Ground Observations Correlated to Satellite Data

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THE GLOBE PROGRAM
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Abstract

Data was collected at our school's weather station every other day of classes weather permitting. Our station was outside of Fredonia Middle School which is a rural area about 40 miles southwest of Buffalo, near Lake Erie. Our data compares our ground observations to satellite data from NASA Langley.

key words: cloud, satellite, observations, ground-truthing

Research Question

How closely do ground observations correlate to satellite imagery? If they don´t match, which data is accurate and which is inaccurate, and what could be causing the difference? We collected cloud data for approximately six months and compared satellite and surface observations from days with the most complete data sets. From this research we could really figure out how accurate our judgement is from ground level. One of the factors that could make our readings different is we see the clouds in the order of low, mid, high. The satellite sees high, mid, low. This difference could lead to discrepancies between our ground observations and the satellite observations.

Introduction

Clouds have both a heating and cooling effect on our climate. Small changes in cloud cover could have a dramatic positive or negative impact on global climate change (Nutt, 2017). NASA has invested significant resources into the study of clouds and relies on satellite imagery to provide cloud data to scientists.

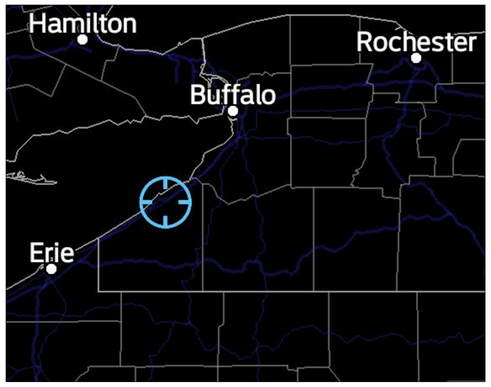
Ground truthing is a key element in assessing the accuracy of space based measurements. In the past, student cloud observations have served as validation of CERES cloud retrieval data (Chambers et al., 2004). The authors of the study noted key differences between the student and satellite observations, referencing both possible student error and limitations in CERES technology.

Research Methods

Study site: We collected our data in Fredonia, NY located at 42.4401° N, 79.3317° W at Fredonia Middle school. Fredonia is a village located in Chautauqua County in western New York. Fredonia is about 2 miles from the Lake Erie shore line, about 40 miles from Buffalo, and 50 miles from Niagara Falls. Because of Lake Erie, along with the elevation and latitude, Fredonia experiences a temperate climate, all four seasons, moderate temperatures, and a long, cold, and dark winter with plenty of lake effect snow.

Data collection: Our study group used the GLOBE protocols to collect data for: air temperature, soil temperature, surface temperature, precipitation and clouds. Data was collected every other school day, from October 17th to March 28th, around 2pm.

Data analysis: The data used for comparison was compiled on spreadsheet and submitted to the GLOBE database through email data entry. We then compared these dates with the corresponding satellite images from NASA. We compared the accuracy for overall cloud cover, low level clouds, mid-level clouds and high level clouds.



GLOBE Badges

Be a **Collaborator**

All team members are listed including students from the same school or schools from around the world, along with clearly defined roles, how these roles support one another, and descriptions of each student's contribution. The descriptions clearly indicate the advantages of the collaboration. If the students collaborated with students from another school, describe how working with other schools improved the research.

Be a **Data Scientist**

The report includes in-depth analysis of students' own data as well as other data sources. Students discuss limitations of these data, make inferences about past, present, or future events, or use data to answer questions or solve problems in the represented system. Consider data from other schools or data available from other databases.

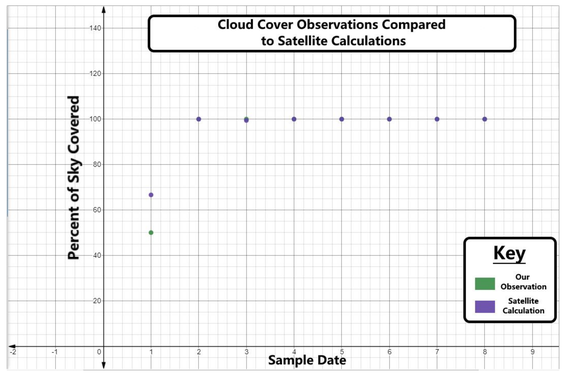
Be a **STEM Professional**

The report clearly describes collaboration with a STEM professional that enhanced the research methods, contributed to improved precision, and supported more sophisticated analyses and interpretations of results.

Results

Our goal of collecting data for 6 months was to see if our ground observations would be similar to the GOES-16 satellite data provided to our group by the National Aeronautics and Space Administration (NASA). Our data was sent to NASA, and they sent back a detailed comparison between observations at our study site, along with calculations from their satellite at the corresponding time. This allowed us to evaluate how close the two data sets were.

On many days, we found that our observations were very similar to the images from the satellite. There were several days, however, when the two sources did not agree on the conditions. This may have been the case for several reasons, such as who collected the ground observations, what the weather conditions were, and how accurate the satellite's calculations were. While there were a few days where the data did not correlate, there were still many days when the satellite agreed with our ground observations. The following graph shows how close the cloud cover observations were from the two sources, along with an example of the comparison of the satellite and ground observations.



NASA Cloud Observation and Satellite Match

Satellite		GEO	Your Observation
Universal Date/Time 2019-01-15		18:33	18:30
Latitude Range Longitude Range		42.13 to 42.77 -79.63 to -78.99	Latitude 42.44 Longitude -79.30
Total Cloud Cover		Overcast 100.00%	Overcast (>90%)
HIGH	Cloud Cover Cloud Altitude Cloud Phase Cloud Opacity		
MID	Cloud Cover Cloud Altitude Cloud Phase Cloud Opacity	Broken 88.62% 2.22 (km) Water 263.54 (K) Opaque	Altocumulus Altostratus
LOW	Cloud Cover Cloud Altitude Cloud Phase Cloud Opacity	Isolated 11.38% 1.94 (km) Water 264.14 (K) Opaque	Cumulus

Discussion

From our observations we can tell that most of the time the data that was compared was accurate. When the data was different most of the time it was on dates when it was overcast. The main difference on these dates was between high cloud cover and low cloud cover. Seven out of the eight overcast days the mid level cloud coverage was the same. The reason for this difference could be the fact that when we were observing from the ground we had a better view of low level clouds and high level clouds could have been obscured by other clouds at low and mid levels. This could be the same case for NASA satellites but the other way around with high and mid level clouds obscuring low level clouds. This is also supported by the data from 2019-01-22 when our high level cloud cover matched the satellite data. This date also supports our other claim because we still had low level cloud coverage and the satellite did not. The low level clouds only matched two days, 2019-01-15 and 2018-11-06. This was because there was either no high level clouds or very little. From this we can learn that in order to get the most accurate cloud observations we will need to use a combination of ground and satellite observations. This is important to weather prediction because clouds are a key part in predicting weather and have a tremendous effect on climate.

Human judgement is not always reliable. It is possible there could also be some error when determining what clouds are in the sky. This could lead to inaccurate data. Data can also be misinterpreted, for example on the date, 2019-01-12, we observed a clear day and the satellite had broken coverage and clouds at all levels. this could be a result of any one of these mistakes.

Conclusions

We've determined that we are mostly accurate from the ground level. Occasionally we were off by a small amount, and one time we were off by a long shot. More often than not we were very accurate, though. We could have been more thorough in our cloud readings, and that could have made our readings closer to the satellite readings. Another factor is sometimes higher clouds block satellites from picking up lower clouds which can affect the reading. We could improve our study by accurately quantifying the correlation between our ground observations and the satellite data. Overall ground observations somewhat closely correlate to satellite data.

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