HOW DOES PRECIPITATION IMPACT AIR QUALITY?

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Abstract

This project focuses on the question: “how does precipitation impact air quality?” The hypothesis we made stated that if there is precipitation then the air quality will worsen because aerosols are coming down from the clouds. Aerosols are tiny pieces of solid and liquid floating around the atmosphere. Data was collected outside by observing the cloud coverage every day and taking photos of the sky as well as using the NASA satellite Globe observer app. We also used the wunderground weather app to note the precipitation accumulation for each day, and we used the purple air application to measure the air quality outside for each day. Our results do not support our hypothesis. The hypothesis we had made claimed that if there is precipitation the air quality will worsen because aerosols are coming down from the clouds. Our investigation/experiment deemed our statement wrong. Clouds are created when water vapor, and invisible gas, turns into liquid water droplets. These water droplets form tiny particles, the aerosols, that are floating in the air. This applies to the real world because it affects people and it can contribute to Global Warming and air quality. Healthy air is necessary for life to live on. It also shows us how humans themselves are affecting our air with gas pollutants.

Key Words: Aerosols, Precipitation, Air quality, Hypothesis, gas

Introduction

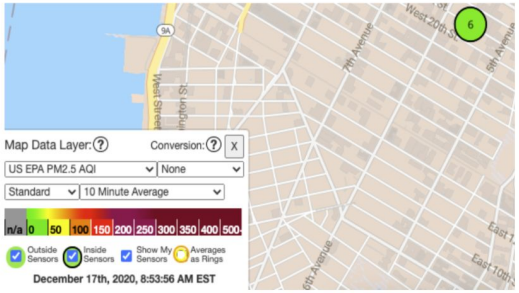
Aerosols are tiny pieces of solid and liquid floating around the atmosphere. Some examples of aerosols are dust, dirt, soot, smoke, and mist. Those are some examples of aerosols we can see with the naked eye. Lots of aerosols are made up of just a few molecules and are too light to see without a microscope. They can come naturally or from human behavior. Construction sites, unpaved roads, fields, smokestacks, and fires are some places where aerosols can come from. When it rains it causes a phenomenon called wet deposition. Wet deposition is when aerosols and population make the air acidic and when it rains it takes all the aerosols and population to the ground where the soil can get rid of them. The purpose of our investigation is to discover how precipitation impacts air quality. In doing so we will have to collect daily air quality data, as well as collect the amount of precipitation accumulated every day. In our study we've decided to focus on air quality and precipitation is because other than the fact that precipitation is connected to the research question, air quality plays a huge role when it comes to aerosols. So when we connect both air quality and precipitation, we can discover if the amount of precipitation accumulated impacts the aerosols in the air on that day. Clouds are created when water vapor, an invisible gas, turns into liquid water droplets. These water droplets form on tiny particles, the aerosols, that are floating in the air. Therefore, we will be investigating how precipitation impacts air quality.

Research Methods

The study sites we used to collect information for this project were Purple Air, Wunderground, and GLOBE. PurpleAir employs laser particle counters PMS5003 and PMS1003. 0.3, 0.5, 1.0, 2.5, 5.0, and 10um suspended particles are counted by these sensors. The sensor processes these particle counts using a dynamic algorithm to measure the mass concentrations of PM1.0, PM2.5, and PM10 in ug/m3. The PMS5003 and PMS1003 sensors are calibrated at the factory. In this project, you will see raw data from purple air located at the “CUNY1 site,” located at 130th street and St. Nicholas Terrace in Manhattan, New York. Wunderground is a weather site. It gives out full forecasts and predictions for the weather every day. This includes precipitation data, air quality data, temperature, etc. for the GLOBE application, NASA scientists use cloud measurements from both below (the ground) and above (the sky) to better explain clouds. Clouds are crucial in transmitting energy from the Sun to various areas of the Earth system. Since clouds shift rapidly, citizen scientists may contribute to the science picture by making repeated observations.

Results

Air Quality Story

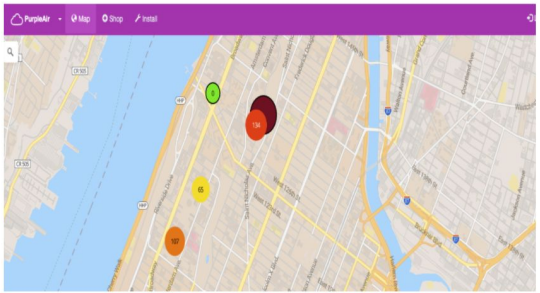


Manhattan, New York - 12/16/20

- Snowy conditions
- Type → Heavy snowfall
- Accumulation → 0.22in

Manhattan, New York - 12/17/20

- Snowy conditions
- Type → Heavy snowfall
- Accumulation → 0.4in



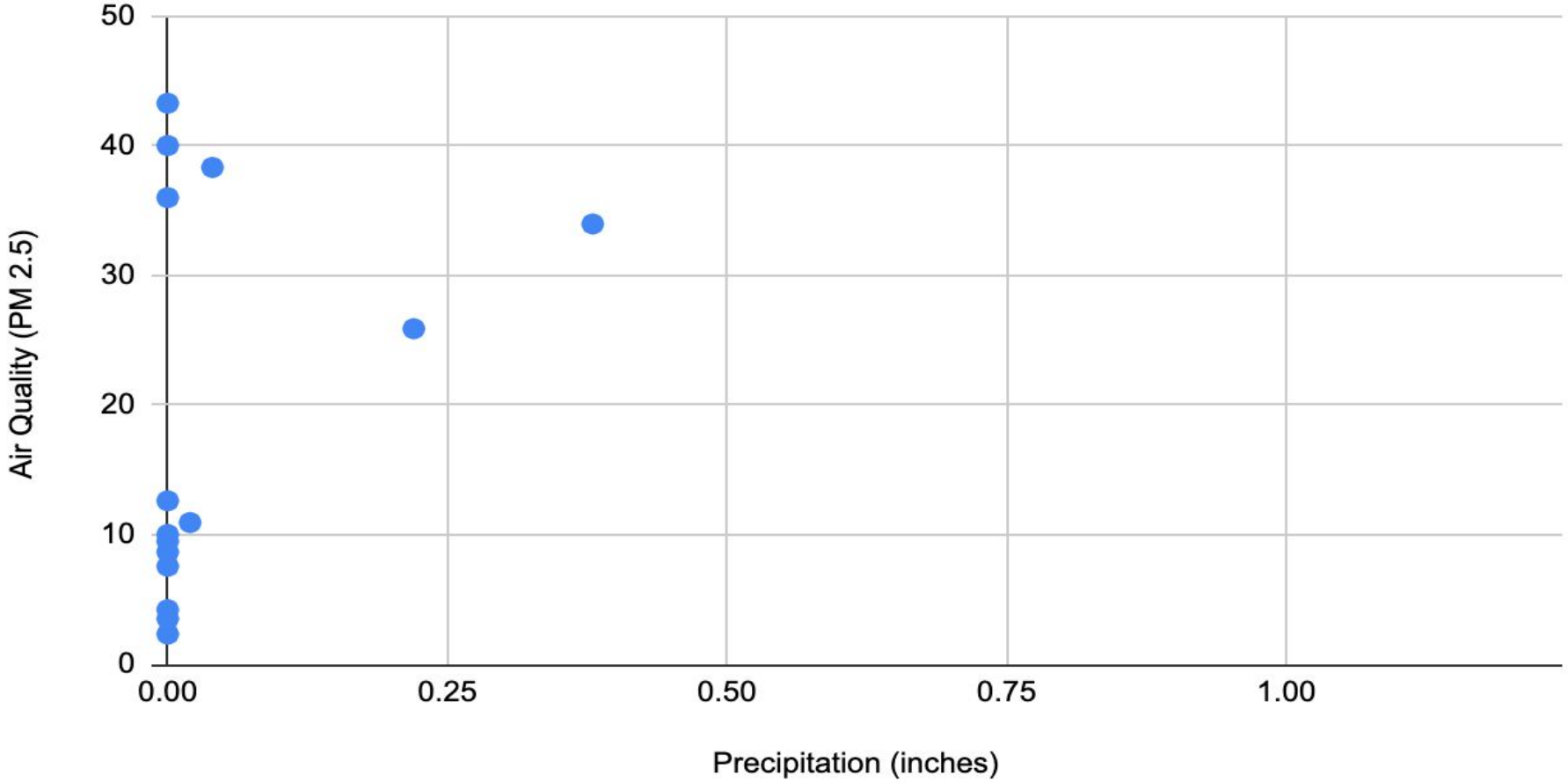
Manhattan, New York - 12/9/20

- Dry conditions
- Type → NO PRECIPITATION
- Accumulation → 0 in

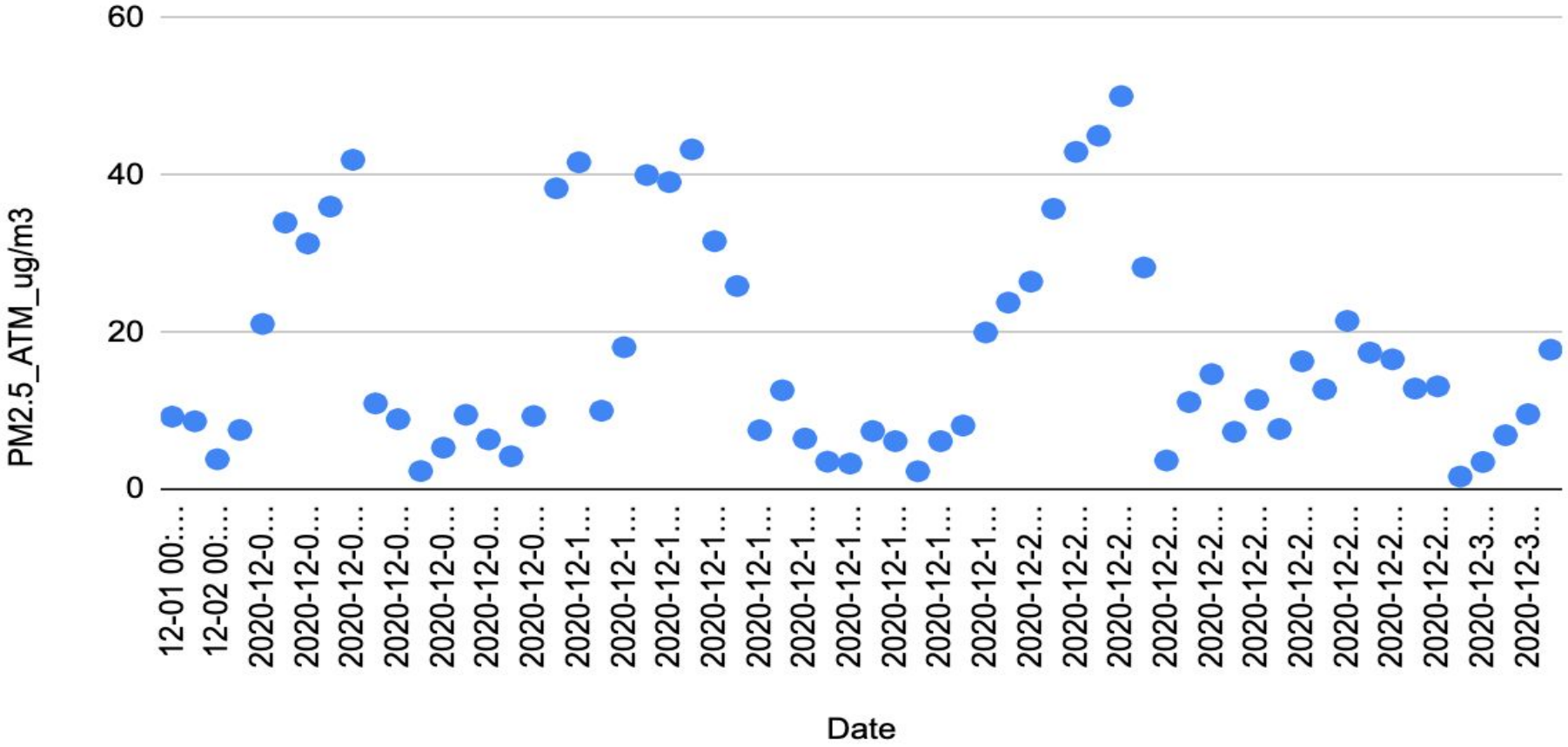
Manhattan, New York - 12/20/20

- Dry conditions
- Type → NO PRECIPITATION
- Accumulation → 0 in

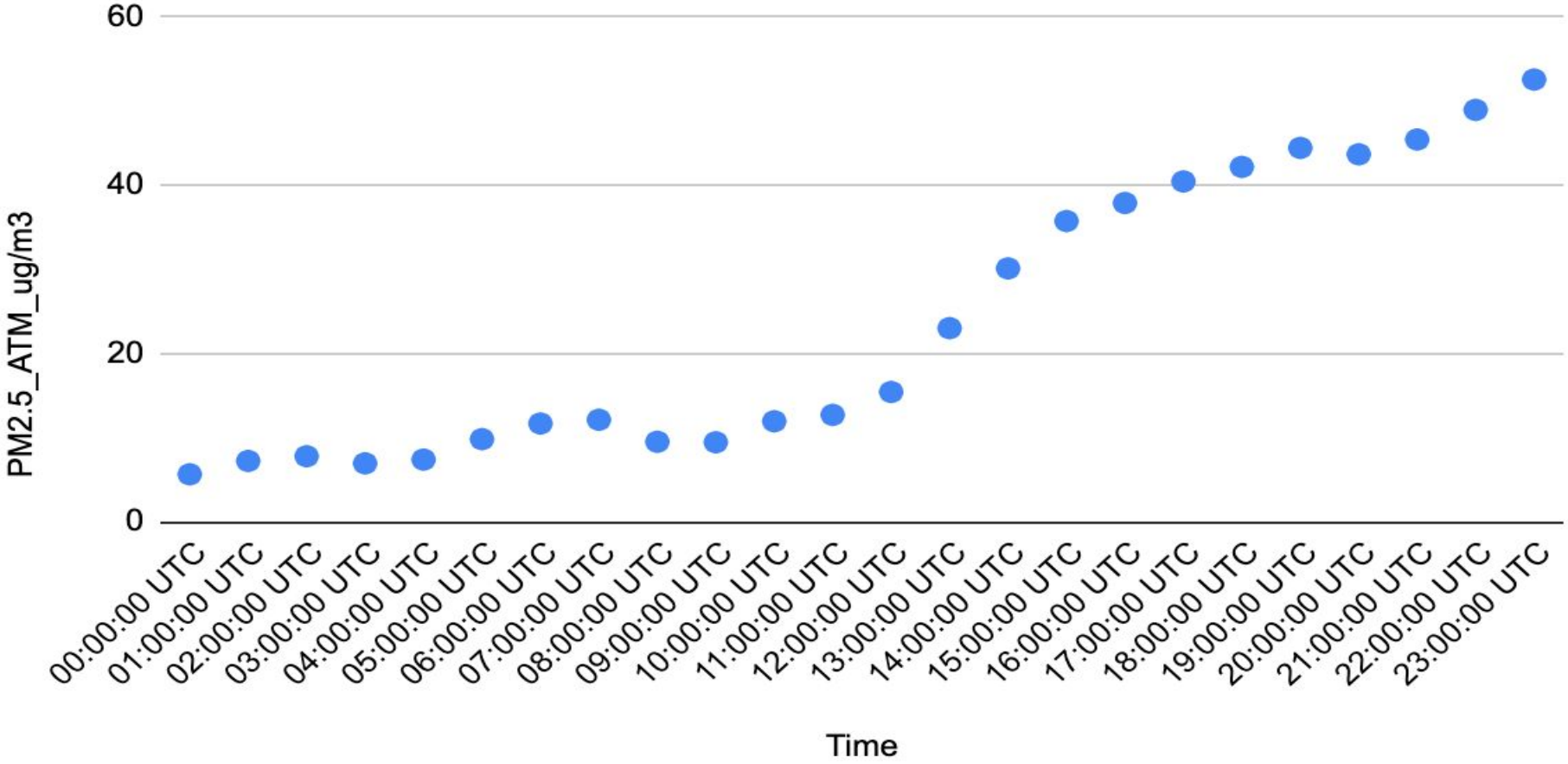
Air Quality (PM 2.5) vs. Precipitation (inches)



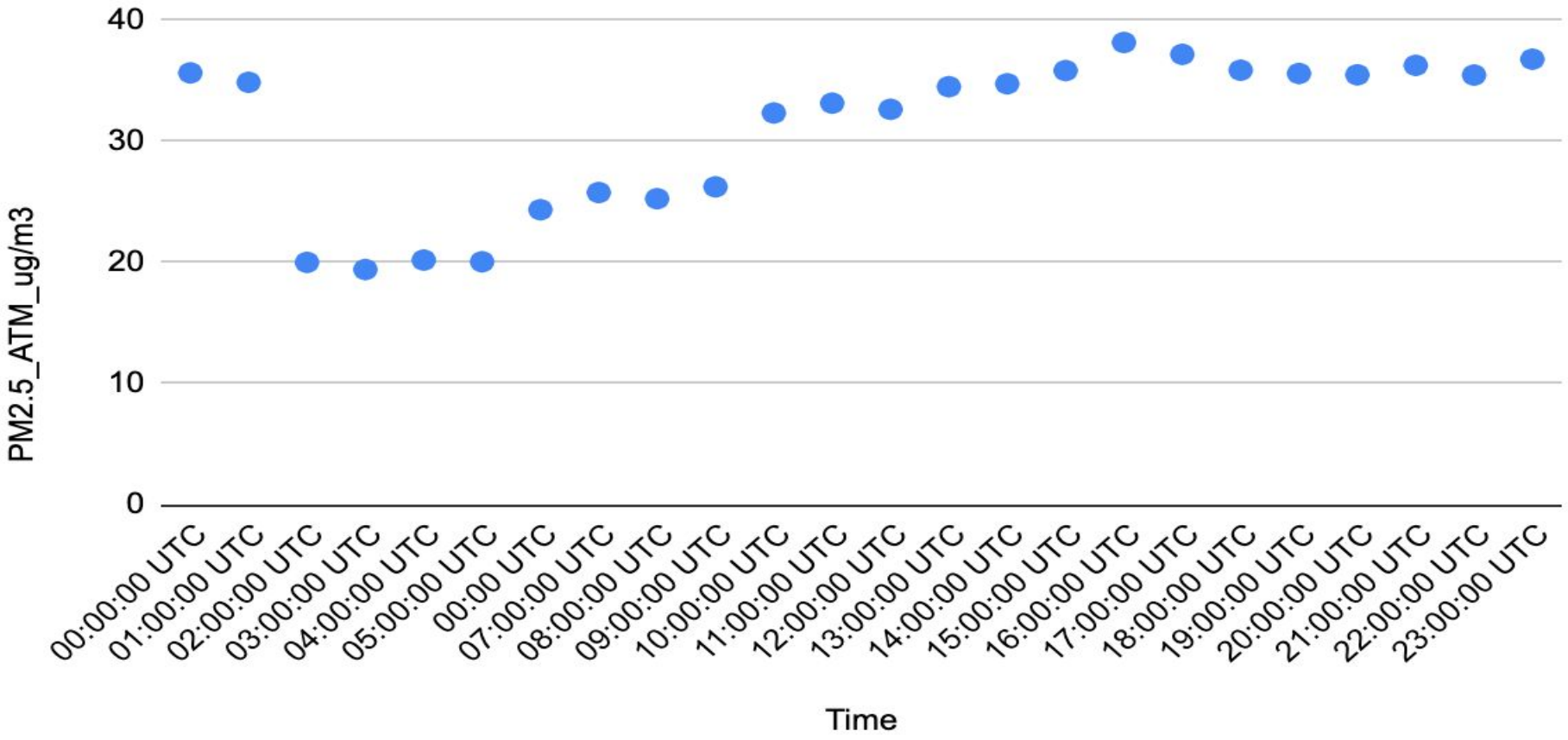
Month of December hourly PM2.5 Data



2020-9-12 Hourly PM2.5 Data



GLOBE Photos from 12/9/20. Cloud coverage: overcast.


2020-20-12 Hourly PM2.5 Data
40
30
20
10
0
PM2.5_ATM_ug/m3
00:00:00 UTC
01:00:00 UTC
02:00:00 UTC
03:00:00 UTC
04:00:00 UTC
05:00:00 UTC
00:00 UTC
07:00:00 UTC
08:00:00 UTC
09:00:00 UTC
10:00:00 UTC
11:00:00 UTC
12:00:00 UTC
13:00:00 UTC
14:00:00 UTC
15:00:00 UTC
16:00:00 UTC
17:00:00 UTC
18:00:00 UTC
19:00:00 UTC
20:00:00 UTC
21:00:00 UTC
22:00:00 UTC
23:00:00 UTC
Time

GLOBE Photos from 12/20/20. Cloud coverage: none

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

These graphs show what the air quality was like on each date as well as the air quality compared to the precipitation accumulated on each day for the month of December 2020. From December 1st to December 31st, our air quality ranged from 1.64 PM 2.5 to 45.03 PM 2.5. This graph shows that overall the air quality within that time period stayed in the good-moderate levels according to the EPA's air quality index. There are also graphs that show hourly data for 12/9 and 12/20, dates that correspond to GLOBE cloud coverage photos.

Discussion

According to our data, there is no clear correlation between air quality PM 2.5 and accumulated precipitation. On the worst and best day for air quality there was no precipitation. On December 22nd the air quality reached a level of 50.06, the highest for the whole month, and the accumulated precipitation was 0.00. On December 29th, the air quality reached a level of just 1.64, representing the day with the lowest air quality for the whole month, and the accumulated precipitation was also 0.00. This clearly shows that there is no correlation between air quality and precipitation for the month of December 2020. The cloud coverage also varied throughout the month, but even when it was overcast, like on December 9th, there was no precipitation (0.00). These results do not support our hypothesis. The hypothesis we had made claimed that if there is precipitation the air quality will worsen because aerosols are coming down from the clouds. Our hypothesis was rejected. We had made the mistake of thinking that the water droplets would worsen the air quality, however, based on our data we cannot conclude that there is a correlation between air quality and precipitation.

Conclusion

The purpose of our investigation is to discover how precipitation impacts air quality. In doing so we will have to collect daily air quality data, as well as collect the amount of precipitation accumulated every day. In our study we've decided to focus on air quality and precipitation because other than the fact that precipitation is connected to the research question, air quality plays a huge role when it comes to aerosols. So when we connect both air quality and precipitation, we can discover if the amount of precipitation accumulated impacts the aerosols in the air on that day. Clouds are created when water vapor, an invisible gas, turns into liquid water droplets. These water droplets form on tiny particles, the aerosols, that are floating in the air. When it rains, the aerosols come down with the water droplets, cleaning the air. From the data we collected, we cannot conclude any correlation between air quality and precipitation. On both the days that had the worst air quality in December (12/22) and the best air quality (12/29) the level of precipitation was 0.00. More research must be done in order to make a conclusion about the relationship between precipitation and air quality.

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Bibliography:

Aerosols: Tiny Particulates in the Air (2007). In *UCAR center for science education*. Retrieved from https://scied.ucar.edu/learning-zone/air-quality/aerosols#:~:text=Aerosols%20are%20a%20part%20of,dioxide%20released%20from%20power%20plants

Particulate Matter (PM) Pollution (n.d.). In *EPA*. Retrieved from https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM

PurpleAir. (2021). In *Real Time Air Quality Monitoring* . Retrieved from https://www2.purpleair.com/

Wunderground . (n.d.). New York City, NY Weather Conditions. In *Local Weather Forecast, News and Conditions* . Retrieved from https://www.wunderground.com/weather/us/ny/manhattan/40.75,-74.00