Aerosols Affect on Global Warming

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Abstract

Our project is focused on a modern issue, global warming, and we wanted to look into how aerosols can effect global warming. Our initial hypothesis was that if more aerosols are present in the atmosphere, then the atmosphere will cool down because aerosols reflect sunlight back which will cool down the atmosphere. Initially we were collecting our data ourselves by hand but the data was disappointing so we decided to research our data, and found a dataset taken by a nephelometer. In the end we found a general trend that as there was more aerosol scattering the temperature was cooler, and concluded that aerosols do help to cool the Earth rather than heat it up.

Introduction

How do aerosols effect global warming? Do they help to cool the Earth or do they heat it up further? We believe that if more aerosols are present in the atmosphere, then the atmosphere will cool down because aerosols reflect sunlight back which will cool down the atmosphere. Aerosols are tiny liquid droplets or solid particles that are so light they're almost completely suspended in the air (University of California San Diego). A few common examples of aerosols are hairspray, the fumes that come out of your car, and fog. After recording some data, we were intrigued by aerosols, so we researched what effects aerosols have on the environment and came up with our question.

Aerosols are very unique in the way they affect the earth's temperature, because they both cool and heat the earth. Aerosols prevent sunlight from reaching the earth's surface through reflection(DOE), which prevents the ground from heating up. Aerosols don't only reflect sunlight but also affect the climate through clouds. Aerosol particles are the seeds on which clouds are formed, because the water vapor in colder air will cling to the aerosols in the form of crystals or cloud droplets. Furthermore, when more aerosols are in the air, the water droplets are separated further, making them smaller, causing more sunlight to be reflected. This is because the water droplets will now cover more surface area. These clouds will then act as natural walls to

the sunlight, blocking the sunlight and then letting that heat energy slowly radiate away into space.

Some Aerosols are natural and necessary for the environment, and can be created from sea spray, volcanoes, and dust from soil and rocks. Natural aerosols actually help cool the earth and have prevented 50% of global warming from greenhouse gases (Unger). Although one cause of natural aerosols is possibly stronger than any other, volcanic eruptions. This is because of the aerosols released during an eruption, which is mostly comprised of sulfur dioxide gas. This sulfur dioxide gas is launched 33,000 feet into the atmosphere, binding to the water in the atmosphere to create large clouds which stay in the atmosphere for a few years (Aerosols). Sulfur dioxide is light colored which makes it very a good reflector for sunlight. For example, in 1991 Mount Pinatubo erupted in the Philippines, this eruption was so powerful that the aerosols released cooled the atmosphere by 0.7-0.9 degrees fahrenheit. This also resulted in 1992 and 1993 being the two coldest years in the last 35 years. This just goes to show how much of an impact aerosols can have on global warming.

Most artificial aerosols also cool down the earth, however one specific artificial aerosol doesn't, black carbon. Black carbon, also known as soot, is the worst aerosol for the environment because it's the only aerosol that absorbs heat. Black carbon is mostly created from the burning of resources, such as oil, gasoline, coal, wood, and other natural resources. Black carbon is very hazardous to the atmosphere because it's black, so it absorbs a significant amount of heat from sunlight. Thankfully, black carbon only lasts for a couple of days to weeks in the atmosphere. However during this time, black carbon affects cloud formations and even impacts regional weather and rainfall patterns (Black Carbon). Furthermore, black carbon when deposited on

snow and ice heavily reduces their ability to reflect sunlight, which makes them melt faster. This increased melting rate has caused significant melting in the arctic region and the himalayas.

After compiling all of our research we still believe that if more aerosols are present in the atmosphere, then the atmosphere will cool down because aerosols reflect sunlight back which will cool down the atmosphere, even though black carbon absorbs some heat. Aerosols cooling the earth is supported also through them forming clouds, which also reflected sunlight.

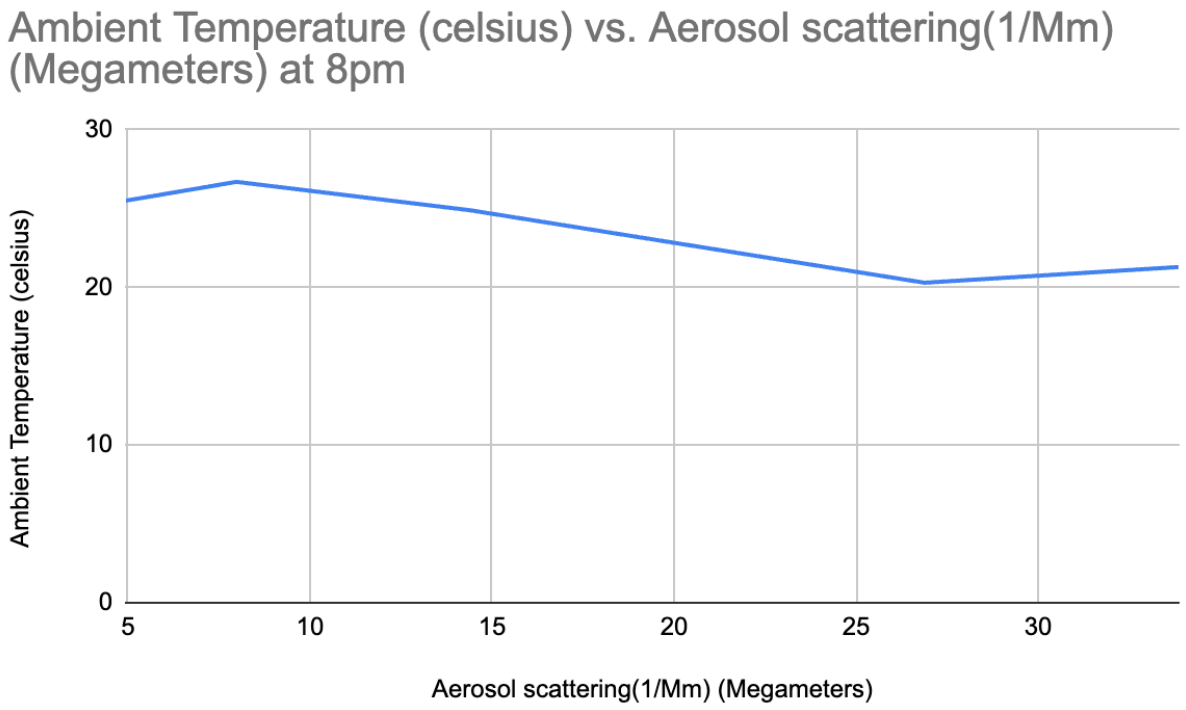
Methods and Materials

This experiment used a photometer to measure the aerosols. We used this photometer to measure the aerosols by going outside while the sun was out at approximately noon, and then pointing it at the sun until the little white dot was in the middle of the photometer. Then we could write down the maximum values that we got on that test and then repeat that process 2 more times. Every week, and get a total of 12 data points, or N4 different days total. Also don't look at the sun.

The surface temperatures was obtained from using a Etekcity Lasergrip 800 infrared thermometer. The surface temperature was of the blacktop in an empty parking lot by going outside at about 11:50. 9 nine points were recorded per day the experiment was tested. All in a period of 2-3 minutes. This was done N4 and 36 data points were recorded. The surface temperature was recorded in celsius. During testing we would make sure to record if snow was present or not. Finally, it's important to make sure to not accidentally measure your foot instead of the blacktop and to not point the infrared at someones eye. Then we found the average of each day was taken.

We also ended up researching aerosol light scattering. Aerosol light scattering is measured by an instrument called a nephelometer. It sits inside a building the atmospheric particles are pulled into an inlet and into the nephelometer. The nephelometer has a light source and a light detector. The light source shines on the particles, the particles scatter the light and then the light detector measures how much light is scattered. The unit of scattering is 1/distance.

Presentation of Data and Results



Date (8pm)	Aerosol scattering(1/Mm) (Megameters)	Ambient Temperature (celsius)
2023-05-21	4.92	25.5
2023-05-22	7.98	26.7
2023-05-18	14.39	24.9

2023-05-20	**26.88**	**20.3**
2023-05-19	**33.88**	**21.3**

Our data is shown as the amount of aerosol scattering per megameter against the temperature in celsius. This shows a general trend that the temperature drops as the aerosol scattering goes up, which supports our hypothesis. There are a few bumps where the temperature goes back up after the aerosol scattering goes up, but that's simply because aerosols aren't the only thing that can affect the temperature. We attempted to get rid of other sources of temperature changes by taking our data at 8pm, where as few other factors cool/heat the earth as possible.

Analysis and Results

Our finding suggest that more scattering aerosols does decrease the ambient temperature. The data recorded shows a general upward curve in temperature, when there are less scattering aerosols. This supports our hypothesis which is, if more aerosols are present in the atmosphere, then the atmosphere will cool down because aerosols reflect sunlight back which will cool down the atmosphere. Other studies also showed that there was an upward curve in temperature when there was less aerosols, and a decrease in temperature when there is more aerosols. I believed we attained these results because we learned that most aerosols present in the atmosphere scatter sunlight. Some experimental errors is that the environmental factors that can effect temperature weren't the same everytime. For example the wind currents were different on different days, but by choosing data that is 4 consecutive days in a row we believe that there shouldn't be too much of a difference. If we did this experiment again we would create an enclosed environment where all the environmental factors could be controlled. Even through

all the possible errors, I believe that this experiment accurately tested our hypothesis because many articles and other research support our with findings.

Conclusion

This experiment's purpose was to determine whether aerosols in the atmosphere increase or decrease the temperature of the atmosphere. It's a commonly held belief that most aerosols reflect sunlight except for a few like soot that absorb it, and that there are many more that scatter rather than absorb. So, many sources like NASA believe that aerosols do decrease the temperature of the atmosphere. Furthermore, our own results support this because the data obtained from NOAA in aerosol scattering particles that shows a correlation between the more aerosols in the atmosphere and the lower the temperature. Therefore, because aerosols do cool down the atmosphere, then they are fighting against global warming.

Discussion

The fact that aerosols help to cool down our planet is important because we don't have to worry about them now, before doing this research they were a possible cause of global warming, whereas now they aren't a consideration. If we repeated this project then I would take many many more data points as to better be able to see the graph and direct cause of the aerosols cooling down the planet. It would also be useful if more places recorded data about aerosols, because it is very difficult to make aerosol data, and almost as difficult to find it online. Most other sources completely agree with our findings.

Acknowledgments

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