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| **PROJECT TITLE** | Integrated Airborne-Mobile Ground Observations and Inventory for Enhanced VOC Source Attribution and Ozone Precursor Mapping in Texas | **PROJECT #** | 26-029 |
| **PROJECT PARTICIPANTS** | **PIs:** Pawel Misztal, Lea Hildebrandt Ruiz, Yue Zhang, Nathan Malarich, Munkhbayar Baasandorj<br>**Students and Postdocs:**<br>*TAMU:* Alana Dodero, Jiayun Zhao, Alexander Treadway, John Gonzales, Rajab Mammadov<br>*UT Austin:* Keuntaek Kim, Hyeonjun Lee, Chun-Ying Chao, Shihao Zhai, Daniel Sung, Sam Lin, Kat Konon<br>*CU Boulder/NOAA:* Nathan Malarich | **DATE SUBMITTED** | 10/10/2026 |
| **REPORTING PERIOD** | **From: 9/01/2026 To: 9/30/2026** | **REPORT #** | 6 |

A Financial Status Report (FSR) and Invoice will be submitted separately from each of the Project Participants reflecting charges for this Reporting Period. I understand that the FSR and Invoice are due to the AQRP by the 15th of the month following the reporting period shown above.

**Detailed Accomplishments by Task for reporting period**

**Preliminary Analysis**

**Mobile Measurements**

***Mobile Measurements (UT Austin)***

During this reporting period, the team completed the planned collocation comparison for the UT Austin Vocus measurements against hourly auto-GC data from the TCEQ monitoring station in Dallas.

Four short collocations were conducted on 31 May and 1, 2 and 4 June (Figure 1, Table 1). Mean differences between the Vocus collocation mean and the TCEQ hourly value were +10% for benzene, -9% for C8 aromatics and -31% for toluene, corresponding to a few tens of ppt in absolute terms. The $C_5H_8H^+$ channel, which sums isoprene, cyclopentene, C5-alkenol fragments and other contributors, was accordingly higher than the chromatographically resolved isoprene reported by the auto-GC.

It should be noted that the auto-GC sampling period did not entirely overlap the Vocus collocation window, and distinct temporal variability occurred during some of those periods, as shown in Figure 1. Taking these factors into account, the agreement between the two instruments is within their combined measurement uncertainties, and the remaining differences are consistent with the potential for sampling different air masses and with ambient values close to the auto-GC detection limit. These comparisons are preliminary and will be revisited as the calibration review is completed.

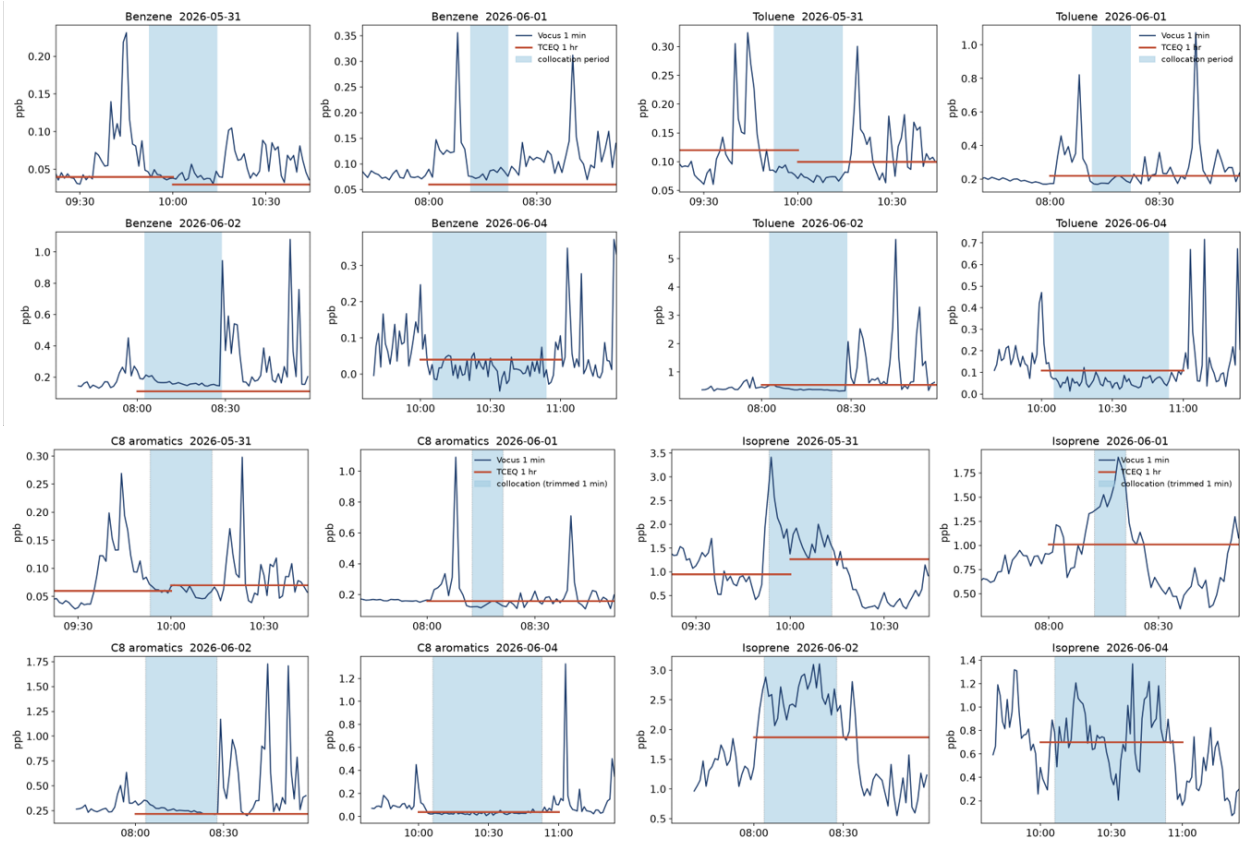


***Figure 1.*** *Comparison of mobile Vocus PTR-ToF-MS measurements (1-min averages, dark blue) with hourly TCEQ auto-GC data (red) for benzene, toluene, C8 aromatics (xylenes + ethylbenzene), and the* $C_5H_8H^+$ *channel (isoprene + cyclopentene + C5 alkenol and other potential fragments) during four stationary collocation periods (May 31, June 1, 2, and 4, 2026) at the TCEQ monitoring site in Dallas (AQS code: 484391018). Shaded areas indicate the collocation period (Fig. by Keuntaek Kim, Misztal Group).*

***Table 1.*** *Differences between Vocus PTR-ToF-MS and TCEQ auto-GC measurements during the four collocation periods. Δ (ppb) is the Vocus collocation mean minus the TCEQ hourly value; Δ (%) is relative to the TCEQ value. Mean ± SD is calculated across the four collocation days (Table by Keuntaek Kim, Misztal Group).*

| **Compound** | **05-31** | **06-01** | **06-02** | **06-04** | **Mean ± SD** |
|---|---|---|---|---|---|
| Benzene | | | | | |
| Δ (ppb) | 0.006 | 0.022 | 0.053 | -0.025 | 0.014 ± 0.033 |
| Δ (%) | 18 | 37 | 49 | -62 | 10 ± 50 |
| C8 aromatics | | | | | |
| Δ (ppb) | -0.005 | -0.027 | 0.039 | -0.012 | -0.001 ± 0.028 |
| Δ (%) | -7 | -17 | 18 | -29 | -9 ± 20 |
| Toluene | | | | | |
| Δ (ppb) | -0.034 | -0.033 | -0.152 | -0.054 | -0.068 ± 0.057 |
| Δ (%) | -31 | -15 | -28 | -49 | -31 ± 14 |
| C5H9+ (isoprene + cyclopentene + other) | | | | | |
| Δ (ppb) | 0.741 | 0.537 | 0.727 | 0.074 | 0.520 ± 0.311 |
| Δ (%) | 67 | 53 | 39 | 11 | 42 ± 24 |

***Mobile Measurements (TAMU)***

**Summary**

For this period, the TAMU team compiled a chemical catalog of plumes, checked mass calibrations, and conducted wind analysis for a data center site in Richardson, TX.

A repeatable plume of glycol-related compounds was observed downwind of a data center campus in Richardson, TX, on every well-sampled pass in the 2026 campaign. On 1, 2 and 4 June, propylene glycol was enhanced 5.8 to 9.2 times above background in plume air, together with a $C_5H_{10}O_2$ feature (14 to 25 times), a feature consistent with diacetone alcohol (5 to 7 times), glycol ethers (DPG or PGMEA, 2–3×) and, on 4 June, hexylene glycol (3.3×). The plume appeared on the road downwind of the northeast edge of the campus, and wind back-trajectories from three days with differing wind directions converge on a single point there. No fluorinated compounds or glycol oxidation products were enhanced. Identifications of the $C_5H_{10}O_2$ and diacetone alcohol features are tentative and the enhancements are expressed as uncalibrated ion signals.

**Measurements and approach**

The mobile Vocus PTR-ToF was run in $NO^+$ mode at 10 s resolution, with zero-air backgrounds subtracted and calibration periods removed. Plume points were 10 s points inside the campus box where the $C_5H_{10}O_2 \cdot NO^+$ ion (m/z 132.06), the strongest site-specific signal, exceeded 5 ions $s^{-1}$, plus one point on each side. Background was the mean of the hour before and the hour after each pass. Each ion's enhancement was tested against 3,000 random sets of background points of the same length. An ion counts as enhanced when $p < 0.01$, the ratio is at least 1.5×, and the plume signal is at least 1 ion $s^{-1}$. The van had no wind sensor, so wind data came from the KTKI (McKinney) and KDAL (Love Field) ASOS stations, averaged over each pass. 31 May had too few plume points to analyze and is shown only on the map.

**Winds and plume location**

The plume moved with the wind but always traced back to the same corner of the campus (Figure 2). The northeast edge of the campus is the only location where the plume appeared on all analyzed passes.

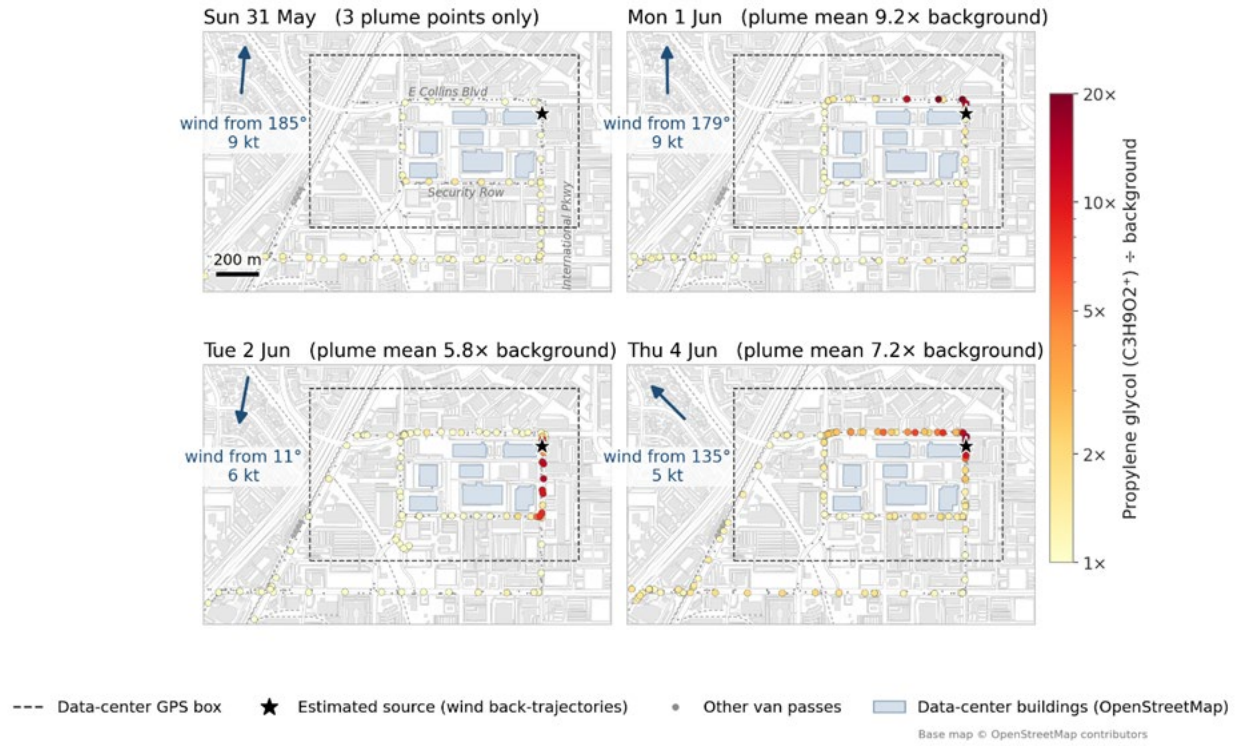


***Figure 2.*** *Propylene glycol ($C_3H_9O_2^+$) along the van track, as a multiple of each pass's background. Arrows show the wind direction (ASOS average over the pass); the star is the source estimated from wind back-trajectories; the dashed box is the campus area used to define plume points; blue shading shows building footprints. Base map © OpenStreetMap contributors. (Figure by Alexander Treadway, TAMU)*

**Compounds in the plume**

The same mix of glycol-related compounds rose together on all three analyzed passes (Figure 3). Ratios below are plume mean ÷ background mean; only values that passed the noise test are shown.

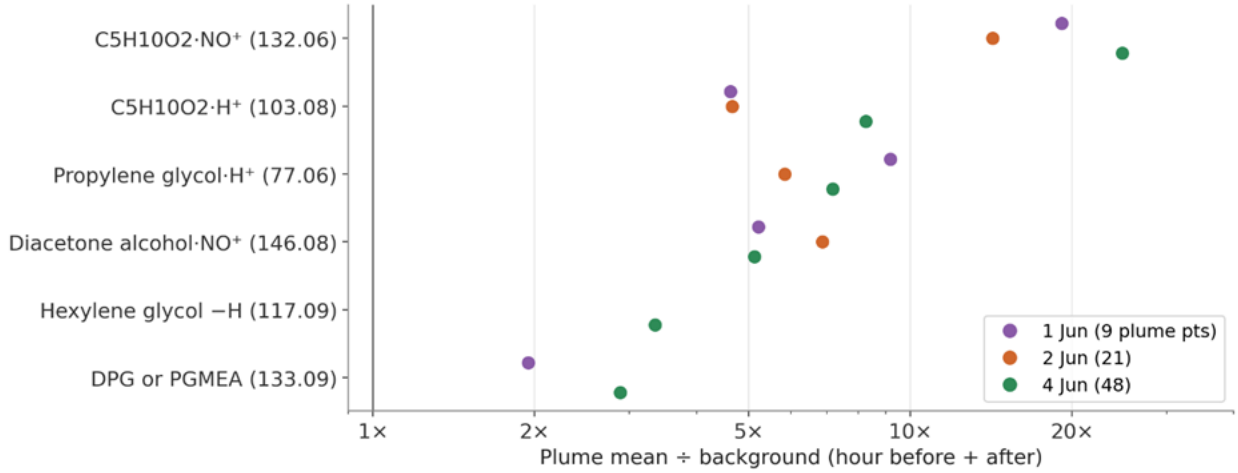

***Figure 3.*** *Plume mean ÷ background (hour before + after) for each glycol-related ion. Each color is one pass; a missing dot means that ion was not above background noise that day. (Figure by Alexander Treadway, TAMU)*

- **$C_5H_{10}O_2$ (m/z 132.06 and 103.08)** is the strongest signal, 14–25× as its $NO^+$ adduct. Its protonated ion rose 4.6–8.3× at a constant ratio of 0.43–0.48 to the adduct, so both are one compound. $C_5H_{10}O_2$ is consistent with $C_5$-carbonyls and $C_5$-alkenols. The exact isomeric identity can be narrowed down using the expected fragment ratios from standard calibrations.
- **Propylene glycol (m/z 77.06)** rose 9.2×, 5.8× and 7.2× on 1, 2 and 4 June.
- **Diacetone alcohol (m/z 146.08, tentative)** rose 5.1–6.9× on every pass.
- **Hexylene glycol (m/z 117.09)** passed the noise test only on 4 June (3.3×); it has its own off-site sources that raise the background.
- **DPG or PGMEA (m/z 133.09)**, glycol-ether solvents, rose 1.9× on 1 June and 2.9× on 4 June.

Figure 4 shows the signals behind those ratios. Background levels were 0.7–3.5 ions $s^{-1}$ for every ion shown, and plume means were 3–22 ions $s^{-1}$. Peak 10 s values were higher still: up to ~90 ions $s^{-1}$ for $C_5H_{10}O_2$ and ~20 ions $s^{-1}$ for propylene glycol on 4 June.

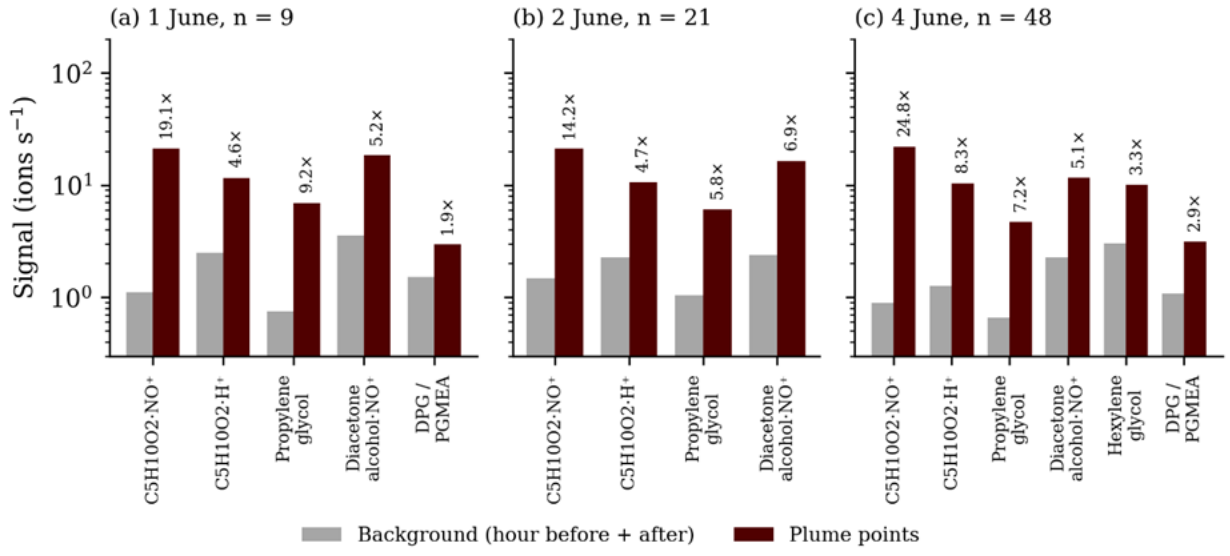


***Figure 4.*** *Mean signal in plume points (dark) and in the background hour before and after each pass (grey), log scale. Numbers give the plume-to-background ratio; n is the number of 10 s plume points. Only ions above background noise are shown. Signals are uncalibrated ion counts. (Figure by Alexander Treadway, TAMU)*

**Discussion**

These observations are consistent with a steady and localized source of glycols and glycol-related solvents at the northeast edge of the campus rather than with passing traffic or regional background. The same compounds rose together on every analyzed pass, the plume moved with the wind but traced back to the same location, and roads upwind of that location remained at background. The compound mix would be consistent with cooling-system fluids or maintenance chemicals, although no source was confirmed on site.

## Stationary Measurements

### UT Austin AMS analysis

The UT Austin supersite measurement team performed source apportionment using positive matrix factorization (PMF) for the measurement period from May 26 to June 21. High-resolution organic aerosol mass spectral data spanning m/z 12–120 with 1-minute time resolution were used as inputs to the PMF model.

Preliminary results (Figure 5) indicated that at least three-factor solution was reasonable based on Q/Qexp diagnostic analysis of solutions ranging from 1 to 10 factors. The three-factor solution could be interpreted based on the mass spectral profile and their physical characteristics. The three factors were **hydrocarbon-like organic aerosol (HOA), less-oxidized oxygenated organic aerosol (LO-OOA)**, and more-**oxidized oxygenated organic aerosol (MO-OOA)**. HOA represents fresh organic aerosol and is typically associated with primary organic aerosol (POA) from fossil fuel combustion. LO-OOA and MO-OOA typically represent secondary organic aerosol (SOA).

Figure 6 shows the median concentrations of each factor for each hour of the day to characterize their diurnal patterns. The three factors exhibited distinct patterns, suggesting differences in their sources and atmospheric processes. HOA exhibited an initial peak at approximately 8 a.m., coinciding with the morning rush hour in Houston and suggesting a substantial contribution from vehicle emissions. A second peak occurred at approximately 10 p.m., potentially reflecting changes in planetary boundary layer (PBL) height. A shallower nighttime PBL can cause pollutant accumulation near the surface, resulting in higher HOA concentrations.

LO-OOA concentrations generally began increasing in the morning following a dip 9-10 am and peaked in the afternoon. This pattern is consistent with the influence of solar radiation and photochemical production. MO-OOA exhibited a less pronounced diurnal pattern than HOA and LO-OOA, with concentrations increasing in the morning and remaining slightly elevated in the afternoon. This pattern may partly reflect further oxidation of LO-OOA. MO-OOA may originate from both local aerosol aging and regional transport.

In the MTR #4 (August 2026), we reported that the plume observed from June 17 to June 21 may have been associated with pollutants transported from the Gulf. The PMF results are consistent

with this interpretation, as MO-OOA concentrations were elevated during the same period. Aerosols undergo oxidation during long-range transport; therefore, the elevated MO-OOA concentrations observed during the plume period are consistent with a contribution from secondary, aged organic aerosol.

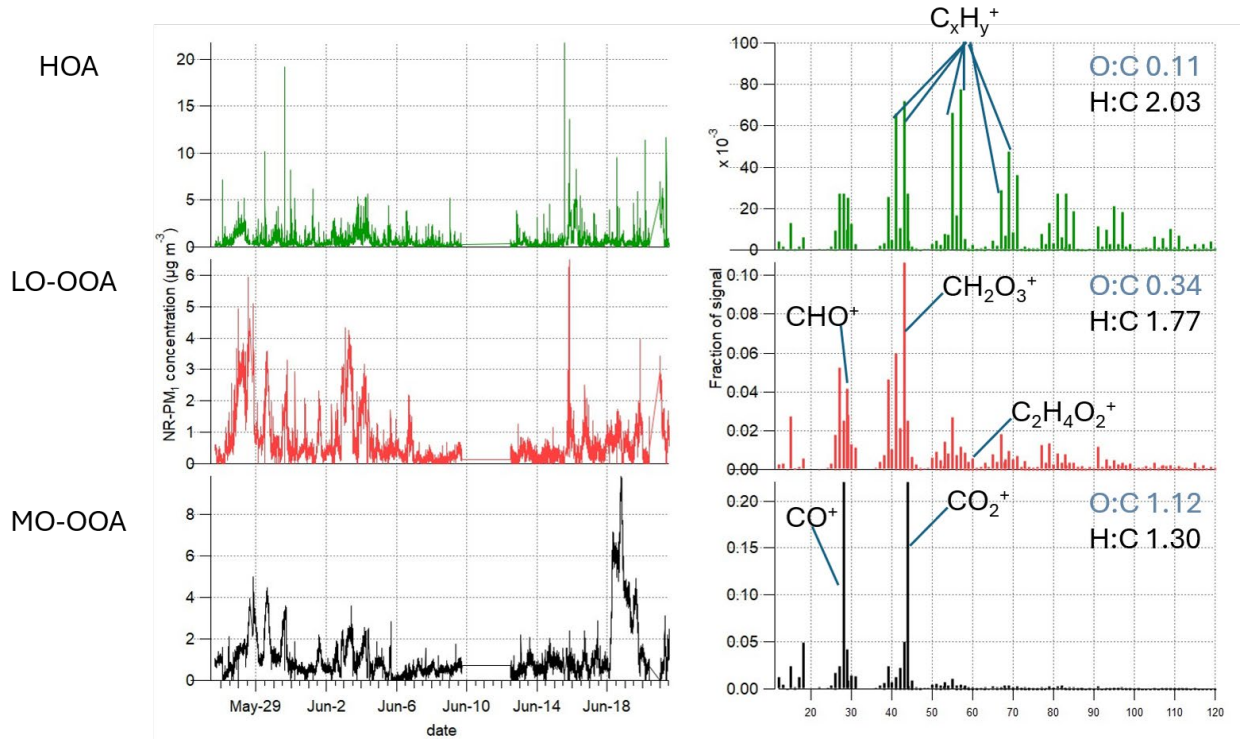


**Figure 5.** Time series (left) and mass spectral profiles (right) of HOA, LO-OOA, and MO-OOA. (Figure by Chun-Ying Chao, UT Austin)

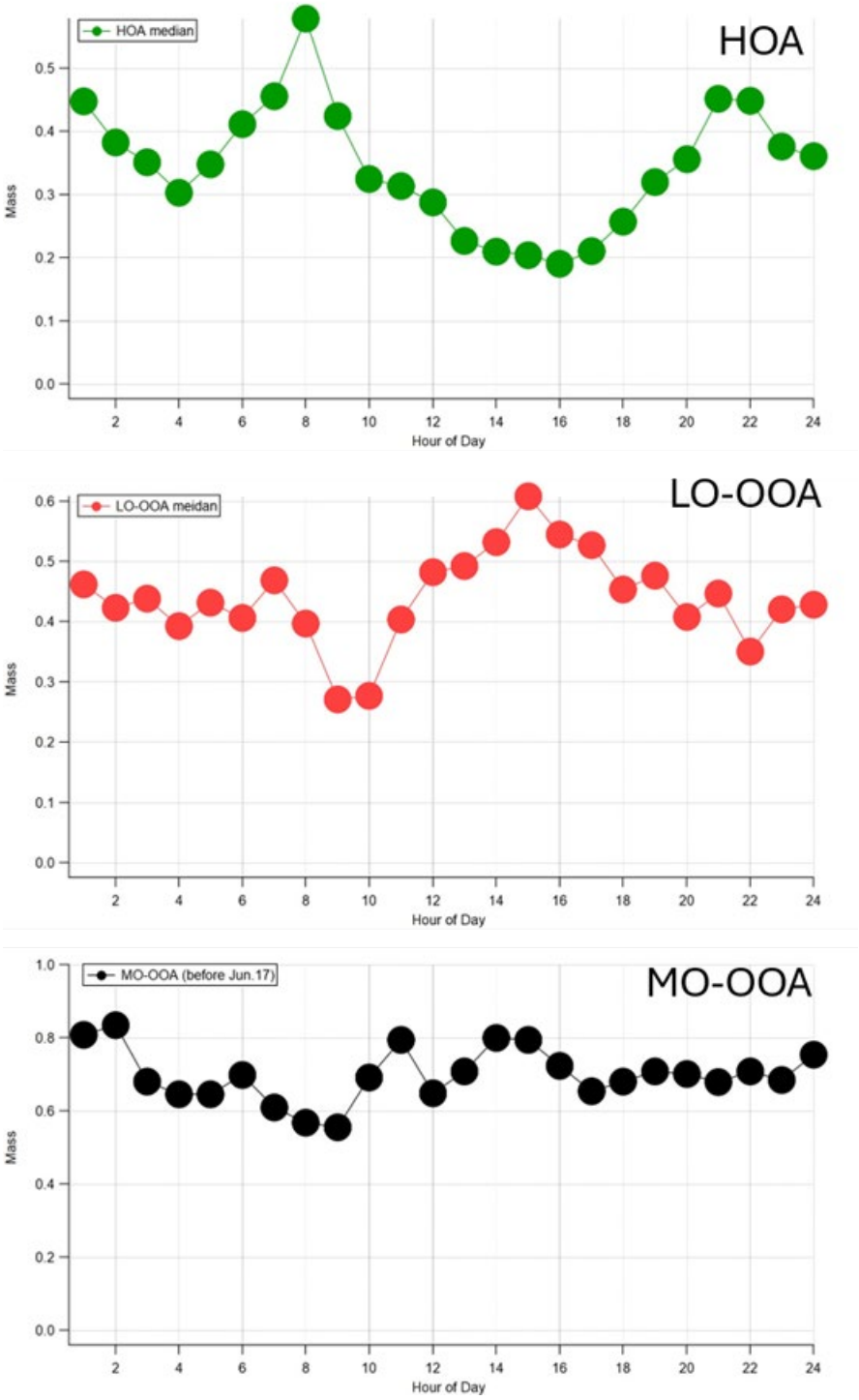


Figure 6. Diurnal patterns of HOA, LO-OOA, and MO-OOA. Note: Data collected after June 17 were excluded from the MO-OOA analysis to better characterize its typical diurnal pattern. (Figure by Chun-Ying Chao, UT Austin)

**Identify Any Problems or Issues Encountered and Proposed Solutions or Adjustments**

None.

**Goals and Anticipated Issues for the Succeeding Reporting Period**

For the mobile measurements, the calibration will be refined further, including the use of compound-to-compound sensitivity ratios from the full set of calibrations and optimization of the background treatment at low ambient concentrations.

From November 2 to 6, 2026, the UT Austin and TAMU teams plan to conduct joint mobile air quality measurements in Austin to complement the sampling that focused previously on Dallas, San Antonio and Houston. The campaign will provide complementary measurements around the data center and selected facilities listed in the Toxics Release Inventory (TRI). The planned route (Figure 7) will cover areas relevant to both efforts, with two runs anticipated per day, yielding approximately ten route measurements over the five-day campaign. Repeated coverage will help characterize spatial patterns and variability between runs. Suggestions from TCEQ are welcome.

The mobile platform will carry a Vocus proton-transfer-reaction time-of-flight mass spectrometer (Vocus PTR-ToF-MS), a time-of-flight aerosol mass spectrometer (ToF-AMS), an ozone monitor, and a QuantAQ sensor. The campaign will also include colocation at a Texas Commission on Environmental Quality (TCEQ) monitoring site. Although an automated gas chromatograph (auto-GC) is not available at the site, the teams will review the available site monitoring data and compare overlapping measurements with the mobile observations. These comparisons will support evaluation and interpretation of the mobile measurements.

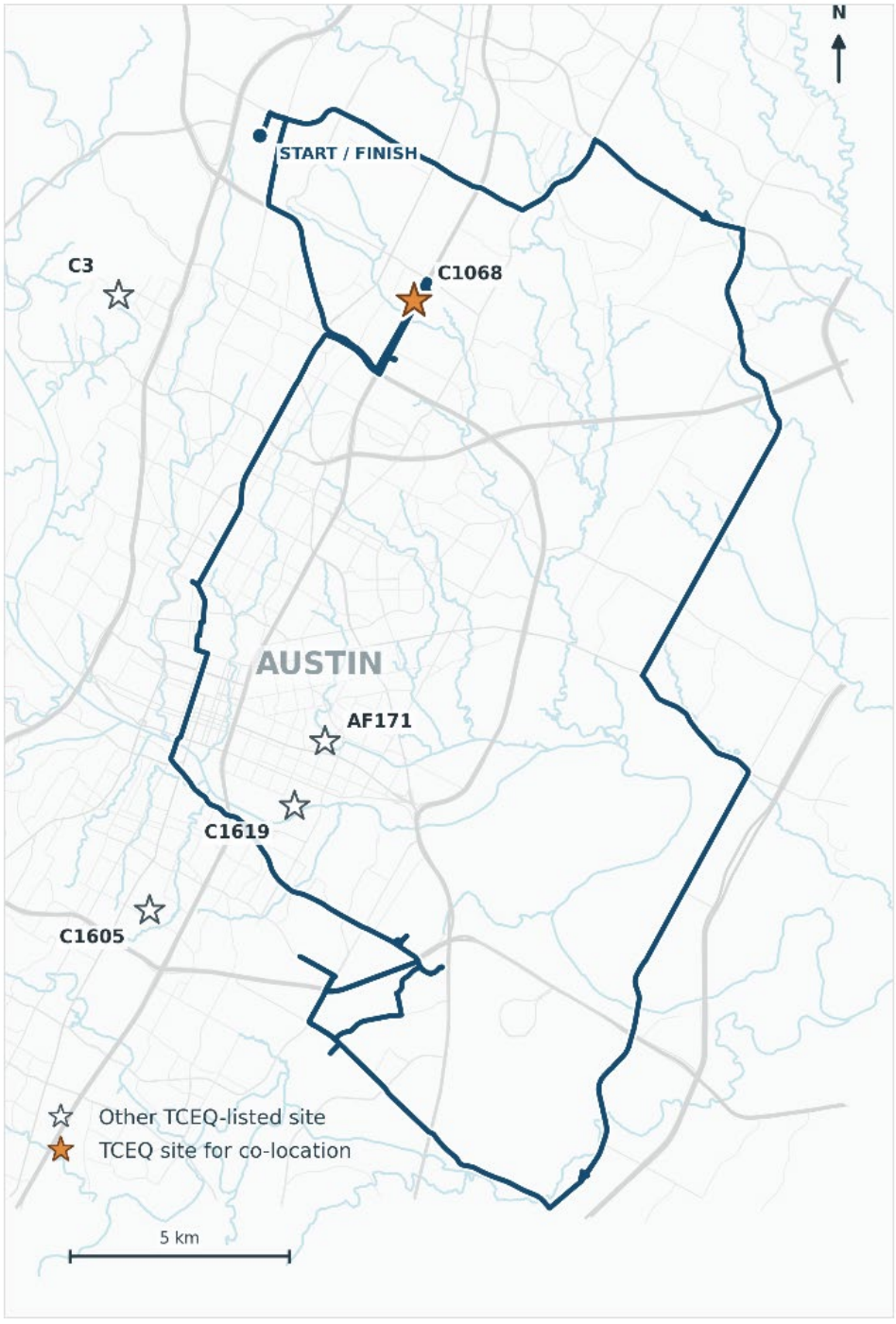


**Figure 7.** Planned preliminary mobile monitoring route in Austin, Texas. White stars mark TCEQ monitoring sites; the orange star marks the proposed co-location site (C1068).

**Publications and Presentations**

Do you have any publications related to this project currently under development? If so, please provide a working title, and the journals you plan to submit to.

☐ **Yes** ☒ **No**

Do you have any publications related to this project currently under review by a journal? If so, what is the working title and the journal name? Have you sent a copy of the article to your AQRP Project Manager and your TCEQ Liaison?

☐ **Yes** ☒ **No**

Do you have any bibliographic publications (ie: publications that cite the project) related to this project that have been published? If so, please list the reference information. List all items for the lifetime of the project.

☐ **Yes** ☒ **No**

Do you have any presentations related to this project currently under development? If so, please provide working title, and the conference you plan to present it (this does not include presentations for the AQRP Workshop).

☒ **Yes** ☐ **No**

*Accepted for oral presentation at the AGU26 Annual Meeting, San Francisco, December 7-11, 2026:*

*Keuntaek Kim, Hyeonjun Lee, Daniel H Sung, Chou-Hsien Lin, Shihao Zhai, Chun-Ying Chao, Alana Dodero, Jiayun Zhao, Alexander Treadway, John Gonzales, Yue Zhang, Lea Hildebrandt Ruiz, and Pawel K Misztal: Spatiotemporal Characterization of Urban VOCs in Dallas, Houston, and San Antonio using Mobile and Stationary PTR-ToF-MS Measurements from the AQRP-TexAQS Campaign.*

Do you have any presentations related to this project that have been published? If so, please list reference information. List all items for the lifetime of the project.

☐ **Yes** ☒ **No**

Have any personnel changes occurred that were not listed in the original proposal? If so, please include a detailed description of the personnel change(s) below.

☐ **Yes** ☒ **No**

Are any delays expected in the progress of the research? If so, please include a detailed description of the potential delay below.

☐ **Yes** ☒ **No**

Describe any possible concerns/issues (technical or non-technical) that AQRP should be made aware of.

None

Are you anticipating using all the available funds allocated to this project by the end date? If not, why and approximately what is the amount to be returned?

☒ **Yes** ☐ **No**

Submitted to AQRP by
Pawel Misztal