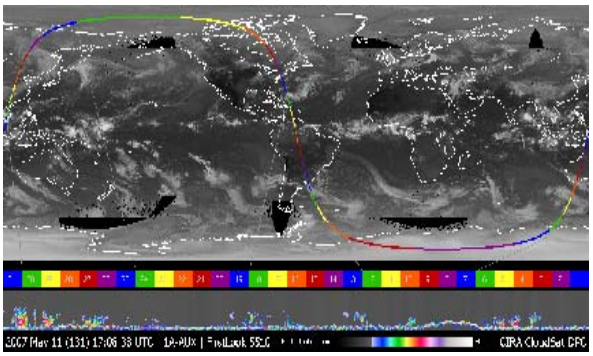
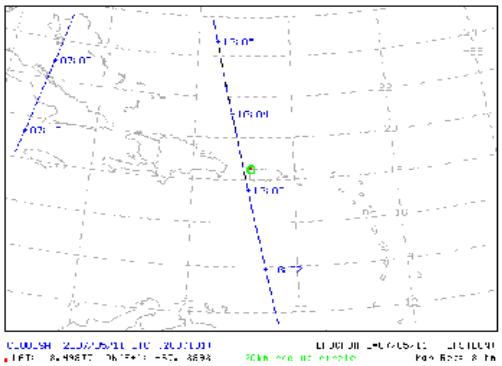
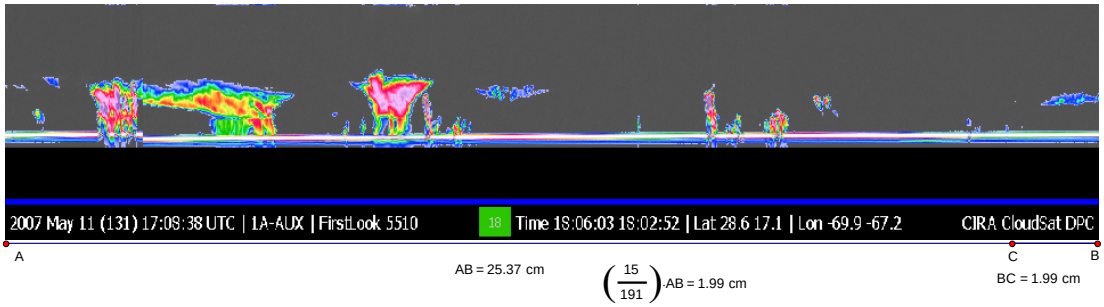
How to Determine Your Location on an Orbit Segment from a Quicklook Image of the CloudSat Overpass?







Site name is: Ramey_School_PR, Spacecraft is: CLOUDSAT
Geodetic latitude = 18.50N, Longitude = 67.14W, Geocentric latitude = 18.38N, Local radius = 6376.0km

GMT				Satellite	Satellite	Viewing	Solar	Relative	Scat ang	Glint	Satellite	Satellite	Dist to
year	mo	da	hr mn sc	azimuth	elevation	zenith	zenith	azimuth	(bk=180)	prob(%)	heading	direction	site (km)
2007	5	11	18 3 7	257.75	87.10	2.90	23.39	15.02	159.40	30.43	347.72	ascend	32.02

GLE Research Team 2008

By:
Ainimer Quiñones
Natalia Justiniano
Francine Roettger
Keishla Valle

Ramey School
201 Arch Road
Aguadilla, Puerto Rico
00603

GLOBE Teacher:
Mr. Richard Roettger

Abstract

After making many observations using the CloudSat Total Sky Imaging protocol, we wanted to compare our observations with the CloudSat Quicklook image. This quest lead us to the question “How can we determine our school’s location along the orbital segment of a CloudSat Quicklook image?”

We believe that multiplying the total distance of a Quicklook image by the ratio of time from beginning of a segment to the predicted time of overpass to the total time of a segment will be the distance of that location from the beginning of a segment. We used the software program *Geometer's Sketchpad* to copy and paste the orbit segment Quicklook image and measure the total distance of the segment. From the calculated distance of the location using ratio of times, we measured the distance to determine the location of our school on the orbit segment Quicklook image.

To verify our procedures for calculating the location on the segment Quicklook image, we used the small, isolated Island of Desecheo as a topographical landmark. Using the predicted time for overpass of Desecheo Island, we could calculate the distance from the beginning of the segment to Desecheo and compare it with the distance of the topographical landmark. We compared the calculated location and the topographical location of Desecheo and concluded that it was not a good match.

After double checking our predicted time of overpass, calculations and getting the same results, we checked with the scientists responsible for the predicted time of overpass and the times on the CloudSat Quicklook image. They assured us that the times were accurate and our calculations should work. It was suggested that the GTOPO30 dataset used for the topographic profile of a Quicklook image might not be accurate for

Desecheo Island. Personnel from the US Geological Survey confirmed the input error for Desecheo Island on the GTOPO30 dataset.

With the reassurances from the different scientists that our protocol for determining a location on the CloudSat Quicklook image should work quite accurately; we feel confident that our hypothesis is correct. If the verification using Desecheo matches our calculation as expected, we will be very happy. We are pleased that we were able to detect an error in the GTOPO30 dataset for Desecheo Island as a result of the verification process using our protocol.

Research Question/Hypothesis

In order to make a comparison of our cloud observations with the radar data from the CloudSat Quicklook image of an overpass, we need to be able to find our location on the segment of that overpass. We believe that multiplying the total distance of a Quicklook image by the ratio of time from beginning of a segment to the predicted time of overpass to the total time of a segment will be the distance of that location from the beginning of a segment.

Materials and Method

To test our hypothesis we used the software program *Geometer's Sketchpad.* We copied and pasted the uncompressed orbit segment Quicklook image and measured the total distance of the segment. Multiplying this distance by ratio of times, we obtained the distance to the location of our school on the orbit segment Quicklook image.

After applying our procedures using Ramey School's latitude and longitude to find our location on the CloudSat Quicklook image, we did not have a way to verify our calculations. (See Image 1) When the overpass was to our west we noticed on four occasions, a small brown dot on the relative topography window of the Quicklook image. We believe this topographic landmark is the small isolated Island of Desecheo located about 40 km to our southwest. We decided to apply our procedure using Desecheo Island to locate its location on the Quicklook image to compare and verify how accurate our calculated location with the topographical landmark.

Below are our detailed procedures using Geometer's Sketchpad or a formatted Word document to determine your location on a segment from a CloudSat Quicklook image. If you do not have Geometer's Sketchpad program you can use the "Direction on How to Find Your Location on a Segment from CloudSat Quicklook Image Using Microsoft Word Document" protocol to replicate our calculations.

Direction on How to Find Your Location on a Segment from a CloudSat Quicklook Image Using Geometer's Sketchpad

Items you will need:

-Your location's latitude and longitude (decimal format)
-Time of overpass of your location
-Segment of the CloudSat Quicklook Image
- *Geometer's Sketchpad Software*

Procedures:

Time of Overpass of Your Location

- Enter your longitude and latitude on NASA LaRC Satellite Overpass Predictor Website: http://www-angler.larc.nasa.gov/cgi-bin/predict/cloudsat.cgi
- Set **date of overpass** for the date you are searching
- Limit solar zenith angle to: "Click **day** only"
- Click submit
- Record **time of overpass** (Hour, Minute, Second) Time will be in UT (universal time)

Note: Use the predictor to find the time of overpass **after** the actual day of overpass. This will be the most reliable time of overpass.

The Segment of CloudSat Quicklook Image for Your Location

- Go to the CloudSat Data Processing Center's website: http://www.cloudsat.cira.colostate.edu/dpcstatusQL.php
- Locate and click on the granule number that corresponds with your date and time of overpass
- Locate and click on the color segment of overpass that corresponds with your location
- Right click on the "opened" segment to copy and paste

Measuring and Calculating Your Location Directions Using Geometer's Sketchpad

After copying and pasting the segment on a Geometer's Sketchpad sketch

- Minimize the segment to fit the page
- Construct a line segment from one edge of the image to the other
- Highlight the endpoints of the segment then go to **measure**, and then click on **distance**. You will then have the **Total Distance**

- Calculate the **Time of Overpass** by subtracting the beginning time of segment from time of overpass[NASA LaRC Satellite Overpass Predicator]
- To calculate the **Total of Time** of the segment you subtract the beginning time from the ending time of the segment.
- Calculate the **Ratio of Time** by dividing **Time of Overpass** by **Total Time of Segment**
- Multiply **Ratio of Time** by **Total Distance** of segment. This is **Your Distance from Beginning of Segment** (**Your Location on the Segment**)
- Construct a new line segment from the beginning of the image to **Your Distance from Beginning of Segment**
- Highlight the endpoints of this segment then go to **measure**, and then click on **distance**. Drag the endpoint until distance matches **Your Distance from Beginning of Segment**
- The endpoint will be **Your Location on the Segment**

It is time to compare your cloud observations with the CloudSat Quicklook Image!

Direction on How to Find Your Location on a Segment from CloudSat Quicklook Image Using Microsoft Word Document

Items you will need:

-Your location's latitude and longitude (decimal format)
-Time of overpass of your location
-Segment of the CloudSat Quicklook Image
-Ruler

Procedures:

Time of Overpass of Your Location

- Enter your longitude and latitude on NASA LaRC Satellite Overpass Predictor Website: http://www-angler.larc.nasa.gov/cgi-bin/predict/cloudsat.cgi
- Set **date of overpass** for the date you are searching
- Limit solar zenith angle to: Click **day** only
- Click submit
- Record **time of overpass** (Hour, Minute, Second) Time will be in UT (universal time)

Note: Use the predictor to find the time of overpass **after** the actual day of overpass. This will be the most reliable time of overpass.

The Segment of CloudSat Quicklook Image for Your Location

- Go to the CloudSat Data Processing Center's website: http://www.cloudsat.cira.colostate.edu/dpcstatusQL.php
- Locate and click on the granule number that corresponds with your date and time of overpass
- Locate and click on the color segment of overpass that corresponds with your location
- Right click on the "opened" segment to copy and paste in a Microsoft Word document

Microsoft Formatting Directions

After copying and pasting the segment on a Microsoft Word document

- Go to File and press Page Setup
- Press Margins tab and click landscape orientation, then ok
- Right click on the segment image and click format picture
- Click on Size tab and change the width to 9 inches (size and rotation)
- Leave **look aspect ratio** and **relative to original picture size** with check marks
- Write date, time of overpass, segment number and granule number

- Print a copy

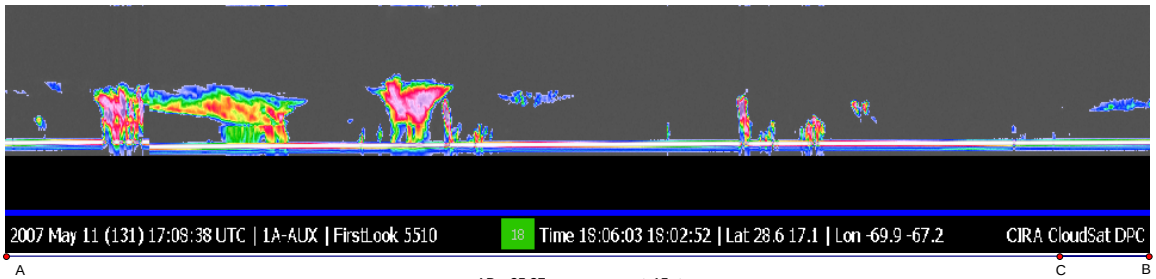
Measuring and Calculating Your Location Directions

- With a centimeter ruler, measure the distance from one edge of the segment to the other to find the **Total Distance**
- Calculate the **Time of Overpass** by subtracting the beginning time of segment from time of overpass[NASA LaRC Satellite Overpass Predicator]
- To calculate the **Total of Time** of the segment you subtract the beginning time from the ending time of the segment.
- Calculate the **Ratio of Time** by dividing **Time of Overpass** by **Total Time of Segment**
- Multiply **Ratio of Time** by **Total Distance** of segment. This is the **Your Distance from Beginning of Segment** (**Your Location on the Segment**)
- With a centimeter ruler measure **Your Distance from Beginning of Segment**
- The endpoint will be **Your Location on the Segment**

It is time to compare your cloud observations with the CloudSat Quicklook Image!

Data Summary

Image 1



AB = 25.37 cm

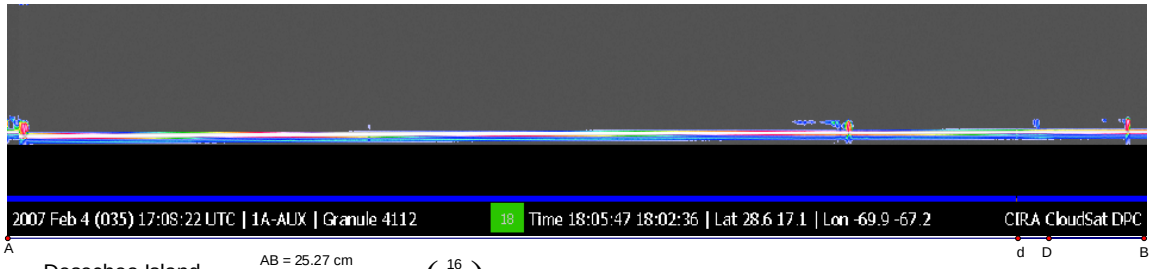
$\left(\frac{15}{191}\right)$.AB = 1.99 cm

BC = 1.99 cm

Site name is: Ramey_School_PR, Spacecraft is: CLOUDSAT
Geodetic latitude = 18.50N, Longitude = 67.14W, Geocentric latitude = 18.38N, Local radius = 6376.0km

GMT				Satellite	Satellite	Viewing	Solar	Relative	Scat ang	Glint	Satellite	Satellite	Dist to
year	mo	da	hr mn sc	azimuth	elevation	zenith	zenith	azimuth	(bk=180)	prob(%)	heading	direction	site (km)
2007	5	11	18 3 7	257.75	87.10	2.90	23.39	15.02	159.40	30.43	347.72	ascend	32.02

Image 2



Desecheo Island
18.383298N
67.472714W
February 4 2007
18:02:52
VZ 0.20

AB = 25.27 cm

$\left(\frac{16}{191}\right)$.AB = 2.12 cm

Bd = 2.81 cm BD = 2.12 cm

$\left(\frac{BD}{AB}\right)$.191 = 16.02

$\left(\frac{Bd}{AB}\right)$.191 = 21.22

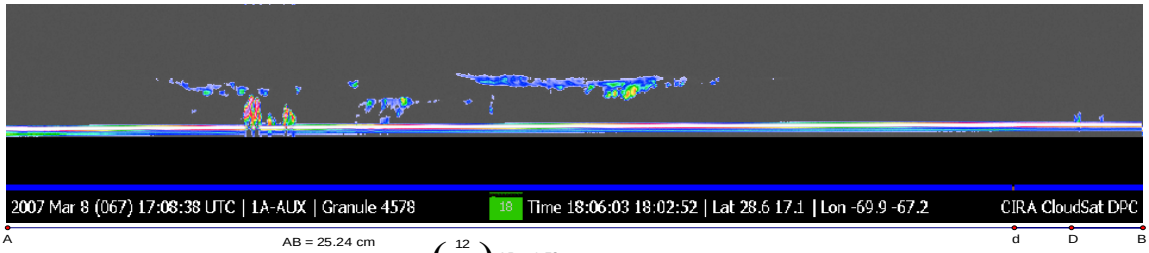
21.22-16.02 = 5.20

An absolute difference of 5.2 seconds

DESECHEO ISLAND CLOUDSAT Overpass Prediction at latitude= 18.385214° longitude(E+)= -67.469457°
Geodetic latitude = 18.38N, Longitude = 67.47W, Geocentric latitude = 18.27N, Local radius = 6376.0km

GMT				Satellite	Satellite	Viewing	Solar	Relative	Scat ang	Glint	Satellite	Satellite	Dist to
year	mo	da	hr mn sc	azimuth	elevation	zenith	zenith	azimuth	(bk=180)	prob(%)	heading	direction	site (km)
2007	2	4	18 2 52	76.32	89.80	0.20	39.61	134.46	140.25	6.72	347.70	ascend	2.18

Image 3



AB = 25.24 cm

$\binom{12}{191}$.AB = 1.59 cm

Bd = 2.86 cm BD = 1.59 cm

Desecheo Island
18.383298N
67.472714W
March 8 2007
18:03:04
Viewing Zenith 0.18

$\binom{BD}{AB}$.191 = 12.01

21.62-12.01 = 9.61

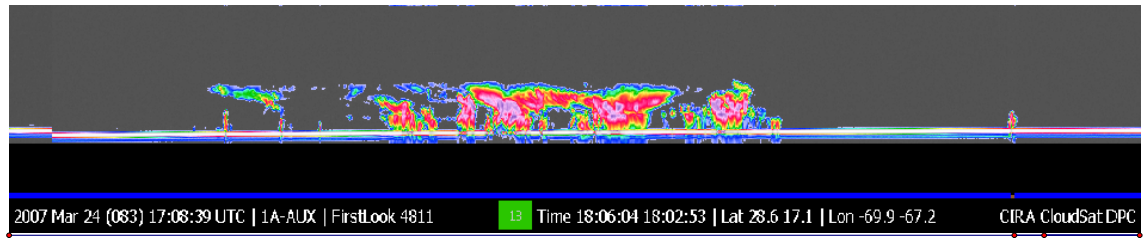
$\binom{Bd}{AB}$.191 = 21.62

An absolute difference of 9.61 seconds

Desecheo Island CLOUDSAT Overpass Prediction at latitude= 18.385214° longitude(E+)= -67.469457°
Geodetic latitude = 18.38N, Longitude = 67.47W, Geocentric latitude = 18.27N, Local radius = 6376.0km

GMT				Satellite	Satellite	Viewing	Solar	Relative	Scat ang	Glint	Satellite	Satellite	Dist to
year	mo	da	hr	mn	sc	azimuth	elevation	zenith	zenith	azimuth (bk=180)	prob(%)	heading	direction	site (km)
2007	3	8	18	3	4	78.63	89.82	0.18	30.81	144.78	149.05	19.61	347.71	ascend	1.96

Image 4



AB = 25.06 cm

$\binom{16}{191}$.AB = 2.10 cm

Bd = 2.78 cm BD = 2.12 cm

Desecheo Island
18.383298N
67.472714W
March 24 2007
18:03:09
Viewing Zenith 0.00

$\binom{BD}{AB}$.191 = 16.14

21.18-16.14 = 5.04

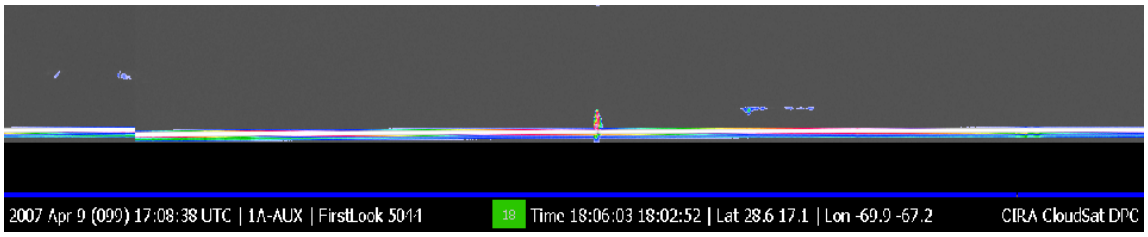
$\binom{Bd}{AB}$.191 = 21.18

An absolute difference of 5.04 seconds

Desecheo Island CLOUDSAT Overpass Prediction at latitude= 18.385214° longitude(E+)= -67.469457°
Geodetic latitude = 18.38N, Longitude = 67.47W, Geocentric latitude = 18.27N, Local radius = 6376.0km

GMT				Satellite	Satellite	Viewing	Solar	Relative	Scat ang	Glint	Satellite	Satellite	Dist to
year	mo	da	hr	mn	sc	azimuth	elevation	zenith	zenith	azimuth (bk=180)	prob(%)	heading	direction	site (km)
2007	3	24	18	3	9	276.71	90.00	0.00	27.18	42.39	152.82	27.79	347.72	ascend	0.05

Image 5



A d D B

Desecheo Island
18.383298N
67.472714W
April 09 2007
18:03:08
Viewing Zenith 0.09

AB = 25.29 cm

$\binom{16}{191}$.AB = 2.12 cm

BD = 2.12 cm

Bd = 2.78 cm

$\binom{BD}{AB}$.191 = 15.98

$\binom{Bd}{AB}$.191 = 20.98

20.98-15.98 = 5.00

An absolute difference of 5.00 seconds

year	mo	da	hr	mn	sc	GMT azimuth	Satellite elevation	Satellite zenith	Viewing zenith	Solar azimuth	Relative Scat ang (bk=180)	Glint prob(%)	Satellite heading	Satellite direction	Dist to site (km)
2007	4	9	18	3	8	78.34	89.91	0.09	24.76	169.23	155.15	34.84	347.72	ascend	1.04

Image 6

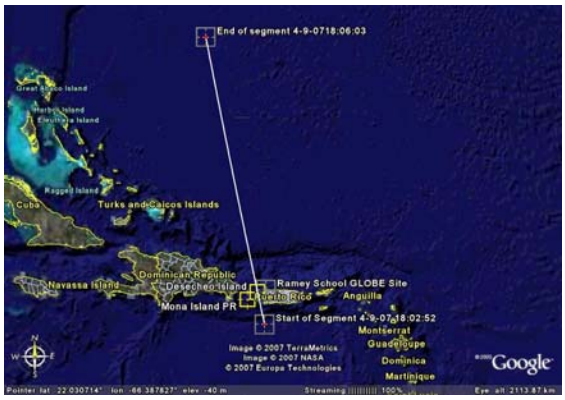


Image 7

Analysis and Results

The four times that Desecheo Island appeared as a topographical landmark on the CloudSat Quicklook image, we performed the calculations and found that our calculated location and the topographic location of Desecheo Island did not match. To compare the differences, we multiplied the total time of the segment by the ratio of distance from the start of the segment to the total distance of segment to calculate the time from the beginning of the segment for the calculated and topographical locations of Desecheo Island. Since CloudSat is traveling approximately 6.9 km/s at the surface, multiplying the difference in time by 6.9 km/s will be the distance between the topographical and calculated locations of Desecheo Island. Since the approximate distance of a segment from a Quicklook image is 1315 km, our differences in distances between the topographical and calculated location of Desecheo Island is relatively small. (See Images 2 to 5)

The differences in time and distance from each location are listed in the table below.

Date of CloudSat Overpass of Desecheo Island	Difference in Time from the Topographical and Calculated Locations of Desecheo Island (seconds)	Distance Between the Topographical and Calculated Locations of Desecheo Island (kilometers)
February 4, 2007	5.20	36
March 8, 2007	9.61	66
March 24, 2007	5.04	35
April 9, 2007	5.00	35

We were still not satisfied with our results, which lead us to contact Don Reinke of the CloudSat Data Processing Center to verify that the times stamped on the Quicklook images were accurate. We contacted Louis Nguyen of the NASA Langley Satellite

Overpass Predictor Site to verify that the predicted times of overpass were accurate. They both confirmed that the times we were using for our calculations were accurate. Don Reinke thought that the differences in our calculated location and the topographical location of Desecheo Island could be that the “brown dot” is not Desecheo Island or there could be an error with the GTOPO30 topographic database or there is another island north of Desecheo Island. Using Google Earth we verified our latitude and longitude (18.383298 N, 67.472714 W) of Desecheo Island that was used to obtain the predicted time of overpass. Plotting the stamped latitude and longitude from the Quicklook image for the overpass segment on Google Earth (See images 6 to 7) we verified that CloudSat passed over Desecheo Island. There is no island north of Desecheo Island, so Don Reinke suggested we contact someone from the U.S. Geological Survey working with the GTOPO30 database. We contacted Darin VanBerg of the Earth Resources Observations and Science and verified that our latitude and longitude for Desecheo Island was only off by 0.25 km east of the center using Landsat 5 database. Even though the GTOPO30 database for Puerto Rico was a good match, it appears that Desecheo Island was not positioned correctly because of inaccuracies of the input of the data sources used to create the output in the GTOP30 database. Darin mentioned that EROS is currently in the process of planning to update the GTOPO30 dataset within the next 18 months with more accurate and up-to-date input data.

CONCLUSIONS

After the analysis of our verification calculations using Desecheo Island as a topographical landmark we were not completely satisfied with its accuracy. Even though our differences in distance between the topographical and calculated location of Desecheo Island were relatively small, we felt that there should be a much smaller difference. It would have been great if they matched at first. We would have been satisfied that our procedures for locating your position on a CloudSat Quicklook image worked and our hypothesis was correct. Since this was not the case we had to find out why it was not correct.

In the process of discovering why there was not a good match, we discovered an error in the GTOPO30 dataset used for the topographic window of the CloudSat Quicklook image thanks to the support of Don Reinke and Darin VanBerg. With the reassurance from both of these scientists that our calculation should give accurate results, we now feel very confident that our hypothesis is correct.

Now that we have developed a protocol for locating your position on an orbital segment of a CloudSat Quicklook image, other students and schools can accurately compare their cloud observation with the radar data from the CloudSat Quicklook image.

Discussion

Ramey School is a member of the CloudSat Educational Network (CEN) which uses CloudSat total sky imaging protocol to collect data from the Earth's surface to compare with the satellite's radar data. During this project we collected the following data: the current temperature, the types of clouds, the percentage of cloud cover, cloud images, and the precipitation at the time of the CloudSat of our school.

The CloudSat satellite is a member of the A–Train constellation of polar-orbiting satellites (Aqua, CloudSat, CALIPSO, PARASOL, and Aura) which collects a variety of atmospheric data. The scientists use this data of Earth's energy balance and water cycle in order to have a better understanding of climate changes, making better weather prediction and forecasts among many other advances. The better understanding we have of clouds and the interactions with our atmosphere, the better our community will be prepared for future floods, droughts, hurricanes and other types of natural disasters. This is critical for sustainable communities to raise crops, plan for development in suitable location, plan for adequate water supplies, and other additional factors.

The purpose of our research project was to develop a method to find our location on the CloudSat Quicklook image so that we could compare our observation with the radar image. Even thought we were not able to verify our methods using the topographic landmark of Desecheo Island, we located an error in the GTOPO30 database for Desecheo Island. We are looking forward to when the USGS updates the GTOPO30 dataset with the accurate location of Desecheo Island so we can repeat our research project with accurate results.

Acknowledgements and Bibliography

Don Reinke
Cooperative Institute for Research in the Atmosphere (CIRA)
CloudSat Data Processing Center Implementation Manager
1375 Campus Delivery
Colorado State University
Fort Collins, CO 80523-1375
reinke@cira.colostate.edu

Darin VanDeBerg
Data and Applications Support
Science Applications International Corporation (SAIC)
Contractor to U.S. Geological Survey
Earth Resources Observations and Science (EROS)
Sioux Falls, SD 57198
Tel: 605-594-6151 (x6954)
Tel: 800-252-4547
Fax: 605-594-6589
dvandeberg@usgs.gov

Louis Nguyen
National Aeronautics and Space Administration
Langley Research Center
Hampton, VA 23681
l.nguyen@NASA.GOV

Debra K. Krumm, Ph.D.
Director of Outreach
NASA CloudSat Mission
Colorado State University
Department of Atmospheric Science
1371 Campus Delivery
Fort Collins, CO 80523-1371
Voice: 970-491-8790
Fax: 970-491-8166
dkrumm@atmos.colostate.edu

WEBSITES

Predicted Time of Overpass
http://www-angler.larc.nasa.gov/cgi-bin/predict/cloudsat.cgi

CloudSat Quicklook Image
http://www.cloudsat.cira.colostate.edu/dpcstatusQL.php

Description of Quicklook Image Features
http://www.cloudsat.cira.colostate.edu/images/QuicklookFAQ.pdf

Google Earth Resources
http://www.cloudsat.cira.colostate.edu/resourcesGE.php

CloudSat's Education and Outreach Page
http://cloudsat.atmos.colostate.edu/education

CloudSat Total Sky Imaging Protocol (Modified From 2003 GLOBE Teacher's Guide)
http://cloudsat.atmos.colostate.edu/cen/CloudSat_Total_Sky_Imaging_Protocol.pdf

CloudSat Total Sky Imaging Protocol
http://cloudsat.atmos.colostate.edu/cen/Total_Sky_Imaging_Field_Guide_Feb07.pdf

Overview of the CloudSat Education Network
http://cloudsat.atmos.colostate.edu/cen/overview.doc

Special CEN CloudSat Quadrant Protocols
http://cloudsat.atmos.colostate.edu/cen/quadrantinstructs.pdf

Special CEN Precipitation Protocols
http://cloudsat.atmos.colostate.edu/cen/precipinstructs.pdf

Geometer's Sketchpad software
http://www.dynamicgeometry.com/index.php