

A satellite is shown in space, oriented diagonally from the top left towards the bottom right. It has a complex body with various instruments and a large, rectangular solar panel array extending from its side. The background is a deep blue space filled with numerous small white stars. At the bottom of the image, the curved horizon of the Earth is visible, showing a blue sky and white clouds. The overall scene is a high-quality digital rendering of a satellite mission.

# PM<sub>2.5</sub> vs AOD Cont.

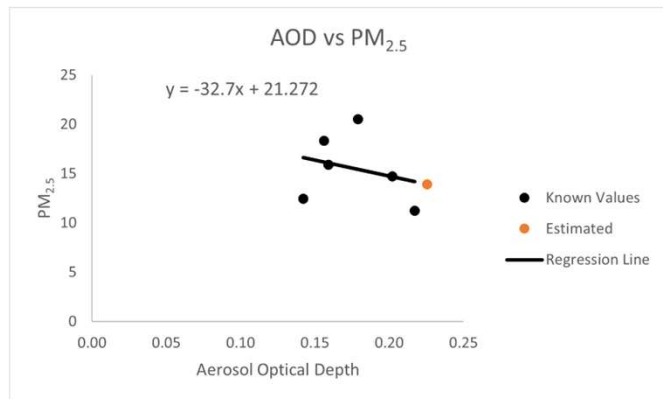
By Drew Clark, Justin Myers, Krish Pudasaini, Sunshine Carmona

Image Credit: <https://ceres.larc.nasa.gov/instruments/satellite-missions/>

# Background - Sunshine

## Last Project

- Featured Chicago
- Only used 5 points
- Super clear day led to inconsistent data



## This Project

- Features the Detroit and Dearborn areas
- Using more data points
- Data collected from August 3rd, 2025, a smokier day
- Should produce a more exact AOD vs. PM<sub>2.5</sub> linear regression

# Methods

## Purple Air

Data points were chosen manually and downloaded as a csv file

Collected data was filtered to only show results for the 3rd of August

Data from the same A and B sensors was averaged to get one measurement

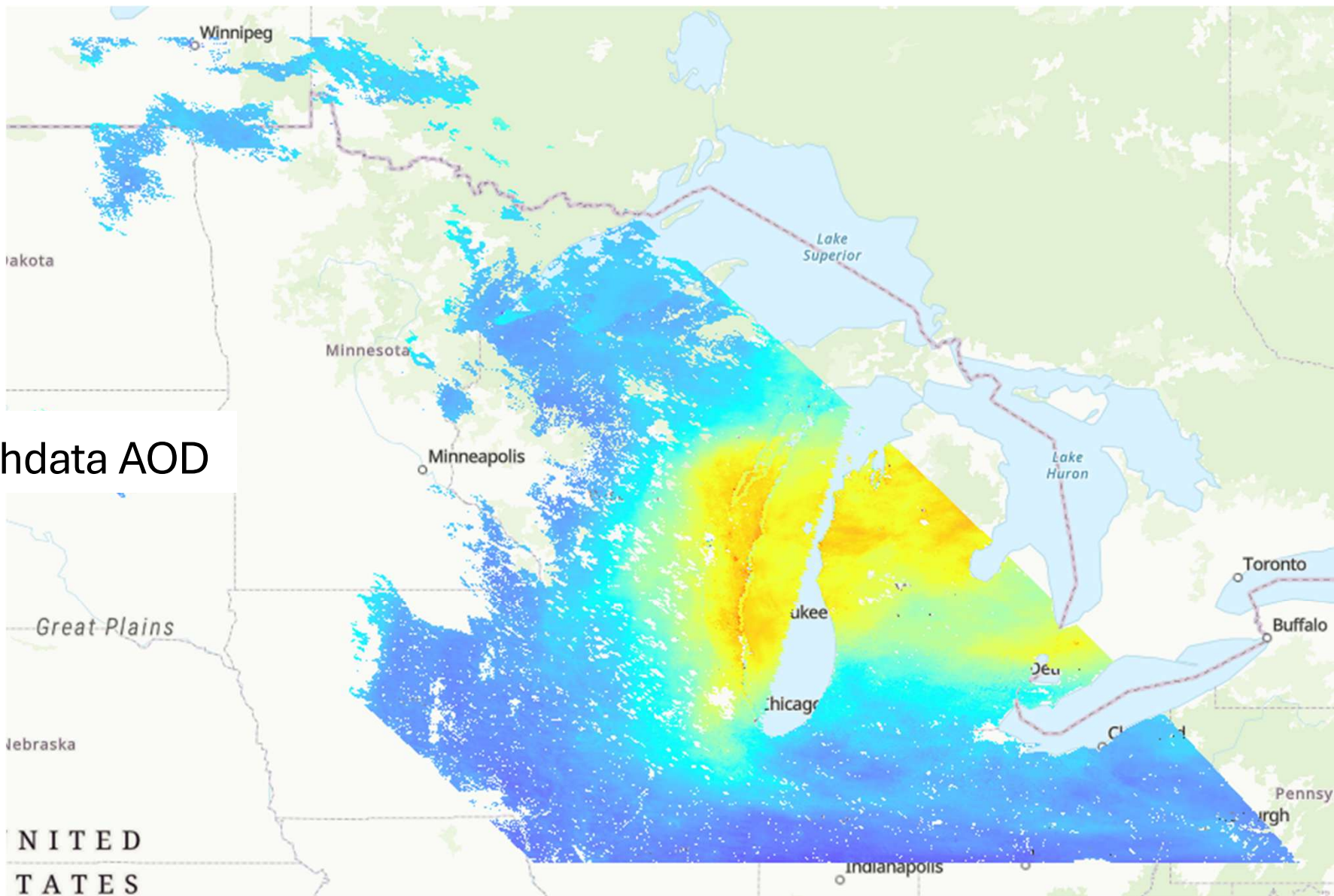
## Earthdata

Using the Purple Air map, pixels of the raster were matched to a sensor average  $PM_{2.5}$

AOD for the pixels were recorded manually and added to an excel to be charted as a linear regression



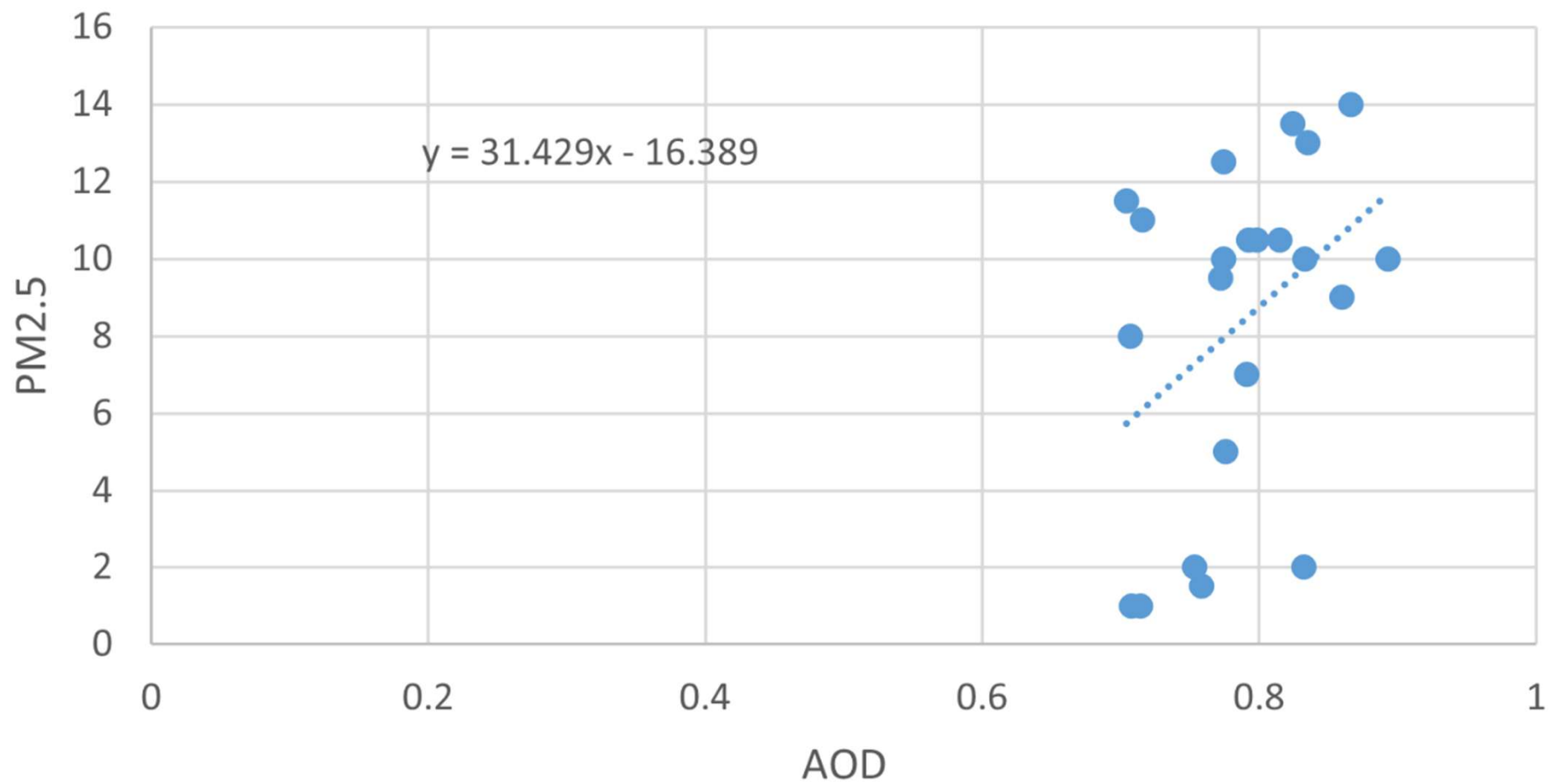
# NASA Earthdata AOD



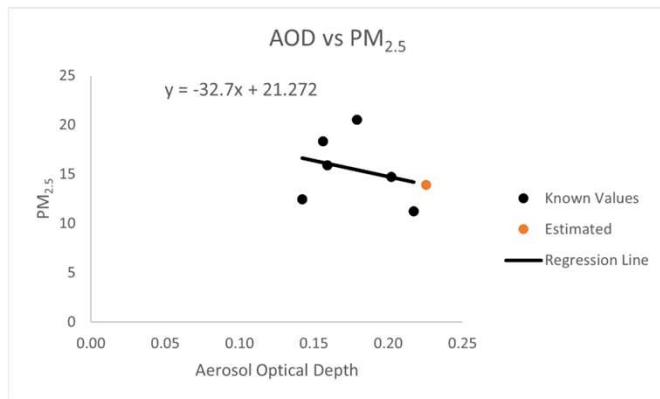
# Results

Location	Name	AOD	PM2.5 A	PM2.5 B	PM2.5 avg
Crestwood Highschool	1501 N. BEECH Daly Dearborn Heights, MI 48127	0.708	2	0	1
burt road popeyes	8 Mile & Burt-5acd	0.815	10	11	10.5
East 8-mile and Mound Road	8 Mile & Mound-8bd3	0.893	10	10	10
Algonquin & Freud	Algonquin & Freud				
Paul/Calhoun Street	Arab American National Museum				
17523 Stamwich Street	AREN PROJECT Livonia	0.832	2	2	2
Schemansky Park	Auddette/Mayfair	0.758	0	3	1.5
Covenant House Academy East	Boggs Elementary School	0.772	10	9	9.5
CBS? West 11 mile rd	CBS News Detroit NEXT	0.866	18	10	14
3446 Dexter Ave/Fenkell st	Dexter & Fenkell-5a5c	0.776	5	5	5
Bridgeview Park	EC-Deacon St	0.714	2	0	1
Wheelhouse Detroit	EGLE-ATWATER-008	0.707	11	5	8
New Center Park	EGLE-CADILLACPLACE-003	0.833	10	10	10
Hamtramck High School	EGLE-Hamtramck HS-010	0.753	1	3	2
7500 Donald Court	EGLE-WARREN-DO-004		1	10	5.5
3636 Fort/Visger	Fort & Visger - 3636	0.798	12	9	10.5
3610 S liddlesdale	GDI 3610 S liddlesdale				
Morang Street Mission	GDI Sent Loves The Kids Child Facility	0.824	14	13	13.5
Karcher Agency	Geneva Street				
Triumph Perfecting Church	HFH CURES 12				
McClellan st/east canfield st	HFH CURES 13				
Hyde Park Road and Antietam Ave	HFH CURES 20				
Charlevoix ave and cadieux road	HFH CURES 22				
Casino ave and Beaconsfield st	HFH CURES 25				
Buckingham Rd and Kercheval St	HFH CURES 28				
1321-1331 Nicolet Place	Lafayette Park	0.716	11	11	11
Southwest Rides	Lawndale & Vernor - fc2b				
Faith temple baptist church	Little Butterfly	0.774	13	12	12.5
8725 Joy Road	Livernois & Joy-637e	0.835	14	12	13
Jamison Baptist Church	Mack & Conner-b30				
allen temple christian methodist episcopal church	McClellan & Kercheval - cfbc				
Ecclesia Christian Ministries	Milford & Vancourt - 7DC0	0.704	13	10	11.5
8421 Northfield Boulevard	REAL_OAK PARK	0.860	10	8	9
Gaffke Park	SC Snet1		11	10	10.5
Dequindre Cut Greenway ramp	st. aubin & lafayette-a599	0.774	10	10	10
The Stoudamire	The Stoudamire				
Still point zen buddhist temple	Trumbull & Canfield-7ba2	0.792	11	10	10.5
Mt. Zion baptist church	Van Dyke & Mack CFF1				
Marcus Garvey Academy	Van dyke&kercheval - 24ed				
Vernor highway & Cadillac blvd	Vernor & Cadillac-5af6	0.791	3	11	7

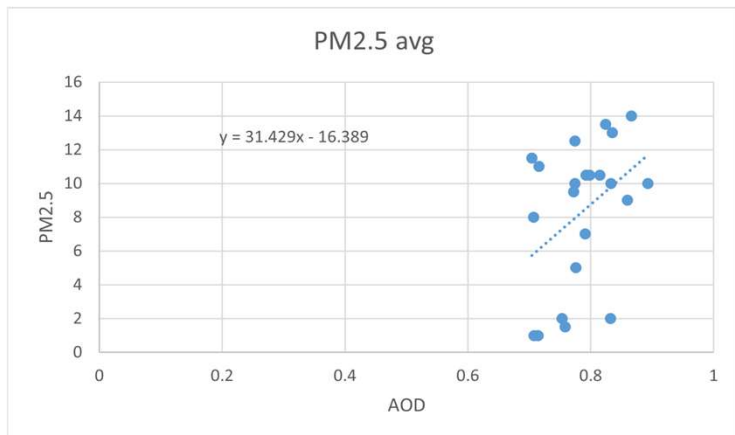
# PM2.5 avg



## Discussion - Sunshine



- Purple Air sensors are too inaccurate for small scale use.
- Using the sensors with a team that can guarantee quality could improve research potential.
- Smokier days do provide more consistent results.



# Background/Methods/Previous - Drew

**Site:** Ann Arbor

**Data:** 5 points, Purple Air. Data was attempted to be gathered from <https://ladsweb.modaps.eosdis.nasa.gov/>

**Day:** The day picked was clear. This had led to picked results and data that was not consistent

**Regression:** For Pm2.5 I had combined and gathered the average

# Methods/New

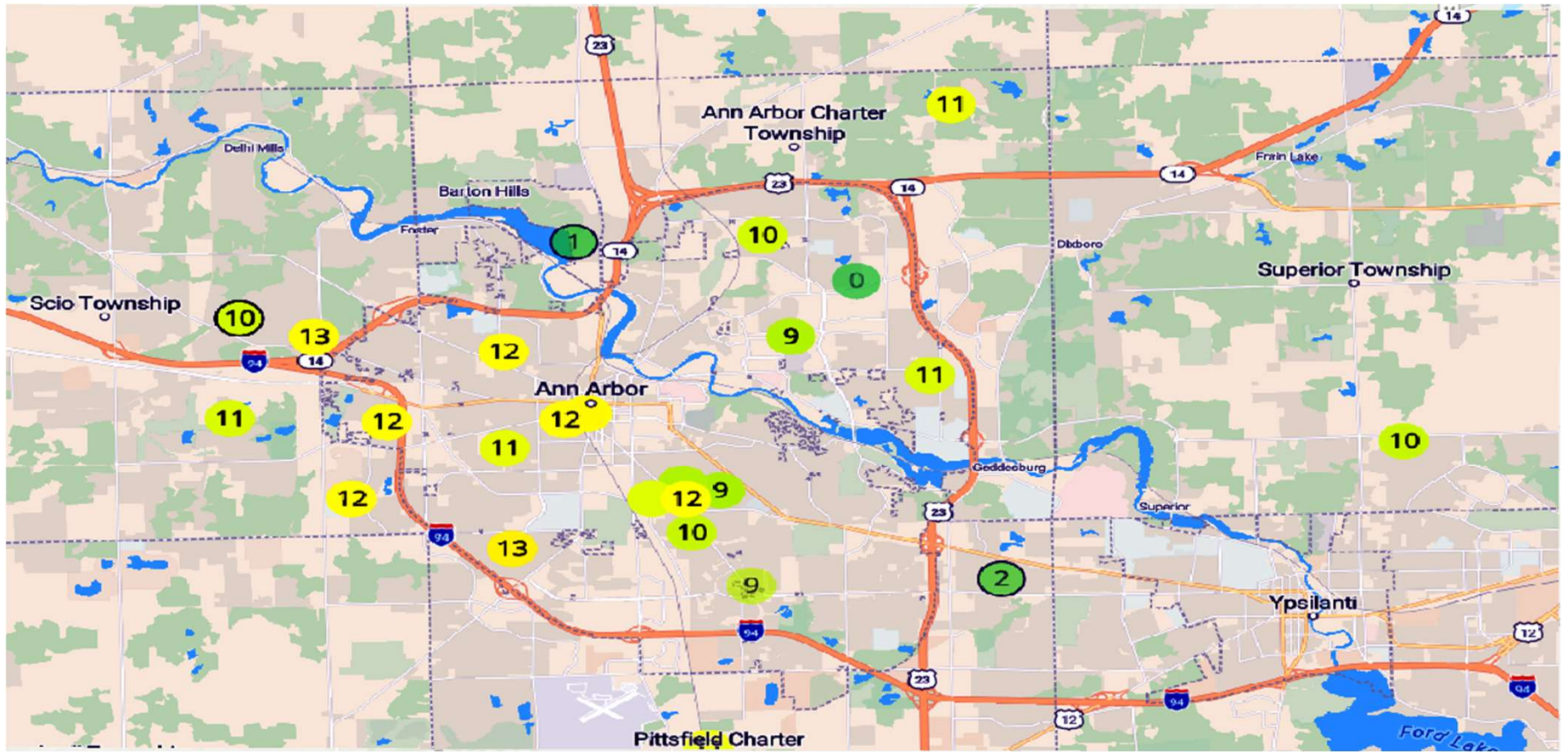
**Site:** Ann Arbor

**Data:** 15 points were gathered but 13 were used. Purple air was used for the points. Data was gathered from NASA WorldView. Used MAIAC data

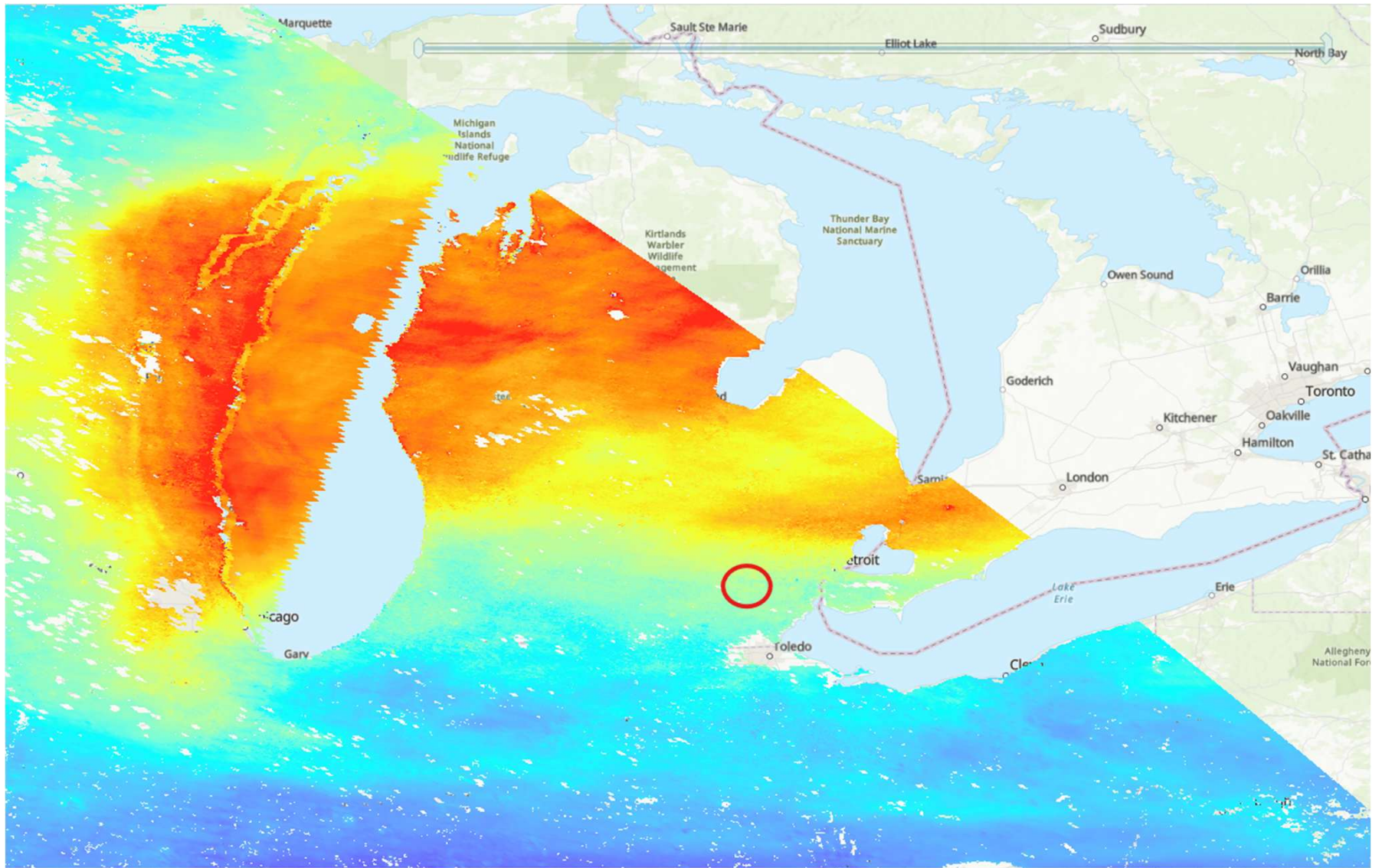
**Day:** The date picked is 03AUG25. The day shows significant smoke due to fires from Canada

**Regression:** For the Pm2.5 I had created graphs based off of sensor A and B.

Also utilized was Spatial Collection 3x3 grid method.

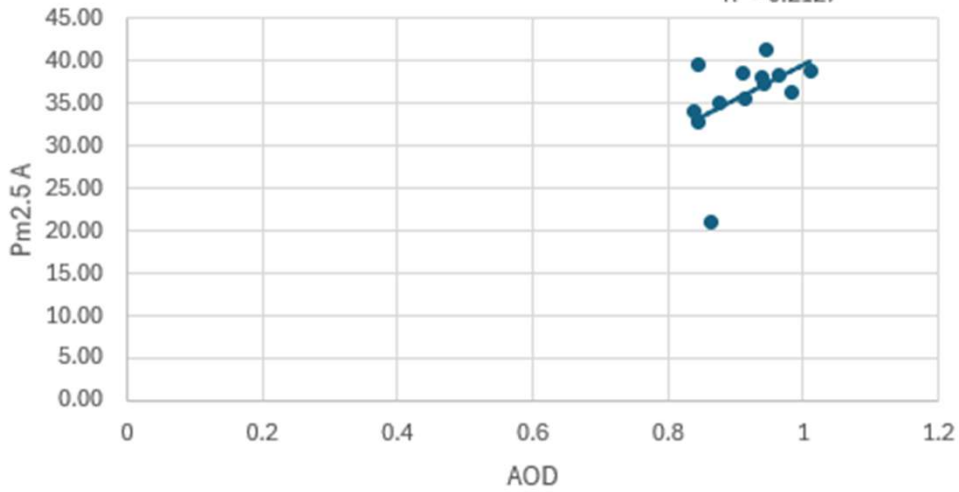




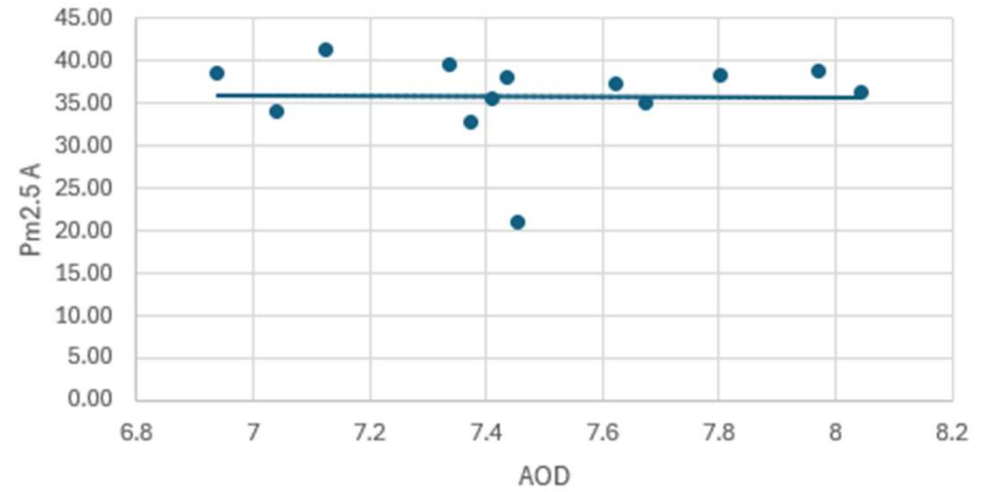


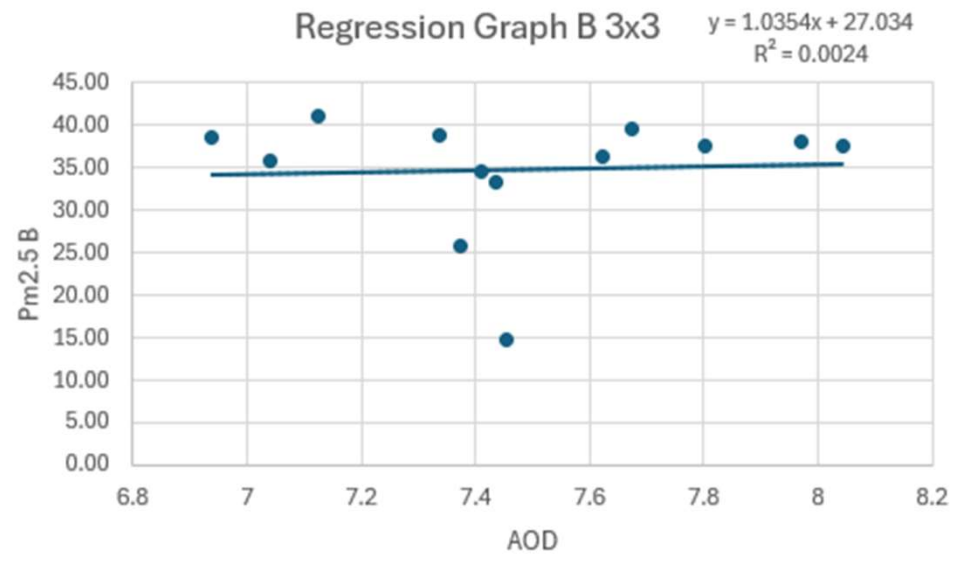
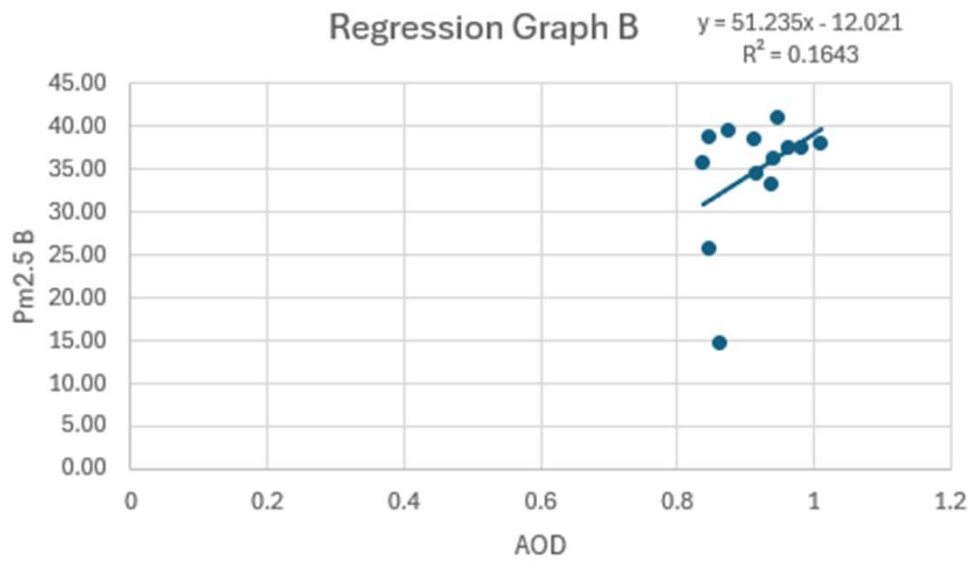
Places	AOD	PM 2.5A	PM 2.5B	8/3/2025	AOD Grid	Pm 2.5A	Pm 2.5B
Brookside	0.941	37.40	36.30		7.6224	37.40	36.30
Earhart Es	0.982	36.30	37.50		8.0434	36.30	37.50
Placid Wa	0.963	38.40	37.60		7.8031	38.40	37.60
Jack's Bar	0.846	32.80	25.80		7.3724	32.80	25.80
Larrytown	0.938	38.10	33.30		7.4368	38.10	33.30
Bruns Par	0.846	39.70	38.80		7.3373	39.70	38.80
bdsj	0.946	41.40	41.10		7.1228	41.40	41.10
Upper Wa	0.875	35.10	39.70		7.6735	35.10	39.70
Ann Arbor	0.838	34.20	35.80		7.0415	34.20	35.80
Lawton Ele	0.911	38.70	38.70		6.938	38.70	38.70
Liberty Gle	0.862	21.10	14.80		7.453	21.10	14.80
Little Lake	0.915	35.60	34.60		7.409	35.60	34.60
Cherry wo	1.011	38.80	38.10		7.9714	38.80	38.10

Regression Graph A  $y = 41.417x - 1.8604$   
 $R^2 = 0.2127$



Regression Graph A 3x3  $y = -0.0739x + 36.522$   
 $R^2 = 2E-05$





# Background – Justin

- AirGradient Sensors (PM<sub>2.5</sub>)
  - 8 locations were chosen
    - 4 in Michigan
    - 4 in Ohio
- AOD Data
  - Level-1 and Atmosphere Archive & Distribution System Distributed Active Archive Center (LAADS DAAC)
    - <https://ladsweb.modaps.eosdis.nasa.gov/>



**Image Credit:** <https://www.airgradient.com/>

# Background

- AirGradient data is not automatically public past 10 days
  - Was not able to use the same sensors to get more data
    - Data was not available through API
- Used two different size buffers on original points in ArcGIS instead
  - Averages values



**Image Credit:** <https://www.airgradient.com/>

# Cloud Cover

March 25<sup>th</sup>, 2026

- The initial date chosen was March 25<sup>th</sup>, 2026
  - Too much cloud cover
  - Values were off
- New date chosen was March 28<sup>th</sup>, 2026
  - Less cloud cover
- NASA Worldview

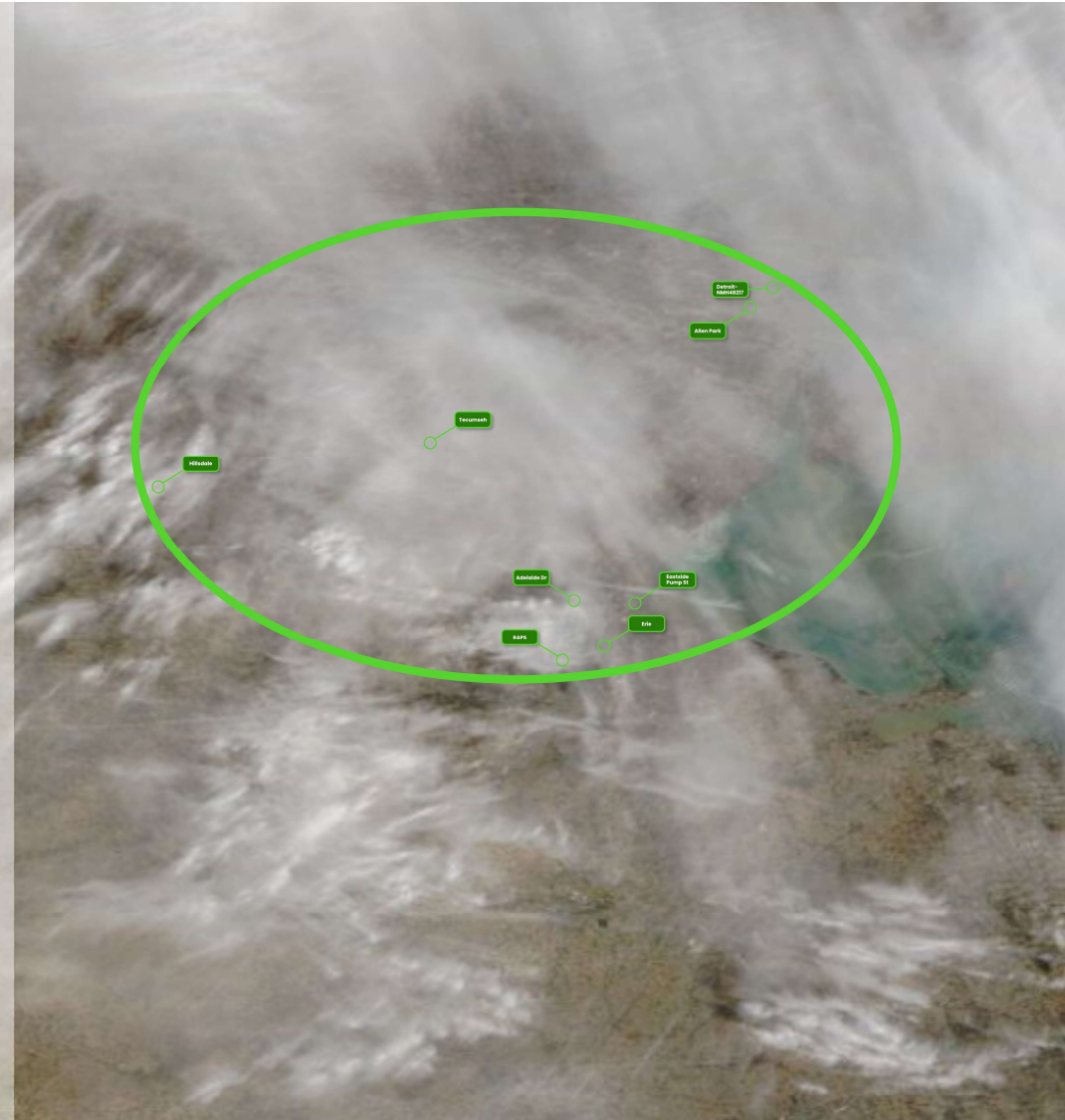


Image Credit: <https://worldview.earthdata.nasa.gov/>

# Cloud Cover

March 28<sup>th</sup>, 2026



Image Credit: <https://worldview.earthdata.nasa.gov/>

# Locations Points

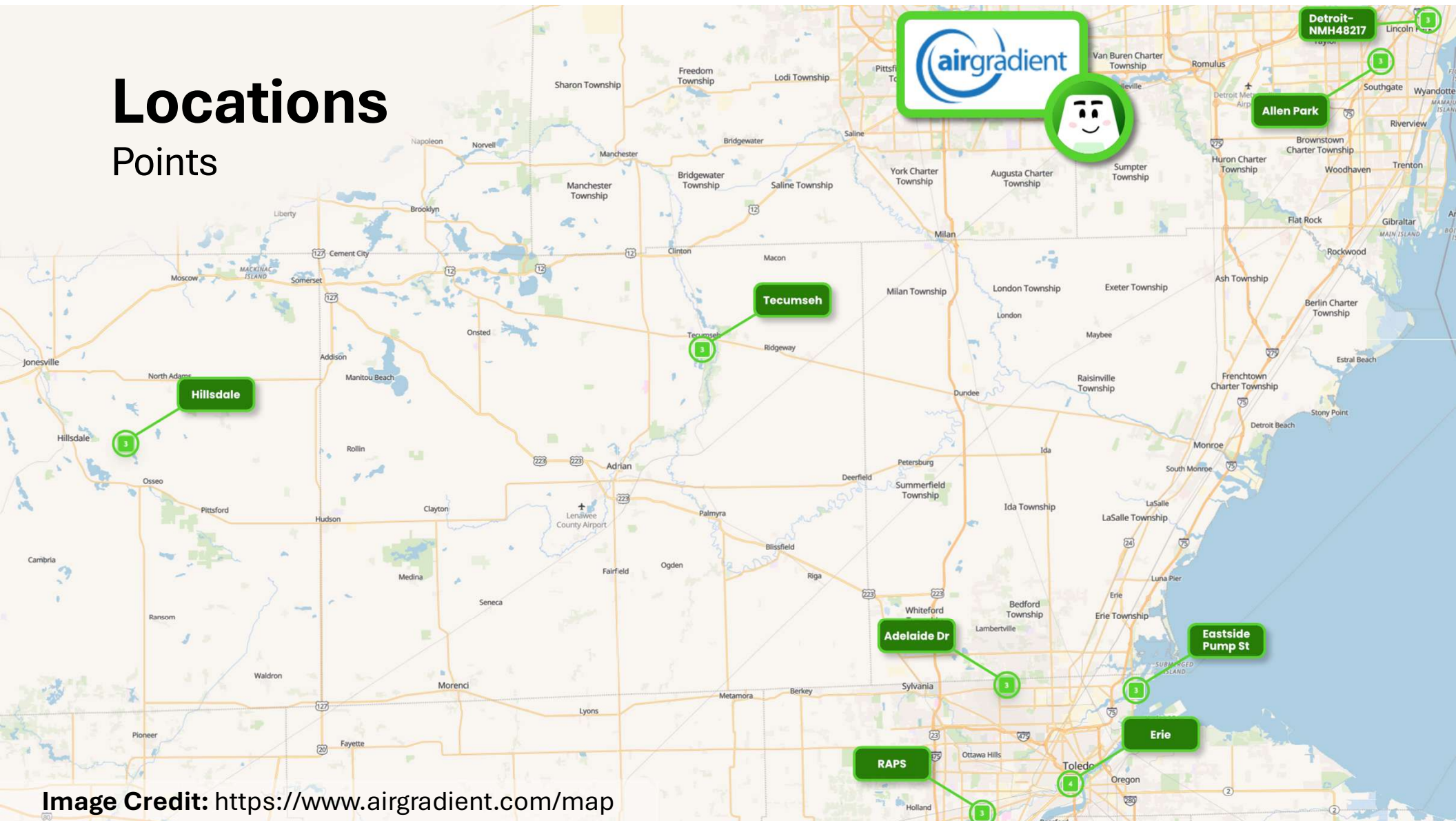


Image Credit: <https://www.airgradient.com/map>

# Results

## Points

- Regression Equation:
  - $y = 1.5296x + 3.679$
  - $R^2 = 0.0222$
- Statistically Significant
  - Weak Relationship
- Negligible Linear Relationship
  - Positive Slope

Service	Monitor Name	Location	AOD (47)	Ground	Time
AirGradient	Adelaide Dr	Toledo	-0.014	3.4	3pm
AirGradient	Eastside Pump St	Toledo	0.114	3.9	3pm
AirGradient	Erie	Toledo	0.136	4.6	3pm
AirGradient	RAPS	Toledo	0.027	4.6	3pm
AirGradient	Tecumseh	Tecumseh	0.08	3.4	3pm
AirGradient	Hillsdale Michigan	Hillsdale	0.062	3.5	3pm
AirGradient	Allen Park	Allen Park	0.114	3.3	3pm
AirGradient	Detroit-NMH48217	Detroit	0.114	4.6	3pm

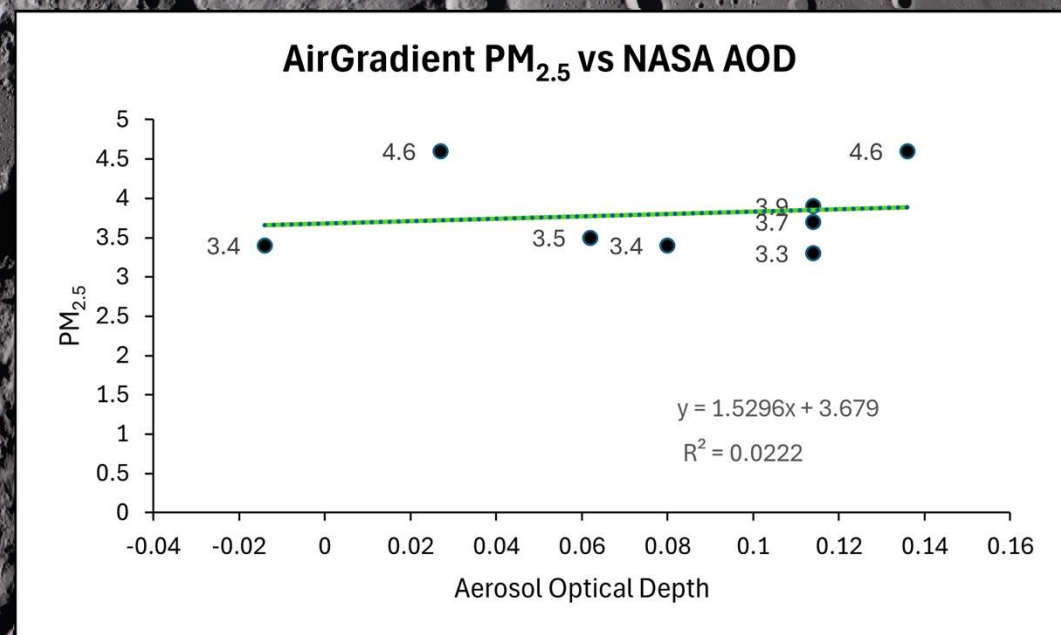
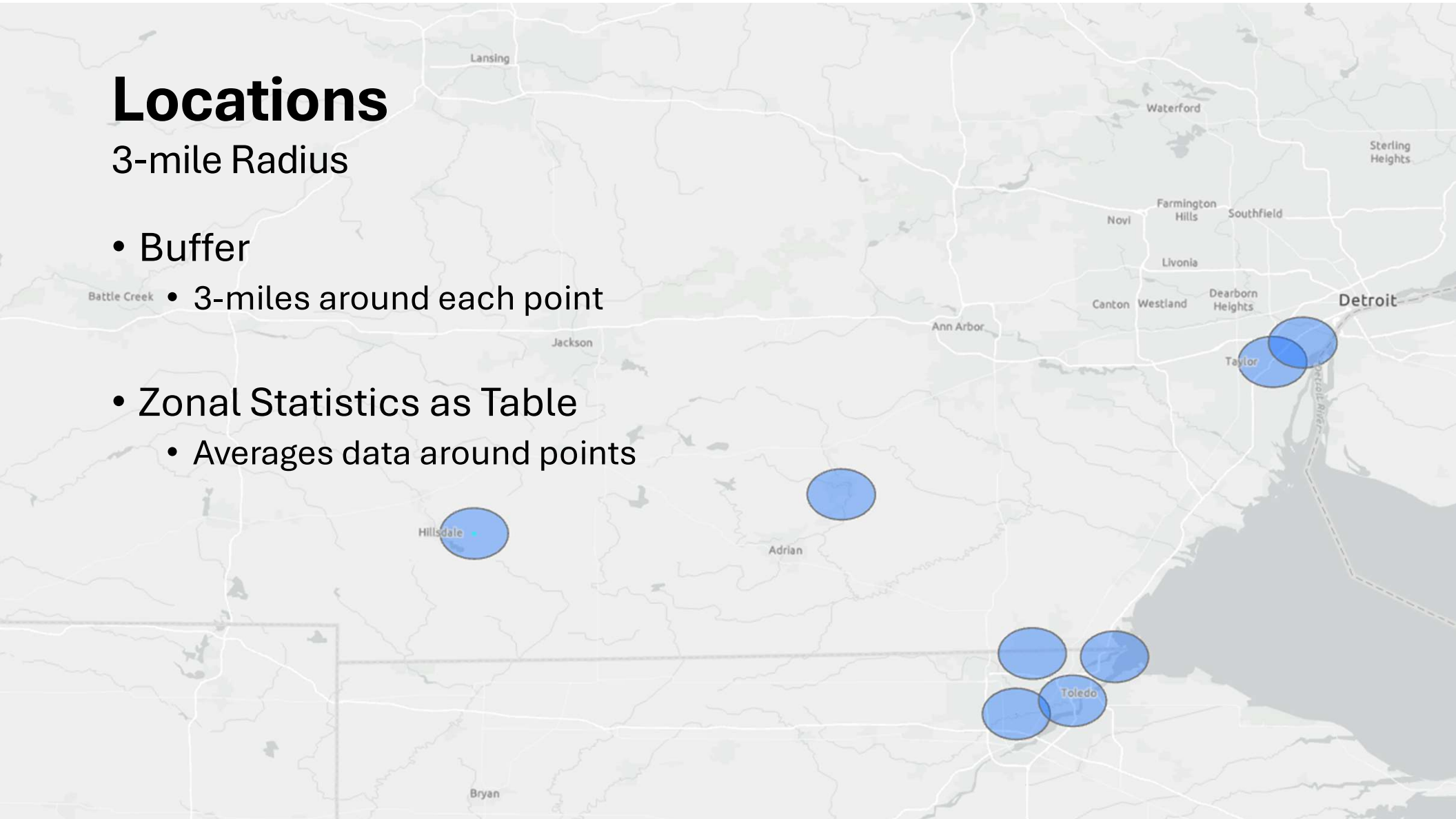


Image Credit: NASA

# Locations

## 3-mile Radius

- Buffer
  - 3-miles around each point
- Zonal Statistics as Table
  - Averages data around points



# Results

## 3-mile Radius Average

- Regression Equation:
  - $y = 0.7922x + 3.7418$
  - $R^2 = 0.0064$
- Statistically Significant
  - Weak Relationship
- Negligible Linear Relationship
  - Basically No Slope

Service	Monitor Name	Location	AOD (47)	Ground	Time
AirGradient	Adelaide Dr	Toledo	-0.00429	3.4	3pm
AirGradient	Eastside Pump St	Toledo	0.11675	3.9	3pm
AirGradient	Erie	Toledo	0.101714	4.6	3pm
AirGradient	RAPS	Toledo	0.027	4.6	3pm
AirGradient	Tecumseh	Tecumseh	0.028857	3.4	3pm
AirGradient	Hillsdale Michigan	Hillsdale	0.057875	3.5	3pm
AirGradient	Allen Park	Allen Park	0.114	3.3	3pm
AirGradient	Detroit-NMH48217	Detroit	0.146	3.7	3pm

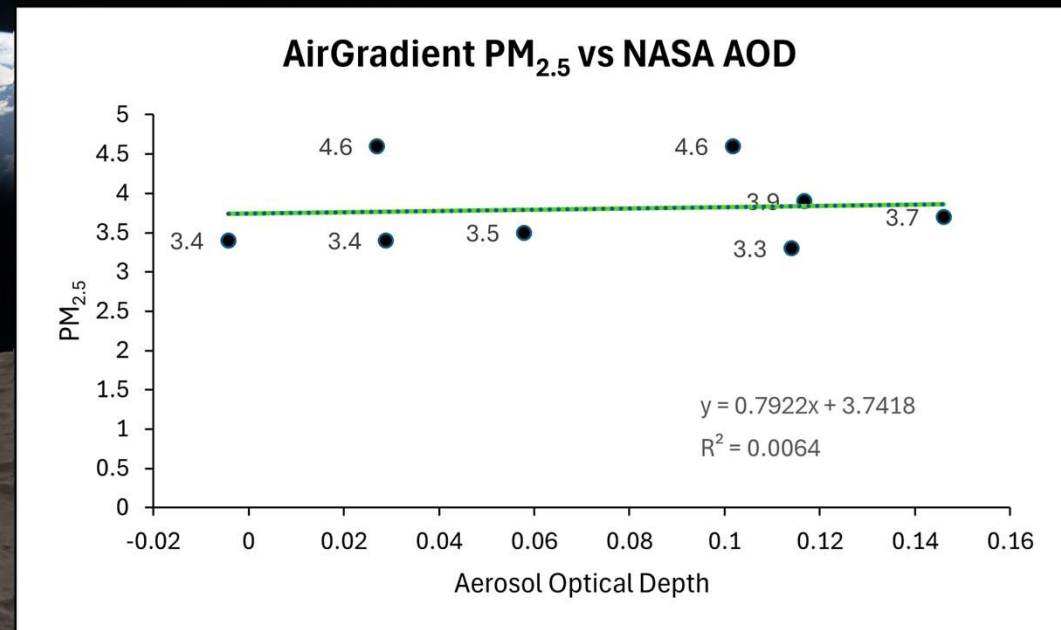
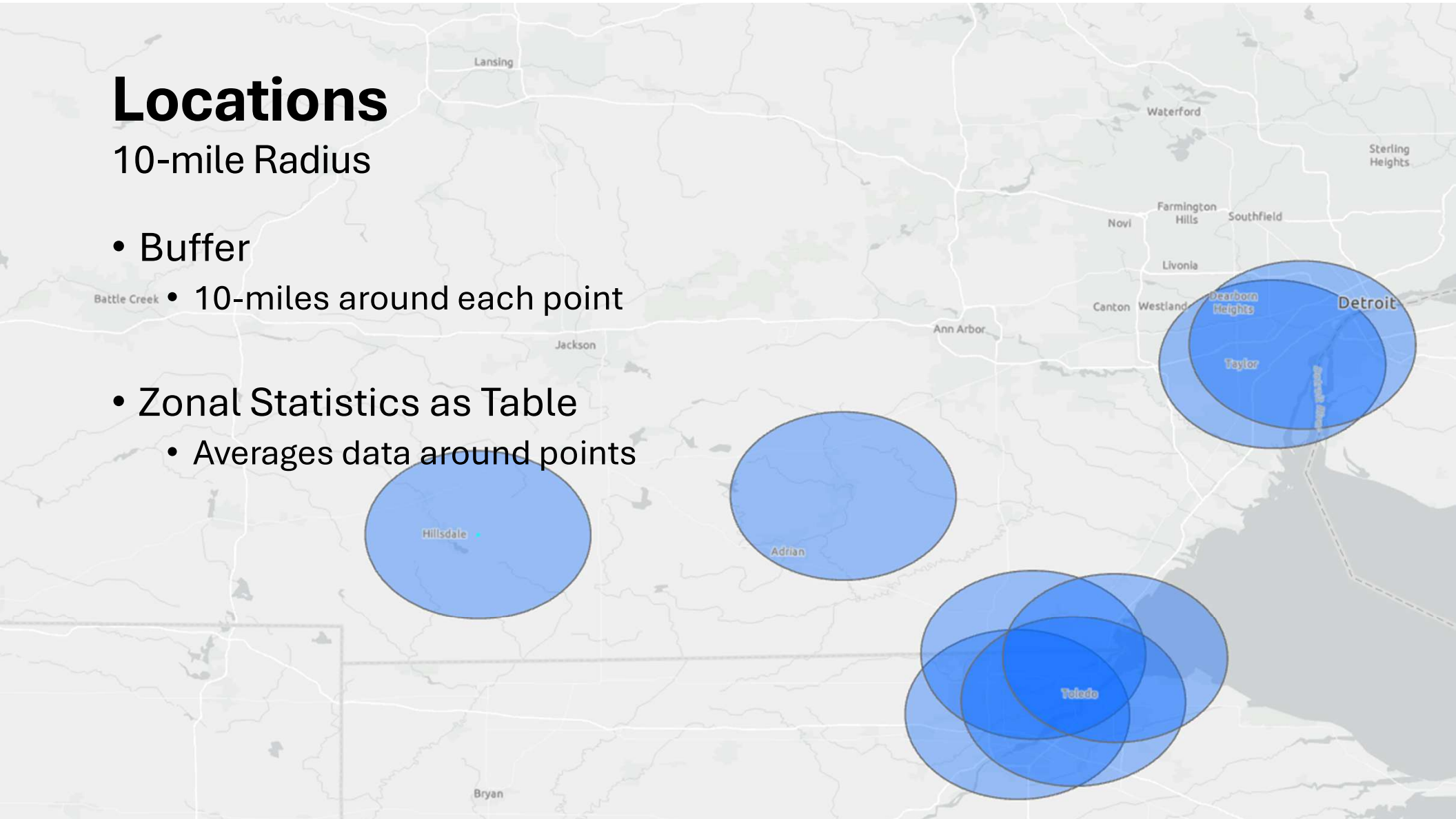


Image Credit: NASA

# Locations

10-mile Radius

- Buffer
- 10-miles around each point
- Zonal Statistics as Table
  - Averages data around points



# Results

## 10-mile Radius Average

- Regression Equation:
  - $y = -3.4043x + 4.0917$
  - $R^2 = 0.0332$
- Statistically Significant
  - Weak Relationship
- Negligible Linear Relationship
  - Negative Slope

Service	Monitor Name	Location	AOD (47)	Ground	Time
AirGradient	Adelaide Dr	Toledo	0.057438	3.4	3pm
AirGradient	Eastside Pump St	Toledo	0.105425	3.9	3pm
AirGradient	Erie	Toledo	0.089988	4.6	3pm
AirGradient	RAPS	Toledo	0.048645	4.6	3pm
AirGradient	Tecumseh	Tecumseh	0.078013	3.4	3pm
AirGradient	Hillsdale Michigan	Hillsdale	0.067087	3.5	3pm
AirGradient	Allen Park	Allen Park	0.105956	3.3	3pm
AirGradient	Detroit-NMH48217	Detroit	0.132824	3.7	3pm

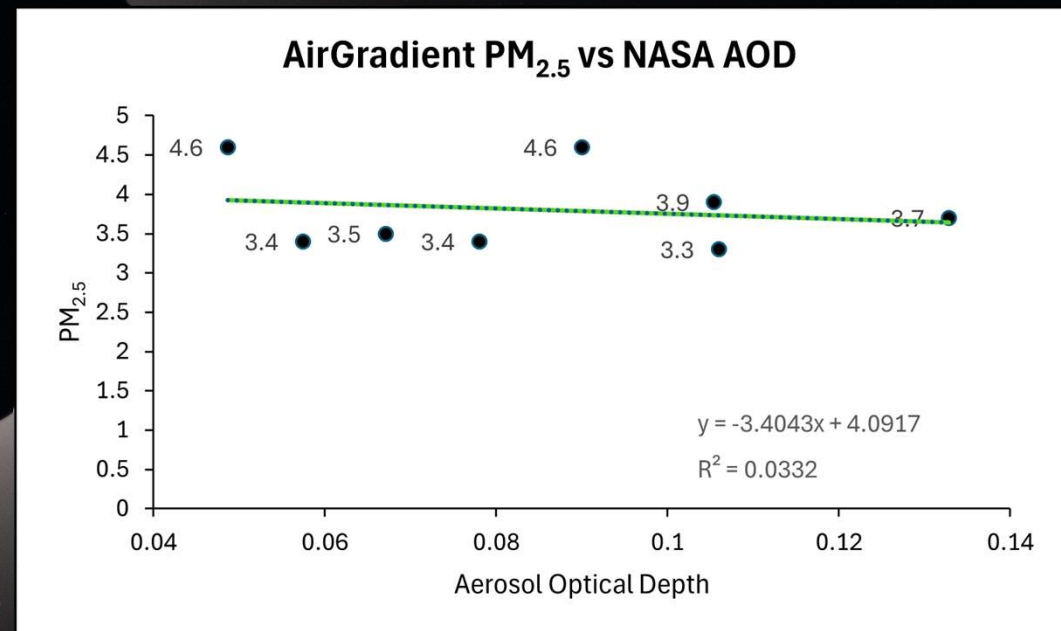


Image Credit: NASA

# Conclusion

- Although the day chosen was clear, that can actually lead to lower  $R^2$  values
  - Low atmospheric turbidity
  - More air samples would be needed to establish a strong trend
- Temperature and humidity data are needed to get a more complete picture of AOD
  - Not enough “noise”



# Introduction

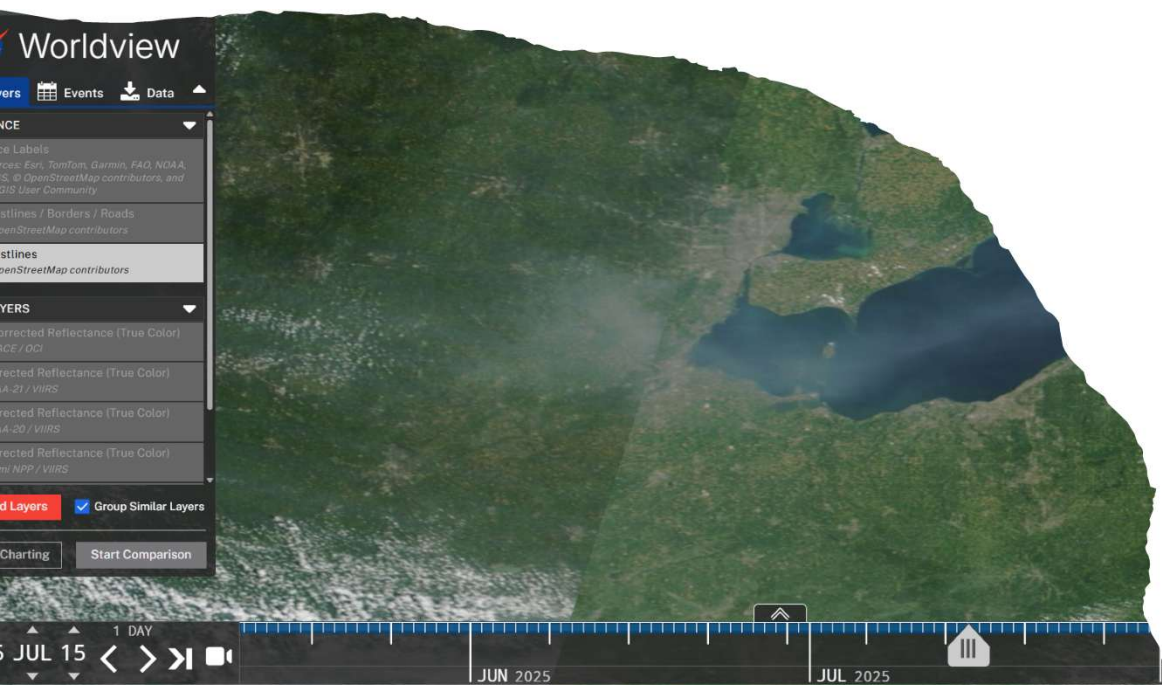
- PM2.5 is a critical air pollutant with diameter of 2.5 micrometers or smaller
- Satellite-derived Aerosol Optical Depth (AOD) provides information on the total aerosol loading in the atmospheric column and can be used as an indirect indicator of particulate pollution.
- In this study, AOD from the NASA MODIS MAIAC MCD19A2 product was compared with ground-based PM2.5 data from PurpleAir sensors in Toledo, Ohio.
- The objective of the analysis is to evaluate the relationship between satellite-observed aerosol loading and surface-level PM2.5 concentrations using a linear regression-based comparative approach.

# Steps followed

- Identification of area (Toledo, Ohio)
- Identification of date (July 15 2025, Cloudy or smoky day)
- MCD19A2 data between 10-11AM and 1-2PM

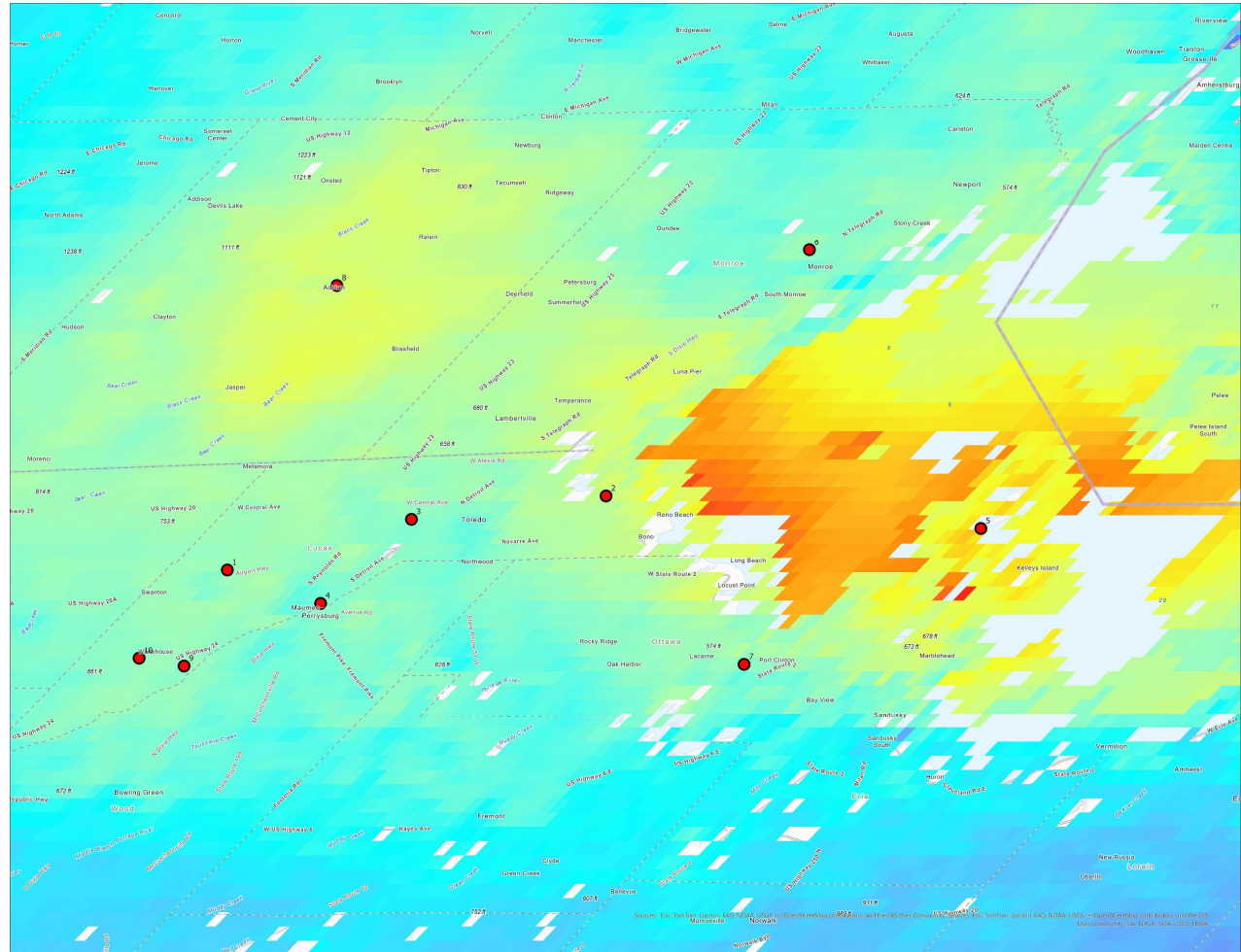
<https://ladsweb.modaps.eosdis.nasa.gov>

- Each raster cell represents roughly a **1 km**
- Data collection from local sensors, Purple air sensors
- Arc Pro for data input and interpretation
- Extract multi values to point
- Bilinear interpolation



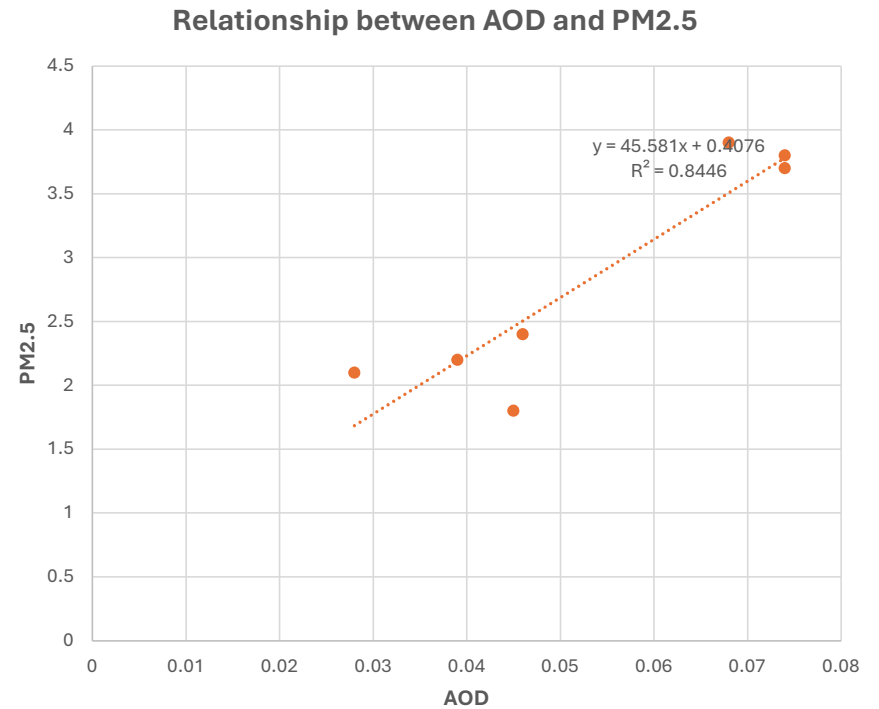
# July 15, 2025

SN	Lat	Lon	Local sensors (PM2.5)	AOD
1	41.60878	-83.7976	0.41	0.361977
2	41.68493	-83.3749	0.48	0.433279
3	41.66087	-83.6119	0.42	0.340793
4	41.57451	-83.6249	0.42	0.339625
5	41.65146	-82.8156	0.53	0.339625
6	41.93868	-83.4246	0.45	0.359748
7	41.51195	-82.9621	0.45	0.347891
8	41.90197	-84.0297	0.61	0.452956
9	41.51028	-83.7294	0.42	0.359737
10	41.51818	-83.8015	0.43	0.351104



# March 28 2026 (Previous Study-Clear day)

Longitude	Latitude	Sensor	PM 2.5 (1:30)	AOD
-83.64226	41.62057	Air Gradient	3.8	0.074
-83.61575	41.72365	Air Gradient	1.8	0.045
-83.54625	41.64407	Air Gradient	3.9	0.068
-83.475	41.7194	Air Gradient	3.7	0.074
-83.53827	41.64872	Purple Air	2.4	0.046
-83.59097	41.68333	Purple Air	2.2	0.039
-83.61166	41.66076	Purple air	2.1	0.028



# Results

- AOD increases, PM2.5 also increases.
- The slope (0.434) indicates that a 1-unit increase in AOD corresponds to an increase of about  $0.434 \mu\text{g}/\text{m}^3$  in PM2.5.
- The intercept (0.1681) means that when AOD is zero, the model predicts PM2.5 to be about  $0.1681 \mu\text{g}/\text{m}^3$ .
- The  $R^2$  value is 0.4638, which means that about 46.38% of the variation in PM2.5 is explained by AOD in this dataset.
- This indicates a moderately strong relationship between satellite-derived aerosol loading and ground-measured PM2.5.
- From comparison of previous and present study, AOD was more predictive of PM2.5 on the clear day than on the smoky day.
- If some smoke is aloft and not fully mixed down, AOD can be high without PM2.5 increasing proportionally at the surface

