Aerosol's effect on Temperature

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THE GLOBE PROGRAM
Global Learning and Observations to Benefit the Environment

Abstract

Aerosols play a significant role in Earth's climate system by influencing the net energy balance from the sun. They can scatter sunlight back into space, leading to cooling, or absorb radiation, causing localized warming. This study was prompted by the need to better understand the localized effects of aerosols, particularly in urban areas where aerosol concentrations are often elevated due to human activities. Background research indicates that aerosols can have both direct (scattering/absorption) and indirect (cloud formation) effects on temperature. This study focuses on the direct effects, using GLOBE protocols to collect and analyze data.

Research Question

Asking Questions

- Does an increase in aerosol concentration correlate to a decrease in
- temperature? This is a key piece of knowledge to see how the
- environment responds to PM2.5. We hypothesize that there will be,
- as aerosols can reflect sunlight, cooling the Earth.
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Introduction

Content Knowledge

- Aerosols are tiny particles suspended in the air. They occur naturally,
- often as a result of volcanic eruptions and combustion, but can also
- be produced by human activities such as factory emissions and
- machinery operation. Although they are frequently overlooked in
- climate change discussions, aerosols play a crucial role in both the
- Earth's climate and human health. Aerosols can either warm or cool the planet. Certain types, like sulfate aerosols, reflect sunlight back into space, creating a cooling effect that mitigates some of the warming caused by greenhouse gases. Conversely, other aerosols, such as black carbon, absorb sunlight and contribute to atmospheric warming. This dual nature makes aerosols a significant factor in the Earth's energy balance.

Research Methods

Planning Investigations

Describes the planning process

- 1. Use the GLOBE aerosol measurer to measure aerosol concentration (µg/m3) at noon and for a full month, from Feb. 4, 2025, to Mar. 4, 2025.
- 1. Measure local air temperature at the same time and location as the aerosol density measurements using a digital thermometer. Ensure the thermometer is shielded from direct sunlight to avoid inaccurate readings.
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- 1. Record all data in a spreadsh, including date, time, aerosol density, & temperature.
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- 1. Perform statistical analysis to determine the significance of the relationship.

Carrying Out Investigations

Describes what happened

- We carried out all of our investigations at the school.
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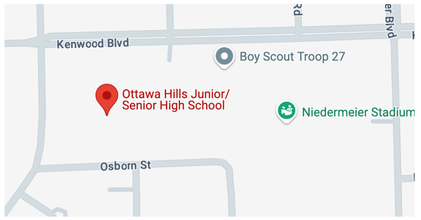


GLOBE Badges

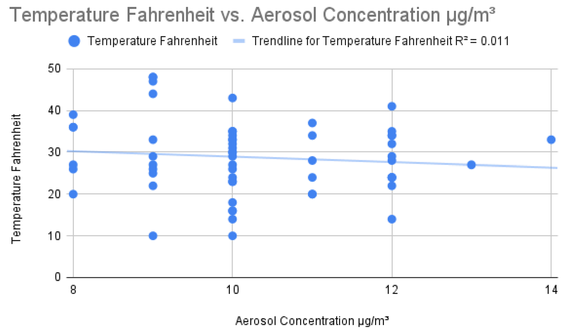
We earned the badges of Collaborator and Data Scientist. We demonstrated strong teamwork and excellent data analysis.

Results

Analyzing Data

We found no significant correlation between temperature and aerosol concentration. Our coefficient of determination was 0.011, meaning that only around 1.1% of variation in Temperature was explained by aerosol concentration. There was a slight negative association.

Figure #1



Discussion

Interpreting Data

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- There may be several reasons for this. Firstly, the sample size or duration of the data might be insufficient to capture the long-
- term or large-scale effects of aerosols, which can vary regionally and over time. Secondly, & perhaps more importantly, the data
- did not account for confounding variables, such as cloud cover,
- or natural climate variability, which play a much larger role in the temperature than aerosols. To mitigate these factors, we could randomly select the location to avoid confounding variables, & gather more data.

Conclusions

- Conclusion:
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- Based on our sample of data, there is not convincing evidence that aerosols significantly affect temperature. The
- R2 value for the data is only 0.011, meaning only
- approximately 1% in the variability of the temperature data
- is explained by aerosol density.
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Bibliography

References

- 1. Pöschl U. Atmospheric aerosols: composition, transformation, climate and health effects. Angew Chem Int Ed Engl. 2005 Nov 25;44(46):7520-40. doi: 10.1002/anie.200501122. PMID: 16302183.
- 1. ScienceDirect. (n.d.). Aerosols. Retrieved October 30, 2023, from https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/aerosol
- 1. Wang, P., Yang, Y., Xue, D. et al. Aerosols overwhelm greenhouse gases contributing to a warmer climate and more weather extremes on the path to carbon neutrality. Nat Commun 14, 7257 (2023). https://doi.org/10.1038/s41467-023-42891-2
- 1. Arfin,., Pillai, A.M., Mathew, N. et al. An overview of atmospheric aerosol and their effects on human health. Environ Sci Pollut Res 30, 125347–125369 (2023). https://doi.org/10.1007/s11356-023-29652-w
- 1. World Meteorological Organization. (n.d.). WMO Bulletin: Heatwaves worsen air quality and pollution. Retrieved October 30, 2023, from https://wmo.int/news/media-centre/wmo-bulletin-heatwaves-worsen-air-quality-and-pollution