Ground Level Ozone Research (GLOR)

Deploying 6 New PAMS-*lite* sites during the Summer-Fall 2025 Field Campaign

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Objectives of GLOR

- Study the formation of ground-level ozone using high-resolution measurements of precursors and meteorological conditions at sites within and surrounding the Phoenix-metro area.
- Ground-level observations from summer-fall 2025 will be used in a modeling effort for the MAG Ozone State Implementation Plan (SIP) Weight of Evidence.
- Determine the impacts of transport, wildfires, and anthropogenic sources on ozone production.

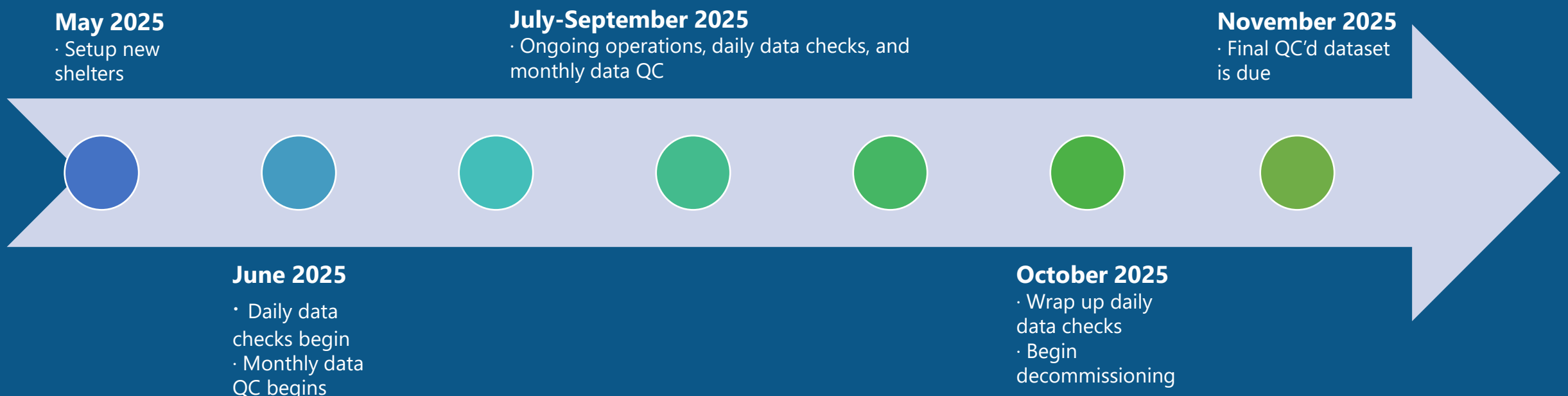
Sampling Locations

- JLG is an existing Photochemical Assessment Monitoring Station (PAMS)
- Add shelters at the other 6 sites to run a PAMS-*lite* suite
  - C2-C12 VOCs
  - True NO_2
  - Total Reactive Nitrogen (NO_y)
  - Continuous Formaldehyde
- "*Lite*" because we're not adding meteorological equipment since it's already available at most sites

Sidetrack: PAMS Network

- *Main objective is to develop a database of ozone precursors and meteorological measurements to support ozone model development and track the trends of key ozone precursor concentrations.*
- The goal of and parameters sampled at PAMS Network sites are well aligned with the GLOR objectives.
- The sampling approach for GLOR is very similar to PAMS sites (i.e., PAMS-*lite*).
- The similarity between this campaign and the existing PAMS Network will provide value and context for future ozone research.

Project Timeline



- Hourly automated alerts are applied to all data streams to catch issues as quickly as possible.
- Data are reviewed by an analyst assigned to each site daily to catch any issues not caught by the automated alerts.
- All data streams are fully QC'd monthly and delivered to stakeholders.

VOC Sampling

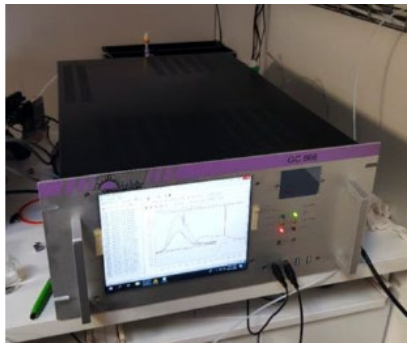
- Hourly samples of C2-C12 VOCs
- Consolidated Analytical Systems (CAS) Chromatotec
  - C2-C6 and C6-C12 Gas Chromatograph (GC)-Flame Ionization Detector (FID)
- Electrolysis to create GC carrier gas – no helium/hydrogen needed
- Nightly automated calibration with retention time standards
- Weekly automated calibration with internal permeation sources

VOC Sampling

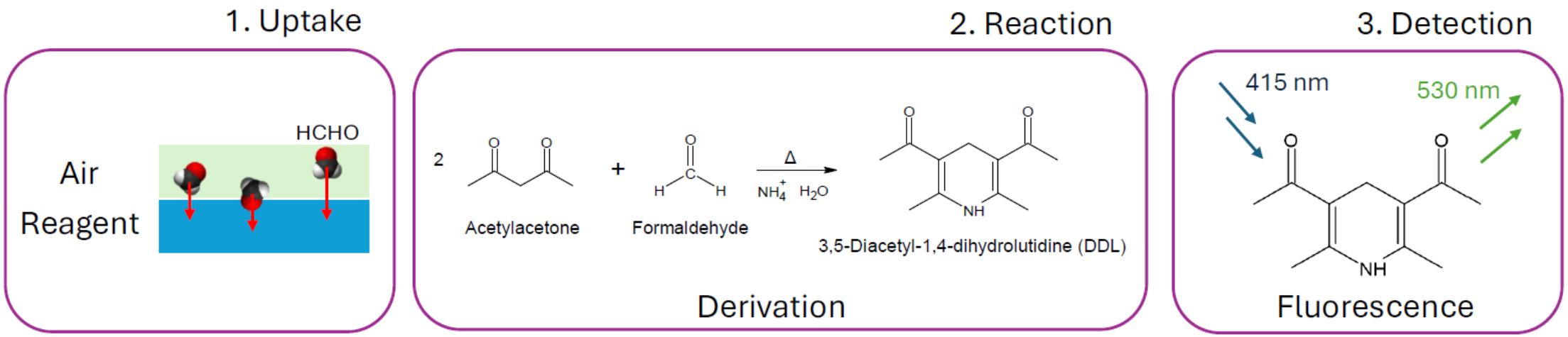
- Up to 60 quantifiable VOCs per hour including C2-C12 Total VOCs (TVOC)
  - TVOC includes unidentified VOCs
- Following EPA PAMS Technical Assistance Document (TAD) and ADEQ Quality Assurance Project Plan (QAPP) for instrument maintenance, calibration, and data QC

Quantified VOC List			
Ethane	1-Pentene	3-Methylhexane	a-Pinene
Ethylene	Cis-2-Pentene	2,2,4-Trimethylpentane	n-Propylbenzene
Propane	2,3-Dimethylbutane	n-Heptane	m-Ethyltoluene
Propene	3-Methylpentane	Methylcyclohexane	p-Ethyltoluene
i-Butane	n-Hexane	2,3,4-Trimethylpentane	1,3,5-Trimethylbenzene
n-Butane	Isoprene	Toluene	o-Ethyltoluene
Acetylene	1-Hexene	2-Methylheptane	b-Pinene
Trans-2-Butene	2,4-Dimethylpentane	3-Methylheptane	1,2,4-Trimethylbenzene
1-Butene	2,3-Dimethylpentane	n-Octane	n-Decane
Cis-2-Butene	2,2-Dimethylbutane	Ethylbenzene	1,2,3-Trimethylbenzene
Cyclopentane	2-Methylpentane	m&p-Xylenes	m-Diethylbenzene
i-Pentane	Methylcyclopentane	Styrene	p-Diethylbenzene
n-Pentane	Benzene	o-Xylene	n-Undecane
1,3-Butadiene	Cyclohexane	n-Nonane	n-Dodecane
Trans-2-Pentene	2-Methylhexane	i-Propylbenzene	Total nonmethane organic compounds (TNMOC)

Continuous Formaldehyde

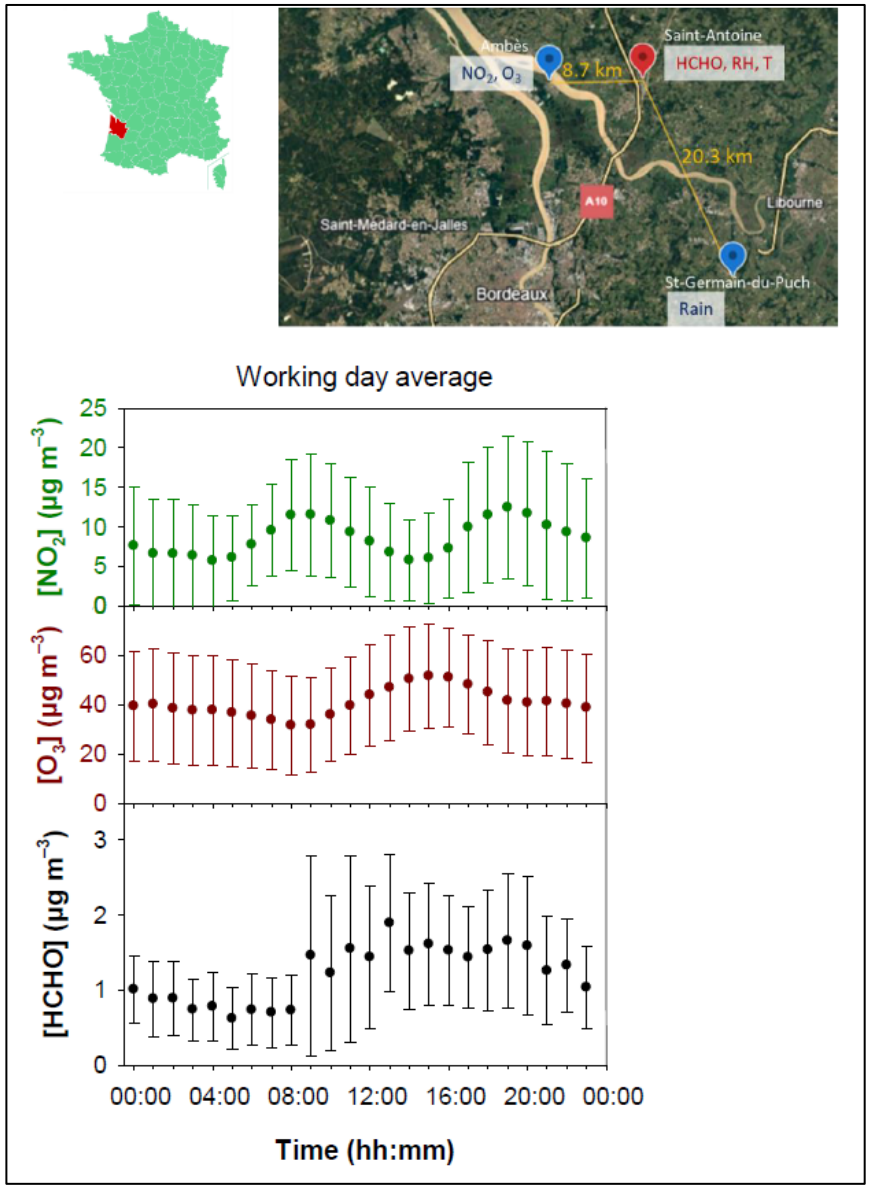


- New AirmoF system from Chromatotec via CAS
- Online method compared to PAMS carbonyl sampling (i.e., offline DNPH cartridges)
- Reaction of formaldehyde with 3,5-diacetyl-1,4-dihydrolutidine (DDL)
- DDL detected via fluorescence
- 20-minute data resolution of formaldehyde



Continuous Formaldehyde

- Example data from the AirmoF system
- Able to observe daily variation in formaldehyde which correlated with ozone concentrations
- Limit of Detection = 0.19 µg/m^3
- Shows ± 5% reproducibility over three months of calibration
- Requires monthly reagent renewal
- Nightly automatic calibration



True NO_2

- Teledyne N500 Cavity Attenuated Phase Shift (CAPS) True NO_2-NO_X-NO Analyzer
- *Direct* measurement of NO_2 using CAPS spectroscopy
- The indirect measure of NO_2 can be biased high when photochemistry is important (i.e., significant presence of total reactive nitrogen [NO_y]) because these species are also converted by the catalyst to NO
- Following EPA PAMS TAD and ADEQ's QAPP for maintenance, calibration, and data QC

Total Reactive Nitrogen (NO_y)

- Teledyne T200U-NO_y Trace Level Chemiluminescence NO-NO_y Analyzer
- NO_y converter + chemiluminescence reaction cell to measure NO and NO_y
- Lower detectible limit of 50 ppt
- Combination of nitrogen measurements also allows the calculation of NO_x and NO_z
- Also following EPA PAMS TAD and ADEQ's QAPP for maintenance, calibration, and data QC

Calibration of True NO_2 & NO_y

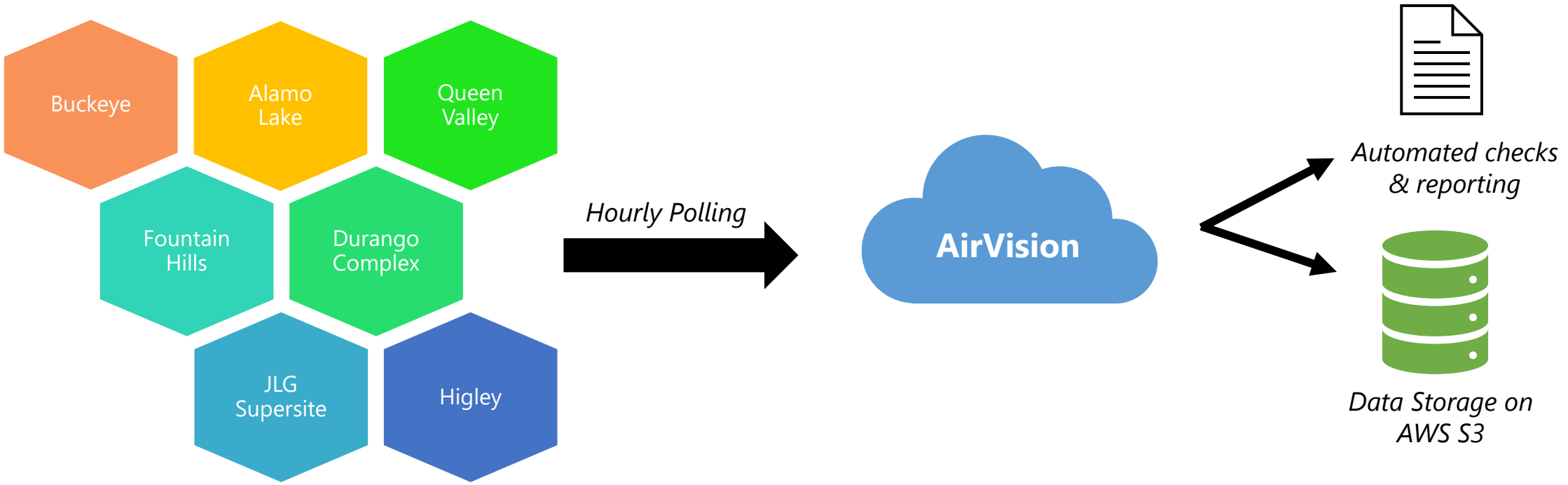
- NO calibration gas available at each site
- Teledyne T750U Portable Trace Level Calibrator & 751H Portable Zero Air Generator used to calibrate True NO_2 and NO_y instruments
- Offset monthly Zero/Span and Multipoint Verification (MPV)
  - Calibration occurring every other week at every site
- MPV before and after sampling season

T750U Calibrator

751H Zero Air Generator

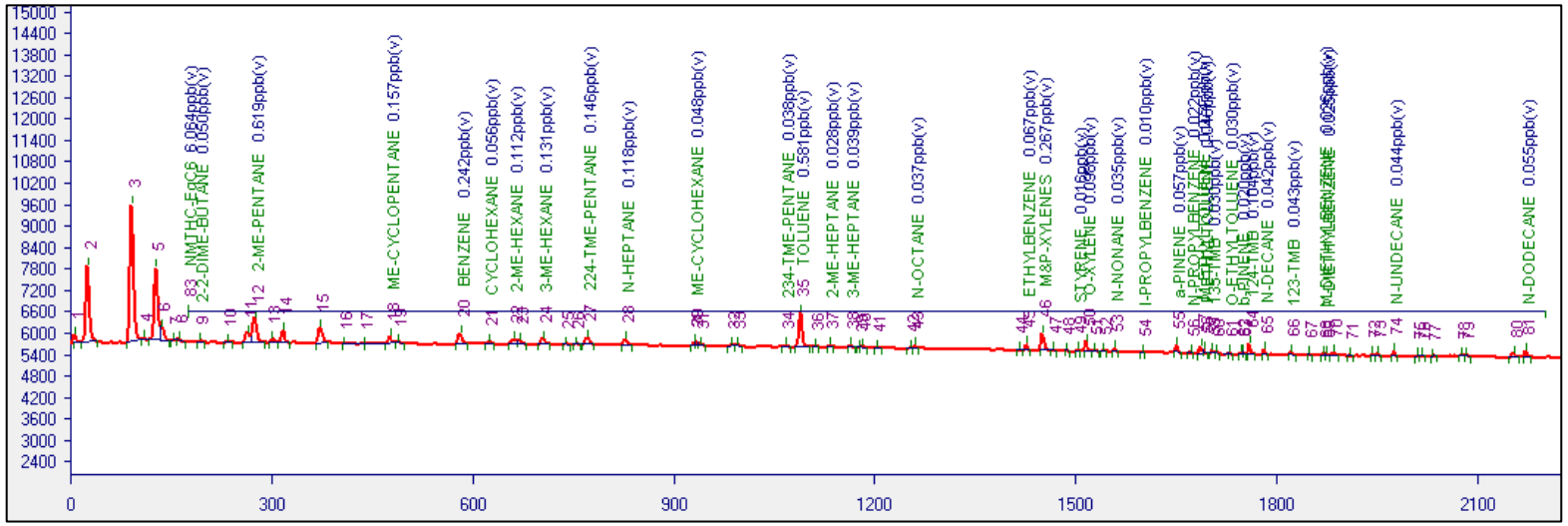
Data Flow and Storage

- Utilize Agilaire 8872s Data Acquisition Systems (DAS) for on-site data collection and aggregation.
- AirVision server on AWS collects information from all sites and runs hourly automated checks.



Data QC

- Reviewing all GC-FID chromatograms to assess baselines, peak integration, unknown peaks, and coelution.
- Following the PAMS TAD for flagging of VOC, Formaldehyde, NO_x, and NO_y data
- Data will QC'd monthly with a Secondary QC at the end of the campaign



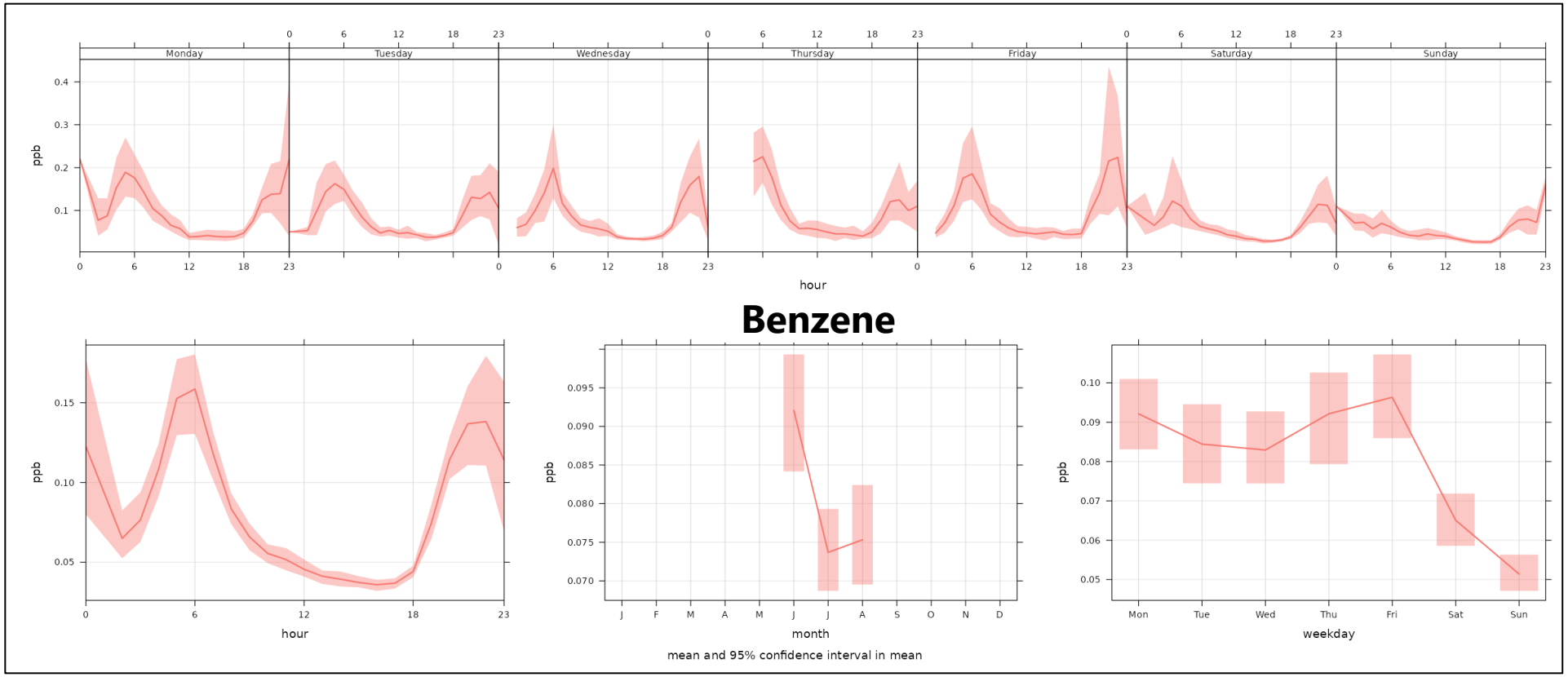
Example of a normal C6-C12 Chromatogram

How does this aid GLOR?

- High temporal resolution samples of ground-level ozone precursors (VOCs/Formaldehyde/NO_x/NO_y)
- Modeling for SIP based on observations instead of emissions inventories
- Identify impacts of transported wildfire smoke on ozone and ozone precursors in the Phoenix metro and outlying areas
- Isolate anthropogenic impacts on ozone using widespread site design

Data Monitoring & Validation at JLG

We've been assisting ADEQ in monitoring and reviewing PAMS data from the JLG Supersite for the last 3 years with good results.



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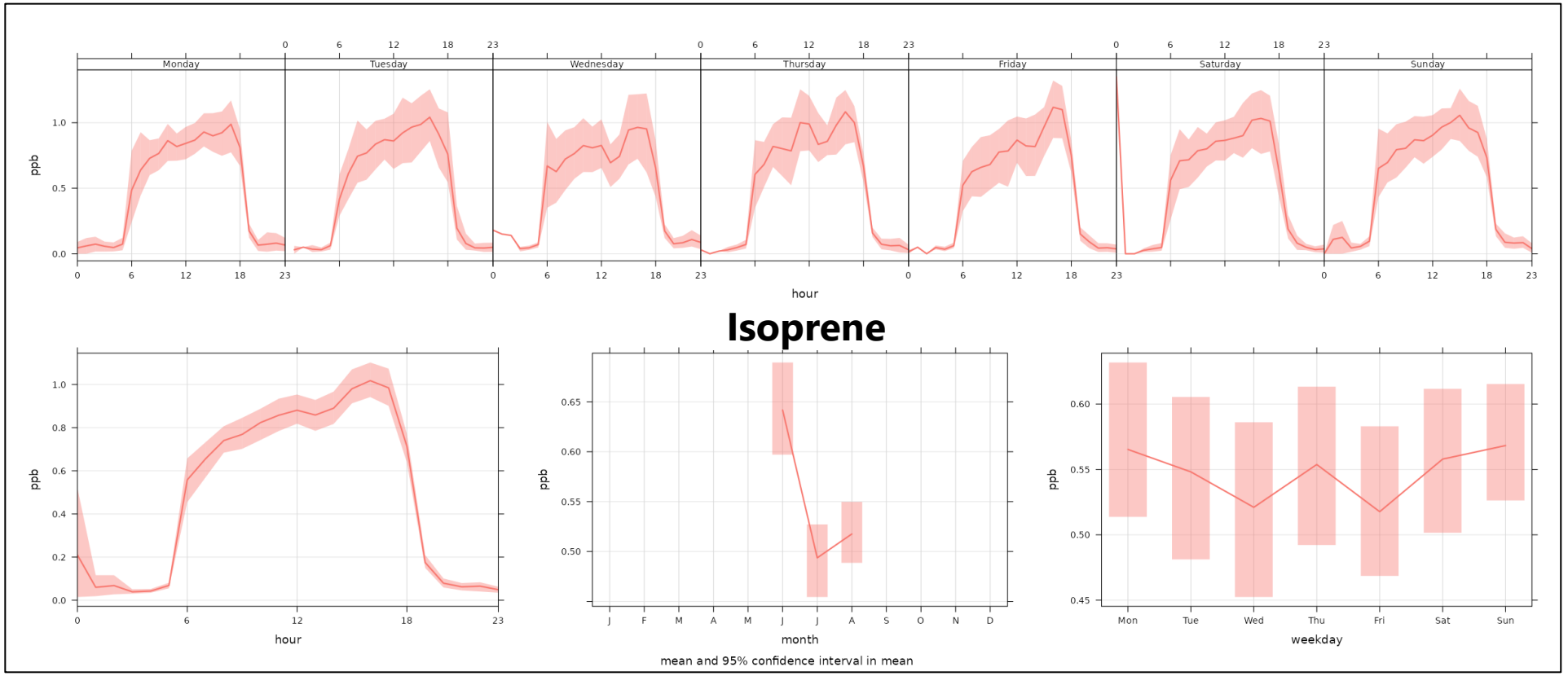

Conclusions

- Sonoma Tech, CAS, ASU, and partners will be setting up 6 new PAMS-*lite* sites in and around the Phoenix metro area.
- New instrumentation will include C2-C12 VOCs, True NO_2, NO_y, and Continuous Formaldehyde.
- High temporal resolution ozone precursor measurements will assist in completing the GLOR goals and MAG SIP modeling.
- Data will be available on EPA's Air Quality System (AQS)
  - Data obtained has significant potential to help modeling of ozone production in the southwest U.S. and highly valuable to other PAMS operators.

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