GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

Georgia's Experience in Ethylene Oxide Monitoring

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National Ambient Air Monitoring Conference
Air Toxics – EtO Session

GEORGIA EPD ETHYLENE OXIDE MONITORING LOCATIONS

Location	Number of Sites	Monitoring Began	Site Selection Criteria
South Dekalb Monitoring Station	1 site	June 2019	Urban Background and NATTS site. EPA required all NATTS sites to begin monitoring for ethylene oxide in January 2020
Cobb County	4 sites (additional sites for spatial)	September 2019	Near Sterigenics
City of Covington	4 sites (additional sites for spatial)	October 2019	Near Becton Dickinson
General Coffee State Park	1 site	September 2019	Rural Background
Fulton County	4 sites	January 2020	Near Sterilization Services of GA

Data presented is collected through May 31, 2021

COLLECTION METHODS

ATEC at NATTS Site

Outdoor Xonteck 911

Entech passive sampler with timer module

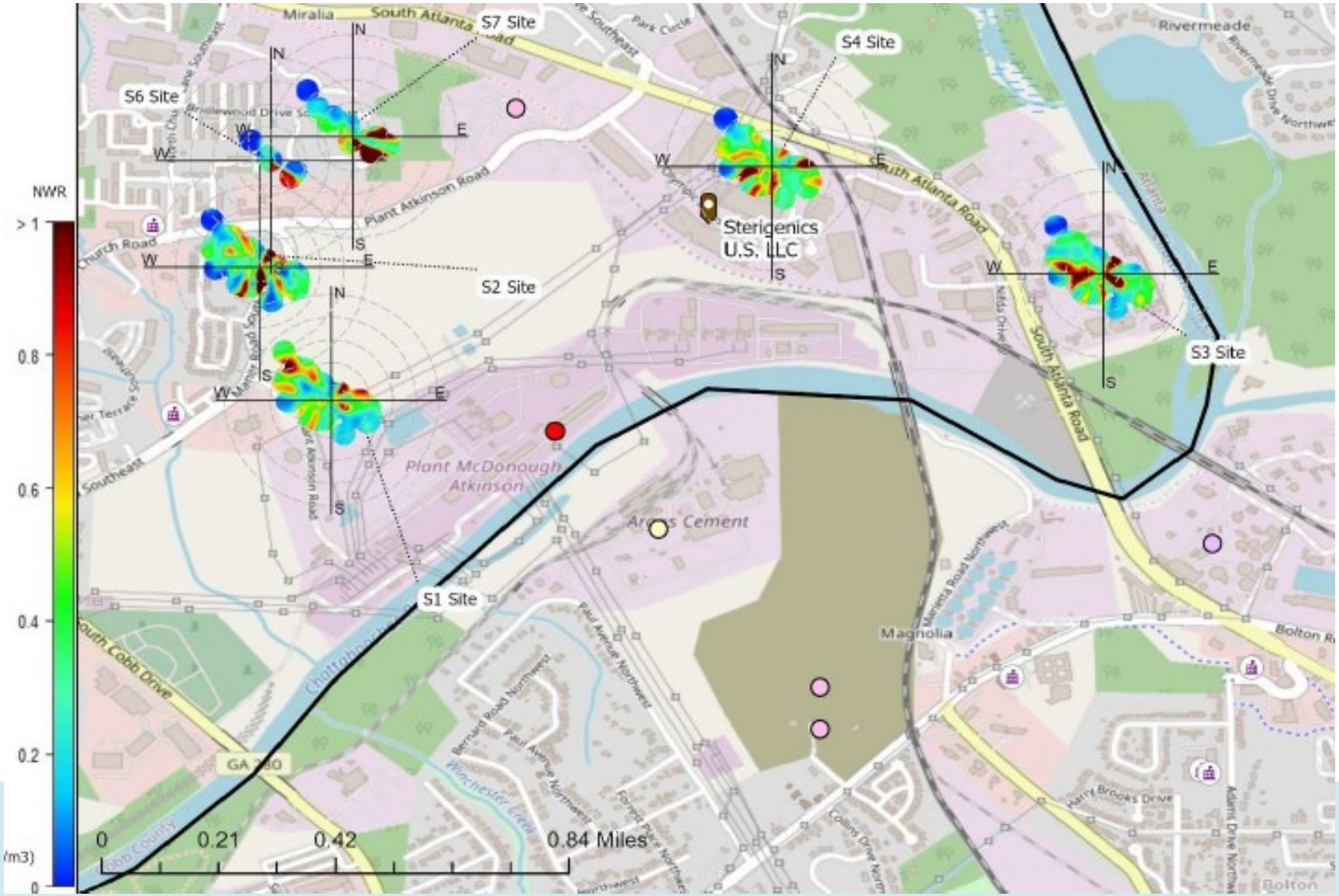
Indoor Xonteck 910

Picarro G2920

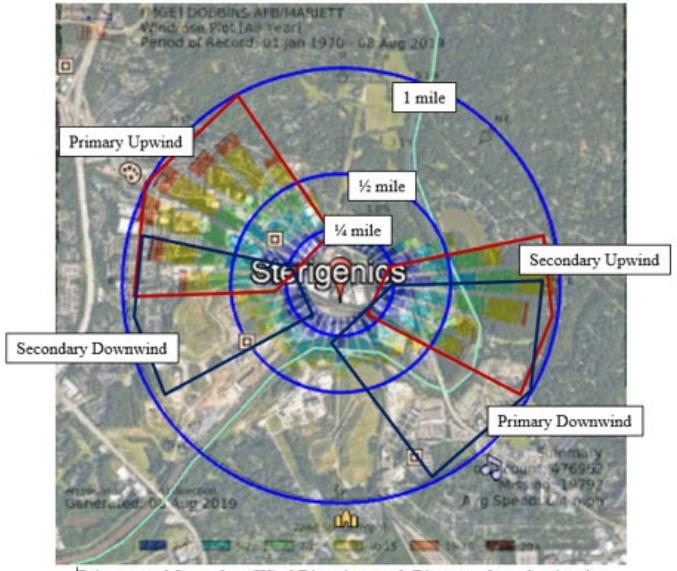
EPD MONITORING PLAN OBJECTIVES

- On-going monitoring study
- Characterize air around the facilities of concern
- High Quality Study under EPA Approved QAPP (Level II)
- Collect samples once every 6 days a 24-hour period
- Gain understanding of background concentrations– at an urban (NATTS site) and rural site
- EPA's contract laboratory – Eastern Research Group (ERG) for consistency in analytical analysis
- Monthly Quality Assurance samples and trip blanks collected
- 75% Data Completeness per quarter for study
- Inter-laboratory comparisons with GA EPD Laboratory
- CDC's Agency for Toxic Substances and Disease Registry (ATSDR) and the GA Department of Public Health will utilize data for health assessments

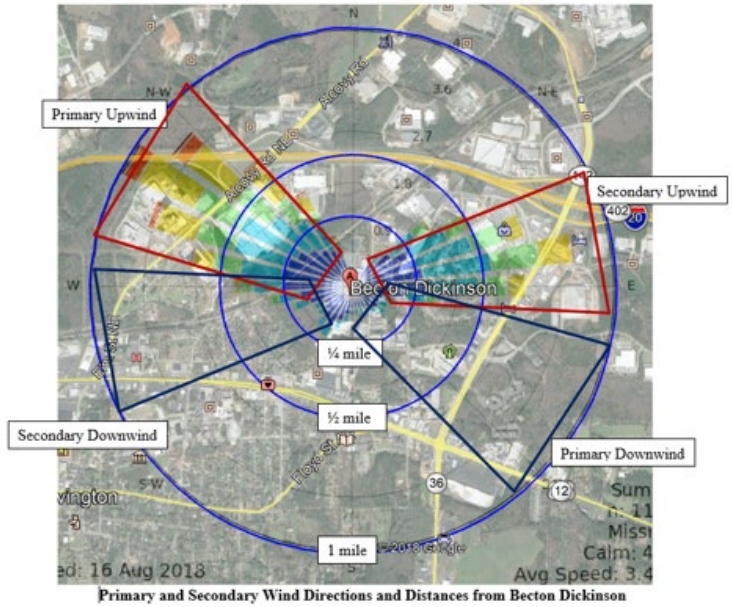
POLAR PLOTS


S7 Site
S4 Site
S6 Site
S2 Site
S3 Site
S1 Site
Sterigenics U.S. LLC
Plant McDonough Atkinson
Argos Cement
Miralia
Rivermeade
Magnolia
Bolton
South Atlanta Road
Plant Atkinson Road
Church Road
South Cobb Drive
GA 280
NWR
> 1
0.8
0.6
0.4
0.2
0
0
0.21
0.42
0.84 Miles

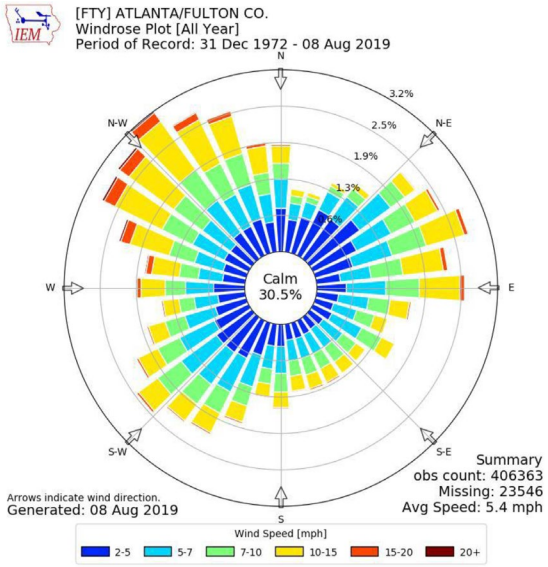
MONITORING SITE SELECTION



Primary and Secondary Wind Directions and Distances from Sterigenics



Primary and Secondary Wind Directions and Distances from Becton Dickinson

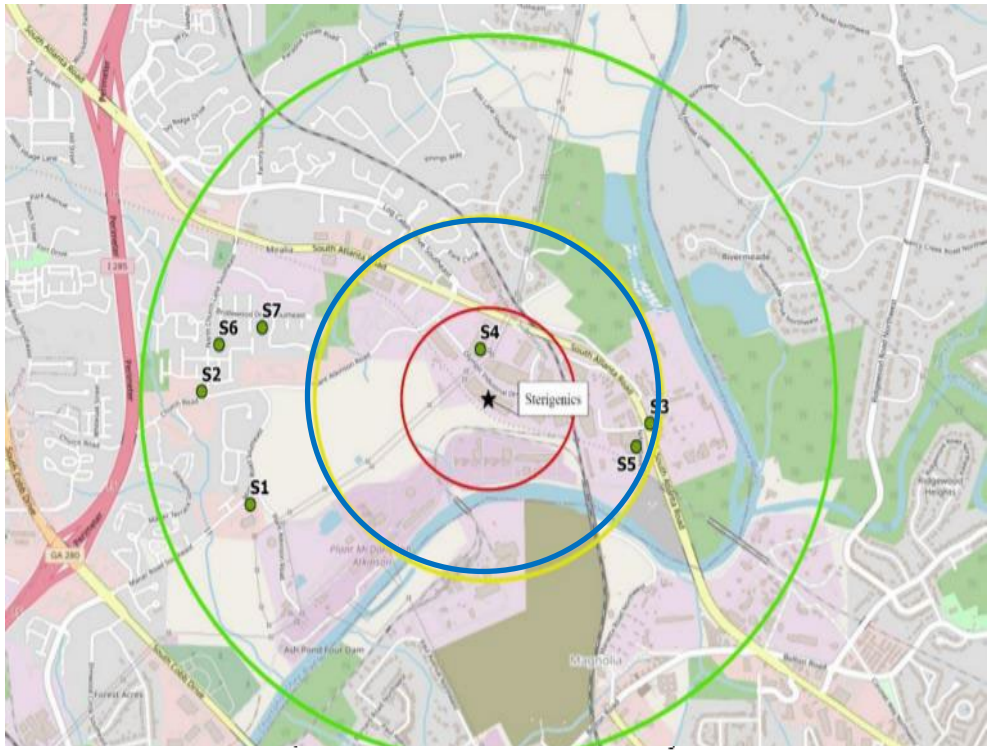


For the Fulton County area, there were no predominant wind directions – sites chosen in same wind direction

Looking at upwind and downwind in the primary and secondary air flow directions
Comparing concentrations at ¼ mile, ½ mile, and 1 mile at each location over course of study

MONITORING DESIGN

- Sample in 4 quadrants within ¼ mile of facility fenceline each sample day
- Once a month – sample one location side by side
- Once a month – compare ¼ mile and ½ or 1-mile concentrations
- Sample at NATTS site on passive sampler each sample day
- Sample at background site every twelve days



Site ID	Distance from facility	Why this site was selected
S1	About ¾ mile	Captures primary upwind and secondary downwind directions
S2	About ¾ mile	Captures primary upwind and secondary downwind directions
S3	About ½ mile	Captures secondary upwind and primary downwind directions
S4	Less than ¼ mile	Proximity to the facility
S5*	About ½ mile	Captures secondary upwind and primary downwind directions ***Note: site location was discontinued due to unstable roof**
S6	About ¾ mile	Captures primary upwind and secondary downwind directions
S7	About ¾ mile	Captures primary upwind and secondary downwind directions

QUESTIONS TO BE ANSWERED

Initial Study

- How does the concentration vary over time?
- What is the spatial gradient of the concentration?
- Does the sample collection method impact the concentration?
- What are the background levels?
- Can two labs get the same result?

Community Scale Air Toxics Monitoring Grant

- Compare multiple laboratories in same canister analysis
  (ERG, GA EPD Laboratory, EPA R4 LSASD)
- Compare concentrations collected by passive, active, and continuous samplers
- Evaluate change in ethylene oxide concentration with wind direction

MONITORING INITIAL STEPS

- Quality Assurance Project Plan (Category II) approved by EPA
- Develop SOPs for new equipment
- Find suitable locations for sampling (~6 sites per facility)
- Equipment zero-checked for ethylene oxide concentration
  - Conducted by ERG initially; inhouse annually
- Learn how to calibrate passive samplers
- Develop system to protect from flooding
- Develop the validation checksheets and set up AirVision file import templates

ANALYTICAL CHALLENGES

- Contract laboratory changed analytical methods (29 ion rather than 44 ion to quantify ethylene oxide)

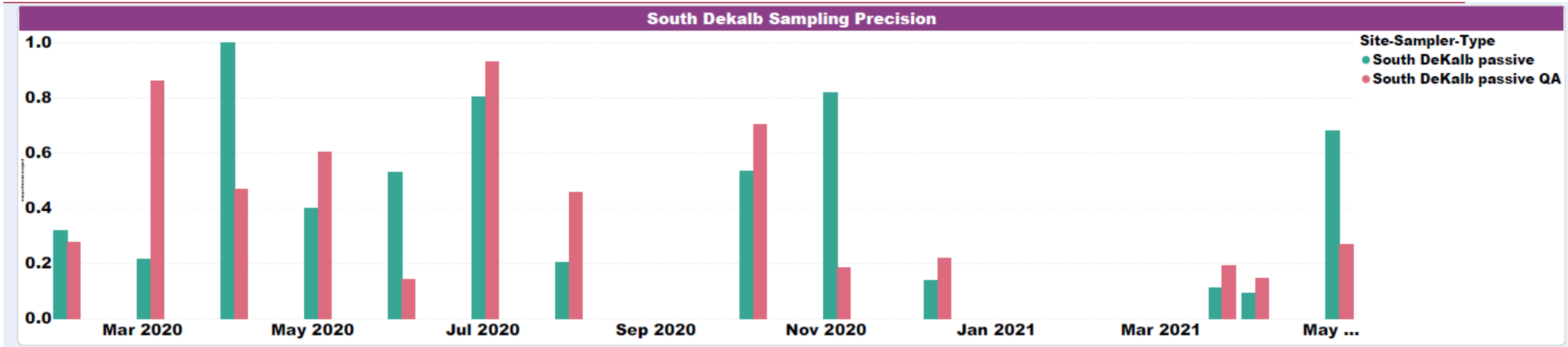
- Flexibility in T0-15 (target ion, cleaning with humidified air versus nitrogen) can result in differences in concentrations reported
  - Two laboratories using same procedures result in significantly different concentrations
  - Entech noted that cleaning with zero air destroys the lining of the canisters – newer canister coating procedure now available – may not have same impact

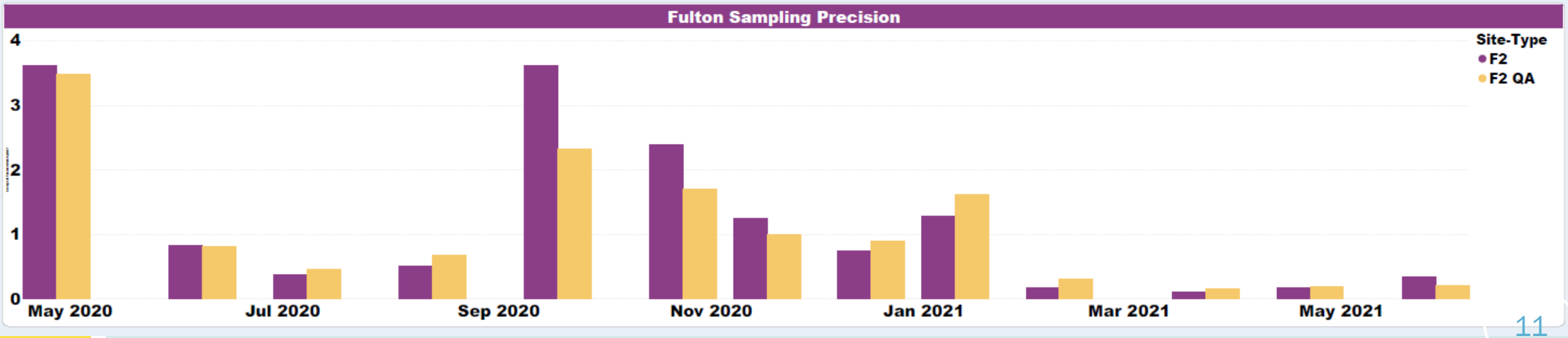
- Issues with calibration gas standard stability

- Measuring at or near detection limit very challenging - especially with precision measurements

Can two labs get the same result?

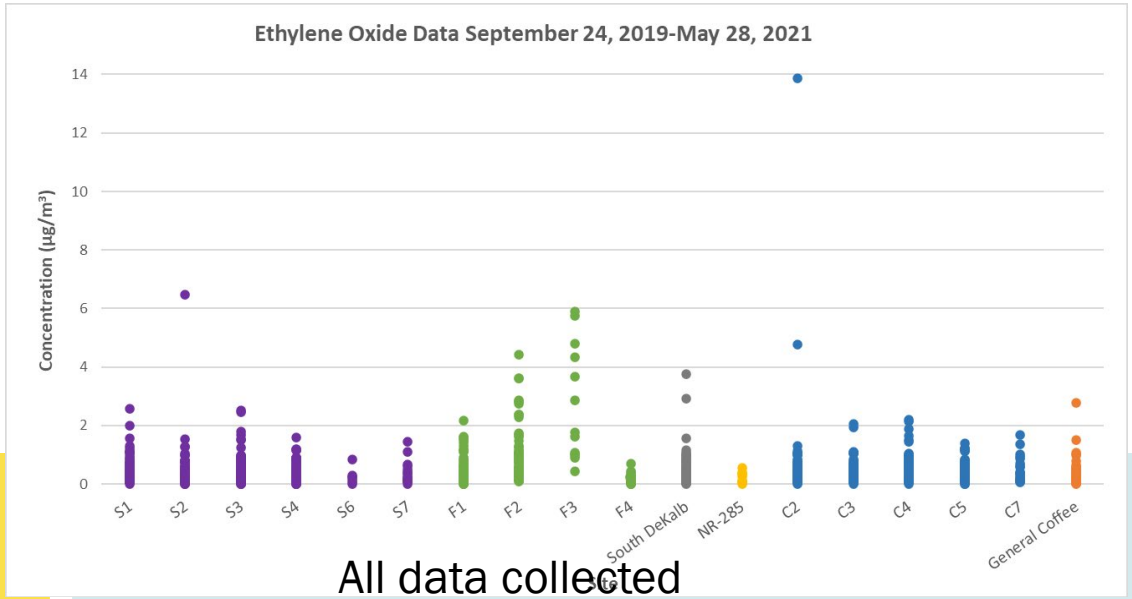
PRECISION CHALLENGES



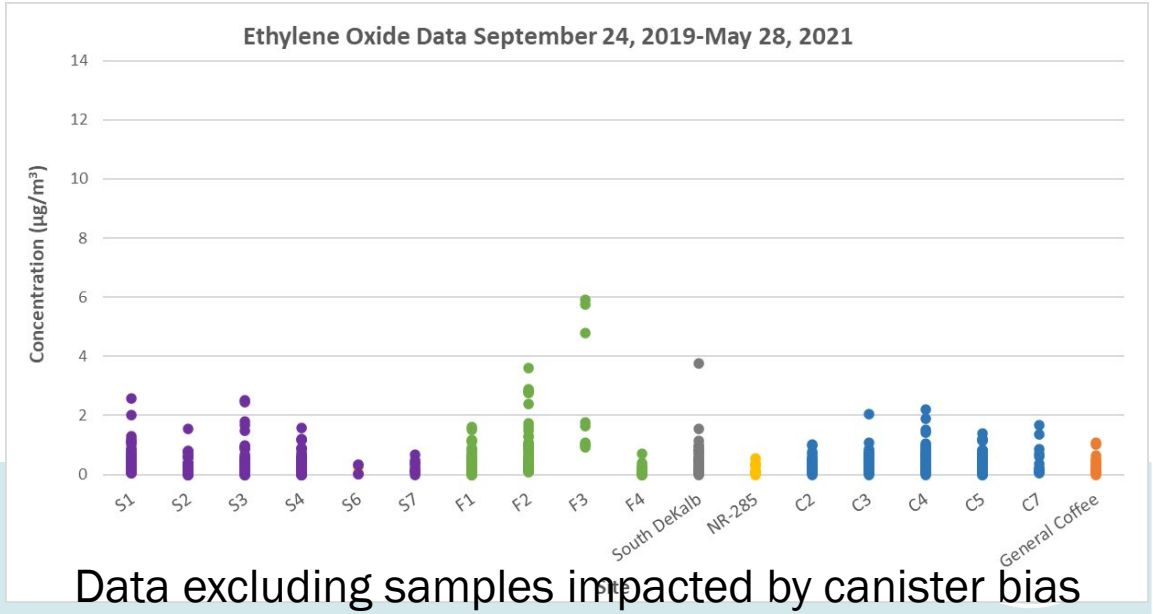


CANISTER BIAS

- Some canisters potentially “grow” ethylene oxide while in the canister
- More prevalent in certain series, but not every canister in the series
- GA EPD Laboratory found that cleaning the canisters ~150 times with humidified air prior to use will eliminate bias
- ERG canisters subject to a “flag check” – reviewing the history of the canister (at all sampling sites) for history of high concentrations
- Approximately 30% of our samples were impacted
- https://www.epa.gov/sites/default/files/2021-05/documents/technical-note-on-eto-canister-effect-052521.pdf



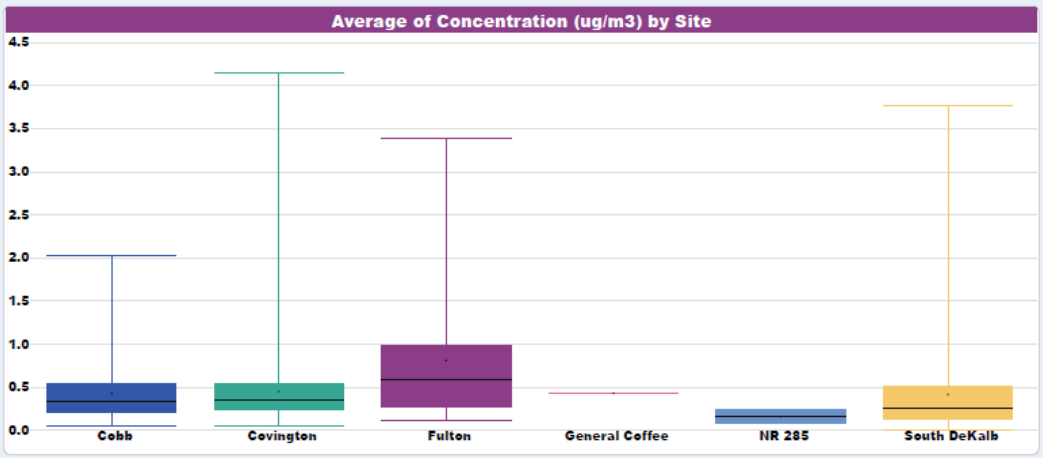
All data collected



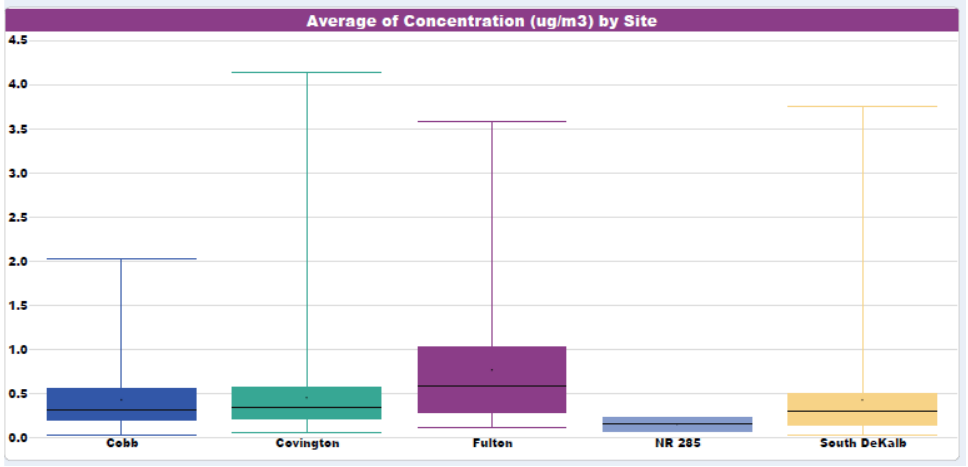
Data excluding samples impacted by canister bias

PASSIVE SAMPLER ZERO END PRESSURE

- Some samples reached ambient pressure by collection
- Collocated samples indicated that concentration was not affected
  - Average concentration of samples was not significantly affected by inclusion of zero end pressure samples
- Data reported to AQS does not include zero end pressure samples
- Data in report presented with and without zero end pressure samples

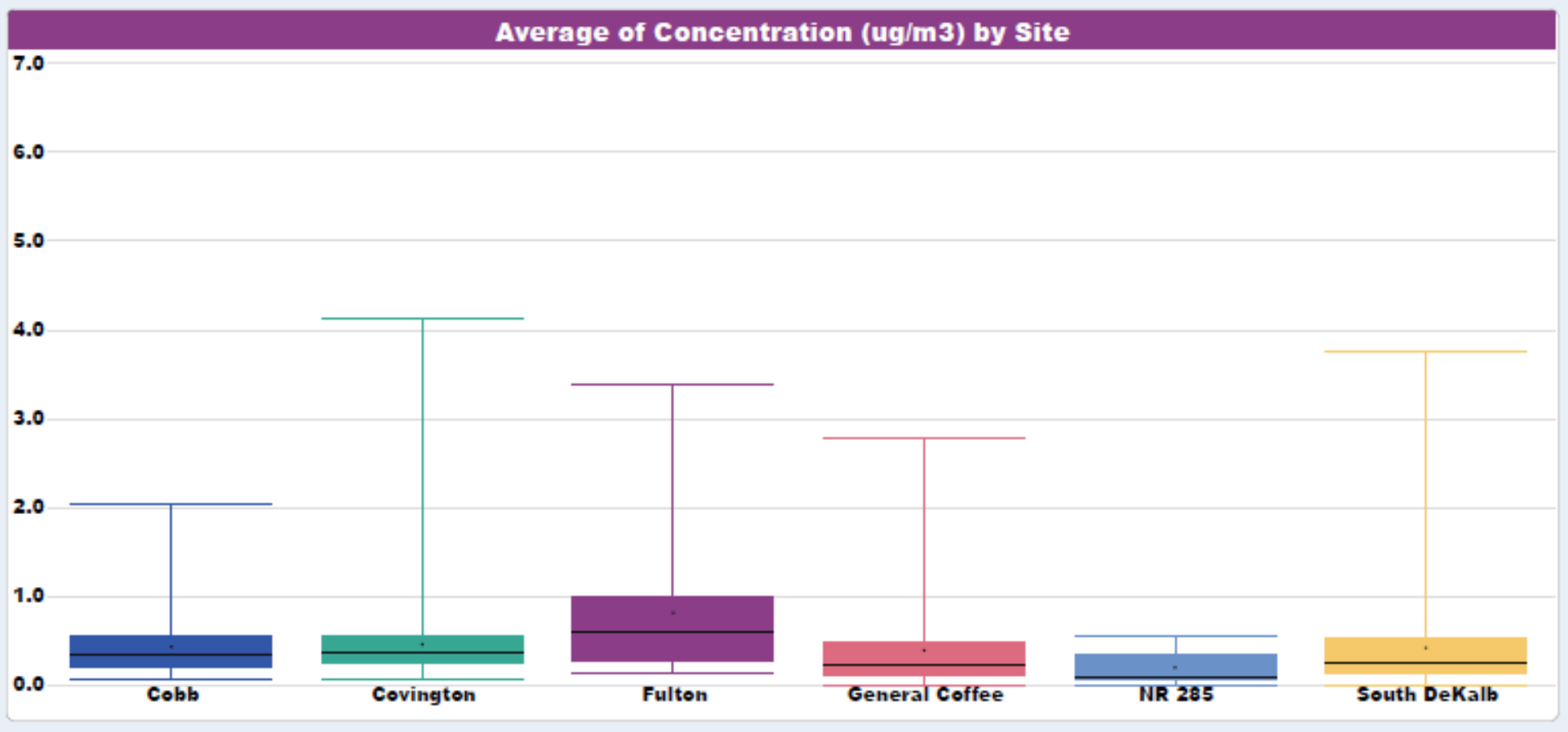


All samples represented



Zero end pressure samples excluded

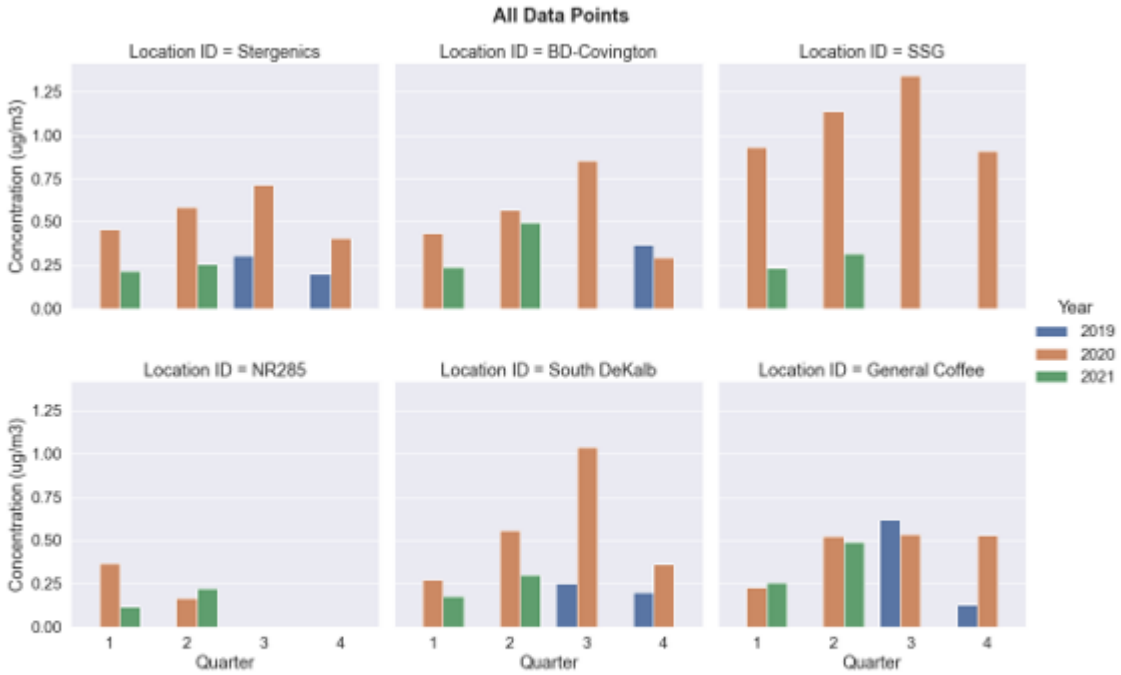
GA EPD RESULTS THROUGH MAY 31, 2021



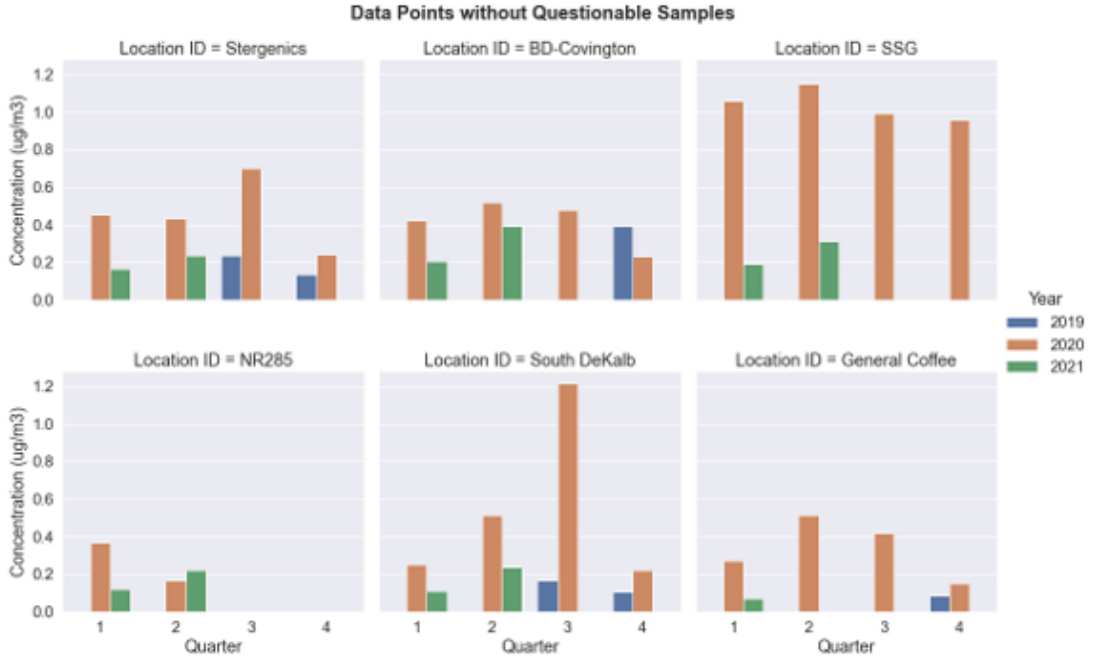
Data includes samples impacted by canister bias
2019 data: August – December
2021 data: January – May

SEASONAL VARIATIONS

How does the concentration vary over time?



Seasonal Averages by Calendar Quarter, Including All Data



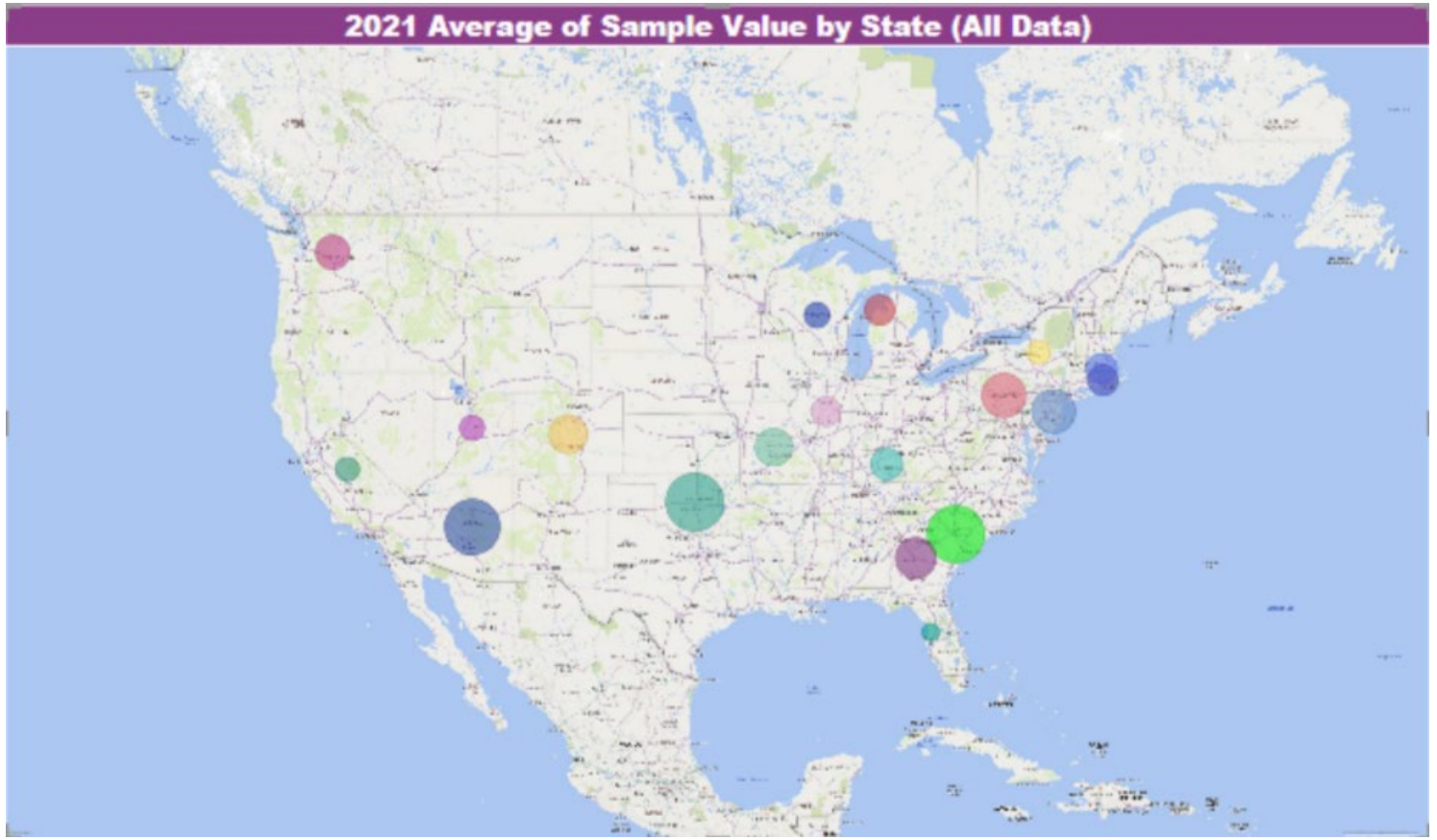
Seasonal Averages by Calendar Quarter, without Questionable Canister Data

Seasonal variation seen nationwide with EPA data

August – December 2019
January – December 2020
January – May 2021

PRELIMINARY CONCLUSIONS FROM AQS DATA TO DATE

- EPA method needs refinement – too much variability in data; method is not sensitive enough
- All sites in Georgia and in the US are measuring ethylene oxide concentration well above the levels that EPA considers acceptable
- EPA continues to assert that not all ethylene oxide in ambient air is coming from commercial sterilizers and chemical manufacturers. Research is ongoing.



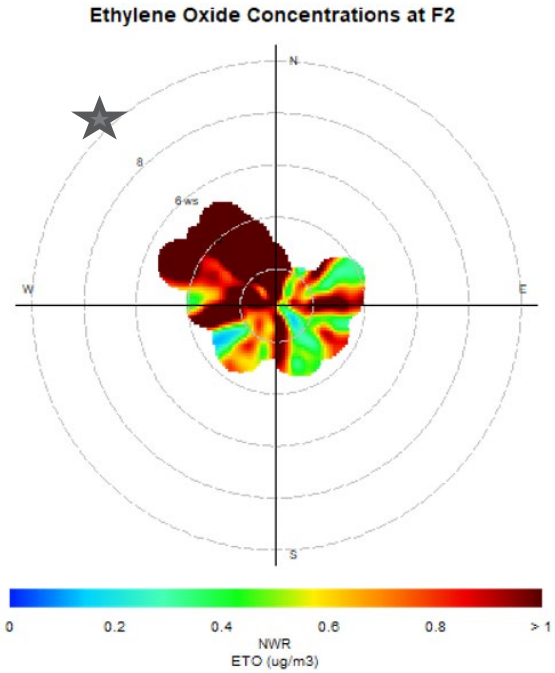
EFFECT OF FACILITY CONTROLS

As of February 2021, each of the facilities had fugitive ethylene oxide emission controls (in addition to previously installed emission controls on the backvents and sterilization process)*.

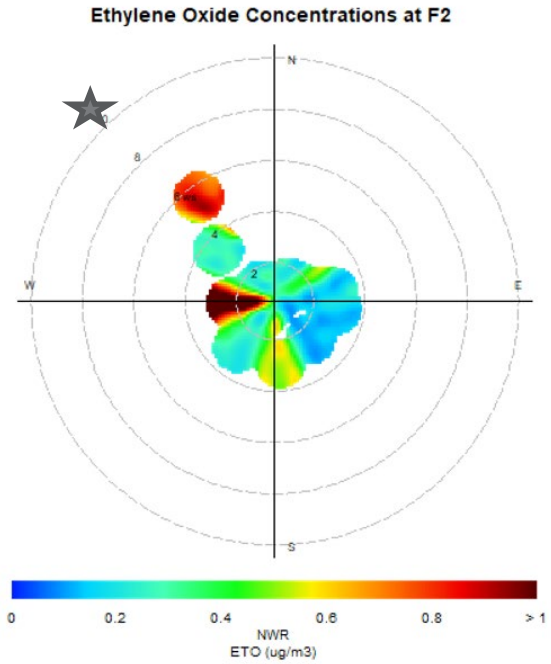
To show how the controls impacted the ethylene oxide concentration measurements in the communities, we graphed the concentration and wind speed in polar plots.

Comparison of Fulton area F2 Monitoring Site near Sterilization Services

Before Controls Installed



After Controls Installed



★ Facility location

*Back vent controls were added at SSG on January 18, 2020. Negative pressure systems were installed with dry bed controls at SSG on January 26, 2021.

SPATIAL VARIATION

What is the spatial gradient of the concentration?

Inconclusive - Depending on the area monitored, we observed the ethylene oxide concentration changes as you moved further out from the source.

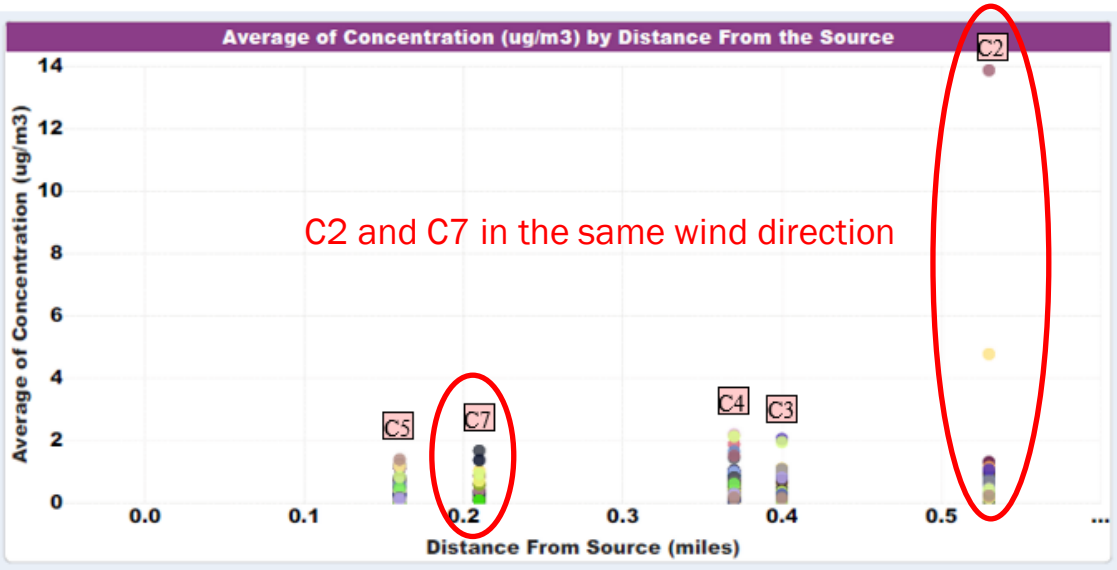


Figure 44. Table and Graph of the C Sites Distances from Becton Dickinson

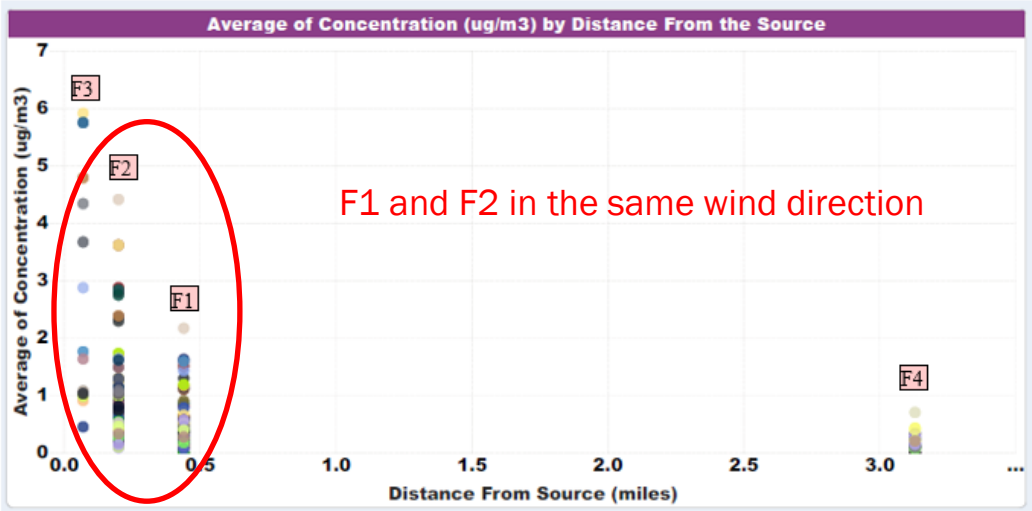


Figure 51. Table and Graph of F Sites Distances from Source

IMPACT OF SAMPLER TYPE

Does the sample collection method impact the concentration?

- Passive samplers (method code 149) appear to result in higher concentration than the pressurized (active) samplers (method code 150).

- More comparisons need to be done.

Sample Average and Max Summary With All Data			
Site-Sampler-Type	Count of Concentration (ug/m3)	Average of Concentration (ug/m3)	Max of Concentration (ug/m3)
South DeKalb ATEC	26	0.26	3.09
South DeKalb passive	104	0.42	3.76

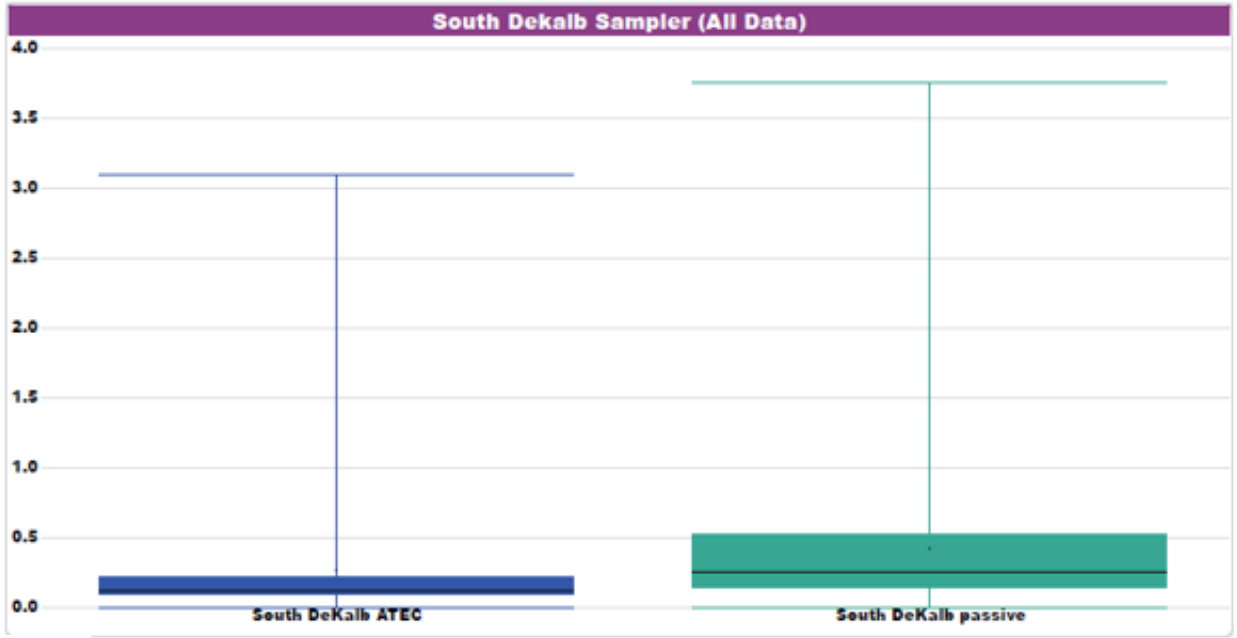
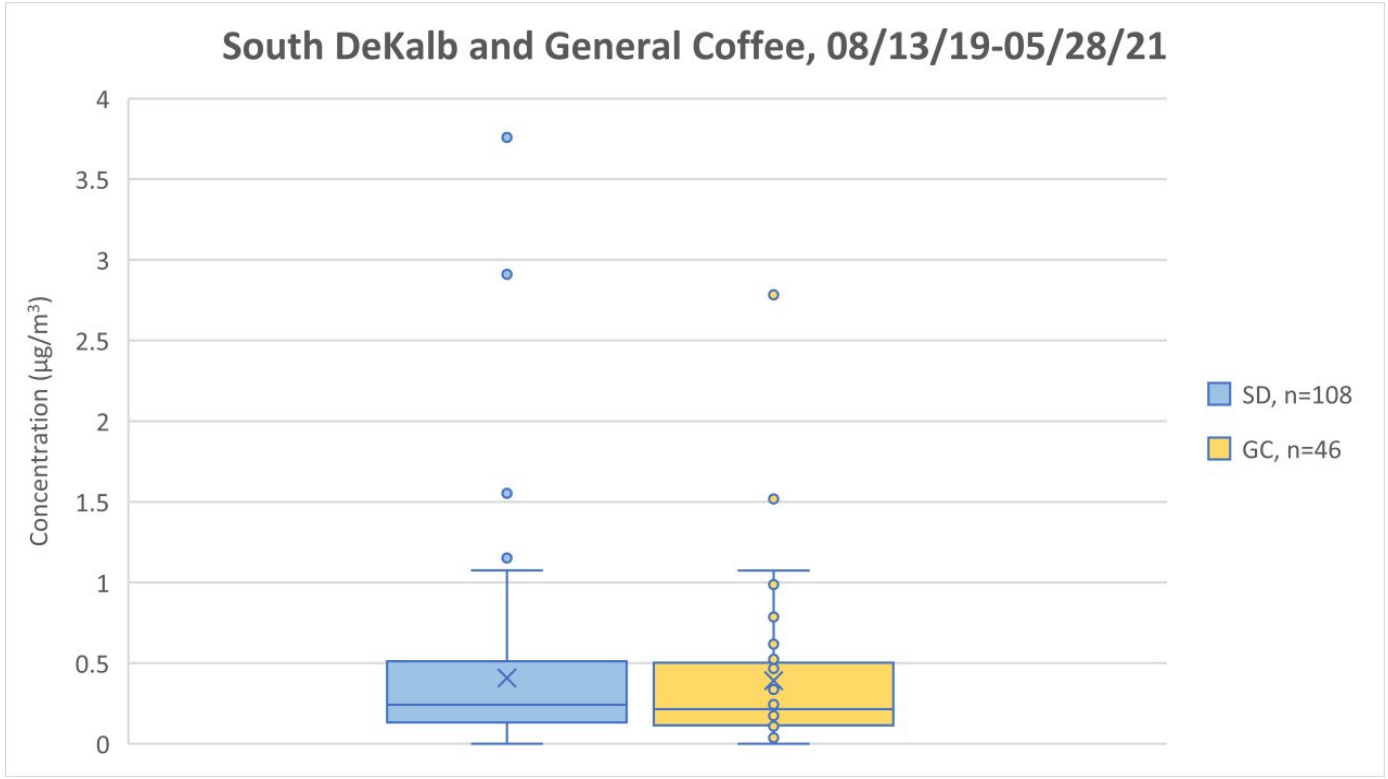


Table and Box and Whisker Plot Comparing the Pressurized Samples and Passive Samples at the South DeKalb Site, Including All Data

COMPARISON OF BACKGROUND DATA

What are our background levels?

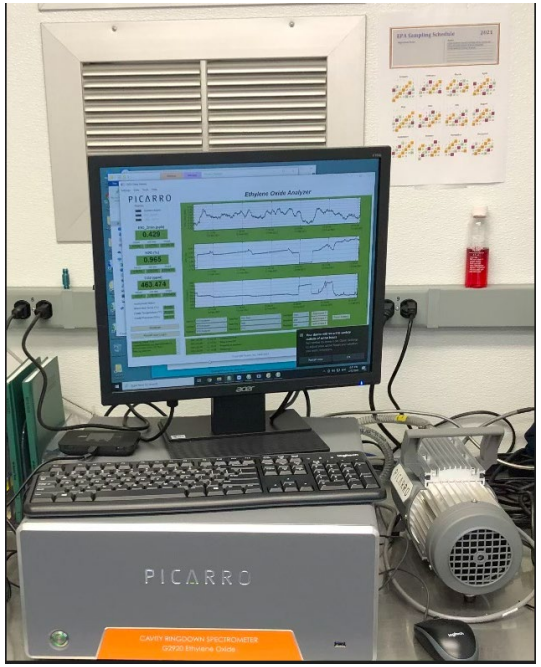


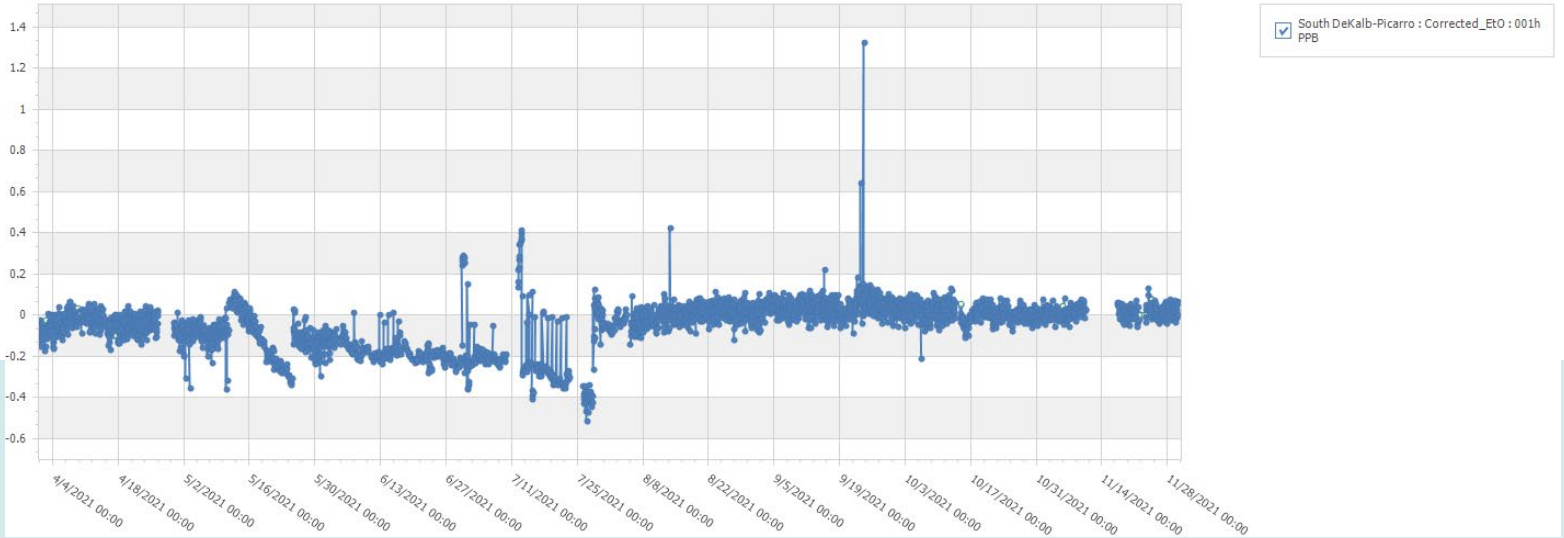
Average Concentration

- South DeKalb - Urban Background (NATTS site) – 0.37 µg/m³
- General Coffee – Rural Background – 0.27 µg/m³

METHOD DEVELOPMENT – PICARRO G2920

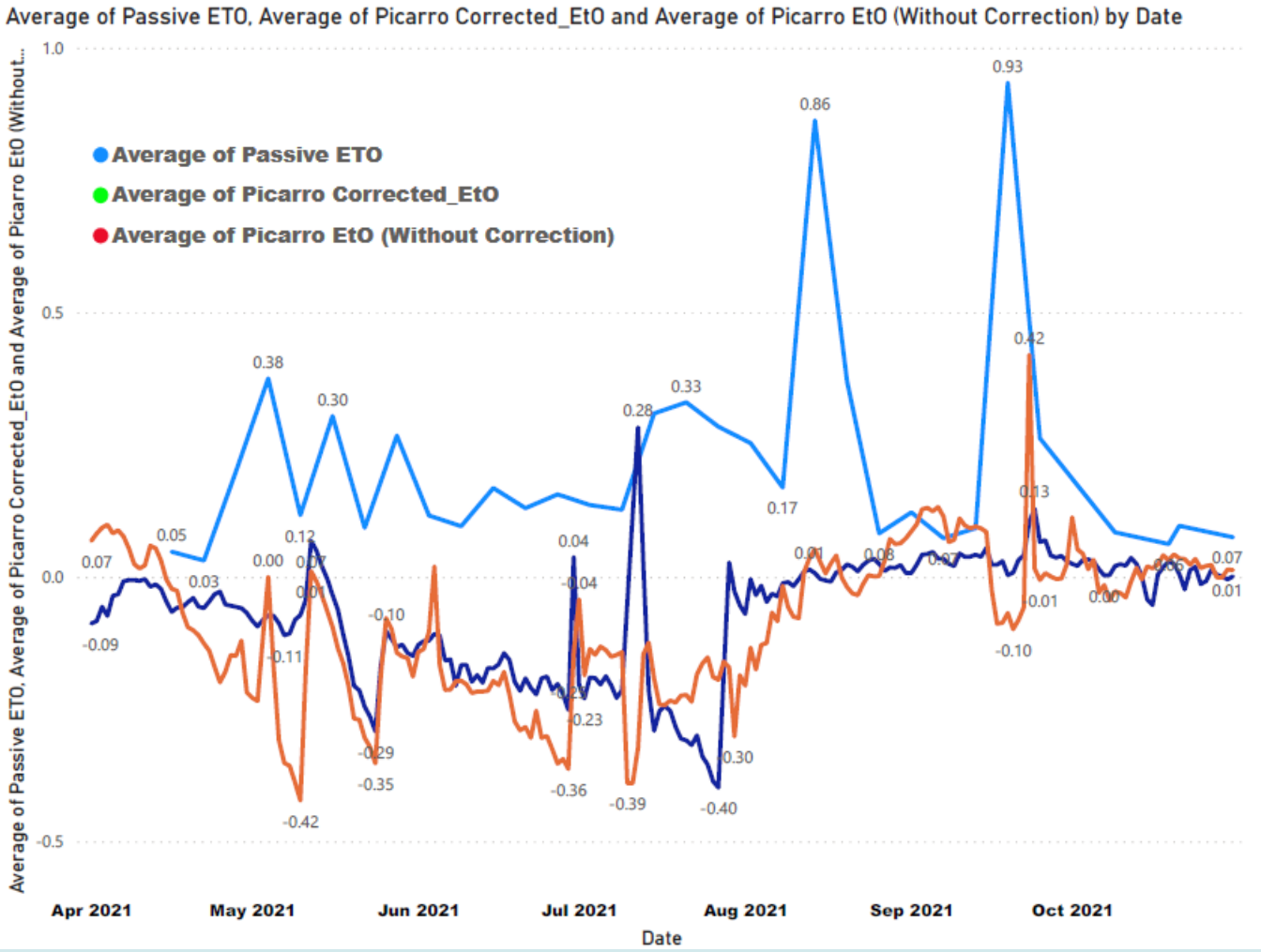
- Installed at NATTS Site April 2021 – November 2021
- Linearity verified at GA EPD Laboratory for zero and span prior to deployment
- Instrument installed February 2021
- AirVision Integration – major challenge
  ~14 diagnostic channels to be validated
- Significant instrument drift observed
- Identification of frequency of zero check – hourly, daily, weekly? Hourly was chosen
- Span check used CO_2 gas as surrogate – correlates well with EtO





METHOD DEVELOPMENT – PICARRO G2920

- Multiple Discussions with OAQPS and ORD on Picarro performance
- Picarro installed an updated zero-reference scrubbing system – July 2021
- Zero Reference Module installed October 2021 to automatically "correct" for zero values
- Picarro manually corrected hourly data collected April 2021 – October 2021 for zero checks
- Final study verification at EPD lab November 2021 – drift within EPD's original QAPP specifications
- Zero Reference Module encountered cavity pressure error December 2021
- Unit decommissioned – December 2021



EVALUATIONS ONGOING FOR COMMUNITY SCALES AIR TOXICS MONITORING GRANT

- Community sampling continues to date
- Comparison of ERG, GA EPD Laboratory, and R4 LSASD Canister data using TO15
- Comparison of passive versus pressurized (active) sampling
- Comparison of canister data to Picarro continuous data
- Evaluation of continuous ethylene oxide data relative to meteorology

QUESTIONS?

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https://epd.georgia.gov/ethylene-oxide-information

https://airgeorgia.org