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ORD Vapor Intrusion Research Projects Update

John Zimmerman, Alan Williams, and Brian Schumacher

USEPA ORD

Overview

- Projects presented today:
  1. Large Buildings
     a. Virginia Site
        i. Climate zone 4a – temperate, humid subtropical
        ii. Different from prior research efforts in zone 5
     b. Alaska Site
        a. Climate zone 8 – darn cold (subartic)
  2. Soil Gas Safe Community

Large Buildings (VA): Subslab Sampling Methods Comparison and High-Volume Sampling

The large building research program objectives were:

(a) characterize vapor intrusion into large building and determine the controlling factors,

(b) compare factors controlling vapor intrusion into large buildings to that of nearby residences, and

(c) examine indicators, tracers, and surrogates (ITS), such as radon and pressure differential, that may provide us a better understanding of the timing of sampling.

Large Buildings (VA): Subslab Sampling Methods Comparison and High-Volume Sampling (Cont.)

Summary of Findings:

- In this study, either low volume sampling or HVS would have likely led to similar site management decisions, although HVS provided confidence that the sampling information is indicative of a larger soil gas plume.

- This study did not identify any systematic differences between conventional, vapor pin, and CA-style probe installations for subslab soil gas sampling. The decisions for site management would probably be the same if the data from any subslab port style, active sampling techniques using the field GC/ECD or capillary controlled evacuated canisters, or sampling with either type of passive samplers over durations less than two weeks.

- Subslab TCE concentrations changed in a majority of precipitation events with >5 cm rainfall; however, the direction of change was inconsistent. HVS resulted in decreased TCE concentrations throughout the subslab environment that required months to rebound.

Large Buildings (VA): Subslab Sampling Methods Comparison and High-Volume Sampling (Cont.)

Four journal articles in review:

1. Zimmerman, J.H., Alan Williams, Brian Schumacher, Chris Lutes, Laurent Levy, Gwen Buckley, Victoria Boyd, Chase Holton, Todd McAlary, Robert Truesdale. (In Review). "The Representativeness of Subslab Soil Gas Collection as Effected by Probe Construction and Sampling Methods." *Groundwater Monitoring & Remediation*

2. Zimmerman, J.H., Alan Williams, Brian Schumacher, Chris Lutes, Laurent Levy, Gwen Buckley, Victoria Boyd, Chase Holton, Todd McAlary, Robert Truesdale. (In Review). "Distribution of Subslab Soil Gas Concentrations of VOCs and Radon in a Compartmentalized Warehouse: Rate and Causes of Temporal Change." *Groundwater Monitoring & Remediation*

3. Williams A., Zimmerman, J.H., Schumacher, B., Lutes, C., Levy, L., Buckley, G., Boyd, V., Holton, C., Mali, D., and R. Truesdale. (In Review). "Influence of Sampling Collection Times and Volumes on Observed Subslab Soil Gas VOC." *Groundwater Monitoring & Remediation*

4. Lutes, C., Victoria Boyd, Gwen Buckley, Laurent Levy, Kate Bronstein, John H. Zimmerman, Alan Williams, and Brian Schumacher. (In Review). "Impact of Hurricanes, Tropical Storms, and Coastal Extratropical Storms on Indoor Air VOC and Radon Concentrations." *Groundwater Monitoring & Remediation*

One EPA Report in review:

Williams, A., Schumacher, B.A, J.H. Zimmerman. 2022. Subslab Soilgas Standardization report. U.S. Environmental Protection Agency, EPA/600/R-21/272.

Fairbanks, Alaska - Large Building Research Project

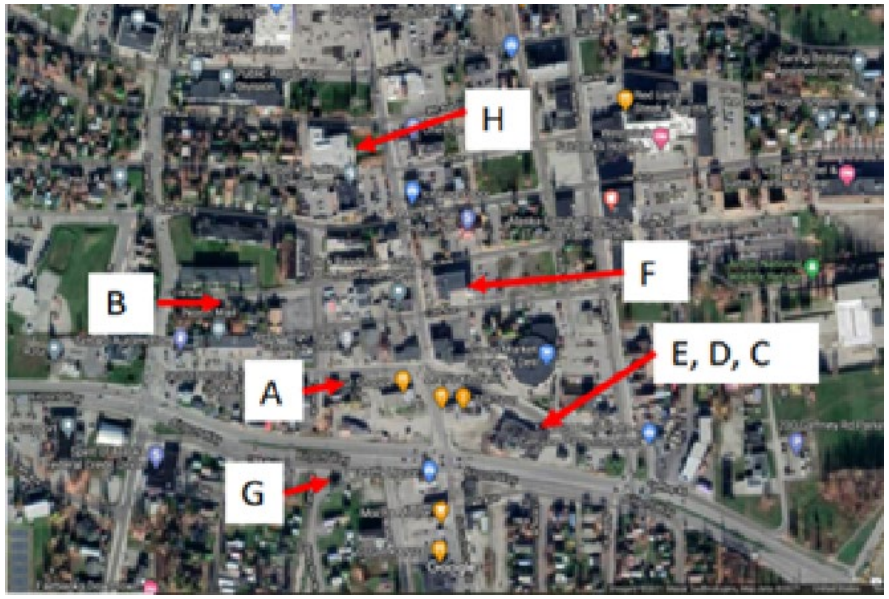
- Characterize VI in large buildings and determine controlling factors
  - Describe the degree of spatial variability observed in indoor air and subslab soil gas concentration in at least six sampling zones over 15 months. (Detailed observations of multiple buildings at the same time)
  - Identify controlling factors of indoor concentration.
- Compare the controlling factors of a large building with that of a nearby residence
  - Compare the degree of vapor intrusion observed in similarly situated commercial and residential buildings
  - Are the primary controlling factors for commercial and residential vapor intrusion similar when the buildings are situated in the same climatic conditions and near a similar source of VOCs?

Fairbanks, Alaska - Large Building Research Project (Cont.)

- Examine indicators and tracers (IT), such as radon and pressure differential that may provide us a better understanding of the timing of sampling
    - Determine relationship of radon to VOC concentrations at the test site in indoor air.
    - Examine relationship between differential temperature, soil temperature and indoor air concentrations of VOCs and radon.

Fairbanks, Alaska - Large Building Research Project (Cont.)

- 5 Buildings
  - A. Real Estate (1,500,W)
  - B. Church (4,000,W)
  - C. Café (4,800, E)
  - D. Alterations Shop (4,000, E)
  - G. Insurance Office (1500,W)



- Weekly VOC and Continuous Radon Sampling, December 2020 – March 2022
  - Indoor Air, Subslab, Outdoor Air
- Two locations with Continuous VOC and Radon Sampling
  - Church (B, 8/21 – Present)
  - Insurance Office (E, 9/21 – Present)
- Two intensive sampling studies (Twice Daily for 8 days)
  - August 2021 (Warm)
  - January 2022 (Cold)

RadonEye

http://radonftlab.com/radon-sensor-product/rd200/

Indoor/outdoor radon data collected every hour

RAD7

https://durridge.com/products/rad7-radon-detector/

Subslab radon data collected monthly

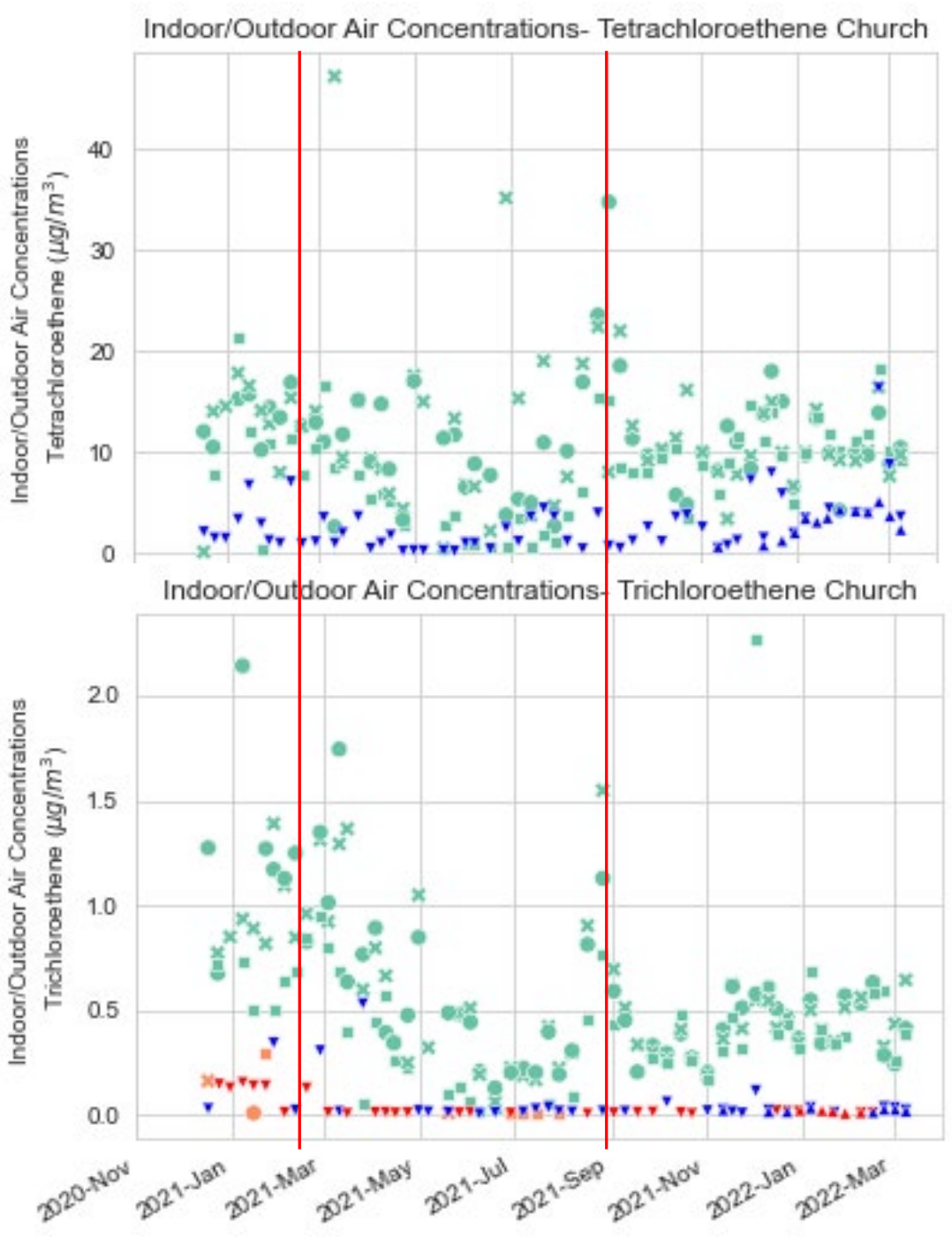
Long Term Temporal Variability – Indoors, Church, PCE and TCE

Indoor Air Data Flag
- All Indoor Air Detects are shown as Green markers
- All Indoor Air Non-Detects shown as Orange markers

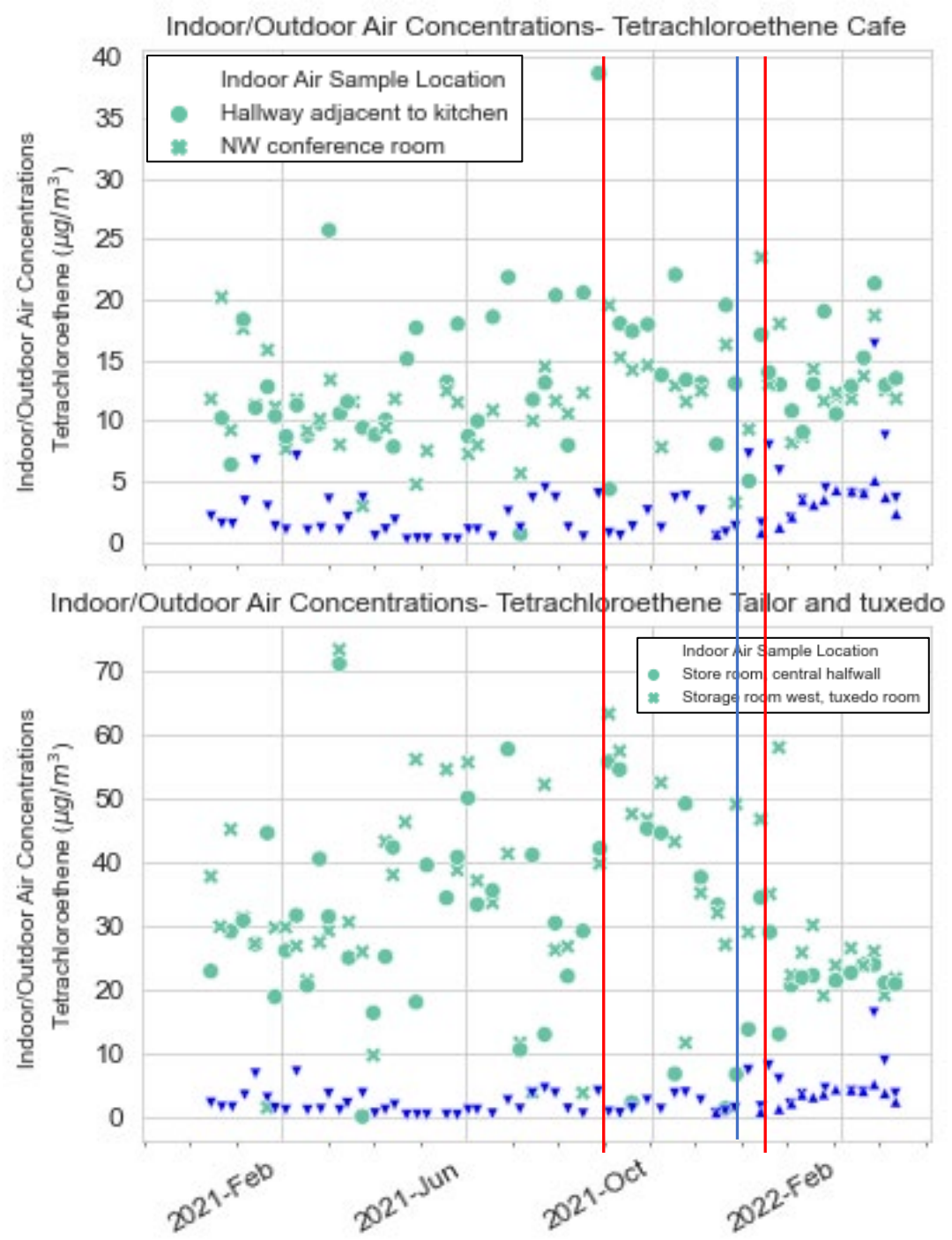
Indoor Air Sample Location
- B, Main room South end
- B, kitchen
- F2, Chapel

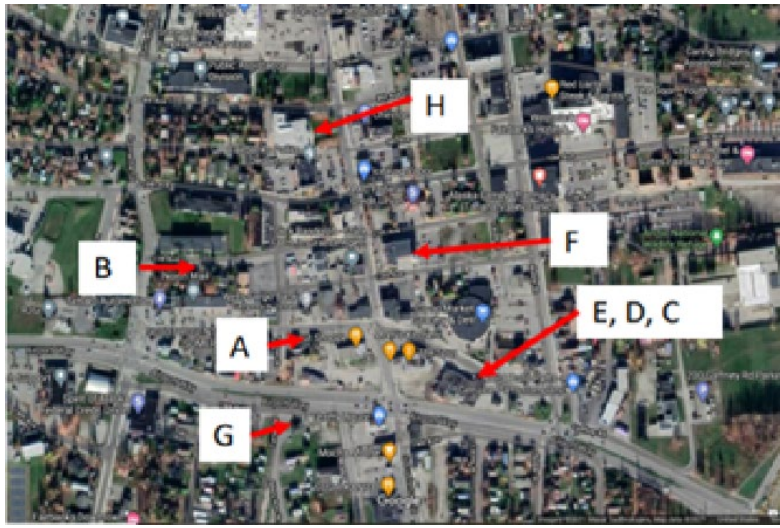
Outdoor Air Data Flag
- All Outdoor Air Detects are shown as Blue markers
- All Outdoor Air Non-Detects shown as Red markers

Outdoor Air Sample Locations included:
- OA-12 [Church, south]
- OA-15 [State Farm]



Long Term Temporal Variability Across Buildings – Indoor PCE





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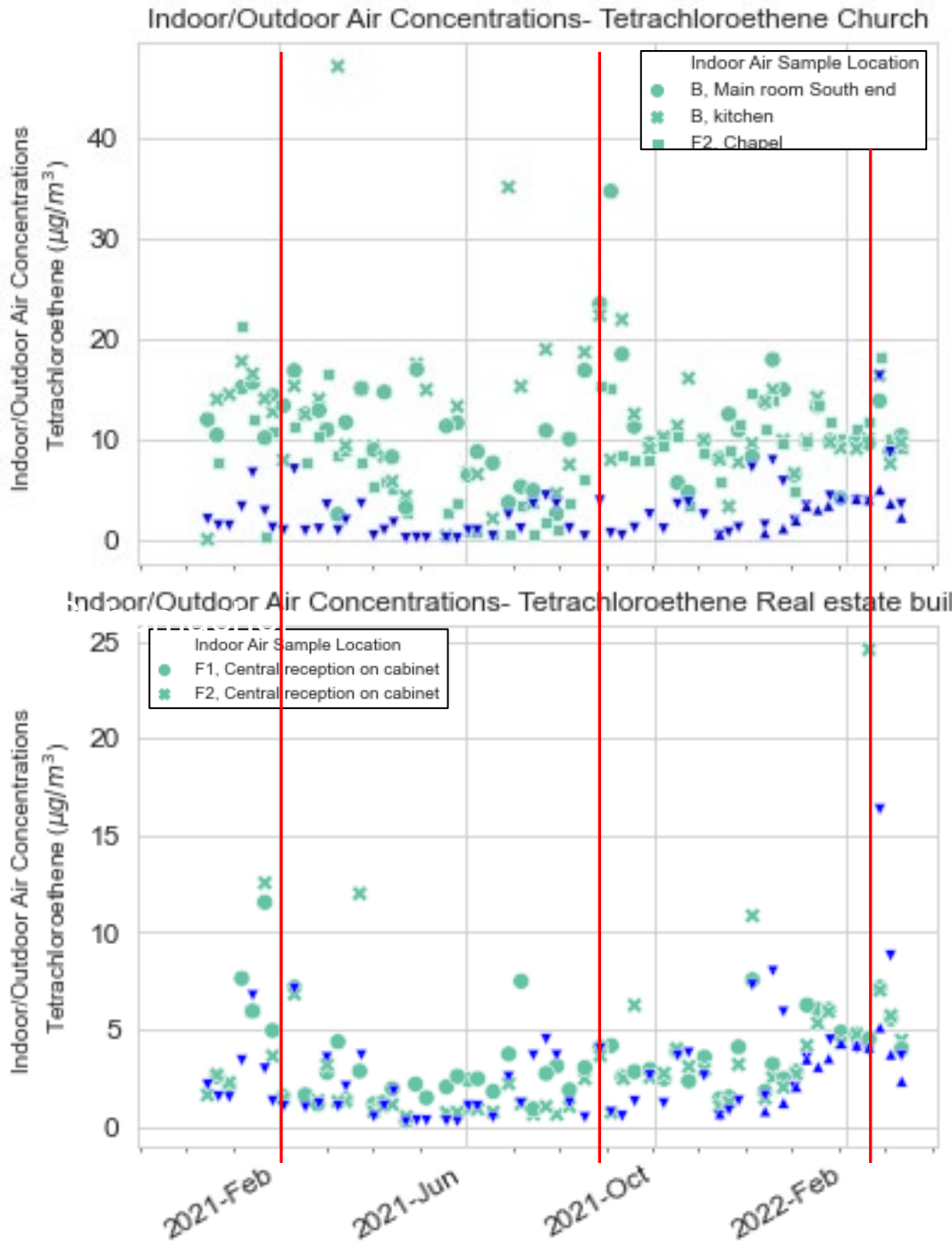

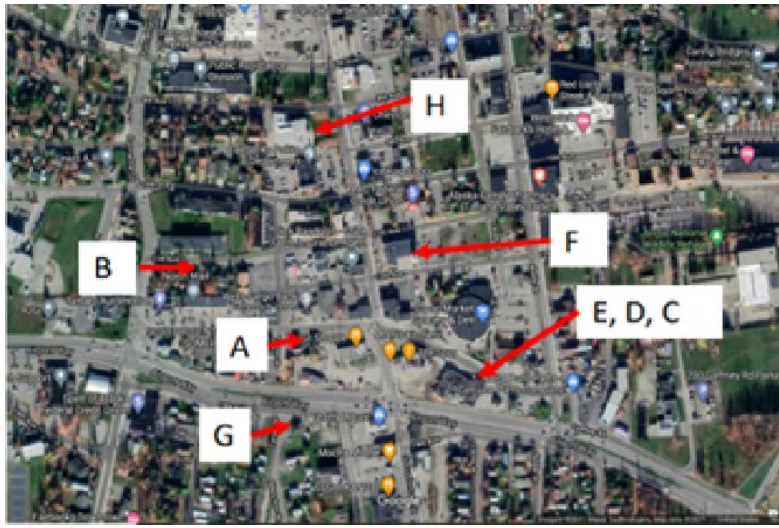

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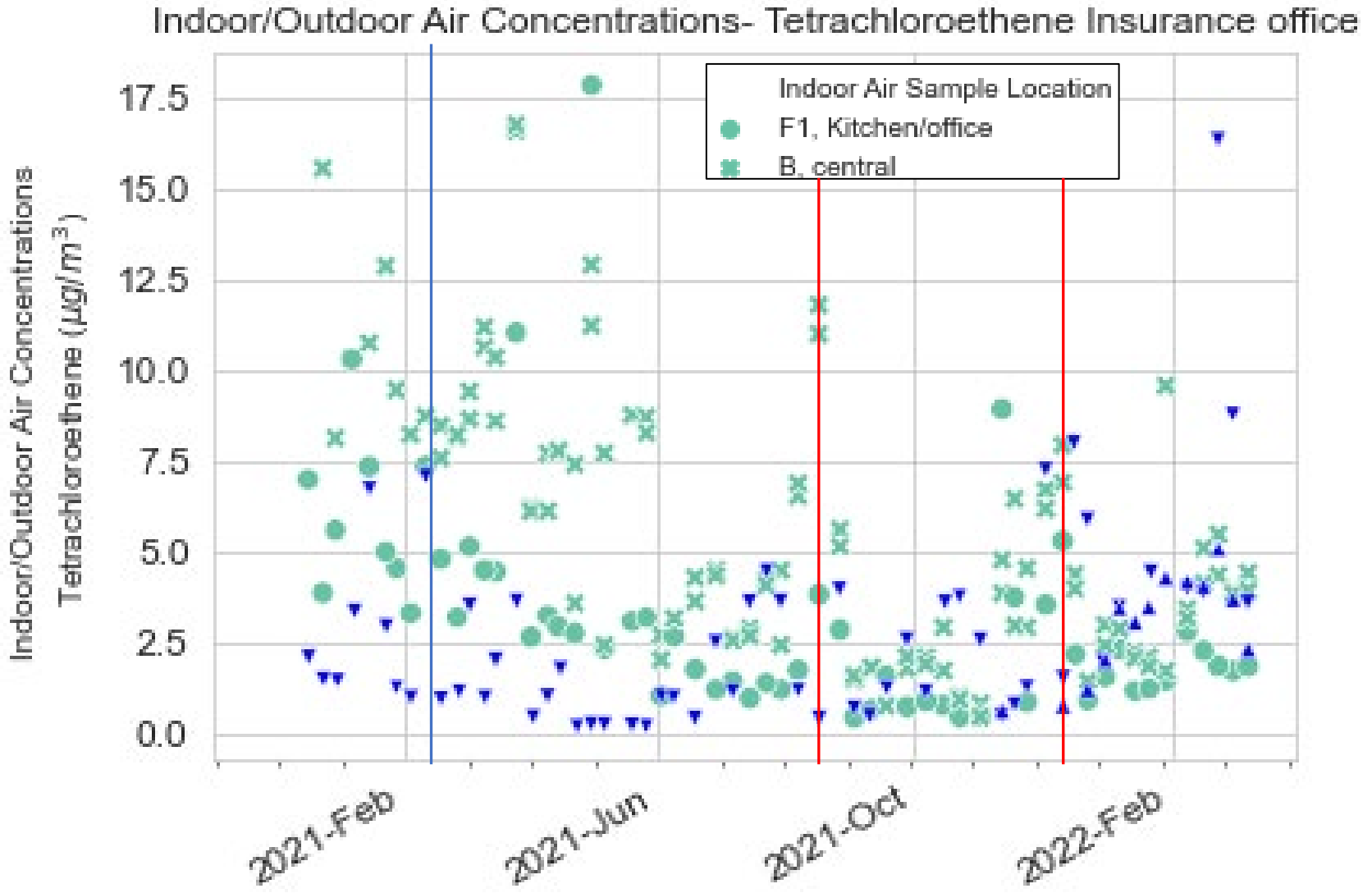

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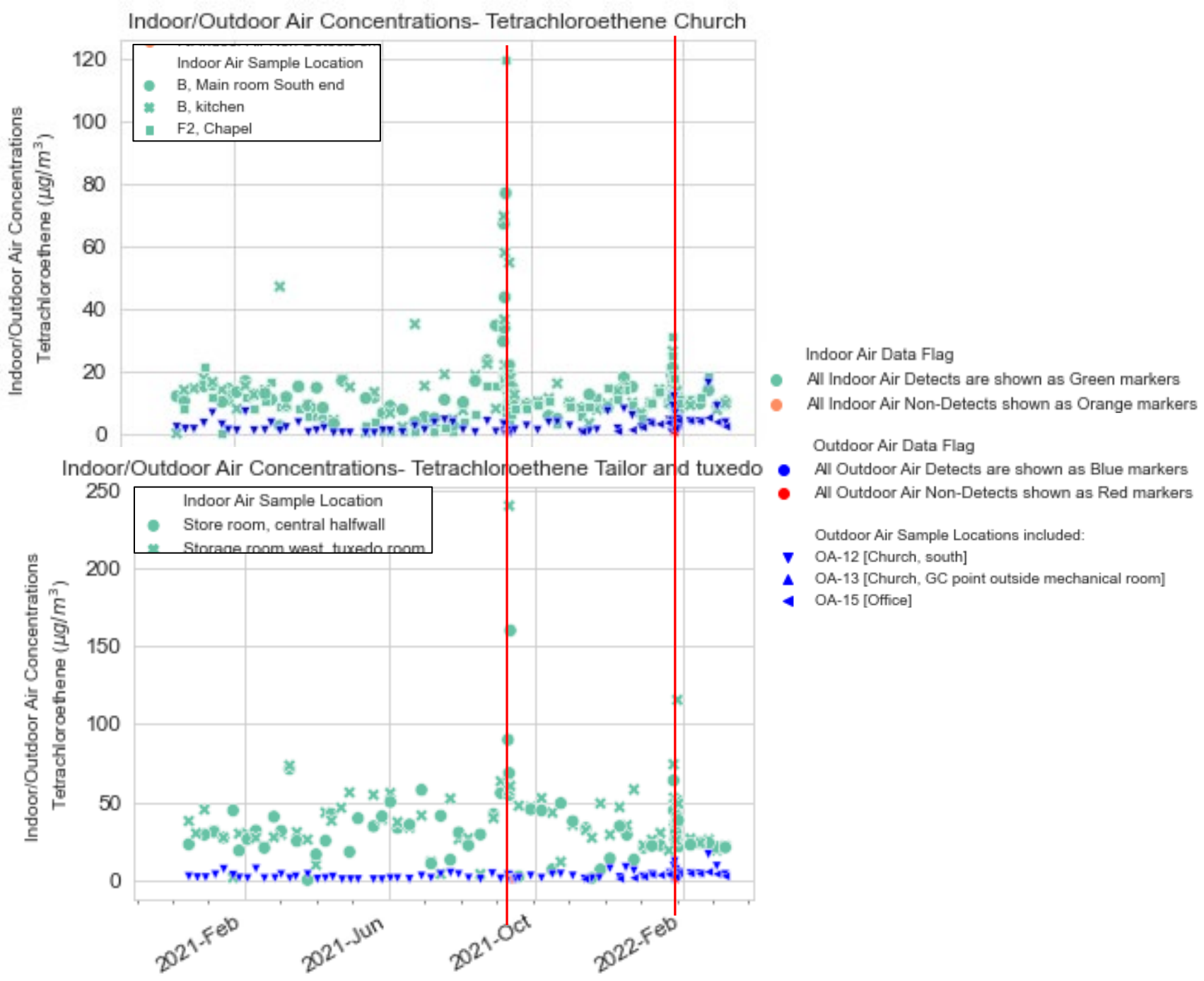
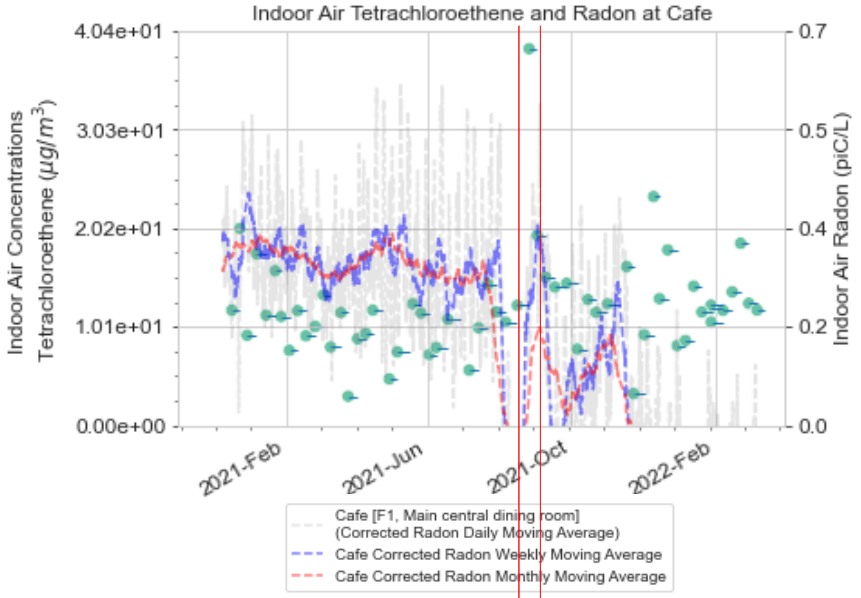
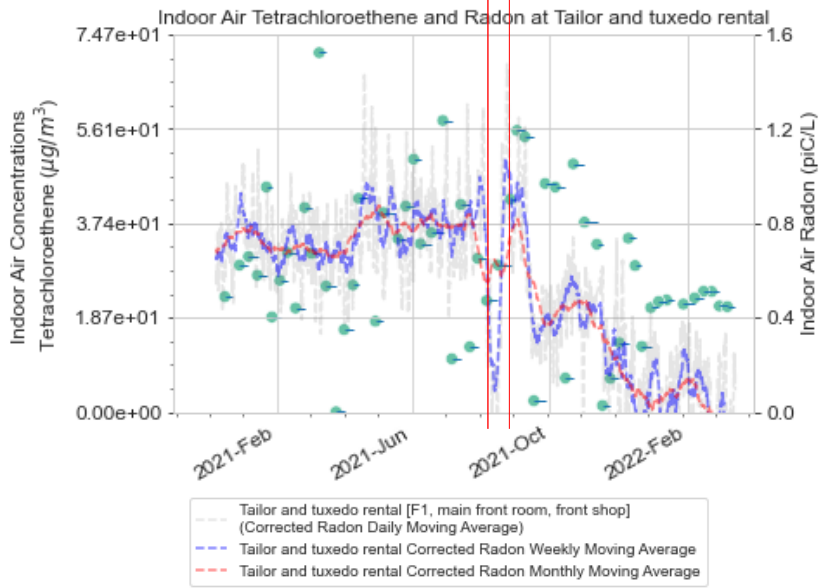
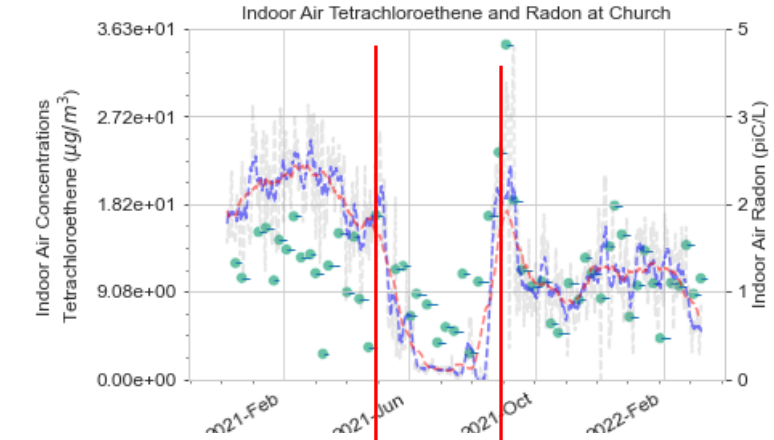
PCE Indoor Temporal Variability Including Two Periods of Short-Term Sampling (9/8/21-9/15/21 and 1/23/22-1/29/22)

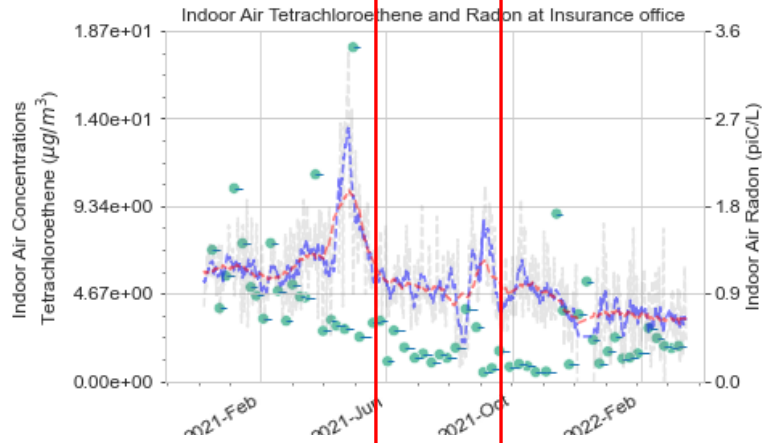


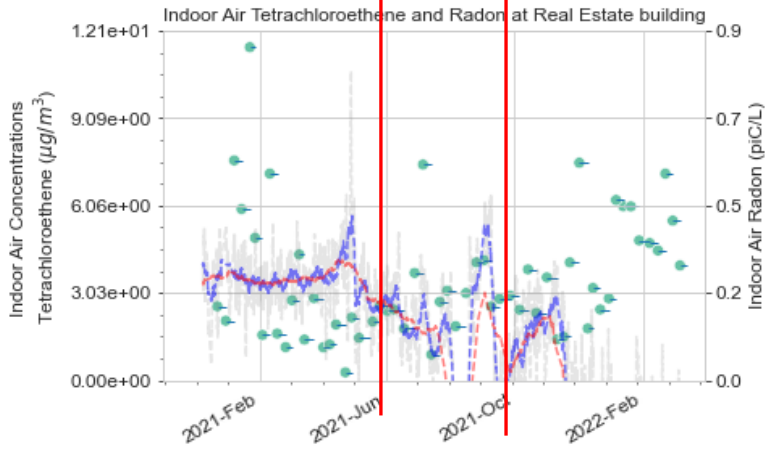
VOCs vs. Radon in Indoor Air – Full Year Trends











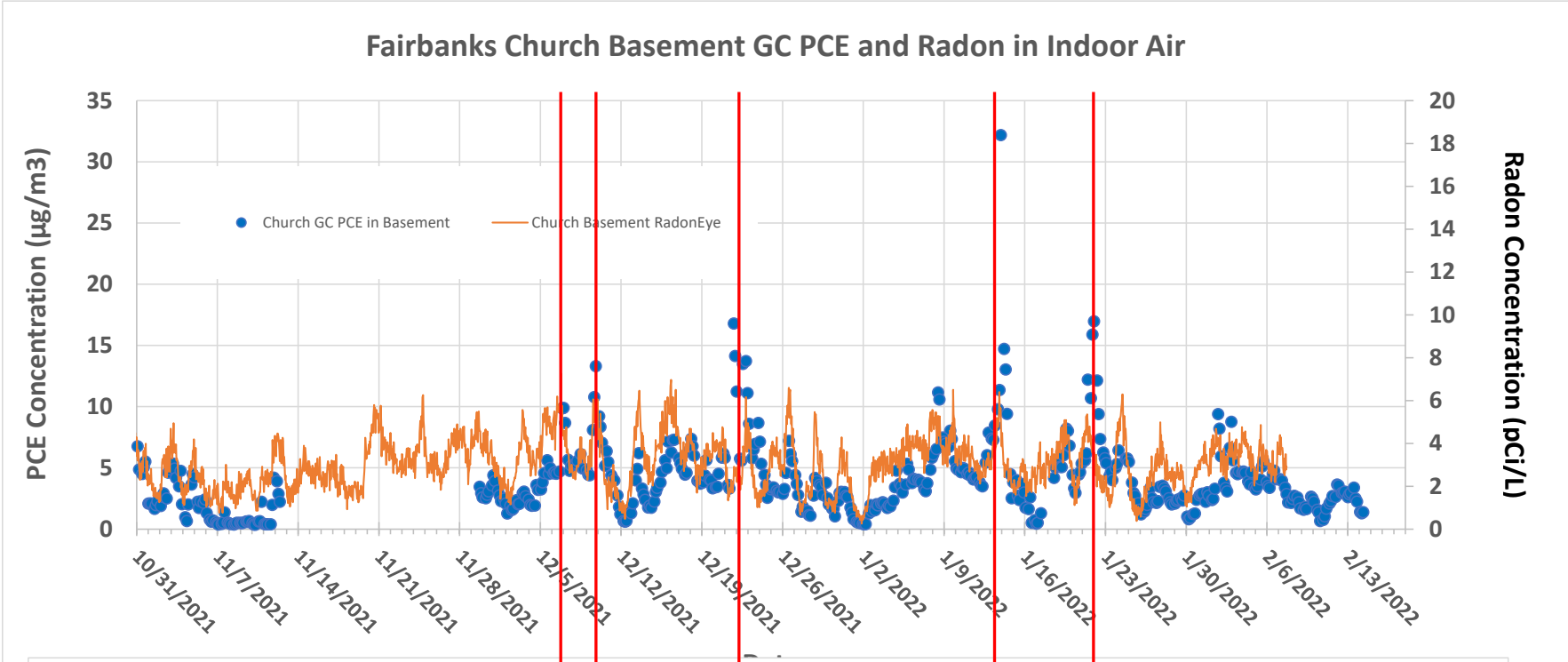
A Simple Look at Radon Spatial Screening in Indoor Air

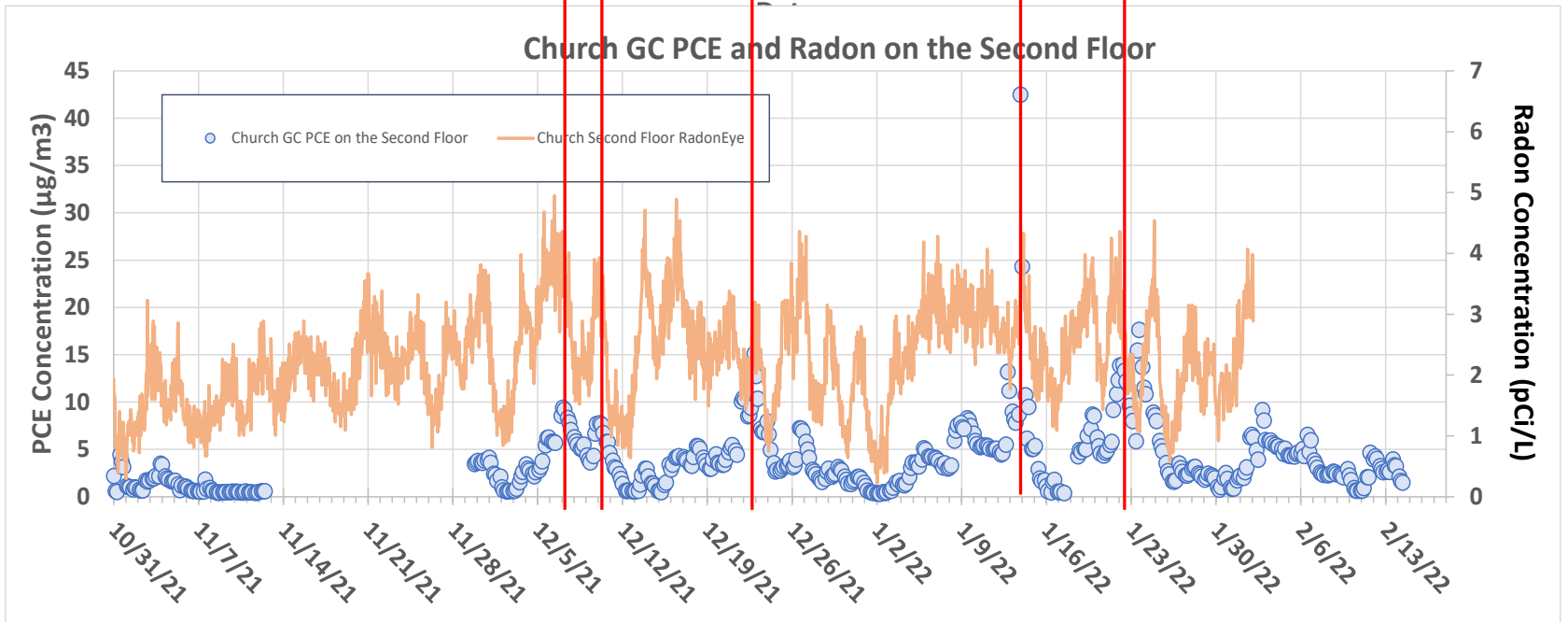
Radon Eye Data, Except Ambient RAD-7; All Units (pCi/l)

Location	Long Term Average Indoor Radon	Standard Deviation Indoor Radon	Long Term Average Subslab Radon	SS AF, corrected for ambient (unitless)
Church Basement	4.4	2.07	165	0.024
Church Second Floor	2.2	1.22	165	
Residential Style Office Basement	1.38	0.56	228	0.004
Residential Style Office Upstairs Kitchen	1.07	0.58	228	
Tailor and Tuxedo (two instruments)	0.90-1.12	0.30-0.41	151	0.004
Not For Profit	0.51	0.27	90	0.001
Office building first floor	0.58	0.25	106	0.002
Office building second floor	0.44	0.23	106	
Outdoor Air At Church	0.40	0.37	NA	

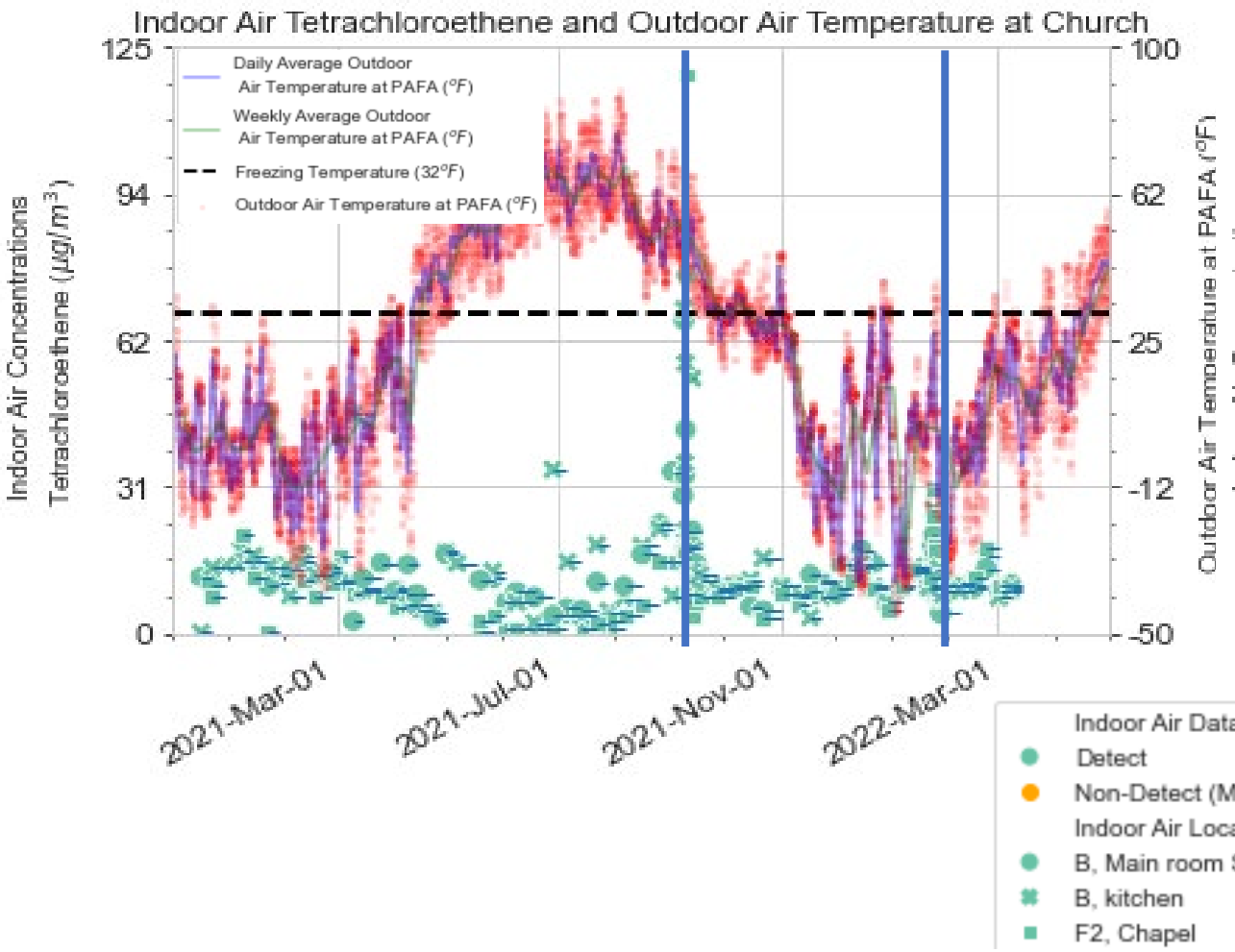
Compare EPA Residential Default VOC AF = 0.030; Median 0.003

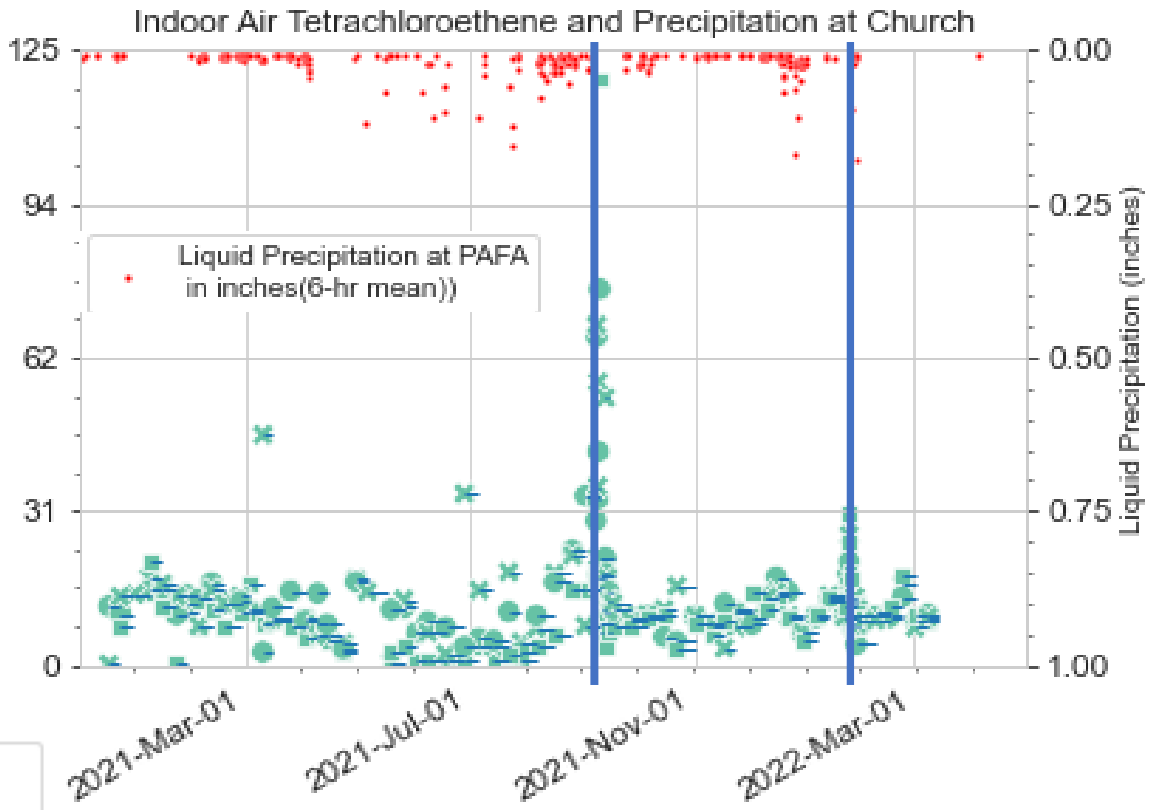
VOCs vs. Radon – High Temporal Resolution Data



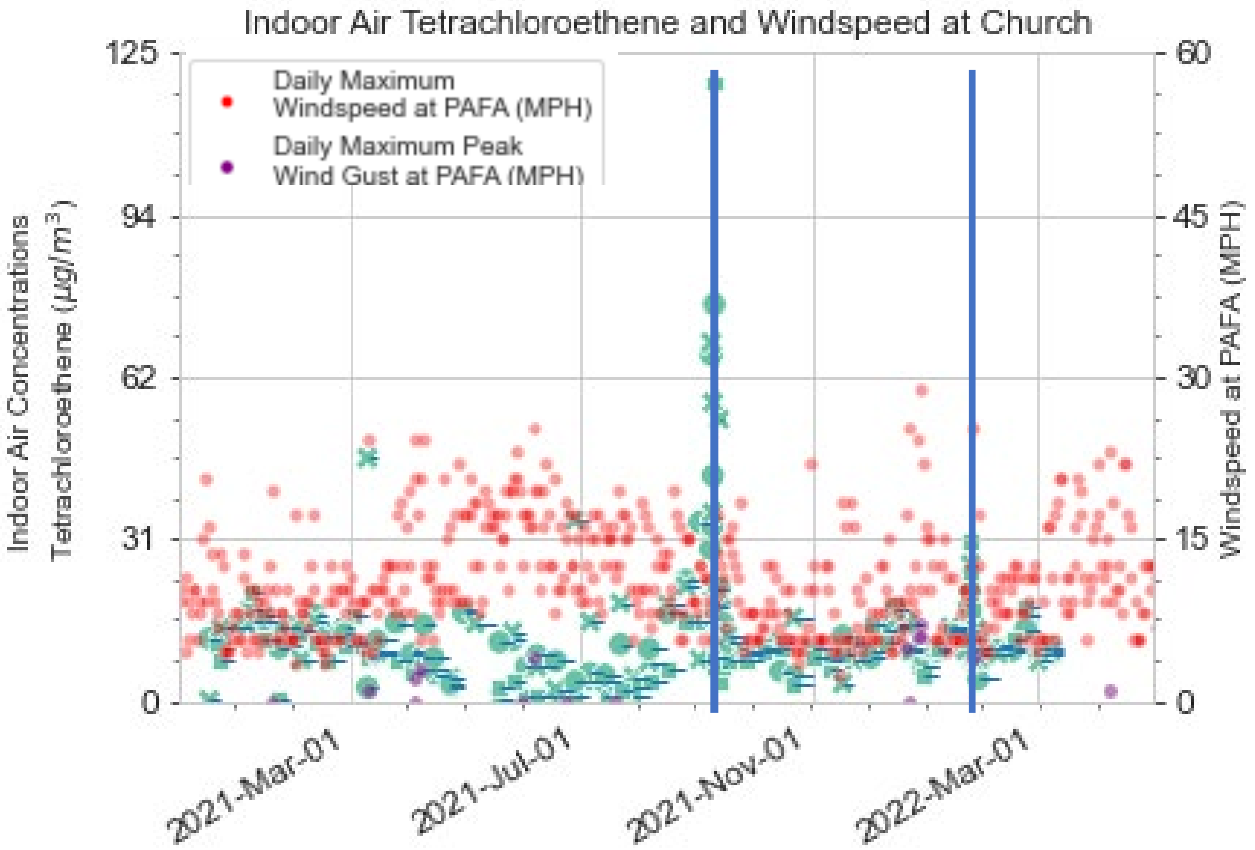


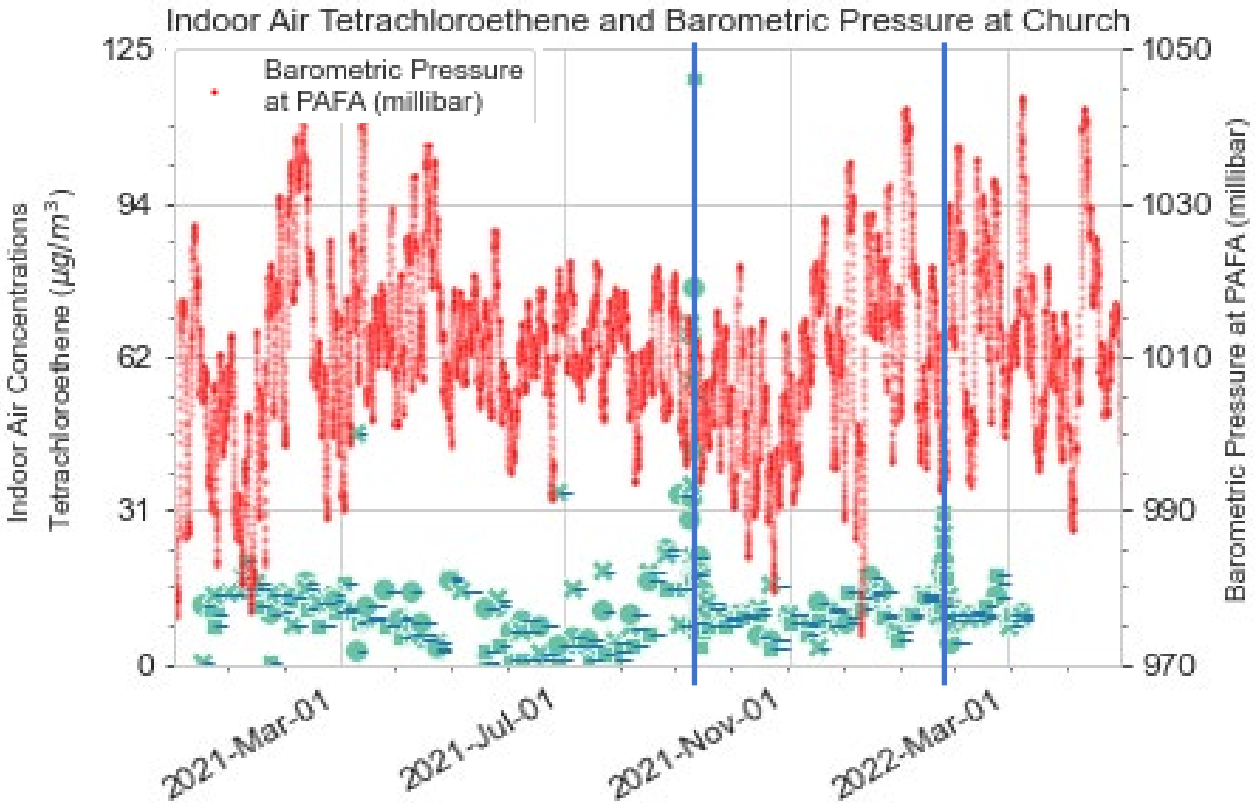
Looking for Meteorological Drivers – Church PCE

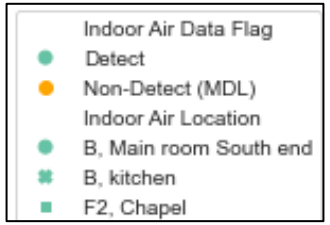




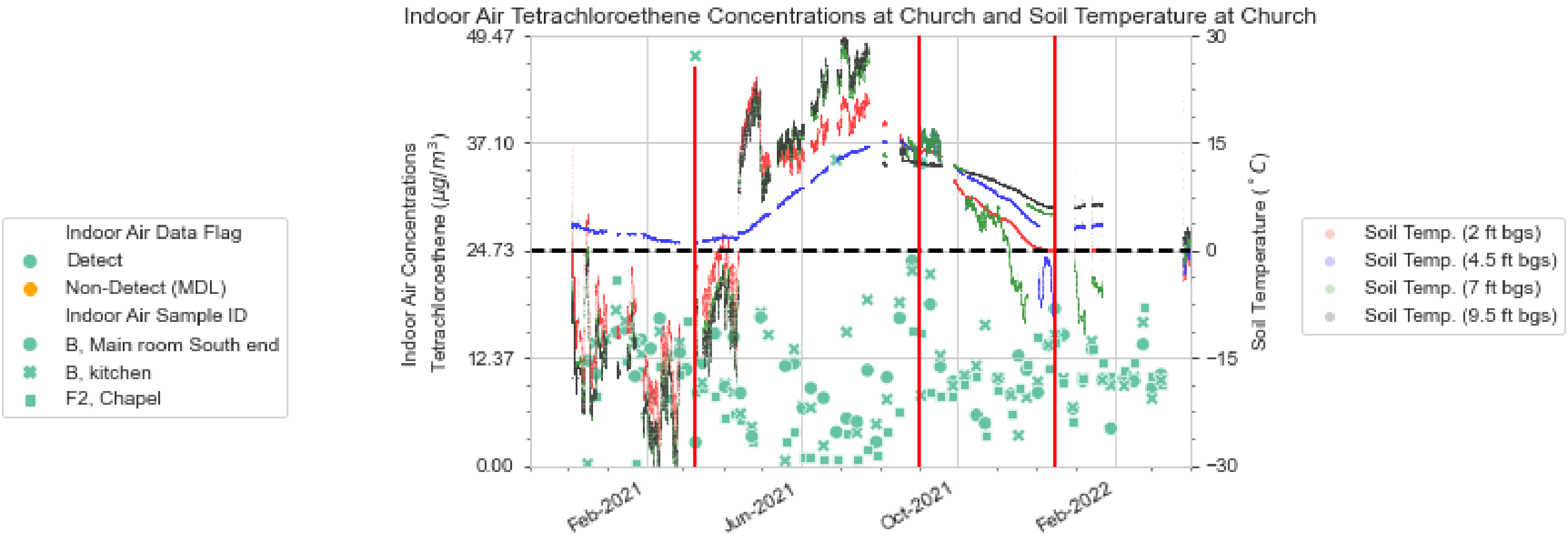
Looking for Meteorological Drivers – Church PCE (Cont.)







Looking for Meteorological Drivers – Church PCE (Cont.)



Soil Temperature vs. VOCs Church

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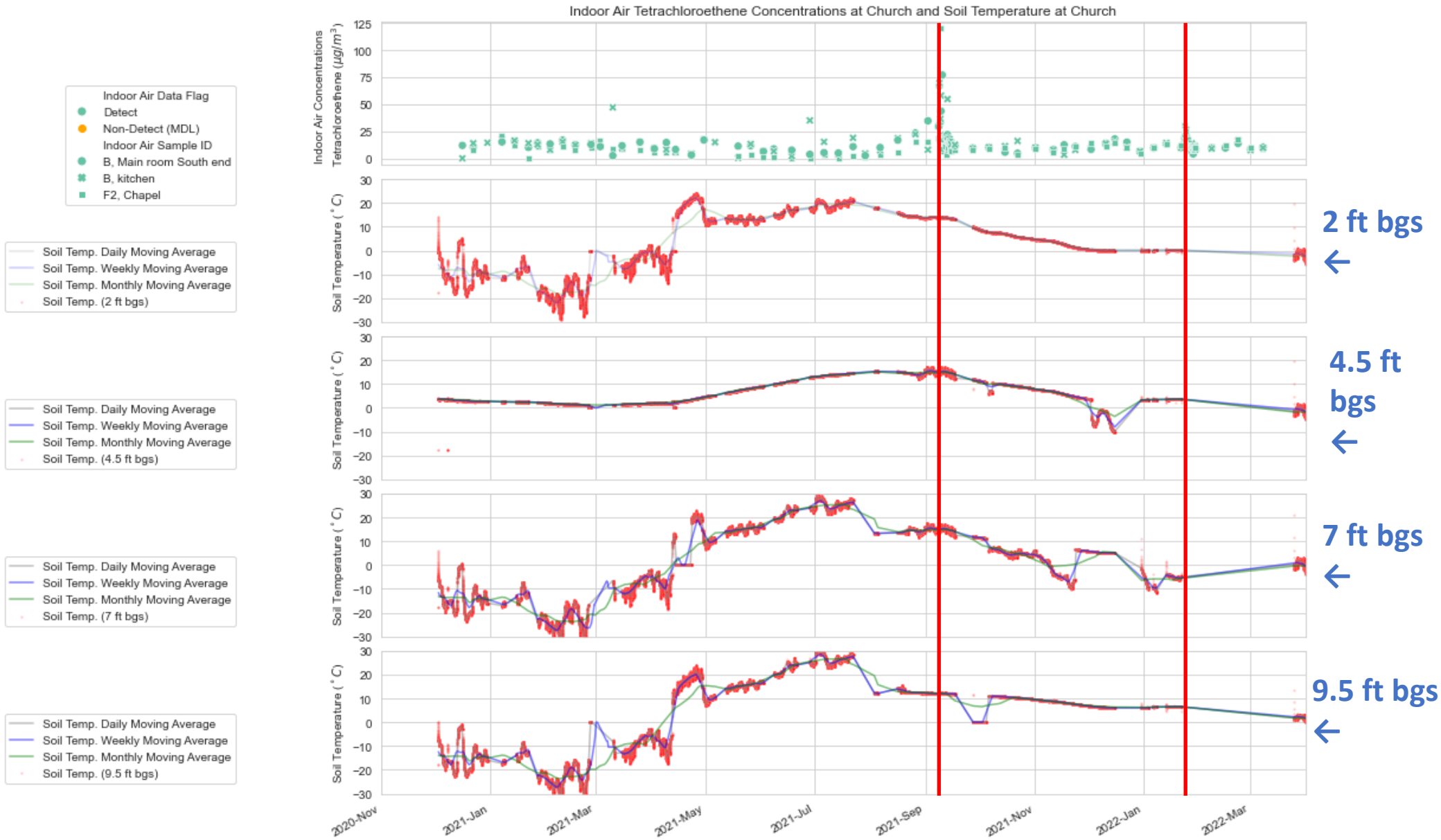


Products to be delivered in FY23

Proposed Journal Articles to be published Fall of 2023

- Estimation of the Number of Samples to Collect to Characterize VI under a Large Building
- Seasonal and Spatial Variability of Indoor Radon and VOC Concentrations Due to Vapor Intrusion
- Pulsed Vapor Intrusion During Summer and Winter Intensive Sampling Events

‘Soil Gas Safe Community’ Project

- As the IT approach for determining when to sample has advanced, the need to expand to the community scale, instead of the select individual homes and buildings, has been identified.
- Quickly identify:
  (a) homes and buildings ‘at risk’ for VI;
  (b) contaminants of concern for VI in the soil gas, and;
  (c) have ‘baseline’ measurements showing elevated soil gas intrusion into indoor air (radon).
- Community involvement and community scientists/occupants need to be an active part of the process.

‘Soil Gas Safe Community’ Project

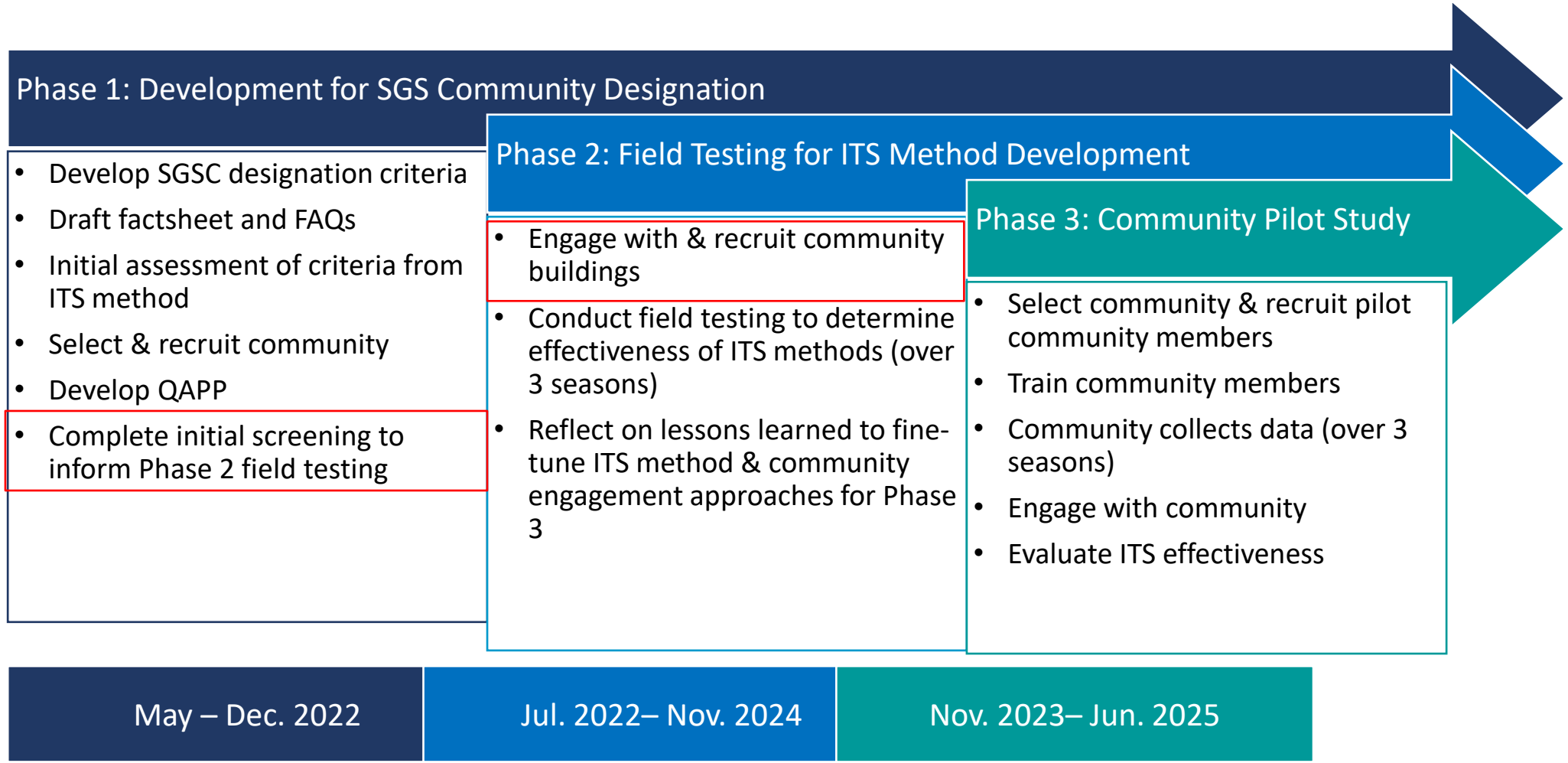
- Community members ‘at risk’ for VI should have:

a) easy access to participate and collaborate with the remedial program decision makers as an equal participant (along with their expert consultants),

b) bring their **own** building-specific evidence of soil gas intrusion (SGI), and

c) be a part of the risk management decision making for their residence or building.

SGS Communities Project Phases and Timeline



Dates are subject to change. Phases will overlap to allow for completion of sample analyses, database management, assessments, and community engagement.

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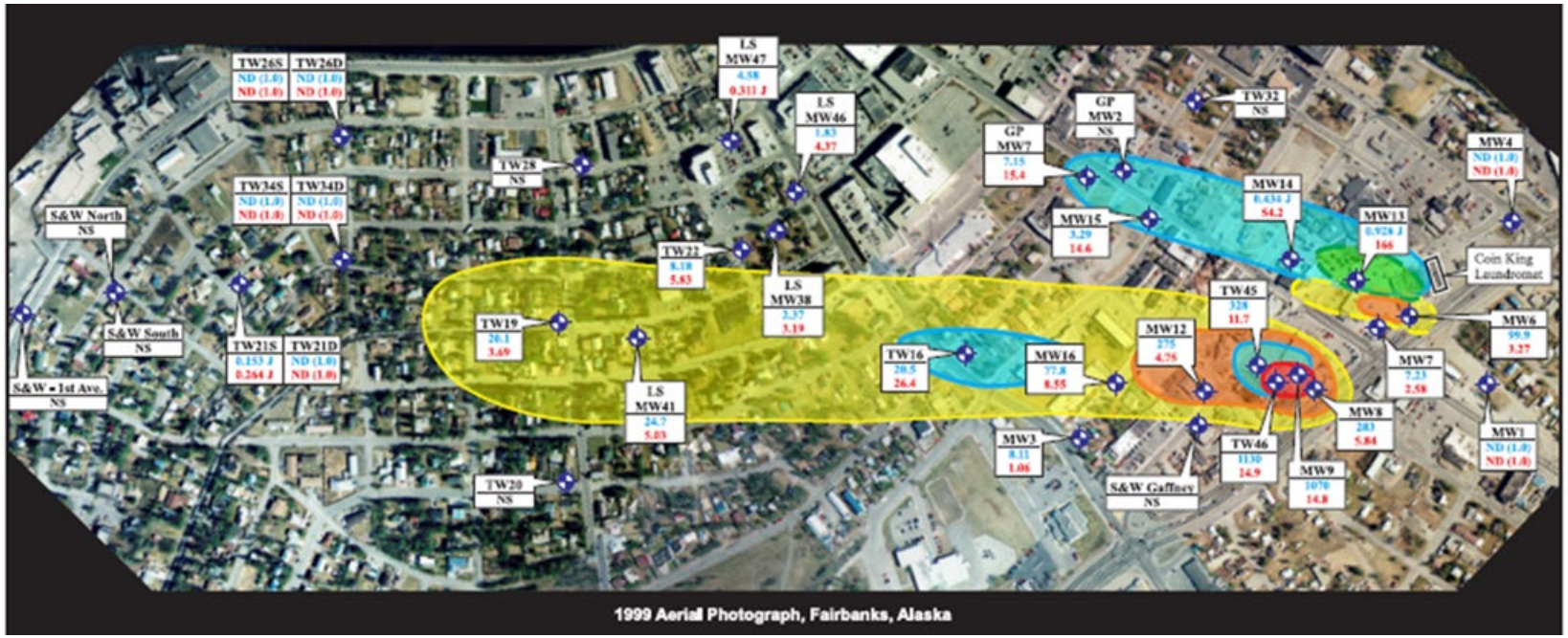
‘Soil Gas Safe Community’ Project



- Why this community for the “Soil Gas Safe Community” project.
  - (1) Commercial and residential buildings over the same shallow groundwater VOC plume,
  - (2) accessible 24/7,
  - (3) in a climatic zone different from Indianapolis and Layton, Utah,

‘Soil Gas Safe Community’ Project

Phase 2 Study

- Three Seasons, 1 convenient and 3 triggered sampling events per season per location
  - Indoor air quality and subslab soil gas OR exterior soil gas
  - Staff will install and return to collect Radiello's; about 5 minutes per visit
  - Indoor air sampling
    - VOCs (with Radiello passive sampler)
    - Radon, particulate matter, CO_2, humidity, temperature (with AirThings View Plus)

View Plus looks like a thermostat and runs all the time. Data can be seen on the panel, smartphone app, or Internet.

‘Soil Gas Safe Community’ Project

- On 11/16/22 we held a information meeting invited residents and business owners within the Northern end of the plume. Presented our study and requested volunteers

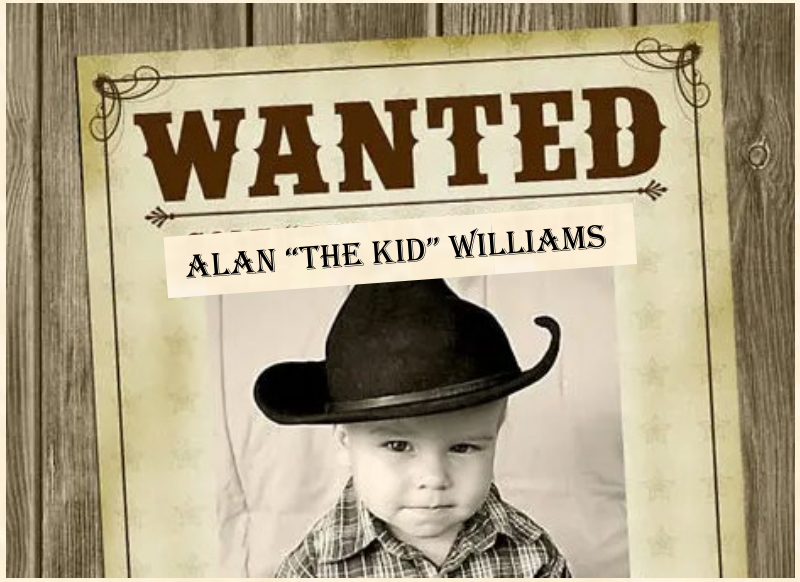
‘Soil Gas Safe Community’ Project

- Communicated with fact sheet, door hanger, door to door visits.
- From 132 potential residences, we have 10 residents committed, 3 waiting for consent forms, 8 that have expressed interest. We would like a total of 25 – 30 residents to make a statistically robust data set.

WANTED!!

FIELD SITE FOR PHASE 3 OF THIS PROJECT.

IF YOU KNOW OF A POSSIBLE CANDIDATE SITE, PLEASE CONTACT ONE OF THE FOLLOWING:



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Contact

- Zimmerman.johnh@epa.gov
- Williams.Alan@epa.gov
- Schumacher.Brian@epa.gov

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The views expressed in this [abstract/presentation/poster] are those of the author(s) and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

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Questions and Discussion

Thank You for your time and attention.

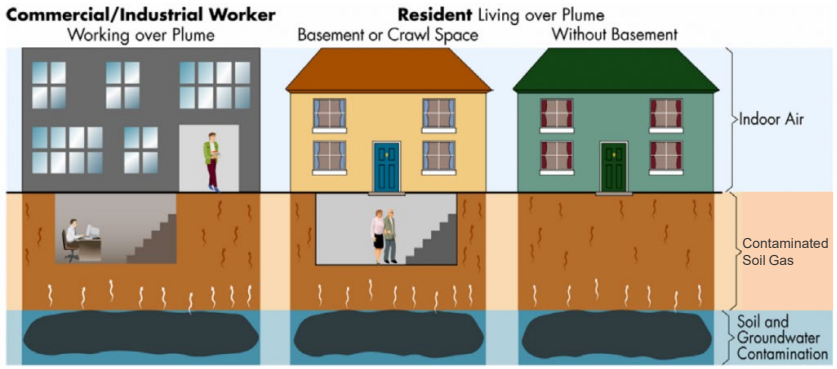
FACT
SHEET
FALL 2022

Soil Gas Safe Communities

Is your indoor air healthy? Here is how you can find out.

A group of researchers – Environmental Protection Agency, RTI International, and Jacobs in collaboration with the Alaska Department of Environmental Conservation (ADEC) – would like to partner with you to conduct pioneering research to better understand the indoor air quality and potential sources of indoor air contamination in your neighborhood.

We are developing a new concept to quickly identify indoor contaminants of concern that may be entering buildings from contaminated soil gas beneath homes and buildings in communities. The results can then be used to inform health and safety risks at a community scale and identify actions you and your neighbors can take to improve indoor air quality.



Adapted from ITRC, https://vim-1.itrcweb.org/introduction-to-vi-mitigation-fact-sheets/

SOIL GAS

Soil gas is the gas underground between solid soil particles. It is above the water table and can be contaminated with volatile organic compounds (VOCs), such as dry cleaning solvents or gasoline, resulting from a chemical spill, leak or improper disposal. Naturally-occurring sources such as radon, may also contaminate soil gas.

Depending upon each building's construction and ventilation, soil vapors can rise through small cracks in foundations and other openings into the building. This migration-exposure pathway is called vapor intrusion.

POTENTIAL FOR VI

The potential for vapor intrusion (VI) typically happens at a community-scale. For example, a groundwater contamination plume hundreds of yards long may be underneath dozens of buildings.

Buildings with basements, cracked floors, stone foundation walls, dirt floors or crawlspaces may be affected by VI.

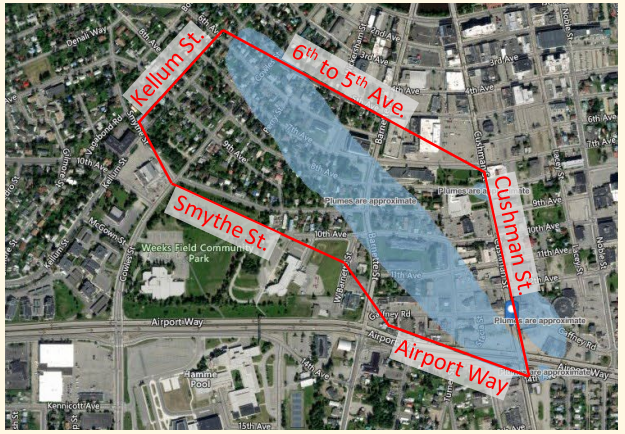
Indoor air concentrations will vary by building and over time, by occupant behavior, weather, and season. Soil gas/vapor concentrations are typically much higher in the subsurface than those found in indoor air.

SOIL GAS SAFE COMMUNITIES: FAIRBANKS, ALASKA

STUDY AREA

VOCs and naturally occurring radon gas have been identified in the subsurface in your community. The known contamination source is the Gaffney West VOC plume (approximate area shown in blue).

We are **seeking 30 volunteer homes** (specifically single-family homes and ground-floor residences of multi-unit buildings) within the areas north of Airport Way, south of 5th and 6th Ave., east of Kellum St. and west of Cushman St. **to schedule a free soil gas and indoor air screening** of their properties to assess the potential for indoor air impacts from the existing soil vapor plume.



SAMPLE COLLECTION

Fall 2022: VOCs and naturally occurring radon gas will be measured. Exterior soil gas samples will be collected at multiple depths in the public rights-of-way by drilling a small diameter hole into the ground. These samples will help us understand which buildings may benefit from indoor sampling.

Winter 2022 – Spring 2024: We would also like to collect indoor air and subslab or soil gas samples at various times to determine if VI is occurring, and how the indoor air quality varies over time. A local technician will seek written consent from residents and building owners to enter the property and will work with residents to identify good times to place 1 sampler in the basement or crawlspace and 1 on the first floor.

The technician will return occasionally, with the resident's permission, to collect the samples during the study. Follow-up visits should last about 10 minutes.

The air samplers are small and will be placed in 'out of the way' breathing zones. The AirThings sampler is about the size of an alarm clock and shows the radon concentration on the screen.

Subslab samples will be collected by drilling a small hole (about 1 inch) into an inconspicuous location on the floor (such as a closet) and installing a vapor pin. The hole will be capped after sample collection.

Sampling results will be shared with building owners and residents after the study is complete.

TO SCHEDULE A FREE SCREENING

PLEASE CONTACT:

Madeline Collins, Jacobs AK

Email: madeline.collins@jacobs.com

Phone: 618-975-0323

For more information and questions about the Soil Gas Safe Communities project, please email us at soilgassafe@rti.org

TO LEARN MORE

Gaffney VOC Plume:
https://dec.alaska.gov/spar/csp/sites/gaffney/

Vapor Intrusion in Alaska:
https://dec.alaska.gov/spar/csp/vapor-intrusion/

Radon in Alaska:

https://dggs.alaska.gov/pubs/id/30163

https://dggs.alaska.gov/hazards/radon.html