Last Week's Surface Temperature vs. This Week's Precipitation Rates

Eliza Hoelzle & Kaylin Zheng

Ottawa Hills Junior/Senior High School

Honors Chemistry

Dr. Kreischer Gajewicz

5 March 2025

Table of Contents

Abstract

How can surface temperature affect precipitation, and what would that mean for our warming planet? When temperatures rise, evaporation increases, which in turn creates more precipitation. This was the basis for our hypothesis that as surface temperature rises, so will precipitation. We collected surface temperature on turf, grass, and asphalt using an Etekcity infrared thermometer. We used a ruler to measure the amount of precipitation, and after creating two graphs we found that our hypothesis was incorrect. Our data suggested that as temperatures dropped, precipitation increased. Based on other studies we found with similar procedures, we concluded that one of our main sources of error was our small sample size, with only one day we recorded containing precipitation. Throughout our experiment, we learned many things about climate change and how it could affect major weather events such as hurricanes and floods and are excited to see what studies like ours could uncover in the future.

Introduction

Since 1850, Earth's temperature has risen a whopping two degrees Fahrenheit, averaging about 0.11° Fahrenheit per decade. (Lindsey & Dahlman, 2024). Alongside concerning temperature levels, precipitation levels of the Earth have been increasing, with the United States having record precipitation rates since 2019. But is there any correlation between these two rapidly changing environmental factors? It has been proved that there can be up to a 4% increase in precipitation per 1° Fahrenheit rise. (National Centers for Environmental Information, 2020). This resulted in the rising question of whether last week's surface temperature would affect next week's precipitation and what this means for the future of climate change. If the surface temperature is higher for one week, then the next week will have more precipitation because the higher temps will result in more evaporation. (United States Environmental Protection Agency, 2024) This would result in higher temperatures overall and could lead to increased natural disasters such as floods and hurricanes.

As the average temperature of the Earth's surface rises, it's only logical that evaporation would increase as well. This creates heightened precipitation levels to balance. This idea is supported by Deke Arndt, Chief of NCEI's Climate Science and Services Division, who stated, "But to oversimplify: a warmer atmosphere can hold more water vapor and an atmosphere with more water vapor can make more precipitation." (National Centers for Environmental Information, 2020) This means that warmer air, impacted by surface temperature, can hold more water vapor. This can cause longer, harsher precipitation events in the long run.

As the climate changes, panic rises throughout, due to the escalating numbers of natural occurring disasters. Ice jams, rapid snowmelts, and persistent heavy rainfall stemming from

heightened temperatures are followed by river flooding, more specifically in the Missouri, Mississippi Plate, and Arkansas rivers. The adjusting climate also warms the oceans and causes rising sea levels. While this occurs, hurricanes and typhoons become stronger and catastrophic. Recent studies have shown, “Helene was by far the deadliest inland hurricane on record, exceeding Hurricane Agnes in 1972, which killed 128 people in the northeastern U.S. And it was the third deadliest in the continental U.S. since operational forecasting began in the 1960s, after Hurricanes Katrina (2005) and Camille (1969).” (Mock, 2024) Hurricane Helene lasted from September 24, 2024, to September 27, 2024, costing about 59.6 billion dollars, five years after the peak precipitation rates in 2019. (Cooper, 2024, pg. 5) These staggering statistics prove the warming of the Earth has an alarming impact on natural disasters that have a high chance of harming natural habitats and lives.

In conclusion, the answer to whether last week's surface temperature could affect next week's precipitation and what this means for the future of climate change could help explain and predict major weather events such as hurricanes and floods. As the climate is changing, it's only natural that the precipitation levels will change with it, and it is important to realize that climate change isn’t just rising temperature. It can be a lot more dangerous and is already seriously affecting people's lives. The hypothesis that last week's surface temperature would affect next week's precipitation could help answer questions about the correlation between climate change and natural disasters.

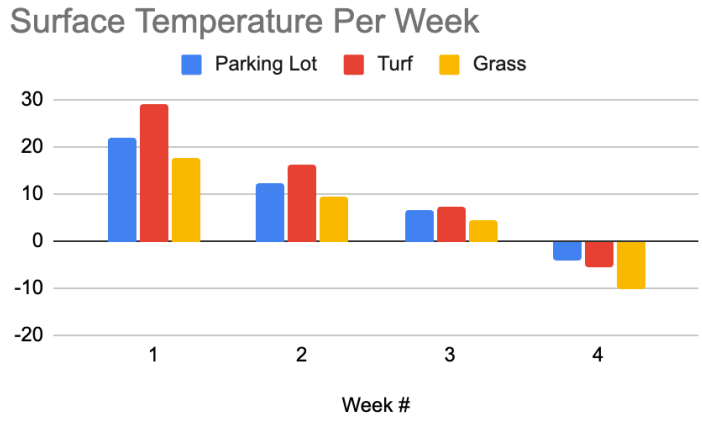
Methods and Materials

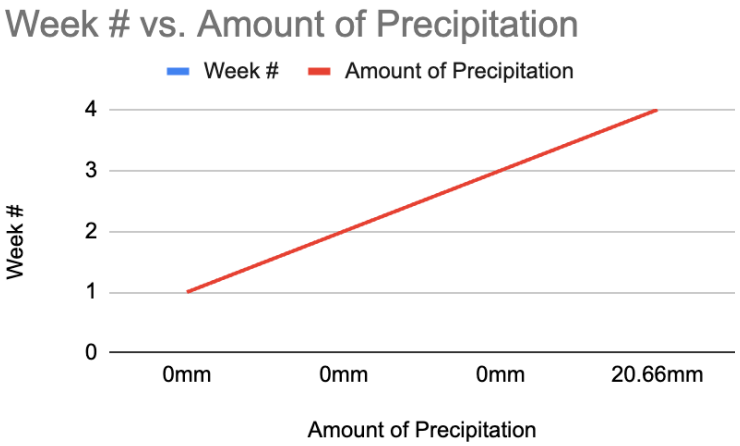
For our experiment, we took nine data points from nine different days. We used Globe to collect our data and share it with the world. The Globe protocols we used were surface temperature and precipitation. To increase the accuracy of our surface temperature data, we took temperatures from three different surfaces, asphalt, turf, and grass. The thermometers we used were Etekcity infrared thermometers, and they used lasers to get temperatures without touching the ground, which was very helpful in our data collection.

For precipitation, we counted in millimeters and used estimates for unmeasurable spots. The estimates we used were trace, less than 10 millimeters, and measurable, more than ten millimeters. These methods of data collection were easy yet accurate, allowing us to gather a sufficient amount of data points. We recorded our data in data sheets that we made beforehand to give us organized and reliable information. The website we used, Globe, allowed us to share our findings with the world, while also giving us the resources to look at other people's data from the same protocols and location, furthering our data points and allowing us to give more accurate results. After we analyzed our data, we connected our data with research that we have gathered on the cause and effect of surface temperature and precipitation on climate change.

Our experiment was low risk but some safety precautions were taken. As we collected data, we used a laser thermometer gun. This could cause harm if pointed in the eyes, damaging the retina. To prevent this, we ensured the laser always pointed toward the ground and never came in contact with bodies.

Presentation of Data and Results





Our graph indicates how different amounts of precipitation affect the surface temperature of different temperatures. In our experiment, we measured the surface temperature and amount of precipitation. The first graph, titled "Surface Temperature Per Week," shows the surface temperatures of three different surfaces: parking lot, turf, and grass, over four weeks. The parking lot consistently shows high initial temperatures but gradually decreases over time. Turf has the highest temperature in week 1. However, temperatures across all surfaces decline over the weeks, with the lowest values shown in week 4, where all three surfaces have either

reached or dropped below zero. This indicates a cooling trend, possibly influenced by external factors such as weather changes or increased precipitation.

The second graph shows the amount of precipitation recorded over the weeks. The data reveals no precipitation was observed in weeks 1 through 3, but a substantial increase (20.66 mm) occurred in week 4. This sharp increase in precipitation coincides with the notable decrease in surface temperatures in the first graph, suggesting a possible correlation between increased rainfall and cooling of the surfaces. This relationship highlights the impact of precipitation on temperature reduction, especially in outdoor environments.

Analysis and Results

Our findings suggest that as surface temperature decreased from 29 degrees Celsius as the peak temperature throughout our study, which occurred in week one, to -10 degrees Celsius at our lowest temperature, which occurred in week four, there is an inverse relationship between surface temperature and precipitation. Our data suggested that as the surface temperature went down, precipitation increased. Our hypothesis stated that surface temperature and precipitation had a direct relationship, therefore as the surface temperature went up precipitation would follow. However, throughout all of our data points, it is clear that our hypothesis was incorrect. One of the main studies we used to support our hypothesis was a study from the National Centers for Environmental Information, which stated that there can be up to a 4% increase in precipitation per 1° Fahrenheit rise. This study was done professionally, so it's easy to see why it had a different conclusion from ours. By comparing our results to professionally done studies, it is clear where we could have improved. For example, we didn't collect enough data points, with only one day we recorded having precipitation. Also, the days we collected were few and far between, only collecting data about once a week. Because of this, it is very likely that our conclusion would have been different if we were able to collect every day, or at least every day with precipitation. This would drastically improve the accuracy of our findings. We still feel as if we were unable to correctly test our hypothesis, that if surface temperature increases, so will precipitation, because we didn't have enough data points to draw an accurate conclusion. But with that being said, our procedure and methods of data collection would be sufficient to test our hypothesis if we were able to collect more data.

Conclusion

Our hypothesis that if surface temperature increases, so will precipitation, was proven false by our results. By collecting data outside with thermometers and ruler, we were able to make two graphs, a graph showing surface temperature decreasing over time, and a graph showing precipitation increasing over time. By comparing these two graphs, we saw the inverse relationship of surface temperature and precipitation, whereas surface temperature decreases, precipitation increases. The results we expected and our hypothesis were based on one main study from the National Centers for Environmental Information, which concluded that there can be up to a 4% increase in precipitation per 1° Fahrenheit rise in temperature. Although we didn't get the results we expected, we believe our project was still an important topic to test especially when related to climate change.

Discussion

If the project was to be repeated, we would have made many changes. Most importantly, we would have had a bigger sample size to increase the accuracy of our results. With environmental projects, it can be hard to gather data because of the unpredictability of nature. There were no guarantees that we could collect the data we needed to create a conclusion we were confident about. But, this research and research from projects like it are very important, especially in the coming years. As our planet warms, we need to think of other environmental impacts global warming can have. While many people think of droughts, it is important to think about other major weather events that can be caused by global warming. Throughout this project, we have tried to look at a facet of climate change that we feel isn't recognized as a danger. And with more severe weather every year such as hurricanes and floods, we believe it is critical to keep testing hypotheses like ours so we can try to find a solution. If this project were to be repeated, we would suggest a larger sample size, consistent testing days, and a larger area for testing.

Acknowledgments

We would like to acknowledge our teacher at Ottawa Hills High School, Dr. KG. She provided us with so much knowledge, help, and materials, and we could not have achieved this without her. We would also like to acknowledge the *Globe* organization, especially Sara Mierzwiak and Grant Wilson, for insight on other data points. We are beyond grateful for all of these wonderful people!

References

Climate Change Indicators: Weather and Climate. (2023, June 27). U.S. EPA. Retrieved January 31, 2025, from https://www.epa.gov/climate-indicators/weather-climate

Hurricane Facts. (n.d.). Weather.gov. Retrieved January 31, 2025, from https://www.weather.gov/source/zhu/ZHU_Training_Page/tropical_stuff/hurricane_anatomy/hurricane_anatomy.html

Mock, C. (2024, October 7). *How Hurricane Helene became a deadly disaster across 6 states*. Retrieved January 31, 2025, from https://sc.edu/uofsc/posts/2024/10/conversation-hurricane-helene-deadly-disaster-six-states.php#:~:text=Helene%20was%20by%20far%20the

OSBM. (2024, October 23). *Hurricane Helene Recovery*. https://www.osbm.nc.gov/hurricane-helene-dna/open

A Warming Earth is Also a Wetter Earth. (2020, November 18). National Centers for Environmental Information. Retrieved January 31, 2025, from https://www.ncei.noaa.gov/news/warming-earth-also-wetter-earth