Community Monitoring of Industrial Pollution

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Introduction

We work with 56 Portland Neighborhood Association boards providing the data from seven government agencies on Portland industrial air pollution. This results in a frequent question – how to monitor industrial air pollution? Although Oregon Department of Environmental Quality (DEQ) owns most of the ideal regulatory-grade air pollution monitors, DEQ rarely, if ever, deploys their devices in the Portland neighborhoods most affected by industrial air pollution. With rare exception, their equipment either sits on the shelf at their well-funded lab staffed by experts, or is used in the neighborhoods with the safest air quality.

Starting in 2018, Cascadia Action began purchasing consumer-grade monitoring equipment to measure industrial pollution. At that time, affordable and accurate air pollution monitors started entering the consumer market for the first time. Instead of $25 K per device, the price tag of the existing regulatory-grade equipment, new consumer-grade devices were $100-300 per unit. Our two reports on monitors are here:
portlandcleanair.org/files/reports/Diesel%20particulate%20monitoring.pdf
pdxcleanair.org/files/reports/PCA_VOC_report.pdf

While new consumer-grade hardware is impressive, it lacks easy ways to visualize the data collected and setup is often not well explained by the manufacturer. Our data collection with the PocketLab Air, Flow 1, and Purple Air monitors required working with GIS mapping technicians, Excel specialists, and computer programmers to view our results. In 2020 we got to work making automated computer programs so our neighbors would not need multiple specialists to monitor industry.

Monitoring airborne particulate

To measure airborne particulate, we use the PocketLab Air mounted on bicycles. The Environmental Protection Agency (EPA) has published a correction to the Plantower sensor, used in the PocketLab Air. We applied the EPA correction in Excel which is:
=(.0534*C3)-(0.0844*H3)+5.604
Our study on page two shows that a co-located PurpleAir was as accurate as a nearby DEQ regulatory-level particulate monitor, except during extreme forest fire events:
portlandcleanair.org/files/reports/DPCA_Diesel_particulate_at_I_5.pdf

It was expensive and tedious to use GIS mapping every time we did a bike ride for data collection. A volunteer from Mapbox automated our mapping on their platform so we would no longer need to use ARCGIS to visualize the data. A web engineer volunteered and scripted a web interface which automatically applies the EPA correction and maps the results in Mapbox. Now we just load the data onto the page and instantly get corrected map results.

Throughout the pandemic a volunteer bicyclist rode with our PocketLab Air from his home to the I-5 corridor where the worst unfiltered truck traffic can be found, according to ODOT. His rides found that particulate would often double when riding in neighborhoods near I-5, as shown here:

DEQ has not taken a single particulate sample in neighborhoods near I-5 during their 35 years of data collection. Our report on the I-5 particulate monitoring is here:
portlandcleanair.org/files/reports/DPCA_Diesel_particulate_at_I_5.pdf

Pairing an Android smartphone with the PocketLab Air and retaining the data was tricky due to the 30-minute maximum limit for Android devices before they go to sleep. This action disconnected the phone and the PocketLab Air and resulted in the loss of all data collected from the ride. So, iPhones, which can be set to stay "awake" indefinitely, were adopted instead of Android phones. The volunteer then wrote easily understood procedures, all the steps required to use the equipment, and these are included at the end of this report.

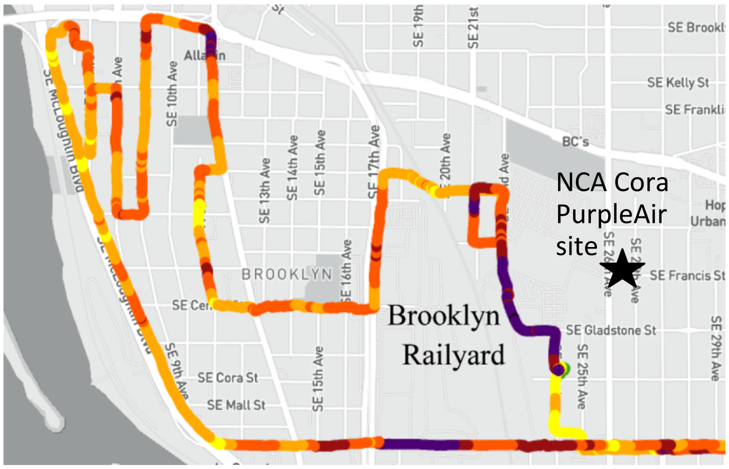
We knew one factor that affected the amount of airborne industrial pollution was the presence of an inversion. An atmospheric inversion occurs when air temperature increases with altitude. Inversions reduce or prevent the vertical mixing of ground level pollutants resulting in higher concentrations. The ideal conditions for the formation of a surface inversion are cloud-free skies at night and light surface winds. A balloon-borne sounding is required to measure air temperatures aloft and if an inversion exists and how strong it is. No such soundings existed over Portland for the period of our bicycle-ride data collections. Also, surface wind speed affects particulate concentrations: calm to light winds yield highest concentrations, moderate to strong winds yield lowest concentrations.

Consulting a retired professional meteorologist, we learned that NOAA runs high-resolution three-dimensional supercomputer models of the atmosphere. The output of these models for the planned and actual times and locations of our data collections were accessed through two websites. We relied on **https://rucsoundings.noaa.gov** for vertical profiles of temperature and wind. This required computing the difference in temperature over different surface depths to determine if there would be, or had been, an inversion, and to estimate its strength. And we accessed **www.ready.noaa.gov/READYcmet.php** for seven categories of surface layer atmospheric stability: Pasquill stability classes A through G. Procedures and examples are shown at the end of this report.

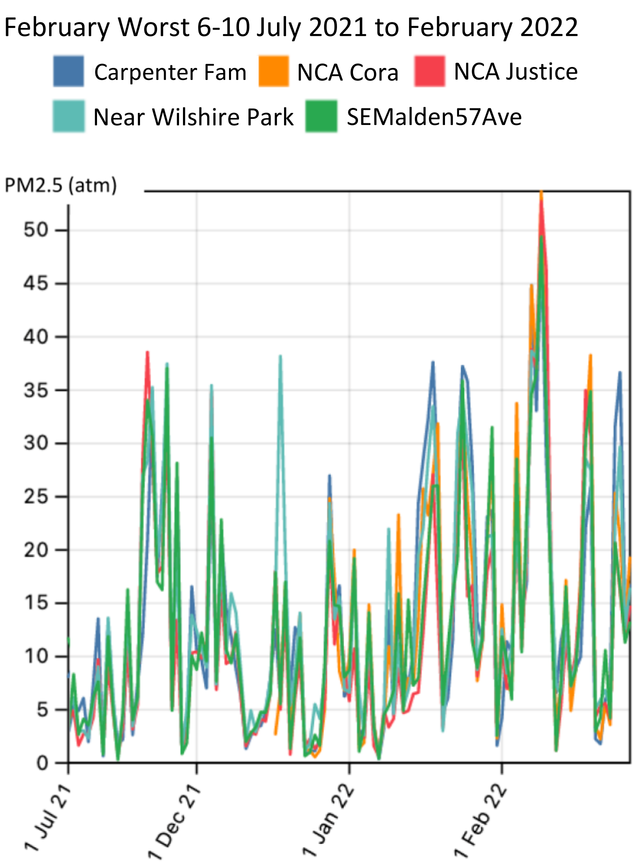
A: Extremely unstable conditions
B: Moderately unstable conditions
C: Slightly unstable conditions
D: Neutral conditions
E: Slightly stable conditions
F: Moderately stable conditions
G: Extremely stable

PurpleAir monitors are ideal to measure PM2.5 particulate as a stationary monitors operating 24/7 year-round. However, the PurpleAir webpage makes it difficult to view long-term graphs of collected data, especially comparative graphs from multiple sites. Our team scripted a PurpleAir Data downloader that acquired all the PurpleAir data ever collected in the Portland area. We paid an online data hosting site to store the collected data and created a webpage that automatically and instantly graphs any time period from multiple or single monitors.

One result of concern was at the Brooklyn railyard. The PurpleAir showed high levels of ongoing particulate and the mobile monitoring showed an obvious plume, represented in dark purple in the following image.



The plume appears to be coming off the railyard, about 1,000 feet from where the the PurpleAir called NCA Cora was located:



According to our analysis of the PurpleAir data, Cora had among the worst ten particulate levels from July 2021 to February 2022. The PurpleAir data looks accurate as it does not contain the PurpleAir error where the data is a straight line, shown on the bottom of page 22 of this report.

For regulatory-grade particulate results we need a Model 1371 Grimm Mini Wide Range Aerosol Spectrometer (MiniWRAS). We currently have $18,000 in the bank, donated to partially fund this $38,700 device. This is the only portable instrument on the market capable of real-time monitoring of diesel particulate, identifiable by its unique particle size. The MiniWRAS counts and measures particles and their sizes from .01 to 35 microns. This device may be bicycle mounted and can incorporate GPS locations, allowing the same GIS mapping of the data as the Pocketlab maps shown in this report.

Volatile Organic Compound (VOC) Monitoring

Industrial solvents often smell bad; however, upon exposure the human nose stops detecting them quickly. In the last few years new sensors and monitors became available that can provide a TVOC (Total Volatile Organic Compounds) reading, a reading of the combined sum of all industrial solvents in the air. We built a webpage that automated mapping and started biking around areas with a strong solvent smell. These Flow monitors can be used in both stationary and mobile modes. At the time of this report we are nearing completion of our automatic graphing webpage for stationary monitors.

To obtain regulatory-grade VOC analysis, we worked with Eurofins, an EPA and Oregon-certified lab. Eurofins mailed us $800 Summa canisters and charged about $250 per sample for canister rental and analysis. Summa canisters are spherical, six-liter, stainless steel containers about the size of a basketball and weigh about six pounds each. They have a nearly chemically inert interior surface manufactured for air sampling. Summa canister lab analysis can detect approximately 60 VOCs and their airborne concentrations.

We took Summa canister samples at nine sites near industry. For example, here is a Summa canister result from a neighborhood near Columbia steel's stinky painting operation:

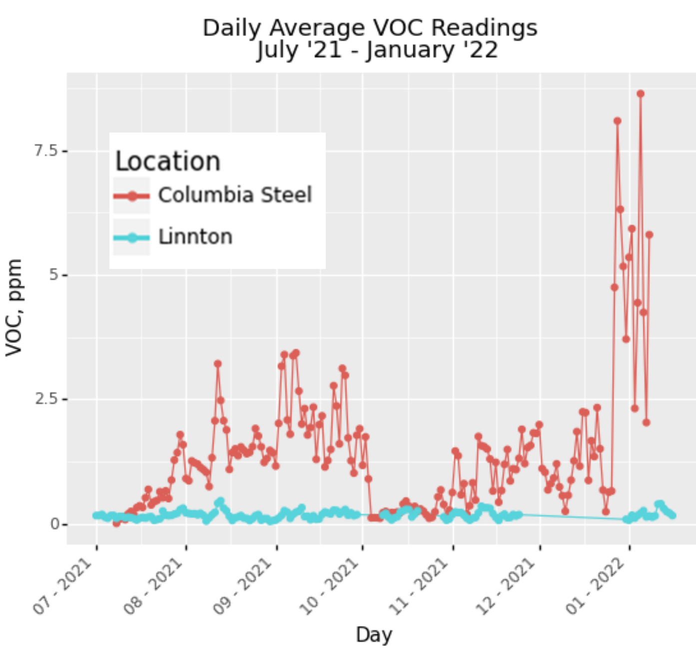
2/9/22 45.59 -122.72

Ethanol	93 ppbv
2-Propanol	2.6 ppbv
Toluene	2.2 ppbv
m,p-Xylene	1.0 ppbv

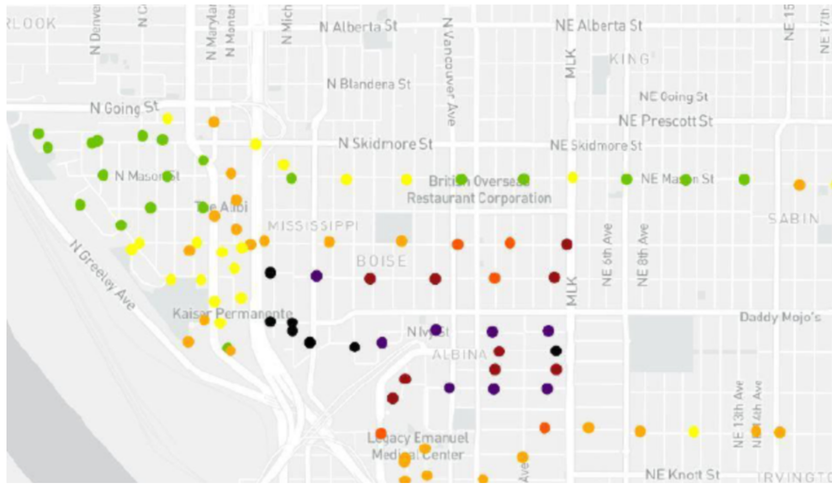
Another Summa canister result form a neighborhood near the petrochemical tank farms in Linnton:

Ethanol	19 ppbv
Hexane	2.8 ppbv
Cyclohexane	0.96 ppbv
2,2,4-Trimethylpentane	1.2 ppbv
Benzene	0.69 ppbv
Heptane	0.71 ppbv
Toluene	2.2 ppbv
m,p-Xylene	1.1 ppbv

Here are the results of the stationary Atmotube, a discontinued VOC monitor nearly identical to the Flow monitors we use now. This graph shows results from for a Linnton site, relatively far from industry, and much higher readings from Columbia Steel:



The Flow/Atmotube monitors were indispensable for knowing where to deploy a Summa canister. We these stationary monitors at three locations near Portland industry. Those results are not available in this version of the report -- we haven't completed creating the automatic graphing webpage for the Flow used as a stationary monitor. We also deployed a bicycle-mounted Flow and found what appears to be a plume emanating from the Albina railyard, a known VOC emitter according to EPA NEI data:

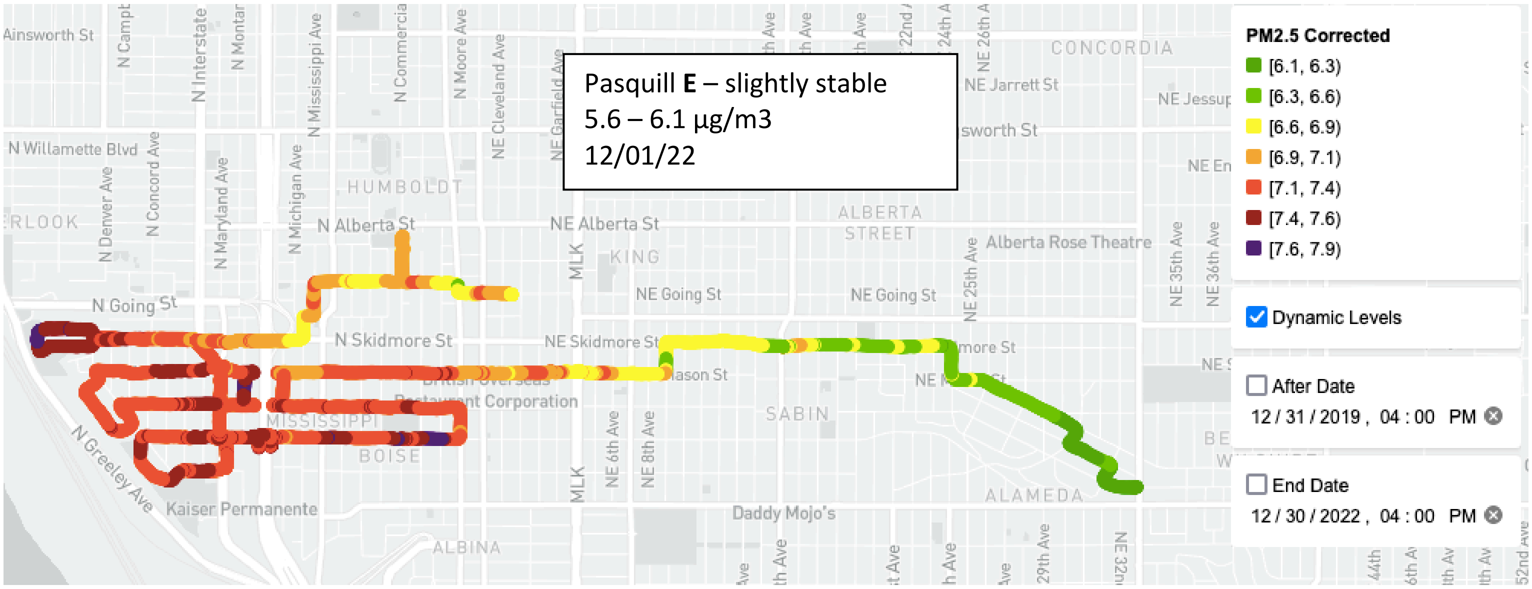


We did not deploy a wind monitor because the meteorologist we are working with advised us that measuring wind direction can be extremely difficult. For example, a building or topographic change can redirect a north wind to become an east wind in a specific area. So, we assume that low readings near a pollution source that also has high readings can mean either the source is not emitting at that time or only reflects changes in wind direction.

More Results

The following pages are a series of maps and tables of our results. We don't believe our results replace the need for regulatory equipment; we are working to purchase that equipment. Our results are best viewed as survey-level data that indicate where likely industrial air pollution exists.

Colors on the following maps show particulate and VOC concentrations over the range measured: green (lowest) to purple (highest) are defined for each ride. These colors do not indicate Air Quality Index categories defined by the Environmental Protection Agency.


Pasquill **E** – slightly stable
5.6 – 6.1 µg/m3
12/01/22
PM2.5 Corrected
[6.1, 6.3)
[6.3, 6.6)
[6.6, 6.9)
[6.9, 7.1)
[7.1, 7.4)
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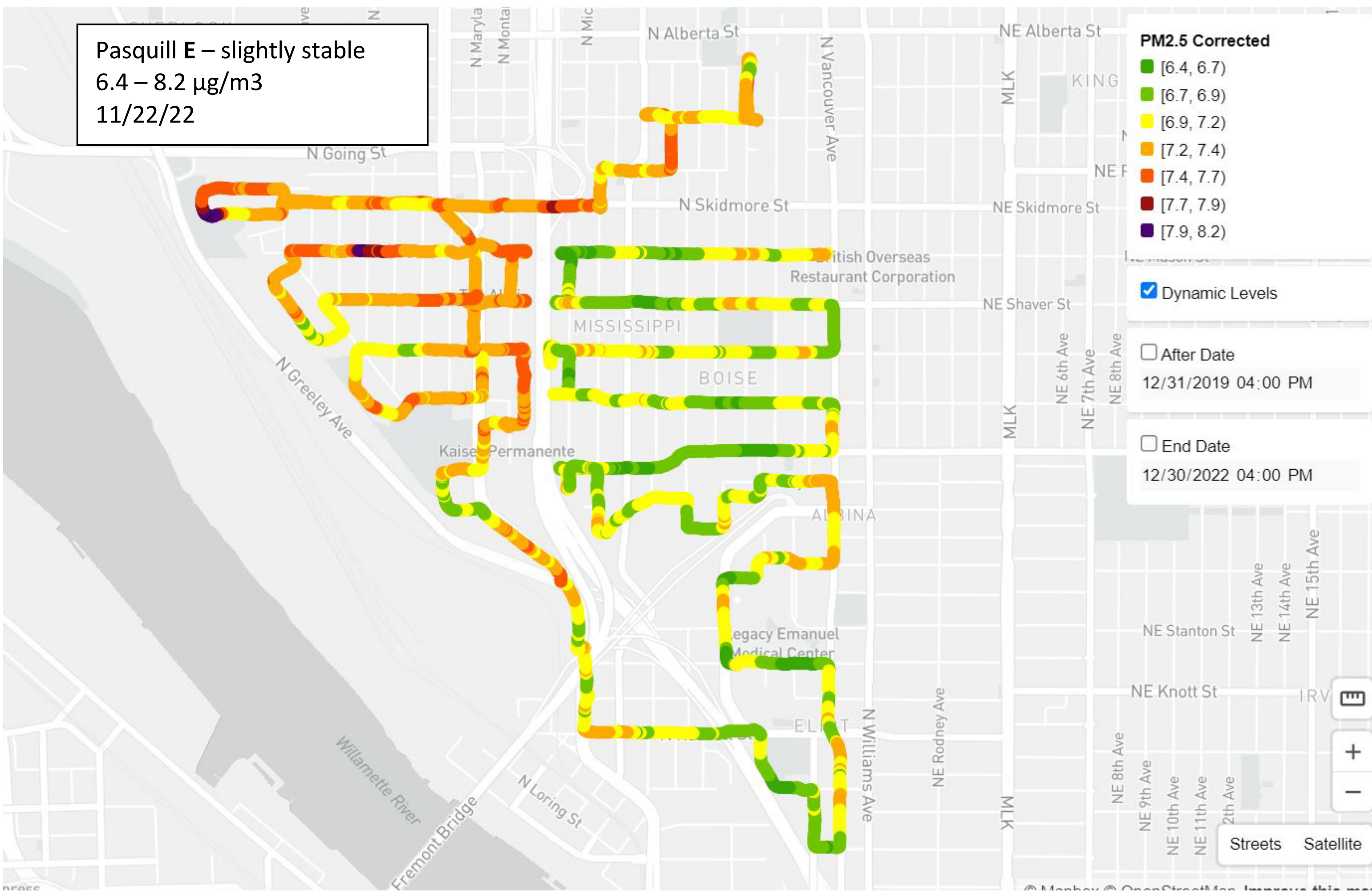
12 / 31 / 2019 , 04 : 00 PM
End Date
12 / 30 / 2022 , 04 : 00 PM


Pasquill **E** – slightly stable
6.4 – 8.2 µg/m3
11/22/22
PM2.5 Corrected
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[6.9, 7.2)
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End Date
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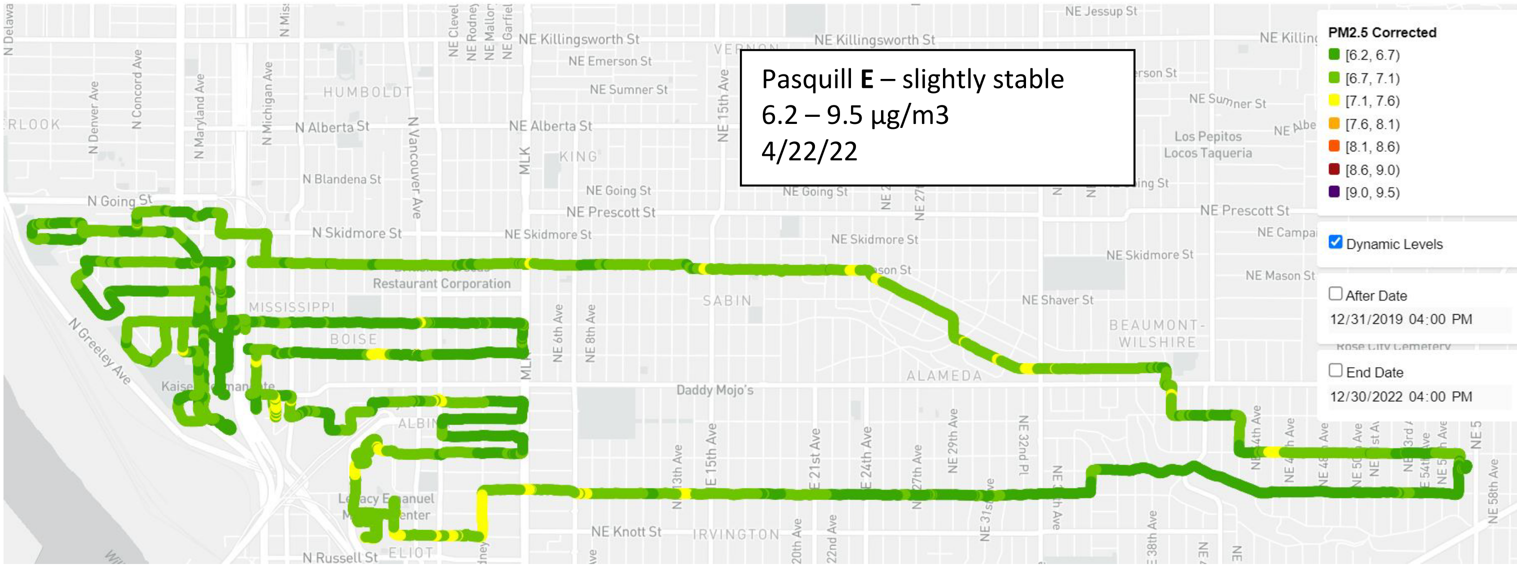
Streets
Satellite


Pasquill **E** – slightly stable
6.2 – 9.5 µg/m3
4/22/22
PM2.5 Corrected
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[7.1, 7.6)
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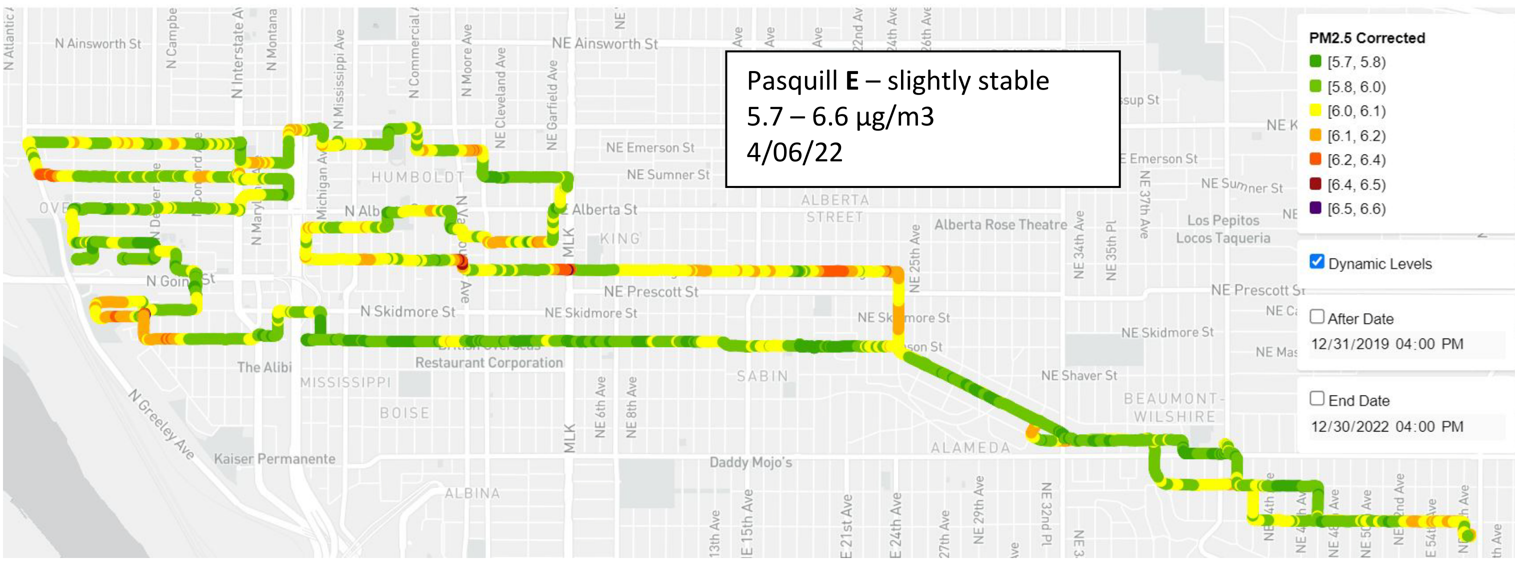
End Date
12/30/2022 04:00 PM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5.7 – 6.6 µg/m3
4/06/22
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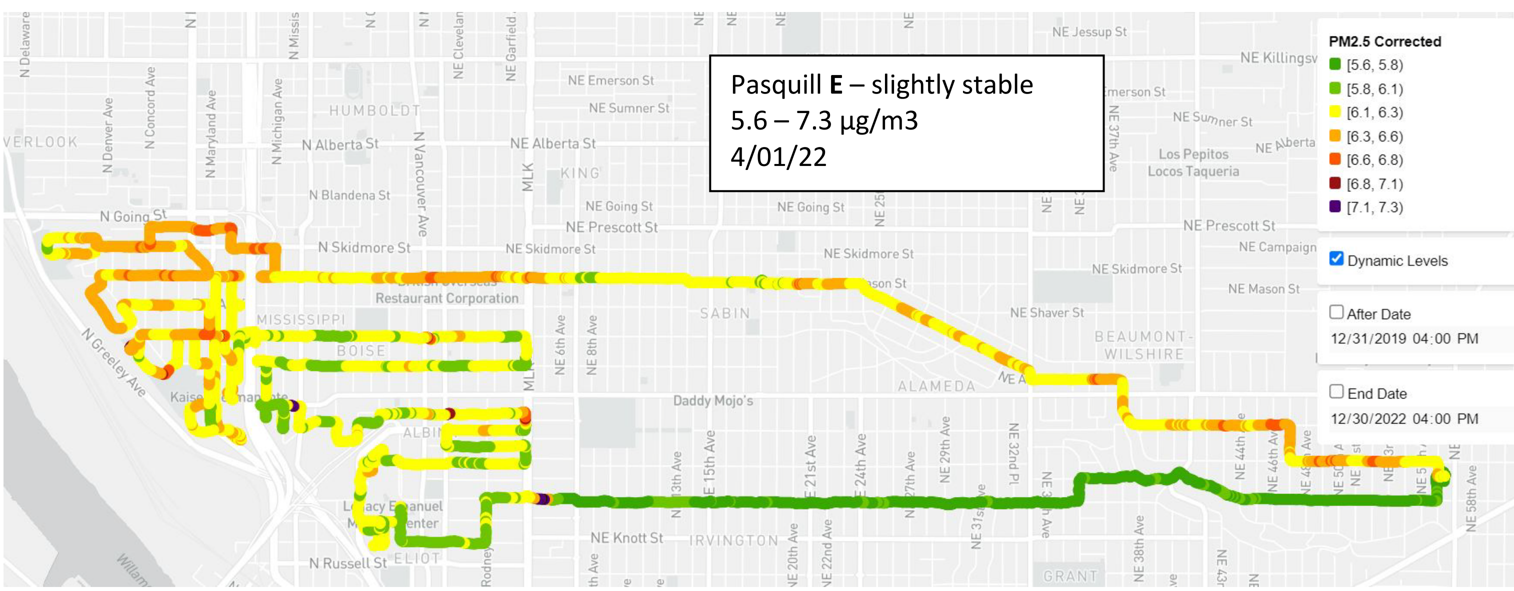
Pasquill **E** – slightly stable
5.6 – 7.3 µg/m3
4/01/22
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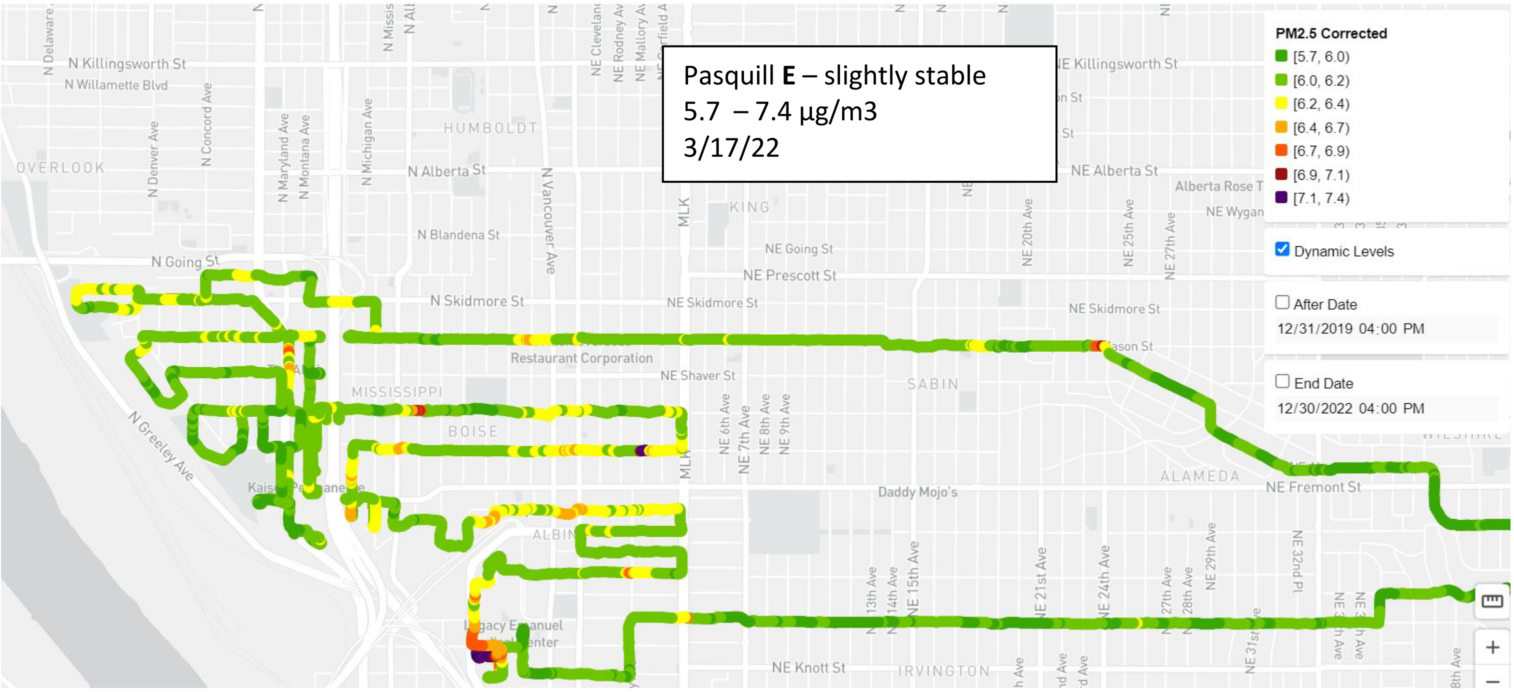
Pasquill **E** – slightly stable
5.7 – 7.4 µg/m3
3/17/22
PM2.5 Corrected
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[6.0, 6.2)
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[6.9, 7.1)
[7.1, 7.4)
Dynamic Levels
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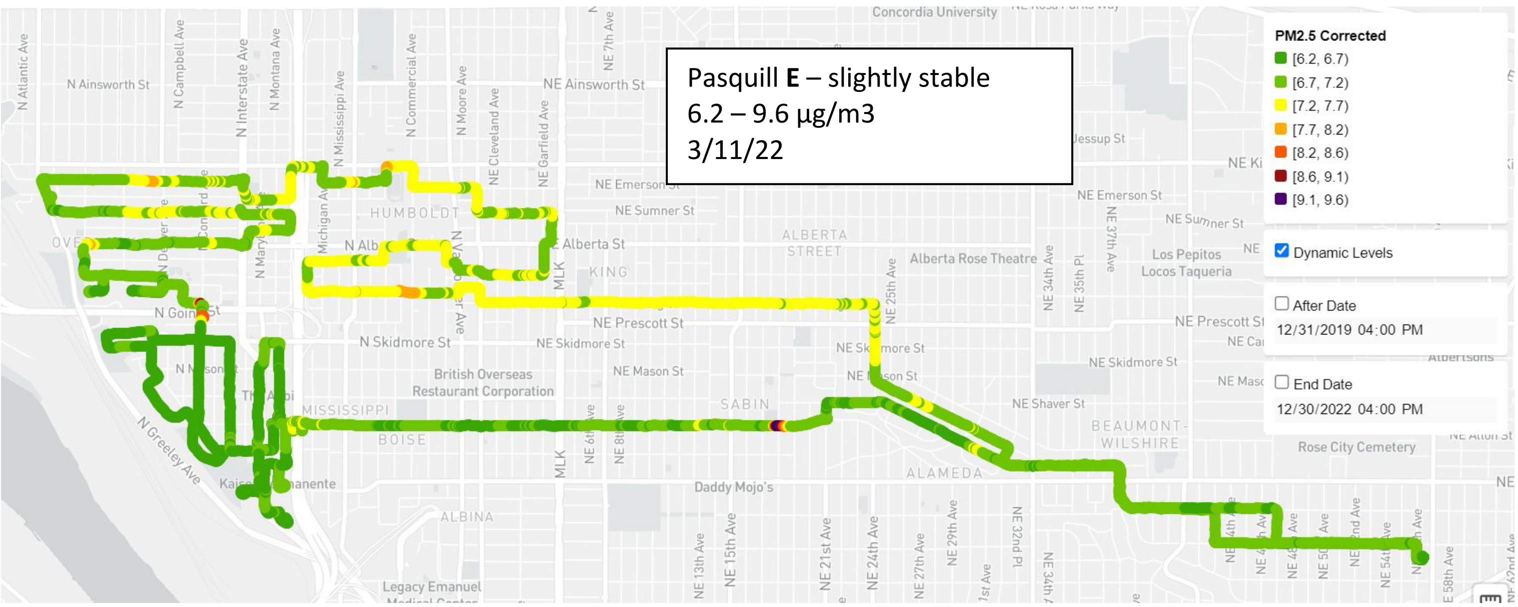
End Date
12/30/2022 04:00 PM
N Killingsworth St
N Willamette Blvd
HUMBOLDT
OVERLOOK
N Alberta St
N Blandena St
N Going St
N Skidmore St
NE Going St
NE Prescott St
NE Skidmore St
NE Shaver St
Restaurant Corporation
MISSISSIPPI
BOISE
SABIN
ALAMEDA
NE Fremont St
Daddy Mojo's
N Greeley Ave
NE Knott St
IRVINGTON
NE Killingsworth St
NE Alberta St
KING
MLK


Pasquill **E** – slightly stable
6.2 – 9.6 µg/m3
3/11/22
PM2.5 Corrected
[6.2, 6.7)
[6.7, 7.2)
[7.2, 7.7)
[7.7, 8.2)
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[8.6, 9.1)
[9.1, 9.6)
Dynamic Levels
After Date
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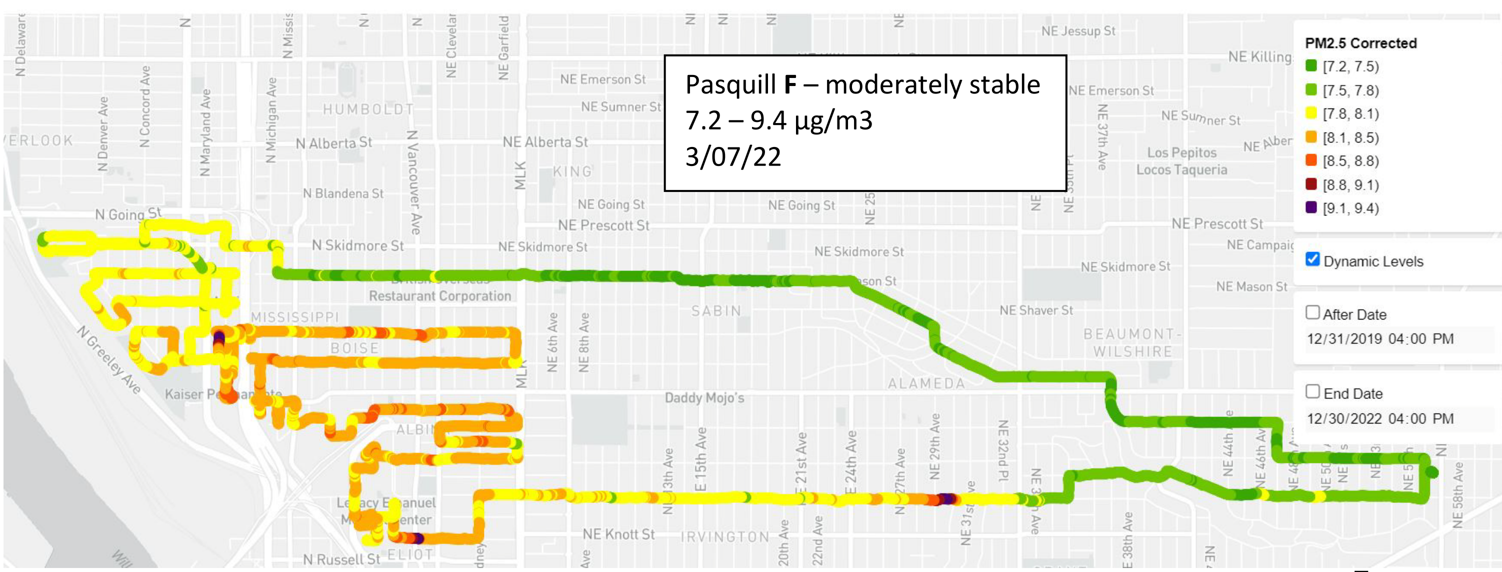
End Date
12/30/2022 04:00 PM
Concordia University
N Ainsworth St
NE Ainsworth St
NE Emerson St
NE Sumner St
HUMBOLDT
ALBERTA STREET
Alberta Rose Theatre
Los Pepitos Locos Taqueria
NE Prescott St
N Skidmore St
NE Skidmore St
NE Mason St
British Overseas Restaurant Corporation
MISSISSIPPI
BOISE
SABIN
BEAUMONT-WILSHIRE
ALAMEDA
Rose City Cemetery
Daddy Mojo's
ALBINA
Legacy Emanuel
N Greeley Ave


Pasquill **F** – moderately stable
7.2 – 9.4 µg/m3
3/07/22
PM2.5 Corrected
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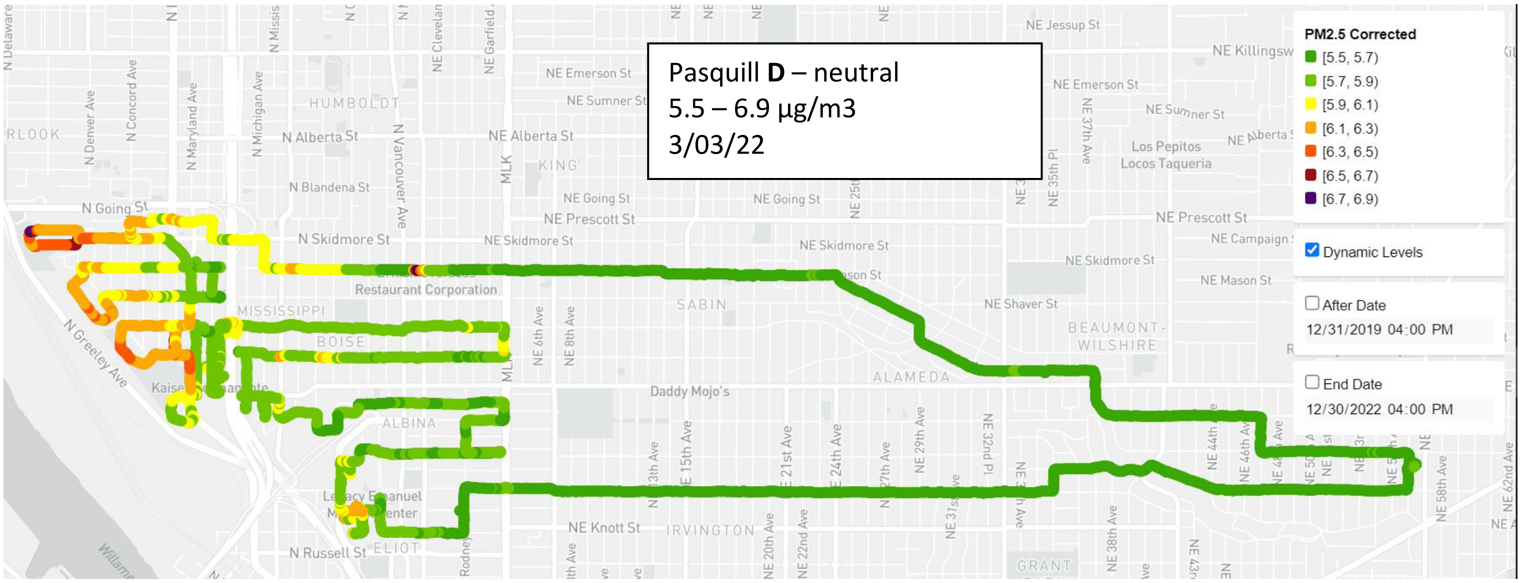
12/31/2019 04:00 PM
End Date
12/30/2022 04:00 PM
NE Jessup St
NE Emerson St
NE Sumner St
HUMBOLDT
N Alberta St
NE Alberta St
N Blandena St
N Going St
NE Going St
NE Prescott St
N Skidmore St
NE Skidmore St
Restaurant Corporation
MISSISSIPPI
BOISE
SABIN
BEAUMONT-WILSHIRE
ALAMEDA
Daddy Mojo's
N Greeley Ave
NE Knott St
IRVINGTON
N Russell St
ELIOT
Los Pepitos Locos Taqueria


Pasquill **D** – neutral
5.5 – 6.9 µg/m3
3/03/22
PM2.5 Corrected
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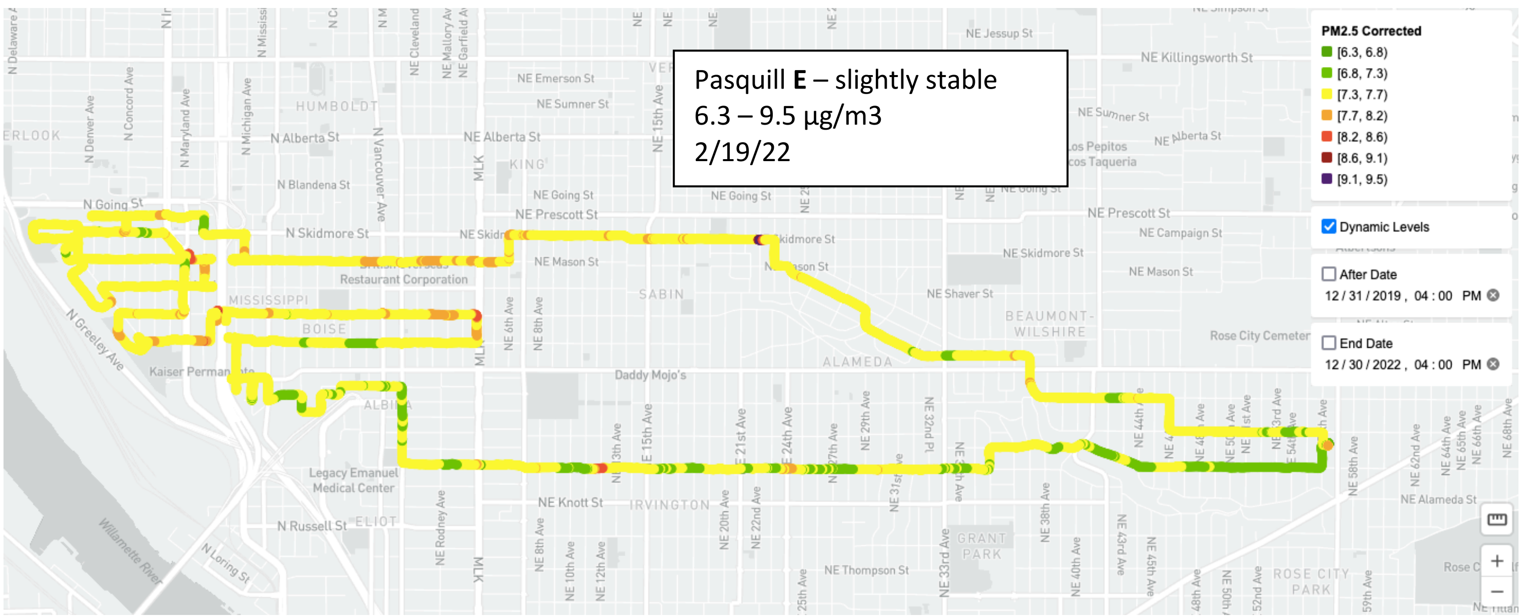
Pasquill **E** – slightly stable
6.3 – 9.5 µg/m3
2/19/22
PM2.5 Corrected
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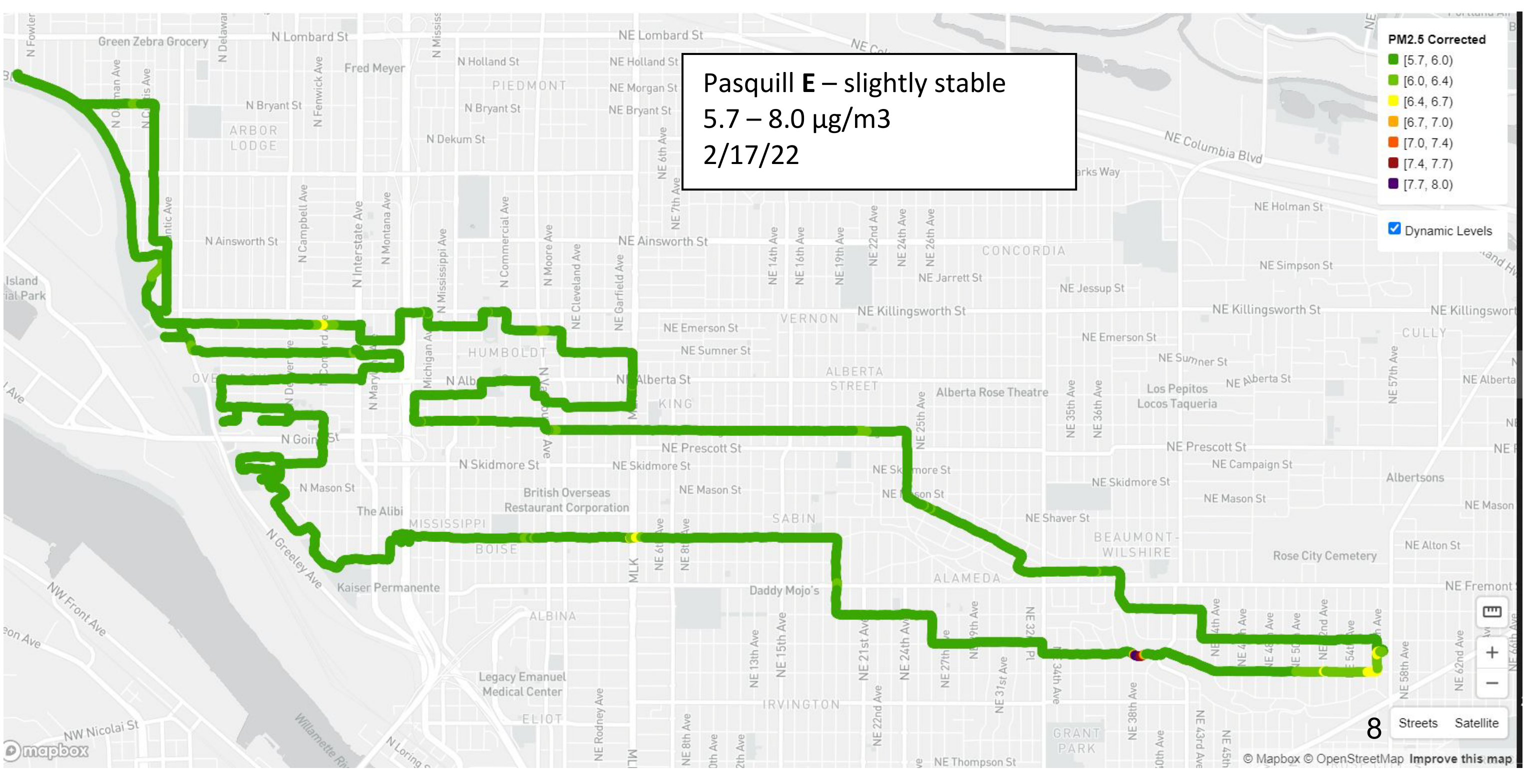
End Date
12 / 30 / 2022 , 04 : 00 PM


Pasquill **E** – slightly stable
5.7 – 8.0 µg/m3
2/17/22
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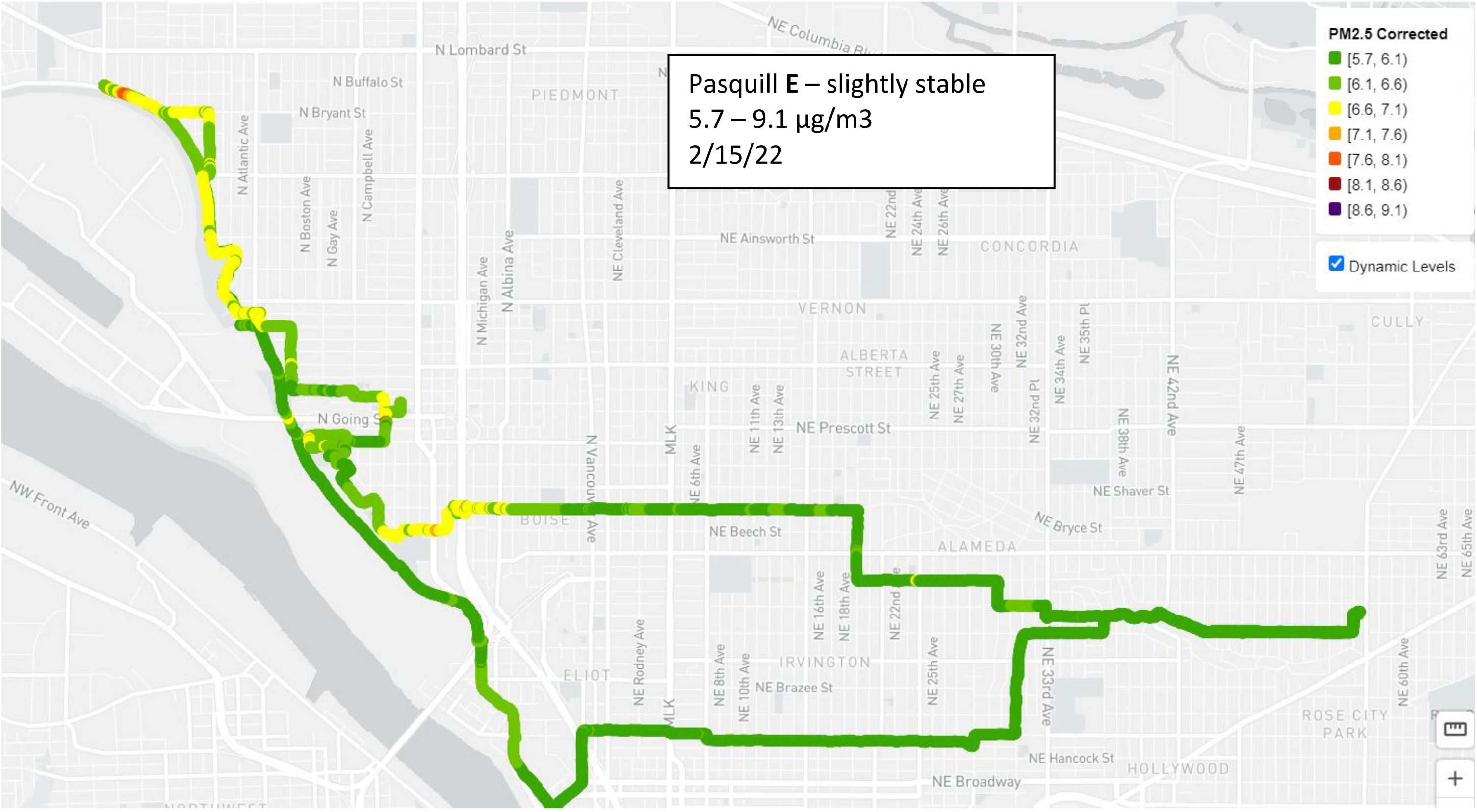
[7.0, 7.4)
[7.4, 7.7)
[7.7, 8.0)
Dynamic Levels
Streets
Satellite
© Mapbox © OpenStreetMap Improve this map


Pasquill E – slightly stable
5.7 – 9.1 µg/m3
2/15/22
PM2.5 Corrected
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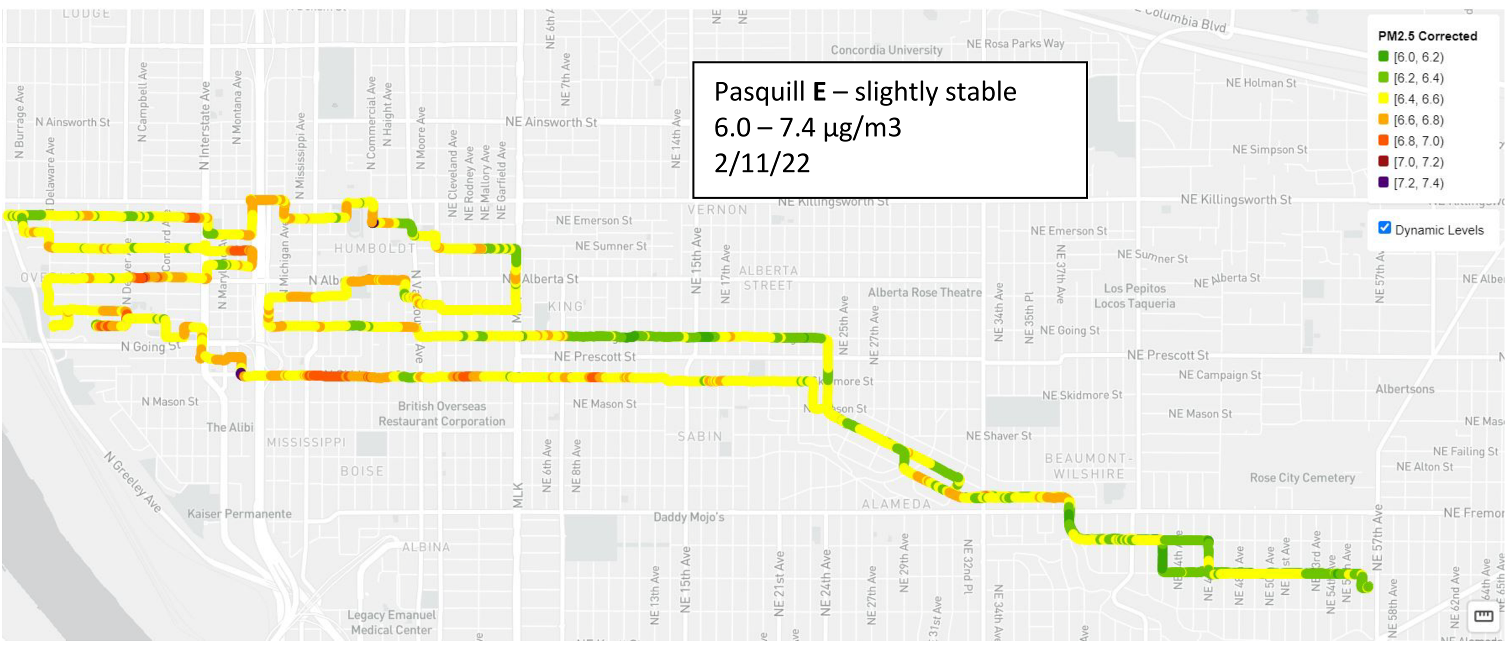
Pasquill E – slightly stable
6.0 – 7.4 µg/m3
2/11/22
PM2.5 Corrected
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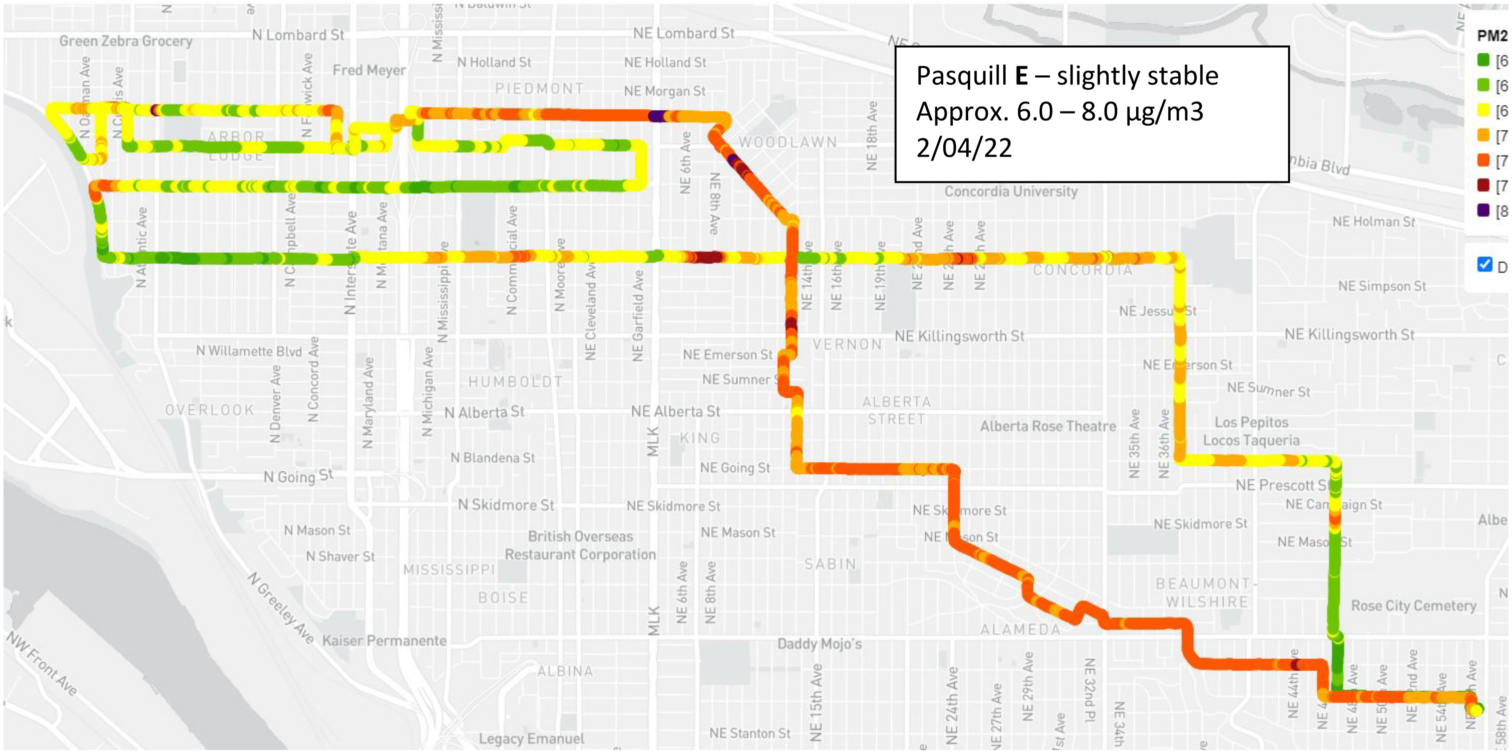
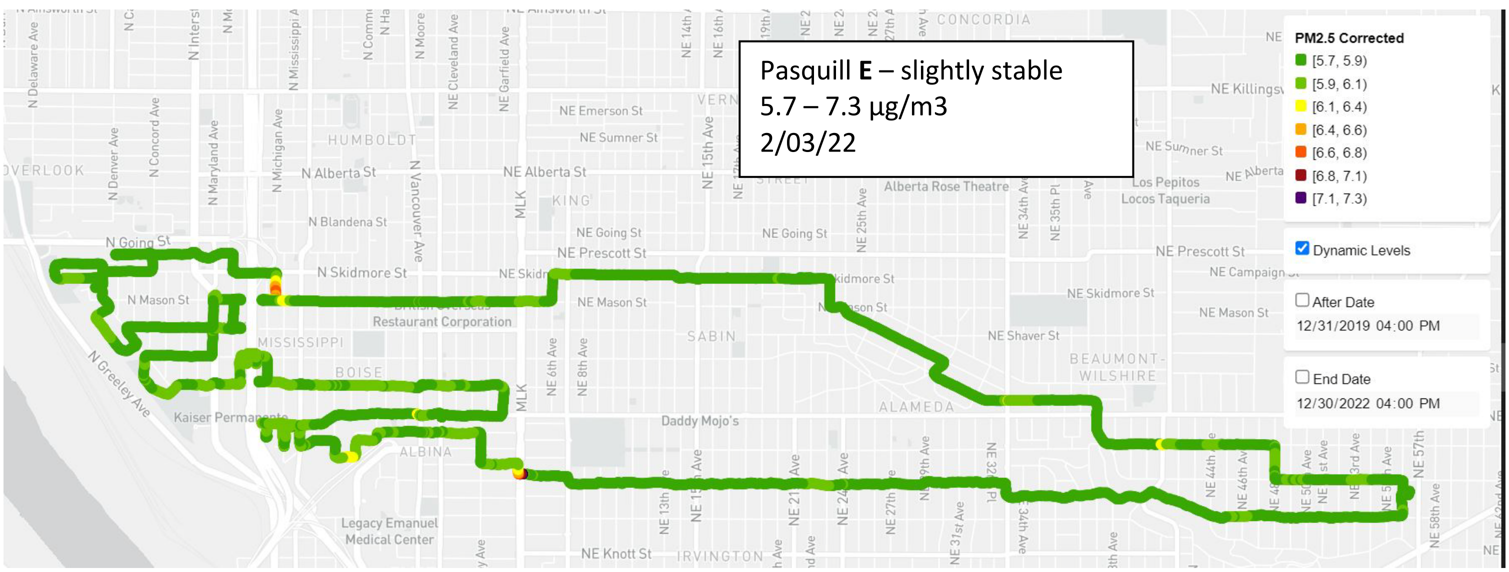
Dynamic Levels


Pasquill **E** – slightly stable
Approx. 6.0 – 8.0 µg/m3
2/04/22
PM2


Pasquill **E** – slightly stable
5.7 – 7.3 µg/m3
2/03/22
PM2.5 Corrected
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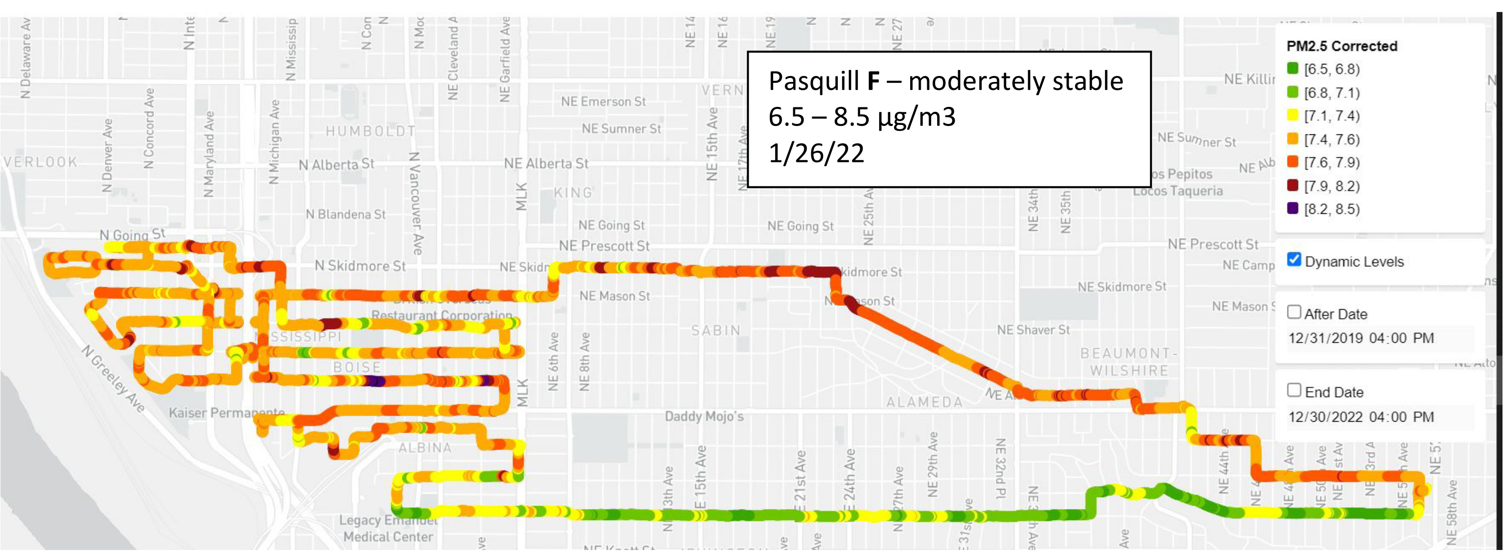
Pasquill **F** – moderately stable
6.5 – 8.5 µg/m3
1/26/22
PM2.5 Corrected
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Dynamic Levels
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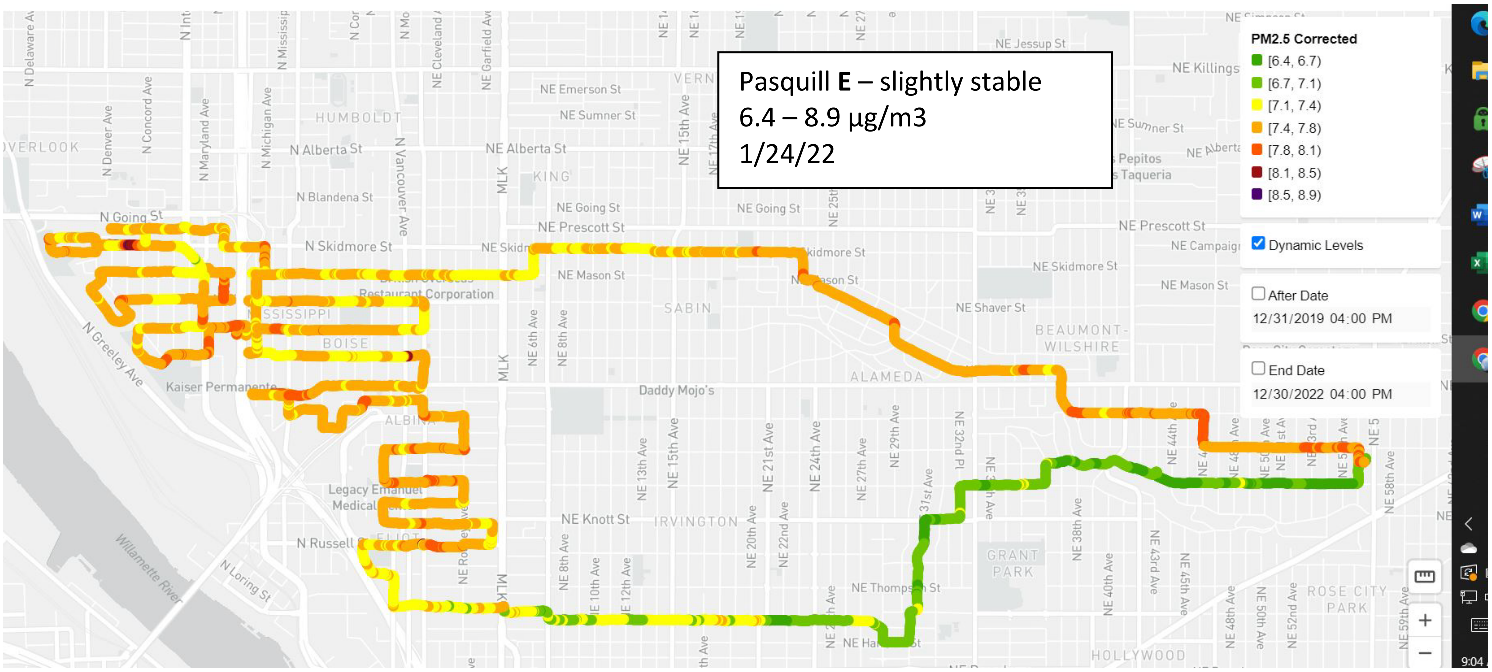
12/30/2022 04:00 PM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1/24/22
PM2.5 Corrected
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[7.1, 7.4)
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Dynamic Levels
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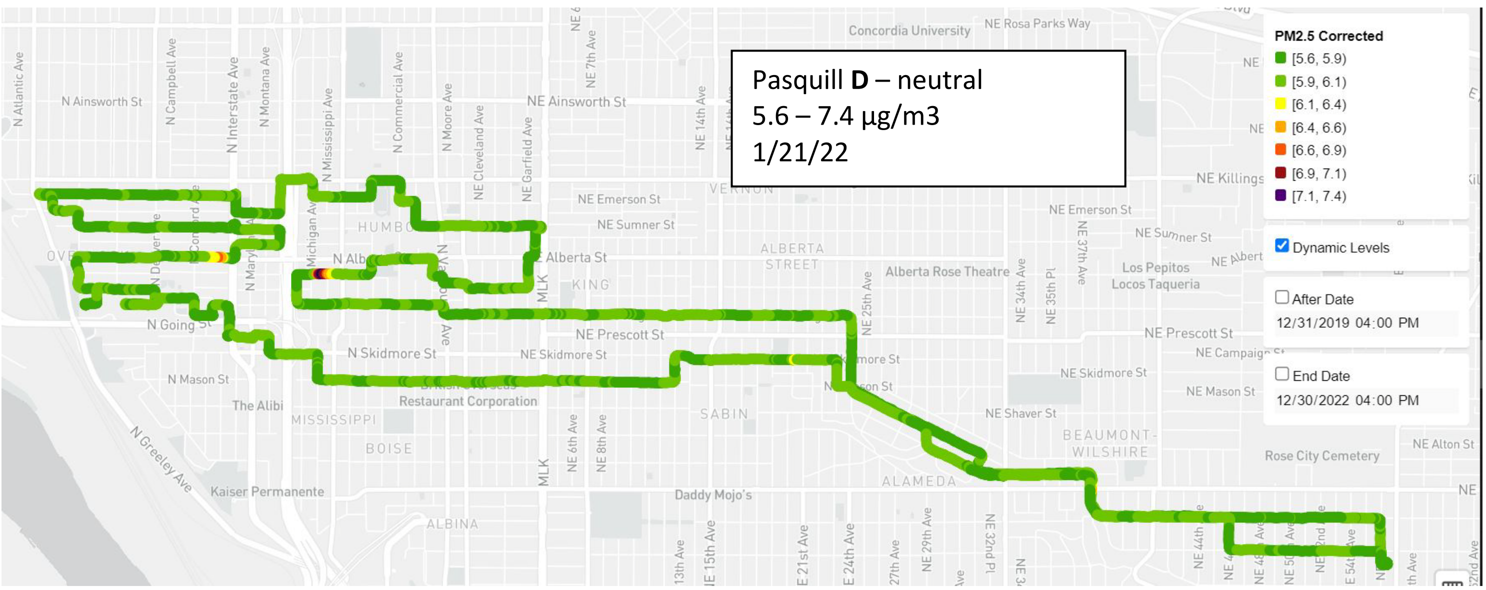
End Date
12/30/2022 04:00 PM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1/21/22
PM2.5 Corrected
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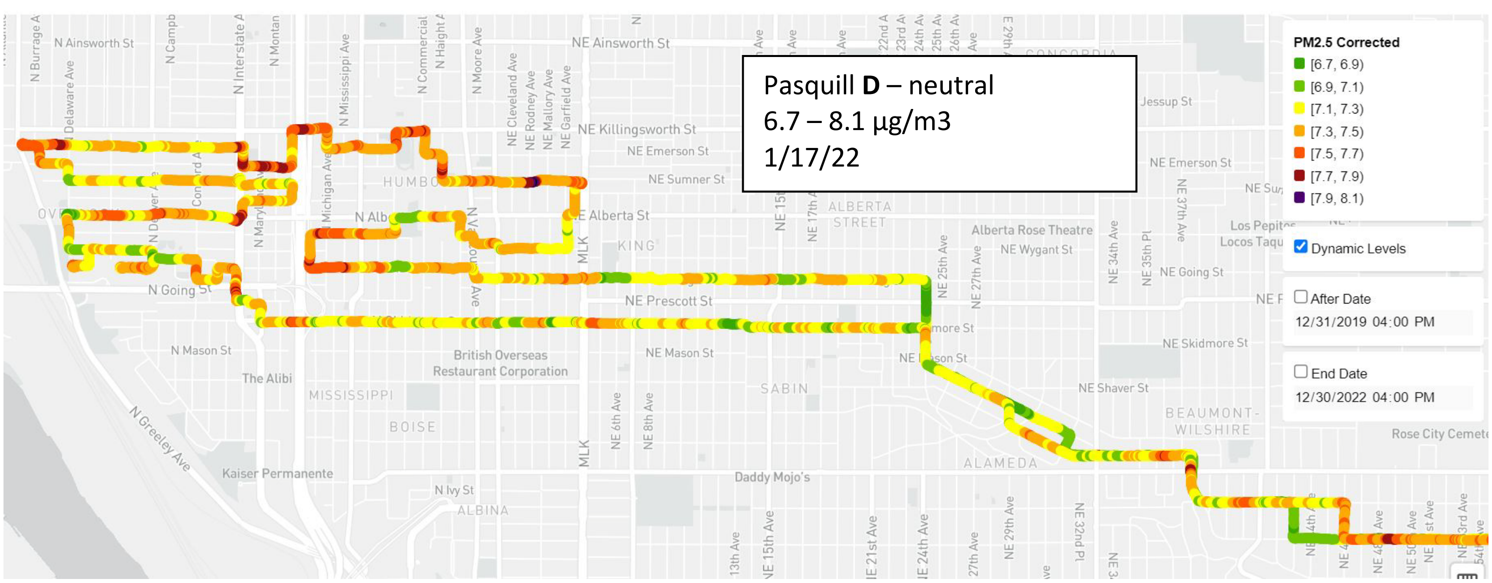
Pasquill **D** – neutral
6.7 – 8.1 µg/m3
1/17/22
PM2.5 Corrected
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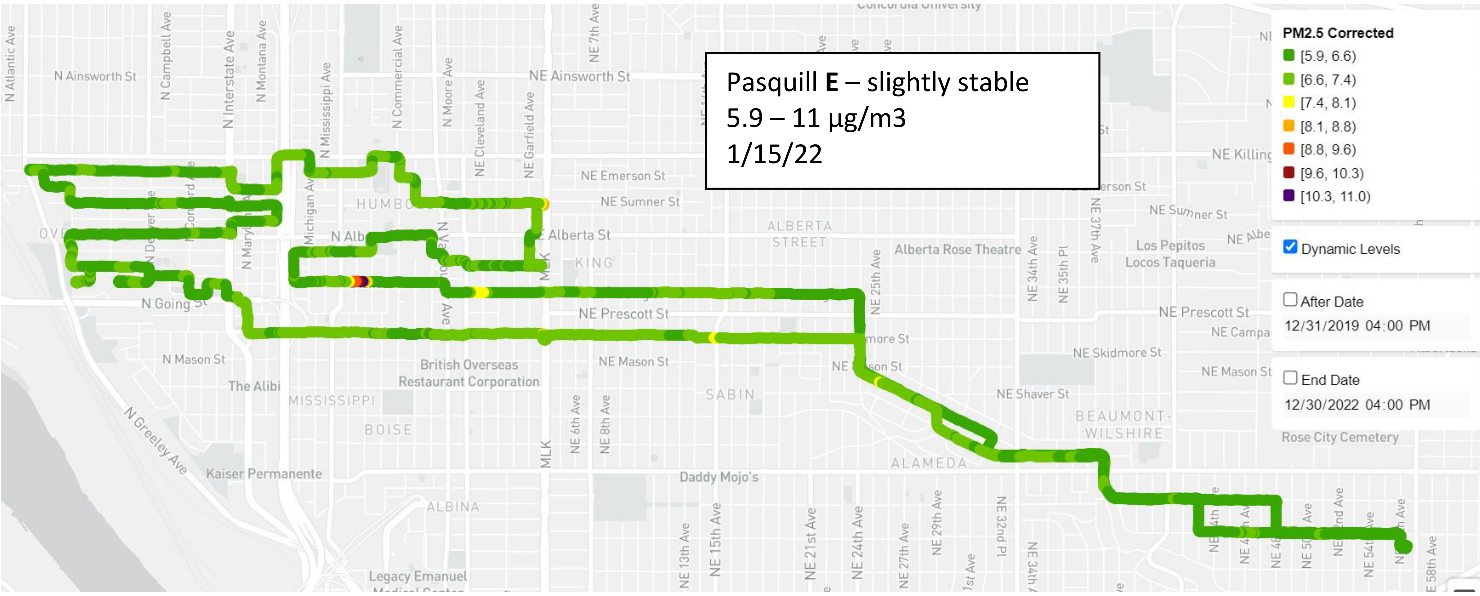
12/30/2022 04:00 PM


Pasquill **E** – slightly stable
5.9 – 11 µg/m3
1/15/22
PM2.5 Corrected
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12/31/2019 04:00 PM
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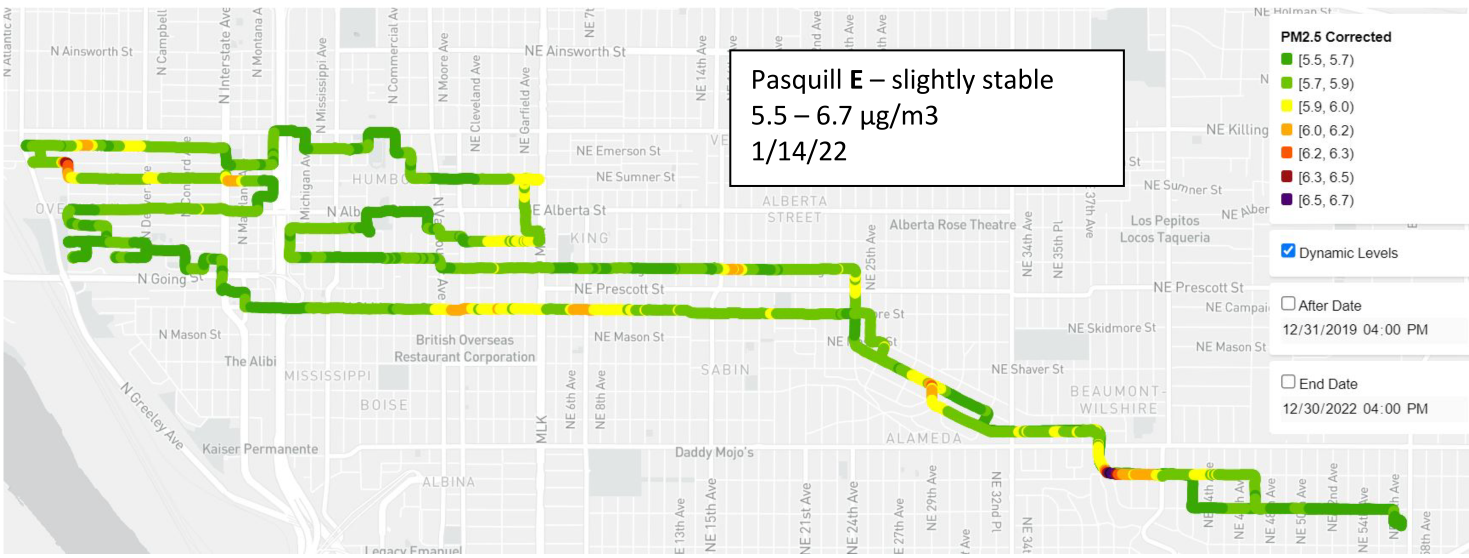
12/30/2022 04:00 PM


Pasquill **E** – slightly stable
5.5 – 6.7 µg/m3
1/14/22
PM2.5 Corrected
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[5.7, 5.9)
[5.9, 6.0)
[6.0, 6.2)
[6.2, 6.3)
[6.3, 6.5)
[6.5, 6.7)
Dynamic Levels
After Date
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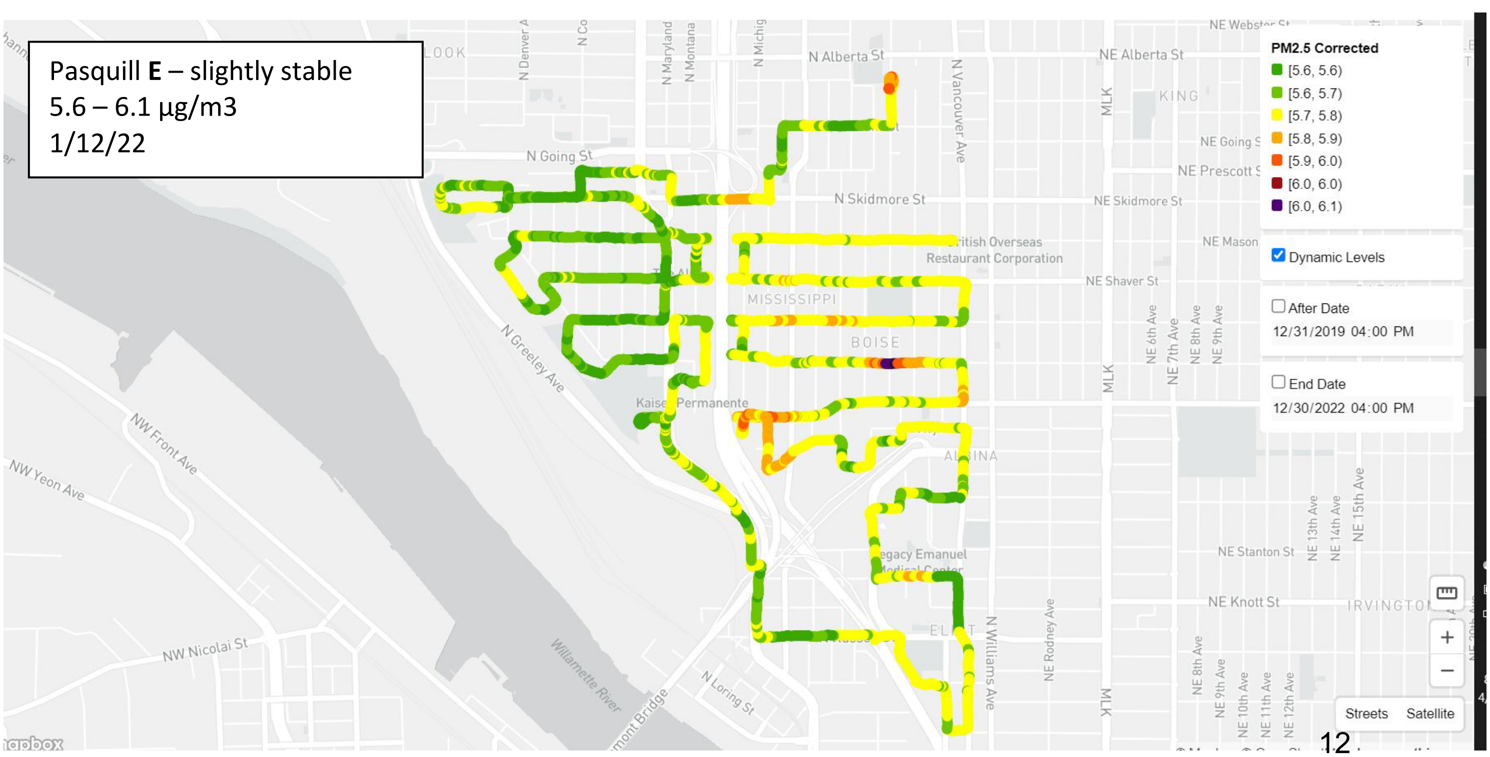
12/30/2022 04:00 PM


Pasquill **E** – slightly stable
5.6 – 6.1 µg/m3
1/12/22
PM2.5 Corrected
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[5.7, 5.8)
[5.8, 5.9)
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Dynamic Levels
After Date
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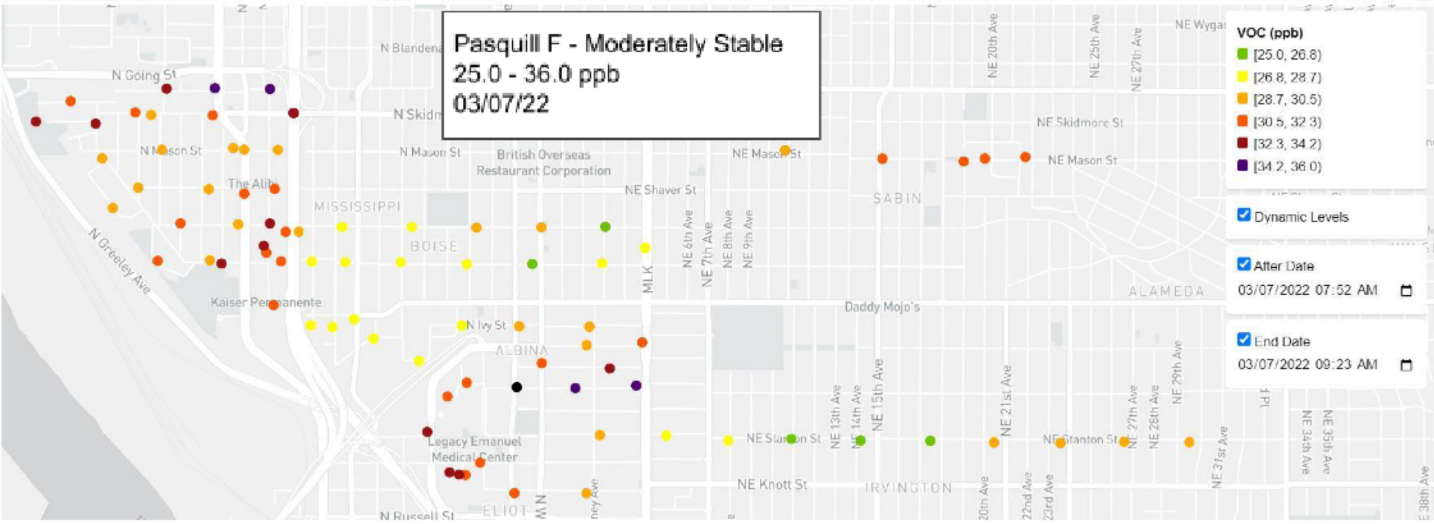
End Date
12/30/2022 04:00 PM
Streets
Satellite


Pasquill F - Moderately Stable
25.0 - 36.0 ppb
03/07/22
VOC (ppb)
[25.0, 26.8)
[26.8, 28.7)
[28.7, 30.5)
[30.5, 32.3)
[32.3, 34.2)
[34.2, 36.0)
Dynamic Levels
After Date
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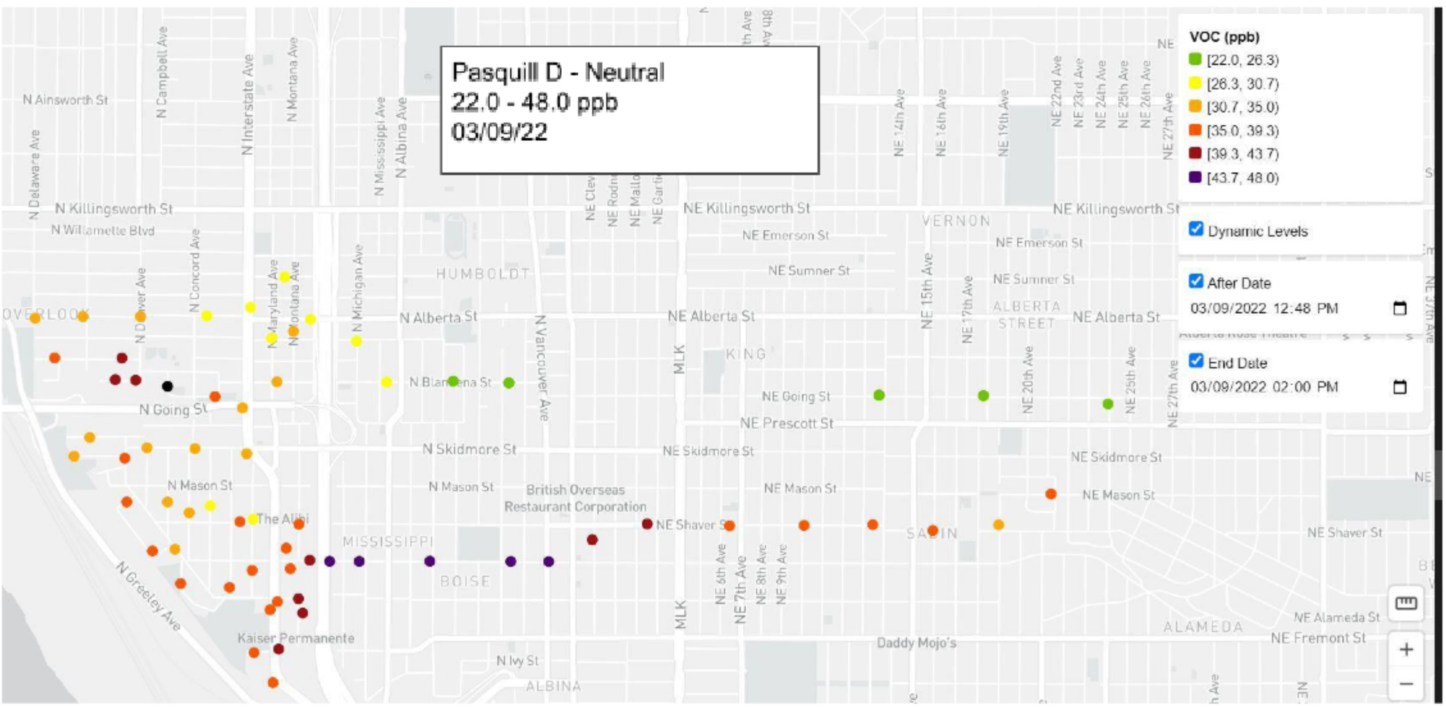
End Date
03/07/2022 09:23 AM


Pasquill D - Neutral
22.0 - 48.0 ppb
03/09/22
VOC (ppb)
[22.0, 26.3)
[26.3, 30.7)
[30.7, 35.0)
[35.0, 39.3)
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Dynamic Levels
After Date
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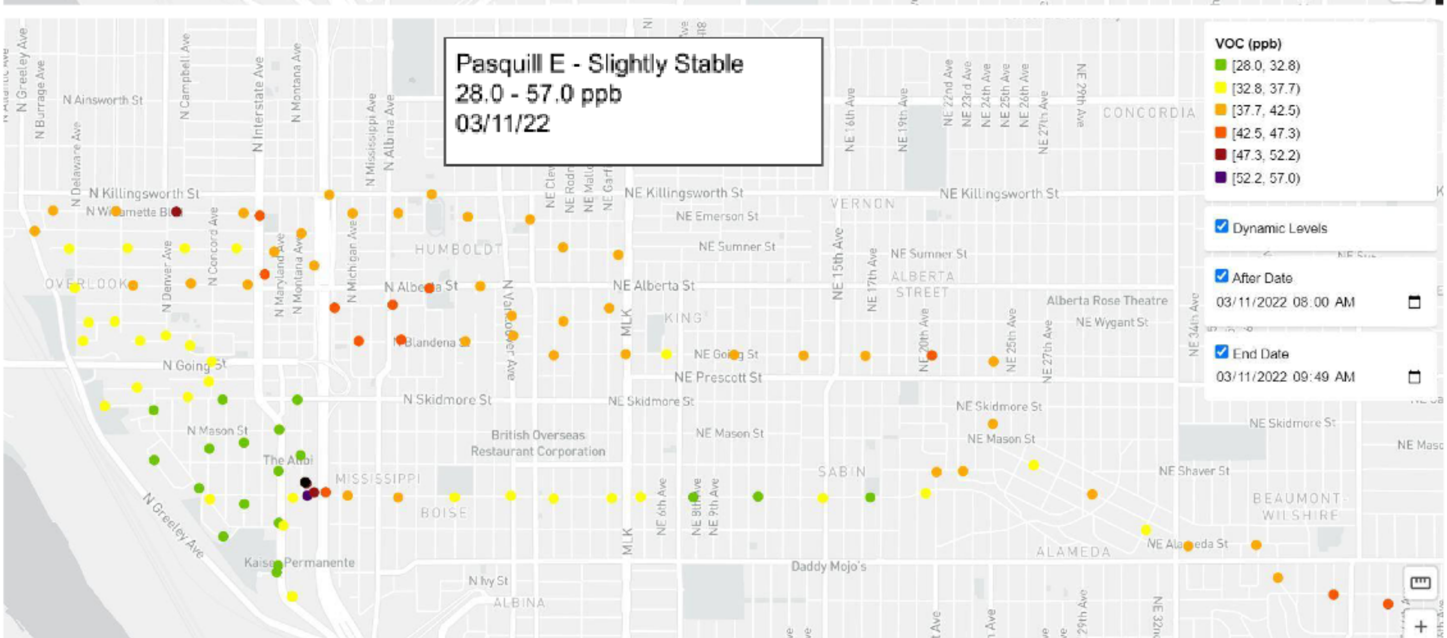
End Date
03/09/2022 02:00 PM


Pasquill E - Slightly Stable
28.0 - 57.0 ppb
03/11/22
VOC (ppb)
[28.0, 32.8)
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[37.7, 42.5)
[42.5, 47.3)
[47.3, 52.2)
[52.2, 57.0)
Dynamic Levels
After Date
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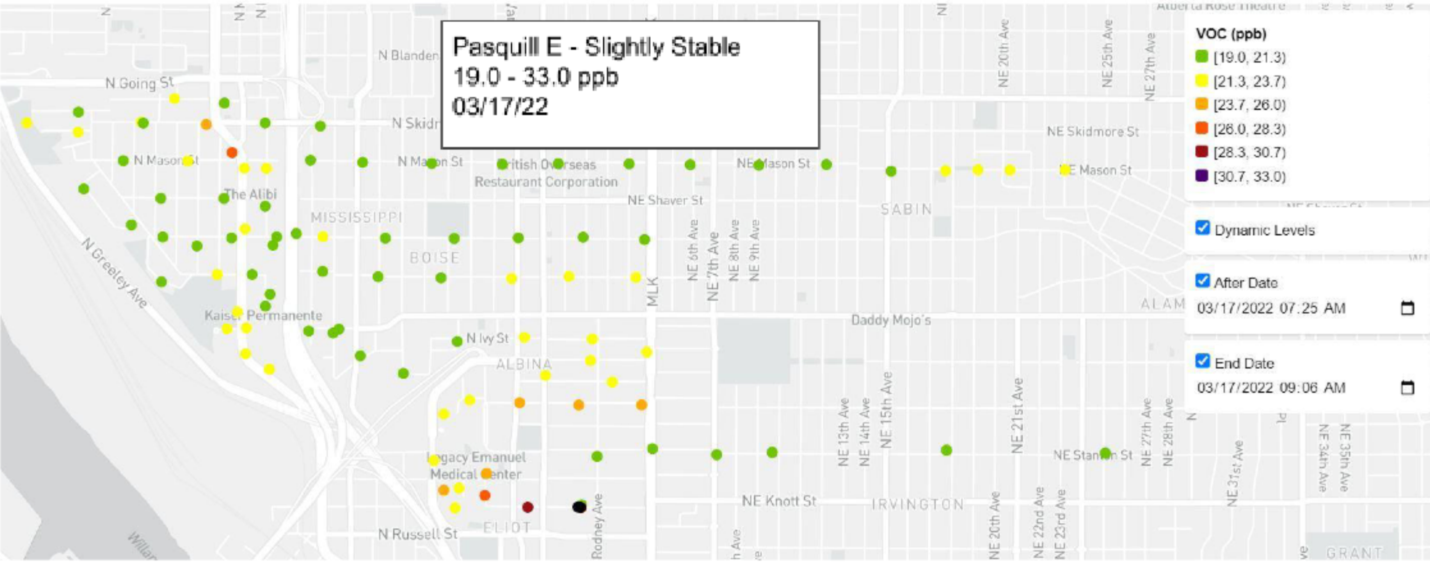
End Date
03/11/2022 09:49 AM


Pasquill E - Slightly Stable
19.0 - 33.0 ppb
03/17/22
VOC (ppb)
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[21.3, 23.7)
[23.7, 26.0)
[26.0, 28.3)
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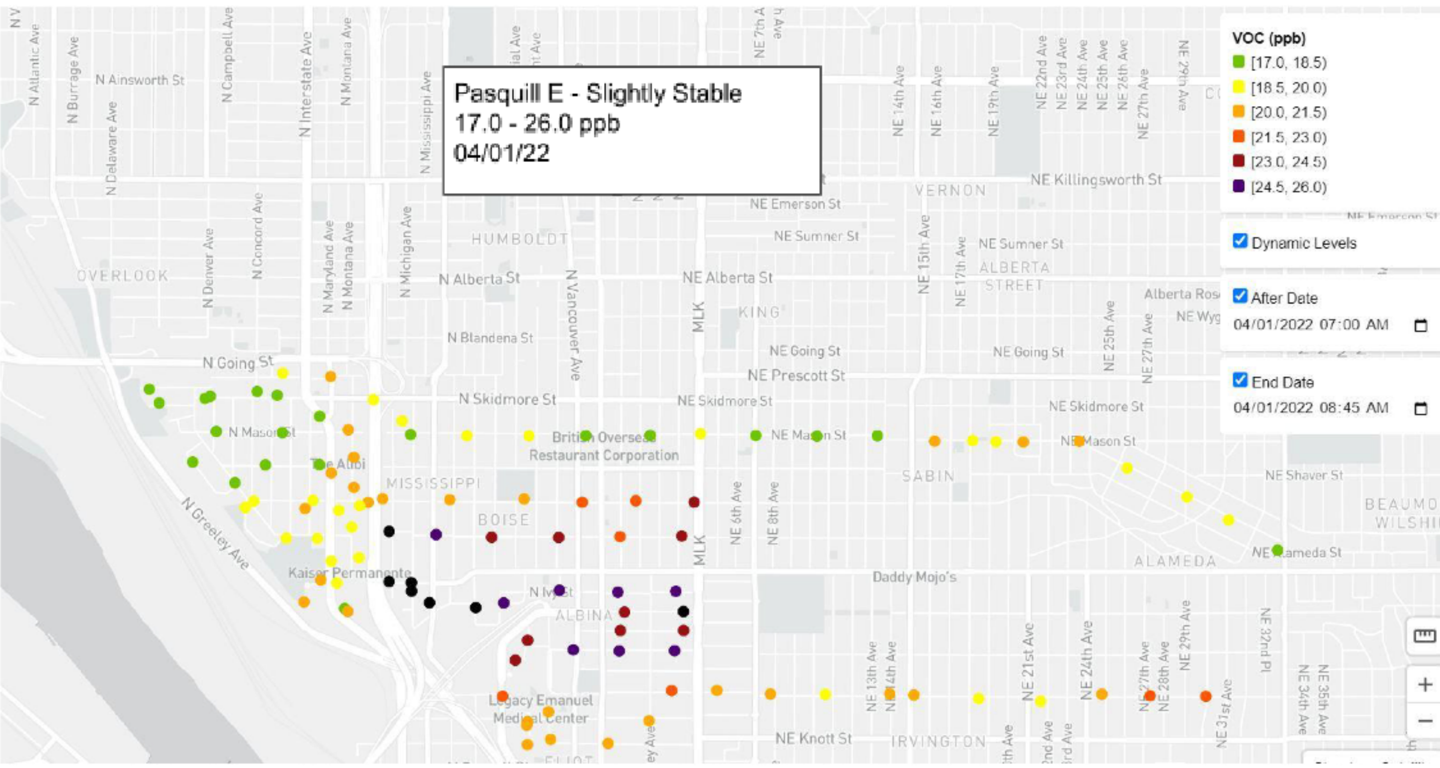
Pasquill E - Slightly Stable
17.0 - 26.0 ppb
04/01/22
VOC (ppb)
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[20.0, 21.5)
[21.5, 23.0)
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After Date
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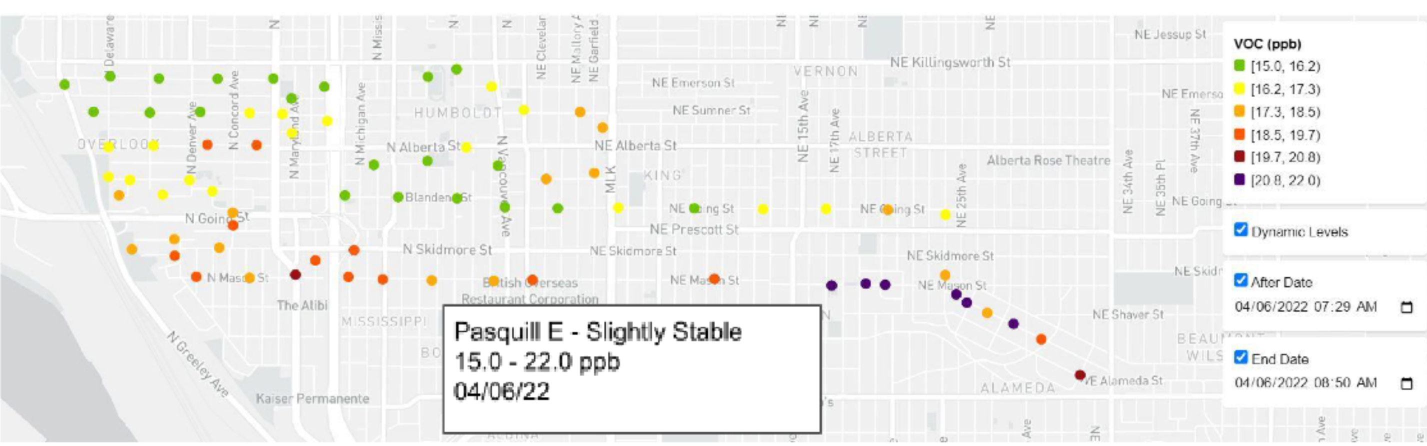
04/01/2022 08:45 AM


Pasquill E - Slightly Stable
15.0 - 22.0 ppb
04/06/22
VOC (ppb)
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[18.5, 19.7)
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After Date
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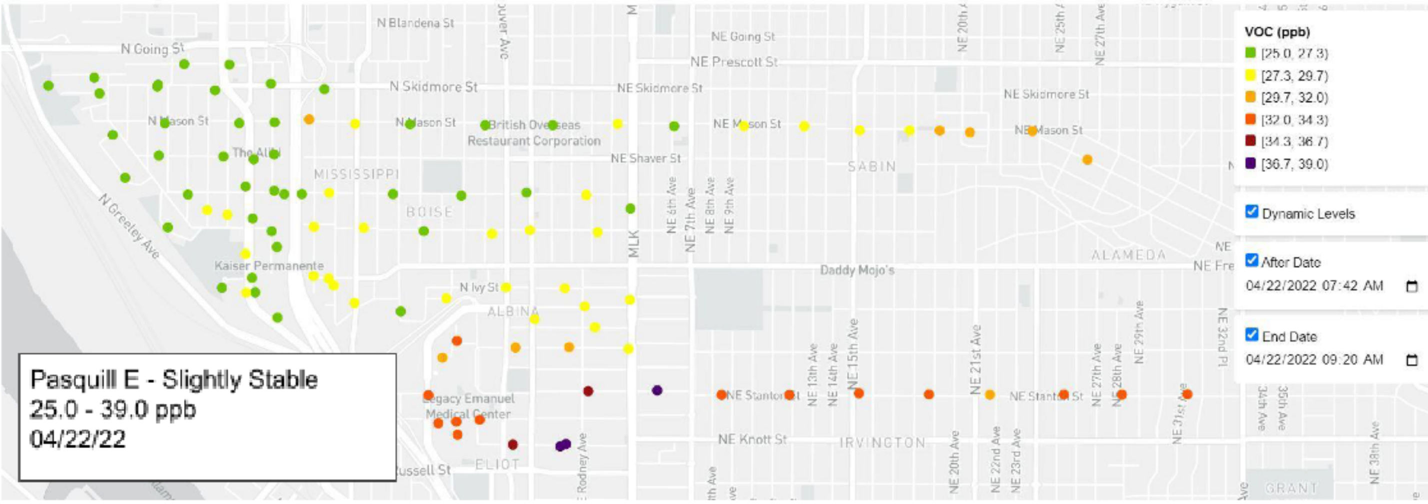
Pasquill E - Slightly Stable
25.0 - 39.0 ppb
04/22/22
VOC (ppb)
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[34.3, 36.7)
[36.7, 39.0)
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After Date
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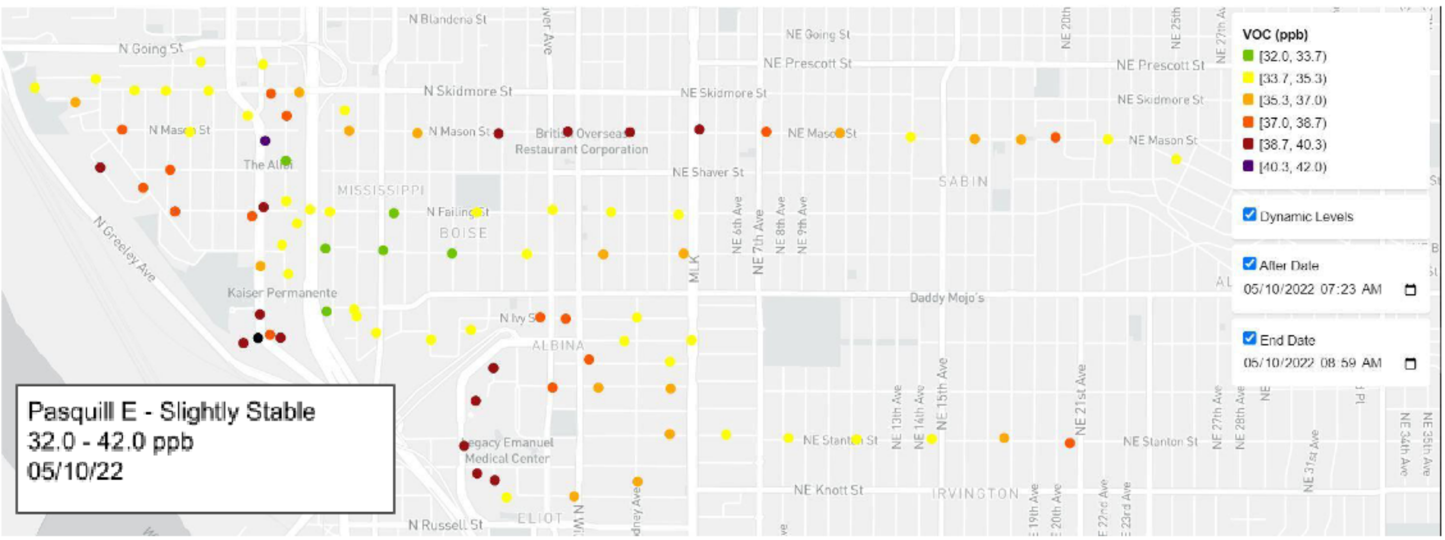
04/22/2022 09:20 AM


Pasquill E - Slightly Stable
32.0 - 42.0 ppb
05/10/22
VOC (ppb)
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Dynamic Levels
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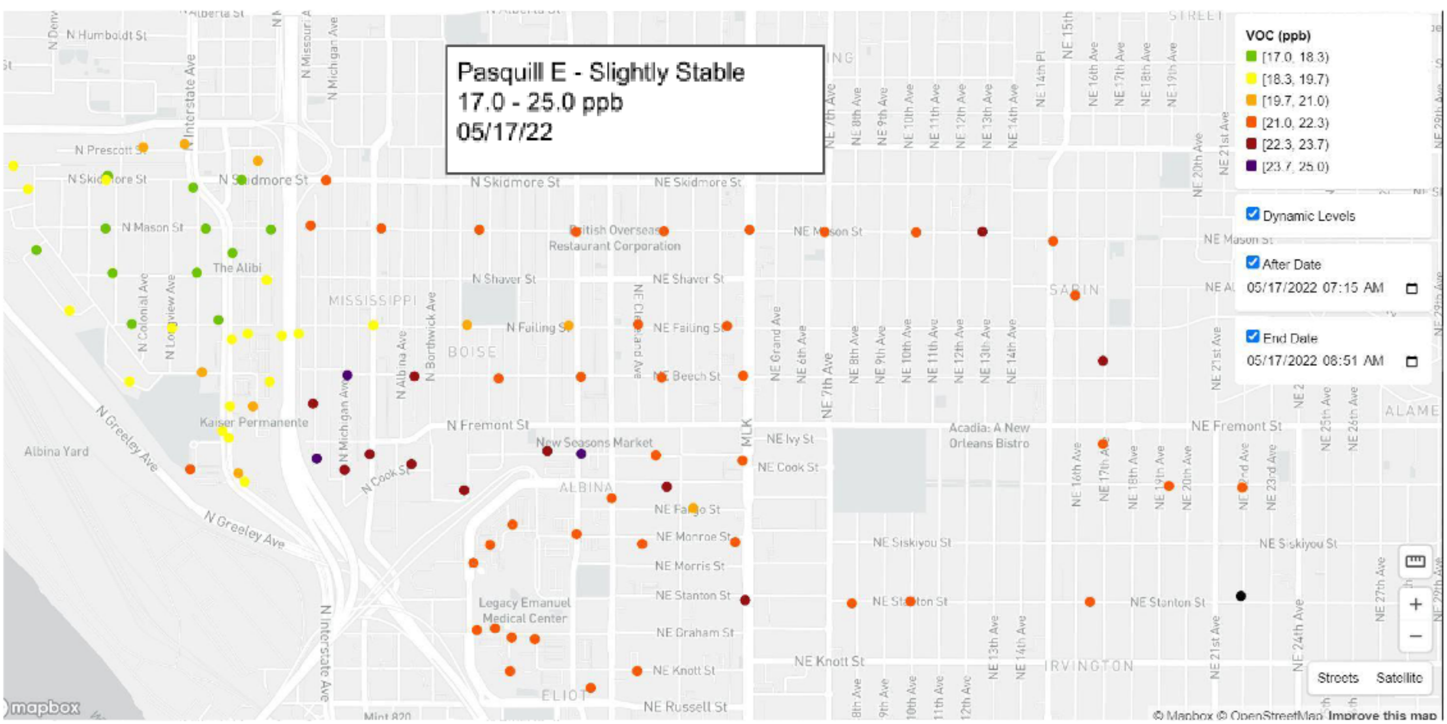
05/10/2022 08:59 AM


Pasquill E - Slightly Stable
17.0 - 25.0 ppb
05/17/22
VOC (ppb)
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[19.7, 21.0)
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[22.3, 23.7)
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Dynamic Levels
After Date
05/17/2022 07:15 AM
End Date
05/17/2022 08:51 AM
Streets
Satellite
mapbox
© Mapbox © OpenStreetMap Improve this map

Summa Canister Data		Portland OR / Corrales NM		
Date	Coordinates	VOCs Found	Concentrations	Pasquill Stability Index
Albina Rail Yard				
2/23/22	45.54 -122.68	ND	ND	D - Neutral
3/14/22	45.54 -122.68	ND	ND	E - Slightly Stable
Columbia Steel Mill				
2/9/22	45.59 -122.72	Ethanol	93 ppbv	E - Slightly Stable
		2-Propanol	2.6 ppbv	
		Toluene	2.2 ppbv	
		m,p-Xylene	1.0 ppbv	
2/24/22	45.59 -122.72	ND	ND	D - Neutral
5/17/22	45.59 -122.72	ND	ND	D - Neutral
Ecolube				
2/10/22	45.60 -122.69	ND	ND	D - Neutral
Linnton Tank Farms :				
NuStar				
3/6/22	45.58 -122.77	ND	ND	D - Neutral
Zenith Energy				
3/6/22	45.56 -122.73	Ethanol	19 ppbv	E - Slightly Stable
		Hexane	2.8 ppbv	
		Cyclohexane	0.96 ppbv	
		2,2,4-Trimethylpentane	1.2 ppbv	
		Benzene	0.69 ppbv	
		Heptane	0.71 ppbv	
		Toluene	2.2 ppbv	
		m,p-Xylene	1.1 ppbv	
Foss Maritime				
4/5/22	54.58 -122.77	ND	ND	E - Slightly Stable
Kinder Morgan				
4/5/22	45.60 -122.78	Ethanol	8.4 ppbv	E - Slightly Stable
		Acetone	15 ppbv	
		2-Propanol	8.4 ppbv	
		Hexane	0.96 ppbv	
		Toluene	0.82 ppbv	

Intel (New Mexico)				
Windover Ln				
2/5/22	35.22 -106.65	Ethanol	37 ppbv	A - Extreamely Unstable
		2-Propanol	16 ppbv	
La Entrada				
2/5/22	35.23 -106.64	ND	ND	F - Moderatley Stable

Compiling Purple Air Data

Generating Graphs

Purple Air offers stationary air quality monitors that can be set up at a home or business and provide live feed data to the Purple Air website. With this, we can see how air quality differs or remains the same across all the neighborhoods in a city. Unfortunately, this is only real-time data. It was previously not possible to visualize changes in air quality over time. With a special software developed by Christopher Dieringer, we can generate graphs from logged sensor data. We refer to this interface as the “auto-grapher”. For this report, we decided the graph the top 10 outdoor sensors with the highest readings for January 2022 and February 2022 respectively.

Compiling all this data caused some roadblocks with the software. Most notably the auto-grapher crashed when we graphed multiple sensors over long periods due to the way data was pulled from the cloud. Each graph downloaded hundreds of thousands or millions of data points. Christopher changed the way the data was aggregated which simply put, reduced the number of data points being downloaded and eliminated the crashes. We also decided to break up the data into 4 sets to make the graphs easier to read. For example, we graphed January’s top 1-5 and 6-10 sensors separately.

We noticed data anomalies from when many sensors first came online. The sensors reported high spikes in pollution. The spikes sometimes took months to smooth out into accurate readings. We do not know why this occurs. Perhaps the sensors come online and go through some form of diagnostic and the high readings are the result of a test. The slope that follows could be time offline with no readings, then as the sensor is set up in its desired location, the actual readings come through. One of these sensors named “South Woodstock” shows months of spiked readings, perhaps this sensor was moved from an indoor location to an outdoor one; either way, it does not follow the pattern of the other anomalies. Other spikes can be seen that correspond to the wildfires of Summer 2020, our graphs leave this data out as readings during wildfires are considered inaccurate. Not to mention, the spikes in the data offset the graph and make the bulk of the readings impossible to read. In the meantime, we decided to graph our data starting from July 2021 which is after the anomalies and wildfires.

After selecting the dates and sensors to be graphed, the program displays a graph. Highlighting the top left corner three dots appear. A dropdown menu allows the user to save the image as a PNG or as an SVG file. The SVG file can be opened in a new tab which when zoomed in provides the clearest opportunity to screenshot the graph. This method currently excludes the color key so we added a new key using a text box in Microsoft Word.

Generating Maps

To provide context to the graphs we wanted to illustrate where the sensors were located. The auto-grapher is planned to have a map feature but this is still in development. For the time being, we created a spreadsheet with the top sensors in order of highest reading, we included the name of the sensors and their location as latitude and longitude. Using Google My Maps we were able to input the excel document and set which columns should be entered as site names and respective coordinates. We set the site icons as numbers for ease of viewing and took a screenshot. Then we overlayed the spreadsheet and added a tile using Microsoft Word.

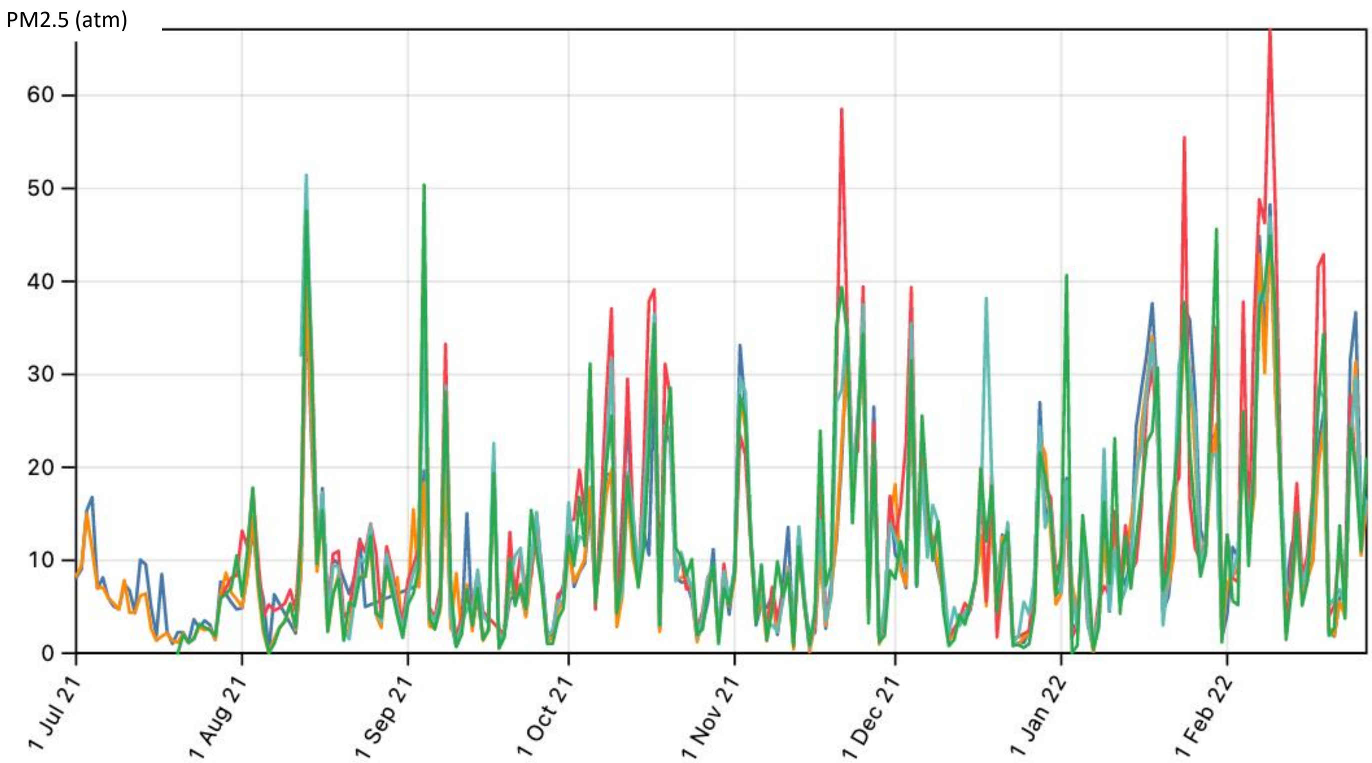
The Maps

#	Neighborhood	Pollution (PM2.5)	Sensor Name
1	Arbor Lodge	15.7504085	Carpenter Fam
2	Milwaukie	15.56991127	Sellwaukie Homestead
3	Beaumont - Wilshire	14.76268376	Near Wilshire Park
4	Lents	14.41419667	NCA Woody Guthrie Place
5	Arbor Lodge	14.35116559	LunaAL
6	Brentwood - Darlington	13.87933818	Flavel near the GrocOut
7	Lents	13.86684003	Raymond in Northeast Lents
8	Woodstock	13.48765294	South Woodstock
9	Northwest District	13.45451691	NCA-24th-Raleigh-Outside
10	Richmond	13.44999552	SE Richmond

#	Neighborhood	Pollution (PM2.5)	Sensor Name
1	Lents	22.85059013	Raymond in Northeast Lents
2	Lents	22.27295166	NCA Woody Guthrie Place
3	Lents	20.47763031	NCA Village
4	Brentwood - Darlington	20.23685762	Flavel near the GrocOut
5	Lents	18.88270943	NCA Pub
6	Brooklyn	18.74405594	NCA Cora
7	Beaumont - Wilshire	17.89784975	Near Wilshire Park
8	Hazelwood	17.63139877	NCA Justice
9	Brentwood - Darlington	17.43360492	SEMalden57Ave
10	Arbor Lodge	17.21953223	Carpenter Fam

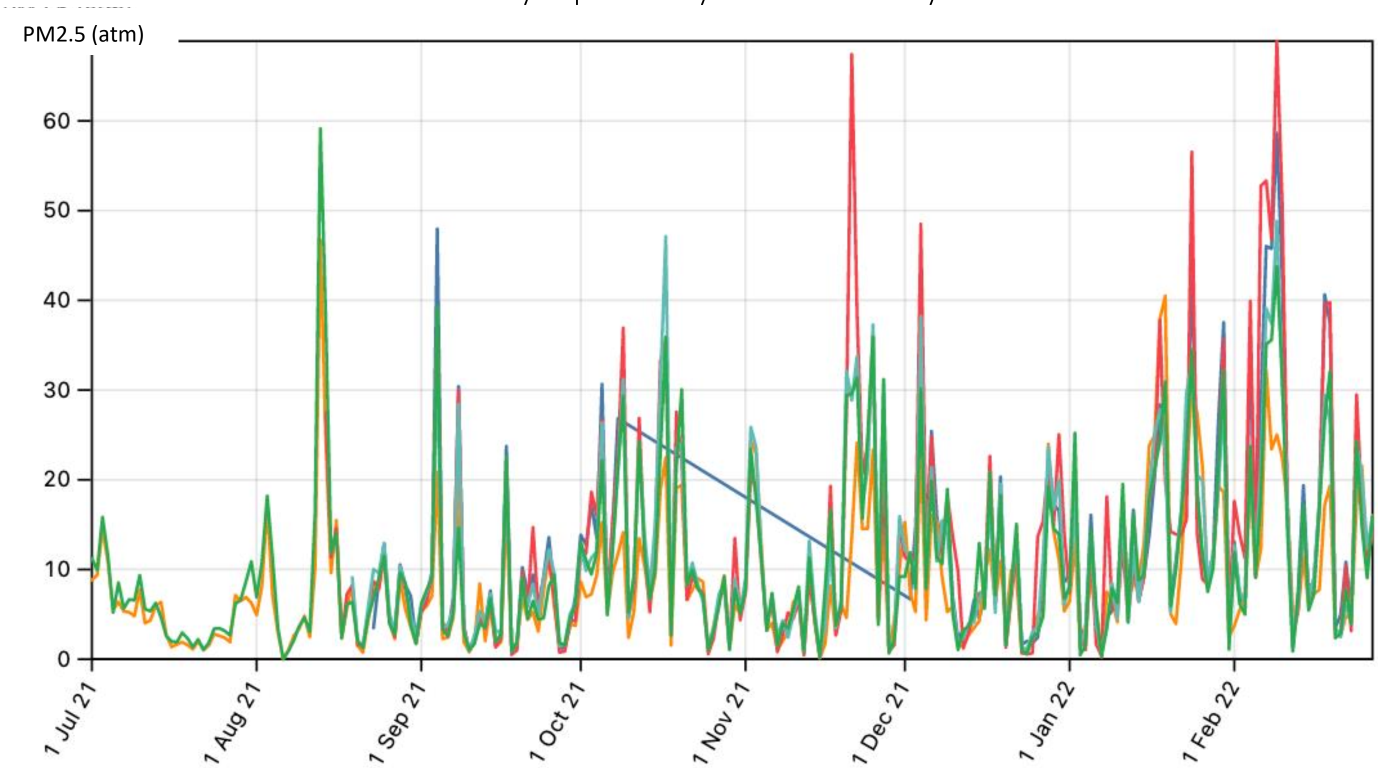
The Graphs

January Top 1-5 July 2021 to February 2022



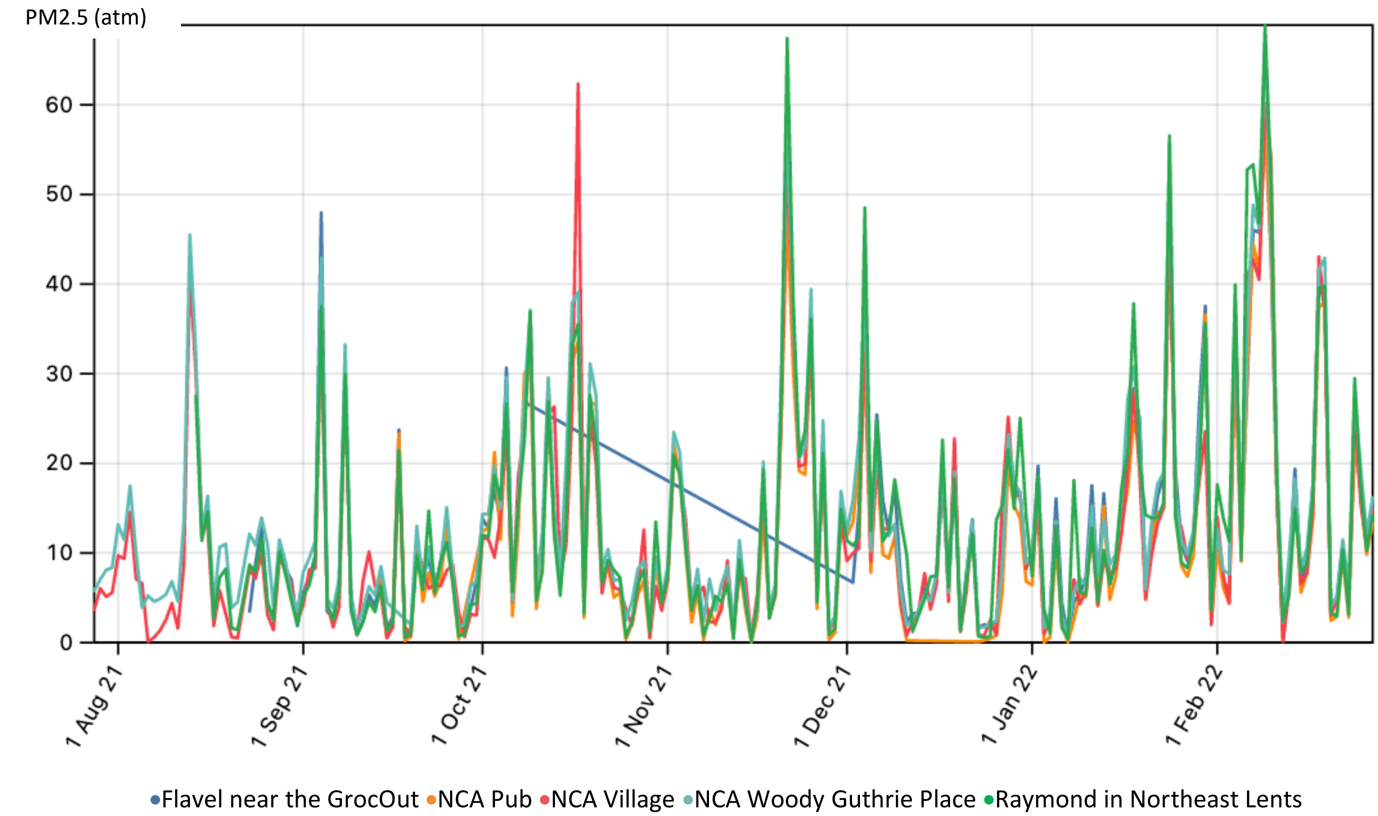
•Carpenter •LunaAL •NCA Woody Guthrie Place •Near Wilshire Park •Sellwaukie Homestead

January Top 6-10 July 2021 to February 2022

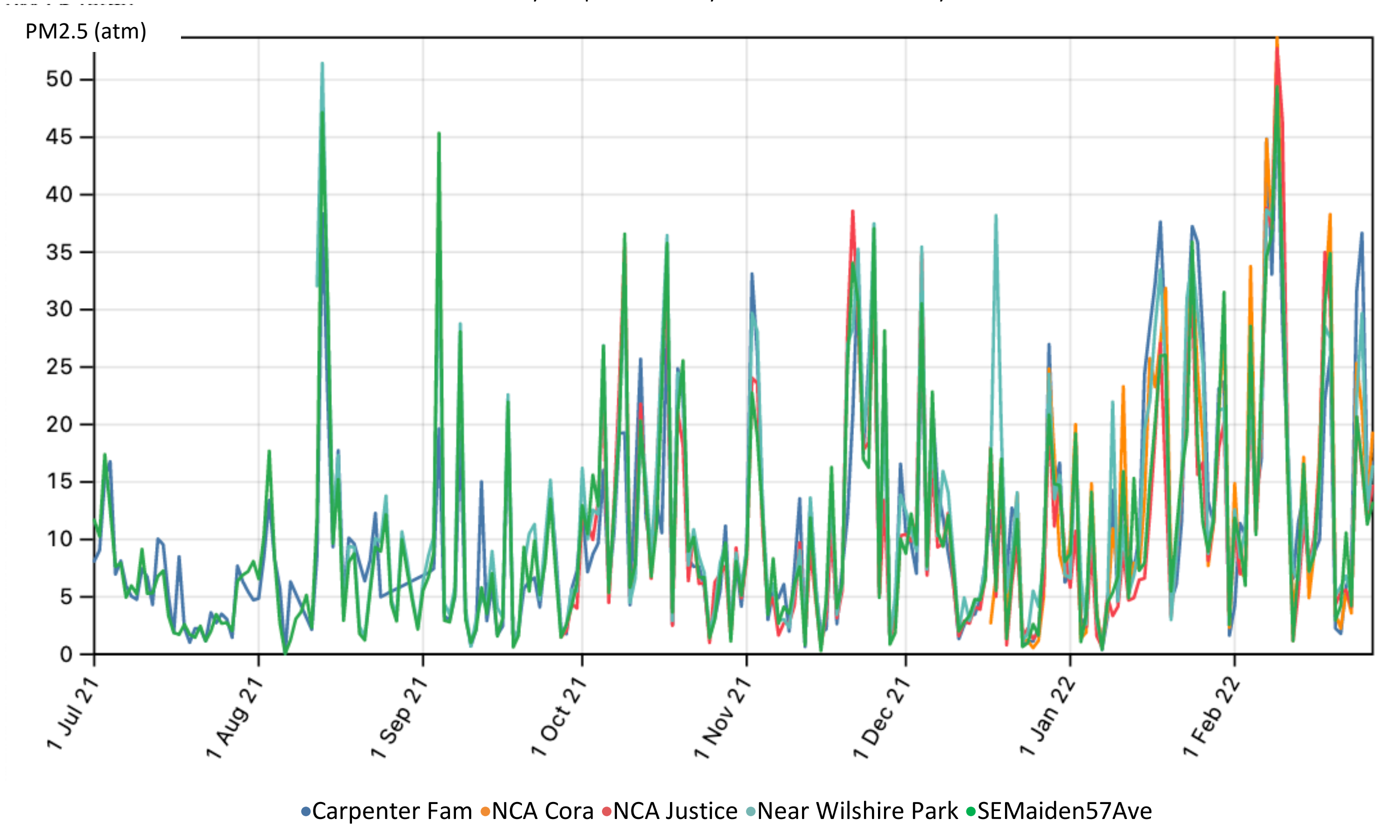


•Flavel near the GrocOut •NCA_24th_Raleigh-Outside •Raymond in Northeast Lents •SE Richmond •South Woodstock

February Top 1-5 July 2021 to February 2022

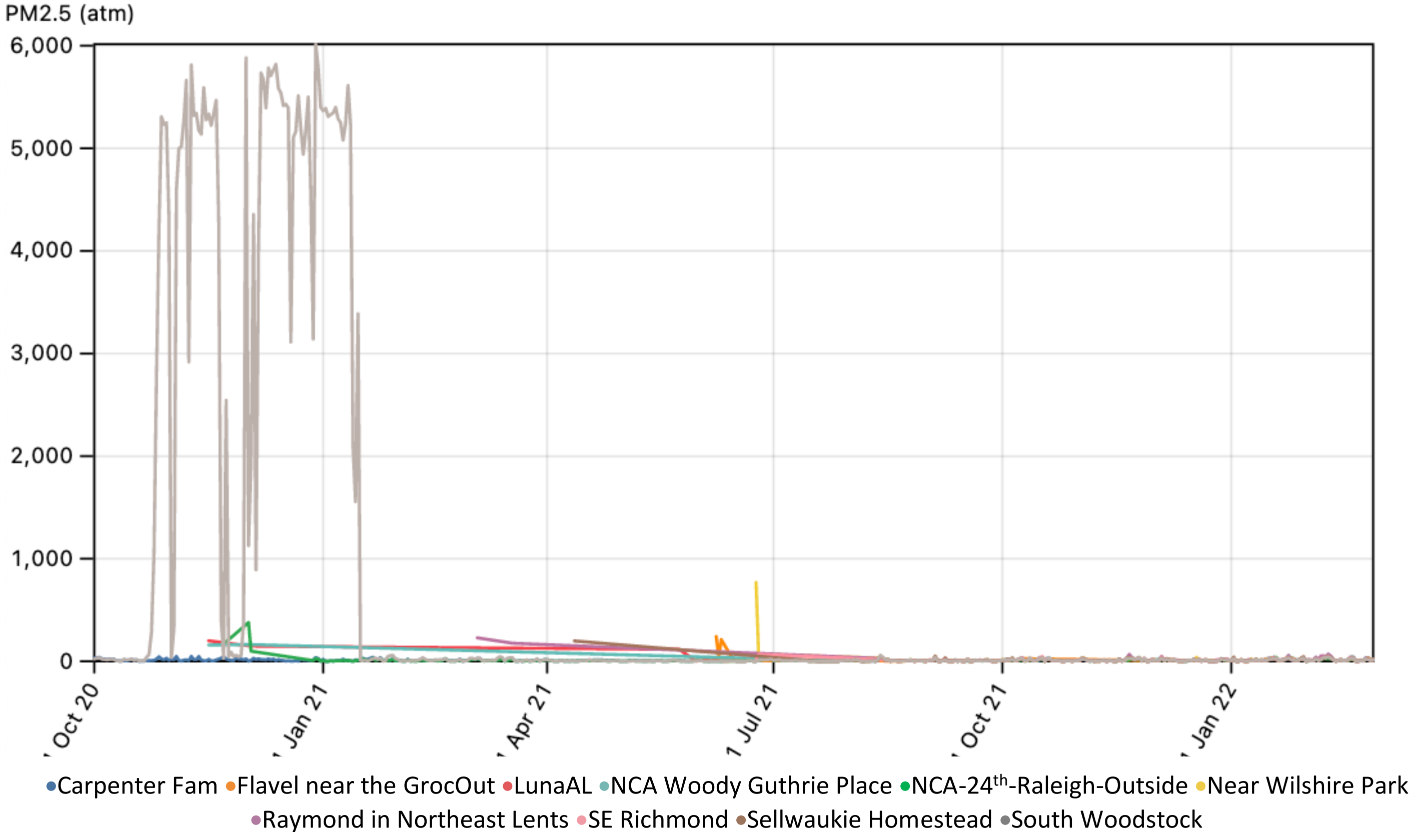


February Top 6-10 July 2021 to February 2022

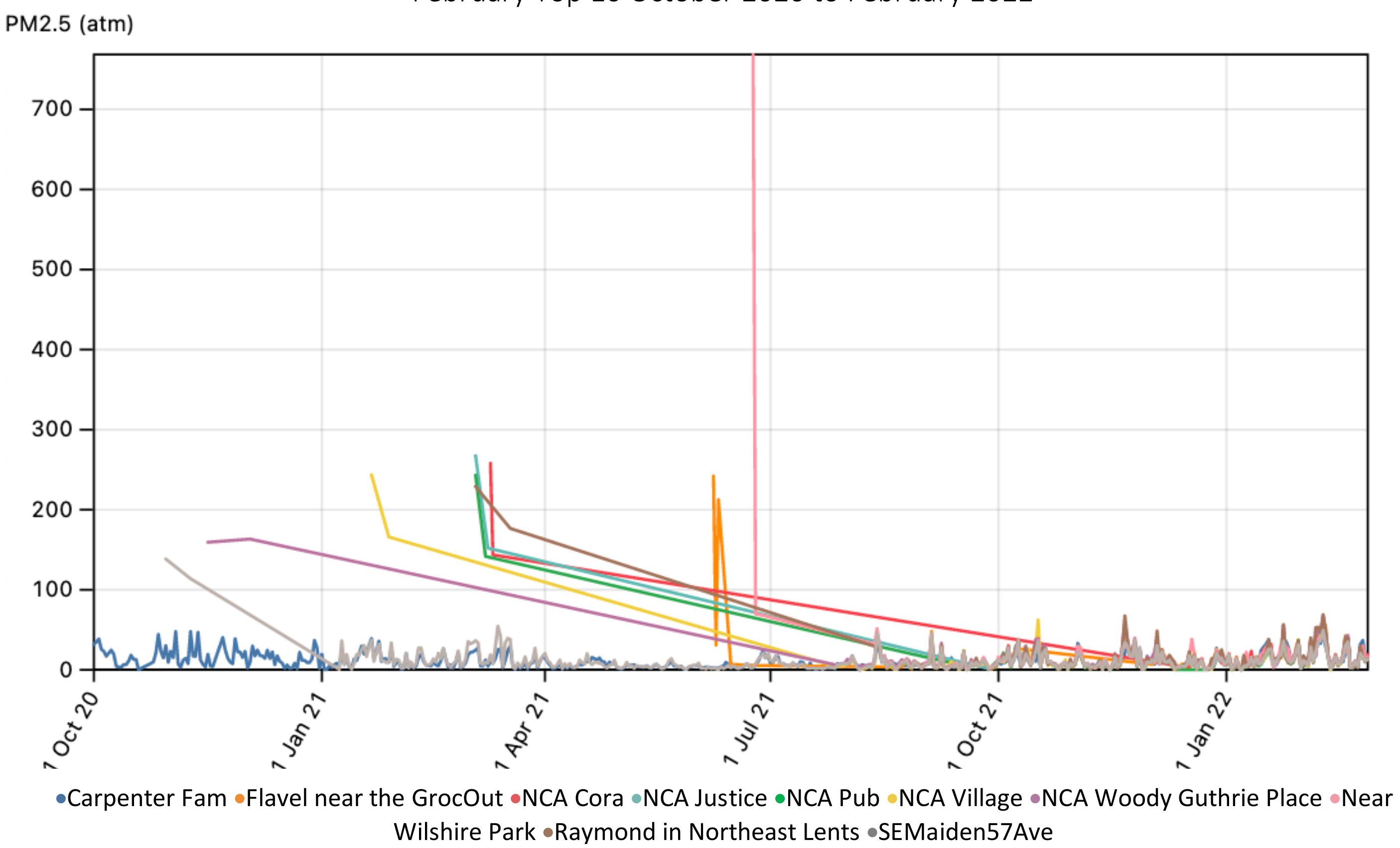


The following graphs illustrate the anomalous data spikes between October 2020 and July 2021.

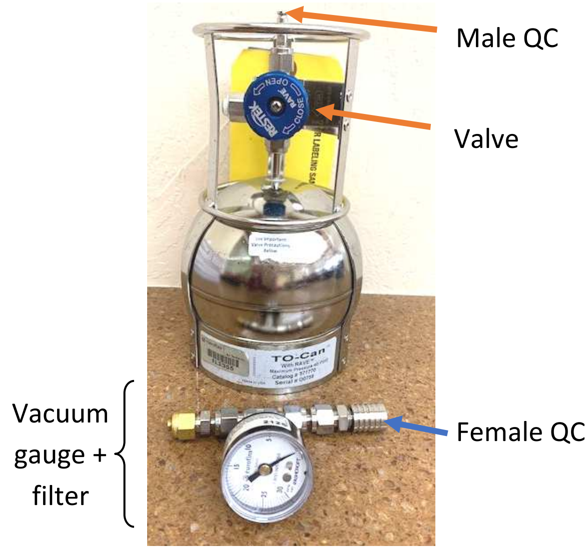
January Top 10 October 2020 to February 2022



February Top 10 October 2020 to February 2022



Field Sampling Procedure Using Canisters with Quick-Connect (QC) Fittings: Grab Sample Collection



Equipment provided by the laboratory:

- Evacuated Canister
- Vacuum gauge with a built-in particulate filter
- Chain-of-Custody (COC)

Equipment to be supplied by field technician:

- 9/16” wrench
- ½” wrench

Preparing the canister for sample collection:

1) Place the canister in the desired sample location. Confirm valve is closed (turned clockwise).

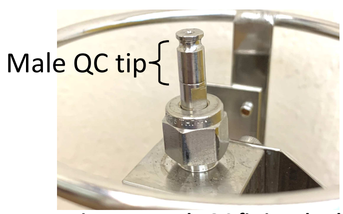


Figure 1. Male QC fitting check

2) Check the male QC on the canister and verify the stem tip is tight. If loose, finger tighten by screwing tip clockwise (Fig 1.)

3) To install the vacuum gauge on the canister, pull back on the sleeve of the female QC fitting (Fig 2.)

Figure 2. Female QC installation

4) Place the female QC fitting over the male QT fitting located on top of the canister, then release the sleeve once fully seated. Gently pull up on the gauge to make sure it is securely connected to the canister. Once installed the vacuum gauge will read zero.

5) Verify initial canister vacuum and vacuum gauge/filter assembly connection.

   a. With the brass cap securely installed, open and close the valve quickly to register the vacuum of the canister.

   b. The vacuum on the gauge should read steady at ***25 to 30 in Hg*** (Fig. 3)

   c. Record initial vacuum level (“Hg) on the Chain of Custody (COC) in the “Initial (in Hg)” field.

Figure 3. Pre-sample Vacuum check

Collecting the sample:

Figure 4. Removing brass cap

6) To begin sampling, ensure the valve is ***CLOSED***, remove the brass nut on the vacuum gauge using a 1/2" wrench to stabilize and 9/16" wrench to turn cap, as pictured in Fig 4.

7) Open the canister valve counter clockwise **no more than 1/2 turn** to begin sampling. Attempts to open the valve further can lead to valve damage and sample loss. Note the start date/time on the COC.

8) ***At the start of sampling, the vacuum gauge will read approximately 16 to 17 in Hg*** and remain at this reading for approximately 2 minutes for a 6L canister and 15 seconds for a 1L canister before the vacuum can be observed dropping toward zero. (Fig 5.)

Figure 5. Sample Start Vacuum

9) When the vacuum gauge nears 5 in Hg, close the valve by hand-tightening clockwise. (Fig 6.) At the point of closing the valve, note the vacuum and record on the COC in the "Final (in Hg)" field. (Once the valve is closed, the vacuum gauge will read zero.) Do not use tools to tighten the valve.

   Record the stop date/time. Approximate canister fill times to 5 in Hg are shown in Table 1.

Figure 6. Sample End Vacuum

Table 1. Approximate Fill Times for Grab Samples with filter assembly

Canister Size	Fill time to 5 in Hg
1 Liter	~1 minute
6 Liter	~7 minutes

Note: Unless specified by your sampling and analysis plan, it is not critical to end the sample at 5 in Hg when collecting grab samples. However, leaving residual vacuum in the canister provides a check that the canister did not leak during transport to the laboratory.

Preparing the canister sample for return shipment to lab:

10) Detach the gauge by pulling back the sleeve of the female QC fitting and lifting it upwards off of the canister. Replace the brass nut on the vacuum gauge assembly by hand tightening. Record vacuum gauge filter assembly barcode number in the “Flow Controller #” field on the COC.

11) Finish filling out the COC. In the Can # field, write the serial # or barcode circled below from the base of the canister. This number must be entered exactly as shown onto the COC to ensure no canister discrepancies upon receipt by the lab.

12) Make sure all canister tags are filled out and match the COC. If cans are unused, please check the “unused” box on the canister tag. Return canisters and vacuum gauge filter assemblies in boxes provided by the laboratory using the packaging provided. Place the completed COC in each sample box, making sure the samples have been relinquished properly by signing and dating the “Relinquished by:” field. *Note: You may keep a carbon copy of the COC for your records.*

13) Securely tape box shut and ship to the laboratory via USPS, FedEx, or UPS. Canisters should be delivered within 10 days of sample collection to ensure laboratory has sufficient time to process samples within the 30 day sample hold time.

Note: A replacement fee will be applied if the vacuum gauge filter assembly is not returned intact.

Laboratory Return Address: Eurofins Air Toxics, 180 Blue Ravine Rd. Suite B, Folsom, CA 95630

For questions, please call 800-985-5995

OVERVIEW

<u>WHOLE AIR SAMPLING OF VOCS</u> (per Eurofins Air Sampling Guide)

- Summa canisters are among the most commonly used containers, rugged and designed to provide superior inertness and extended sample storage times.
- **The sample is referred to as a "whole air sample"**
- **Your air sample will be collected passively relying on the vacuum in the canister to drive the air sample collection**. (No pump is involved.)
- **Opening the stainless steel bellows valve allows the air sample to enter the canister**.
- **A grab sample is taken over a short interval (i.e., 1-5 minutes) to provide a point-in-time sample concentration**.
- **Eurofins Air Toxics requires that canisters be returned within 15 days of receipt.** Using canisters beyond 15 days increases the risk of having an unacceptable initial vacuum at the start of sampling.
- **The canister is subsequently sealed and transported to the laboratory for analysis.**

<u>HARDWARE USED WITH THE CANISTER</u>

- **the valve:** A stainless steel bellows valve is mounted at the top of the canister. It maintains the vacuum in the canister before sampling and seals the canister after sampling. No more than a half turn is required to open the valve. Hand tighten to close the valve but do not over-tighten it after sampling or it may become damaged.
- **brass cap attached to the valve:** This ensures that there is no loss of vacuum due to a leaky valve or accidentally opened valve. It also prevents dust and other particulate matter from damaging the valve. The cap is removed before sampling and replaced after the sample collection.
- **built-in particulate filter:** A 2-micron stainless steel filter restricts the flow into the canister.
    - **Grab sample fill times** for Canisters: **6 Liter < ~~5 minutes~~ revised 8 minutes;** 1 Liter < 1 minute
- **vacuum gauge:** A rough gauge used to measure the initial vacuum of the canister before sampling and the final vacuum upon completion.

<u>RULES</u>

· DO NOT use canister to collect explosive substances, radiological or biological agents, corrosives, extremely toxic substances or other hazardous materials. It is illegal to ship such substances and you will be liable for damages.
· NEVER allow liquids (including water) or corrosive vapors to enter canister.
· DO NOT attach labels to the surface of the canister or write on the canister; you will be liable for cleaning charges.
· DO NOT over tighten the valve, and remember to replace the brass cap.
· IF the canister is returned in unsatisfactory condition, you will be liable for damages.
· AND, **if you have any questions or need any support**, our experienced project management team is just a phone call away at **800-985-5955.**

Step-by-step procedure for canister grab sampling

Before you get to the field:

1. **Verify contents of the shipped package.** (e.g., Chain of Custody, canister, particulate filter (built in) and vacuum gauge)
2. Make sure you **include a 9/16" and 1/2" wrench in your field tool kit**.
3. **Verify the initial vacuum** level prior to going to the field. It should be greater than 25" Hg. a. Confirm that the valve is closed (knob should already be tightened clockwise).

b. **Remove the brass cap**. Reverse order in Field Sampling Procedure.

c. **Attach the vacuum gauge**.

d. **Attach brass cap** to side of gauge tee fitting to ensure a closed train.

e. Open and close valve quickly (a few seconds).

f. Read vacuum on the gauge and record this on "Initial Vacuum" column of COC.

g. Verify that canister valve is closed and remove gauge.

h. Replace the brass cap.

If it is less than 25" Hg, contact your Project Manager.

4. Have **confirmation of a weather inversion** to establish the time of sampling.
5. Have **confirmation of a "hot spot"** by an air sampling device to establish the location of sampling.

When ready to sample:

1. **Confirm that valve is closed** (the blue knob should already be tightened clockwise).
2. **Attach the vacuum gauge** to the canister. (Steps 3, 4 on Field Sampling Procedure)
3. **Verify the initial vacuum** of the canister. (Step 5)
   - Remove the brass cap (Step 6)
   - Open (counter- clockwise) and close (clockwise) the valve quickly, <1/2 turn
   - Record the initial vacuum level on the Chain of Custody (COC)

5. **Open the valve counter-clockwise**, no more than 1/2 turn. (Step 7)
   (A 6-liter canister normally takes less than 5 minutes to fill.)
6. **Close the valve** by hand tightening the knob clockwise, no more than 1/2 turn. (Step 8)
   Aim for a final vacuum of 5"Hg.
7. Read and **record the final vacuum** of the canister in the "Initial Vacuum" column of COC.
8. **Detach the vacuum** gauge by pulling back the sleeve and lifting. (Step 9)
9. **Replace the brass cap**.

11. **Fill out the COC**. (It's important to note the canister serial # on the COC.) (Step 10)
12. **Fill out the canister sample tag** (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC). (Step 11)
13. **Place the COC in the box** and retain a copy. (Step 13)
14. **Return the canister** and associated hardware in the box provided. Tape the box shut.
    Ship via USPS, FedEx, or UPS. Expedited shipping is not required.

Unreturned canisters and associated hardware will result in additional charges as outlined in the media agreement.

Meteorological Planning and Analysis
for
Particulate Matter (PM) and Volatile Organic Compounds (VOC) Measurements

Background

https://www.arl.noaa.gov/

The NOAA Air Resources Laboratory (ARL) mission is to improve the ability of our Nation to protect human and ecosystem health and to support a vibrant economy through advanced atmospheric sciences and technologies. ARL's research focus area is on the surface of the earth from one meter below the soil up to 2,000 meters in the atmosphere (aka the boundary layer), which has a significant impact on people's health and safety, business, and the environment.

Pasquill Stability Classes. Plan measurements when **E**, **F** or **G** is forecast.

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Pasquill Stability Classes

A: Extremely unstable conditions	D: Neutral conditions
B: Moderately unstable conditions	E: Slightly stable conditions
C: Slightly unstable conditions	F: Moderately stable conditions
G: Extremely Stable	

Meteorological conditions defining Pasquill stability classes.

	Daytime insolation			Night-time conditions	
Surface wind speed (m/s)	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	<= 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

Other Parameters Affecting Pollution Concentration. The Vertical Mixing Coefficient (m^2/sec - mixing length times velocity) is a measure of the turbulent mixing within the Boundary Layer used by the Air Resources Laboratory Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) transport and dispersion model to calculate the vertical movement of pollutants. The Vertical Mixing Coefficient decreases above the boundary layer.

Lapse Rate (the change of temperature with height) is one component of atmospheric stability, also called Static Stability. Vertical mixing is also affected by how much turbulence is generated by the change in the wind speed with height. Static Stability may either enhance or suppress the wind generated turbulence. The ratio of two is the Dynamic Stability, which can be represented by the Vertical Mixing Coefficient. Dynamic Stability is never constant in space or time. The heating of various terrain types by the Sun causes the surface to heat unevenly, leading to variations in wind velocity and temperature. As sunlight increases, into the afternoon on a non-cloudy day, the mixing increases. The combination of the change in temperature, and wind, with height causes vertical stability or instability.

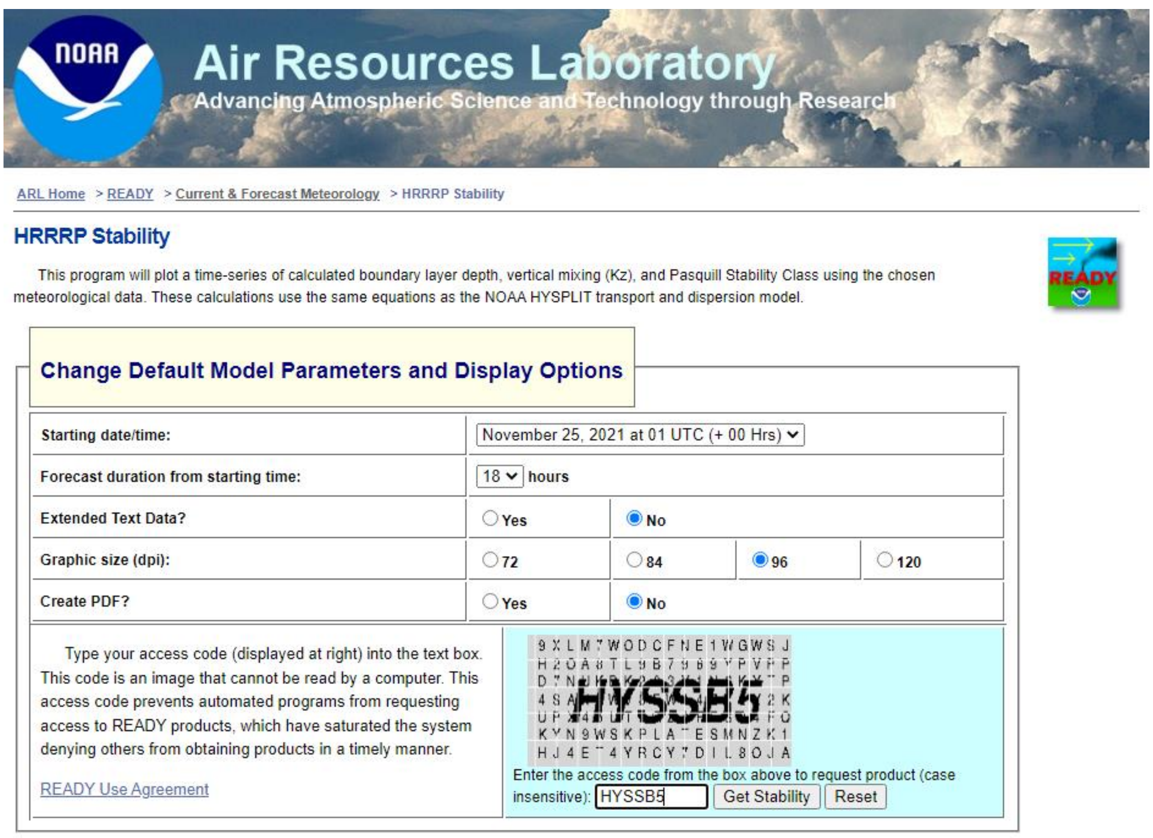
Measurement Planning for Maximum Concentrations

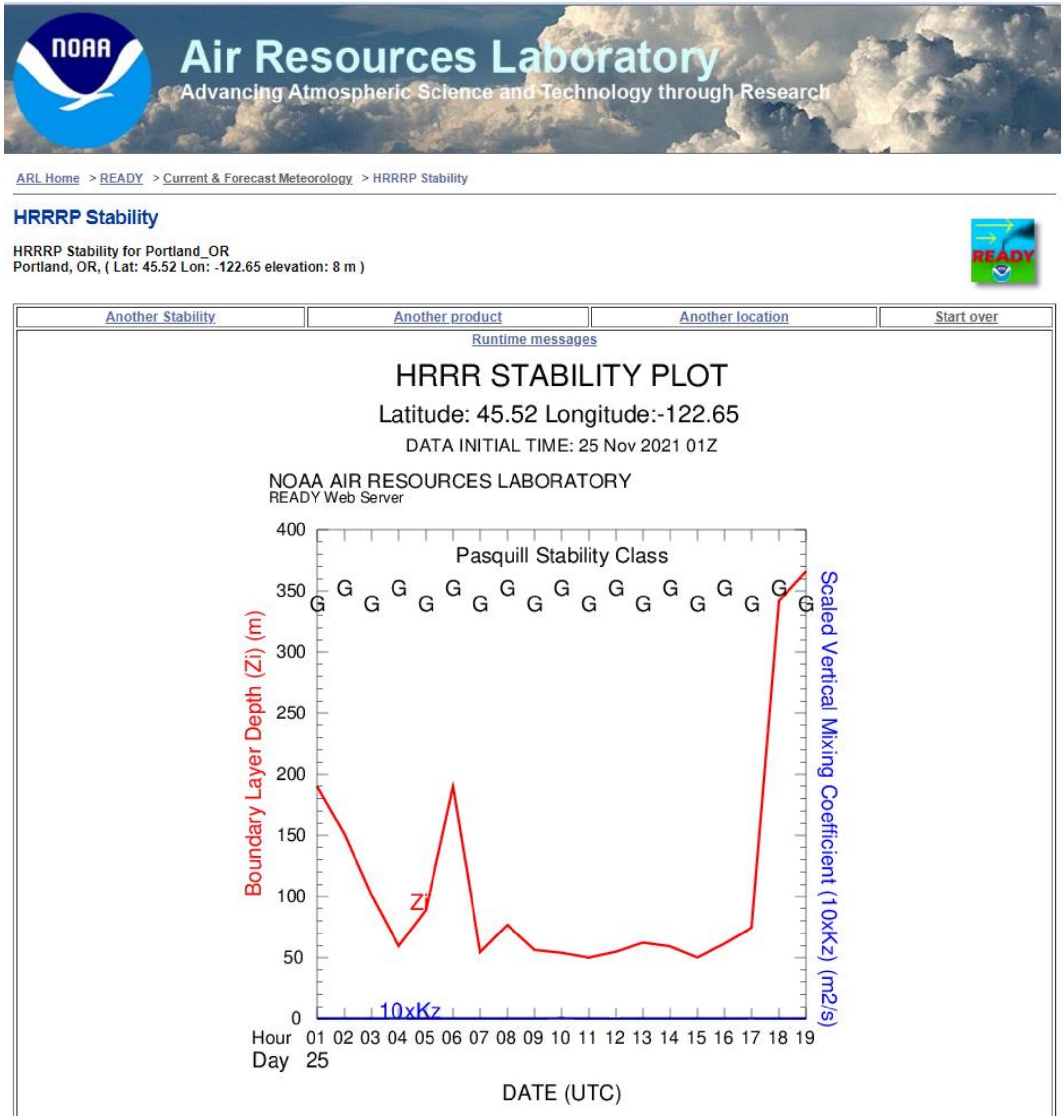
<u>18-Hour Next Day Planning</u>.

The High-Resolution Rapid Refresh (HRRR) model is run hourly, after integrating meteorological data from all sources.

At or after 4:00 pm PST (00:00 UTC) go to
https://www.ready.noaa.gov/READYcmet.php [Current and Forecast Meteorology]
Select: Portland, OR, then Continue
STABILITY TIME SERIES, Choose HRRR Model (3km, 18h, 1hrly, CONUS, pressure), then Go
Select latest Meteorological Forecast Cycle, then Next
See interface below:

Select current (earliest) Starting date/time:
Forecast duration from starting time: 18 hours
Extended text data? No
Graphic size (dpi): 96
Create PDF? No
Enter access code, then Get Stability





Forecast Hourly Pasquill Stability Classes are shown along with forecast Boundary Layer Depth and Scaled Vertical Mixing Coefficient. Higher PM and VOC concentrations are expected with lower Boundary Layer Depths and lower Vertical Mixing Coefficients.

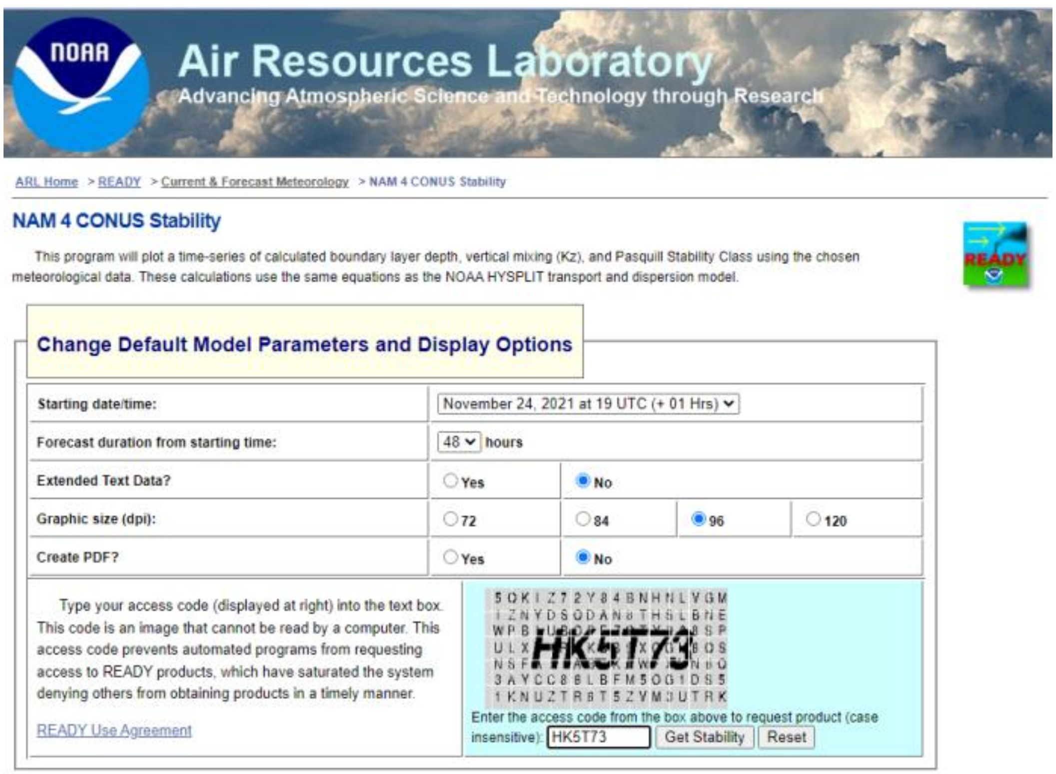
Latitude: 45.52 Longitude:-122.65 is the location of the grid-point of the HRRR 3-kilometer resolution horizontal grid, nearest to 45.517 ^{o}N & -122.65 ^{o}W, approximately the Portland, Oregon intersection of SE 16th Avenue and SE Oak Street.

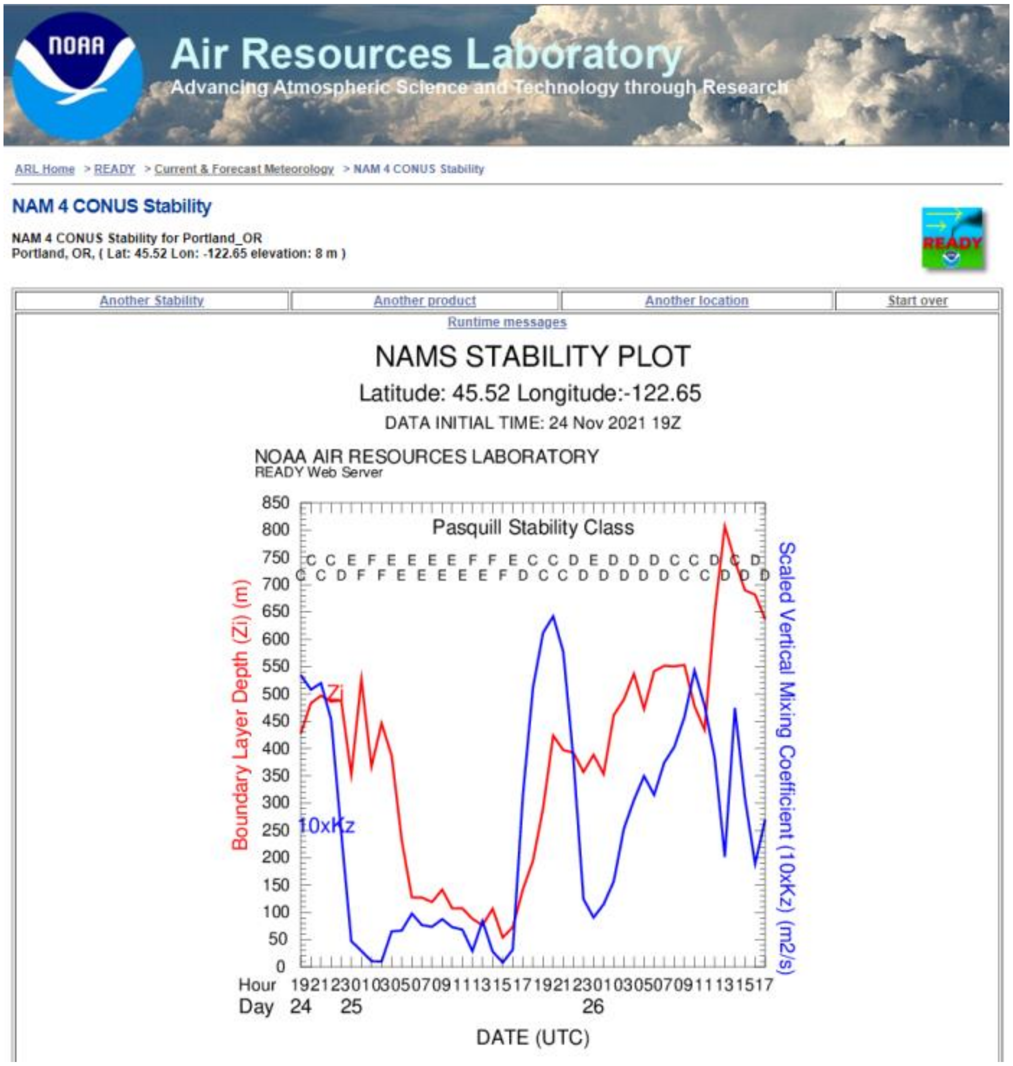
48-Hour Planning.

North American Mesoscale (**NAM**) Forecast System model is run hourly, after integrating meteorological data from all sources.

https://www.ready.noaa.gov/READYcmet.php [Current and Forecast Meteorology]
Select: Portland, OR, then Continue
STABILITY TIME SERIES, Choose NAM Model (3km, 48h, 1hrly, CONUS, pressure-sigma hybrid), then Go
Select latest Meteorological Forecast Cycle, then Next
See interface below:

> Select current (earliest) Starting date/time:
> Forecast duration from starting time: 48 hours
> Extended text data? No
> Graphic size (dpi): 96
> Create PDF? No
> Enter access code, then Get Stability

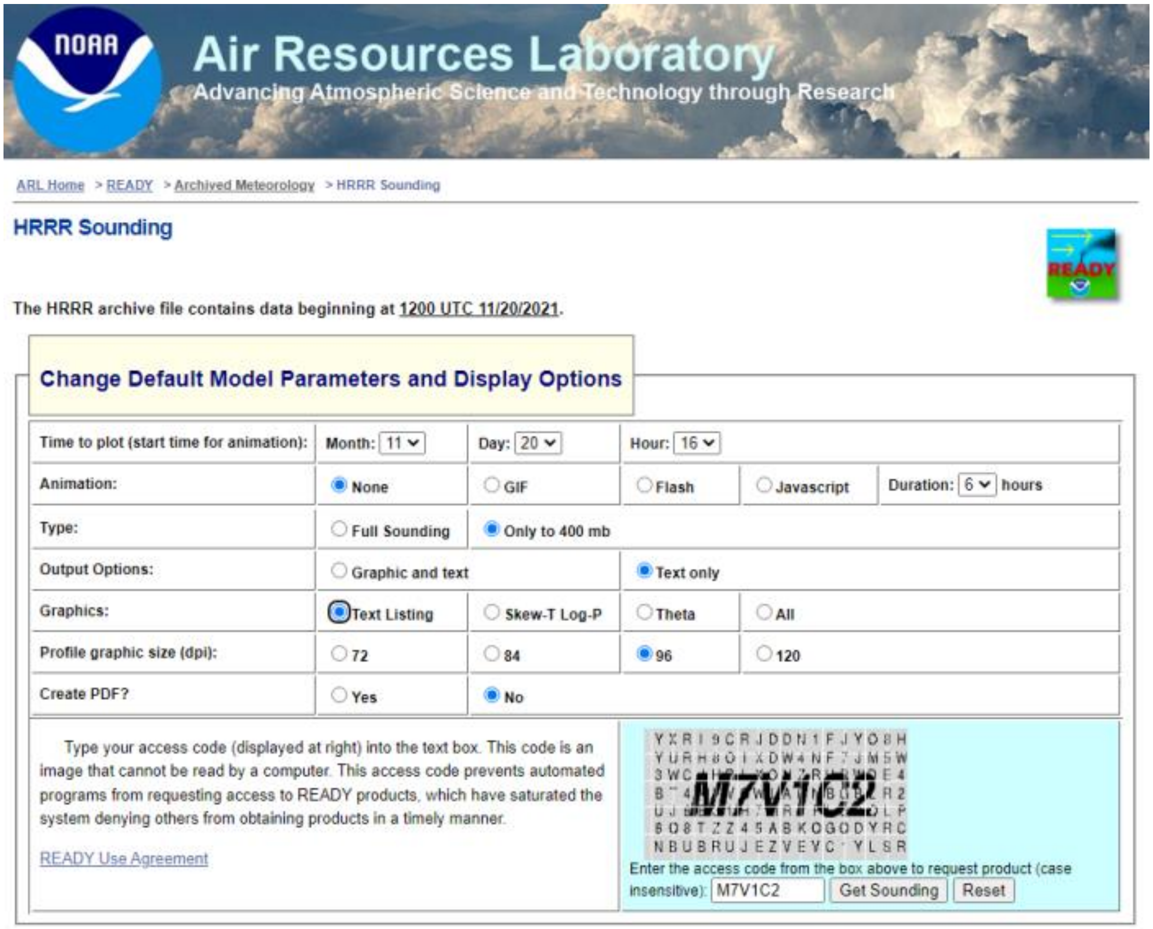




Meteorology: Post-Measurement Analysis

https://www.ready.noaa.gov/READYamet.php [Archived Meteorology]
Select: Portland, OR, then Continue
SOUNDING, Choose HRRR (3km, 1 hourly, U.S.). then Go
Select HHHR Meteorological File for the analysis date and the time interval when the measurements were taken (00-05 UTC, 06-11 UTC, 12-17 UTC, 18-23 UTC) latest Meteorological Forecast Cycle, then Next
See interface below:

> Select current (earliest) Starting date/time:
> Forecast duration from starting time: 48 hours
> Extended text data? No
> Graphic size (dpi): 96
> Create PDF? No
> Enter access code, then Get Stability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HRRR Sounding
READY
The HRRR archive file contains data beginning at 1200 UTC 11/20/2021.
Change Default Model Parameters and Display Options
Time to plot (start time for animation): Month: 11 Day: 20 Hour: 16
Animation: None GIF Flash Javascript Duration: 6 hours
Type: Full Sounding Only to 400 mb
Output Options: Graphic and text Text only
Graphics: Text Listing Skew-T Log-P Theta All
Profile graphic size (dpi): 72 84 96 120
Create PDF? Yes No
Type your access code (displayed at right) into the text box. This code is an image that cannot be read by a computer. This access code prevents automated programs from requesting access to READY products, which have saturated the system denying others from obtaining products in a timely manner.
READY Use Agreement
M7V1C2
Enter the access code from the box above to request product (case insensitive): M7V1C2 Get Sounding Reset