

AIR QUALITY RESEARCH PROGRAM

**Texas Commission on Environmental Quality
Contract Number 582-22-20017
Awarded to The University of Texas at Austin**

**Quarterly Report
March 1 – May 31, 2025**

Submitted to

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Texas Air Quality Research Program

Quarterly Report

March 1 – May 31, 2025

OVERVIEW

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

- (i) to support scientific research related to Texas air quality, in the areas of emissions inventory development, atmospheric chemistry, meteorology, and air quality modeling,
- (ii) to integrate AQRP research with the work of other organizations, and
- (iii) to communicate the results of AQRP research to air quality decision-makers and stakeholders.

PROGRAM ACTIVITIES FOR THE QUARTER

During this reporting period, AQRP focused on financial oversight, research project monitoring, and program planning activities. AQRP Grant Manager audited Financial Status Reports (FSRs) submitted by Subawardees and corresponding with awardee institutions to address expense-related questions and concerns. Primary AQRP FSR-Invoices were prepared and submitted to TCEQ.

Monthly Technical Reports (MTRs) were collected from Subawardees and reviewed by both AQRP and TCEQ Project Managers. AQRP Project Managers also worked directly with Subawardees to address research-related questions arising from MTR content and ensure timely clarification of technical issues.

AQRP and TCEQ Project Managers reviewed and discussed upcoming biennium milestones, research priorities, and technical and advisory council rosters. In addition, Budget Revision Review Forms (BRRFs) for projects under the 10% threshold requiring no TCEQ approval were reviewed and processed.

Planning for the 2025 AQRP Workshop began during this quarter, with coordination underway for the event scheduled to be held at The University of Texas at Austin on August 26, 2025. AQRP also submitted the required TCEQ Personnel Eligibility List and HR certification for UT Austin personnel.

Throughout the quarter, the AQRP Program Manager maintained weekly meetings with the TCEQ Project Manager to discuss the status of projects, administrative deliverables, and ongoing program updates.

BACKGROUND

Section 387.010 of House Bill (HB) 1796 (81st Legislative Session), directs the Texas Commission on Environmental Quality (TCEQ) to establish the Texas Air Quality Research Program (AQRP). The University of Texas at Austin (UT) was selected by the TCEQ to administer the program. A contract for the administration of the AQRP was established between the TCEQ and UT. 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).

A new AQRP contract was executed for the 2024-2025 biennium and funding of \$750,000 per year was awarded.

RESEARCH PROJECT CYCLE

The Research Program is implemented through a nine-step cycle each biennium. 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 research priorities. The Air Quality Research Program (AQRP) Director, in consultation with the Independent Technical Advisory Committee (ITAC), the Advisory Council (the Council), and the Texas Commission on Environmental Quality (TCEQ), develop research priorities; the research priorities are released along with a Request for Proposals (RFP).
- 2) Project proposals relevant to the research priorities are solicited. The RFP will be found at <https://aqrp.ceesa.utexas.edu/> once released.
- 3) The 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 of Texas'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.
- 6) All Investigators are notified of the status of their proposals, either intent to fund, not funded, or contingent (not funded at this time, but being held for possible reconsideration if funding becomes available).
- 7) Intent to fund projects are assigned an AQRP Project Manager at UT Austin and a Project Liaison at TCEQ. The AQRP Project Manager is responsible for ensuring that project objectives are achieved in a timely manner and that effective communication is maintained among investigators involved in multi-institution projects. The AQRP Project Manager has responsibility for documenting progress toward project measures of success for each project. The AQRP Project Manager works with the researchers, and the TCEQ, to create an approved work plan for the project.

The AQRP Project Manager also works with the researchers, TCEQ, and the Program's Quality Assurance officer to develop an approved Quality Assurance Project Plan (QAPP) and Work Plan for each project. Subaward Agreements are issued. The AQRP Project Manager reviews monthly, quarterly, annual, and final reports from the researchers and works with the researchers to address deficiencies.

- 8) The AQRP Director and the AQRP Project Manager for each project describe progress on the project in the ITAC and Council meetings dedicated to on-going project review.
- 9) The project findings are communicated through multiple mechanisms. Final reports are posted to the AQRP web site (<https://aqrp.ceesa.utexas.edu/>); research briefings are developed for the public and air quality decision makers; and a bi-annual research conference/data workshop is held.

During this period, the AQRP performed step 7.

Research Projects
FY 2024-2025 Projects

Project 24-003 (University of Houston)

Title: Improving Emission Rates Estimates of Commercial Marine Vessels	Status: ACTIVE 08/12/2024 – 08/31/2025
PI: James Flynn (University of Houston)	Funded Amount: \$242,048
Co-PI: Christian Lindhjem (Ramboll)	AQRP Project Manager: Vincent Torres
Co-PI: Jerker Samuelsson (FluxSense)	TCEQ Project Liaison: Cody McClain

Abstract: The Texas Commission on Environmental Quality (TCEQ) relies on emission inventories to shape the State Implementation Plan (SIP), crucial for managing air pollutants such as nitrogen oxides (NO_x) and ozone (O₃). Recognizing the significance of reliable data, the team of the University of Houston (UH) and Ramboll proposed this research project to address the research priority identified by the Air Quality Research Program (AQRP) to improve emission inventories for commercial marine vessels (CMV).

CMV emissions, particularly NO_x, constitute a substantial portion of coastal NO_x emissions. In the Houston-Galveston-Brazoria nonattainment area, CMVs accounted for approximately 18% of NO_x emissions in 2019, with a continued significant contribution expected for years to come. Among different vessel categories, smaller commercial vessels, notably towboats, were responsible for about 42% of CMV NO_x emissions in Texas in 2019 (TCEQ, 2023). Towboat and tugboat emissions have greater uncertainty than other CMV categories due to the lack of information on engines and the uncertainties of engine loads and operating parameters. This project aims to improve our understanding of commercial marine exhaust emissions, focusing on NO_x, volatile organic compounds (VOC), PM_{2.5}, and hydrocarbon speciation. The emphasis on smaller vessels will improve our ability to intercept their exhaust plumes.

Employing the instrumented UH research boat, our approach involves sampling emission plumes from vessels downwind of busy shipping lanes in Galveston Bay. Plumes will be identified by elevated levels of carbon dioxide (CO₂), NO_x, and other compounds. The research team expects to sample plumes from hundreds of towboats to meaningfully constrain the emission inventory. Leveraging real-time Automatic Identification System (AIS) transponder data, which reports vessel identification, position, speed, and draft, enhances our ability to connect measured plumes to individual vessels and ascertain engine information.

Emissions rates, derived from the field measurement data, will be compared with EPA expected values for each of the sampled and identified vessel engines. Multiple encounters with the same vessel over the sampling period will provide insights into emission variability. The analysis results have the potential to enhance the accuracy of the commercial marine emission inventory and

speciated VOC reactivity. Such improvement can be integrated into various modeling frameworks, including those utilized for SIP modeling that support air quality planning efforts.

Project updates:

March 2025:

- Conducted sampling missions for 12 days.
- Measured discreet plumes from 198 boats, including push boats and oceangoing vessels.
- Sampled four Volatile Organic Compounds (VOC) canisters.
- Performed multipoint calibrations.

April 2025:

- Conducted sampling on April 1, 9, 10, and 11 and logged ~150 discrete plumes across these four days. The total number of uniquely identified pushboat plumes for the project was ~390.
- Conducted final calibrations.
- Removed the heaviest equipment (FluxSense instruments, Aroma-VOC, and the Teledyne T640 and enclosure) from the boat on April 16 using the crane at the Seabrook Ship Yard. (see images below).
- Made plans to remove the boat on May 1st and deliver it back to the University of Houston (UH) campus.

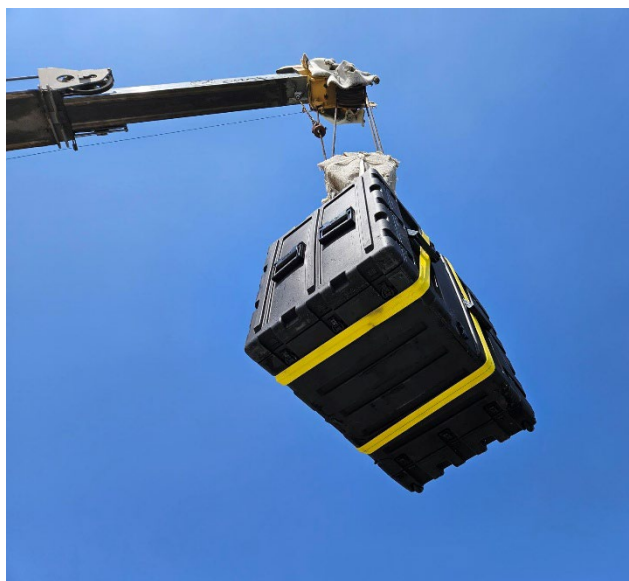


Figure 24-003-1. Unloading equipment from the boat on April 16, 2025.



Figure 24-003-2. Unloading equipment from the boat on April 16, 2025.



Figure 24-003-3. Unloading the FluxSense instrument from the boat on April 16, 2025.

May 2025:

- Removed the University of Houston's (UH) research boat from the water on May 1st, 2025, and delivered it back to the university's campus.
- University of Houston, FluxSense, and Ramboll held a meeting to discuss the data collected and determine plans for analysis.
- Worked on extracting precise plume times for easier identification and cross-referencing with ship identification logs.
- The University of Houston's team quality assured/quality checked (QA/QC) on the raw trace gas and meteorological data collected during the intensive campaign.
- Used public data sources to identify the engine characteristics for nearly all vessels whose plumes were measured.
- Final trace gas and meteorological data was delivered to the field team on May 28th, 2025 for them to begin analysis tasks.

Preliminary analysis:

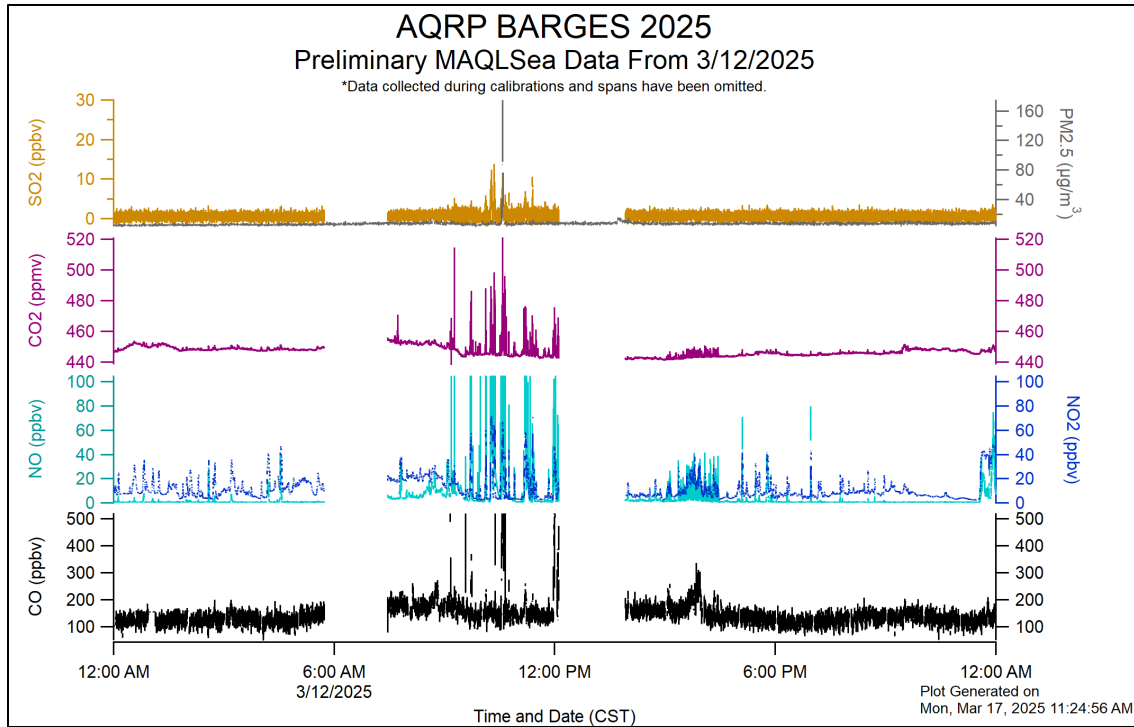


Figure 24-003-4. Preliminary gas and aerosol data collected on 3/12/2025 on board the UH research boat.

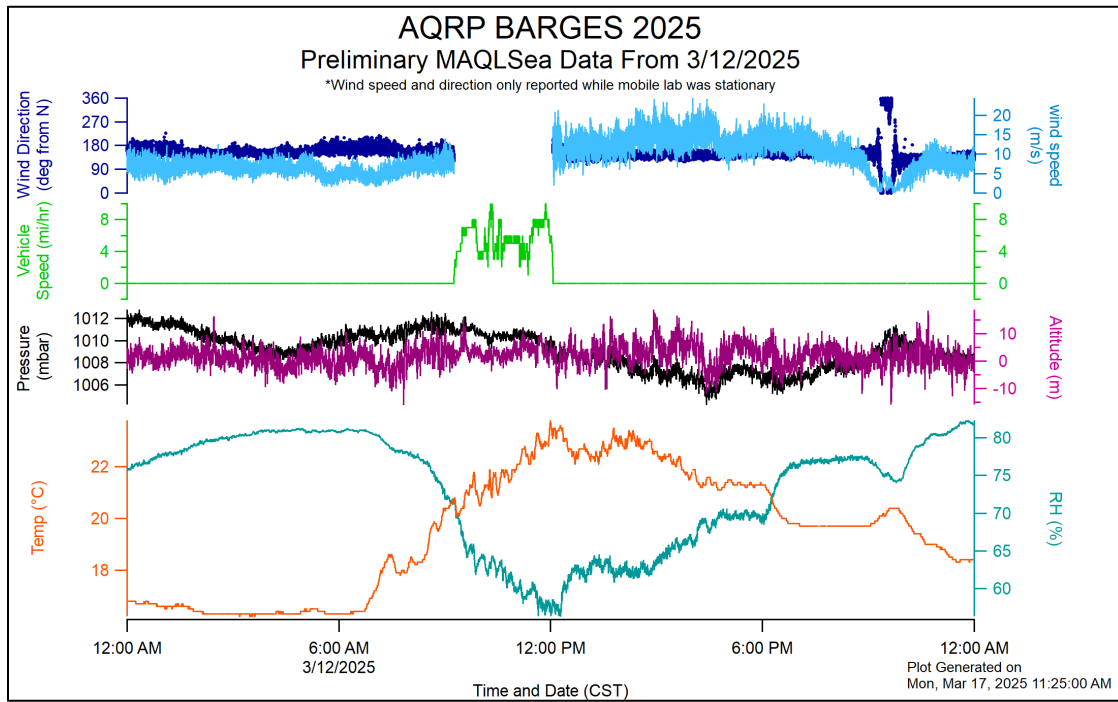


Figure 24-003-5. Preliminary meteorological data collected on 3/12/2025 on board the UH research boat.

- Preliminary calculations by Ramboll using nominally corrected Level 0 data indicate that most plumes sampled are relatively close to Environmental Protection Agency ratios; however, some are notably different.
- Ramboll conducted a preliminary analysis of a sample of the Nitrogen Oxides (NO_x) and Carbon Dioxide (CO₂) plume concentrations to identify uncertainties in the measurements.
- Used a technique employed by other remote sensing researchers to compare the relative NO_x vs. CO₂ concentrations by using linear slope regression.
- Found the resulting NO_x emissions relative to the fuel consumed were mostly within the range of expected values for the few vessels analyzed.

Data collected: Field data collected.

Problems/issues encountered and proposed solutions:

- Original anchor windlass (winch; ~2001 build date) broke plastic guide to keep line from fouling roller – immediate solution was to sample plumes by trailing vessels since we could not maintain a stationary position; long-term solution was to replace windlass with new fully stainless-steel windlass.
- Recommendation by marine mechanics was to tie off the anchor line to the bow cleat to relieve stress on the new windlass. This resulted in an unexpected pull angle on the line at the bow roller, which caused the line to chafe on a metal edge, ultimately causing the line to fail and a loss of the anchor – Solution was to return to the marina immediately, and the marine mechanics were contacted en route to the marina. They came out and installed a new anchor and anchor line, as well as installing a cleat near the windlass to maintain the desired pull angle and prevent chafing and damaging to the anchor line in the future.
- Occasional overheating issues on FluxSense instruments due to the requirement for blowing ambient cabin air as a method of buffering swings in temperature from the air conditioning cycling on and off. The fan installed was underpowered for the length of ductwork required to reach the instrument enclosure on the rear deck, causing the instrument internal temperature issues as the weather warmed up. – The solution was to adapt a continuous duty marine bilge blower, which significantly increased air flow to the FluxSense instruments.
- Nitric Oxide instrument's Photo Multiplier Tube (PMT) cooler failed and was replaced.
- MeFTIR and MeDOAS mirrors were adjusted to optimize the signal (photon counts).
- The nitrogen dioxide (NO₂) analyzer has been applying more internal smoothing to the data than is desired, and changing settings per Teledyne technical support does not appear to address the issues. Will discuss the impacts to data with Ramboll.
- Relative concentrations of NO_x and CO₂ were not precisely time-aligned, so time alignments will be used to minimize regression errors.
- It was not readily apparent whether Carbon Monoxide (CO), Particulate Matter (PM), or Sulfur Dioxide (SO₂) plume concentrations were distinct relative to background

concentrations. The same regression techniques will be applied to these emission concentrations.

Goals and anticipated issues for succeeding reporting period:

- Complete sampling of boats and begin data processing.
- Receive full funding from the University of Houston Division of Research for this project.
- Remove the boat from the water and have it delivered back to the UH campus.
- Have a meeting with FluxSense and Ramboll to discuss the data collected and determine plans for analysis.
- Extract precise plume times for easier identification and cross-referencing with ship identification logs.
- Finalize data and share with project partners.
- Write a program to analyze all plumes to allow precise plume time alignments.
- Tabulate the results relative to the expected emissions values with regression uncertainties.

Detailed analysis of the progress of the project to date: To be reported in subsequent reports.

Project 24-004 (Ramboll)

Title: Evaluating Updates to CAMx and NO _x Emission Inventories Using TEMPO Measurements over Texas	Status: ACTIVE 08/12/2024 – 08/31/2025 Funded Amount: \$229,691 AQRP Project Manager: Elena McDonald-Buller
PI: Jeremiah Johnson (Ramboll)	TCEQ Project Liaison: Robert Kierstead

Abstract: Nitrogen oxide (NO_x) emissions are critical to ozone formation in Texas and consequently accurate NO_x emission inventories are essential to air quality planning using the Comprehensive Air Quality Model with Extensions (CAMx). Previous work by our team showed that highly resolved (sub 1 km) NO₂ column measurements by the National Aeronautics and Space Administration (NASA) Geostationary Coastal and Air Pollution Events (GEO-CAPE) Airborne Simulator (GCAS) aircraft can constrain the CAMx NO_x emission inventory for Houston with source-category specificity. In this project, research team will evaluate whether NO₂ column measurements by the new NASA Tropospheric Emissions: Monitoring of Pollution (TEMPO) satellite can constrain CAMx NO_x emission inventories as successfully as the GCAS aircraft. At the same time, research team will investigate how improving the CAMx NO_x chemistry (i.e., particle nitrate photolysis), NO₂ vertical distribution and soil NO_x emission inventory influence CAMx agreement with measured NO₂ columns. This project will determine how the new Tropospheric Emissions: Monitoring of Pollution (TEMPO) satellite can be used for NO_x emission inventory evaluation. Lessons learned and techniques developed for this project could be applied to other areas in the United States.

Project updates:

March 2025:

Task 1: Texas 4 km CAMx baseline simulation for NO₂ and Ozone: Completed development of aircraft cruise emissions. Completed configuration and completed initial basecase 3-D CAMx source apportionment run. Performed QA procedures and delivered model outputs, sector-specific NO_x emissions, and WRF meteorology to other project participants. Started NO₂ and ozone basecase model performance evaluation at surface monitors.

Task 2: Create TEMPO NO₂ Diurnal Profiles and Compare to Diurnal NO_x Emission Maps:

Continued processing TEMPO NO₂ columns in preparation for comparison to NO_x emission maps under Task 2 and CAMx NO₂ columns under Task 3. Compared TEMPO NO₂ columns with CEM NO_x emissions for select large power plants in Texas.

Task 4: CAMx Updates and Testing: Began implementing nitrate photolysis updates in CAMx.

Task 6: Project Management and Reporting: Submitted Monthly Technical Report for February 2025.

April 2025:

Task 1: Texas 4 km CAMx baseline simulation for NO₂ and Ozone: Completed NO₂ and ozone basecase model performance evaluation at surface monitors.

Task 2: Create TEMPO NO₂ Diurnal Profiles and Compare to Diurnal NO_x Emission Maps: Continued processing TEMPO NO₂ columns and completed processing of CAMx diurnal NO_x emissions.

Task 4: CAMx Updates and Testing: Continued implementing nitrate photolysis updates in CAMx.

Task 6: Project Management and Reporting: Submitted Monthly Technical Report for March 2025.

May 2025:

Task 1: Texas 4-km Comprehensive Air Quality Model with Extensions (CAMx) baseline simulation for Nitrogen Dioxide (NO₂) and Ozone: Completed NO₂ and ozone basecase model performance evaluation at surface monitors.

Task 2: Create TEMPO NO₂ Diurnal Profiles and Compare to Diurnal Nitrogen Oxides (NO_x) Emission Maps: Compared Tropospheric Emissions: Monitoring of Pollution (TEMPO) NO₂ columns against CAMx diurnal NO_x emissions for basecase simulation.

Task 3: Comparison of NO₂ Columns between CAMx and TEMPO: Compared CAMx NO₂ columns by emissions sector for basecase simulation against both TROPOspheric Monitoring Instrument (TROPOMI) and TEMPO NO₂ columns and prepared spatial maps.

Task 4: CAMx Updates and Testing: Conducted literature review and implementation of nitrate photolysis updates in CAMx. Conducted literature review, held internal discussions, and made updates to Model of Emissions of Gases and Aerosols from Nature (MEGAN) soil NO_x parameterization. Performed CAMx sensitivity simulations exploring MEGAN soil NO_x updates and alternative boundary conditions. Started model performance evaluation at NO₂ and ozone surface monitors for these sensitivity simulations.

Task 5: Estimating NO_x Emissions by Sector and by Time of Day Using CAMx Source Apportionment and TEMPO Retrievals: Began using Multi-Linear Regression (MLR) technique to estimate NO_x emissions by sector and time of day using CAMx NO₂ source apportionment results and TROPOMI and TEMPO satellite retrievals.

Task 6: Project Management and Reporting: Submitted Monthly Technical Report for April 2025.

Preliminary analysis: Comparison of the CAMx basecase against satellite NO₂ columns reveals a high bias in rural areas. Additionally, we found the basecase simulation has a high ozone bias across most of the East Texas CAMx 4 km domain. We therefore investigated MEGAN soil

Nitrogen Oxide (NO) and Nitrous Acid (HONO) emissions and made updates based on literature review. Using these new, lower soil NO_x emissions, we performed a CAMx sensitivity simulation for a short period that showed improved performance for surface NO₂ and ozone. Our final report will document our biogenic emissions updates and comparison of both simulations against TEMPO and TROPOMI NO₂ columns.

Data collected: None to report.

Problems/issues encountered and proposed solutions:

Goals and anticipated issues for succeeding reporting period: Configure final CAMx simulation informed by comparison to TEMPO satellite measurements and evaluation at surface monitoring stations. Compare NO₂ columns with final CAMx simulation under Task 3. Apply MLR technique to new CAMx source apportionment results to estimate NO_x emissions by sector and time of day under Task 5.

Detailed analysis of the progress of the project to date: None to report.

Project 24-007 (University of Houston)

Title: Texarkana Intensive Campaign	Status: ACTIVE 08/12/2024 – 08/31/2025
PI: James Flynn (University of Houston)	Funded Amount: \$309,703
Co-PI: Sascha Usenko (Baylor University)	AQRP Project Manager: Vincent Torres
Co-PI: Edward Fortner (Aerodyne Research Inc.)	TCEQ Project Liaison: Chola Regmi

Abstract: The Texarkana Texas (TX)-Arkansas (AR) metropolitan area has recently become an area of concern due to elevated fine Particulate Matter (PM_{2.5}) aerosol loadings. The area is forested and contains a few large paper mills which are one potential source of the PM. These paper mills are located in Texas, Arkansas, and Louisiana. There are other possible industrial sources of PM_{2.5} and it is possible that the PM_{2.5} is being advected into the area from sources well outside of the area. The upcoming changes to regulatorily acceptable PM_{2.5} levels necessitate a better understanding of the cause of these enhanced PM_{2.5} levels in the Texarkana area. A comprehensive study of the particle and gas phase chemical species associated with these PM_{2.5} exceedance episodes will assist in interpreting the source of these air masses.

A three-week field deployment in Texarkana, TX during the February-March 2025 time period to examine the sources of high PM_{2.5} loadings in the Texarkana area will be conducted. This study obtained information regarding the chemical species present in these high-loading events in both particle and gas phase. This information will better inform policymakers with respect to the health hazards associated with these higher aerosol loading events.

Objectives for this study include:

1. Characterize selected PM_{2.5} and Volatile Organic Compound (VOC) point sources in the Texarkana area.
2. Evaluate background PM_{2.5} conditions in the vicinity, including upwind of the Texarkana TX-AR metropolitan area. Given the location of the metropolitan area this will likely involve measuring areas outside of the state of Texas but would not emphasize detailed emission factors for out-of-state sources.
3. Any highly local effects which might be present and impacting the measurement of PM_{2.5} at the Texarkana New Boston Station (C1031) will be examined.

The University of Houston, Baylor University, and Aerodyne are nationally recognized for their experience in development and deployment of mobile air quality labs. These customizable, comprehensive, and dynamic platforms provide on-the-go monitoring and analysis of aerosol, VOCs, trace gas, boundary layer height, and meteorological parameters. Texarkana's air quality is impacted by local sources, photochemical processing, and transport from multiple regions. This complexity can be overcome with the deployment of mobile air quality laboratories which have

several advantages in study areas such as Texarkana. These advantages include real-time monitoring, flexibility in sampling location and time, response to plumes or events (e.g., potential aerosol or precursor plumes), source characterization (e.g., upwind vs downwind), repeat measurements, and accessibility in complex environments.

Project updates:

March 2025:

- Completed field measurements on March 2, 2025, and departed Texarkana.
- The Mobile Air Quality Lab (MAQL3) went to Waco to unload Baylor University's (BU) equipment and returned to the University of Houston (UH) on 3/3.
- Began data processing and finalization.
- Aerodyne generated a time series of the gas phase which is currently under QA in concert with analyzing truck notes to better determine appropriate points of emphasis during analysis.

April 2025:

- The University of Houston (UH) data processing was finalized.
- Full budgets were set up by the UH Department of Research.
- Aerodyne completed GPS and wind vector time series plots for their smaller mobile lab (minAML).
- Aerodyne began processing and quality assuring the gas phase of the chemical ionization mass spectrometer (Vocus CI-TOF) data for the entire campaign.

May 2025:

- Shared data with the field team, and discussions were held to plan analysis and reporting.
- Vocus CI-ToF data for the entire campaign has been processed, and time traces for all ions of interest have been developed. Quality assurance was performed to remove calibration, filter, or otherwise non-sample gas chromatograph (GC) data. GC Vocus data still needs to be completely processed, including quality assurance.
- Raw trace gas and meteorological data collected during the intensive campaign was quality assured/quality checked (QA\QC) by the University of Houston team.

Preliminary analysis:

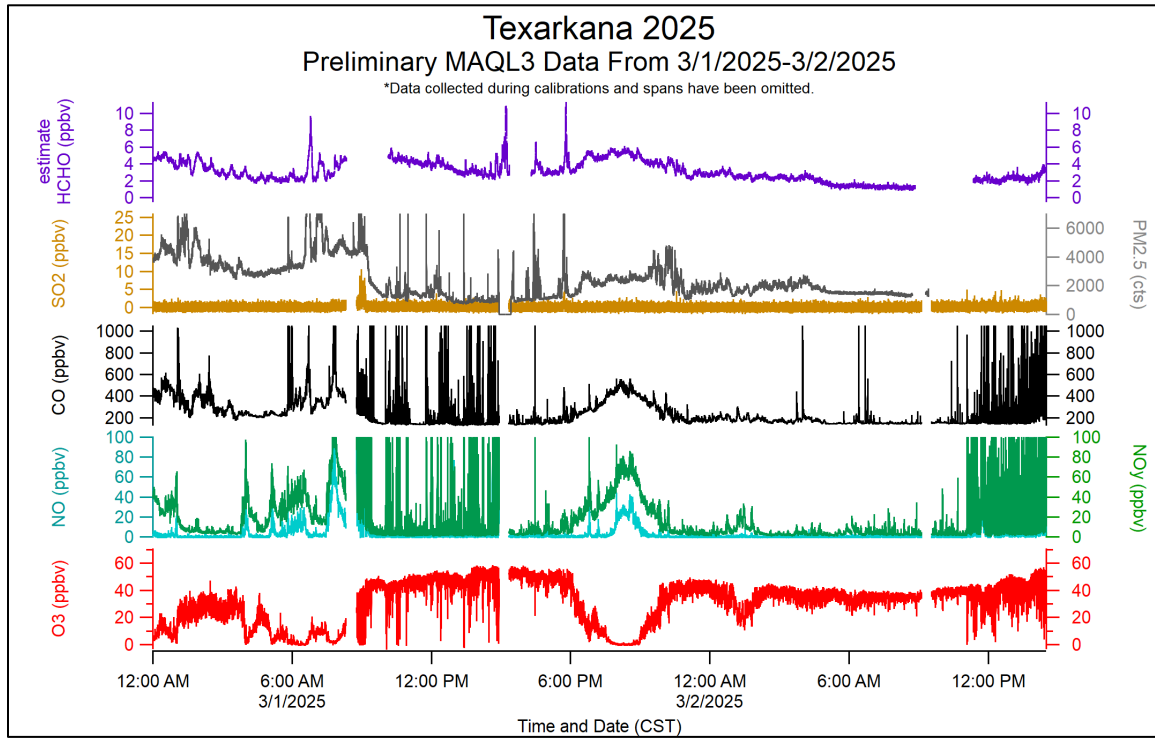


Figure 24-007-4. Preliminary gas and aerosol data collected on 3/1/2025 by MAQL3.

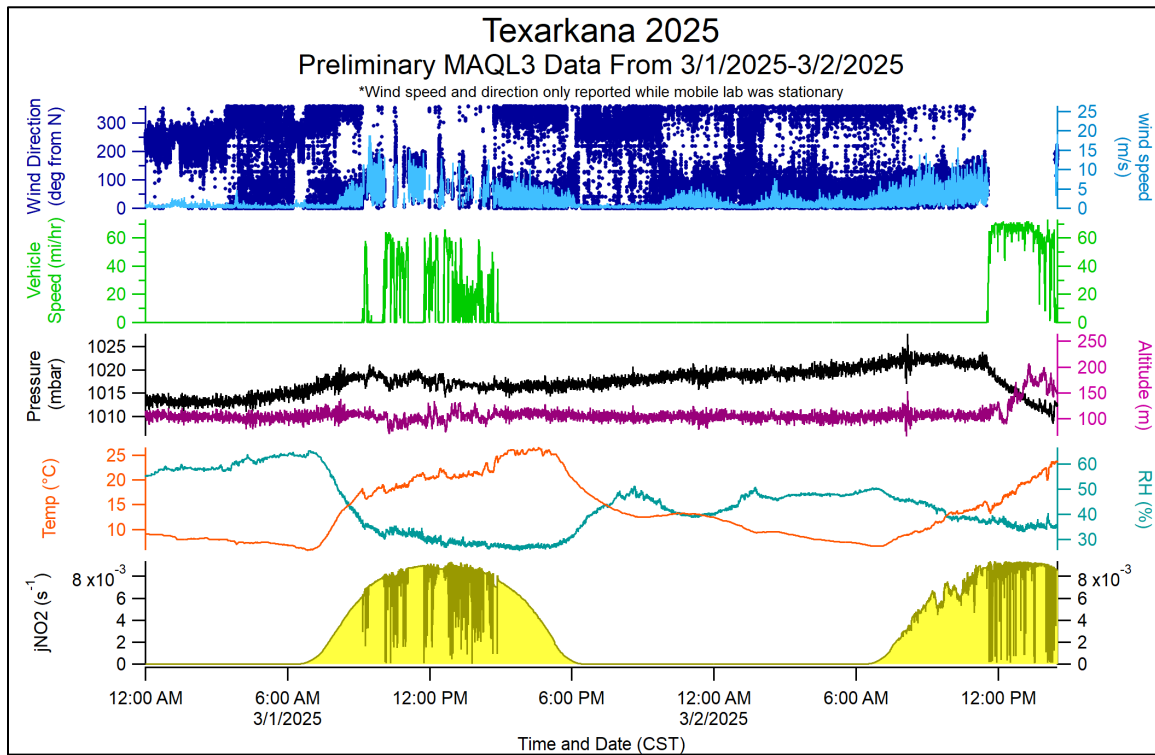


Figure 24-007-5. Preliminary meteorological data collected on 3/1/2025 by MAQL3.

Below are exemplary data from mobile and stationary overnight measurements made on February 12 and 13 by the Aerodyne minivan atmospheric mobile laboratory (minAML) that was outfitted with a Vocus proton transfer reaction time of flight mass spectrometer (PTR-TOFMS) with thermal desorption pre-concentration gas chromatography (TDPC-GC) instrument package for evaluating VOC species from emission sources and in ambient air.

On February 12, the minAML made several passes of the Graphics Packaging International (GPI) facility located near Domino, TX, south-southwest of Texarkana, TX. The Vocus PTR-TOFMS operated in direct mode, with atmospheric sample sent directly to the Vocus inlet, bypassing the GC preconcentration and separation. Spectra of ambient air upwind and downwind of the GPI facility was collected, shown in Figure 3. Note that the spectra shown are scaled with some ion signals off-scale (e.g. $m/z = 59$, typically acetone) to allow for visualization of significant differences in signal across the mass spectra. Four unit-masses (63, 81, 93, 137) with large enhancement relative to background air are highlighted. Using the high mass-resolving power of the Vocus instrument, the protonated ions associated with each of these unit mass peaks, shown in Figure 24-007-4, can be identified.

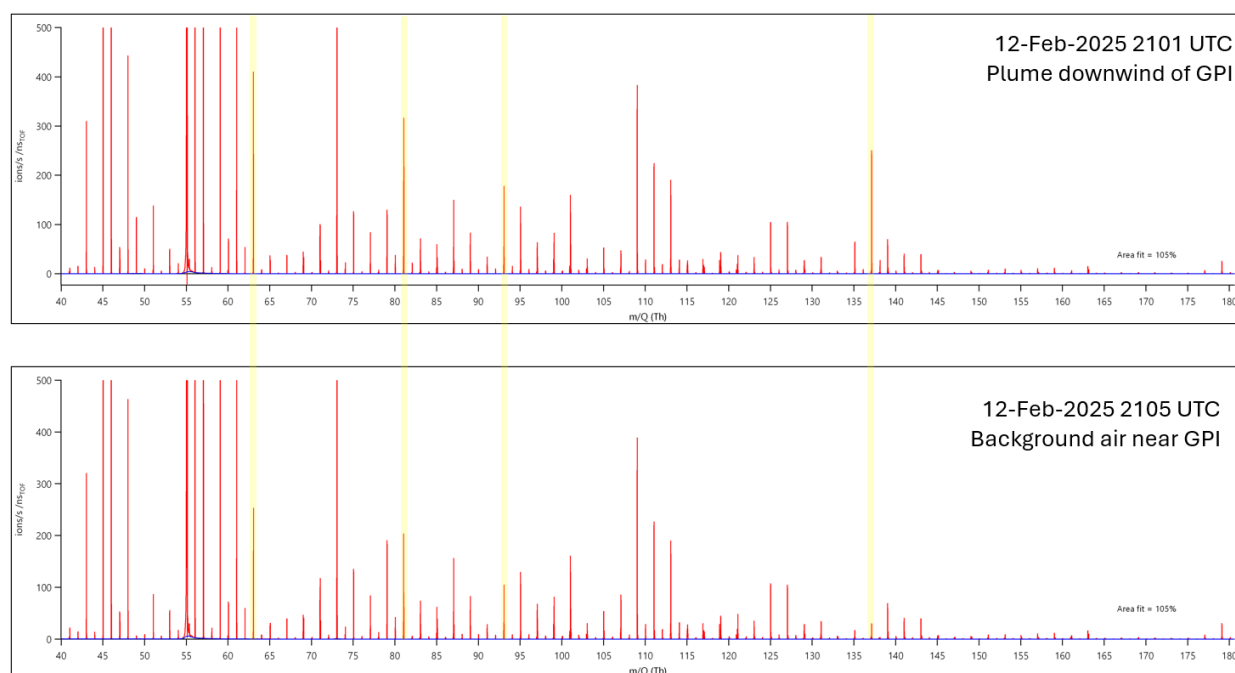


Figure 24-007-6. Vocus measurements are depicted upwind and downwind of the GPI facility.

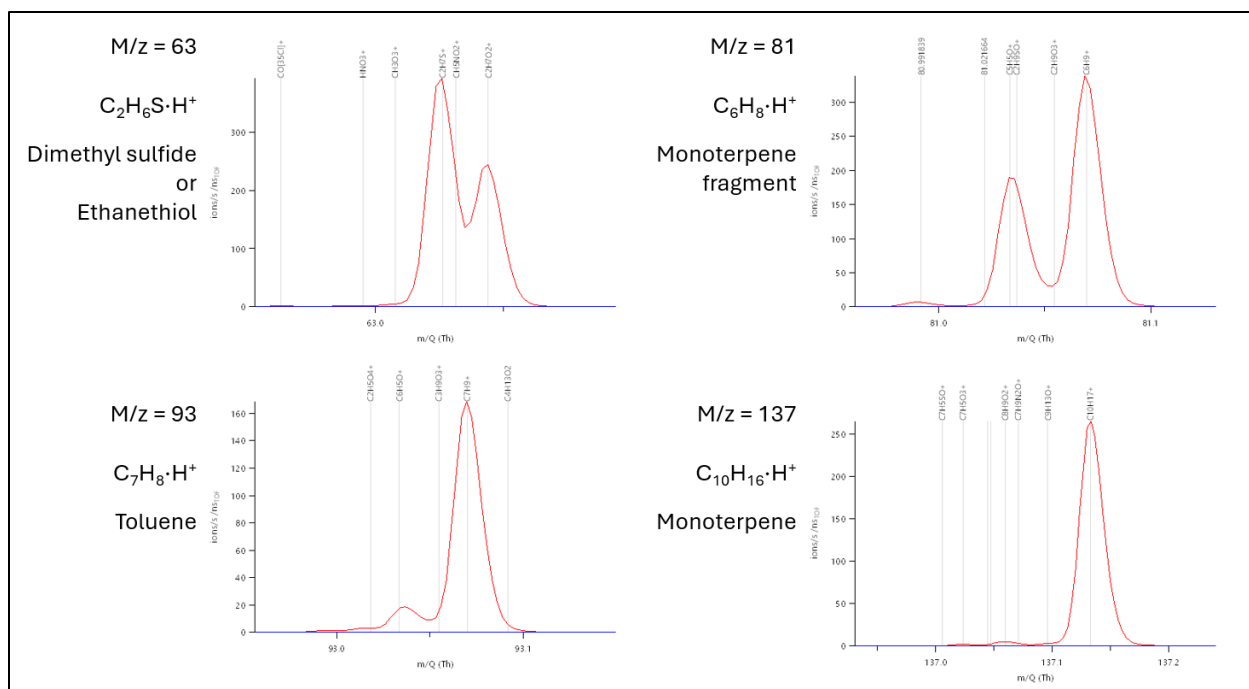


Figure 24-007-7. High resolution peak fitting of the masses of focus.

Table 24-007-1. The primary ion formulas and likely source molecules are depicted for the masses of focus.

Unit Mass	Ion formula plus proton)	Likely source molecule
63	$C_2H_6S \cdot H^+$	Dimethyl sulfide/ethanethiol
81	$C_6H_8 \cdot H^+$	Monoterpene fragment
93	$C_7H_8 \cdot H^+$	Toluene
137	$C_{10}H_{16} \cdot H^+$	Monoterpene

On February 13, the minAML made several passes of the Domtar Ashdown (Domtar) paper mill near Ashdown, AR, north-northwest of Texarkana. Included in this drive, the minAML parked downwind of Domtar and collected a GC sample while the Vocus indicated an elevated monoterpene signal ($m/z = 137$ & 81), associated with paper mill emissions [Strömvall and Petersson, 1991]. Using the GC for pre-separation, we can speciate the monoterpenes in this sample, indicating a mixture of at least 6 different isomers (Figure 24-007-5). After completing the measurement drive for the day, the minAML was parked at the Texarkana RV Resort park, southwest of Texarkana, with instruments operating overnight. That evening, the site experienced wind from the north and monoterpene signals elevated above the background. A GC sample collected overnight shows that the enhanced monoterpene signal has a strikingly similar mixture of monoterpene species to Domtar, while roughly 50x lower in signal strength. This could indicate that VOC emissions from Domtar were transported to the RV park roughly 15 miles downwind.

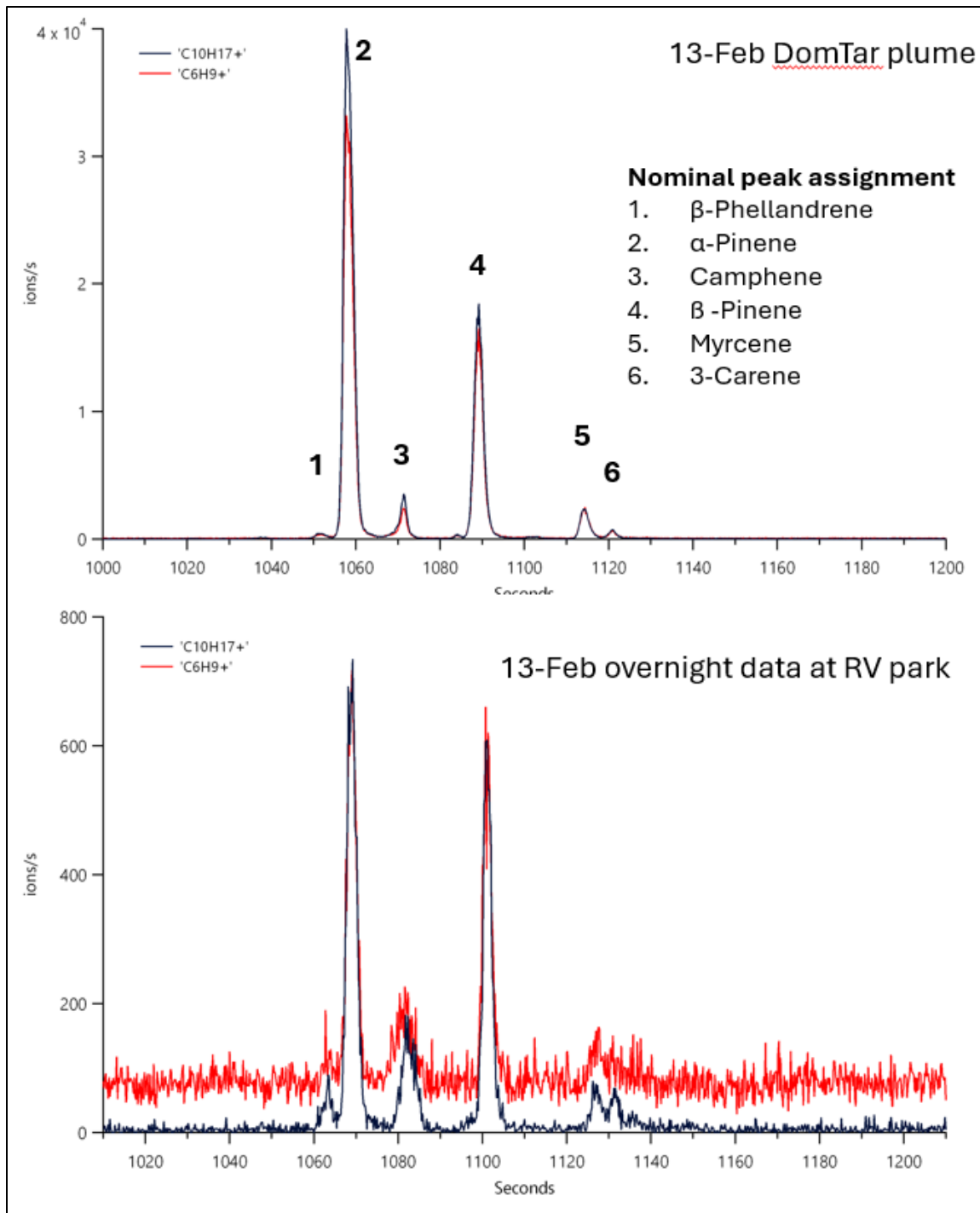


Figure 24-007-8 Monoterpene speciation is depicted both immediately downwind of Domtar and at the RV park base site.

Data collected: Raw data has been collected and will be processed into final data. Final trace gas and meteorological data was delivered to the field team on May 28, 2025, to begin analysis tasks.

Problems/issues encountered and proposed solutions: None.

Goals and anticipated issues for succeeding reporting period:

- Collaborate with the full project team for data analysis.
- Identify case days for more detailed analysis.
- Begin writing the Draft Final report.

Detailed analysis of the progress of the project to date: None to report.

References:

Strömvall and Petersson, 1991, [https://doi.org/10.1016/0269-7491\(93\)90092-3](https://doi.org/10.1016/0269-7491(93)90092-3)

Project 24-021 (University of Houston)

Title: Improving WRF representation of coastal, marine, and residual boundary layers and quantifying the effects on ozone prediction

Status: ACTIVE
08/12/2024 – 08/31/2025
Funded Amount: \$186,978

PI: Yuxuan Wang

AQRP Project Manager:
Elena McDonald-Buller
TCEQ Project Liaison: Gabriel Lee

Abstract: This AQRP project continues our efforts of modeling the 2021-2023 offshore field campaign data in the Houston-Galveston-Brazoria (HGB) area, with a focus on the evaluation and improvement of the meteorological model representation of coastal, marine, and residual boundary layers. The models to be investigated are the Weather Research and Forecasting (WRF) and Comprehensive Air Quality Model with Extensions (CAMx), the state’s regulatory photochemical model. The field campaigns include the Tracking Aerosol Convection Experiment-Air Quality (TRACER-AQ) studies during July – October 2021 (TAQ1) and April – October 2022 (TAQ2) and the 2023 Mobile and Offshore Air Quality Monitoring Project during May-Oct 2023. They collected unprecedentedly rich observations of meteorological factors and atmospheric composition including planetary boundary layer (PBL) and ozone (O₃) over diverse offshore locations, such as the Houston Ship Channel, Galveston Bay, and the Gulf of Mexico. Utilizing these observations to evaluate and improve models, the project will focus on the following primary science questions:

How well does mesoscale meteorological and photochemical grid modeling replicate coastal/maritime boundary layers observations from the 2021-2023 offshore observations?

How sensitive is WRF prediction of coastal/maritime boundary layers to model parameters? To what extent do the 2021-2023 offshore observations constrain those parameters?

How will the simulation of residual layer ozone be improved by explicitly parameterizing the entrainment of free tropospheric ozone into the residual layer?

What are the effects of improved PBL and residual layer (RL) simulation on offshore ozone prediction and source attribution in CAMx?

Perturbed physics ensembles (PPEs) will be conducted to the WRF model to explore parameter uncertainties and identify parameter combinations that yield simulations most consistent with observations. As boundary layer dynamics are crucial for the diffusion, accumulation, and deposition of ozone and its precursors, the project will improve our predictability of ozone in the HGB and better understand the sources of high offshore O₃ that may relate to ozone exceedances.

The project specifically targets the AQRP Priority Research Priorities FY2024-2025: Photochemical air quality models concerning model improvements to WRF PBL schemes, and TRACER-AQ and over-water measurements concerning additional analyses of those campaign data.

Project updates:

March 2025:

Task 4: Submitted Task 4 Report on March 17, identified additional perturbation schemes, and performed simulations and conducted analysis for additional schemes.

Task 5: Calculated the residual layer height and working on Task 5 report.

April 2025:

Task 5: Submitted Task 5 Report on April 15.

Task 6: Prepared the Domain for CAMx.

May 2025:

Task 6: Completed re-gridding of emission files for the Comprehensive Air Quality Model with Extensions (CAMx) domain 3. Selected the representative days for the initial CAMx test run and completed the base run for these days. Worked on running CAMx using the meteorology from the improved Weather Research and Forecasting model (WRF) model. Worked on the Task 6 report.

Preliminary analysis:

In March, we conducted additional sensitivity simulations to test and identify the best-performing schemes and their possible combinations to improve planetary boundary layer height (PBLH) over the Bay and the Gulf. We activated a 1-D ocean mixed-layer model in the WRF. This scheme is expected to improve the PBLH over water by improving the simulation of the diurnal variation of sea surface temperature (SST) and the exchange of heat and moisture between the upper ocean and the atmosphere. Further, the 1-D ocean mixed layer model is combined with one of our previously selected best schemes (PBLH12) to see their combined effects on PBLH. A summary of additional simulations is shown in Table 24-021-1.

Simulation ID	Perturbations
PBL_base	None
PBLH12	New Simplified Arakawa-Schubert (NSAS) cumulus scheme
PBLH22	1-D ocean mixed layer model
PBLH23	PBLH12 + PBLH22

Table 24-021-1 Summary of WRF simulation cases and adopted schemes.

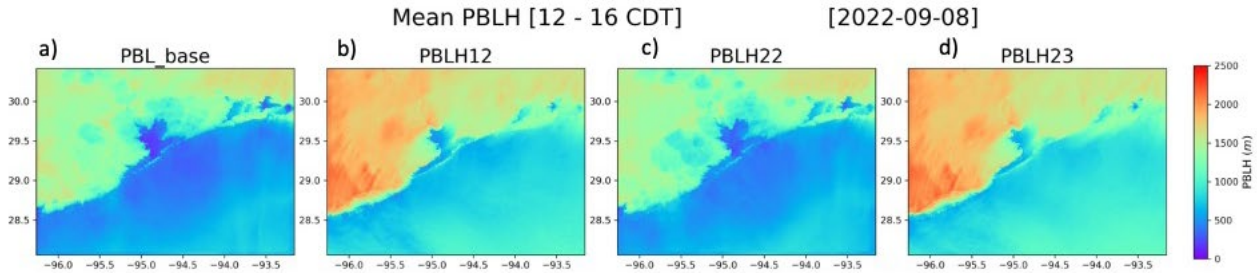


Figure 24-021-9 Spatial distribution of the afternoon (12:00 -16:00 CDT) mean PBLH from a) PBL_base, b) PBLH12, c) PBLH22, and d) PBLH23 runs over the study area for Sept. 08, 2022.

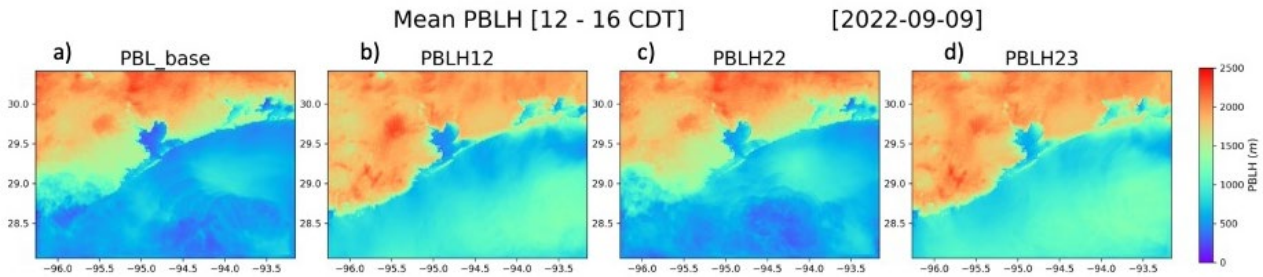


Figure 24-021-10 Spatial distribution of the afternoon (12:00 -16:00 CDT) mean PBLH from a) PBL_base, b) PBLH12, c) PBLH22, and d) PBLH23 runs over the study area for Sept. 09, 2022.

A. Residual Layer:

We calculated the residual layer (RL) height using the potential temperature gradient, which is thermodynamically defined as the rate of change in potential temperature (θ) with height (z). The RL top was identified as the height where the sharpest increase in the potential temperature gradient occurred, typically above $3\text{ }^{\circ}\text{C}/\text{km}$, marking the transition from the weakly stratified residual layer to the capping inversion. We then compared the calculated RL height with ceilometer-observed PBL heights at La Porte. Figure 24-021-3 compares the observed PBLH, the model-predicted PBLH, and the thermodynamically diagnosed RL height for Sept. 24, 2021, across four model configurations: PBL_base, PBLH5, PBLH12, and PBLH14. In each panel, the background shading shows the modeled vertical gradient of potential temperature ($\partial\theta/\partial z$), which helps identify key atmospheric layers. On this day, the ceilometer data clearly shows the presence of a nocturnal residual layer, which is not captured by the base model, as it only simulates a shallow stable boundary layer at night. However, the perturbed simulations (PBLH5, PBLH12, and PBLH14) show a better agreement with the observed residual layer.

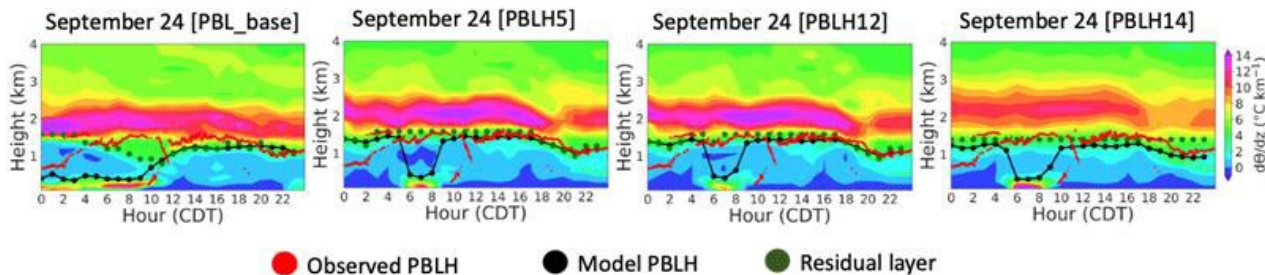


Figure 24-021-11 Observed and modeled planetary boundary layer height (PBLH), along with the calculated residual layer heights for Sept. 24, 2021, at La Porte. The panels show results from four model configurations: PBL_base, PBLH5, PBLH12, and PBLH14. The background shading represents the modeled vertical gradient of potential temperature ($\partial\theta/\partial z$). Red dots indicate ceilometer-observed PBLH, black lines show model-predicted PBLH, and green markers represent the diagnosed residual layer top based on potential temperature gradient analysis.

Detailed analysis of the residual layer will be described in the Task 5 Report, which was due April 15, 2025.

In April, we set up three nested domains for the Comprehensive Air Quality Model with extensions (CAMx) that cover the contiguous United States, Southeast Texas, and the Houston-Galveston-Brazoria (HGB) area, as shown in Figure 24-021-4a. The domains are aligned with the Weather Research and Forecasting (WRF) domains but have smaller spatial coverage. The horizontal resolution of the outermost domain (d01), the inner domain (d02), and the innermost domain (d03) is $12 \text{ km} \times 12 \text{ km}$, $4 \text{ km} \times 4 \text{ km}$, and $1.33 \text{ km} \times 1.33 \text{ km}$, respectively. All the domains have identical vertical resolutions with 30 vertical levels from the surface to $\sim 100 \text{ hPa}$. The number of grid cells in the domains d01, d02, and d03 is 372×222 , 180×150 , and 216×180 , respectively.

We are currently preparing the emission input files for the CAMx simulations. Emissions will be based on the 2019 State Implementation Plan (SIP) modeling platform provided by the Texas Commission on Environmental Quality (TCEQ). For domains d01 and d02, the emissions inventories are spatially cropped to match the respective model domains. For domain d03 (Figure 24-021-4b), emissions are being re-gridded from the 4 km inventory following the approach described in Li et al. (2023).

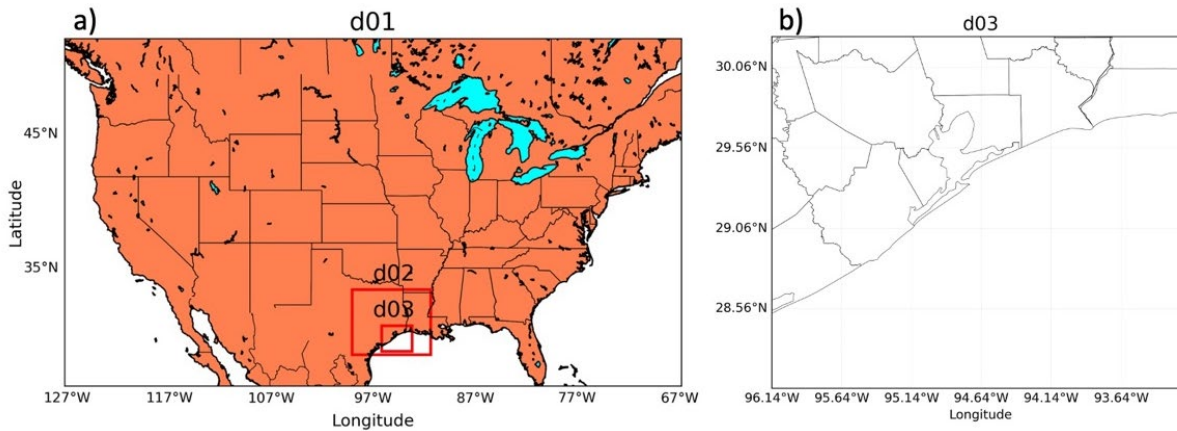


Figure 24-021-4 a) CAMx nested model domains, b) the finest domain covering the HGB region.

In May, we finished preparing the emission input files for the CAMx simulations. The emissions are based on the 2019 State Implementation Plan (SIP) modeling platform provided by the Texas Commission on Environmental Quality (TCEQ). For domains d01 and d02, the emissions inventories were spatially cropped to match the respective model domains. For domain d03, emissions are re-gridded from the 4 km inventory following the approach described in Li et al. (2023).

For the initial CAMx test run, we selected four days: September 8–9, 2021, and September 9–10, 2022, representing both high ozone and clean days. The base CAMx simulations for these periods have been completed. Figure 24-024-5 presents a time series comparison of observed and modeled ozone over Galveston Bay for September 9–10, 2022. The results show that the CAMx base simulation (red line) tends to overestimate ozone compared to observations (black line), particularly during the afternoon hours on September 9. We are currently running CAMx using meteorology from the improved WRF simulation and will compare those results with the base run as well as other periods from the Tracking Aerosol Convection Experiment – Air Quality (TRACER-AQ) campaign periods.

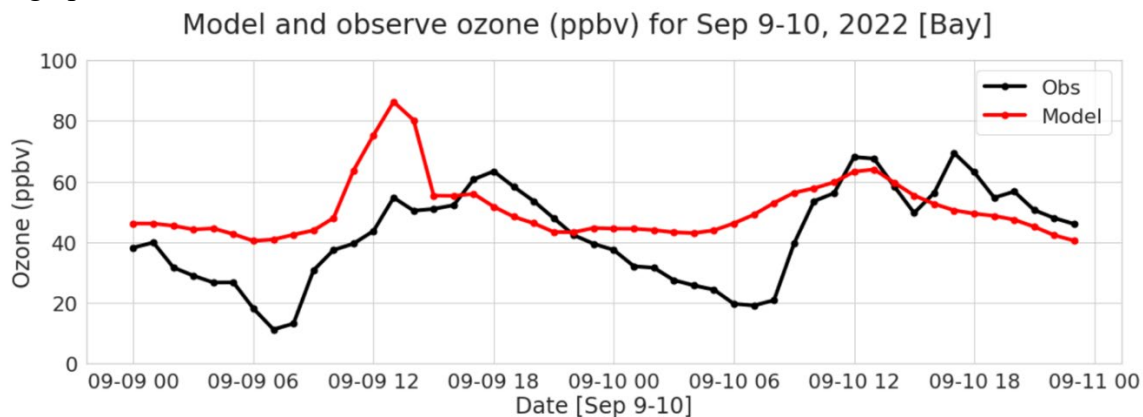


Figure 24-021-5 Time series of CAMx base modeled (red) and observed ozone (ppbv) over Galveston Bay for September 9-10, 2022.

Data collected: None to report.

Problems/issues encountered and proposed solutions: None to report.

Goals and anticipated issues for succeeding reporting period: Continue with Task 6. Run the CAMx model with improved meteorology and the zero-emission case, and work on the Task 6 report.

Detailed analysis of the progress of the project to date: None to Report.

References:

Li, W., Wang, Y., Liu, X., Soleimanian, E., Griggs, T., Flynn, J., and Walter, P.: Understanding offshore high-ozone events during TRACER-AQ 2021 in Houston: Insights from WRF-CAMx photochemical modeling, *Atmos. Chem. Phys.*, 23, 13685–13699, <https://doi.org/10.5194/acp-23-13685-2023>, 2023

Project 24-024 (The University of Texas at Austin)

Title: Novel Observations of Quantified Source Apportionment of Ozone, Particulate Matter and Contributing Precursors in the El Paso Area	Status: ACTIVE 08/12/2024 – 08/31/2025 Funded Amount: \$280,810 AQRP Project Manager: Vincent Torres TCEQ Project Liaison: Celinda Vallejo-Rodriguez
PI: Pawel Misztal (UT Austin)	

Abstract: The United States Environmental Protection Agency recently lowered the annual National Ambient Air Quality Standard (NAAQS) for fine particulate matter or particulate matter small than 2.5 μm in diameter ($\text{PM}_{2.5}$) from 12 to 9 $\mu\text{g m}^{-3}$. This new annual standard brings the El Paso region to near non-attainment for $\text{PM}_{2.5}$, underlining the importance of understanding the composition and sources of $\text{PM}_{2.5}$ and O_3 in El Paso.

An improved understanding of El Paso organic aerosol and ozone is therefore essential and will directly benefit the Texas Commission on Environmental Quality (TCEQ) in guiding how to manage El Paso's air quality.

Project 24-024 will focus on improving our understanding of the contributions of volatile organic compounds (VOC) to formation of secondary organic aerosol (SOA). This work will contribute with spatiotemporal observations of SOA composition and its gas-phase organic precursors, measured by a comprehensive suite of state-of-the-science instrumentation deployed in the University of Texas electric mobile laboratory. Work will include analysis of recently collected data in El Paso, conducting novel comprehensive mobile and stationary measurements in El Paso region, and air quality modeling by the Comprehensive Air-quality Model with extensions (CAMx).

The proposed work is highly relevant to the TCEQ AQRP priority research areas and will contribute to knowledge about the sources contributing to high PM, O_3 and VOC (e.g. toluene) episodes in this region.

Project updates:

March 2025:

Task 2b: The El Paso-Juarez Comprehensive Air Quality Model with Extensions (CAMx) basecase simulation is nearly completed; two months required modifications to the time stamp processing for the transition across the December spin-up period to January 2022. Data post-processing and quality assurance assessments are ongoing for the ten months of the simulation that have been completed.

Explicit simulation of ethylene oxide and toluene will require use of the Reactive Tracer (RTRAC) algorithm within CAMx. Ramboll had developed an RTRAC parameter file for ethylene oxide chemistry and deposition for use by Dr. Yosuke Kimura and Dr. Elena McDonald-Buller under an ongoing project for the U.S. Department of Energy (DOE), which will also be utilized for the El Paso-Juarez simulation. During March, Ramboll provided a similar file for toluene to be used in this AQRP study.

Task 3: Activities in March continued focusing on large data processing including data analysis from the High-Resolution Time of Flight Aerosol Mass Spectrometer (HR-TOF-AMS) and Vocus Proton Transfer Reaction Time of Flight Mass Spectrometer (Vocus-PTRTOFMS). The Vocus dataset has been processed and is now further calibrated and quantified. Volatile Organic Compound (VOC) calibration curves for each day are constructed to yield quantified concentration signals. Figure 24-024-1 shows visual representation of three example markers: benzene, toluene, and methanethiol. The graphs show spatiotemporal distribution of the relative abundances of these compounds. It demonstrates the extent of VOC measurements conducted and points to different locations of sources. For example, enhancements of odorous methanethiol were encountered near San Elizario where benzene and toluene were relatively low. In contrast, toluene and benzene were elevated as measured multiple times along the border. Further analysis of the wind directions and source apportionment will point to the exact sources and their categories.

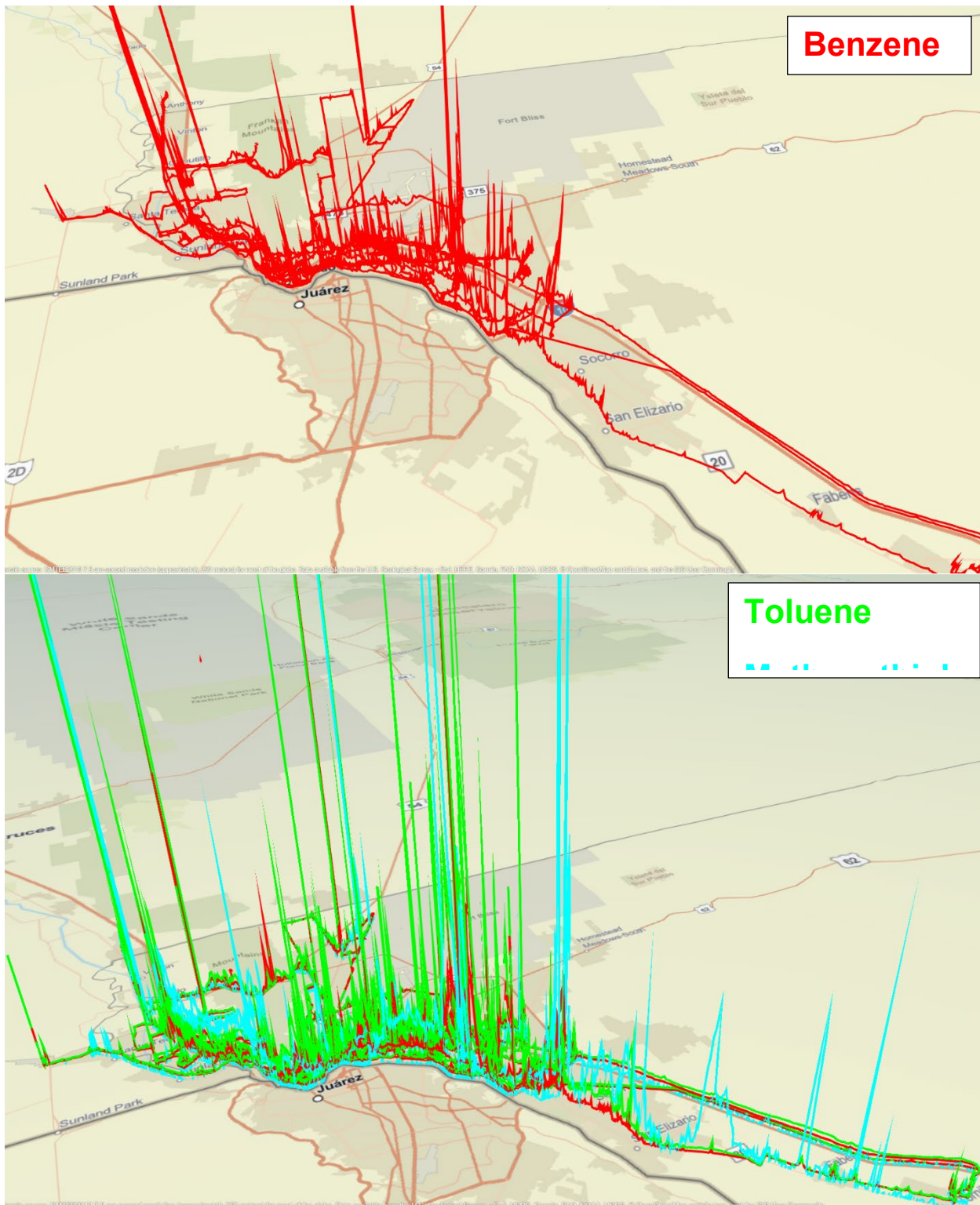


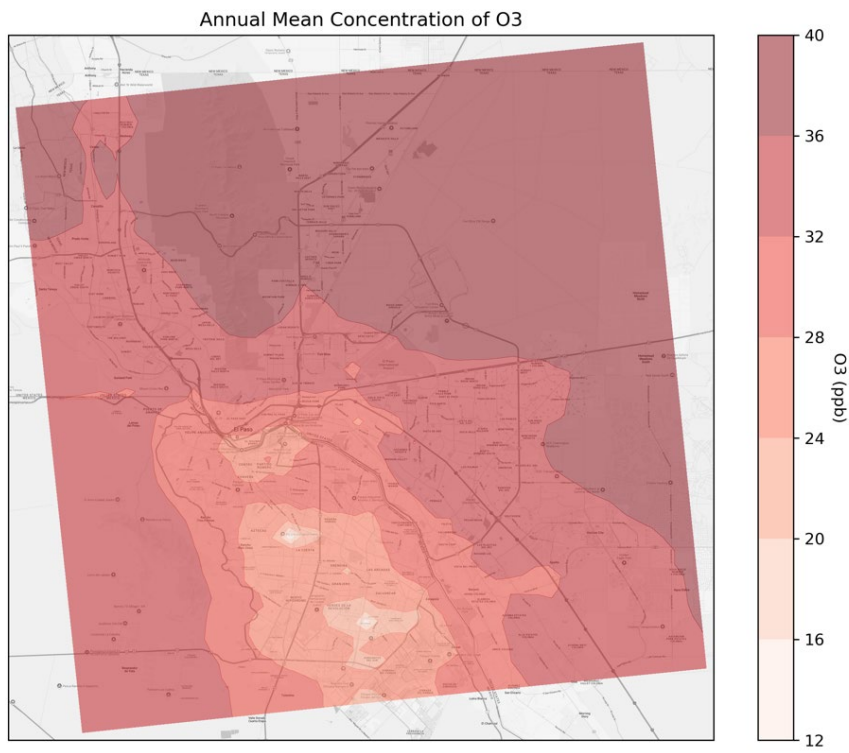
Figure 24-024-1. A 3D representation of select VOC markers measured by the Vocus-PTRTOFMS, with benzene denoted in red, toluene in green, and methanethiol in cyan.

April 2025:

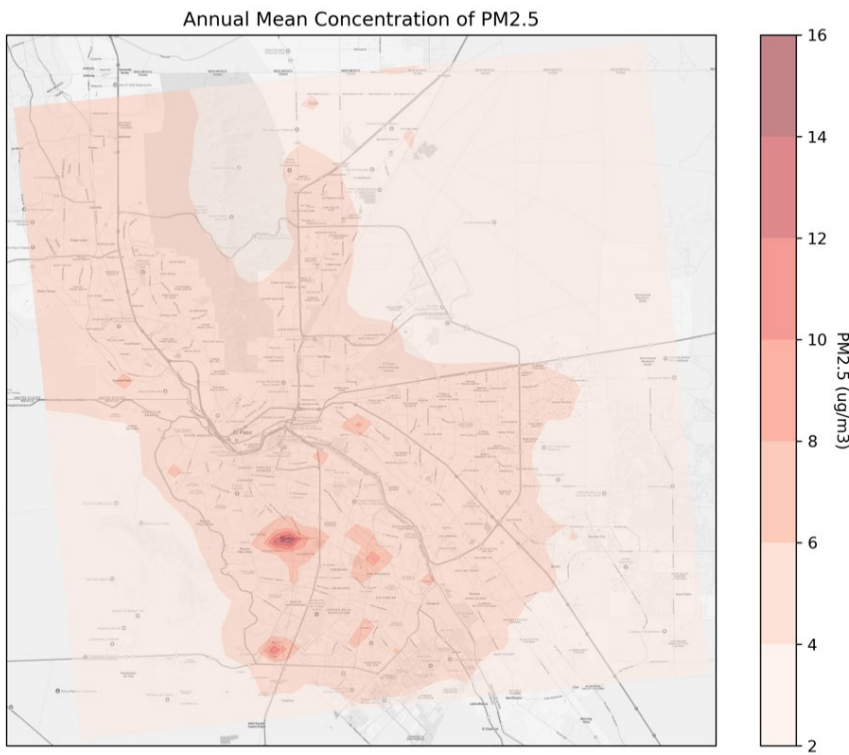
Task 2b: The El Paso-Juarez Comprehensive Air Quality Model with Extensions (CAMx) 2022 basecase simulation was completed in April. Initial contour maps of simulated annual mean and 95th percentile concentrations by grid cell of ozone (O₃), fine particulate matter (PM_{2.5}), nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO₂), and the Carbon Bond 6 (CB6) lumped TOL species (representing toluene and other monoalkyl aromatics) are shown in Figures 24-024-2 and 3. Similar maps showing 75th percentile and maximum concentrations can be found at <https://utexas.box.com/s/l3e0bw9a0ymx2a16eayo3tiw6bfl7n4x>. Quality assurance activities have been ongoing. Data collection for comparing CAMx simulated O₃ and PM_{2.5} concentrations with ambient observations was initiated for sites within El Paso (Texas Commission on Environmental Quality (TCEQ) network) and within the Juarez and Chihuahua municipalities (El Instituto Nacional de Ecología y Cambio Climático (INECC)). Ambient O₃ observations are available at six El Paso sites: Ojo de Agua, Skyline Park, Ivanhoe, El Paso Chamizal, Ascarate Park SE, and Socorro Hueco, and four sites in Mexico: Planta de Tratamiento de Aguas Residuales Norte and Instituto de Ingeniería y Tecnología in Juarez and Centro and Sur in Chihuahua. PM_{2.5} observations are available at four of these sites: El Paso Chamizal, Ascarate Park SE, Juarez Instituto de Ingeniería y Tecnología, and Chihuahua Sur.

A Reactive Tracer (RTRAC) algorithm in CAMx was configured to examine emission source contributions to toluene and ethylene oxide concentrations in El Paso-Juarez. The modeling team processed explicit toluene and ethylene oxide emissions for the 2022 base year from the U.S. Environmental Protection Agency's (EPA) modeling platform using SMOKE. Emission source "tags" for toluene are shown in Table 24-024-1. For some source categories, such as U.S. fires and area and point sources in Mexico, the CB6 lumped TOL species was used as a surrogate when explicit toluene (TOLU) emissions were not readily available. The simulation will begin at the Texas Advanced Computing Center (TACC) in April.

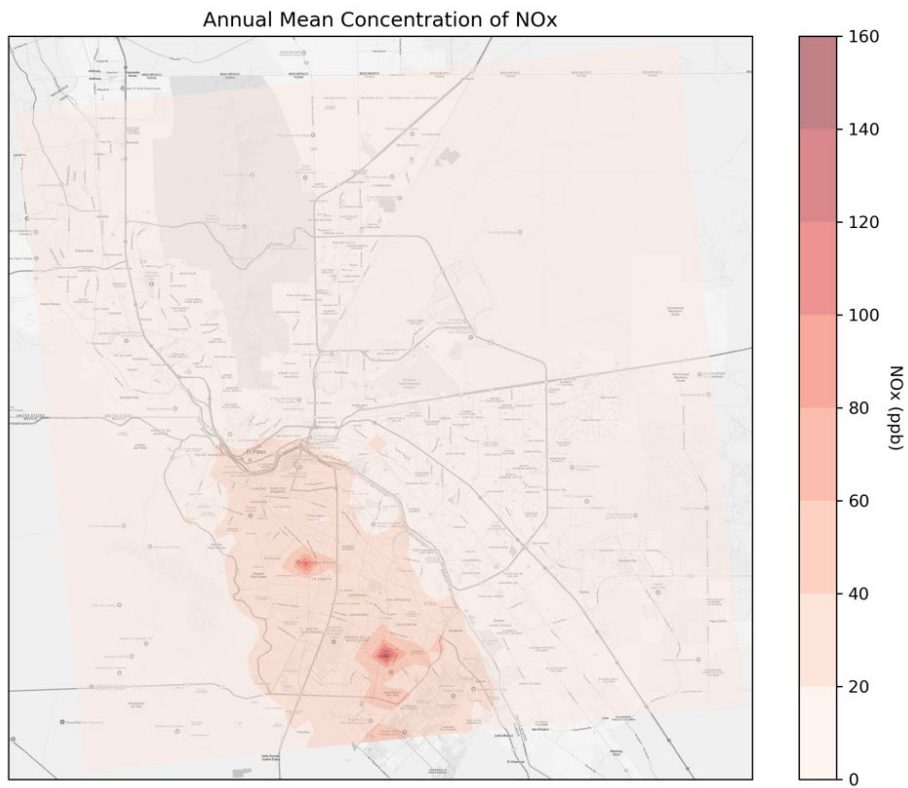
(a) O₃



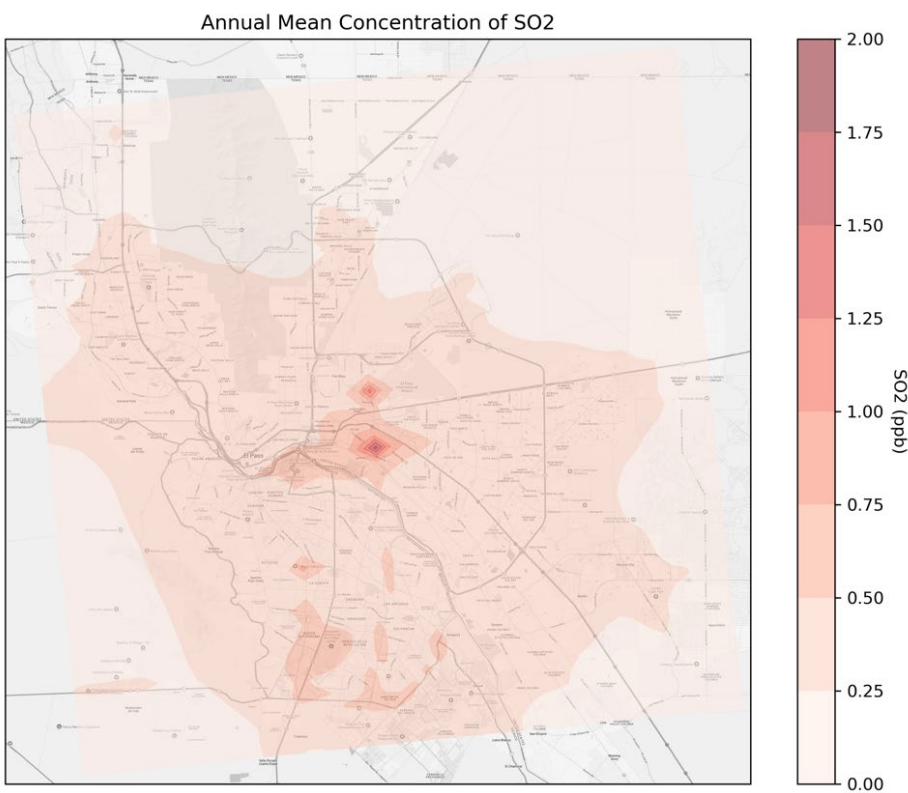
(b) PM_{2.5}



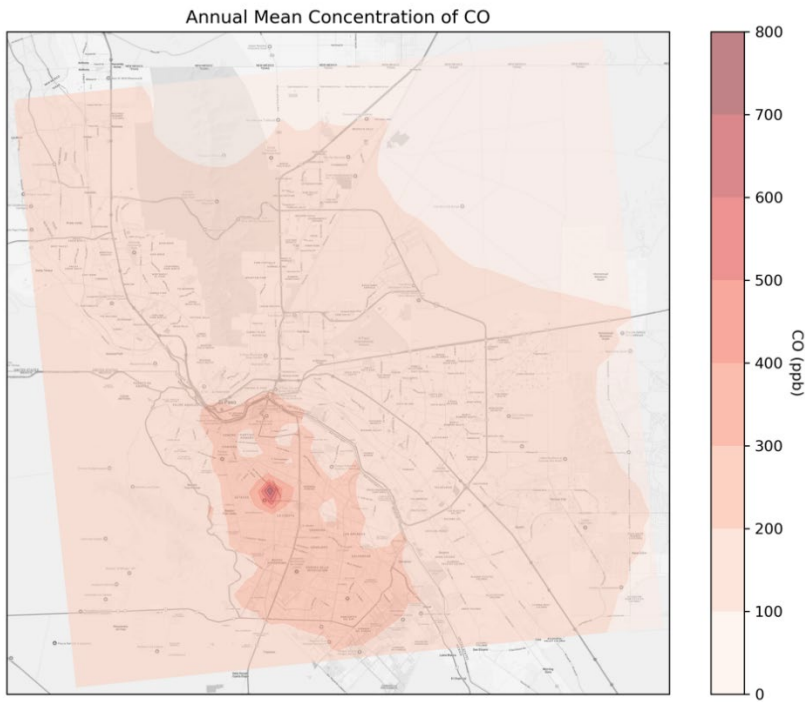
(c) NO_x



(d) SO₂



(e) CO



(f) CB6 TOL

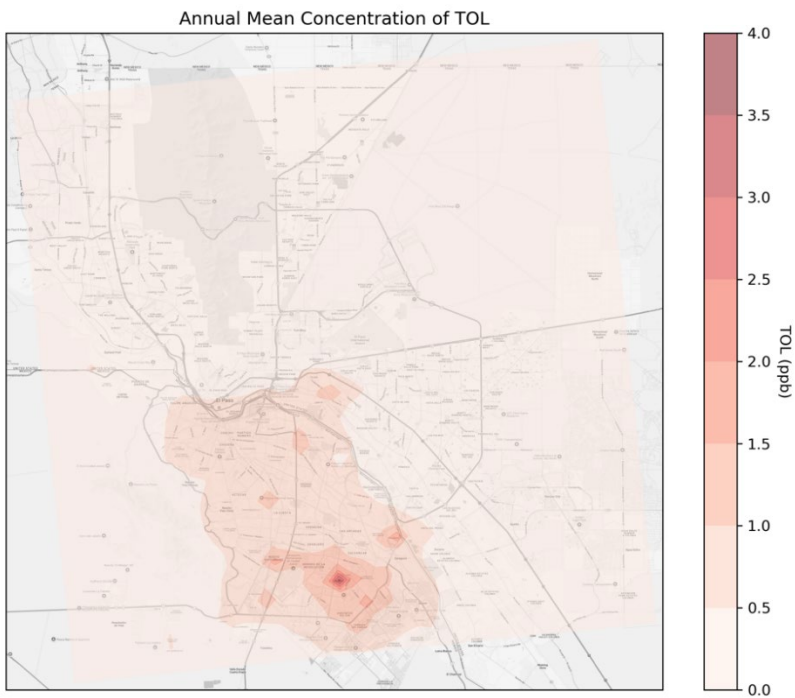
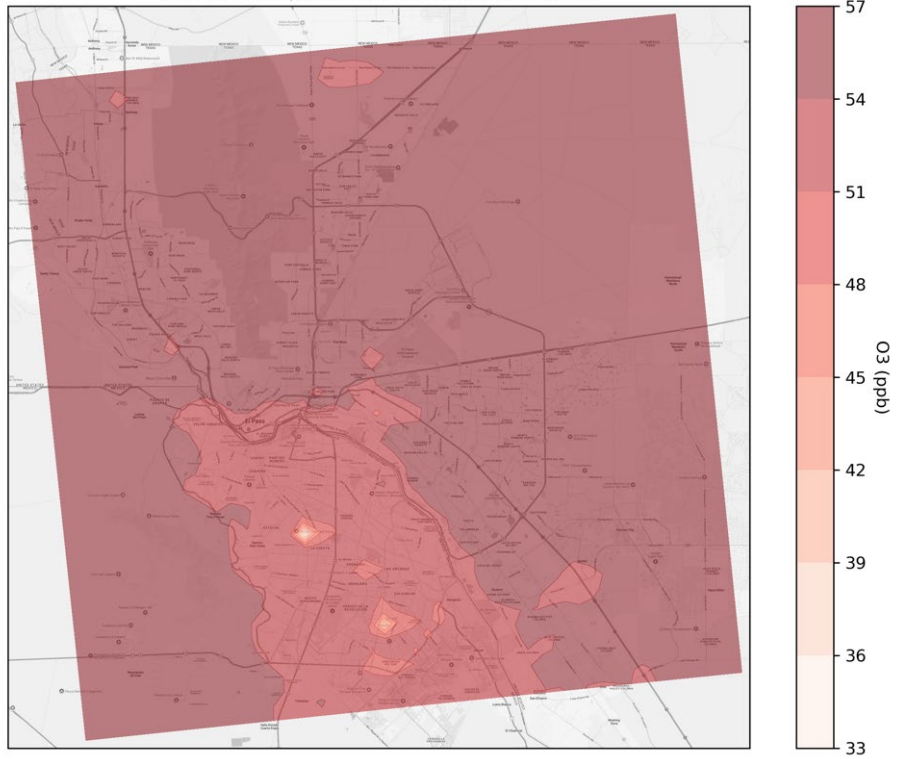


Figure 24-024-2. CAMx basecase simulated mean concentrations of (a) ozone, (b) PM_{2.5}, (c) NO_x, (d) SO₂, (e) CO, and (f) CB6 TOL species during 2022 in the El Paso-Juarez domain. Note differences in scales between plots.

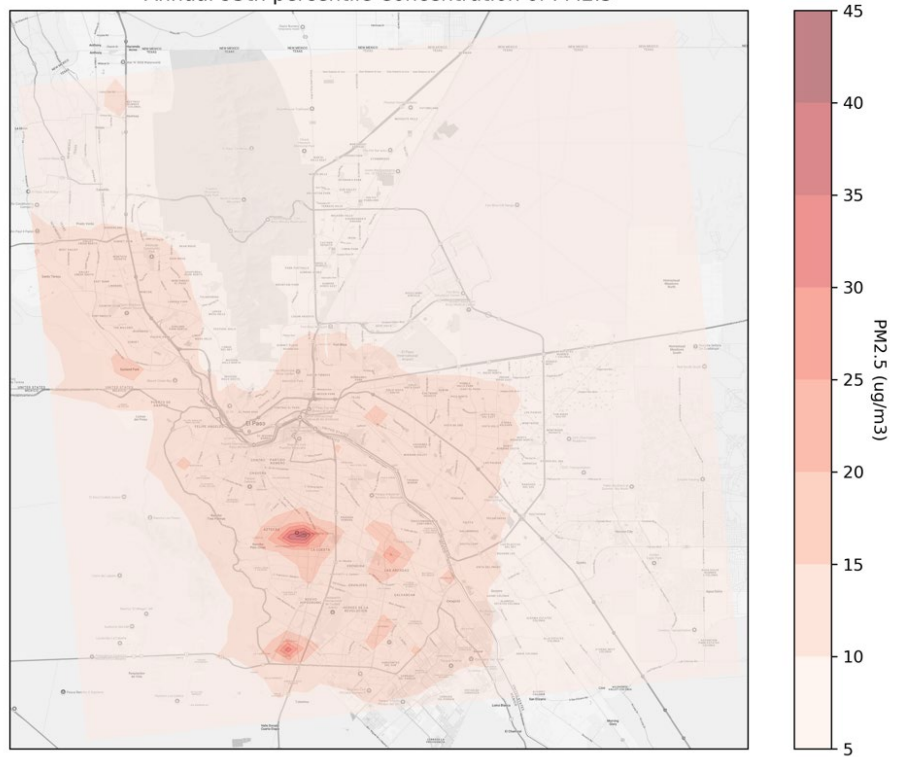
(a) O₃

Annual 95th percentile Concentration of O₃



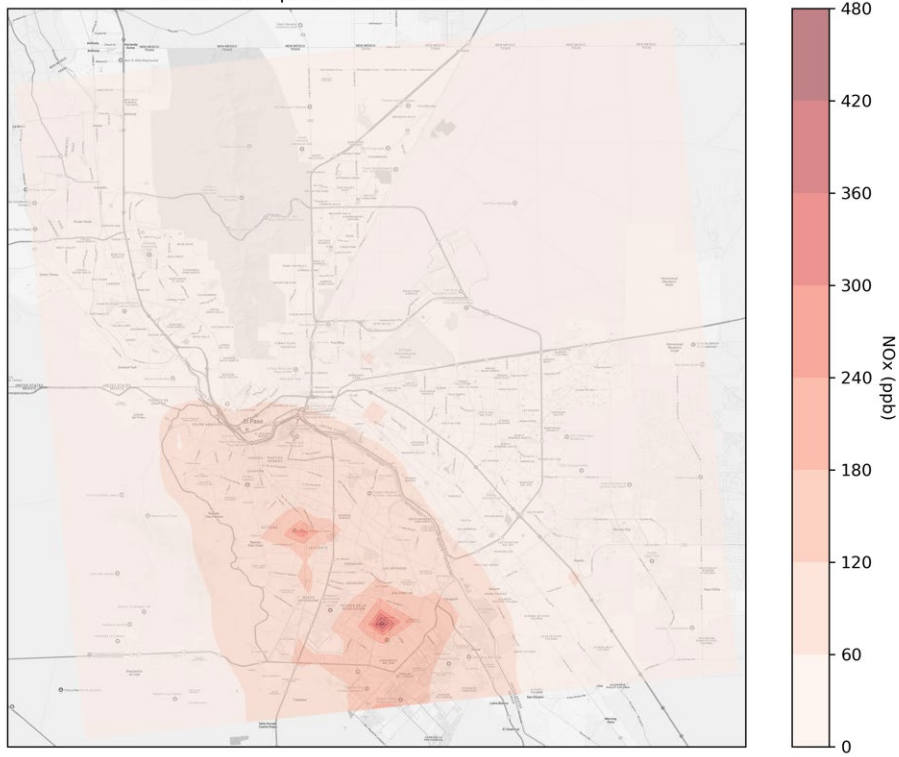
(b) PM_{2.5}

Annual 95th percentile Concentration of PM_{2.5}



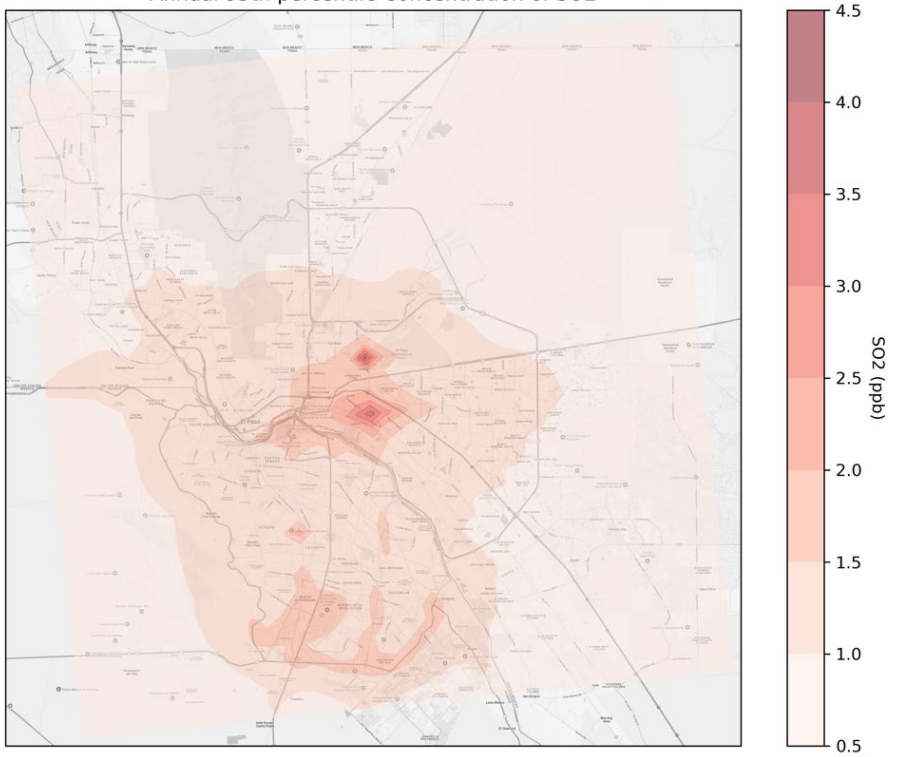
(c) NO_x

Annual 95th percentile Concentration of NO_x

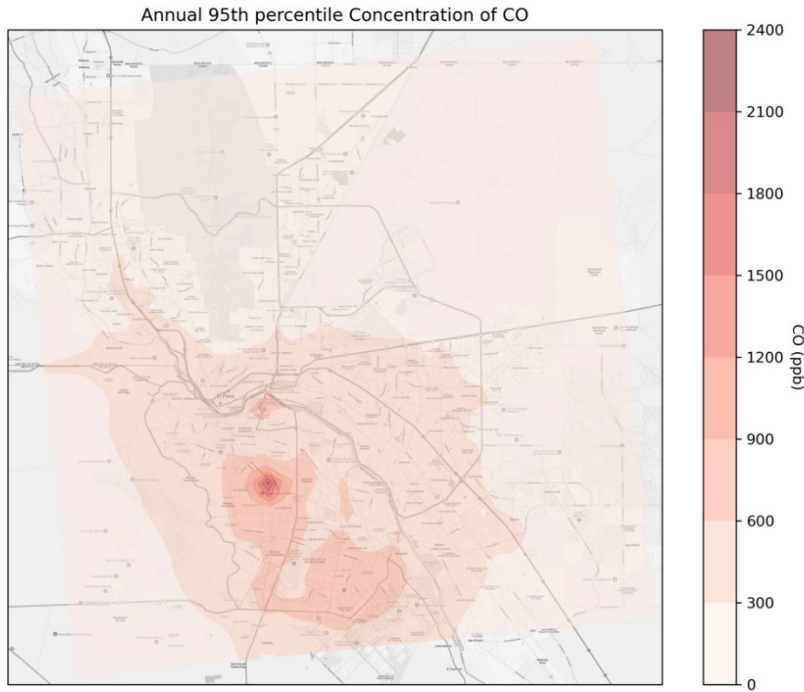


(d) SO₂

Annual 95th percentile Concentration of SO₂



(e) CO



(f) CB6 TOL

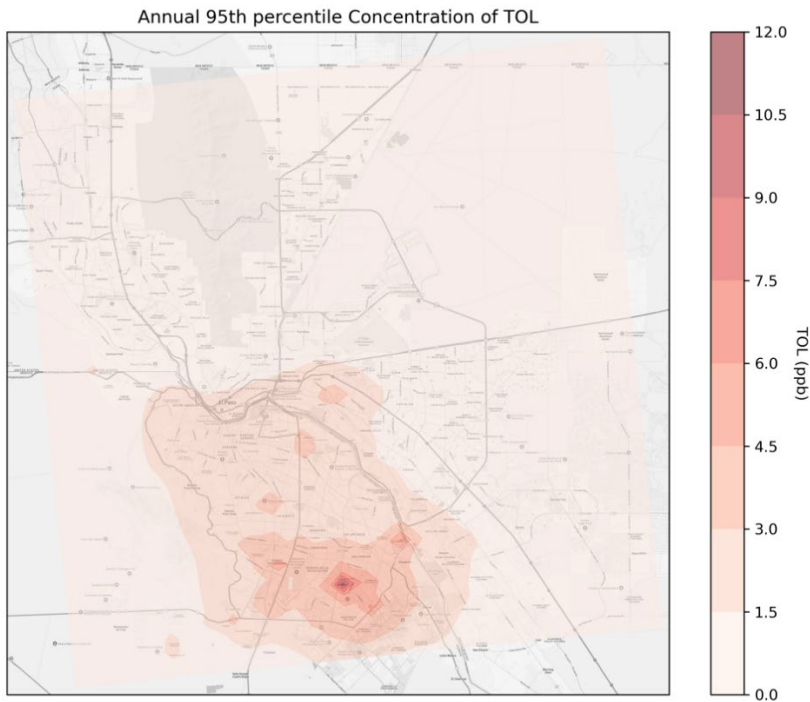


Figure 24-024-3. CAMx basecase simulated 95th percentile concentrations of (a) ozone, (b) PM_{2.5}, (c) NO_x, (d) SO₂, (e) CO, and (f) CB6 TOL species during 2022 in the El Paso-Juarez domain. Note differences in scales between plots.

Table 24-024-1. RTRAC emission source tagging for toluene.

Emission Sector ID	Description	Low Level or Elevated Source	RTRAC Grouping (NA = Source does not have toluene emissions)	Explicit Toluene (TOLU) or CB6 TOL Surrogate
afdust	Area fugitive dust	Low	NA	NA
airports	Aircraft and ground support equipment	Low	Nonroad	TOLU
livestock	Livestock	Low	NA	NA
nonpt	All other nonpoint	Low	Area	TOLU
nonroad	Nonroad	Low	Nonroad	TOLU
np_oilgas	Nonpoint source oil and gas	Low	Oil and Gas	TOLU
np_solvents	Solvents	Low	Solvent	TOLU
onroad_area	Onroad	Low	Onroad	TOLU
openburn	Open burning	Low	Area	TOLU
ptagfire	Agricultural fires	Elevated	Fire	TOL
ptfire-rx	Prescribed fires	Elevated	Fire	TOL
ptfire-wild	Wildfires	Elevated	Fire	TOL
pt_oilgas	Point source oil and gas	Elevated	Oil and Gas	TOLU
ptegu	Electric Generating Units (EGU)	Elevated	EGU	TOLU
ptnonipm	All other non-EGU point	Elevated	NEGU	TOLU
rail	Locomotives	Low	Nonroad	TOLU
rwc	Residential Wood Combustion	Low	Area	TOLU
fertilizer	Fertilizer	Low	NA	TOLU
beis4	Biogenic	Low	NA	TOLU
cmv_c1c2	Commercial Marine Vessels	Low	NA	NA
cmv_c3	Commercial Marine Vessels	Low	NA	NA
canmex_ag	(Mexico) Agriculture	Low	NA	TOLU
canmex_area	(Mexico) Nonpoint	Low	Mexico Area	TOL
canmex_point	(Mexico) Point	Elevated	Mexico Point	TOL
mexico_onroad	(Mexico) Onroad	Low	Mexico Onroad	TOLU

Task 3: Activities in April continued focusing on large data processing including data analysis from the High-Resolution Time of Flight Aerosol Mass Spectrometer (HR-TOF-AMS) and Vocus Proton Transfer Reaction Time of Flight Mass Spectrometer (Vocus-PTRTOFMS).

Preliminary particle data have been analyzed. Combined with the GPS data, spatial distributions of non-refractory PM_{10} were generated during all mobile measurement periods between 1/6/2025 and 1/18/2025. To observe diurnal variation of the PM in the area, timeseries of PM concentrations were also generated for all stationary measurements during the same time. Figures 24-024-4 – 24-024-6 show examples of the results from HR-TOF-AMS.

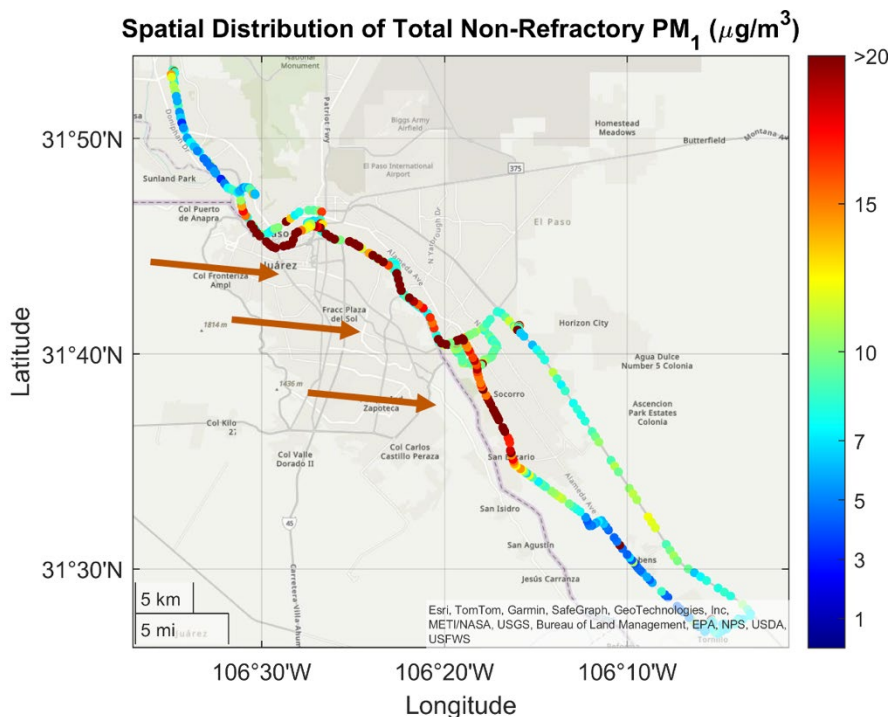


Figure 24-024-4: Spatial Distribution of Total Non-Refractory PM_{10} , 1/10/2025.

We observed elevated PM concentrations near the US-Mexican border, with wind coming from the west. Figure 24-024-4 above shows an overview of a mobile measurement track performed on 1/10/2025, between 14:07 and 21:15 (local time). The wind direction during this time varied from W, NW and WSW direction (indicated by the burnt orange arrows on the figure), with speeds between 3 mph to 14 mph (hourly average). We noticed that while driving near the highway that borders Mexico, Figure 1 shows enhancement of total PM_{10} to over $20 \mu\text{g}/\text{m}^3$. In addition, during this high concentration period, most of the PM_{10} detected were organic aerosols (not shown here) with concentrations between $14 - 16 \mu\text{g}/\text{m}^3$. We also observed a slight increase of inorganic aerosol during the same high concentration period.

We noticed elevated PM concentrations overnight, suggesting there could be a strong diurnal variation of PM in the area. Figures 24-024-5 and 24-024-6 below show stationary measurement results of different PM_{10} species from two different nights. From Figure 24-024-5, we observed that both organic and inorganic aerosol concentration increase starting around midnight on 1/9/2025. The

PM concentrations peaked at around noon with a total of over $30 \mu\text{g}/\text{m}^3$ and then started to decrease. Figure 24-024-6 shows similar trends where we saw a sharp increase in both organic and inorganic PM around 3 AM on 1/13/2025. The PM concentration continued to increase, reaching its peak of over $30 \mu\text{g}/\text{m}^3$ around noon, before decreasing again. One reason for higher nighttime PM concentrations is a lower planetary boundary layer height (which leads to less mixing in the atmosphere); however, this does not explain the sharp increase we observed on 1/13. Further analysis including wind direction, wind speed, as well as source apportionment, is needed to determine the possible causes of these elevated PM level periods at night.

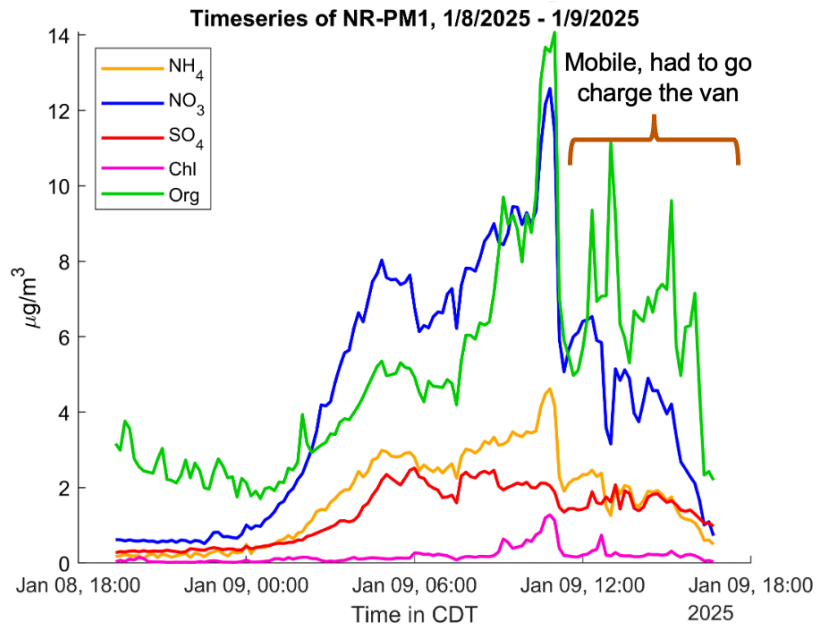


Figure 24-024-5: Timeseries of different PM species detected during stationary measurement 1/8/2025 – 1/9/2025.

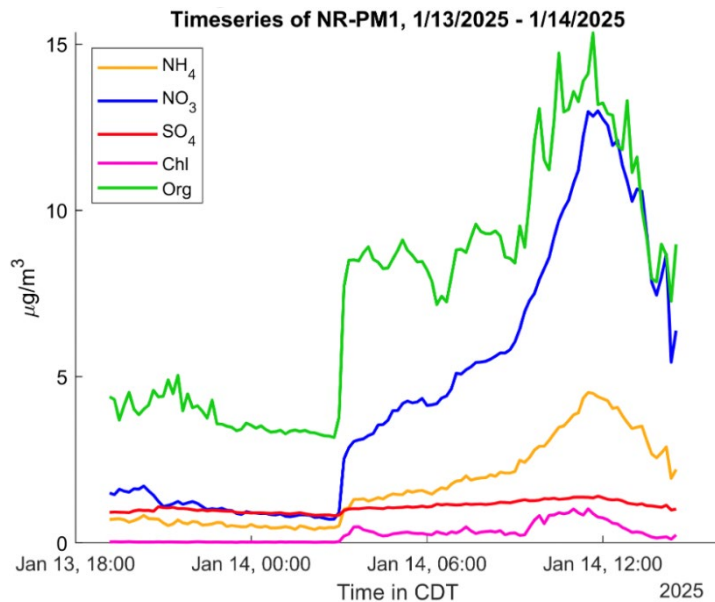


Figure 24-024-6: Timeseries of different PM species detected during stationary measurement 1/13/2025 – 1/14/2025.

Preliminary multivariate factor analysis was conducted on mobile comprehensive VOC data from the Vocus-PTRTOFMS and revealed 8 distinct factors which grouped compounds by covariance similarities (Figure 24-024-6). Out of 1524 detected ions, 683 VOCs were fed to the factor analysis to aid in source apportionment of individual and groups of VOCs. For instance, the factor tentatively attributed to “Gasoline and Petrochemical” comprised high loadings of toluene, benzene, C8 – C10 aromatics and other related VOCs. It was distributed across El Paso with different localized enhancements in the north and central El Paso. The “Combustion” factor was represented by furanoids, aromatics and nitrogen containing compounds such as C₇H₇NO consistent with benzamide. This factor’s hotspot was localized around a burning house. The factor attributed to “Cooking and VCPs” grouped long-chain fatty acids such as C₁₆H₃₀O₂ and long-chain hydrocarbons used in volatile chemical products (VCPs). This factor was spatially expressed close to restaurants and fast-food facilities as well near residences. The “Siloxane factor” was characterized by C₈H₂₄Si₄O₄ (D4), C₁₀H₃₀Si₅O₅ (D5) and other volatile cyclic siloxanes widely used as lubricants and in personal care products (PCPs). In contrast to primary VOCs directly emitted from different sources, a group of oxygenated VOCs (OVOCs) was represented by “OVOC” Factor which was less localized than other factors indicating mixing across the city. This factor seemed more sensitive to time of day and meteorological conditions affecting photochemical processes. Further data analysis will confirm source apportionment of PM1 SOA and other markers which will be combined with the wind direction analysis to separate El Paso contributions from those of Juarez.

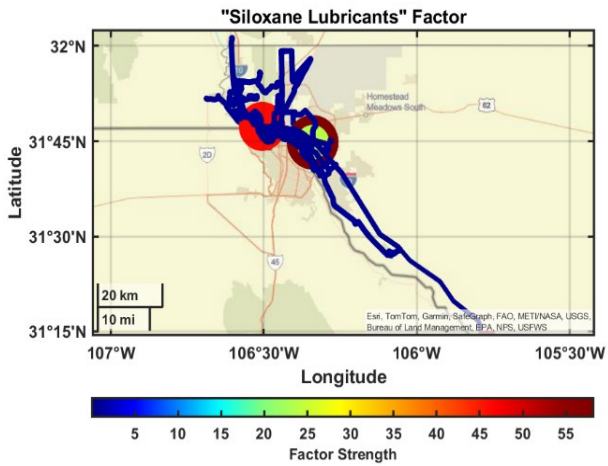
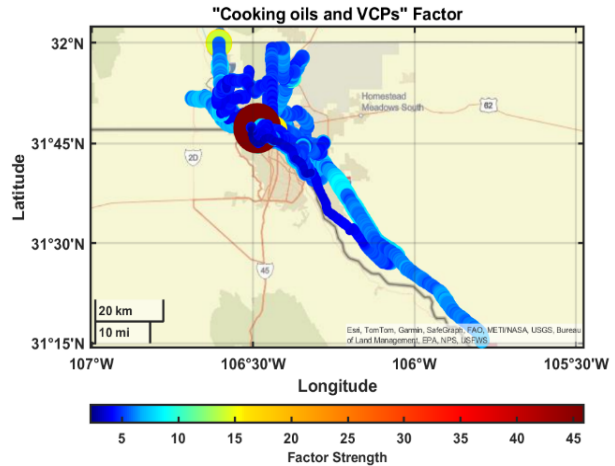
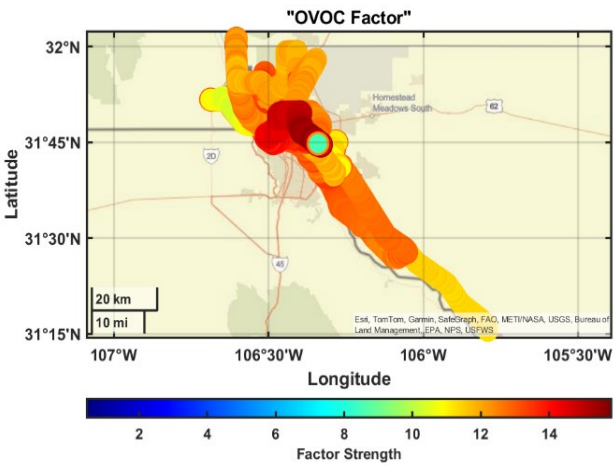
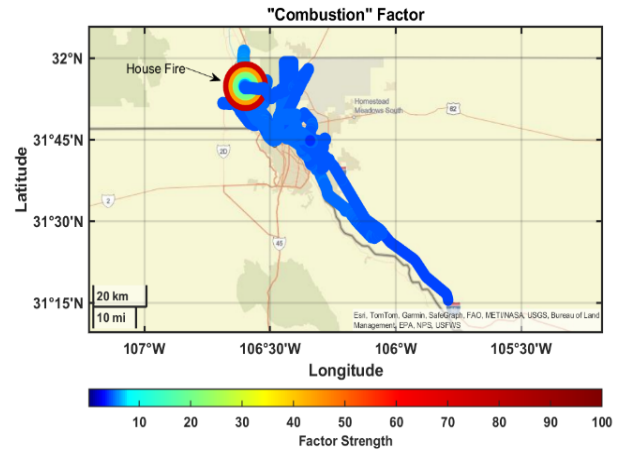
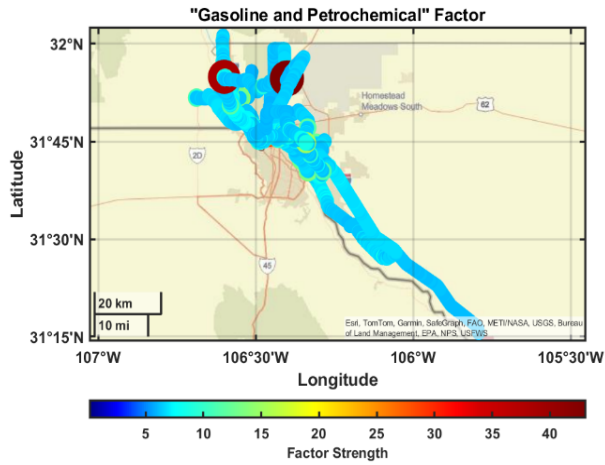


Figure 24-024-7. Spatial maps of dominant preliminary factors to help source apportionment analysis.

May 2025:

Task 2b: A Comprehensive Air Quality Model with Extensions (CAMx) simulation with the Reactive Tracer (RTRAC) algorithm was completed to examine toluene and ethylene oxide concentrations and emission source contributions in the El Paso-Juarez modeling domain. Ethylene oxide was modeled explicitly in RTRAC; emission sources included commercial sterilization facilities and publicly owned wastewater treatment plants in Texas and New Mexico. Ethylene oxide emissions information for Mexico was not available. Explicit toluene (TOLU) emissions were used for most source categories, except area and point sources in Mexico and fires (wildfires, prescribed, and agricultural) for which the Carbon Bond 6 (CB6) lumped TOL species (representing toluene and other monoalkyl aromatics) was used as a surrogate.

CAMx simulated 95th percentile concentrations of ethylene oxide and toluene concentrations during 2022 are shown in Figures 24-024-8 and 24-024-9, respectively. The Chamizal site is the most comprehensively instrumented within the Texas Commission on Environmental Quality (TCEQ) network, including auto-GC measurements for air toxics as well as monitoring of ozone, fine particulate matter (PM_{2.5}), nitrogen oxides (NO_x), sulfur dioxide (SO₂), and meteorological parameters. Ethylene oxide has not been routinely measured at existing stationary monitoring sites in El Paso. The top 10% of CAMx simulated ethylene oxide concentrations and emission source contributions by prevailing wind direction at Chamizal are shown in Figure 24-024-10.

Contributions from commercial sterilization facilities to peak ethylene oxide concentrations at Chamizal varied with wind direction, with the largest associated with emissions from the New Mexico facility under northwesterly winds. Emissions in the U.S. Environmental Protection Agency's (EPA's) 2022v1 modeling platform from this source were approximately 0.48 tons per year (tpy) versus 0.023 tpy collectively from the two sources located in El Paso. Comparisons of CAMx simulated against measured toluene concentrations via a box and whisker analyses at Chamizal (Figure 24-024-11) suggested reasonable agreement of interquartile ranges but a low model bias with higher observed values. CAMx simulated emission source contributions to toluene concentrations at Chamizal, shown in Figure 24-024-12, are dominated by Mexican onroad sources and, to a lesser extent, point and area sources.

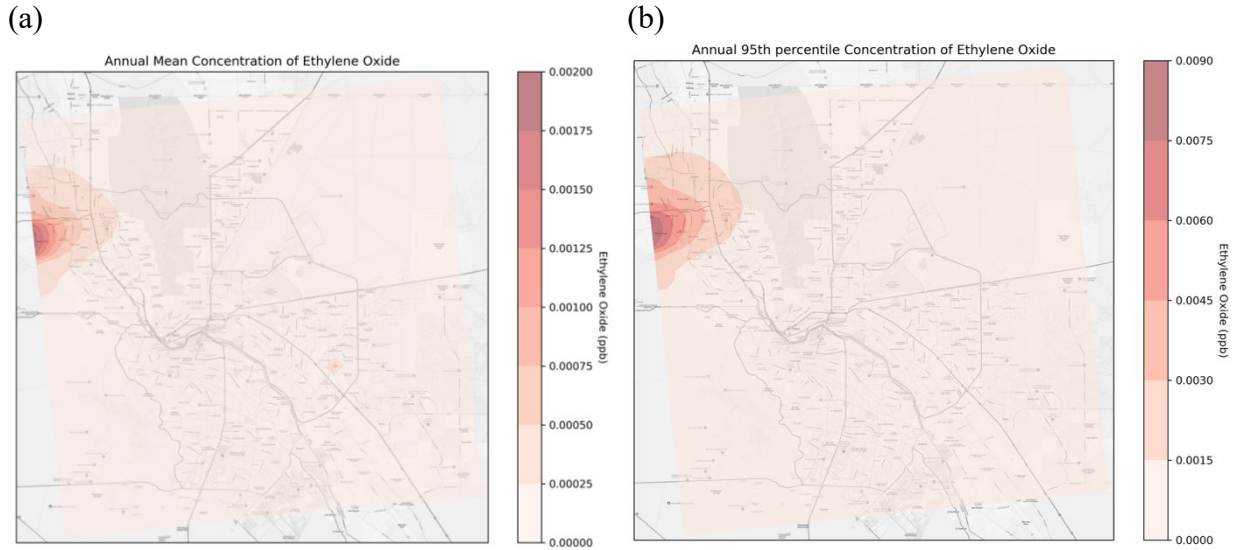


Figure 24-024-8. Simulated 2022 annual (a) mean and (b) 95th percentile concentrations of ethylene oxide by grid cell from the CAMx RTRAC simulations. Note differences in scales between plots.

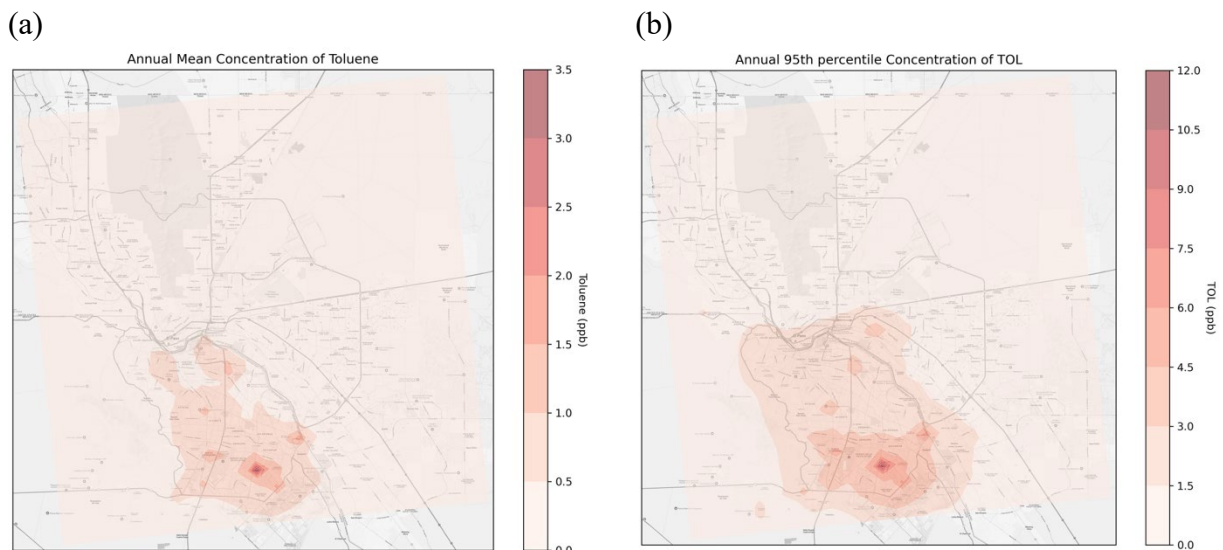
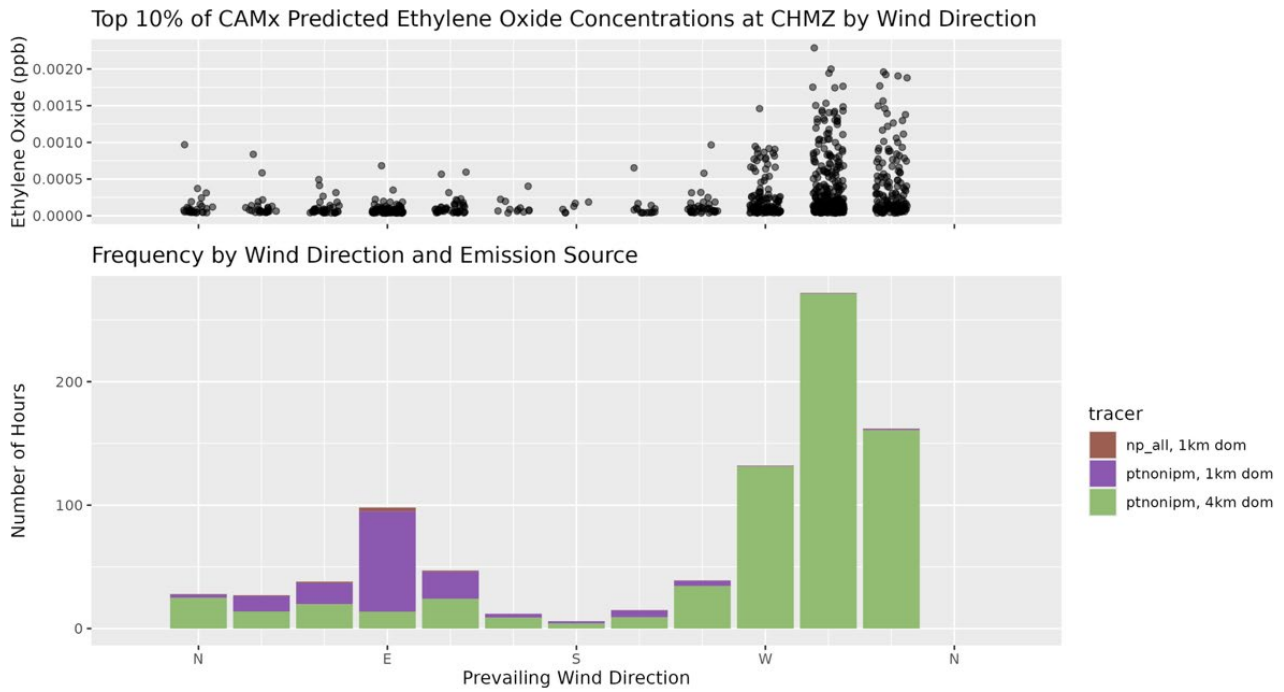


Figure 24-024-9. Simulated 2022 annual (a) mean and (b) 95th percentile concentrations of toluene by grid cell from the CAMx RTRAC simulations. Note differences in scales between plots.

(a)



(b)

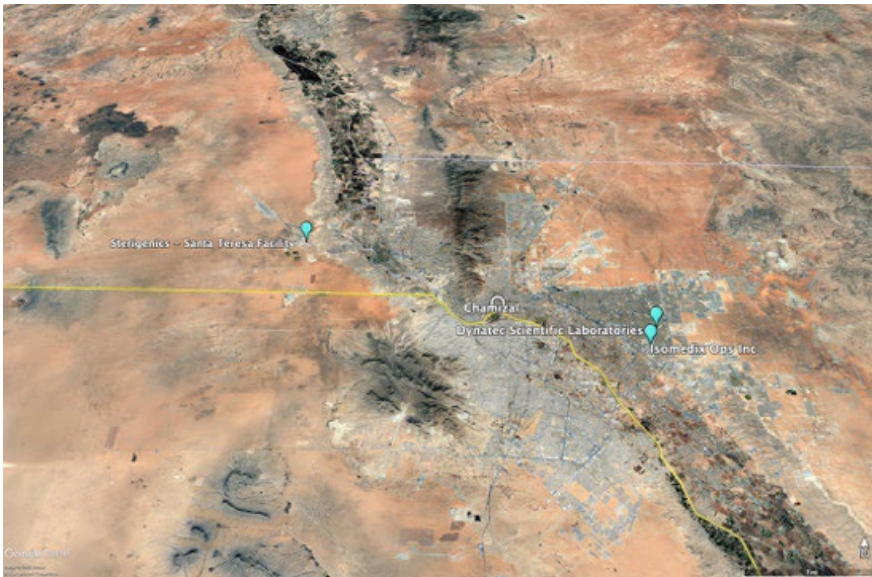


Figure 24-024-10. (a) Top: Annual top 10% of CAMx simulated ethylene oxide concentrations by prevailing wind direction. Bottom: Frequency by wind direction and contributions from nonpoint and non-electric generating unit (EGU) point sources. (b) Locations of point sources of ethylene oxide in the EPA 2022v1 inventory. Note that the Sterigenics facility is within the 4-km and other facilities within the 1-km El Paso-Juarez modeling domains.

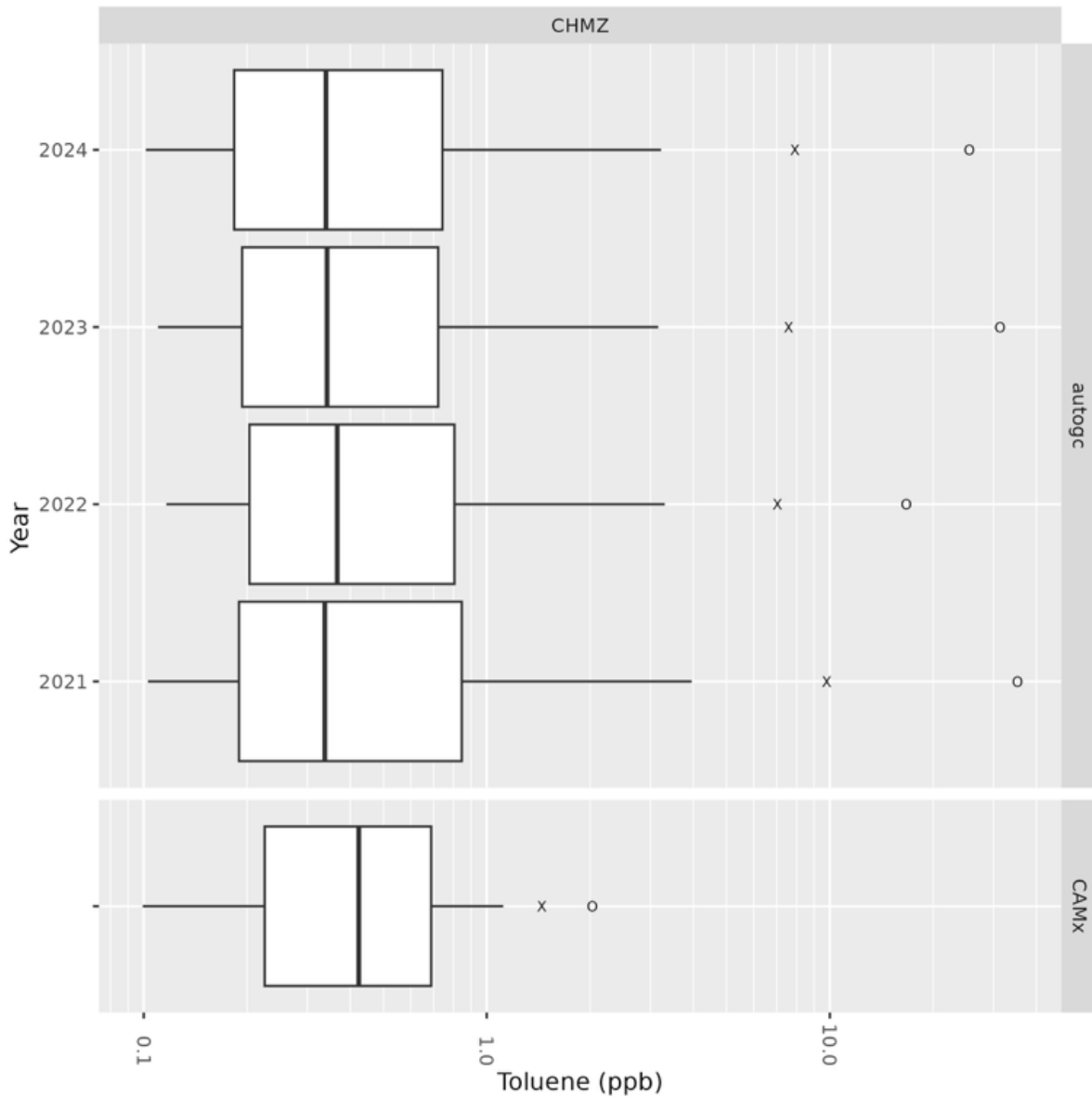


Figure 24-024-11. Box and whisker plots of measured concentrations during 2021 - 2024 versus CAMx simulated concentrations for the 2022 base year of toluene at Chamizal. The box shows the median and interquartile range, whiskers extend to 5th and 95th percentiles, x indicates 99th percentile, and o indicates maximum concentration.

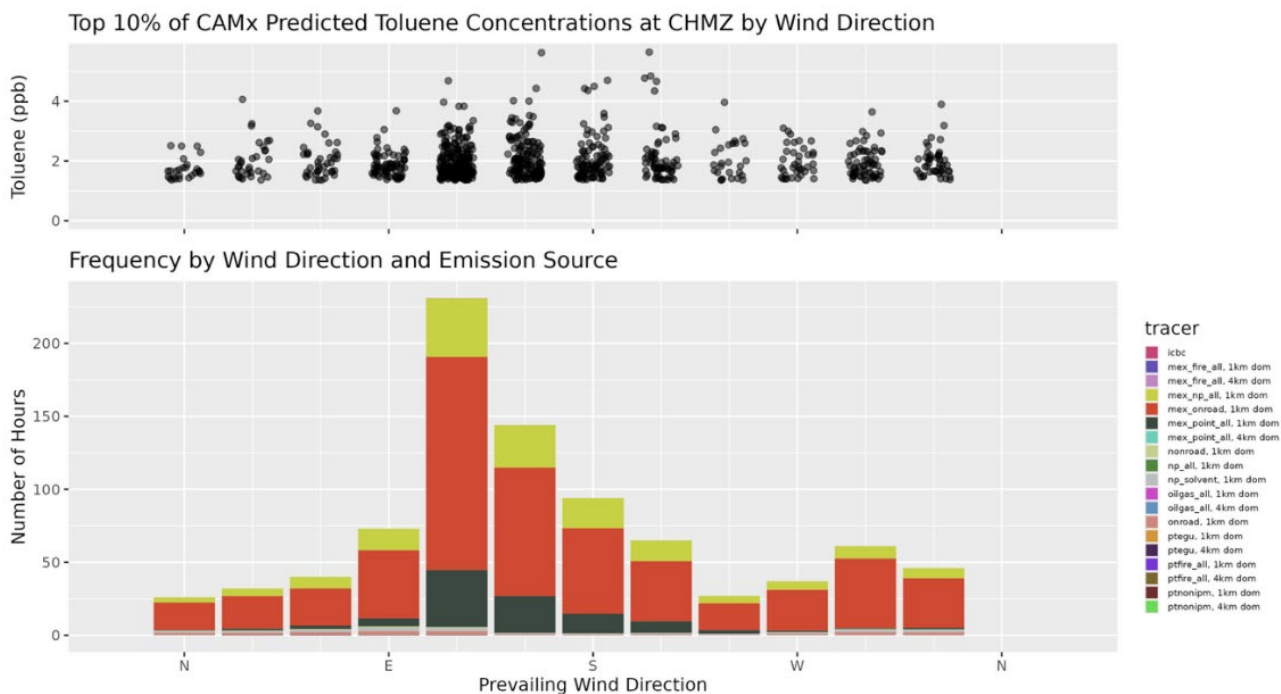


Figure 24-024-12. Top: Annual top 10% of CAMx simulated concentrations of toluene by prevailing wind direction. Bottom: frequency by wind direction and emission source contributions.

Task 3: Observational activities in May and early June were centered on the preparation and execution of the second intensive field campaign in El Paso, conducted during the late spring/early summer period. Mobile measurements were carried out from May 12–22, with a follow-up stationary deployment at UTEP from June 4–10. During the stationary phase, several targeted nighttime and early morning mobile tracks were performed to expand the spatiotemporal dataset, especially to compensate for two days impacted by major dust storms. The executed routes from this campaign are overlaid with the winter tracks in Figure 24-024-13, highlighting areas of overlap and expansion.

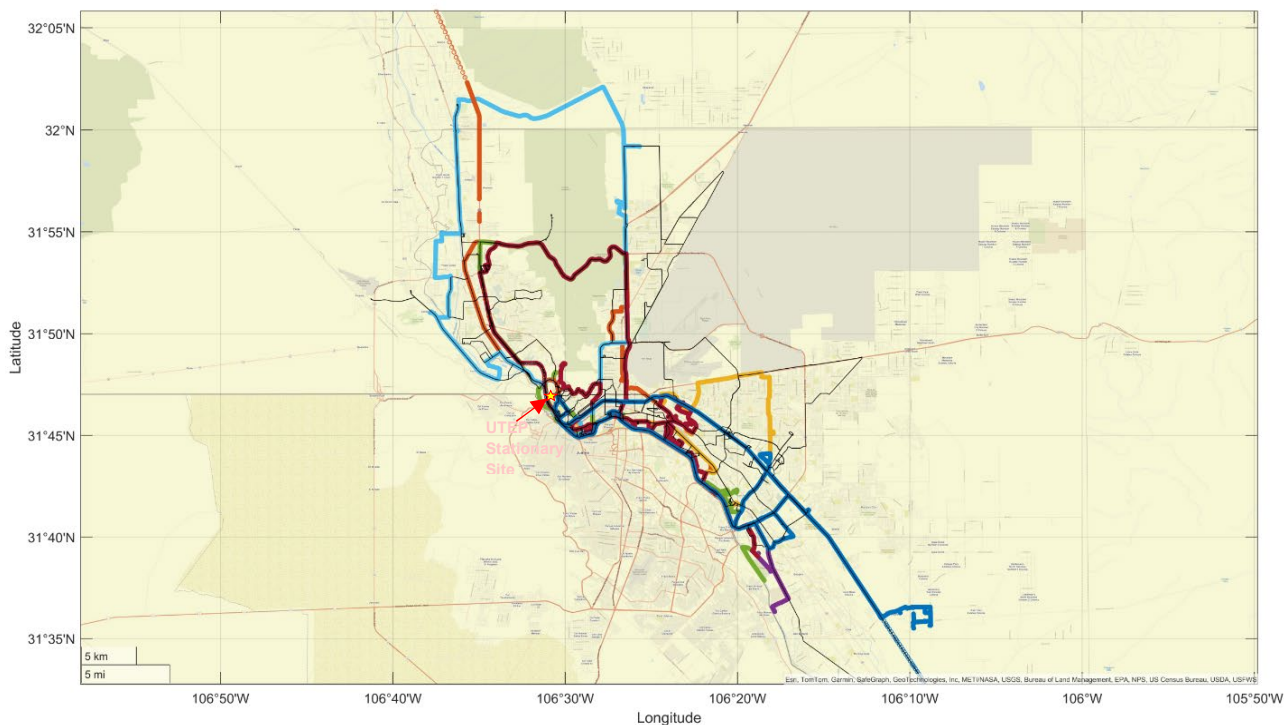


Figure 24-024-13. Completed driving measurement tracks; thin black line denotes winter campaign, while the colored thick lines represent late spring/early summer campaign.

Compared to the winter deployment, the spring campaign captured a distinct set of meteorological and source conditions. Wind patterns were predominantly westerly, enabling the team to track cross-border contributions from Juárez more effectively by driving along the U.S. – Mexico border. Temperatures frequently exceeded 90 °F, sharply contrasting with the sub-40 °F conditions during the polar vortex in winter. Dust storms occurred during early campaign days. These events provided unique opportunities to study coarse-mode dust interactions with gas-phase VOCs, while simultaneously requiring caution to protect instrument inlets and electronics from particulate overload. During dust events, elevated VOCs were observed with reduced PM1 signals, suggesting that in addition to direct sources, larger particles may potentially act as carriers for semi-volatile compounds advected over long distances.

The campaign's mobile tracks (Figure 24-024-13) targeted both previously sampled areas and new hotspots identified during real-time preview analysis. Repeated drives allowed direct seasonal comparisons, while new regions such as the wastewater treatment plant in southern El Paso revealed high concentrations of hydrogen sulfide (H₂S), sulfur-containing VOCs, and reduced nitrogen compounds (e.g., trimethylamine). A similar but chemically distinct source was found near the Las Cruces plant. The team also captured emissions from agricultural zones, noting ammonium nitrate aerosol and elevated methane likely linked to livestock or fertilizer usage. Border drives showed consistent enhancements in aromatics and sulfur compounds, particularly downwind of

Juárez. In addition, high concentrations of solvent-like VOCs were observed downwind Juárez and near trains and industrial corridors.

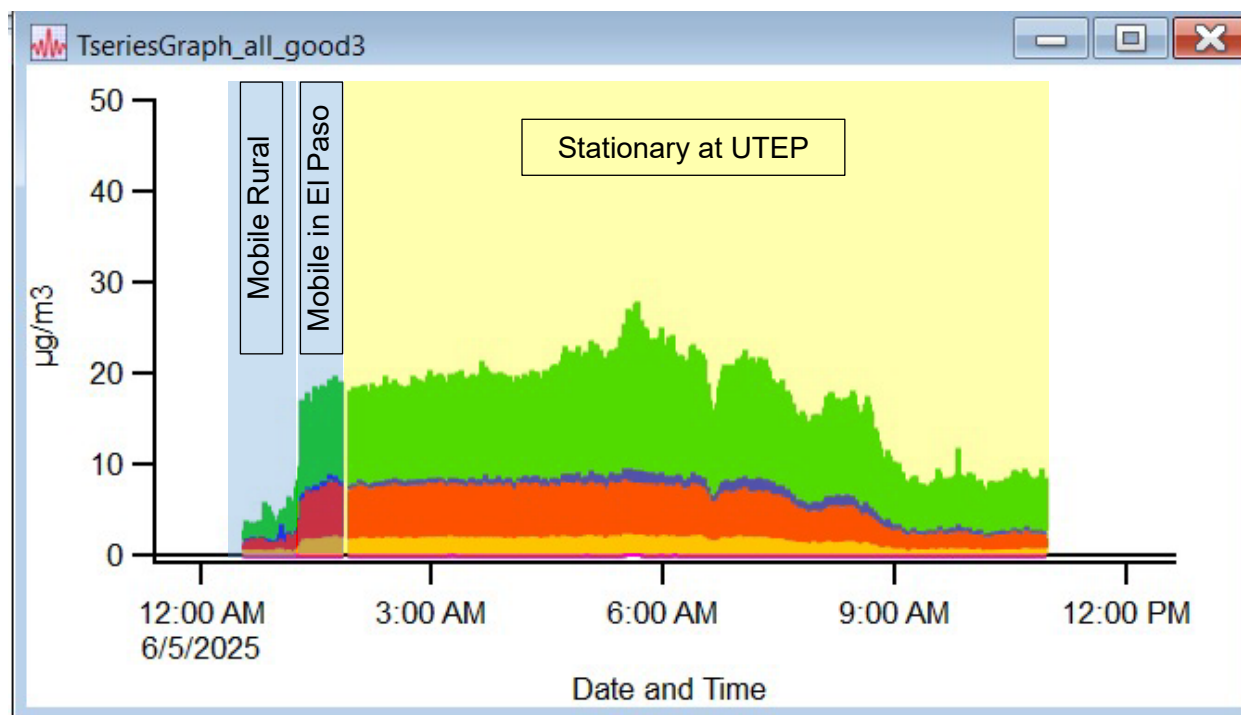


Figure 24-024-14. Preliminary real-time preview data of the night-time drive from Las Cruces to El Paso followed by stationary measurements at the UTEP site overnight and in the morning (CDT time).

Multiday stationary measurements at the UTEP site showed fascinating variabilities due to wind direction, ranging from very clean to heavily polluted air masses. The data also captured strong diel patterns driven by planetary boundary layer (PBL) dynamics. These observations will be directly compared with the speciated GC measurements collected at the UT Austin trailer to further resolve source profiles and temporal trends.

Overall, the campaign produced an extensive dataset of chemically speciated gases and aerosols, collected under diverse meteorological and source conditions. The team conducted repeated intercomparisons collocating with TCEQ monitors (Chamizal, Ascarate Park, Lower Valley) and made targeted visits to known and newly identified sources including refineries, gas stations, landfill flares, cooking sources, and vehicle hotspots. Multiple fire plumes, including suspected biomass burning and industrial flaring, were observed. Despite occasional instrument interlocks and power management challenges under extreme heat, which were resolved in real-time, the instrument uptime was close to 100%. The cooling ducts and insulations were critical to ensure uninterrupted measurements. These early observations will inform holistic analysis across campaigns, detailed source apportionment, and further data analysis workflows to address project objectives.



Figure 24-024-15. Select photographs from the May/June field campaign. Top left: Interior van layout with visible instrumentation and active cooling ducts. Top right: Van during co-location at the UTEP stationary monitoring site. Middle left: Research team preparing for mobile deployment. Middle right: Measurement activities near the wastewater treatment plant. Bottom left: Mobile sampling conducted near the U.S. – Mexico border. Bottom right: Measurement during a mild dust storm with reduced visibility.

Preliminary analysis: As described above.

Data collected: None.

Problems/issues encountered and proposed solutions: None to report.

Goals and anticipated issues for succeeding reporting period: The modeling team will continue to evaluate CAMx simulated concentrations against measurements of criteria pollutants at stationary monitoring site locations within the El Paso and Juarez areas. Intercomparisons of modeled and measured toluene concentrations and characterization of emission source contributions will be made at two El Paso monitoring sites with Volatile Organic Canister (VOC) canister sampling. To the best of our knowledge, air toxics are not currently measured in Chihuahua, Mexico. We will continue to draft materials for the final report and anticipate meeting with the field teams to develop plans for intercomparisons of datasets.

The observation team will continue post-processing and quality assurance of the late spring/early summer campaign data, applying the same workflows used for the winter dataset to enable consistent cross-seasonal analysis. The upcoming work will focus on spatial mapping and source-resolved characterization of both gas-phase and particle-phase pollutants, with particular interest in identifying key contributors to secondary PM formation. In addition to mobile observations, the co-located stationary measurements at the UTEP site will be directly compared with complementary instrumentation from the UT Austin trailer, including GC-based VOC speciation.

A coordinated effort will be made to harmonize datasets from both campaigns to develop a robust picture of seasonal variability, emission source profiles, and pollutant transport dynamics in the El Paso–Juárez airshed. This integration will support improved source attribution, inform future mitigation strategies, and strengthen the scientific basis of the final report.

Detailed analysis of the progress of the project to date: Progress proceeding as planned. More details in the subsequent report.

Independent Technical Advisory Committee

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

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

Confidentiality: As a member of Independent Technical Advisory Committee (ITAC), I understand that I will have access to proposals submitted to the Air Quality Research Program (AQRP). Subject to any legal requirements, I agree to keep the information in these proposals confidential until the selection process is completed and it is appropriate to release information to the public. I understand that there may be certain information that comes to me in my role as a member of ITAC that retains its confidential nature even after the process is concluded. I also understand that I will review said proposals and may have access to the reviews made by other ITAC members. I agree to keep these reviews and the identity of the reviewers confidential until such time as this information is released to the public. (NOTE: For the reviews and reviewers, this information may never be released.)

Conflict of Interest: As a member of ITAC, I agree that I will not evaluate, comment on, or vote on proposals in which I or my home institution is involved, including, but not limited to, any financial interest or in which I have another form of conflict of interest. I understand that ITAC members with conflicts of interest must leave the meeting room or the conference line when a proposal with which they have a conflict is discussed, voted on or otherwise being considered. I understand that I must recuse myself from participating in or attempting to influence at any time the ITAC's or the AQRP Council's consideration or decision concerning such proposals. I agree to bring any issues concerning a possible conflict of interest to the attention of the Director of the AQRP or the TCEQ Air Quality Deputy Director. If there is a question of interpretation regarding whether a conflict of interest exists, I agree that the decision regarding whether a conflict of interest exists will be made by the Director of the Air Quality Research Program or the TCEQ Air Quality Deputy Director.

All members of the ITAC agree to abide by these conflicts of interest and confidentiality provisions prior to participating in the review of proposals. Table 1 contains the 2024-2025 Biennium ITAC members.

Table 1. Independent Technical Advisory Committee Members

Name	Title	Institution
David Allen	Professor and Director, AQRP	The University of Texas at Austin
Doug Boyer	Technical Specialist	TCEQ, Office of Air Director
Brad Pierce	Director, Space Science and Engineering Center	Univ. of Wisconsin-Madison
Don Collins	Professor	University of California, Riverside
Joost de Gouw	Research Physicist, Cooperative Institute for Research in Environmental Sciences (CIRES) Senior Scientist and Fellow	National Oceanic and Atmospheric Administration (NOAA), University of Colorado Boulder
James Nolan	Technical Specialist	TCEQ, Office of Air Director
Lea Hildebrandt Ruiz	Associate Professor	The University of Texas at Austin
Rebecca Sheesley	Associate Professor	Baylor University
William Vizquete	Professor	University of North Carolina
Yuxuan Wang	Associate Professor of Atmospheric Chemistry	University of Houston
Greg Yarwood	Principal	Ramboll
Renyi Zhang	Distinguished Professor of Atmospheric Sciences, Harold J. Haynes Chair in Geosciences	Texas A&M University

TCEQ Relevancy Review

The Texas Commission on Environmental Quality (TCEQ) reviews proposals for relevancy to the State’s air quality research needs. TCEQ approval is required for a project to receive funding from the Program.

Advisory Council

The final group responsible for selecting Air Quality Research Program (AQRP) research projects is the Advisory Council (the Council). The Council consists of between 7 and 11 members. Two Council members with relevant scientific expertise are nominated by the Texas Commission on Environmental Quality (TCEQ). As defined in the AQRP contract, up to four members of the Council can be county judges from the Houston-Galveston-Brazoria (HGB) and Dallas-Fort Worth (DFW) non-attainment counties. Additional members should have a general background in air quality and business practices, and can include elected officials, business community representatives, environmental group representatives, and members of the general public. The Council’s responsibilities are to attend meetings with TCEQ Management and the AQRP to understand the statewide project goals for the funding period, to select for funding the projects reviewed by the Independent Technical Advisory Committee (ITAC) and ranked by the TCEQ, and to assist with the presentation of project final results at locations throughout the state. Table 2 contains the 2024-2025 Biennium Advisory Council Members.

Table 2. Advisory Council Members

NAME	TITLE	INSTITUTION
Dan Baker	Senior Partner	Environmental Reaction Engineering Experts (E REX)
Beata Czader	Air Modeling Team Leader	TCEQ
Andrew De Candis	Clean Cities & Clean Vehicles and H-GAC Cities Co-Director	Houston-Galveston Area Council (H-GAC)
Lyle Hufstetler	Clean Cities Coordinator	Alamo Area Council of Governments (AACOG)
Chris Klaus	Senior Program Manager	North Central Texas Council of Governments (NCTCOG)
Lindley Anderson	Senior Technical Specialist	TCEQ Air Quality Division
Chris Rabideau	Senior Technical Specialist	Chevron
Cyrus Reed	Conservation Director	Sierra Club

FINANCIAL STATUS REPORT

The Air Quality Research Program (AQRP) contract was awarded for FY 24-25 for \$750,000 per year. Funds were distributed across several different reporting categories as required under the contract with TCEQ. The reporting categories are listed below in detail.

Program Administration: Limited to 10% of the overall funding per fiscal year. This category includes all staffing, materials and supplies, and equipment needed to administer the overall AQRP. It also includes the costs for the Council meetings.

ITAC: Funds are to cover the costs, largely travel expenses, for the Independent Technical Advisory Committee (ITAC) meetings.

Project Management: Limited to 8.5% of the funds allocated for Contractual budget category. Each research project is assigned a Project Manager to ensure that project objectives are achieved in a timely manner and that effective communication is maintained among investigators in multi-institution projects. These funds are to support the staffing and performance of project management.

Research Projects / Contractual: Funds available to support awarded research projects.

Program Administration

Program Administration includes salaries and fringe benefits for those overseeing the program, 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.

Dr. David Allen, Principal Investigator and AQRP Director, is responsible for the overall administration of the AQRP. RoseAnna Goewey, AQRP Program Manager, performs program and grant management. Mr. Vincent Torres, AQRP QAPP Manager, reviews and oversees AQRP approval of all project QAPPs.

The University of Texas at Austin’s federally negotiated fringe rates for full-time/benefits eligible employees is 27% in the current fiscal year. Rates are estimated to have a 0.5% increase for full/part-time benefits eligible employees in subsequent years. Program Administration budget will be nearly fully expended by August 31, 2025. Actual balances after 08/31/2025 will be reported to the TCEQ Project Manager and will be included in the 2025-2027 biennium carry forward.

Table 3: Administration Budget (2024-2025 Biennium)

Budget Category	FY 23-25 Budget	Current Expenditures May 2025	Cumulative Expenditures	Remaining Balance
Personnel/Salary	\$106,388.68	\$9,261.60	\$69,457.65	\$36,931.03
Fringe Benefits	\$29,203.45	\$2,500.63	\$18,307.64	\$10,895.81
Supplies	\$26,526.19	\$38.10	\$8,206.46	\$18,319.73
Total Direct Costs	\$162,118.32	\$11,800.33	\$95,971.75	\$66,146.57
Authorized Indirect Costs (10% x Personnel/Salary)	\$10,638.87	\$926.16	\$6,945.77	\$3,693.10
Total Costs	\$172,757.19	\$12,726.49	\$102,917.52	\$69,839.67

ITAC

Table 4 details the 2024-2025 Biennium ITAC budget. Through November 2024, ITAC travel for members to attend meetings is accrued. Additional ITAC travel expenses are expected in August 2025 for members to attend the biannual workshop hosted at UT Austin.

Table 4: ITAC Budget (2024-2025 Biennium)

Budget Category	FY 23-25 Budget	Current Expenditures May 2025	Cumulative Expenditures	Remaining Balance
Travel	\$10,000.00	\$0.00	\$945.97	\$9,054.03
Supplies	\$1,250.00	\$0.00	\$0.00	\$1,250.00
Total Direct Costs	\$11,250.00	\$0.00	\$945.97	\$10,304.03
Authorized Indirect Costs (10% x Personnel/Salary)	\$0.00	\$0.00	\$0.00	\$0.00
Total Costs	\$11,250.00	\$0.00	\$945.97	\$10,304.03

Project Management

Table 5 details the 2024-2025 Biennium Project Management Budget. Expenses include Project Manager salaries, fringes, required supplies, and associated Indirect Costs. AQRP projects fully expending the Project Management budget by August 31, 2025.

Table 5: Project Management Budget (2024-2025 Biennium)

Budget Category	FY 23-25 Budget	Current Expenditures May 2025	Cumulative Expenditures	Remaining Balance
Personnel/Salary (ADMIN+CONTRACTUAL)	\$182,388.68	\$13,275.84	\$126,335.31	\$56,053.37
Fringe Benefits (ADMIN+CONTRACTUAL)	\$50,065.45	\$3,584.48	\$33,374.89	\$16,690.56
Travel-ITAC (CONTRACTUAL)	\$10,000.00	\$0.00	\$945.97	\$9,054.03
Supplies (ADMIN+CONTRACTUAL)	\$35,814.19	\$54.10	\$13,958.04	\$21,856.15
Other (CONTRACTUAL Other, ITAC)	\$3,750.00	\$0.00	\$0.00	\$3,750.00
Contractual (CONTRACTUAL Awards)	\$1,255,125.09	\$165,041.28	\$267,852.73	\$987,272.36
Total Direct Costs	\$1,537,143.41	\$181,955.70	\$442,466.94	\$1,094,676.47
Authorized Indirect Costs (10% x Personnel/Salary)	\$18,238.87	\$1,327.58	\$12,633.54	\$5,605.33
Total Costs	\$1,555,382.28	\$183,283.28	\$455,100.48	\$1,100,281.80

Research Projects

Due to contracting delays, research Subawardees were contracted, but invoices will not be submitted until subsequent quarters. Table 6 shows the 2024-2025 Biennium Research Project budget. The budget allocates \$1,255,125.09 for research projects. The budget includes carry forward from the prior biennium. At the time of this report’s subaward contracts have not invoiced against the AQRP funding. Project 24-024 at The University of Texas was able to utilize funding due to internal financial processes at the University.

Table 6: 2024-2025 Biennium Research Project Budget

2024-2025 Biennium Total Contractual Funding		\$1,222,500.00		
FY 22-23 Contractual Carry Forward		\$32,625.09		
TOTAL CONTRACTUAL BUDGET		\$1,255,125.09		
Project Number	Institution (PI)	Amount Awarded	Cumulative Expenditures	Remaining Balance
24-003	University of Houston (Flynn)	\$159,221.00	\$0.00	\$159,221.00
24-003	Ramboll (Lindhjem)	\$47,827.00	\$3,797.50	\$44,029.50
24-003	FluxSens (Samuelsson)	\$35,000.00	\$0.00	\$35,000.00
24-004	Ramboll (Johnson)	\$229,691.00	\$78,456.00	\$151,235.00
24-007	University of Houston (Flynn)	\$144,233.00	\$0.00	\$144,233.00
24-007	Baylor University (Usenko)	\$88,951.00	\$33,387.93	\$55,563.07
24-007	Aerodyne (Fortner)	\$76,519.00	\$47,151.73	\$29,367.27
24-021	University of Houston (Wang)	\$186,978.00	\$27,559.21	\$159,418.79
24-024	The University of Texas at Austin (Misztal)	\$280,810.00	\$77,500.36	\$203,309.64
FY 24 Total Contractual Funding Awarded		\$1,249,230.00		
FY 24 Contractual Funds Expended			\$267,852.73	
FY Contractual Funds Remaining to be Spent				\$987,272.36
Total Contractual Funding		\$1,255,125.09		
Total Contractual Funding Awarded		\$1,249,230.00		
Total Contractual Funding Contingency		\$5,895.09		
Total Contractual Funds Expended to Date			\$267,852.73	
Total Contractual Funds Remaining to be Spent				\$987,272.36

APPENDIX A. CONTRACTUAL RESEARCH PROJECTS APPROVED FOR FUNDING (BIENNIUM 2024-2025)

Project #	Project Title	Research Priority	Primary Institution: PI	Collab. Institution: Co-PI(s)	Total Budget	AQRP Project Manager	TCEQ Liaison
24-003	Improving Emission Rates Estimates of Commercial Marine Vessels	Improve emission inventories	<i>University of Houston:</i> Flynn	<i>Ramboll:</i> Lindhjem, <i>FluxSens:</i> Samuelsson	\$242,048	Vincent Torres	Cody McClain
24-004	Evaluating Updates to CAMx and NOx Emission Inventories using TEMPO Measurements over Texas	Photochemical air quality models	<i>Ramboll:</i> Jeremiah Johnson	n/a	\$229,691	Elena McDonald-Buller	Robert Kierstead
24-007	Texarkana Intensive Campaign	Development of an ozone and PM _{2.5} field study in El Paso	<i>University of Houston:</i> James Flynn	<i>Baylor University:</i> Usenko; <i>Aerodyne Research, Inc.:</i> Fortner	\$309,703	Vincent Torres	Chola Regmi
24-021	Improving WRF representation of coastal, marine, and residual boundary layers and quantifying the effects on ozone prediction	Photochemical air quality models	<i>University of Houston:</i> Yuxuan Wang	n/a	\$186,978	Elena McDonald-Buller	Gabriel Lee
24-024	Novel Observations and Quantified Source Apportionment of Ozone, Particulate Matter and Contributing Precursors in the El Paso Area	Development of an ozone and PM _{2.5} field study in El Paso	<i>The University of Texas at Austin:</i> Pawel Misztal	n/a	\$280,810	Vincent Torres	Celinda Vallejo-Rodriguez