The Impact of Cloud Cover on Surface Temperature

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Abstract

This environmental research study was created by Shumate Middle School students Kennedy Hardy (Sixth Grade), Peyton Pitt (Seventh Grade), and Adeline Turkington (Seventh Grade). Our study explores the influence cloud cover has on surface temperature. To conduct our research, our team took many cloud measurements utilizing the GLOBE Observer app. We submitted all data to the GLOBE Program, and we recorded our cloud cover data on a Google Sheet. Additionally, we partnered with Shumate's Surface Temperature team of Logan Lancaster (Sixth Grade) and Nicholas Stuart (Seventh Grade). Lancaster and Stuart measured surface temperature daily at four different locations. Each location had a different surface type (asphalt, concrete, water, and grass). Their data was also submitted to the GLOBE Program and added to our team's Google Sheet. All data was collected during our GLOBE Advisory period daily. Our hypothesis, "We believe that increased cloud cover will lead to a decrease in surface temperature values, and a decrease in cloud cover will lead to an increase in surface temperature values. After reviewing the collected surface temperature and cloud cover data, we found out that our hypothesis was correct. The results of this study are very interesting. However, our team plans to continue taking measurements to monitor our claim. The results of our research can be found in this report.

Keywords: **surface temperature, cloud cover, inverse relationship**

Research Question

Our research question for this study is, *"How does cloud cover affect surface temperature?"* Over the past four years, Shumate Middle School Citizen Scientists have collected hundreds of cloud cover measurements for The GLOBE Program. Last year, students Isabella Bienko, Blake Fowler, and Maranda Steinmetz submitted the report called, "Winter Season Cloud Study" In this report, Bienko, Fowler, and Steinmetz investigated the most common cloud formation observed during the winter season. Our team found their work to be interesting, thus we decided to study clouds for our IVSS project. In this study, we focus on the impact that cloud cover has on surface temperature. Surface temperature data for this collected by the Shumate Surface Temperature team (Lancaster and Stuart). All surface temperature data collected can be found below (see Data Summary).

Introduction

Our team found information on per two different GLOBE websites to support our research. First, according to the GLOBE Program etraining module, recording surface temperature is important because it helps us verify satellite data, understand seasonal change, helps us understand the rate of heat and moisture exchange, and to assist in urban planning to understand the Urban Heat Island Effect (2016). Additionally, per the GLOBE Program's Cloud Protocol, measuring cloud cover is important as measurements help us know how much sunlight is reaching the ground and how easily heat from the ground and lower atmosphere can escape to space (2017).

Hypothesis:

We believe that surface temperature values will decrease with an increase in cloud cover, and surface temperature values will increase with a decrease in cloud cover.

GLOBE Badges

- **I Make an Impact** - We would like to apply for this badge as our research team examined the influence cloud cover has on surface temperature. This is an important concept when trying understand Earth's energy budget.
- **I am a Data Scientist** - Our team collected many cloud measurements utilizing the GLOBE Observer app. All measurements were submitted to the GLOBE Program. We designed a Google Sheet to organize our data, and we shared our data with the Shumate Surface Temperature team (Lancaster and Stuart).
- **I am a Collaborator** - In order to conduct this environmental research study, collaboration was a must. Each member of our team collected, analyzed, and submitted data to the GLOBE Program. As stated above, our team also worked with the Shumate Surface Temperature team (Lancaster and Stuart).

Research Methods

GLOBE Protocols Utilized in this Study:

- Atmosphere
  - Clouds
  - Surface Temperature
- **Study Sites:**
  - Grass - 2019 - 2020 Small Tree
  - Concrete - 2019 - 2020 Front Sidewalk Site
  - Pond - Retention Pond - Salinity Study - GLOBE Advisory
  - Asphalt - 2019 - 2020 Staff Parking Side - Asphalt
    - Please see GLOBE Study Sites and aerial images below.
- **Time Frame:**
  - Tuesday, October 15, 2019 - Thursday , February 6, 2020

Materials:

For Taking Cloud and Contrail Measurements

- Mobile Device - Tablet with NASA GLOBE Observer app downloaded.
  - *One can also utilize a GLOBE Cloud Chart in the absence of technology.*
- NASA GLOBE Observer App - Utilized to measure clouds and contrails.
- Chromebook - Utilized to store data and send measurements electronically to the GLOBE Program.
- Google Spreadsheet - Utilized to store data and create data tables and graphs.

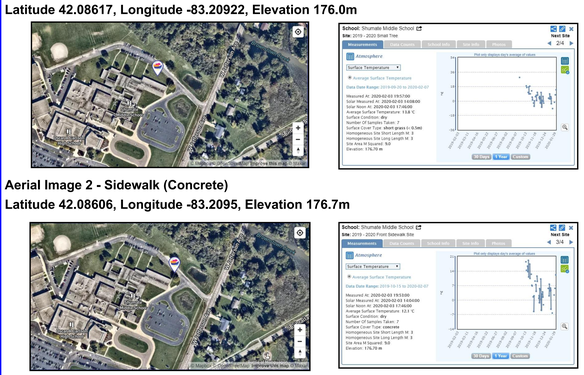
Methods:

For Taking Cloud and Contrail Measurements

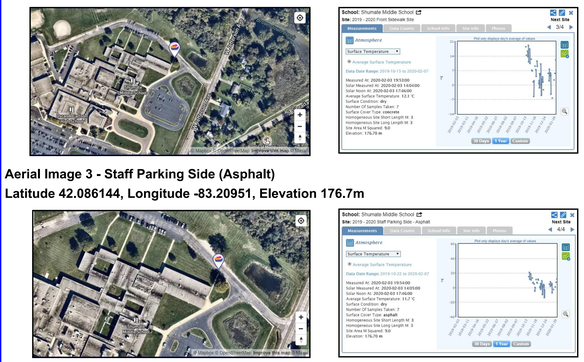
- Gather a mobile device (with GLOBE Observer app downloaded on it) and travel outside to your selected study site.
  - As stated above, one can take a cloud measurement using a GLOBE Cloud Chart. The observation can be submitted manually via the GLOBE website.
- Follow the instructions on the app, and capture your cloud observation.
- Send the observation to the GLOBE Program.
- Log the data on a Google Spreadsheet for easy analysis.
- Log the data on the classroom Citizen Science whiteboard and discuss daily observations with team members.

GLOBE Study Sites:

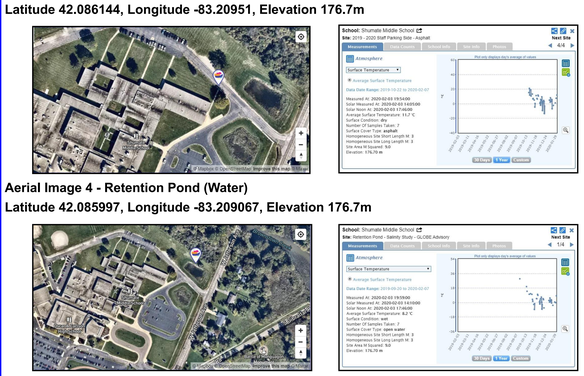
Aerial Image 1 - Small Tree Study Site (Grass)
Latitude 42.08617, Longitude -83.20922, Elevation 176.0m



Aerial Image 2 - Sidewalk (Concrete)
Latitude 42.08606, Longitude -83.2095, Elevation 176.7m

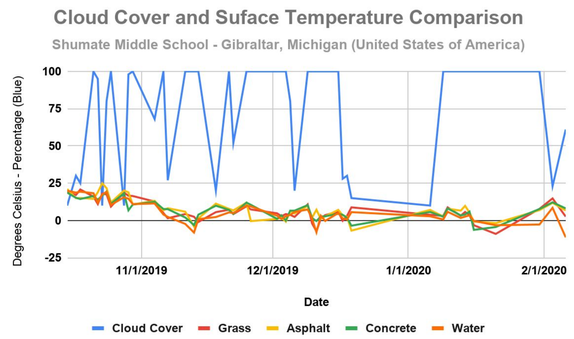


Aerial Image 3 - Staff Parking Side (Asphalt)
Latitude 42.086144, Longitude -83.20951, Elevation 176.7m



Aerial Image 4 - Retention Pond (Water)
Latitude 42.085997, Longitude -83.209067, Elevation 176.7m

Results



Small Tree (Grass) Analysis - The average surface temperature for the Small Tree (Grass) study site was 6.8 degrees celsius. The maximum surface temperature measurement(s) was 20.8 degrees celsius, and the minimum surface temperature measurement(s) was - 9.0 degrees celsius. Please see the graph above to view the data.

Sidewalk (Concrete) Analysis - The average surface temperature for the Concrete (Asphalt) study site was 6.9 degrees celsius. The maximum surface temperature measurement(s) was 19.4 degrees celsius, and the minimum surface temperature measurement(s) was - 6.3 degrees celsius. Please see the graph above to view the data.

Staff Parking Side (Asphalt) Analysis - The average surface temperature for the Staff Parking Side (Asphalt) study site was 7.8 degrees celsius. The maximum surface temperature measurement(s) was 20.5 degrees celsius, and the minimum surface temperature measurement(s) was - 6.8 degrees celsius. Please see the graph above to view the data.

Retention Pond (Water) Analysis - The average surface temperature for the Retention Pond (Water) study site was 5.5 degrees celsius. The maximum surface temperature measurement(s) was 20.0 degrees celsius, and the minimum surface temperature measurement(s) was - 11.3 degrees celsius. Please see the graph above 1 to view the data.

Mathematics Equations Utilized - We utilized an average, maximum, and minimum functions on our data tables to better analyze the data.

Possible Uncertainties Present in the Data - Human and/or technology error(s).

Discussion

Overall, we believe that our team successfully investigated the inverse relationship between cloud cover and surface temperature. Again, per the graph above, as cloud cover increases, surface temperature decreases. When cloud cover decreases, surface temperature increases. In addition to finding an inverse relationship, we believe that our team took accurate measurements. We submitted many measurements to the GLOBE Program via the GLOBE Observer app. Our team also worked together really well with Shumate's Surface Temperature team. Together we created a Google Sheet and both teams uploaded data. Our team uploaded daily cloud cover measurements, and the surface temperature team uploaded surface temperature measurements taken at four different study sites (grass, asphalt, concrete, and water).

Moving forward, our team plans on taking additional cloud cover measurements. Taking additional measurements will help our research team better understand how cloud cover affects surface temperature. Will the relationship between surface temperature and cloud cover change during the spring and summer months? Our team took many late fall and early winter measurements for this project. Finally, we look forward to continuing working with the Shumate Surface Temperature Team throughout the remainder of the 2019 - 2020 school year. We are excited to share our data with students and scientists from around the world.

Conclusions

For this project, our hypothesis was correct. As stated above, we believe that surface temperature values will decrease with an increase in cloud cover, and surface temperature values will increase with a decrease in cloud cover. As is evident in Graph 1 (see above), the surface temperature values decreased with an increase in cloud cover. Additionally, the surface temperature values increased with a decrease in cloud cover. Based on this evidence, we believe there is an inverse relationship between cloud cover and surface temperature.

Bibliography

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