Medford Memorial Middle School, NJ
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Correlations Between Cloud Cover, Split Water Vapor, and Cloud Altitude in Medford, NJ

Abstract

GOES-16 (Geostationary Operational Environmental Satellite), also known as GOES-East, is a geostationary satellite that was launched in 2016. It records weather observations from multiple different types of instruments. The satellite images used for this research were recorded from a product produced using Band 13 of GOES-16's ABI (Advanced Baseline Imager). Band 13 is water vapor. Split water vapor is the difference between the 6.2-micron band and the 7.3-micron band. The ABI uses specific bands of the electromagnetic spectrum to identify factors in the environment. Brightness temperature is the temperature when all of the light of an electromagnetic spectrum wavelength is absorbed and converted into heat when the temperature of the object starts at absolute zero. It is measured in degrees Kelvin. All split water vapor data is brightness temperature data. The thicker the cloud, the closer the split water vapor value will be to zero. The thinner the cloud, the more negative the split water vapor value. The research questions include: What is the correlation between split water vapor and cloud coverage? What is the connection between split water vapor and high as well as mid-level clouds? The objective of this research is to find a correlation between ground-based cloud coverage observations and GOES-16 satellite data. During four consecutive weeks, ground cloud observations using the GLOBE cloud protocol, cloud data sheets, and the GLOBE observer app, were recorded. As the results show, there is little to no correlation between total cloud coverage and mid-level clouds to split water vapor. However, there is a consistent correlation between high-level clouds and split water vapor. If a future scientist were to research similar topics to this, it would be recommended that they collect data for a longer period of time.

Key Words: GOES-16, ABI, Clouds, Water Vapor, Electromagnetic Spectrum

Research Question

The research questions are "What is the correlation between split water vapor and cloud coverage?" and "What is the connection between split water vapor and high, as well as mid-level clouds?" Knowing the correlation between split water vapor and cloud formation is important because then upcoming severe weather can be predicted easier and reduce the risk of damage to people and property. It also brings up the topic of advanced satellites to the surface and spreads the word about all the possibilities they are now capable of. Scientists may be interested in this data because if there is a correlation, then scientists can identify clouds by their split water vapor signature. In 30 years from now, if the satellite sees split water vapor signatures get consistently closer to zero, it might mean that Earth's systems' temperatures might be causing water to be able to evaporate quicker because of a temperature increase.

Introduction

The problem is figuring out what the correlation between split water vapor and cloud coverage is by looking at satellite images and ground cloud observations. It is important to know the correlation between split water vapor and cloud coverage because there is scientific literacy to be spread about the improvement in the GOES-R series of satellites. GOES-16 is a geostationary satellite with an orbit height of 22,236 miles (NOAA Headquarters, 2017).[1] It is a huge advancement from previous GOES. GOES-16 is part of the GOES-R series of satellites. It gathers three times more information, four times more spatial resolution, and five times faster coverage (NOAA).[2] Previous GOES had five bands of spectral information and the GOES-R series satellites have a total of 16 bands that collect a variety of information that can help scientists all over the world (NOAA).[3] Previous GOES had a spatial resolution of four square kilometers and the GOES-R series satellites have a spatial resolution of two square kilometers (NOAA).[4]

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1 https://phys.org/news/2017-01-goes-satellite-images-earth.html

2 https://www.goes-r.gov/spacesegment/abi-improvements.html

3 https://www.goes-r.gov/spacesegment/abi.html

4 https://www.goes-r.gov/spacesegment/abi.html

This is important because now there are more specific, detailed pixels in satellite images. Older GOES used to only be able to take pictures of one-fifth of the Earth in five minutes and new GOES can take pictures of the whole earth in five minutes (NOAA).[5] This is a major improvement because in real lifetime, images can be updated and the latest info can be gathered every five minutes. This is relevant towards the community because if citizens are able to understand the relationship between cloud coverage and water vapor, then they will also getting a better understanding of how satellites can be used to predict the weather and how satellites will be utilized later for other weather events, both usual and catastrophic.

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5 https://www.goes-r.gov/spacesegment/abi.html

Research Methods

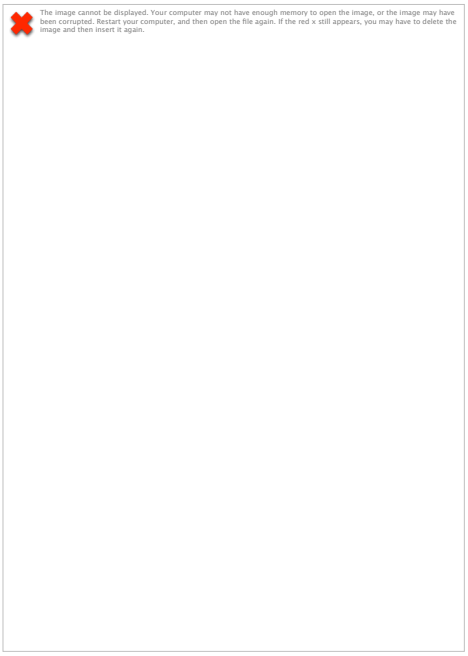
The climate in Medford, New Jersey is fairly moderate with cold winters and warm summers. It can be humid, but temperate. The land cover in Medford is grassy and wooded.

During this research, the GLOBE Cloud Protocol was used and in this, the cloud coverage, high-level clouds, mid-level clouds, low-level clouds, and surface conditions were identified. Also, the GLOBE Cloud Observer App was used. From this, data was entered and sent to GLOBE. Satellite matches from NASA Langley e-mails were received to help further our observations and analysis. During a four-week period, cloud observations were collected every day at Medford Memorial School's designated Atmospheric GLOBE data taking site. These observations were taken consistently at solar noon, ± one hour. A note was taken of any high, mid, or low-level clouds with the aid of the Atmospheric Investigation Cloud Protocol data sheet. Total cloud coverage and surface conditions were also noted. From this, data was entered into the GLOBE Cloud Observer App. With the help of Dr. Tim Schmit, NOAA, reliable ABI data was found. This data was compared to cloud observations. To analyze the data in the research, a table was made. The table included GOES-16 satellite images of the United States, the time and date. Satellite images were identified on each date that ground cloud data was taken. The data we collected answered our questions because it allowed us to find, or not find, a correlation between split water vapor, ground-cloud observations, mid-level cloud altitude, and high-level cloud

altitude. Photographs were taken. The brightness temperature of the water vapor of the pixel that covered Medford New Jersey was recorded.

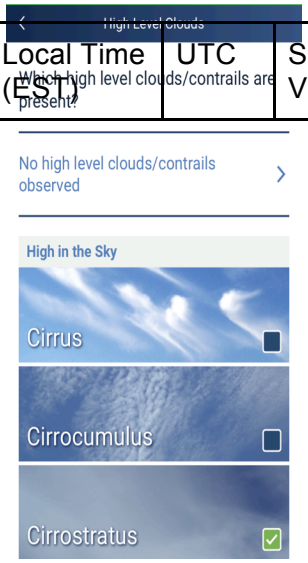
GLOBE certified study site at Medford Memorial.

Royce Jacobs taking cloud observations at Medford Memorial Middle School.



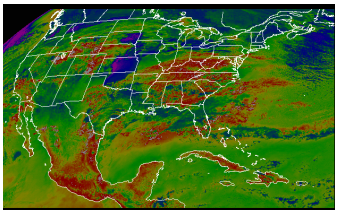
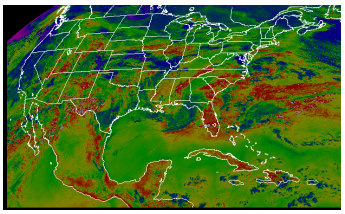
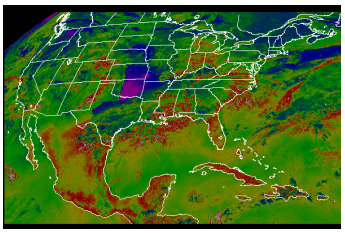
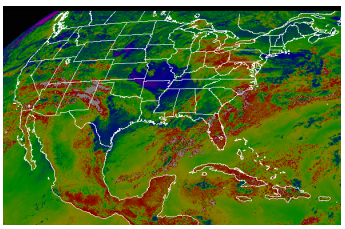
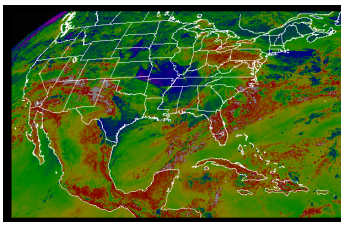
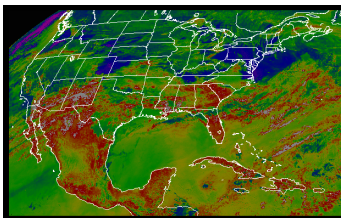
Sophia and Samantha taking cloud observations.

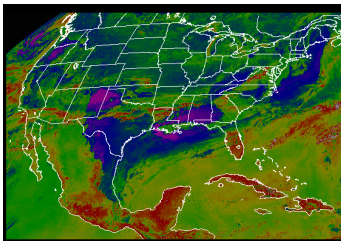
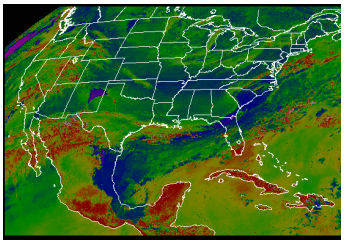
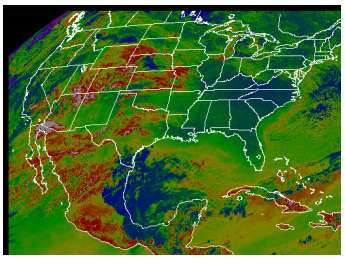
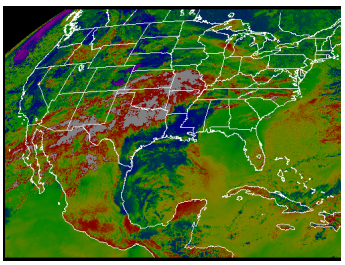
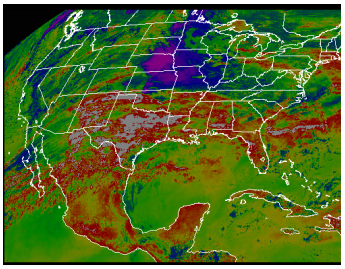
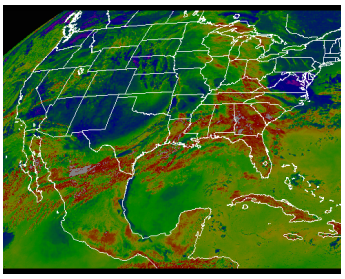
Date	Local Time (EST)	UTC	Split Water Vapor	Mid-Level	High-Level Cloud	Total Cloud Cover	Image

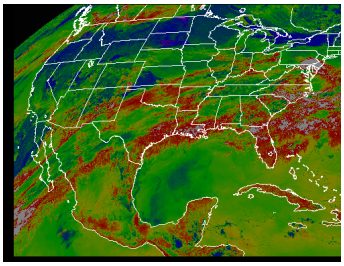
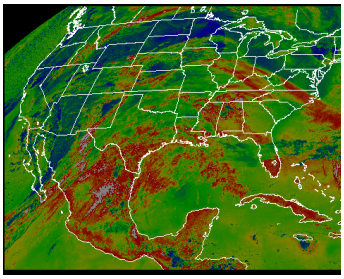
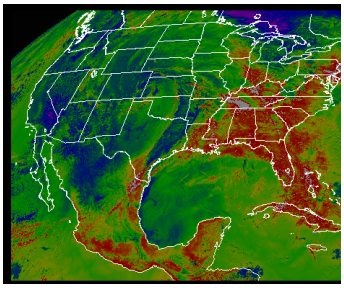
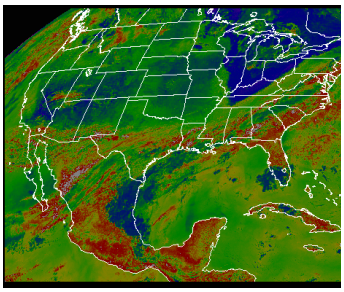
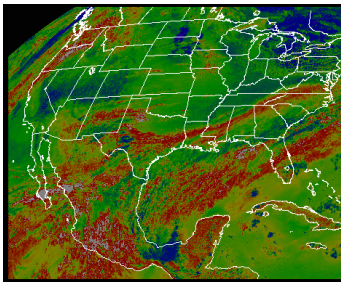


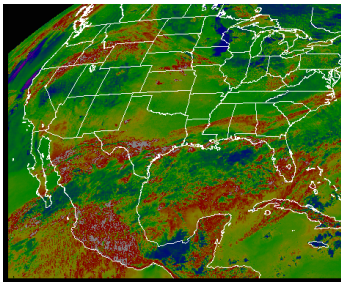
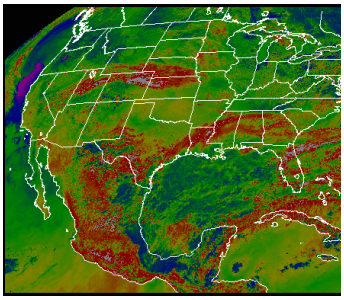
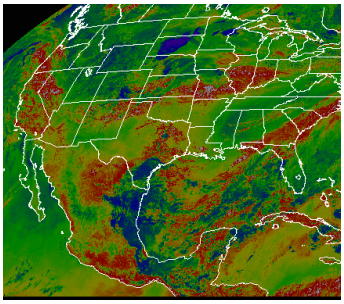
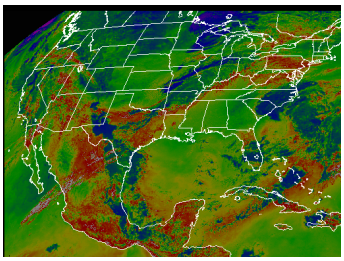
Cloud observation entry into the GLOBE Cloud Observer App.

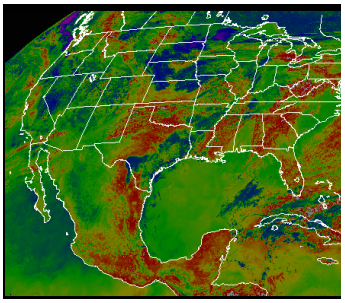
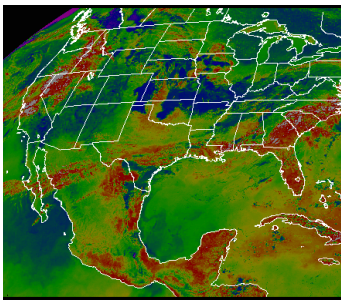
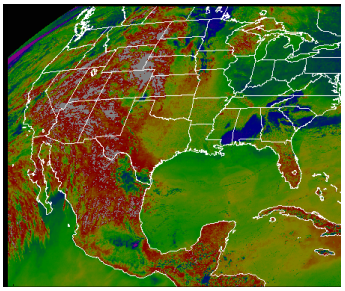
Data entry on GLOBE website.

			(Brightness Temperature)	Cloud Altitude	Altitude	Observations	
2/26/19	12:38	17:38	-45	N/A	N/A	3	
2/27/19	11:44	16:44	-65	4.6 (km)	7 (km)	4	
2/28/19	12:38	17:38	-43	3.68 (km)	8.61 (km)	3	
3/1/19	12:17	17:17	-46	N/A	N/A	5	
3/2/19	1:17	18:17	-67	2.2 (km)	N/A	5	
3/3/19	1:22	18:22	-41	5.21 (km)	7.64 (km)	5	

3/4/19	12:31	17:31	-47	N/A	N/A	5	
3/5/19	12:00	17:00	-40	No Clouds	No Clouds	0	
3/6/19	12:32	17:32	-46	N/A	N/A	3	
3/7/19	11:45	16:45	-50	2.55 (km)	No Clouds	4	
3/8/19	12:32	17:32	-49	N/A	N/A	5	
3/9/19	10:54	15:54	-46	N/A	N/A	2	

3/10/19	12:38	18:38	N/A	N/A	N/A	5	N/A
3/11/19	11:29	17:29	-89	3.48 (km)	8.16 (km)	2	
3/12/19	12:29	18:29	-55	No Clouds	No Clouds	2	
3/13/19	11:46	17:46	-84	N/A	N/A	2	
3/14/19	N/A	N/A	N/A	N/A	N/A		N/A
3/15/19	11:52	17:52	-78	5.97 (km)	10.17 (km)	4	
3/16/19	2:45	20:45	-46	N/A	N/A	1	

3/17/19	1:15	19:15	-44	No Clouds	No Clouds	2	
3/18/19	12:30	18:30	-50	2.4 (km)	No Clouds	6	
3/19/19	11:51	17:51	-48	3.18 (km)	No Clouds	0	
3/20/19	12:32	18:32	-70	N/A	N/A	4	
3/21/19	N/A	N/A	N/A	N/A	N/A		N/A
3/22/19	N/A	N/A	N/A	N/A	N/A		N/A
3/23/19	N/A	N/A	N/A	N/A	N/A		N/A

3/24/19	1:04	19:04	-62	3.56 (km)	No Clouds	3	
3/25/19	11:41	17:41	-50	3.93 (km)	7.72 (km)	5	
3/26/19	12:32	18:32	-42	N/A	N/A	0	

Discussion

The results mean that split water vapor can correlate to some meteorological measurements. The table helped to analyze and identify the numerical values of clouds as well as compare split water vapor with clouds. Possible sources of error could include the assigning of numerical values to clouds. Another factor could include the vapor with a time shift of daylight saving thus making solar noon change. Similar studies that correlated to the context of research were not found. The results that were drawn have answered the research question of, what is the correlation between cloud coverage and split water vapor. The results drawn answered the research question by providing insight on how more water vapor in the sky means that the thickness of clouds may increase compared to if there was less water vapor the clouds would be thinner.

Conclusion

The results have concluded that there is little to no correlation between total cloud cover and split water vapor. The data also shows that there is a little correlation between mid-level clouds and split water vapor. However, there is a consistent correlation between high-level clouds and split water vapor. This conclusion was reached by looking at GOES-16 images, split water vapor data, brightness temperature data, and high along with mid-level altitude data in satellite matches. This research is important to the community because local and worldwide meteorologists as well as climatologists could use this information to predict upcoming weather events that could possibly endanger the community. This information could also be used to identify supercell thunder clouds. Future GLOBE research might be to develop protocols that use ABI data from GOES, because the GOES-R series is a satellite partner of the GLOBE program.

Badges

- Be a Data Scientist

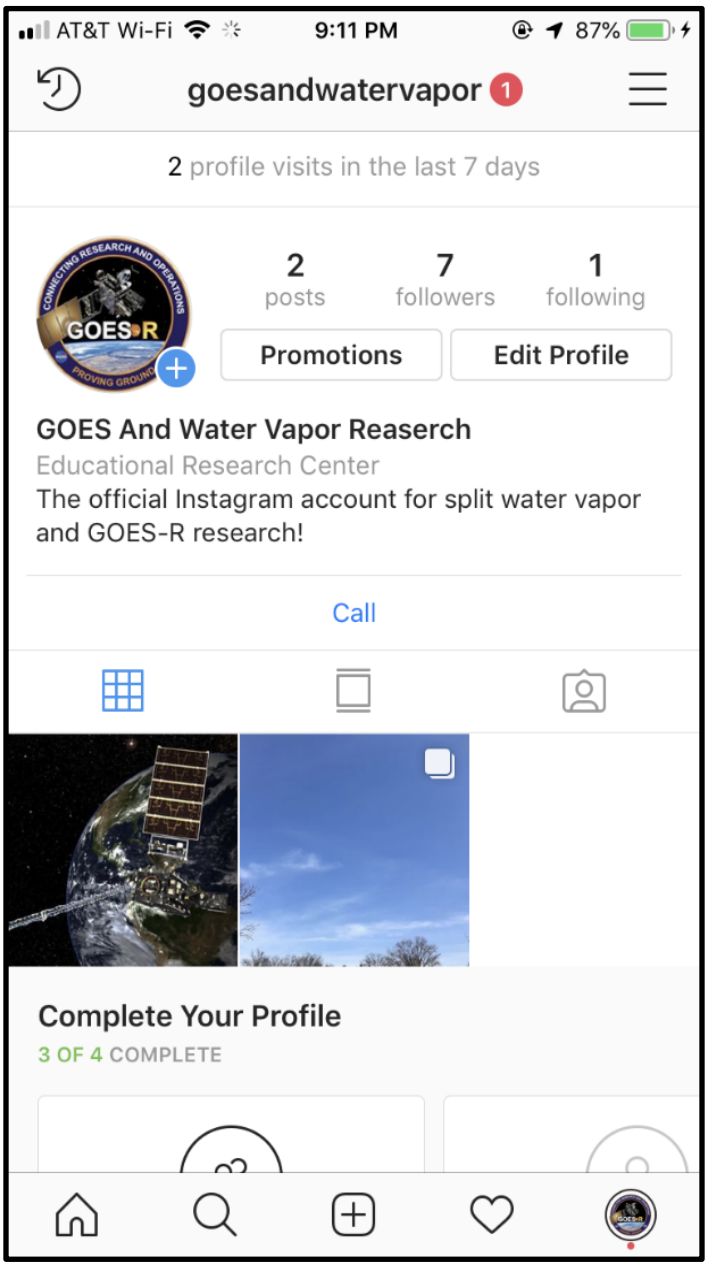
We would like this badge because we analyzed multiple data sets and compared them in different ways.

- Be a STEM Professional

We believe we earned this badge because we collaborated with Dr. Tim Schmit, University of Wisconsin, CIMSS and NOAA. His input was invaluable to our research.

- Be a STEM Storyteller

On Instagram, we created an account that shares our data and will spread knowledge to people interested in our topic. Scientific literacy can be spread and our account will also spread knowledge on how we have used GOES-16 to answer our research question. (https://www.instagram.com/goesandwatervapor/?hl=en). See image on next page!


AT&T Wi-Fi
9:11 PM
87%
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1
2 profile visits in the last 7 days
2
posts
7
followers
1
following
Promotions
Edit Profile
GOES And Water Vapor Reaserch
Educational Research Center
The official Instagram account for split water vapor and GOES-R research!
Call
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3 OF 4 COMPLETE

Bibliography/Citations

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http://cimss.ssec.wisc.edu/goes/OCLOFactSheetPDFs/ABIQuickGuide_SplitWV_BTDiffv2.pdf
Split Water Vapor Fact Sheet

http://rammb-slider.cira.colostate.edu/?sat=goes-16&z=0&im=12&ts=1&st=0&et=0&speed=130&motion=loop&map=1&lat=0&opacity%5B0%5D=1&opacity%5B1%5D=0.5&hidden%5B0%5D=0&hidden%5B1%5D=0&pause=0&slider=3760&hide_controls=0&mouse_draw=0&follow_feature=0&follow_hide=0&s=rammb-slider&sec=conus&p%5B0%5D=band_13&p%5B1%5D=split_window_difference_10_3-12_3&x=5000&y=5000
Real time data from Split Water Vapour from e-mail

https://www.globe.gov/documents/10157/21723051/161103GLOBE-IVSS+BADGES_6-8.pdf/26104574-8548-40ad-a56c-cedcc29915a3
IVSS Rubric^^

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Rubric

OWL Writing
https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_formatting_and_style_guide/footnotes_and_endnotes.html

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