Air Monitoring

December 6th 2023

LOUDOUN CLIMATE PROJECT

http://www.loudounclimate.org/air-monitoring

About Loudoun Climate Project

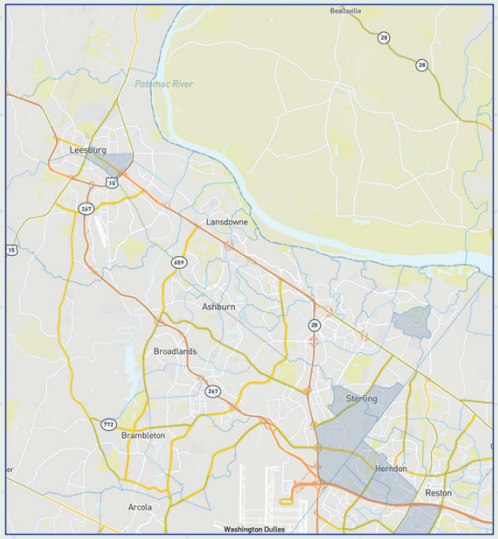
•Formed as a 501c3 in 2020 by combining two previous groups, 350 Loudoun and Sustainable Loudoun

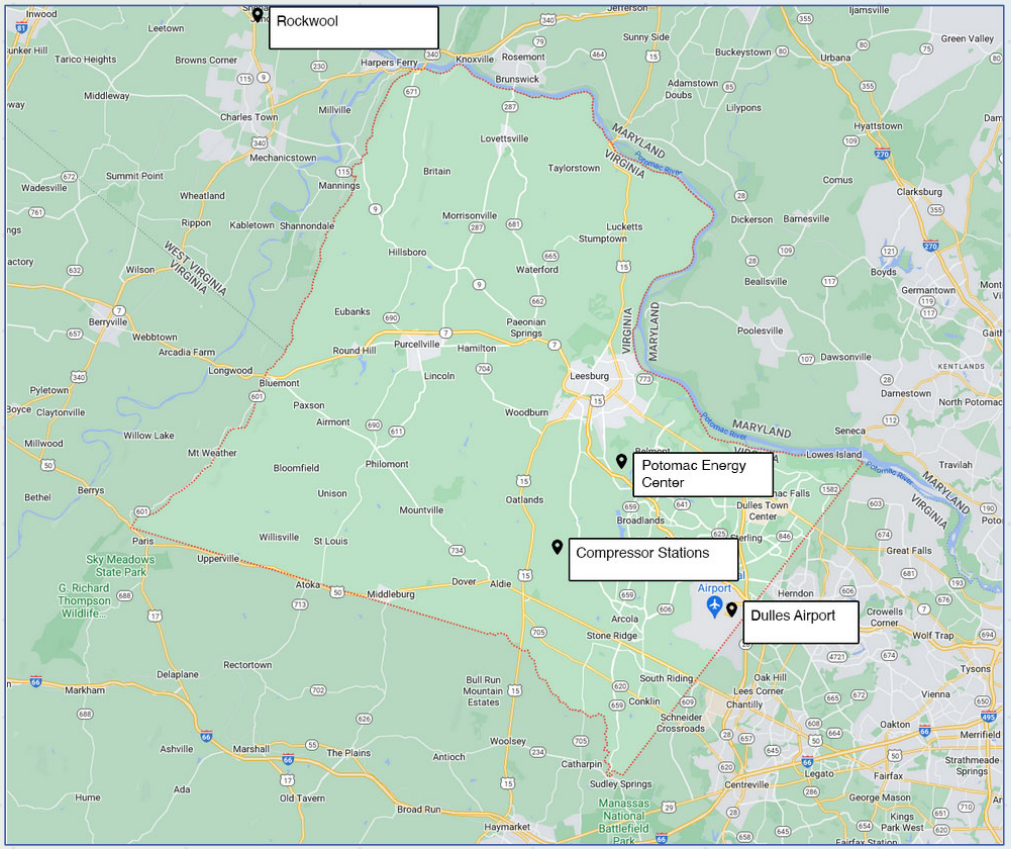
•All volunteer, at least so far

•VCN Member

About Loudoun County

- Suburban and rural composition
- DEQ has one monitor in Ashburn
- The wind is most often from the west for 2.3 months, from May 25 to August 3 and for 7.2 months, from October 6 to May 11
- Several EJ Zones

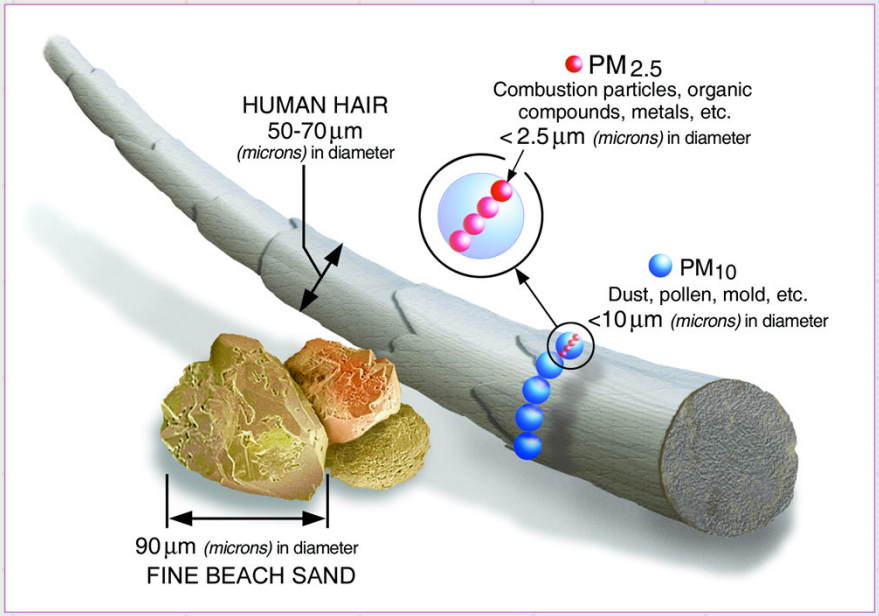




What is particulate pollution?

- Dust
- Dirt
- Soot
- Smoke
- Drops of Liquid

Some particles are big enough (or appear dark enough) to see — for example, you can often see smoke in the air. Others are so small that you can't see them in the air.



Where does particulate pollution come from?

- **Primary or Mechanical Sources**: Emitted directly from a source, such as construction sites, unpaved roads, fields, smokestacks or fires.
- **Secondary or Chemical Sources:** Most particles form in the atmosphere as a result of complex reactions of chemicals such as sulfur dioxide and nitrogen oxides, which are pollutants emitted from power plants, industries and automobiles.

Why monitor air pollution?

- Started partially because of Rockwool
- Measuring particulates (PM2.5) is indicative of emissions sources that also tend to emit greenhouse gasses
- “Think global, act local”. This way we hopefully highlight GHG emissions sources in a way that connects through public health.
- Not much other monitoring in place.
- Possible direct warming effect of particulate pollution

ASHBURN

Data time: 12/13/2022 4:00 PM ET

Location

Address:	Broad Run High School
Latitude:	39.02473
Longitude:	-77.48925
Region:	Northern

Air Quality Information

Pollutant	Concentration	Units of Measure
NO2	6	PPB
Ozone	31	PPB

Historical Data Concentration

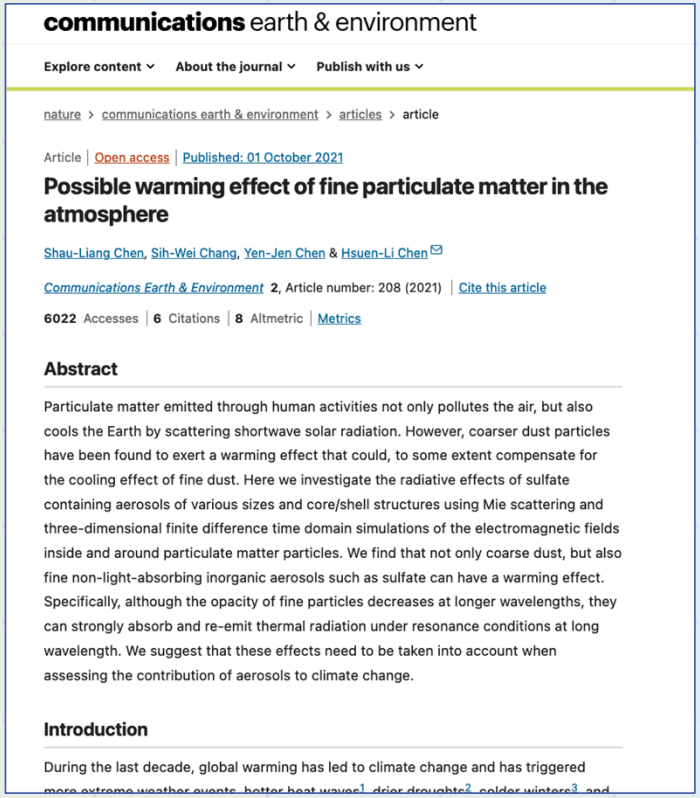
Hour	AQI	Class	Program	Responsible Pollutant	Activity Caution	Risk Groups
16:00	6	Good	NO2	NO2	None	None
16:00	29	Good	Ozone	Ozone	None	Children and people with asthma are the groups most at risk.
15:00	4	Good	NO2	NO2	None	None
15:00	29	Good	Ozone	Ozone	None	Children and people with asthma are the groups most at risk.
14:00	4	Good	NO2	NO2	None	None
14:00	30	Good	Ozone	Ozone	None	Children and people with asthma are the groups most at risk.
13:00	2	Good	NO2	NO2	None	None
13:00	30	Good	Ozone	Ozone	None	Children and people with asthma are the groups most at risk.
12:00	3	Good	NO2	NO2	None	None
12:00	28	Good	Ozone	Ozone	None	Children and people with asthma are the groups most at risk.
11:00	4	Good	NO2	NO2	None	None

Possible direct warming effect of particulates

“We find that not only coarse dust, but also fine non-light-absorbing inorganic aerosols such as sulfate can have a warming effect. “

From:

https://www.nature.com/articles/s43247-021-00278-5



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Possible warming effect of fine particulate matter in the atmosphere

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Abstract

Particulate matter emitted through human activities not only pollutes the air, but also cools the Earth by scattering shortwave solar radiation. However, coarser dust particles have been found to exert a warming effect that could, to some extent compensate for the cooling effect of fine dust. Here we investigate the radiative effects of sulfate containing aerosols of various sizes and core/shell structures using Mie scattering and three-dimensional finite difference time domain simulations of the electromagnetic fields inside and around particulate matter particles. We find that not only coarse dust, but also fine non-light-absorbing inorganic aerosols such as sulfate can have a warming effect. Specifically, although the opacity of fine particles decreases at longer wavelengths, they can strongly absorb and re-emit thermal radiation under resonance conditions at long wavelength. We suggest that these effects need to be taken into account when assessing the contribution of aerosols to climate change.

Introduction

During the last decade, global warming has led to climate change and has triggered

Particulate Regulatory History

The Clean Air Act directs EPA to set the primary NAAQS at a level that protects public health, including the health of sensitive or at-risk groups, with an adequate margin of safety. EPA expressly considers the available information regarding health effects among at-risk populations, including information available for how this pollutant impacts minority populations and low socioeconomic status populations, in decisions on the primary NAAQS.

On January 6, 2023, the U.S. Environmental Protection Agency (EPA) announced a notice of proposed rulemaking to strengthen the nation's national ambient air quality standards (NAAQS) for fine particle pollution, also known as fine particulate matter, or PM 2.5

EPA is proposing to revise the level of the primary (health-based) annual PM2.5 standard from 12.0 micrograms per cubic meter (μg/m³) to a level within the range of 9.0 to 10.0 μg/m³

Final Rule	Primary/ Secondary	Indicator	Averaging Time	Level [1]	Form
1971	Primary	TSP [2]	24-hour	260 μg/m^3	Not to be exceeded more than once per year
			Annual	75 μg/m^3	Annual geometric mean
36 FR 8186 Apr 30, 1971	Secondary	TSP	24-hour	150 μg/m^3	Not to be exceeded more than once per year
			Annual	60 μg/m^3	Annual geometric mean
1987	Primary and Secondary	PM_{10}	24-hour	150 μg/m^3	Not to be exceeded more than once per year on average over a 3-year period
52 FR 24634 Jul 1, 1987			Annual	50 μg/m^3	Annual arithmetic mean, averaged over 3 years
1997	Primary and Secondary	$PM_{2.5}$	24-hour	65 μg/m^3	98th percentile, averaged over 3 years
			Annual	15.0 μg/m^3	Annual arithmetic mean, averaged over 3 years [3],[4]
62 FR 38652 Jul 18, 1997		PM_{10}	24-hour	150 μg/m^3	Initially promulgated 99th percentile, averaged over 3 years; when 1997 standards for PM10 were vacated, the form of 1987 standards remained in place (not to be exceeded more than once per year on average over a 3-year period) [5]
			Annual	50 μg/m^3	Annual arithmetic mean, averaged over 3 years
2006	Primary and Secondary	$PM_{2.5}$	24-hour	35 μg/m^3	98th percentile, averaged over 3 years [6]
			Annual	15.0 μg/m^3	Annual arithmetic mean, averaged over 3 years [2], [7]
71 FR 61144 Oct 17, 2006		PM_{10}	24-hour [8]	150 μg/m^3	Not to be exceeded more than once per year on average over a 3-year period
2012	Primary	$PM_{2.5}$	Annual	12.0 μg/m^3	Annual arithmetic mean, averaged over 3 years [2], [7]
78 FR 3086 Jan 15, 2013	Secondary		Annual	15.0 μg/m^3	Annual arithmetic mean, averaged over 3 years [2], [7]
	Primary and Secondary		24-hour	35 μg/m^3	98th percentile, averaged over 3 years [6]
	Primary and Secondary	PM_{10}	24-hour [8]	150 μg/m^3	Not to be exceeded more than once per year on average over a 3-year period

(1)

Health Impacts of Particulate Pollution

- Higher likelihood of children developing asthma
- Worsening of COPD in adults
- Slowed lung function growth in children and teenagers
- Increased risk of heart attacks and strokes
- Higher likelihood of getting lung cancer
- Higher likelihood of developing diabetes
- Neurological effects in adults including reduced brain volume, cognitive decrements and dementia.
- Impacts to pregnancy and birth outcomes, such as preterm birth, low birth weight and fetal and infant mortality
- Increased risk of death from cardiovascular disease

85k - 200k premature deaths per year in the US as of 2021

8.3 million premature deaths per year globally

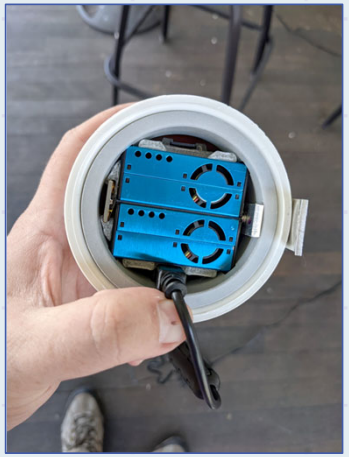
About PurpleAir Monitors

- Low cost, around $300 each
- New ones (PA2-FLEX) include VoC detection
- PA2's monitor PM1, PM2.5, and PM10
- Easy to set up
- WiFi, low power requirements
- Durable, low maintenance
- Cloud platform at purpleair.com

Can anyone set up a PurpleAir monitor?

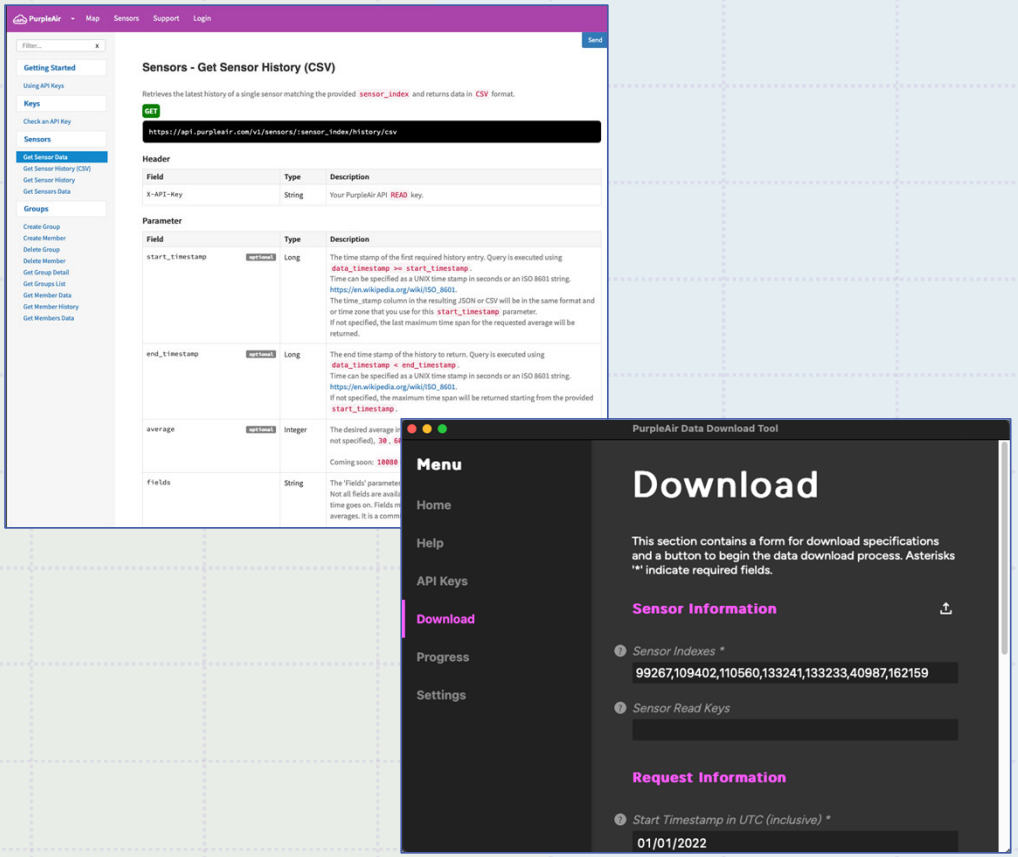
Yes! You could set your own up using a computer or a smartphone.

www.purpleair.com



PurpleAir Application Programming Interface (API)

- Relatively simple and easy to use
- Access to historical data in bulk using download tool.
- Anyone can get any data
- Can be used for custom application development
- Some changes in the last year or two.
- CSV downloads used to be free.
- Now you buy points with dollars, and spend points on API calls.



The AQI – Air Quality Index

Air Quality Index	Who Needs to be Concerned?	What Should I Do?
Good 0-50	It's a great day to be active outside.	
Moderate 51-100	Some people who may be unusually sensitive to particle pollution.	**Unusually sensitive people:** *Consider reducing* prolonged or heavy exertion. Watch for symptoms such as coughing or shortness of breath. These are signs to take it easier. **Everyone else:** It's a good day to be active outside.
Unhealthy for Sensitive Groups 101-150	Sensitive groups include **people with heart or lung disease, older adults, children and teenagers.**	**Sensitive groups:** *Reduce* prolonged or heavy exertion. It's OK to be active outside, but take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. **People with asthma** should follow their asthma action plans and keep quick relief medicine handy. **If you have heart disease:** Symptoms such as palpitations, shortness of breath, or unusual fatigue may indicate a serious problem. If you have any of these, contact your heath care provider.
Unhealthy 151 to 200	**Everyone**	**Sensitive groups:** *Avoid* prolonged or heavy exertion. Move activities indoors or reschedule to a time when the air quality is better. **Everyone else:** *Reduce* prolonged or heavy exertion. Take more breaks during all outdoor activities.
Very Unhealthy 201-300	**Everyone**	**Sensitive groups:** *Avoid all* physical activity outdoors. Move activities indoors or reschedule to a time when air quality is better. **Everyone else:** *Avoid* prolonged or heavy exertion. Consider moving activities indoors or rescheduling to a time when air quality is better.
Hazardous 301-500	**Everyone**	**Everyone**: *Avoid all* physical activity outdoors. **Sensitive groups:** Remain indoors and keep activity levels low. Follow tips for keeping particle levels low indoors.

AQI Category	Index Values	Previous Breakpoints (1999 AQI) ($\mu g/m^3$, 24-hour average)	Revised Breakpoints ($\mu g/m^3$, 24-hour average)
Good	0 - 50	0.0 - 15.0	0.0 – 12.0
Moderate	51 - 100	>15.0 - 40	12.1 – 35.4
Unhealthy for Sensitive Groups	101 – 150	>40 – 65	35.5 – 55.4
Unhealthy	151 – 200	> 65 – 150	55.5 – 150.4
Very Unhealthy	201 – 300	> 150 – 250	150.5 – 250.4
Hazardous	301 – 400	> 250 – 350	250.5 – 350.4
	401 – 500	> 350 – 500	350.5 – 500

Location Selection

- Start with locations from the “Suggest a Location” form at loudounclimate.org/air-monitoring
- Priority given to areas close to known large emitters and EJ areas based on https://screeningtool.geoplatform.gov
- Priority for geographic distribution
- 10 monitors currently:
    - Aldie (1)
    - Ashburn (1)
    - Lansdowne (1)
    - Leesburg (1)
    - Lovettsville (1)
    - Roundhill (1)
    - Sterling (3)
    - Waterford (1)
- We want to add 10 more as soon as possible

Strategy

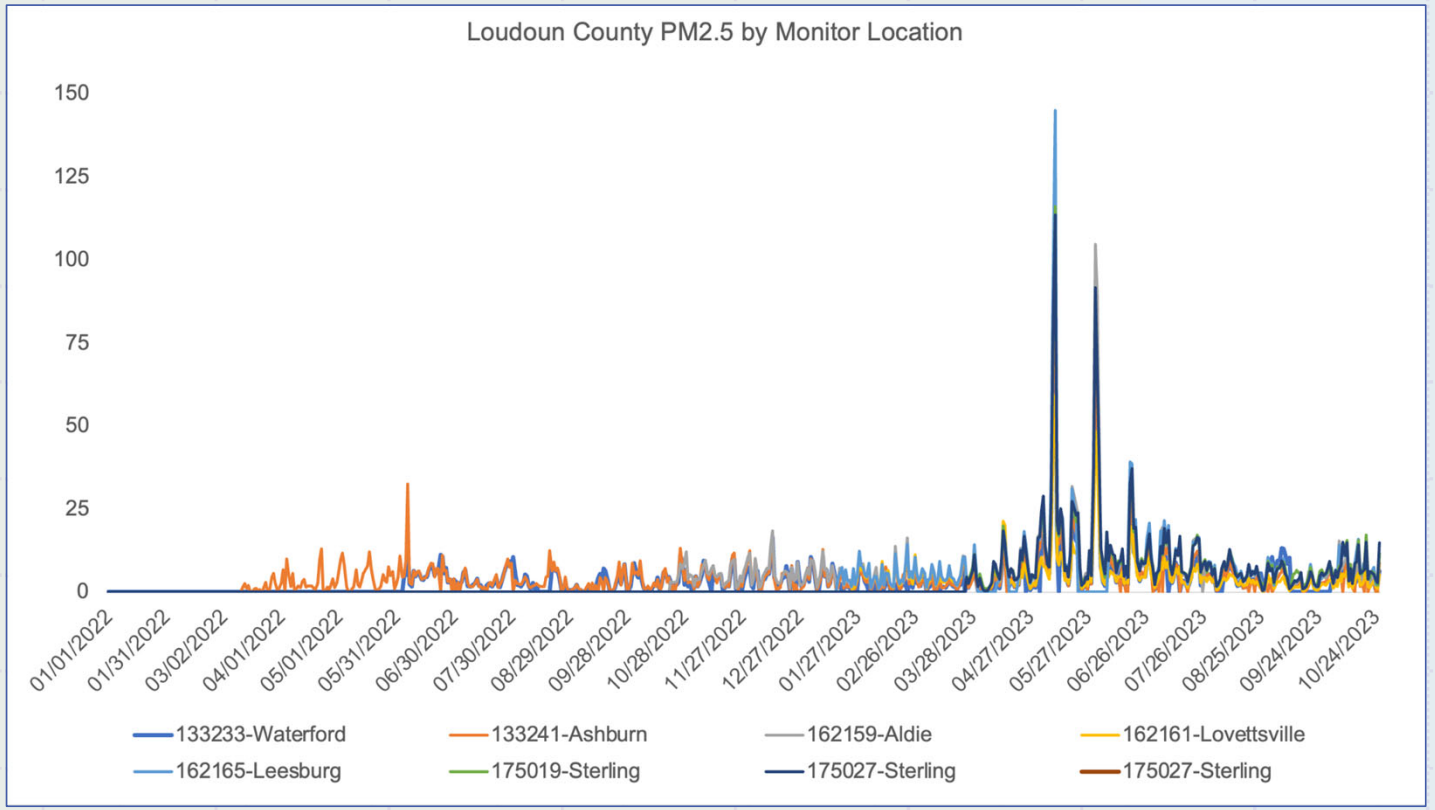
Monitors

• Loudoun Climate Project purchases, installs and maintains monitors in our program.
• Homeowners volunteer via a web form
• Homeowner provides electricity and wifi connection
• Occasional maintenance needed.

Data

• Data liberation policy: We intend to make all data publicly available at www.loudounclimate.org/air-monitoring.
• Bulk data downloads starting w/ 2021. 2022 is available now, as well as 2023 through 11/25/2023. We will update 2023 w/ the full year after 1/1/2024
• Starting to work w/ data analysts as we are able to.
• Working on building an application for historical data viewing application

PM2.5 Jan 1 2022 to Oct 24th 2023



Data field is pm2.5_alt
Which includes a calibration factor

Daily Averages Table

Min	0.6	0.6	0.8	1.1	-	-	0.3	0.2	0.6	1.0	0.4	-		
Max	97.8	82.5	112.4	51.1	75.5	103.5	131.6	59.3	144.9	116.0	113.5	**144.9**		
Avg	8.0	7.1	8.1	7.0	5.0	4.9	8.2	5.3	9.0	10.2	10.2	**7.2**		
SD	8.1	6.2	7.4	5.0	7.1	7.5	11.7	6.5	11.7	12.6	12.9	**8.6**		
Good AQI Days	462	612	688	327	477	589	365	274	250	212	212	**406**		
Moderate+ AQI Days	4	2	4	1	4	4	4	1	2	4	4	**3**		
Date	**40987-Sterling**	**99267-Round Hill**	**109402-Leesburg**	**110560-Round Hill**	**133233-Waterford**	**133241-Ashburn**	**162159-Aldie**	**162161-Lovettsville**	**162165-Leesburg**	**175019-Sterling**	**175027-Sterling**	**Daily Avg**	**30-day MA**	**Data Comment**
06/24/2023	5.4	6	6.4		2.7	3.5	5.6	2.8		4.6	4.6	4.6	17.1	
06/25/2023	4.5	4.7	5.4		1.5	0	4	1.9		4	3.9	3.3	17.2	
06/26/2023	12.6	11	12.3		7.1	9.5	11.8	5.3		12.2	12.5	10.5	17.4	
06/27/2023	5.2	5.8	5.5		2.5	2.4	4.9	3.2		5.3	4.9	4.4	17.4	
06/28/2023	33	37.9	34.3		32.6	30.9	43.4	21.6		37.2	36.9	34.2	18.4	
06/29/2023	78.9	82.5	79.8		70.5	75.1	104.8	48.3		90	91.8	80.2	20.6	**Canadian Wildfires
06/30/2023	51	61.7	57		57.6	53.1	89.2	41.4		66.7	66.3	60.4	22.1	
07/01/2023	38.5	35.6	37.5		31.6	35.2	45.2	22.6		42.1	44	36.9	22.6	
07/02/2023	12.2	10.1	11.9		7.4	9.1	12.3	6.3		12.6	13.3	10.6	22.3	
07/03/2023	8.5	5.6	7.6		2.9	5.3	7.9	3.1		7.1	8.3	6.3	22.1	
07/04/2023	5.6	5.2	9.2		1.8	2.3	4.3	2.2		4.3	5.5	4.5	22.0	
07/05/2023	16.5	8.9	11.1		7.6	13.3	14.9	6.8		16.2	18	12.6	22.1	
07/06/2023	11.2	10.2	10.1		5.4	7.8	9.2	4.5	11.2	9.4	9.4	8.8	21.5	
07/07/2023	14.2	11.5	14.3		8.6	10.9	13.4	6.3	13.7	13.7	14.2	12.1	19.7	
07/08/2023	11.9	11.2	11.5		7.3	7.8	11.4	5.4	11.4	10.8	11.4	10.0	16.5	
07/09/2023	10.3	9.1	10.1		5.6	6.8	9.8	5	10	9.2	11.1	8.7	16.2	
07/10/2023	5.9	6.1	6.2		2.9	3.1	5.2	3.1	6	6	5.8	5.0	15.9	
07/11/2023	8.2	7.4	8.9		4.9	4.8	6.7	4.6	7.4	9.5	8.5	7.1	15.4	
07/12/2023	10.5	10	10.6		5.7	0	8.6	4.7	8.7	8.6	9.7	7.7	15.0	
07/13/2023	13.6	12	14.3		8.5	10.8	12.9	6.2	12.4	12.3	13.1	11.6	15.2	
07/14/2023	5.2	4.3	6.1		2.3	2.6	4.8	2.6	5.2	5.1	4.8	4.3	15.1	
07/15/2023	8.4	6.9	8		3.1	0	6.9	3	6.5	7.4	7.9	5.8	15.2	
07/16/2023	5	5.4	5.4		2.3	0	4.7	2.7	7.3	4.3	4.4	4.2	15.0	
07/17/2023	29.8	33.6	30.8		26.4	26.9	33.6	18.4	39.2	32.9	32.7	30.4	15.1	
07/18/2023	28.9	26.9	28.8		24.9	26.9	36.1	19.7	38.7	35	37.2	30.3	15.4	
07/19/2023	15.6	14.4	15.1		11.9	12.2	16.4	11.7	18.4	18.1	19.1	15.3	15.3	
07/20/2023	17.3	17.5	18.2		14.4	16	20.2	9.7	21.9	18.6	19.6	17.3	15.2	
07/21/2023	8.7	8.1	8.7		5.8	6.6	10.3	4.7	10	9.2	9.2	8.1	15.2	
07/22/2023	6.4	6.3	6.8		3.3	3.5	6.4	3.4	6.6	6.4	6.4	5.6	15.2	
07/23/2023	9.5	7.8	9.1		4.9	6.1	8.4	4.6	9.4	10.1	9.5	7.9	15.3	

Red > 35µg/m³, NAACS Scale
https://www.epa.gov/criteria-air-pollutants/naaqs-table

Data field is pm2.5_alt
Which includes a calibration factor

Thank You!

LOUDOUN CLIMATE PROJECT

http://www.loudounclimate.org/air-monitoring

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Sources

- https://www.cdc.gov/air/particulate_matter.html
- https://www.epa.gov/pm-pollution
- https://www.epa.gov/pm-pollution/particulate-matter-pm-basics
- https://www.science.org/doi/10.1126/sciadv.abf4491#tab-contributors
- https://www.epa.gov/sites/default/files/2016-04/documents/2012_aqi_factsheet.pdf
- https://www.epa.gov/system/files/documents/2023-01/PM%20NAAQS%202022%20-%20Standards%20-%20Fact%20Sheet.pdf
- https://www.epa.gov/laws-regulations/summary-clean-air-act
- https://www.lung.org/clean-air/outdoors/what-makes-air-unhealthy/particle-pollution
- https://www.epa.gov/criteria-air-pollutants/naaqs-table
- https://www3.epa.gov/ttn/naaqs/standards/pm/s_pm_history.html
- https://www.vitalstrategies.org/no-safe-level-of-air-pollution-exists-the-world-health-organizations-new-global-air-quality-guidelines-emphasize-how-improving-air-quality-can-achieve-substantial-health-benefits-fo/
- https://iris.who.int/bitstream/handle/10665/345329/9789240034228-eng.pdf?sequence=1&isAllowed=y
- https://www.who.int/news/item/22-09-2021-new-who-global-air-quality-guidelines-aim-to-save-millions-of-lives-from-air-pollution
- https://www.pnas.org/doi/full/10.1073/pnas.1803222115
- https://www.epa.gov/pmcourse/patient-exposure-and-air-quality-index
- https://weatherspark.com/y/147049/Average-Weather-at-Leesburg-Executive-Airport-Virginia-United-States-Year-Round
- https://www.nature.com/articles/s43247-021-00278-5
- https://www.bmj.com/content/383/bmj-2023-077784