the two sites, it will be possible to interpret the spiral measurements by the NASA P-3 and the high altitude measurements by the B200 more comprehensively. The combined airborne and ground based data set has potential to be used for modeling of the ozone in the HSC area. This project will support the AQRP priority research area: Improving the understanding of ozone and PM formation and emission characteristics in the Houston area through supplementary measurements to the NASA Discover-AQ campaign September 2013.

Project Update

A measurement study was carried out in the Greater Houston area during September 2013, in close coordination with the NASA DISCOVER-AQ mission in Houston. Column measurements of VOCs, SO_2, NO_2, and formaldehyde were carried out in the Houston Ship channel for future comparison with aircraft and ground based measurements. A secondary objective was to study direct emissions of the above-mentioned species from refineries and petrochemical industries in the area, as a follow-up to older measurements to provide support data for modeling. The primary methods used were SOF (Solar Occultation Flux) and Mobile DOAS (Differential Optical Absorption Spectroscopy).

During the campaign, mobile remote sensing by the SOF method and Mobile DOAS were carried out in the Houston area on twenty days in September 2013 together with frequent balloon launches. During ten of these days, column measurements of SO_2, NO_2, HCHO and VOCs in a box around the Houston Ship channel were carried out synchronized with science flights by the NASA aircrafts. During the rest of the days more focused industrial measurements were carried out. The weather during the campaign was relatively poor with 4 good clear days, 10 moderate days and the rest rather cloudy. For cloudy conditions the spectral retrieval and interpretation of column results from the optical remote sensing techniques is challenging in terms of spectral retrieval and further work is needed. In this report we describe the column measurements and show some examples of measurements. Further comparison to other measurements will be done when such data are available.

There were relatively few days available for emission measurements in the project since most focus was put on synchronized column measurements with the NASA DISCOVER-AQ aircrafts. A comparison of overall emissions from the main industrial areas in the greater Houston area are shown in Table 1 below for years when SOF/Mobile DOAS studies were performed together with emission inventory data from 2011.

The data indicates that the overall alkene emissions in the HSC have decreased by 20-30%, that alkane emissions have remained the same and that NO_2 and SO_2 emissions were only slightly lower than for previous years. For Mont Belvieu the alkene emissions appear to have decreased by 30-40%. For Texas City the alkane and SO_2 measurements appear to have decreased considerably while being almost the same for NO_2. In all cases the VOC data are 5-10 times higher than the reported emission values, while for NO_2 and SO_2 the measured values are 5-95% higher, with exception for the SO_2 emissions at Texas City which are 300% higher than reported.

During the DISCOVER-AQ campaign a new instrument was brought along to complement the alkane flux measurements with ground concentration measurements of aromatic VOCs, i.e. benzene, toluene, etc. This system is based on an open UV multi-reflection cell connected to a DOAS spectrometer, (MW-DOAS). In addition, a mobile extractive FTIR (meFTIR) was used to measure the concentration of alkanes on the ground. This instrument is based on a closed IR multi-reflection cell connected to a FTIR spectrometer and it has been employed in previous campaigns.

The combination of the MW-DOAS and the meFTIR made it possible to map ratios of the ground concentration of aromatic VOCs and alkanes downwind of industries, allowing aromatic emissions to be inferred by multiplying these ratios with the alkane emission obtained from the SOF measurements. During the campaign side-by-side measurements were carried out with MW-DOAS and a PTR-MS (Aerodyne lab) in the Houston ship channel showing relatively good agreement between the two techniques down to sub-ppb levels.

Table 1 SOF and Mobile DOAS data for different sites measured. Also measurements from earlier campaigns are shown and Emission inventory data for 2011 (Johansson, 2013)

Area	Species	2006	2009	2011	2013	Difference
HSC	Ethene	878 ± 152	614 ± 284	612 ± 168	474.9 ± 79.3	53
	Propene	1511 ± 529	642 ± 108	563 ± 294*	394 ± 245	63
	Alkanes	12276 ± 3491	10522 ± 2032	11569 ± 2598	13934 ± 4321	894
	SO_2	2277 ±1056	3364 ± 821	2329 ± 466	1955 ± 376	1228
	NO_2	2460 ± 885	-	1830 ± 330	2117 ± 672	1103
Mont Belvieu	Ethene	443 ± 139	444 ± 174	545 ± 284	271 ± 33	47
	Propene	489 ± 231	303 ± 189	58*	220 ± 115	25
	Alkanes	874	1575 ± 704	1319 ± 280	2854 ± 1212**	127
	NO_2	-	168 ± 39	305 ± 29	261 ± 91	155
Texas City	Ethene	83 ± 12	122 ± 41	177 ± 48	-	2
	Propene	ND	54 ± 22	56 ± 9*	-	6
	Alkanes	3010 ± 572	2422 ± 288	2342 ± 805	1340 ± 140	242
	SO_2	-	834 ± 298	1285 ± 428	442 ± 134	109
	NO_2	460 ± 150	283 ± 30	492 ± 71	371 ± 55	352

* Propene retrievals were of poor quality throughout much of this campaign
** Only a single day of measurements with variable emissions.

Project 12-006 **STATUS: Active – February 8, 2013**

Environmental chamber experiments and CMAQ modeling to improve mechanisms to model ozone formation from HRVOCs

University of California - Riverside – Gookyoung Heo
Texas A&M University – Qi Ying

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Ron Thomas

Funding Amount: $146,259
($101,765 UC-R, $44,494 TAMU)

Executive Summary

Using reliable atmospheric chemical mechanisms in regulatory models is necessary to formulate effective air quality policies for controls of secondary air pollutants such as ozone (O_3). It is well known that alkenes are a major contributor to radical and O_3 formation in Southeast Texas due to their high emissions and their high reactivities. Particularly, in Harris County, Texas, seven alkenes (ethene, propene, 1,3-butadiene, 1-butene, isobutene, trans-2-butene, and cis-2-butene) are classified as Highly Reactive Volatile Organic Compounds (HRVOCs), and HRVOC emissions have been regulated by Texas Administrative Code, Title 30, Part 1, Chapter 115 (TCEQ, 2102). However, condensed chemical mechanisms commonly used for air quality modeling in the U.S. are designed to model O_3 formation from typical urban ambient volatile organic compound (VOC) mixtures but are not designed to model O_3 formation under atmospheric conditions significantly influenced by highly variable HRVOC emissions that are dominated by a small number of VOC species. Therefore, a chemical mechanism that can be used to simulate O_3 formation from both urban emissions and industrial HRVOC emissions needs to be developed to accurately assess the impact on O_3 formation of regular and episodic HRVOC emissions from industrial sources in Southeast Texas. However, lack of environmental chamber data useful for mechanism evaluation is a critical obstacle to developing reliable mechanisms for the HRVOCs. Among the 7 alkenes regulated as HRVOCs in Southeast Texas, robust chamber data for mechanism evaluation are available only for ethene and propene. The situation is even worse for the higher molecular weight non-HRVOC alkenes. Thus, this study will develop more robust chemical mechanisms for the HRVOCs and non-HRVOC alkenes that are better suited for use under atmospheric conditions influenced by HRVOC emissions, and evaluate and update the initially proposed mechanisms by designing and carrying out environmental chamber experiments for the HRVOCs and non-HRVOC alkenes for which existing data are inadequate. The effect of the mechanism modifications on air quality predictions in Southeast Texas will be evaluated by carrying out 3-dimensional air quality modeling with the Community Multiscale Air Quality modeling system (CMAQ), using both existing mechanisms and the updated and more explicit mechanisms developed in this work.

Project Update

During September 1, 2013 to November 30, 2013, this project tested the existing atmospheric reaction mechanisms leading to ozone formation for five Highly Reactive Volatile Organic Compounds (HRVOCs; 1,3-butadiene, 1-butene, isobutene, trans-2-butene, and cis-2-butene) and five non-HRVOC alkenes (1-pentene, 1-hexene, trans-2-pentene, cis-2-pentene, and 2-methyl-2-butene) by using the newly generated experimental data of the 36 reactor runs selected from the 50 environmental chamber reactor runs performed for the 10 alkenes. The detailed SAPRC-11 (SAPRC-11D) reasonably simulated ozone (O_3) formation from 7 of the 10 alkenes. The mechanism evaluation results for SAPRC-11D increase our confidence in the mechanisms for 1-butene, 1-pentene, isobutene and cis/trans 2-butene and 2-pentene. On the other hand, the evaluation results also highlight mechanism issues for 1,3-butadiene, 1-hexene and 2-methyl-2-butene. Mechanism improvements were made for 1,3-butadiene and 1-hexene. However, those modifications were not complete enough to implement into the CMAQ model. Four SAPRC mechanisms with different levels of VOC lumping (i.e., how emitted reactive volatile organic compounds (VOCs) are represented in the mechanism either by explicit model species (e.g., 1-butene by an explicit model species BUTENE1) or by lumped model species shared by multiple compounds (e.g., 1-butene by a lumped model species OLE1) were implemented in the CMAQ and used to simulate a summer ozone episode during the 2006 Texas Air Quality Study. The mechanism comparison with the CMAQ simulations was focused on comparing CMAQ simulation results between a detailed SAPRC version (SAPRC-11D) and a relatively compact version (SAPRC-11L). The predicted O_3, OH, HO_2 and PAN were significantly different between SAPRC-11D and SAPRC-11L; SAPRC-11D predicted higher O_3 and PAN throughout the domain, higher OH and HO_2 in urban Houston areas and lower OH and HO_2 in areas with less anthropogenic emissions than SAPRC-11L. The chemically detailed emissions data that were generated for SAPRC-11D were used to inspect consistency between the compositions of the lumped alkene species (i.e., OLE1 and OLE2) used in deriving the SAPRC-11L mechanism and the emissions inventory data that air quality simulations heavily rely on. For example, the contributions of major alkenes such as propene, 1-butene, 1-pentene, 1-hexene, 1,3-butadiene, and 3-methyl-1-butene assumed during the development of SAPRC-11L were compared with those based on the emission inventories.

Task 3 Report (Mechanism Developments), Task 4 Report (Implementing SAPRC Mechanisms into CMAQ), Task 5 Report (CMAQ Modeling) were submitted in October, 2013. The mechanism development and evaluation results with the chamber data generated for this project were reported in Task 3 Report, and the CMAQ simulation results and emissions data analysis were reported in Task 5 Report. The draft final report and final report were also submitted. All major findings based on the chamber simulations and CMAQ simulations were reported in the final report, and recommendations for future studies were also included in the final report. Chamber simulations with the Carbon Bond chemical mechanism were also carried out and the results are included in an appendix of the final report to provide additional data to evaluate and update the mechanisms currently used by the TCEQ.

All funds allocated to the project will be used upon the project completion.

Project 12-011	STATUS: Active – January 17, 2013

Investigation of Global Modeling and Lightning NOx Emissions as Sources of Regional Background Ozone in Texas

ENVIRON International – Chris Emery

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

Funding Amount: $77,420

Executive Summary

The production, transport, and fate of tropospheric ozone are highly dynamic processes with contributions from a multitude of anthropogenic and natural sources spanning spatial scales from local to global. The US Environmental Protection Agency (EPA) requires the use of regional photochemical models to demonstrate that local emission control plans will achieve the federal standard for ground-level ozone. As the ozone standard is lowered, sources contributing to uncontrollable "background" ozone become more significant and must be more accurately accounted. In response, regulatory modeling applications have employed continuously larger domains to explicitly include sources over broader portions of the continent. Regional models now include worldwide contributions by deriving boundary conditions from global models. As global models continue to emerge and improve, their contributions to background ozone as represented in regional models need to be evaluated.

The Texas Commission on Environmental Quality (TCEQ) uses the Comprehensive Air quality Model with extensions (CAMx) for research and regulatory photochemical modeling. Two popular global models have been routinely coupled to CAMx: the Goddard Earth Observing System - Chemistry model (GEOS-Chem), developed and distributed by Harvard University, and the Model for OZone and Related chemical Tracers (MOZART), developed and distributed by the National Center for Atmospheric Research (NCAR). A newer global model called AM3, which is the atmospheric component of the CM3 global coupled atmosphere-oceans-land-sea ice model, is developed by Princeton University and the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory (GFDL).

In this project, ENVIRON International Corporation will develop boundary condition inputs for CAMx utilizing output from all three global models (GEOS-Chem, MOZART, and AM3). The sensitivity of simulated ozone to regional boundary conditions will be investigated. We will develop quantitative comparisons of these global models with respect to their ability to provide accurate and reasonable boundary conditions for regional downscaling, particularly as it applies to regulatory ozone modeling.

Project Update

All technical work was completed during the reporting period. A draft report was prepared and submitted to AQRP on October 22. AQRP and TCEQ reviewed the draft and provided comments. A final project report reflecting comments was submitted to AQRP on November 27.

All funds allocated to the project are intended to be used by 11/30/2013.

Project 12-012	STATUS: Active - December 19, 2012

Interactions Between Organic Aerosol and NOy: Influence on Oxidant Production

University of Texas at Austin – Lea H. Ruiz
ENVIRON International – Greg Yarwood

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Mark Estes

Funding Amount: $148,835
($79,461 UT Austin, $69,374 Environ)

Executive Summary

In rural areas where emission rates of NO_x ($NO + NO_2$) are relatively low, ozone formation can be sensitive to secondary NO_x sources such as decomposition of organic nitrates ($R\text{-}ONO_2$). AQRP project 10-042 provided experimental evidence for NO_x production when organic nitrates degrade by OH reaction and photolysis. Implementing NO_x production from OH reaction with organic nitrates causes regional ozone increases that are large enough to affect model agreement with ozone observations. This implies that organic nitrates are less available to NO_x recycling than previous experiments suggested. We are investigating the hypothesis that uptake of organic nitrates into secondary organic aerosol (SOA) reduces the amount of NO_x recycled by organic nitrate photolysis and OH reaction.

The first task in this project is to add the uptake of organic nitrates by SOA to the Comprehensive Air quality Model with extensions (CAMx). The conceptual model of Perraud et al. (2012) is followed, in which organic nitrate molecules stick to aerosol surfaces and become irreversibly buried by accretion of SOA. Results of this initial modeling work is then used to design laboratory chamber experiments in which organic nitrates are formed from the oxidation of VOCs in the presence of NO_x and the distribution of organic nitrates between the gas and particle phases is observed. New chemistries and mechanisms inferred from the experimental data are then tested by including them in a box model of the chamber experiments before they are implemented in CAMx. Finally, the partitioning of organic nitrates between the gas- and particle phase is observed in natural aerosol by conducting ambient measurements near Houston.

Project Update

ENVIRON modified the Carbon Bond 6 (CB6) chemical mechanism to differentiate organic nitrates (ON) between simple alkyl nitrates (AN) that remain in the gas-phase and multi-functional ONs that can partition into organic aerosol (OA). Uptake of multi-functional ONs by OA was added to the Comprehensive Air quality Model with extensions (CAMx). ONs present in aerosols were then assumed to undergo hydrolysis to nitric acid with a lifetime of approximately 6 hours based on laboratory experiments and ambient data. The revised CB6 mechanism, called CB6r2, and regional modeling simulations using CAMx with CB6r2 showed improved performance in simulating ozone and in simulating the partitioning of NOy between ONs and nitric acid.

The University of Texas at Austin conducted ambient measurements in Conroe, TX during the DISCOVER-AQ campaign from August 23 to October 1. The campaign was successful and yielded over one month of data from all instrumentation. Preliminary analysis of the data revealed approximately 100 organic nitrogen species in the gas-phase which exhibited different diurnal variation. Organic nitrogen was also detected in the particle phase which exhibited a strong diurnal cycle with lowest concentrations in the afternoon. Organic species accounted for approximately 70% of dry non-refractory PM_1 mass measured at the Conroe site. In addition to the collection and preliminary analysis of ambient data, UT-Austin also continued analysis of data from environmental chamber experiments.

Preliminary experimental and modeling results from this project were presented at the following meetings: At the annual meeting of the American Association for Aerosol Research we presented a platform presentation entitled “Formation and gas-particle partitioning of organic nitrates: influence on ozone production” on October 3, 2013. At the regional meeting of the American Chemical Society we presented two talks entitled: “Evidence of atmospheric chlorine chemistry in Conroe, TX: Regional implications” and “Atmospheric processing of pollutants in the Houston Region: First insights from DISCOVER-AQ” on November 18, 2013. We also presented our findings at the AQRP workshop on November 14, 2013.

We wrote the final report and submitted a revised final report to the AQRP on December 6, 2013.

All funds allocated to the project are expected to be used by 11/30/2013.

Project 12-013	STATUS: Active – December 14, 2012

Development of Transformation Rate of SO_2 to Sulfate for the Houston Ship Channel using the TexAQS 2006 Field Study Data

ENVIRON International – Ralph Morris

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

Funding Amount: $59,974

Executive Summary
On June 2, 2010, EPA promulgated a new 1-hour SO_2 primary NAAQS with a threshold of 75 ppb. The 1-hour SO_2 NAAQS is much more stringent and replaces the old 24-hour (140 ppb) and annual (30 ppb) SO_2 NAAQS. States are required to submit 1-hour SO_2 State Implementation Plans (SIPs) by February 2014 that demonstrates compliance with the NAAQS by August 2017. Preliminary modeling indicates that SO_2 emissions for numerous sources will result in near-by exceedances of the 1-hour SO_2 NAAQS. Fossil-fueled power plants (73%) and industrial facilities (20%) are the main sources of SO_2 emissions in the U.S. Photochemical oxidants will convert some SO_2 to sulfate thereby reducing SO_2 concentrations. However, the EPA-recommended model for near-source 1-hour SO_2 modeling is the AERMOD steady-state Gaussian plume model that does not treat photochemical oxidants and has a very simple treatment of chemistry (exponential decay). EPA recommends that AERMOD be run with no SO_2 conversion for addressing 1-hour SO_2 NAAQS issues. This assumption may be appropriate for fossil-fueled power plants where the high NO_X concentrations inhibit photochemistry and consequently SO_2 oxidation near the source, but it may not be appropriate for the Houston Ship Channel where the atmosphere can be very reactive (due to HRVOC emissions) resulting in faster SO_2 to sulfate conversion rates.

The goal of this project is to develop a representative SO_2 transformation rate for the Houston Ship Channel area using measurements from the NOAA P-3 aircraft collected during the 2006 Texas Air Quality Study (TexAQS) that can be used with the AERMOD model to simulate 1-hour SO_2 concentrations. The proposed approach uses a grid model to simulate first-order transformation of SO_2 to sulfate for sources in the Houston Ship Channel. The model results with varying transformation rate are evaluated against the 2006 TexAQS P-3 aircraft measurement data to find what transformation rate best fits the observations and to determine whether one hypothetical transformation rate results in statistically better model performance than the other rates used.

Project Update

We prepared a draft Final Report that documented our study results and recommendations. The draft Final Report was submitted to AQRP and TCEQ for their review on September 19, 2013. We revised the draft Final Report to address the comments received from AQRP/TCEQ and submitted the revised Final Report on October 22, 2013. The project outcomes were presented at the AQRP Project Workshop held at Austin, TX on November 14, 2013.

All funds allocated to the project will be used upon the project completion.

Project 13-016	STATUS: Active – November 20, 2012

Ozonesonde launches from the University of Houston and Smith Point, Texas in Support of DISCOVER AQ

Valparaiso University – Gary Morris
University of Houston – Barry Lefer

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Dave Westenbarger

Funding Amount: $86,667
($66,821 Valparaiso, $19,846 UH)

Executive Summary
An intensive series of ozonesonde launches during DISCOVER AQ (September 2013) provides insight into the recirculation of ozone over Galveston and Trinity Bays. With potential operational launch sites at LaPorte, the University of Houston Main Campus, and Smith Point, the coordinated set of ozone profiles will permit us further insights into the importance of re-circulated ozone on exceedence events during the late Summer high ozone season in Houston, Texas.

Project Update
This project resulted in an intensive and coordinated series of ozonesonde launches during DISCOVER AQ (September 2013) from three sites within and around the Houston-Galveston-Brazoria County Region (HGBR): Smith Point, the University of Houston Main Campus, and Ellington Field. In total 63 ozonesonde flights were conducted during the DISCOVER-AQ period with another 32 during the month of August, just prior to DISCOVER. The data gathered provides insight into the recirculation of ozone over Galveston and Trinity Bays as well as the opportunity to explore regional scale variability in boundary layer and lower free tropospheric ozone around the HGBR.

Due to the unusual meteorology in 2013, the overall data set did not capture as many ozone exceedance events as we had anticipated. In the last decade, the typical year has 4 frontal passages in August and September, with most years first frontal passage occurring in mid- to late August. In 2013, the first September frontal passage did not occur until 21 September, and the only prior frontal passage was weak and resulted in a stationary boundary just south of Houston around 16 August. Our preliminary analysis of data from the DISCOVER-AQ period has demonstrated the following:

- The wind patterns from 2013 as compared with a climatology developed from the National Centers for Environmental Prediction (NCEP) data from 2004 – 2012 for Houston demonstrate that the first half of September 2013 meteorologically more resembled early to mid August than September from the climatology.

- The ozone profiles from 2013 as compared with a climatology developed from the Tropospheric Ozone Pollution Project (TOPP) data from 2004 – 2012 for Houston also demonstrate that the first half of September 2013 more resembled early to mid August than September from the climatology.

- Weekly mean ozone profiles from TOPP 2004 – 2012 show a strong tilt through the troposphere in early to mid August, with ozone values increasing with altitude. The same climatology shows that by late August and into September, the mean ozone profiles become more vertical. This change in shape corresponds with the resumption of frontal passages making it through the HGBR.

- The event of 25 September was the only exceedance event during DISCOVER-AQ. A series of ozone profiles demonstrates the influence of high ozone from the lower free troposphere arriving in a dry layer behind the cold fronts of 21 and 25 September.

- Data from Smith Point, both ozonesonde and NATIVE trailer surface data, demonstrate the arrival of the Houston plume over Trinity and Galveston Bays. The weak north synoptic winds brought the plume over the bays where the ozone concentrations intensified, resulting in ozone concentrations > 150 ppbv at NATIVE. The singular occurrence of this event during the DISCOVER-AQ period argues for the installation of an ozone monitor at the surface at Smith Point so the frequency and magnitude of such pollution and potential recirculation events can be quantified.

- It is important to place the DISCOVER-AQ data in the context of the longer-term ozone profile and surface monitor data records from the HGBR.

Project 12-018	STATUS: Active – January 8, 2013

The Effects of Uncertainties in Fire Emissions Estimates on Predictions of Texas Air Quality

University of Texas at Austin – Elena McDonald-Buller
ENVIRON International – Chris Emery

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Clint Harper

Funding Amount: $106,970
($85,282 UT Austin, $21,688 Environ)

Executive Summary

Wildland fires and open burning can be substantial sources of nitrogen oxides (NO_x), carbon monoxide (CO), and non-methane hydrocarbons (NMHCs), which are precursors to ozone formation, as well as particulate matter (PM), sulfur dioxide (SO_2), and ammonia (NH_3). Fire emissions are often transported over long distances and can contribute to exceedances of air quality standards at local and regional levels. Achieving attainment with the National Ambient Air Quality Standards (NAAQS) for ozone has been the primary focus of State Implementation Plans (SIPs) for Texas. Accurate characterization of fire events is necessary for understanding their influence on measured ambient concentrations, for providing a weight of evidence for exceptional event exclusions if necessary, and for conducting air quality modeling for planning and attainment demonstrations. In addition, if more stringent federal standards for ozone are considered in the future, emissions of its precursors from regional sources, such as fires in the Western U.S., Mexico, and Central America, that can contribute to background concentrations will become increasingly important for understanding the relative effectiveness of local and regional emissions control programs. This project examines the effects of uncertainties in fire emissions estimates on modeled ozone and particulate matter concentrations in Texas using the Fire INventory from NCAR (FINN) and the Comprehensive Air Quality Model with extensions (CAMx).

Project Update

This project evaluated the sensitivity of emissions estimates from FINN v.1 (referred to as the FINN default configuration for the purposes of this work) to the variability in input parameters and the effects on modeled ozone and particulate matter concentrations using CAMx. The project included four major tasks:

1. Analysis of the climatology of fires in Texas and central and western states, Mexico and Central America, and western Canada between 2002-2012 using the FINN default configuration.

2. Comparison of fire emission estimates between the FINN default and BlueSky/SmartFire modeling frameworks

3. Evaluation of the sensitivity of FINN emissions estimates to emission factors, land cover classification, fuel loading data, and fire detection and area burned estimation

4. Assessment of the effects of FINN sensitivities on air quality using CAMx.

A literature review of the effects of fires on air quality, climate change and fires, fire emissions estimation methods, and the FINN default model configuration and input parameters was completed. The time period of the CAMx episode spanned from April 1 through October 18, 2008. The analysis focused on the late spring, April and May, and the late summer/early fall, September and October.

The variability in monthly and interannual fire climatologies was explored for Texas, Louisiana, five central states (Arkansas, Kansas, Missouri, Mississippi, Oklahoma), 11 western states (New Mexico, Colorado, Wyoming, Montana, Idaho Washington, Oregon, California, Arizona, and Utah), Mexico, Central America (Guatemala, Belize Nicaragua, Costa Rica), and Western Canada. Fire climatology based on CO emissions estimates indicated that 2008 was close to the 2002-2012 average and varied strongly by region and season reflecting differences in the types of fire events, including prescribed burning, agricultural and crop residue burning, and wildfires.

Comparison of emissions estimates from the FINN default configuration with the Bluesky/SmartFire modeling framework that was used to provide emissions for the original CAMx episode. Because both emissions models are used for regional air quality model simulations in the U.S., it is valuable to compare their emissions estimates and effects on simulated air quality. Comparisons indicated that estimates of CO, VOC, and $PM_{2.5}$ emissions from BlueSky/SmartFire were higher than estimates from FINN; NO_x emissions, however, were higher from FINN than BlueSky/SmartFire. SmartFire uses reported area burned and detections from multiple satellite sensors. In contrast, FINN relies only on the MRR product. Overall, this difference generally results in a greater number of fire detections for BlueSky/SmartFire than FINN. A hypothesis is that higher NO_x emission factors in FINN may compensate for lower estimates of acreage burned, in particular in the central United States.

Sensitivity studies using FINN were constructed to examine the effects of uncertainty in emissions factors, fuel loading, land cover classification, and fire detection and estimation of area burned according to Table 1. Dr. Wiedinmyer visited Dr. McDonald-Buller’s team at the University of Texas at Austin for two days during October 28-29, 2013 with the goal of analyzing the results of the sensitivity scenarios with FINN.

Table 1. Sensitivity studies performed with FINN*

RUN NAME	LAND COVER	FUEL LOADING	EMISSION FACTOR	FIRE DETECTION/ BURN AREA
DEFAULT	default	default	default	default
GlobCover	GlobCover	default	default	default
NEWEMIS	default	default	NEW	default
HIGHEMIS	default	default	HIGH**	default
LOWEMIS	default	default	LOW**	default
NEWEMIS_TEMPFOR	default	TEMPFOR+	NEW^	default
SmartFire	default	default	default	SmartFire
FCCS	FCCS	FCCS	default	default

*Default refers to inputs/parameters included in Wiedinmyer et al. (2011) for FINN version 1 and described in Section 3 of this report.
**Note that LOWEMIS and HIGHEMIS represented modifications to the NEWEMIS scenario (not the FINN default scenario).
^ This simulation was a version of the NEWEMIS that include additional changes in vegetation assignment (described below).
+ Evergreen forests were assigned corresponding fuel loadings of temperate forest rather than boreal forest as assumed in the default configuration.

The sensitivity studies highlighted the potential variability in predicted fire emissions, which were season and region dependent. Variability in emissions estimates among the sensitivity studies and between the sensitivity studies and the FINN default configuration exceeded a factor of two. Interactions between input parameters were complex and not generalizable across geographic regions.

Maximum predicted differences in MDA8 ozone concentrations associated with modifications in FINN input data sources ranged from 4 to more than 60 ppb over the 36-km domain. Differences were particularly evident for the SmartFire scenario in Texas, Louisiana, and the central and western U.S. in both seasons, and the Globcover scenario in Mexico during the spring. Differences in $PM_{2.5}$ concentrations associated with modifications in FINN input data sources ranged from 0.5 to 85 $\mu g/m^3$ over the 36-km domain. Effects were less widespread than those for ozone, a finding consistent with the nature of ozone formation as a secondary pollutant. Geographic locations of differences in $PM_{2.5}$ concentrations between the sensitivity scenarios and the FINN default scenario were consistent with those of $PM_{2.5}$ emissions with relatively stronger effects in Mexico for the GlobCover scenario and in the central U.S. for the SmartFire scenario in the spring and in the western and southern/southeastern U.S. for the SmartFire, GlobCover, and FCCS scenarios in the late summer/early fall.

As illustrated for both ozone and $PM_{2.5,}$ because of the intermittent frequency and variability in the spatial and temporal scales of fire events, impacts on percentile concentrations and mean concentrations over extended time periods may be minimal. On local and regional scales, air quality effects can be quite significant during specific fire events. Within the 12-km domain in Texas, predicted maximum absolute differences in MDA8 ozone concentrations were approximately 18 ppb (11 ppb) for the SmartFire scenario and 7 ppb (9 ppb) for the GlobCover and FCCS scenarios during the spring (late summer/early fall). Maximum absolute differences in 24-hour averaged $PM_{2.5}$ concentrations associated with changes in emissions factors, fuel loading (FCCS), or land cover characterization (GlobCover) ranged from 10 to 40 $\mu g/m^3$ across both seasons; differences between the SmartFire and FINN default scenario were 78 $\mu g/m^3$ in the late summer/early fall and 168 $\mu g/m^3$ in the spring. Predicted changes in FINN fire emissions estimates on maximum (but to a much lesser extent mean and percentile) ozone and $PM_{2.5}$ concentrations were affected by the CAMx horizontal grid resolution and the spatial averaging of fire emissions.

At this time, we intend to use all funds allocated to the project by 11/30/2013.

Project 13-022	STATUS: Active – January 29, 2013

Surface Measurements of PM, VOCs, and Photochemically Relevant Gases in Support of DISCOVER-AQ

Rice University – Robert Griffin
University of Houston – Barry Lefer

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Jocelyn Mellberg

Funding Amount: $206,815
($89,912 Rice, $116,903 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 has 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 will conduct operations in and near Houston in September 2013.

During the Houston operations of DISCOVER-AQ, there will be a need for ground-based measurement support. This project will fill 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 will be deployed using the University of Houston (UH) mobile laboratory.

The measurements made on the mobile laboratory generally will operate in two modes. First, during periods when DISCOVER-AQ flight patterns spiral over a given location, the mobile laboratory will operate at the ground surface beneath these spirals in a stationary mode in which surface air quality parameters are monitored continuously. Additional stationary mode measurements will be made at other locations of interest. When not in stationary mode, the mobile laboratory will be deployed to perform Lagrangian studies of air quality within plumes from major sources of primary pollutants, as well as downwind of the major metropolitan area, to characterize secondary processes at surface level.

Project Update

During the Houston operations of DISCOVER-AQ, a heavily instrumented NASA airplane was based at Ellington Field. During the ten flight days for this aircraft, flights were conducted that included periods of constant-elevation traverses between points above which spirals were conducted (that is, take off and reach high altitude, cruise at high altitude, spiral down over a pre-defined location, cruise at low altitude, spiral up over a second pre-defined location, cruise at high altitude, spiral down over a third pre-defined location, etc.). The circuit of the Houston area, which took approximately two and a half to three hours to complete, was made three times during each flight day. For these operations, there was a need for ground-based measurement support. Measurements for the project described by this quarterly report were made using a mobile laboratory across the area to supplement the continuous ground-based monitoring performed by the Texas Commission on Environmental Quality (TCEQ), the Harris County, the City of Houston, and other entities. Parameters/species measured include meteorology, aerosol black carbon, sub-micron aerosol non-refractory composition, volatile organic compounds, carbon monoxide, nitric oxide, nitrogen dioxide, total reactive nitrogen, sulfur dioxide, and O_3. As part of this project, the chemical composition of water-soluble fine PM also was measured at the TCEQ Manvel Croix site located directly south of downtown Houston.

The measurements made on the University of Houston (UH)/Rice mobile laboratory used in this project generally operated in two modes, determined primarily by occurrence of NASA flight operations. First, during periods when DISCOVER-AQ flights occurred, the mobile laboratory operated in the northwest sector of the Houston metropolitan area at the request of the NASA primary scientific officer for DISCOVER-AQ; the laboratory conducted mobile operations to the extent possible. The aim was to characterize pollutant outflow (southerly winds) or background air inflow (northerly winds). The route used avoided major highways so that the measurements were not dominated completely by vehicular emissions; the mobile laboratory typically remained at one of the two route endpoints overnight prior to a flight day. The route began in the Tomball area and headed to the Conroe spiral point (or vice versa) and was repeated during flight operations. Generally, this represented downwind conditions, allowing for characterization of secondary pollutants in the Houston plume.

On non-flight days and during periods without downtimes for calibration, instrument maintenance, or crew rest, operations were determined based on coordination with other mobile facilities, meteorology, and several scientific questions and/or objectives. This required a mix of mobile and stationary operations. Some of these objectives include measurements in the Houston Ship Channel and Texas City areas to investigate primary emissions from refinery and petrochemical operations, co-location at Manvel Croix and Conroe to compare multiple instrument data, co-location with a Princeton University mobile laboratory that measured ammonia to investigate ammonia-ammonium equilibrium, co-location with other mobile laboratories for inter-comparison purposes, deployment to Galveston to measure inflow on days characterized by southerly flow, sampling near the Washburn Tunnel to characterize vehicular primary emissions, and deployment at various other primary emission sources not affiliated with the petrochemical industry (e.g., landfill, wastewater treatment facility, etc.). During the month of September, activities focused on route selection, data generation, and initial data quality assurance/control (QA/QC) (work plan Tasks 5 and 6).

Between the end of the collection period (September 30, 2013) and the end of the project (November 30, 2013), efforts focused on final QA/QC efforts and subsequent preliminary data analysis (work plan Task 7). Some portions of the data set have not yet undergone the final QA/QC protocol, though this work is expected to be complete shortly. Other tasks over the October 1 to November 30, 2013 period focused on reporting (monthly, quarterly, and final) activities (work plan Tasks 8 and 10) and presentation of results to TCEQ, which occurred on November 14, 2013 (work plan Task 9). Data provision (work plan Task 11) will occur after final QA/QC is complete for all data gathered.

Project 13-024	STATUS: Active – February 20, 2013

Surface Measurement of Trace Gases in Support of DISCOVER-AQ in Houston in Summer 2013

University of Maryland – Xinrong Ren

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Erik Gribbin

Funding Amount: $90,444

Executive Summary:
The link between ozone (O_3) and NO_X (= NO + NO_2) photochemistry has been extensively studied for decades, yet new discoveries have revealed the need to improve scientific understanding of ozone formation chemistry. In order to improve the interpretation of aircraft and satellite observations to diagnose near-surface conditions relating to air quality, high-quality surface observations of ozone and particulate matter (PM) precursors are needed, especially in urban environments like Houston. To support the NASA DISCOVER-AQ study in Houston in summer 2013, we will make surface measurements of trace gases, including O_3, NO/NO_2/NO_Y, and SO_2. Research-grade instrumentation to measure these traces gases will be deployed at two of the science sites identified by TCEQ/AQRP. These measurements will be compared to concurrent aircraft measurements for the periods when the NASA P-3B aircraft conducts spiral profiles over the sites. Vertical distributions of these gases will be observed and compared with surface observations with the aim of improving the capability of transport models for air quality simulations. Data collected in the field study will be analyzed with regard to the source regions and emission profiles, reactive nitrogen budget, and relationship between NO_Z and O_3.

Project Update:
During the period from September 1, 2013 to November 31, 2013, the teams at University of Maryland College Park and NOAA's Air Resources Laboratory have accomplished the following tasks:

(1) Successfully deployed instruments during DISCOVER-AQ and collected trace gas data at the Galveston and Manvel Croix sites.

   a. We successfully deployed research-grade instrumentation to measure trace gases at the Manvel Croix and Galveston sites in support of DISCOVER-AQ in September 2013. NO_2 was measured with a Cavity Ring Down instrument at the Manvel Croix site. At the Galveston site, ozone was measured based on UV absorption photometry; SO_2 was measured based on pulsed fluorescence; and NO/NO_2/NO_Y were measured based on O_3-NO chemiluminescence with the conversion of NO_2 to NO using a blue light converter and of NO_Y to NO using a molybdenum converter.

(2) Completed testing and calibrations of the instruments in the field.

(3) Transported the instruments from the field back to the laboratory for further testing or calibrations.

(4) Completed final testing and calibrations for all instruments in the laboratory that were deployed in the DISCOVER-AQ field study.

(5) Finalized the data and completed the following data analyses:

   a. Measurements results show that highest NO_2 levels at the Manvel Croix site were influenced by plumes from downtown Houston and the Houston Ship Channel, although local emissions were also important to elevated NO_2 levels. Trace gases measured at the Galveston site are generally low, but were occasionally influenced by pollution plumes.

   b. These measurements were compared to concurrent aircraft measurements for the periods when the NASA P-3B aircraft conducted spiral profiles over the sites. In general good agreement was observed between the surface and aircraft measurements. Data collected in the field study were analyzed with regard to the source regions, i.e., dependence on wind direction.

   c. Good correlation between NO_Z and O_3 was observed at the Galveston site, suggesting an ozone production efficiency (OPE) of ~16 ppbv when 1 ppbv of NO_x was converted to NOz. This OPE is a factor of 2 larger than what was observed during DISCOVER-AQ 2011 in the Baltimore-Washington area.

(6) Completed the final report and submitted it to AQRP/TCEQ.

Implementation and evaluation of new HONO mechanisms in a 3-D Chemical Transport Model for Spring 2009 in Houston

University of Houston – Barry Lefer
UCLA – Jochen Stutz
Environ – Greg Yarwood
UNC at Chapel Hill – Will Vizuette

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

Funding Amount: $117,269
($19,599 UH, $17,944 UCLA, $44,496 Environ, $35,230 UNC)

Executive Summary

Although portions of the chemistry that lead to the formation of ozone have been understood for decades, new discoveries have revealed the need to improve scientific understanding of ozone formation chemistry. Radical production in Houston and other urban areas appear to be underestimated by chemical mechanisms. The roles of some radical precursors such as HONO, HCHO, and reactive VOCs in ozone formation in Houston and other Texas cities have not been well understood. Research based on both modeling and field measurements by the University of Houston, ENVIRON, University of California – Los Angeles, and the University of North Carolina – Chapel Hill has shown that nitrous acid (HONO) significantly affects the HOx budget in urban environments like Houston. These chemical processes connect surface emissions, both anthropogenic and natural, to local and regional air quality.

From April 15th to May 30th, 2009, a team of more than 40 scientists representing more than 15 different institutions collected a relatively complete suite of atmospheric measurements, including NO, NO_2, NO_Y, HONO, HNO_3, O_3, CO, SO_2, HCHO, HOOH, OH, HO_2, OVOCs, VOCs, actinic flux, PBL height, O_3 production rates, and vertical profiles (nominally 40m, 150m, 300m) of NO_2, HONO, O_3, SO_2, and HCHO, during the Study of Houston Atmospheric Radical Precursor (SHARP). The SHARP dataset provides us a unique opportunity to examine and improve our understanding of atmospheric HONO formation processes and how they may be implemented into the Comprehensive Air quality Model with extensions (CAMx) 3-D chemical transport model commonly used for SIP evaluations. The objective of this study is to develop, implement, and evaluate missing pathways for HONO formation in a photochemical model, CAMx, that is used routinely for regulatory applications in Texas and other areas. This model update is expected to improve the model's ability to simulate ozone concentrations, because HONO is a potential daytime source of the hydroxyl radical, OH, which plays an important role in the ozone formation cycle. Measurements during the SHARP study in Houston showed that radical production in the early morning was dominated by HONO photolysis.

The modeling strategy is to take advantage of the SHARP data analysis in a previous AQRP project (Project 10-032) to develop parameterizations, based on current understanding of the important processes governing HONO formation, and implement and refine these parameterizations in CAMx using existing modeling databases for the Houston area during the SHARP period. Model performance evaluation will make use of process analysis tools to evaluate how HONO formation pathways influence radical budgets and ozone formation within CAMx simulations.

Project Update

During this quarter, the project team (UH, UCLA, UNC, and ENVIRON) made considerable progress and has worked together to test the new CAMx HONO production mechanisms and compare them to previous estimates of direct emissions of primary HONO from combustion sources as well as homogenous HONO prodution. As part of this effort, the project team used the modified the CAMx surface model to implement and test the following new HONO production processes using the CAMx model:

A) Unimolecular conversion of NO_2 to HONO in the dark.

B) Photo-induced conversion of NO_2 to HONO.

C) Photolysis of surface HNO_3 to HONO.

Previous attempts to implement HONO into 3-D CTMs similar to CAMx have employed empirical parameterizations of HONO production. In contrast, this study explicitly modeled heterogeneous formation of HONO using a surface model available in CAMx. The process based approach developed in this study treats both dark (thermal) and light (photo-enhanced) heterogeneous HONO formation on ground level surfaces. This surface model allows the ground to act as a reservoir for deposited species rather than making the assumption that all processes on surfaces occur instantly. The surface model simulates deposition, photochemical degradation and transformation, and volatilization back into the air (re-emission).

Based on literature reviews and analysis of measurements, reactions of NO_2 and HNO_3 at the surface were implemented in the surface model. Our analysis of these results showed that the surface thermal reaction of NO_2 was necessary to explain nighttime measurements during the SHARP study, while during the day, surface photolytic reactions of HNO_3 and NO_2 were necessary to achieve agreement with observations. Because uncertainties exist in our knowledge of the relevant surface parameters, initial estimates of these parameters were refined, using the SHARP observations, to obtain good agreement between observed and modeled HONO:NO_2 ratios and HONO:HNO_3 ratios.

The implementation of these new HONO formation pathways into CAMx shows that explicitly modeling reactions on surfaces (vegetation, soil) can do a better job of reconciling predicted with observed HONO concentrations and HONO:NO_2 ratios. The best HONO agreement with the surface model was obtained for days when the model did a better job of predicting the observed in-situ NO_2 mixing ratios. Consequently, greater emphasis was placed on the overall model simulation of the HONO:NO_2 ratio than the absolute HONO agreement. Sensitivity simulations with direct emissions of HONO (as 0.8 % of NOx emissions) did not consistently reconcile predicted with observed HONO concentrations and HONO:NO_2 ratios. When using surface model parameters that are consistent with SHARP observations, the HONO produced was found to have a substantial impact on morning OH but only minor impacts on daytime OH and daily maximum O_3.

The project team has completed the implementation and analysis of HONO production mechanisms via the new CAMx land surface model and run this new code for the Spring of 2009. We are currently finishing up the final project report.

Project 12-032	STATUS: Active – January 25, 2013

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

Baylor University – Rebecca Sheesley

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Fernando Mercado

Funding Amount: $45,972

Executive Summary

DISCOVER-AQ (Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality) is a multi-year air quality research study set to focus on Houston, TX in September 2013. NASA's P-3B and B200 aircraft will be deployed to sample vertical profiles over specific focus areas using a spiraling vertical profile flight plans for selected days during the one month sampling campaign. In this study, we will measure elemental carbon (EC), organic carbon (OC), and optical black carbon (BC) at two of these vertical spiral sites during the DISCOVER-AQ mission. Baylor University's research group will collect, analyze, and archive particulate filters collected concurrently with DISCOVER-AQ 2013 Houston-based sampling campaign. Specifically, we will continuously measure OC, EC and BC at two surface sites on each day of the month that the NASA aircraft will be deployed. Collection will occur at two field stations located directly below aircraft focus areas (i.e. vertical profile sites). Results from the carbon measurements taken during the campaign will be disseminated to DISCOVER-AQ investigators and other external research groups. We will also archive particulate filters for future research opportunity. Access to these archived filters will be provided to DISCOVER-AQ investigators and external research groups.

Specific goals of this project are to:

1) Characterize OC and EC concentrations using fine particulate matter ($PM_{2.5}$) and total suspended particulate (TSP) air filter samples collected at two of DISCOVER-AQ Houston's focus areas.
   a. Focus areas include ground stations near Katy and H-NET Jones Forest.
   b. Archive filters for two years at -10°C for future research opportunities.
   c. Provide access of filters to DISCOVER-AQ project leadership and external research groups and collaborators.
2) Measure optical BC using a seven channel aethalometer at the H-NET Jones Forest ground station.
3) Compare ground-based OC, EC, and optical BC with other aerosol measurements made directly over focus areas on NASA's P-3B and B200 aircraft (i.e. water soluble organic carbon and BC).

Project Update

This AQRP project is reporting initial elemental carbon (EC) and organic carbon (OC) characterization of particulate matter (PM) at Moody Tower and Manvel Croix during DISCOVER-AQ Houston Texas 2013. Particulate filter samples were collected over the entire DISCOVER-AQ sampling period at two primary sites and analyzed for off-line for organic and elemental carbon (OC/EC). Furthermore, real-time black carbon (BC) optical data was also collected at these two ground-based sites. The overall research objective was to "***assess ground-level particulate matter formation and emission at two DISCOVER-AQ Houston Focus Areas and compare results to concurrent aircraft measurements made directly above the ground stations***."

Particulate filter sample collections and analysis, as specified under the original project's framework, was successful. The project's sampling efforts were intensified at the two primary sites. PM sampling efforts were expanded to additional DISCOVER-AQ flight sites, Conroe and La Porte, due to the development of research collaborations during the early stages of this project. As a result of this concerted effort, over 300 particulate filters were collected. Fine particulate matter (PM2.5) and total suspended particulate matter (TSP) were collected during the entire month of September 2013 as well as concurrent with the DISCOVER-AQ flights by NASA's P-3B and B200 aircraft.

Over the course of the project the PM2.5 OC ranged from 0.8 to 10.1 µg m^{-3} while the TSP OC ranged from 2.6 to 17.4 µg m^{-3} at Moody Tower. The EC at Moody Tower ranged from 0.2 to 1.2 µg m^{-3} for PM2.5 and from 0.2 to 3.5 µg m-3 for TSP. At Manvel Croix, the PM2.5 OC ranged from 1.2 to 7.2 µg m^{-3} while the TSP OC ranged from 3.0 to 6.7 µg m^{-3}. The EC at Manvel Croix ranged from 0.13 to 2.0 µg m^{-3} for PM2.5 and from 0.1 to 0.7 µg m^{-3} for TSP. The higher carbon maximums at Manvel Croix for the fine particulate matter occurred during morning rush hour samples. Based on these preliminary results we have identified two PM regimes for further characterization: the week of Sept 9-13 for primary emission characterization and the week of Sept 21-28 for PM formation.

The aethalometer at Moody Tower revealed distinct trends in BC concentration with peaks from 04:00 to 10:00 for many days, which is coincident with early morning diesel transport and morning rush hour emissions. The preliminary BC calculated from absorbance at 880nm has been regressed against the preliminary EC measured on the daily 24h MV2.5 QFF. The regression line had a slope of 0.46 and an r^2 of 0.57. However, both data sets need to be finalized. Absorption by other components of particulate matter including windborne dust and iron oxides associated with industrial emissions is possible at this wavelength.

Finally, particulate filters were archived for future PM projects tasked with examining air quality and atmospheric chemistry in the City of Houston and Harris County. Project results, including real-time and off-line measurements, will be promptly disseminated to DISCOVER-AQ investigators. Currently, project PIs are working with the Langley Aerosol Research Group Experiment (LARGE) to compare ground-based measurement with flight-based measurements. LARGE was one of the main research groups focusing on flight-based aerosol measurements for DISCOVER-AQ.

We are anticipating that all funds allocated to this project will be utilized by November 30th, 2013.

Project 12-TN1	STATUS: Active – February 21, 2013

Investigation of surface layer parameterization of the WRF model and its impact on the observed nocturnal wind speed bias

University of Maryland – Daniel Tong
Pius Lee

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Bright Dornblaser

Funding Amount: $64,994

Executive Summary

This study investigates surface layer parameterizations in the Weather Research and Forecasting (WRF) model. The parameterization of energy fluxes from the surface layer significantly impacts the modeled near-surface winds. The WRF model tends to over-predict the surface wind speeds in eastern Texas in the evening hours, especially in coastal regions. This project examines the various similarity theories that parameterize the momentum fluxes of the surface layer used in the WRF meteorological model.

The investigation and possible remedy recommendation for rectifying the high wind-speed-bias is carried out in multiple steps: (A) Understand the sensitivities of the different surface layer schemes, (B) Examine the sensitivity of the flux-profile relationships with regards to synoptic and atmospheric stability conditions, and (C) Investigate the universal flux profile functions and the range of parameter values used by the functions to suggest potential modifications for improvement – especially for the stable regimes. These details of the surface layer schemes are important as they govern the correct timing of the decoupling of near-surface and surface phenomena which are critical in the redistribution of kinetic energy from the residual layer to the surface. The rate of transfer of energy affects the evolution of wind speeds in the lowest layers.

A series of sensitivity runs of the WRF model is devised and conducted with possible recommendation on adjusted values for several of the tunable constants in the surface layer similarity theory parameterizations. Although the runs will focus on an early summer period for the Houston-Galveston-Brazoria area, they should provide insight on the rate and strength of the coupling and decoupling between the surface layer and the lowest model level in a large range of land-use and meteorological conditions.

Project Update

There are two bug fixes in the Yonsei University (YSU) planetary boundary layer (PBL) scheme since WRF version 3.2, both of which deal with PBL simulation under stable atmospheric conditions. The first one introduces an adjustment of the convective velocity scale that results in reduced upper-layer mixing in the stable layer. The second fix aims to reduce the minimum turbulence eddy diffusivity in the stable layer. We reran the simulations between June 3 and 14

2006 with WRF version 3.4.1 to examine the effects of incorporating these fixes. **Error! Reference source not found.**

Figure 1 shows the modeled diurnal evolution of 10 meter wind averaged over the grid cells where the 46 CAMS monitors are located in the Houston-Galveston-Brazoria (HGB) area. It shows that wind speed is still overestimated by WRF 3.4.1 (slab1) but in diminished magnitude when compared to the WRF 3.2 results (slab1-v32). The simulation period averaged bias of 10 meter wind speed at 21 CST has been reduced from 1.1 m s^{-1} to 0.6 m s^{-1} (55%) and 0.4 m s^{-1} (36%) by using the MM5 SL and a modified MM5 SL, respectively. The 5 layer soil thermal diffusion land surface model (LSM), or the slab LSM model in abbreviation, may not have parameterized well the transition of the surface momentum and heat fluxes. This can cause a jump in the low level wind speed in the early evening as evident in its time evolution.

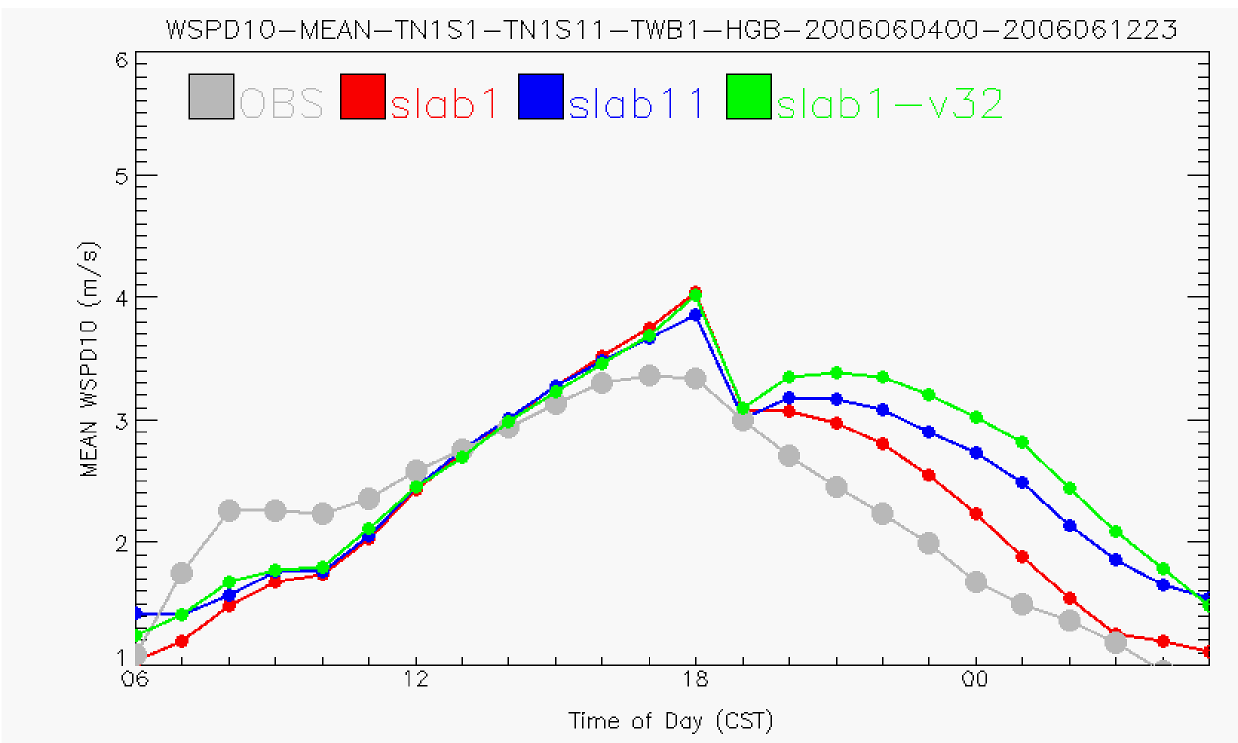

Figure 1. Diurnal variation of WRF model result over grid cells where the 46 CAMs monitors are located over June 4–13, 2006 for: (slab1) using MM5 SL with WRF version 3.4.1, (slab11) using the modified MM5 SL (Jiménez et al., 2012) with WRF version 3.4.1, and (slab1-v32) using MM5 SL with WRF version 3.2.

There are a couple of recent studies that applied different PBL scheme options in the meteorological models attempting to identify the best PBL option in the HGB area (Hu et al., 2010) and in the Gulf states in general (Yerramilli et al., 2010). They independently recommended YSU as one of the preferred PBL schemes producing the least biases in 2 meter temperature and 10 meter wind. Between these studies the NOAH LSM (Ek et al., 2003) is recommended to supersede the simplistic 5-layer soil thermal diffusion LSM. NOAH is a physically based parameterization scheme that has better expandability to incorporate new modeling advancements. Therefore we replaced the slab LSM by the NOAH LSM for testing in two new simulations. Figure 2 shows verification of diurnal variability of 10 meter wind speed over the 46 CAMS sites. It shows that the simulations by using the NOAH LSM have worsen performance than that by using the slab LSM, with increased positive biases at night. However, the discrepancy caused by the modeled abrupt drop in wind speed between 18 and 19 CST were removed.

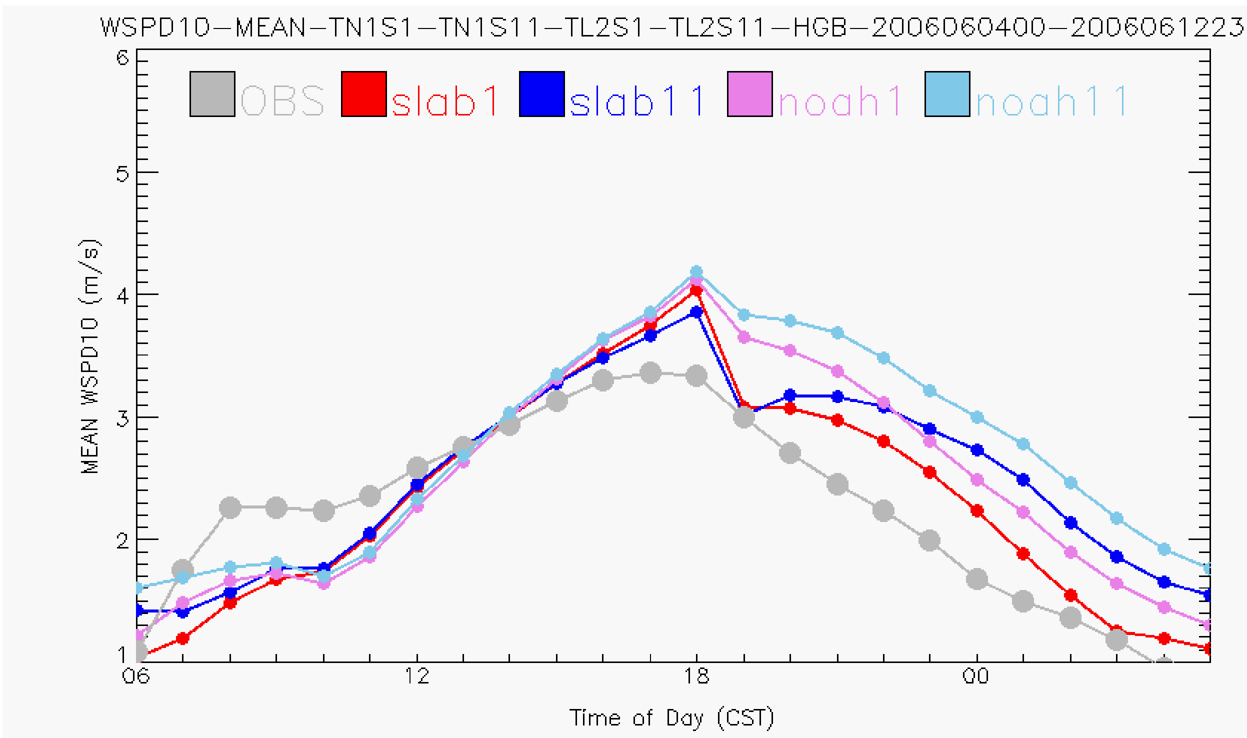

Figure 2. Diurnal variation of WRF predicted 10m wind speed over grid cells where the 46 CAMs monitors are located for the period June 4-13, 2006 for (OBS) observation, and for prediction when applying: (slab1) MM5 SL and 5-layer soil thermal diffusion LSM, (slab11) modified MM5 SL (Jiménez et al., 2012) and 5-layer soil thermal diffusion LSM, (noah1) MM5 SL and NOAH LSM, and (noah11) modified MM5 SL and NOAH LSM.

The remainder of the quarter was dedicated to preparation for final report and on-site final presentation.

Project 12-TN2	STATUS: Active – February 21, 2013

Development of IDL-based geospatial data processing framework for meteorology and air quality modeling

University of Maryland – Daniel Tong
HyunCheol Kim

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Bright Dornblaser

Funding Amount: $69,985

Executive Summary

This project investigates basic computational algorithms to handle Geographic Information System (GIS) data and satellite data, which are essential in regional meteorological and chemical modeling. It develops a set of generalized libraries within a geospatial data processing framework aiming to process geospatial data more efficiently and accurately. The tool can process GIS data both in vector format (e.g., ESRI shapefiles) and raster format (e.g., GEOTIFF and IMG) for any given domain. Processing speeds will be improved through selective usages of polygon-clipping routines and other algorithms optimized for specific applications. The raster tool will be developed utilizing a histogram reverse-indexing method that enables easy access of grouped pixels. It generates statistics of pixel values within each grid cell with improved speed and enhanced control of memory usage. Spatial allocating tools that use polygon clipping algorithms require huge computational power to calculate fractional weighting between GIS polygons (and/or polylines) and gridded cells. To overcome the speed and computational accuracy deterioration issues, an efficient polygon/polyline clipping algorithm is crucial. A key for faster spatial allocation is to optimize computational iterations in both polygon clipping and map projection calculations.

The project has the following specific objectives: (A) To develop an optimized geospatial data processing tool that can handle raster data format and vector data format with enhanced processing time and accuracy, for any given target domain. (B) To collect and to process sample GIS and satellite data. Applications will include a spatial regridding method for emissions and satellite data, such as the Moderate Resolution Imaging Spectroradiometer (MODIS) Aerosol Optical Depth (AOD), the Ozone Monitoring Instrument (OMI), and the Global Ozone Monitoring Experiment (GOME)-2 NO_2 column data. (C) To perform an engineering test with processed fine resolution LULC data.

Project Update

During the period, September 1 ~ November 30, 2013, we have focused on applications of IDL-based Geospatial Processer (IGDP) tool and Weather Research and Forecasting (WRF) engineering test run.

1. Applications of IGDP tool

Applications of IGDP tool are developed and demonstrated. In order to build a lossless spatial regridding tool, we have utilized polygon-clipping algorithms, and have developed a tool to perform accurate spatial regridding of satellite data. Two key algorithms for the regridding tool are developed and implemented: "Conservative remapping" algorithm performs lossless spatial remapping, and "Downscaling" algorithm is designed to generate fine structure out of coarse resolution input data (e.g. satellite pixels), with additional information from fine resolution data set (e.g. fine resolution model simulation). This method can provide very important information such as on long term emission trends by monitoring fine-scale signals of NOx emission from satellite. This can be a potential huge advantage of using advanced spatial regridding techniques.

2. Engineering WRF test run with satellite-observed sea surface temperature

In order to demonstrate the IGDP tool's capability to improve input data for modeling study, we have performed an engineering run using WRF meteorological simulations. This test demonstrates a case study using two sets of Sea Surface Temperature (SST) data: A base case using NCEP real-time global (RTG) 0.5 degree SST, and a test case using SST-update using Geostationary Operational Environmental Satellites (GOES) SST data. The GOES SST was processed and replaced the SST in the WRF input files by utilizing the IGDP tool. The WRF result with updated SST was compared with the control case in which the NCEP SST was used through the standard WPS processing. By using the IGDP tool, we did not need to re-run the WPS step or include extra coding of WPS for cooperating the satellite SST data in the WRF initial and boundary files. This test case clearly shows the advantage of the IGDP tool, which can provide enhanced information using additional data (e.g. geostationary satellite data in this test run) on top of conventional processing of basic data sets for modeling study.

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.

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:

<u>Program Administration</u> – 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.

<u>ITAC</u>
These funds are to cover the costs, largely travel expenses, for the ITAC meetings.

<u>Project Management</u> – 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.

<u>Research Projects</u> / 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 assistance from Rachael Bushn, Melanie Allbritton, and Susan McCoy each provided assistance with program organization and financial management. This included managing 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 10 and 11 funds have been fully expended. This same procedure will be followed for the FY 12 and 13 funds.

In June 2013, UT-Austin received a Contract Extension for the AQRP. This extension will continue the program through December 29, 2015.

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	$0.00	$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							
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**	**$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		$68,340.00	$265,040.00	$333,380.00	$96,685.71	$0.00	$236,694.29
Fringe Benefits		$14,606.64	$47,706.00	$62,312.64	$22,680.22	$0.00	$39,632.42
Travel		$2,850.00	$750.00	$3,600.00	$339.13	$0.00	$3,260.87
Supplies		$10,000.00	$10,000.00	$20,000.00	$3,446.16	$0.00	$16,553.84
Equipment							
Total Direct Costs		$95,796.64	$323,496.00	$419,292.64	$105,032.71	$0.00	$296,141.42
Authorized Indirect Costs		$6,834.00	$26,504.00	$33,338.00	$8,357.91	$0.00	$23,669.44
10% of Salaries and Wages							
Total Costs		**$102,630.64**	**$350,000.00**	**$452,630.64**	**$132,819.78**	**$0.00**	**$319,810.86**
Fringe Rate		22%	22%		23%		

ITAC

All ITAC activities in this period were conducted via email and webinar, therefore no expenses related to ITAC meetings were incurred.

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	$0.00
Supplies		$1,039.95	$284.67	$1,324.62	$1,324.62	$0.00	$0.00
Total Direct Costs		$17,418.81	$6,577.64	$23,996.45	$23,996.45	$0.00	$0.00
Authorized Indirect Costs							
10% of Salaries and Wages							
Total Costs		**$17,418.81**	**$6,577.64**	**$23,996.45**	**$23,996.45**	**$0.00**	**$0.00**

ITAC Budget
FY 2012/2013

Budget Category		FY12 Budget	FY13 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary							
Fringe Benefits							
Travel		$10,000.00	$8,000.00	$18,000.00	$0.00	$0.00	$18,000.00
Supplies		$500.00	$2,000.00	$2,500.00	$0.00	$0.00	$2,500.00
Total Direct Costs		$10,500.00	$10,000.00	$20,500.00	$0.00	$0.00	$20,500.00
Authorized Indirect Costs							
10% of Salaries and Wages							
Total Costs		**$10,500.00**	**$10,000.00**	**$20,500.00**	**$0.00**	**$0.00**	**$20,500.00**

Project Management

During this reporting period 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. They are currently reviewing final project reports for the FY 2012-2013 research cycle.

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	$0.00	$0.00
Fringe Benefits		$28,967.49	$23,102.60	$52,070.09	$52,070.26	$0.00	($0.17)
Travel							
Supplies		$778.30	$207.98	$986.28	$986.22	$0.00	$0.06.00
Total Direct Costs		$175,083.49	$144,637.22	$319,720.71	$319,720.82	$0.00	($0.11)
Authorized Indirect Costs		$14,533.77	$12,132.66	$26,666.43	$26,666.32	$0.00	$0.11
10% of Salaries and Wages							
Total Costs		**$189,617.26**	**$156,769.88**	**$346,387.14**	**$346,387.14**	**$0.00**	**$0.00**

Project Management Budget
FY 2012/2013

Budget Category		FY12 Budget	FY13 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$48,900.00	$152,000.00	$200,900.00	$55,585.75	$0.00	$145,314.25
Fringe Benefits		$9,106.00	$31,800.00	$40,906.00	$11,220.72	$0.00	$29,685.28
Travel		$500.00		$500.00	$0.00	$0.00	$500.00
Supplies		$7,279.76	$6,000.00	$13,279.76	$967.98	$0.00	$12,311.78
Total Direct Costs		$65,785.76	$189,800.00	$255,585.76	$67,774.45	$0.00	$187.811.31
Authorized Indirect Costs		$4,890.00	$15,200.00	$20,090.00	$5,558.57	$0.00	$14,531.43
10% of Salaries and Wages							
Total Costs		**$70,675.76**	**$205,000.00**	**$275,675.76**	**$73,333.02**	**$0.00**	**$202,342.74**

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 $27,500. 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.) $1,402,744 of these funds were allocated to Project 13-004 to allow for the purchase of additional infrastructure equipment and expand the number of Discover-AQ sites. The funds that have not yet been allocated to research projects will be allocated from the next 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 November 30, 2013.

FY 2014-2015

The FY 2014 and 2015 Research/Contractual budgets were originally funded at $825,000 each. Research projects selected from the RFP that closed on November 22, 2013 are expected to be awarded in February 2014.

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		
FY 12 Contractual Funding Transfers		$27,500		
FY 12 Total Contractual Funding		**$842,500**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
12-004	UT-Austin (Torres)	$4,820	$4,819.65	$0.35
12-006	UC-Riverside	$101,765	$93,951.68	$7,813.32
12-006	TAMU/TEES	$44,494	$16,762.00	$27,732.00
12-011	Environ International	$77,420	$72,505.16	$4,914.84
12-012	UT-Austin (Hildebrandt)	$79,463	$78,901.39	$561.61
12-012	Environ International	$69,374	$61,321.09	$8,052.91
12-013	Environ International	$59,974	$59,960.93	$13.07
12-018	UT-Austin (McDonald-Buller)	$85,282	$84,915.51	$366.49
12-018	Environ International	$21,688	$19,866.30	$1,821.70
12-028	University of Houston	$19,599	$15,781.51	$3,817.49
12-028	UCLA	$17,944	$15,232.40	$2,711.60
12-028	Environ International	$44,496	$43,931.67	$564.33
12-028	UNC - Chapel Hill	$35,230	$35,230.00	$0.00
12-032	Baylor	$45,972	$38,486.93	$7,485.07
12-TN1	Maryland	$64,994	$40,155.21	$24,838.79
12-TN2	Maryland	$69,985	$37,478.81	$32,506.19
FY 12 Total Contractual Funding Awarded		$842,500		
FY 12 Contractual Funds Remaining to be Awarded		$0		
FY 12 Contractual Funds Expended to Date			$719,300.24	
FY 12 Contractual Funds Remaining to be Spent				$123,199.76

FY 13 Contractual Funding		$835,000		
FY 13 Contractual Funding Transfers		$2,100,000		
FY 13 Total Contractual Funding		**$2,935,000**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
13-004	UT-Austin (Torres)	$1,571,124	$573,348.78	$997,775.22
13-005	Chalmers University of Tech	$129,047	$53,363.36	$75,683.64
13-005	University of Houston	$48,506	$42,638.27	$5,867.73
13-016	Valparaiso	$46,652	$30,746.97	$15,905.13
13-016	University of Houston	$19,846	$7,789.02	$12,056.98
13-022	Rice University	$89,912	$65,884.92	$24,027.08
13-022	University of Houston	$116,903	$110,792.05	$6,110.95
13-024	Maryland	$90,444	$52,254.80	$38,189.20
FY 13 Total Contractual Funding Awarded		$2,112,434		
FY 13 Contractual Funding Remaining to be Awarded		$822,566		
FY 13 Contractual Funds Expended to Date			$936,818.17	
FY 13 Contractual Funds Remaining to be Spent				$1,998,182
Total Contractual Funding		$3,777,500		
Total Contractual Funding Awarded		$2,954,934		
Total Contractual Funding Remaining to be Awarded		$822,566		
Total Contractual Funds Expended to Date			$1,656,118.41	
Total Contractual Funds Remaining to be Spent				$2,121,382

Summary

The expenditure of FY 2012 funds is proceeding as anticipated. It is expected that all FY 2012 funds, including Research/Contractual funds, will be fully expended by March 31, 2014. In December 2013, the AQRP Administration will request an extension of the end date of the FY 2012 funds from 12/29/13 to 3/31/14 to facilitate the final expenditures. This will also require budget transfers from the ITAC to the Project Management budget.

Once all FY 2012/2013 projects have been fully invoiced, a total of approximately $1,000,000 is expected to remain in FY 2013 project funds. Most of these funds will remain from Project 13-004, which was reduced in scope due to timing issues related to the purchase of infrastructure equipment. An off-shoot project from the AQRP Infrastructure project is expected to be approved that will utilize approximately $100,000 of this amount.

This will leave approximately $900,000 in FY 2013 funds and $825,000 in FY 2014 and FY 2015 funds, respectively, for a total of approximately $2,550,000 in the Research/Contractual budget.

Appendix A

Financial Reports by Fiscal Year

FY 10 and 11

(Expenditures reported as of August 31, 2013.)

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	$0.00	$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					
Other					
Contractual					
Total Direct Costs		$256,925.31	$256,925.31	$0.00	$0.00
Authorized Indirect Costs		$20,281.69	$20,281.69	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$277,207.00**	**$277,207.00**	**$0.00**	**$0.00**

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					
Supplies		$101.25	$101.25	$0.00	$0.00
Equipment					
Other					
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	$0.00	$0.00
Supplies		$1,039.95	$1,039.95	$0.00	$0.00
Equipment					
Other					
Total Direct Costs		$17,418.81	$17,418.81	$0.00	$0.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$17,418.81**	**$17,418.81**	**$0.00**	**$0.00**

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	$0.00
Supplies		$284.67	$284.67	$0.00	$0.00
Equipment					
Other					
Total Direct Costs		$6,577.64	$6,577.64	$0.00	$0.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$6,577.64**	**$6,577.64**	**$0.00**	**$0.00**

Project Management Budget
FY 2010

Budget Category		FY10 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$145,337.70	$145,337.70	$0.00	$0.00
Fringe Benefits		$28,967.49	$28,967.49	$0.00	$0.00
Travel					
Supplies		$778.30	$778.30	$0.00	$0.00
Equipment					
Other					
Total Direct Costs		$175,083.49	$175,083.49	$0.00	$0.00
Authorized Indirect Costs		$14,533.77	$14,533.77	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$189,617.26**	**$189,617.26**	$0.00	$0.00

Project Management Budget
FY 2011

Budget Category		FY11 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$121,326.64	$121,326.64	$0.00	$0.00
Fringe Benefits		$23,102.60	$23,102.77	$0.00	($0.17)
Travel					
Supplies		$207.98	$207.92	$0.00	$0.06
Equipment					
Other					
Total Direct Costs		$144,637.22	$144,637.33	$0.00	($0.11)
Authorized Indirect Costs		$12,132.66	$12,132.55	$0.00	$0.11
10% of Salaries and Wages					
Total Costs		**$156,769.88**	**$156,769.88**	$0.00	**$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					
Other					
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					
Supplies		$101.25	$101.25	$0.00	$0.00
Equipment					
Other					
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 November 30, 2013.)

Administration Budget (includes Council Expenses)

FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$68,340.00	$68,337.48	$0.00	$2.52
Fringe Benefits		$14,606.64	$15,805.72	$0.00	($1,199.08)
Travel		$2,850.00	$339.13	$0.00	$2,510.87
Supplies		$10,000.00	$2,713.43	$0.00	$7,286.57
Equipment					
Other					
Contractual					
Total Direct Costs		$95,796.64	$85,699.27	$0.00	$8,600.88
Authorized Indirect Costs		$6,834.00	$6,792.08	$0.00	$0.26
10% of Salaries and Wages					
Total Costs		**$102,630.64**	**$92,491.35**	**$0.00**	**$8,601.14**

Administration Budget (includes Council Expenses)

FY 2013

Budget Category		FY13 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$265,040.00	$28,348.23	$0.00	$236,691.77
Fringe Benefits		$47,706.00	$6,874.50	$0.00	$40,831.50
Travel		$750.00	$0.00	$0.00	$750.00
Supplies		$10,000.00	$732.73	$0.00	$9,267.27
Equipment					
Other					
Contractual					
Total Direct Costs		$323,496.00	$35,955.46	$0.00	$287,540.54
Authorized Indirect Costs		$26,504.00	$2,834.82	$0.00	$23,669.18
10% of Salaries and Wages					
Total Costs		**$350,000.00**	**$38,790.28**	**$0.00**	**$311,209.72**

ITAC Budget
FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$10,000.00	$0.00	$0.00	$10,000.00
Supplies		$500.00	$0.00	$0.00	$500.00
Equipment					
Other					
Contractual					
Total Direct Costs		$10,500.00	$0.00	$0.00	$10,500.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$10,500.00**	**$0.00**	**$0.00**	**$10,500.00**

ITAC Budget
FY 2013

Budget Category		FY13 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$8,000.00	$0.00	$0.00	$8,000.00
Supplies		$2,000.00	$0.00	$0.00	$2,000.00
Equipment					
Other					
Contractual					
Total Direct Costs		$10,000.00	$0.00	$0.00	$10,000.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$10,000.00**	**$0.00**	**$0.00**	**$10,000.00**

Project Management Budget
FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$48,900.00	$48,876.80	$0.00	$23.20
Fringe Benefits		$9,106.00	$10,064.41	$0.00	($958.41)
Travel		$500.00	$0.00	$0.00	$500.00
Supplies		$7,279.76	$967.98	$0.00	$6,311.78
Equipment					
Other					
Contractual					
Total Direct Costs		$65,785.76	$49,723.86	$0.00	$5,876.57
Authorized Indirect Costs		$4,890.00	$4,092.16	$0.00	$2.33
10% of Salaries and Wages					
Total Costs		**$70,675.76**	**53,816.02**	**$0.00**	**$5,878.90**

Project Management Budget
FY 2013

Budget Category		FY13 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$152,000.00	$6,708.95	$0.00	$145,291.05
Fringe Benefits		$31,800.00	$1,156.31	$0.00	$30,643.69
Travel					
Supplies		$6,000.00	$0.00	$0.00	$6,000.00
Equipment					
Other					
Contractual					
Total Direct Costs		$189,800.00	$7,865.26	$0.00	$181,934.74
Authorized Indirect Costs		$15,200.00	$670.90	$0.00	$14,529.10
10% of Salaries and Wages					
Total Costs		**$205,000.00**	**$8,536.16**	**$0.00**	**$205,000.00**

AQRP Budget

FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$68,340.00	$68,337.48	$0.00	$2.52
Fringe Benefits		$14,606.64	$15,805.72	$0.00	($1,199.08)
Travel		$2,850.00	$339.13	$0.00	$2,510.87
Supplies		$10,000.00	$2,713.43	$0.00	$7,286.57
Equipment		$0.00	$0.00	$0.00	$0.00
Other		$0.00	$0.00	$0.00	$0.00
Contractual		$842,500.00	$719,300.24	$0.00	$123,199.76
ITAC		$10,500.00	$0.00	$0.00	$10,500.00
Project Management		$70,675.76	$64,796.86	$0.00	$5,878.90
Total Direct Costs		$1,019,472.40	$871,292.86	$0.00	$148,179.54
Authorized Indirect Costs		$6,834.00	$6,833.74	$0.00	$0.26
10% of Salaries and Wages					
Total Costs		**$1,026,306.40**	**$878,126.60**	**$0.00**	**$148,179.80**

AQRP Budget
FY 2013

Budget Category		**FY13 Budget**	**Cumulative Expenditures**	**Pending Expenditures**	**Remaining Balance**
Personnel/Salary		$265,040.00	$28,348.23	$0.00	$236,691.77
Fringe Benefits		$47,706.00	$6,874.50	$0.00	$40,831.50
Travel		$750.00	$0.00	$0.00	$750.00
Supplies		$10,000.00	$732.73	$0.00	$9,267.27
Equipment		$0.00	$0.00	$0.00	$0.00
Other		$0.00	$0.00	$0.00	$0.00
Contractual		$2,935,000.00	$936,818.17	$0.00	$1,998,181.83
ITAC		$10,000.00	$0.00	$0.00	$10,000.00
Project Management		$205,000.00	$8,536.16	$0.00	$196,463.84
Total Direct Costs		$3,473,496.00	$981,309.79	$0.00	$2,492,186.21
Authorized Indirect Costs		$26,504.00	$2,834.82	$0.00	$23,669.18
10% of Salaries and Wages					
Total Costs		**$3,500,000.00**	**$984,144.61**	**$0.00**	**$2,515,855.39**

Appendix C

Budgets by Fiscal Year

FY 14 and 15

Authorized Expense Budget - FY14		
Budget Category		**FY14**
Personnel/Salary		$70,000.00
Fringe Benefits		$15,150.00
Travel		$350.00
Supplies		$7,500.00
Equipment		
Contractual		$825,000.00
Project Management		$67,500.00
ITAC		$7,500.00
Total Direct Costs		$993,000.00
Authorized Indirect Costs		$7,000.00
10% of Salaries and Wages		
Total Costs		$1,000,000.00
Fringe Rate		22%
Indirect Rate		10% of salaries and wages

Authorized Expense Budget - FY15		
Budget Category		**FY15**
Personnel/Salary		$70,000.00
Fringe Benefits		$15,150.00
Travel		$350.00
Supplies		$7,500.00
Equipment		
Contractual		$825,000.00
Project Management		$67,500.00
ITAC		$7,500.00
Total Direct Costs		$993,000.00
Authorized Indirect Costs		$7,000.00
10% of Salaries and Wages		
Total Costs		$1,000,000.00
Fringe Rate		22%
Indirect Rate		10% of salaries and wages