

# Building Comprehensive Quality Assurance for the Air Toxics and Ozone Precursors Monitoring Program at the State of Colorado's APCD

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National Ambient Air Monitoring  
Conference, August 2024



**COLORADO**

**Air Pollution Control Division**

Department of Public Health & Environment

# Overview

- I. ATOPs Overview & DAQ Unit
- II. Building a QA Program
- III. Building a Data Processing and Validation Solution



# Air Toxics and Ozone Precursors Program (ATOPs)

Est. Dec. 2022

## Stationary Air Toxics



Time-integrated sampling,  
NATTS/COATTS (VOCs, metals,  
PAHs, carbonyls)

## Mobile Air Toxics



High-time resolution data, mobile and stationary  
(Eiger PTR-MS, AIM Chemical Ionization Time-of  
Flight MS, Picarro, Micro-GC)

## Oil & Gas Mobile Monitoring



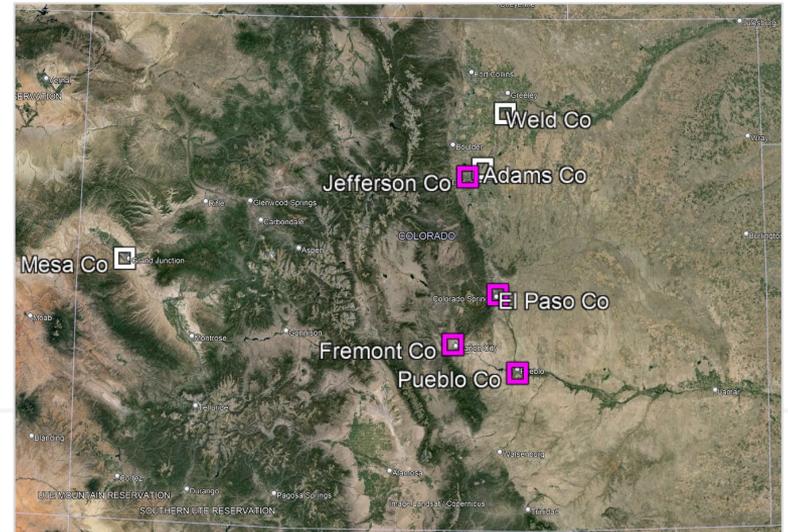
High-time res. data, (open-path  
optical instruments, conventional GC,  
Micro-GC, sensors and canisters)

## Data & QA Unit

Air Toxics Monitoring Database, data  
dashboards, data access

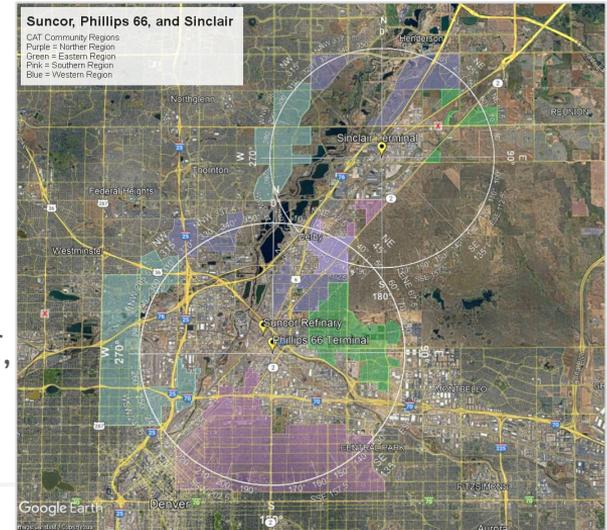
# Overview: Stationary Air Toxics (SAT)

- NATTS - National Air Toxics Trends Station
  - Grand Junction site, in operation since 2004
- COATTS - Colorado Air Toxics Trends Station
  - **Public Protections from Toxic Air Contaminants (HB22-1244):** expands Colorado's air monitoring for air toxics (operated as NATTS sites)
    - Phase 1: 3 sites in 2024
    - Phase 2: 4 sites in 2025
- COOPS - Colorado Ozone Precursor Sites
  - Four fixed locations
  - 81 VOCs, 3-hr samples every 6th day



# Overview: Mobile Air Toxics (MAT)

- Monitoring Assets
  - Community Air Toxics (CAT) Mobile Van
  - Emissions Monitoring Utility (EMU) Mobile Van
  - Mobile Air Remote Monitoring Trailers (MARMOTs)
- Colorado Air Toxics Act (HB21-1189)
  - Monitoring of 3 toxic gasses (benzene, hydrogen cyanide, and hydrogen sulfide)
  - In the communities surrounding 4 covered facilities (within a 3 mile radius)
  - Monitoring completed primarily by the CAT, driving repeated routes



# Overview: Oil & Gas Mobile Monitoring (OMM)

## Monitoring Assets

- Mobile Optical Oil & Gas Sensor of Emissions (MOOSE)
- Colorado Air Monitoring Mobile Lab (CAMML)
- Pyxis Micro-GC and AROMA VOC
- SENSIT SPODs

## Objectives

- Provides monitoring around oil and gas
- Aimed at measuring emissions reaching nearby residential areas
- OMM group works with the Toxicology and Environmental Epidemiology (TEEO) as part of the Oil and Gas Health Information and Response (OGHIR)
- Program to investigate complaints from the public



# Overview: Data & Quality Assurance (DAQ)

## Quality Assurance

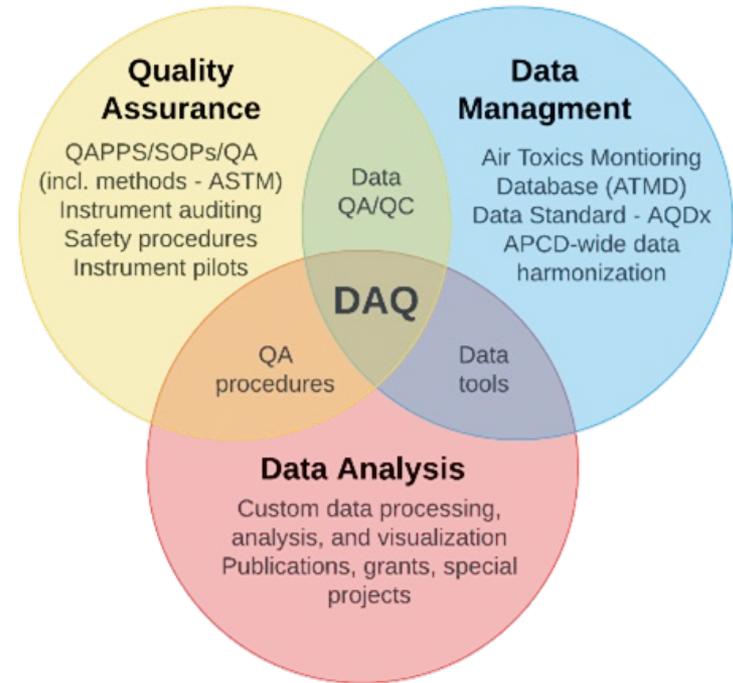
- Ensure high quality data is collected by conducting periodic instrument audits
- QA review/approval of data

## Data Management

- Manage and maintain the Air Toxics Monitoring Database (ATMD)
- Coordinate data sharing outside of ATOPs

## Data Analysis

- Support and assist ATOPs and the APCD in data processing, analysis, and visualization efforts
- Communicating key takeaways to the public

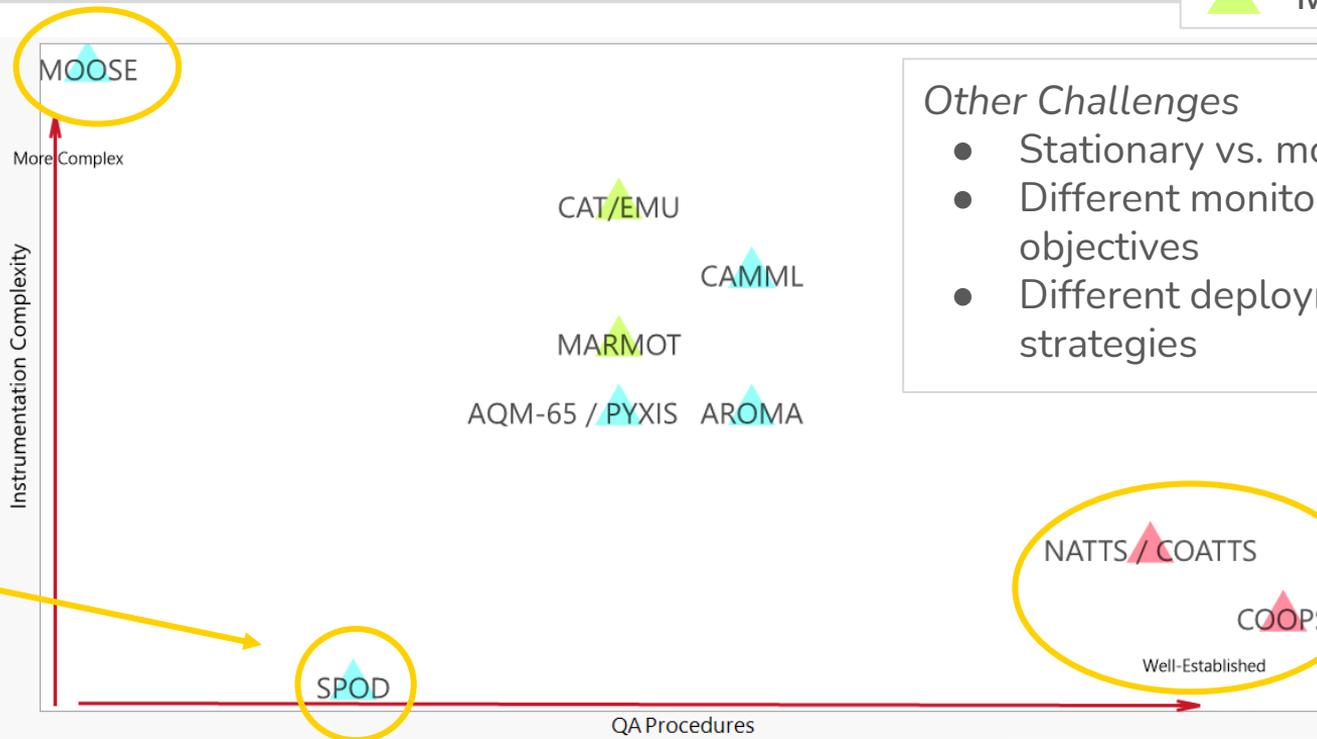


# Key Challenges

▲ SAT  
▲ OMM  
▲ MAT

Highly-novel  
open-path  
optical  
instruments

Low-cost  
sensors



## Other Challenges

- Stationary vs. mobile
- Different monitoring objectives
- Different deployment strategies

Long-running stationary  
sampling methods



# Quality Assurance Components

## *Audits, calibration, and determination of detection limits*

- Internal at this point, but independent from asset operators
- Includes auditing of sampling equipment and monitoring instruments, auditing/calibration of flow meters and controllers, and tracking of recurring maintenance and calibration for other ATOPs equipment

## *Documentation*

- QAPPs developed at the asset-level (as opposed to program-level) due to different monitoring objectives and wide range of instrumentation
- Organization/development/review of other documentation

## *Data Review and Approval*

- Interim/manual processes in place, ATMD will offer standardization
- Need robust QA procedures for ATMD (i.e., auditing the QA/QC workflows)



# QA Examples

## NATTS/COATTS - existing

### Quarterly Performance Audits

- As specified in the TAD for VOC (ATEC), PAH (PUF), Carbonyl (ATEC), and metals (PM10 filters) sampling devices

### Documentation

- Operating and audit SOPs, audit forms, QAPPs following NATTS format, corrective action reports (based on requirements in TAD)

### Data Review and Approval

- ATMD for auto and manual QA/QC for data from laboratory

## CAT/EMU - new protocols

### Quarterly Performance Audits

- For continuous instruments (zeros, specified set points, and audit MDL calculations using 40 CFR)
- Additional checks (e.g., checks for meteorological instruments, incl. GPS)

### Documentation

- Operating and audit SOPs, audit forms, asset QAPPs modelled on APCD TSP format, corrective action reports

### Data Review and Approval

- ATMD for deployment data
- Internal solution for audit processing and verification



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# QA Examples - CAT/EMU Mobile Lab

- Metrics modelled on those applied to continuous criteria pollutant monitors
- Audit levels based on Colorado's Health Guideline Values (HGVs) and level 1 8-hr AEGL limits (i.e., designed to target levels of concern to human health)
- Have internal code/UI to standardize processing of audit data

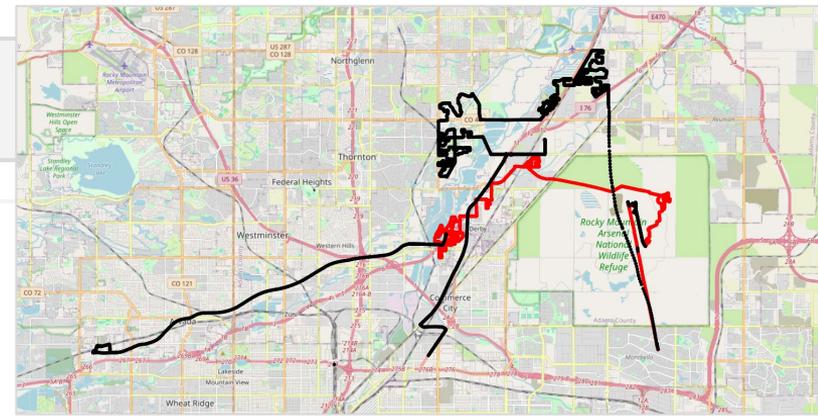
Check	Acceptance Criteria
Percent difference of audit levels (accuracy)	< +15.1%
Percent recovery of audit levels	+/- 30% of 100%
Zero check	< 3x the audit MDL & less than HGV
Relative percent difference of steady state period (precision)	< +15.1%
Audit/calculated MDL check (sensitivity)	< 1/3 HGV or AEGL limit



# Unexpected Challenges

## GPS QA/QC

- Issue: mobile monitoring platform GPS instrument was producing incorrect data (off route, off roads, etc.)
- Short-term solution: filter data based on number of satellites (metadata provided by GPS instrument), imperfect - overfiltered
- Long-term solution: code to (1) invalidate points off roads, and (2) flag points off typical route for manual review



## Complexity of wind speed/direction data collected by mobile platform

- Aerodynamics seem to influence WS/WD data at vehicle higher speeds
- Solution: informationally flagging data when there is low variability in relative wind direction



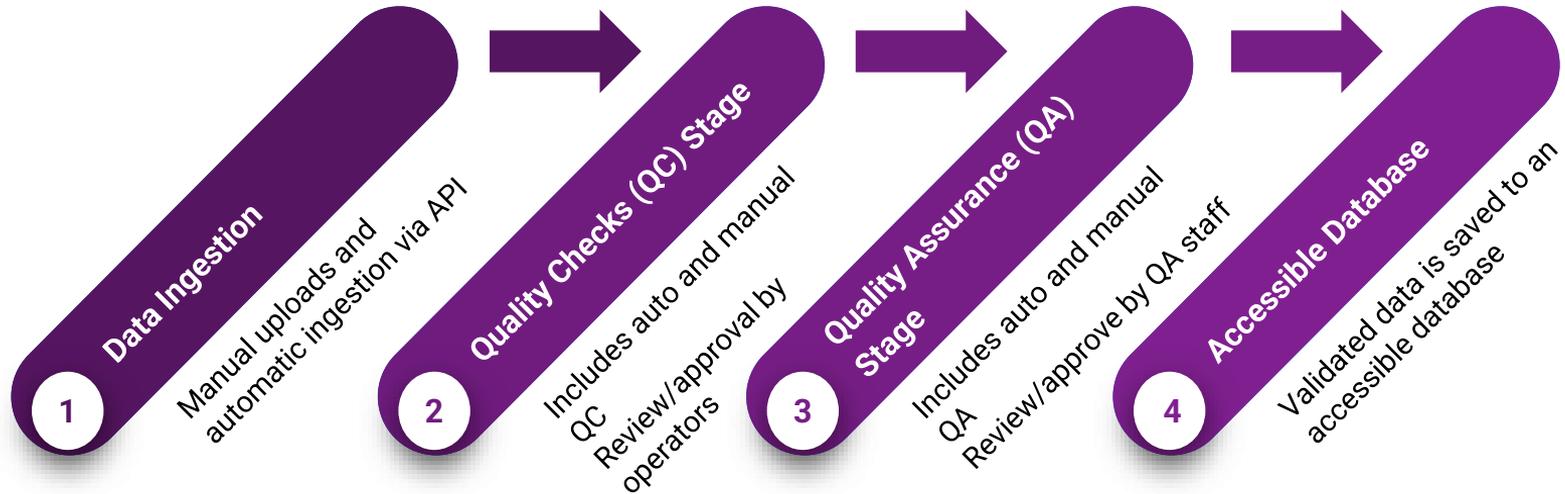
# QA Lessons Learned

For novel instrumentation/platforms

- Helpful to begin with “pilot audits”, to better inform purchasing and equipment needs
- Model QA procedures and documentation on existing programs where possible
- Build QA Program 1 asset/monitoring platform at a time
- Supplemental monitoring information (i.e., meteorological and GPS may present their own challenges - begin auditing these when auditing air toxics instruments)



# Air Toxics Monitoring Database - ATMD

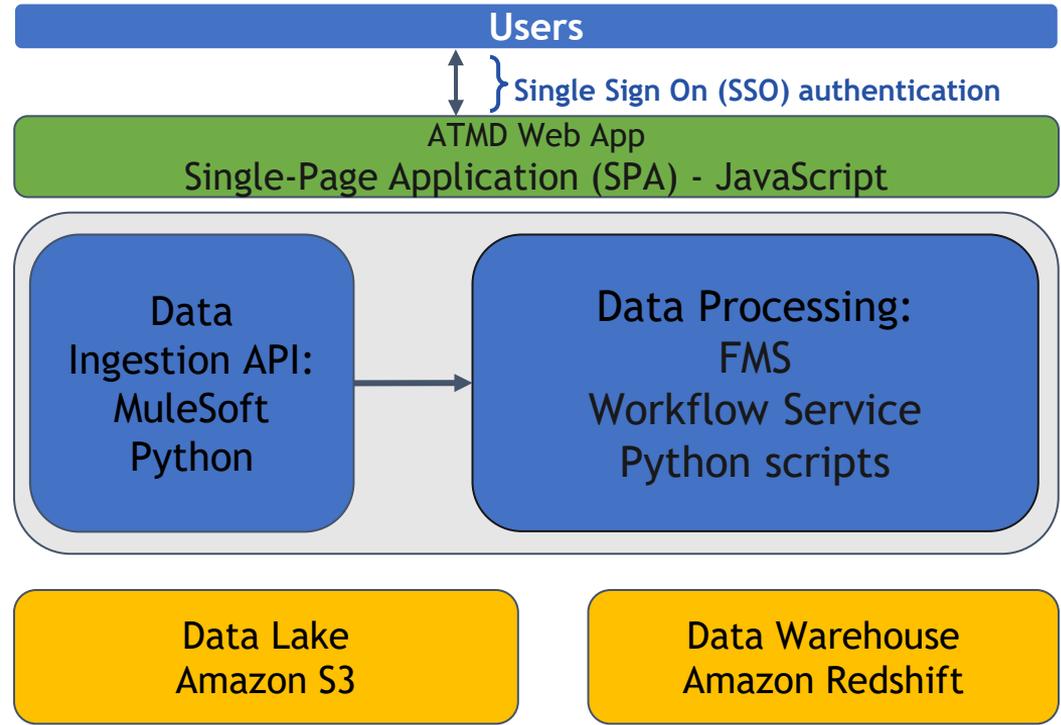


*Admin Page: defining and onboarding new monitoring assets, building QA/QC workflows, managing compound and site libraries*

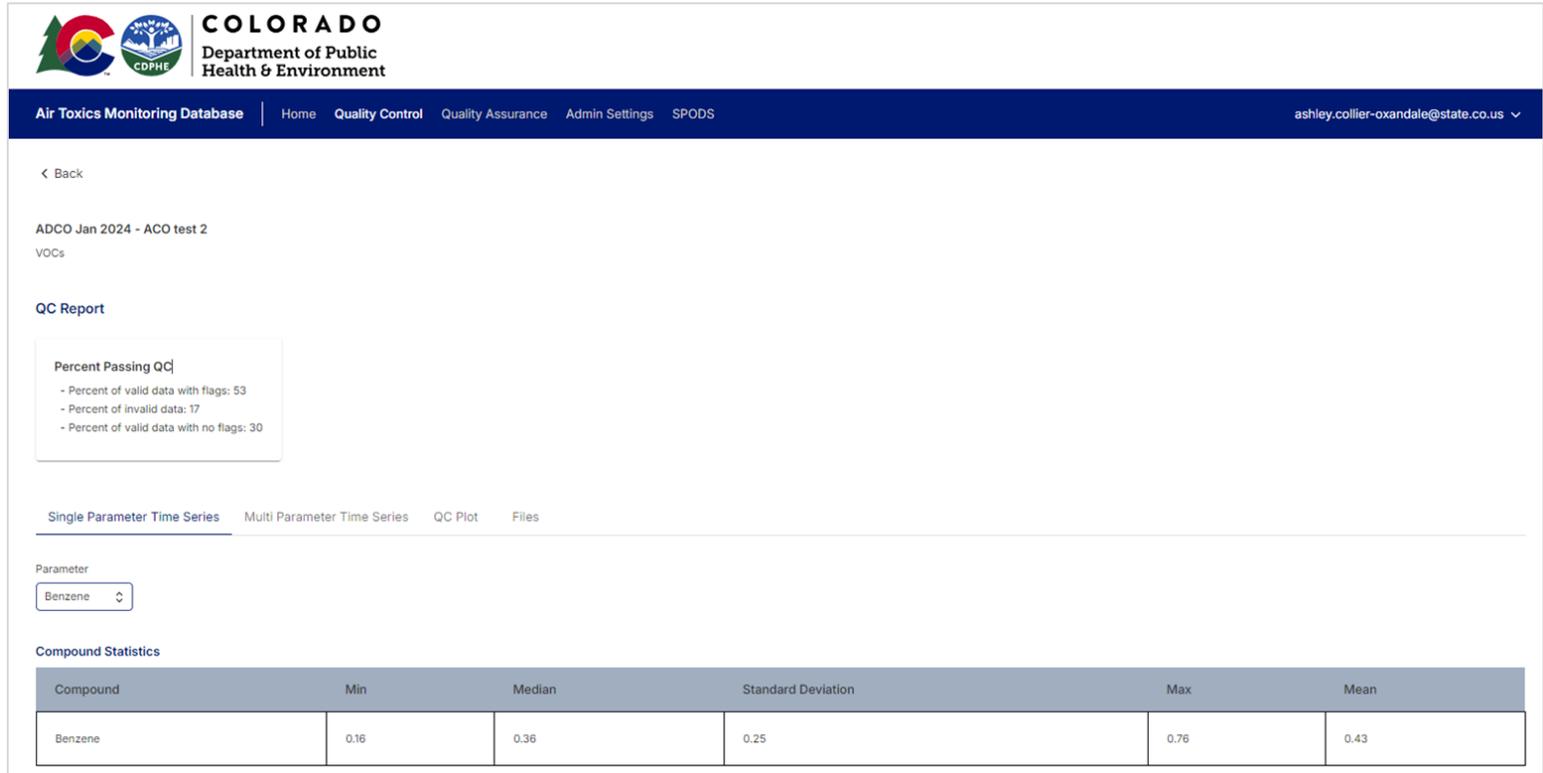


# ATMD Back-End Details

- Using AWS in coordination with other division data modernization efforts
- Saving raw data and QA/QC data separately to “data lake”, and validated data to Redshift database



# ATMD Web - Application Overview



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**Air Toxics Monitoring Database** | Home | **Quality Control** | Quality Assurance | Admin Settings | SPODS | ashley.collier-oxandale@state.co.us

< Back

ADCO Jan 2024 - ACO test 2  
VOCs

**QC Report**

**Percent Passing QC**

- Percent of valid data with flags: 53
- Percent of invalid data: 17
- Percent of valid data with no flags: 30

Single Parameter Time Series | Multi Parameter Time Series | QC Plot | Files

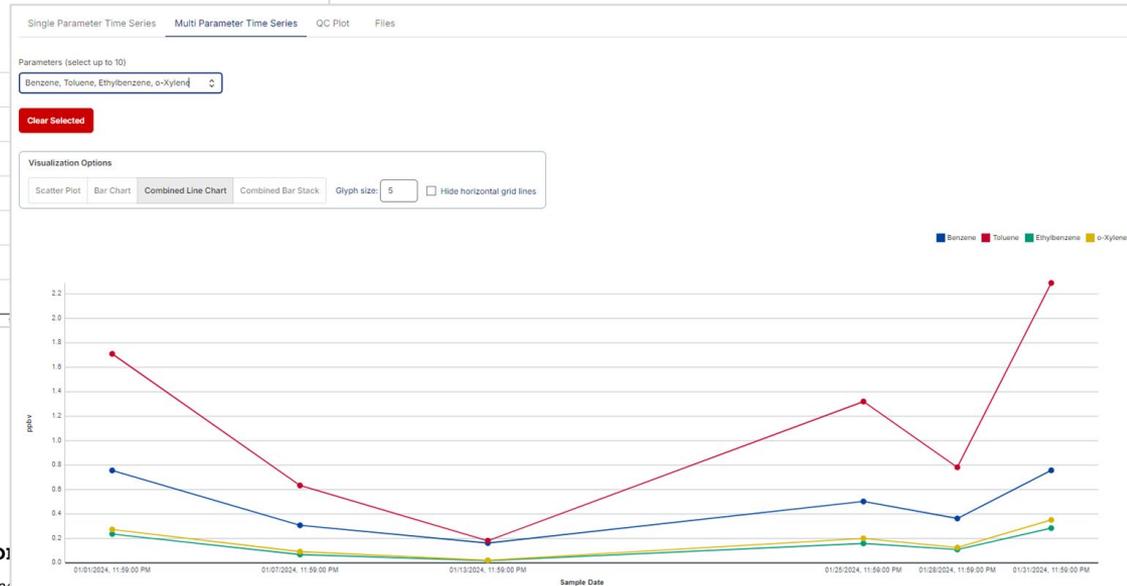
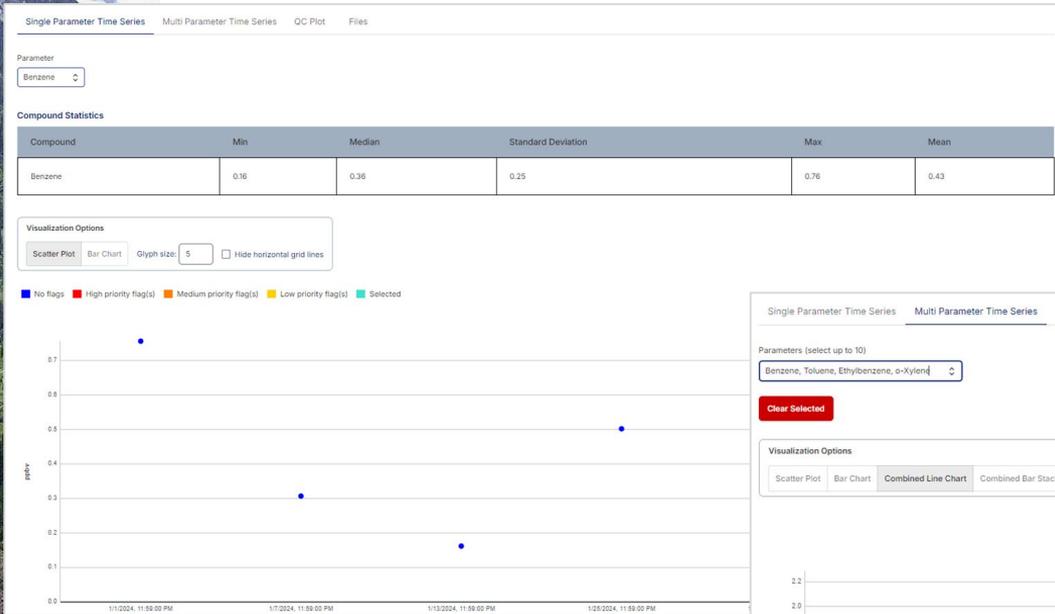
Parameter  
Benzene

**Compound Statistics**

Compound	Min	Median	Standard Deviation	Max	Mean
Benzene	0.16	0.36	0.25	0.76	0.43



# ATMD Web - Application Overview



# ATMD Web - Application Overview

Parameters

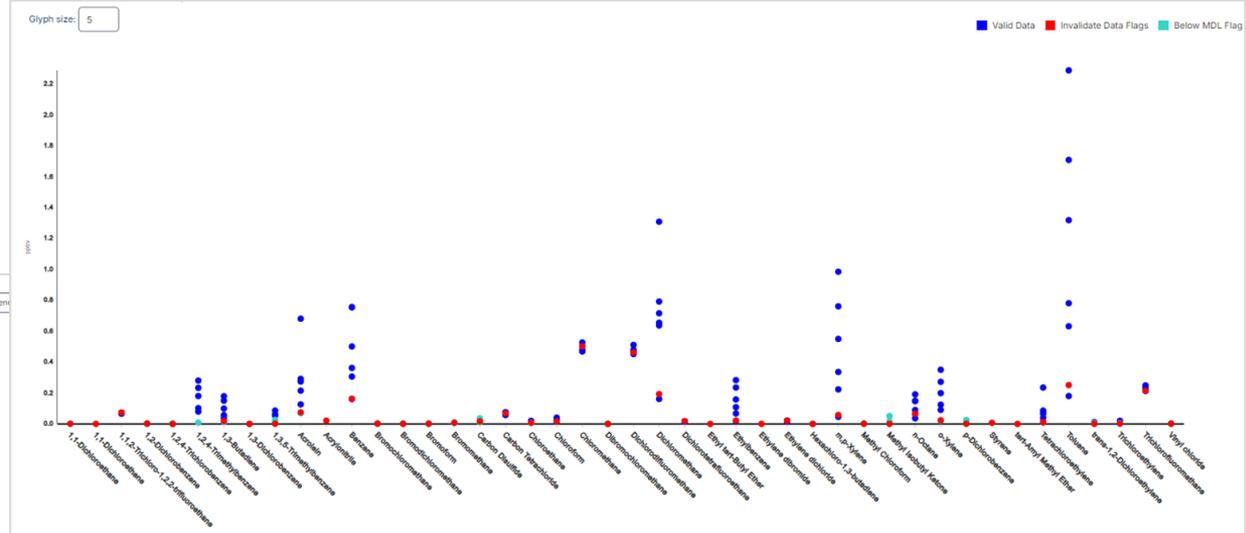
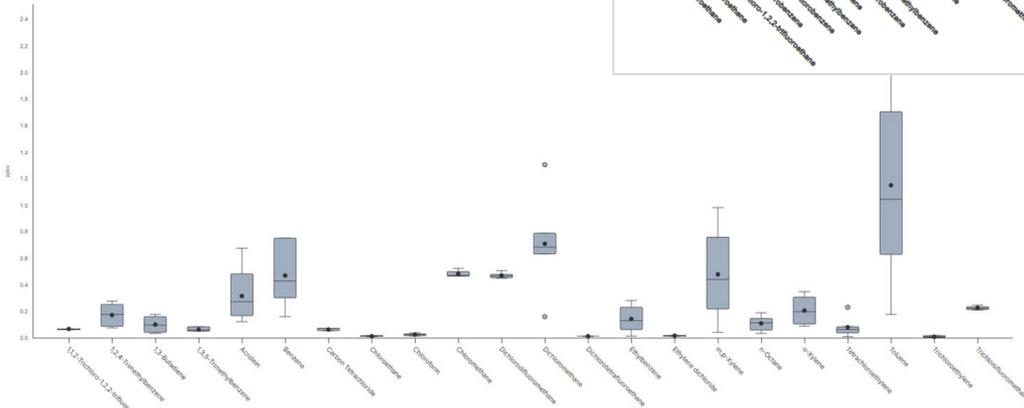
Methyl Chloroform, 1,1,2,2-Tetrachloroethane, 1,1,2-Trichloroethane, 1,1-Dichloroethane, 1,1-Dichloroethene, 1,2,4-Trichlorobenzene, 1,2,4-Trimethylbenzene, Ethylene

Select All Clear Selected

Visualization Options

Y-Axis Scale

Linear Logarithmic



# ATMD Web - Application Overview

## Manual QC Checklist

- RPD should be less than 25.1%. Add flag AB where untrue.
  - In the QC DATA tab in the Monthly Data File, if duplicates are present, verify RPDs in duplicate samples are <25.1% for compounds where at least one of the pair is greater than 5xMDL. If this is untrue, add the following qualifier flag: AB. Also, add AJ flag to all duplicates present.
  - Verify "method" blanks (listed as Blank on QC DATA tab in the Monthly Data File) were run with each analytical batch. If this is untrue, add the following qualifier flag: AS.
  - Verify calibration check samples were run with each batch. If this is untrue, add the following qualifier flag: AS.
  - For canister flow files: check that the runtime (stopped - started) = 24 hrs +/- 1 hr. If this is incorrect, add the following flag to rows with matching SAMPDATE in main table: AB.
  - For canister flow files: the maximum and minimum flows should vary from the average by less than 10.1%. If this is incorrect, add the following flag to rows matching the SAMPDATE in the main table: AI.
- 
- Check that sample status is included on all CoC forms.
  - Check that the sample collection date is less than or equal to 30 days from the canister cleaning date on all CoC forms.
  - Look at each report in the Report Data File individual reports, check that the gather sample pressure at receipt in lab is at least 4" Hg. Add flag AB to any samples that don't.
  - Look at each report in the Report Data File individual reports, check that the "received on date" is less than X days past the release date in the corresponding CoC.
  - Verify proper AQS site code is listed in header of the Data Report File.
  - Check the reported to AQS date (in the Report Data File) to verify upload was within 180 days of sample collection.
  - On the SAMPDATA tab in the Monthly Data File, no data is included from any voided samples. Add flag AB to any voided samples.
  - Flags added during Auto QC have been reviewed.

Delete Deployment

Download Report

Download Processed Data

Rerun Auto QC...

Approve QC...



# ATMD Status and Next Steps

## *Status*

- Beta version in rigorous User Acceptance Testing (UAT)

## *Next Steps*

- Complete/build out remaining asset workflows
- Developing QAPPs and audit procedures for data processing
- Begin processing and sharing data using the ATMD



# ATMD Challenges and Lessons Learned

- Developing a solution for the broad range and types of data collected by ATOPs Units
  - Time-integrated data - *defined/established workflows*
  - Mobile data - *novel technology with developing workflows*
  - Real-time/streaming data - *ability to track instrument status*
- Developing a flexible and adaptable solution that given that monitoring assets in this program are likely to evolve
- Ensuring solution design conforms to Office of Information Technology requirements



# Conclusions

As we continue to build this program and these tools we would love to collaborate and work with others building QA programs for similar instruments

- Advice or feedback on selecting audit criteria for novel instrumentation/compounds?
- Anyone developing QA for similar instrumentation - feedback on process you are using or what you are finding (e.g., accuracy needed for different applications)?
- Is there anyone we should connect with?

★ *North Star: sharing validated air toxics data with the public in meaningful ways*



# Acknowledgements

I would like to extend a very big THANK YOU to all the team members that contributed to this important work in monitoring air toxics in Colorado!

- CDPHE APCD Division Director: Michael Ogletree
- Complete SAT Team: Alicia Frazier (Supervisor), Anna Cochran, Megan Richie, Timothy Weinmann, and Bryttani West
- Complete MAT Team: Derek Price (Supervisor), Natalie Smith, Ezra Levin (former), Rudra Pokhrel, and Munkhzaya (Mooji) Boldbaatar
- Complete OMM Team: Pamela Rickly (Supervisor), Zachary Finewax, Jon Kinny, Drew Martin, Heather McIntyre, and Riley Kloss



# Thank you!

For questions or additional  
information, please contact:  
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