Effects of Several Atmospheric Parameters on Air Quality in a Metro Detroit Suburb

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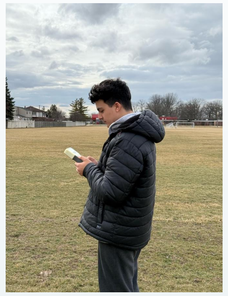
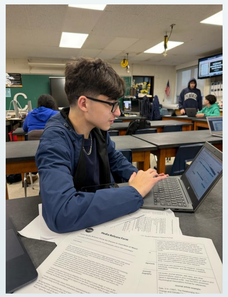
Abstract

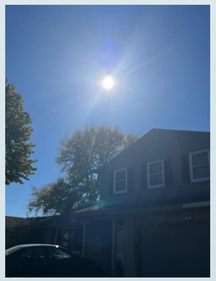
An aerosol is a tiny solid particle or liquid droplet in the atmosphere. Primary aerosols are injected into the atmosphere directly in many ways: sea spray, mineral dust, smoke, and volcanic ash. Secondary aerosols are emitted in another form such as gases and undergo chemical reactions in the atmosphere. Although aerosols are barely visible to the human eye, they still have impact, factoring into Earth's climate, air quality, and cloud creation. To understand how Aerosol Optimal Thickness (AOT), along with temperature, humidity, and pressure affects air quality, data was collected from Mid-August to Late February. To collect aerosol measurements, skies had to be clear of any clouds, trees, powerlines, or other obstacles preventing a direct viewing of the sun. As close to solar noon as possible, a Calitoo Sun Photometer was pointed directly towards the sun at chest height and operated, providing AOT data to be extracted later on. Subsequently, a cloud observation was taken, and current weather data was recorded. In using the photometer, several recordings, or trials, were taken to assure accuracy. The null hypotheses were to see the correlation between barometric pressure, relative humidity, AOT, and temperature all had with air quality. Results found that AOT had the greatest correlation followed by pressure, humidity, and lastly air temperature showed little to no effect on harming the air quality. However, more data could be found to further validate the findings of this research.



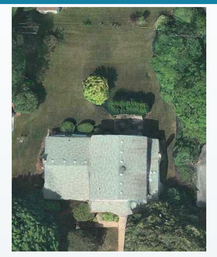


Discussion

Within the work towards finding relationships between air temperature, barometric pressure, and relative humidity with air quality, it was found that all three of those metrics had been found with no major correlation with air quality, therefore rendering their null hypotheses true. This left the null hypothesis surrounding the relationship between Aerosol Optical Thickness and Air quality rejected, as they showed a positive correlation with one another. These conclusions, however, should not be taken too seriously, as the research was not large enough in scope to cover enough of its failures. For instance, though the number of metrics recorded was plentiful enough to come up with these conclusions, they were not plentiful enough to be able to prove anything. Had more research been done, more measurements taken, and more time been put into minor details, this project could have taken a different form. This project's components could have been used for weather analysis or seasonal trends. In its current state, it can be used to an extent in furthering the public's understanding of what air quality is truly about.



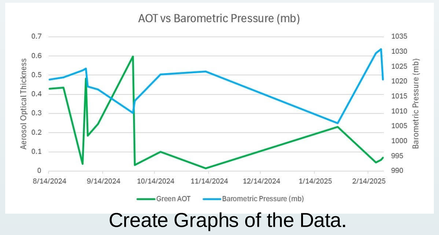
Methodology



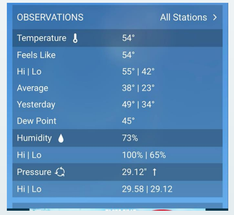
Satellite image of Research Sites: Crestwood High School and researcher backyard

Take Data when skies are clear or mostly clear and do cloud observations on GLOBE app

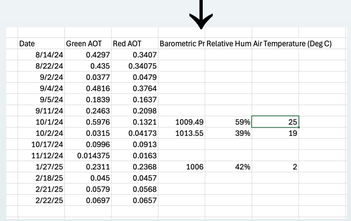
Measure the Aerosol Optical Thickness levels using the Calitoo Sun Photometer



Create Graphs of the Data.



Take atmospheric conditions on WeatherBug



Date	Green AOT	Red AOT	Barometric Pr	Relative Hum	Air Temperature (Deg C)
8/14/24	0.4297	0.3407			
8/22/24	0.435	0.34075			
9/2/24	0.0377	0.0479			
9/4/24	0.4816	0.3764			
9/5/24	0.1839	0.1637			
9/11/24	0.2463	0.2098			
10/1/24	0.5976	0.1321	1009.49	59%	25
10/2/24	0.0315	0.04173	1013.55	39%	19
10/17/24	0.0996	0.0913			
11/12/24	0.014375	0.0163			
1/27/25	0.2311	0.2368	1006	42%	2
2/18/25	0.045	0.0457			
2/21/25	0.0579	0.0568			
2/22/25	0.0697	0.0657			

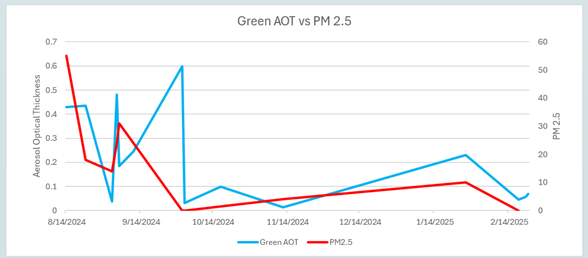
Organize Data on Excel

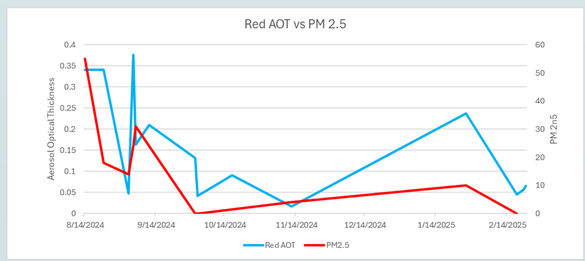
Results

Date	PM2.5	Air Temperature (Deg C)
8/14/2024	55	24
8/22/2024	18	24
9/2/2024	14	20
9/4/2024	24	25
9/5/2024	31	28
9/11/2024		27
10/1/2024	0	25
10/2/2024	0	19
10/17/2024		16
11/12/2024	4	9
1/27/2025	10	2
2/18/2025	0	-12
2/21/2025		0
2/22/2025		-3

Date	PM2.5	Barometric Pressure (mb)
8/14/2024	55	1020.66
8/22/2024	18	1021.34
9/2/2024	14	1023.71
9/4/2024	24	1024.39
9/5/2024	31	1018.29
9/11/2024		1017.27
10/1/2024	0	1009.49
10/2/2024	0	1013.55
10/17/2024		1022.35
11/12/2024	4	1023.37
1/27/2025	10	1006
2/18/2025	0	1029.47
2/21/2025		1030.82
2/22/2025		1020.66

Date	PM2.5	Relative Humidity
8/14/2024	55	68%
8/22/2024	18	39%
9/2/2024	14	40%
9/4/2024	24	39%
9/5/2024	31	42%
9/11/2024		44%
10/1/2024	0	59%
10/2/2024	0	39%
10/17/2024		44%
11/12/2024	4	42%
1/27/2025	10	42%
2/18/2025	0	68%
2/21/2025		51%
2/22/2025		60%





Conclusion

The researchers concluded that select atmospheric conditions affect air quality. A relatively strong, positive correlation was shown between air quality and both red and green AOT measurements. As shown in figures 12 and 13, as the AOT increased, so would PM 2.5 meaning air quality would worsen. This was to be expected as many studies suggested AOT has negative impacts on the air quality. In contrast, air temperature would show little to no correlation with air quality. While it is true data showed little to no correlation between temperature and air quality, it is shown in studies from the World Resources Institute that high temperatures can influence environmental conditions. Some examples are droughts or even wildfires, which in return increase PM levels worsening air quality. Furthermore, the research indicated that barometric pressure had a positive correlation with PM levels. This suggests that high pressures show a decrease in the quality of the air. The Center for Science education supports the data explaining that high pressure leads to dry conditions which increase PM levels like shown in figures 6 and 10. Lastly, small positive correlations were found between relative humidity and air quality. Shown in figures 7 and 11 as the humidity increased so did PM levels. These findings also go along with what Airly Industry suggests. As relative humidity increases, there is less air circulation and particles get trapped in the air decreasing air quality.

Acknowledgements

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