The CloudSat Downlink

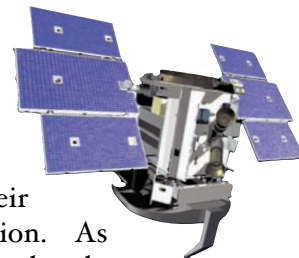## CLOUDSAT Our View into the Clouds

A (Re)-Introduction to the science of the space-borne cloud radar and it's study of the nature of clouds and precipitation – by Todd Ellis

At 3:02 am PDT on April 28, 2006, a Delta II launch vehicle lifted off from Vandenberg Air Force Base in California carrying two NASA satellites into orbit. These two satellites, CloudSat and CALIPSO, became part of a constellation of satellites known as the "A-Train" all focused on learning more about the Earth's atmosphere and many of the factors that affect our weather and climate.

CloudSat's mission is to study clouds and their roles in governing the Earth's weather and climate. Using its special cloud radar, CloudSat continually measures the distribution of clouds around the Earth and by telling us how much water is in those clouds. This also lets us identify types of clouds and discover which clouds are raining when there's no one underneath them to measure the rain. Since its launch, scientists have used CloudSat data in over one hundred scientific studies about clouds and the Earth's atmosphere.

So why is this important? To understand this, take a moment and think about all of the things clouds do. Every drop of precipitation was once part of a cloud. So clouds as part of the water cycle – also known as the hydrologic cycle – are really important to life on Earth as we know it. Ever notice how clouds can look different from other clouds? The appearance of clouds gives us clues that they are important for regulating the amount of energy coming in from the sun and that thicker clouds can reflect much of that light to space. Clouds also affect the energy we can't see. keeping the surface

CloudSat's Launch in April 2006

warm with their infrared radiation. As you can see, clouds are much more than pretty things to look at in the sky.

Climate change will cause changes in clouds as well. Scientists are using data from CloudSat to understand what might happen to clouds if the atmosphere warms. Could clouds make climate changes bigger or smaller? That is an question to which CloudSat is beginning to help us find answers.

As part of CloudSat's mission, the CloudSat Education Network (CEN) helps to train schools around the world to observe the clouds when CloudSat is passing overhead. We can use student observations to validate what CloudSat measures, thereby helping us to make sure that the water CloudSat observes is consistent with the kind of cloud our eyes would see.

In this edition of the *CloudSat Downlink*, we at the CEN are sharing with you the best resources about clouds and the Earth's climate to help you learn about the what we do. In the rest of the newsletter, we will remind you how to find CloudSat Quicklooks – snapshots of the clouds CloudSat is measuring. We have prepared a list of resources related to observing and understanding clouds. And we've included information about the CEN, what we do and how to get involved in case you or another school want to join us for the next few years of learning about clouds with CloudSat!

THE CLOUDSAT QUICKLOOK - SHOW STUDENTS WHAT'S IN THOSE CLOUDS!

On the CloudSat webpage, you can access radar images of the structure of clouds from CloudSat within 24 hours of a recent overpass. Let's take a guided tour of these Quicklooks to see what they tell us so that you can use them in your classroom.

The Quicklook page gives you images like those to the right. The top image shows you where CloudSat passed over, superimposed over an infrared satellite image. The rainbow colored line shows different segments of that particular orbit, or granule, of the satellite data. If you click on a numbered segment, you can access the Cloud Penetrating Radar (CPR) image for that segment of the orbit (bottom image).
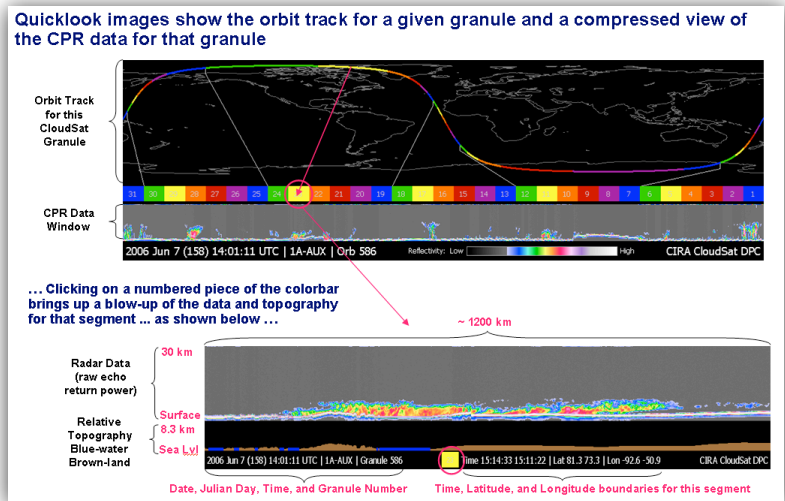
The CPR image shows the amount of reflected energy from the clouds being observed. The more water in the cloud, the more radar energy is reflected back to the radar sensor on the satellite. Places in the clouds with reds and yellows represent areas of clouds with lots of liquid water droplets, and likely locations of precipitation. Blues and greens represent clouds with lower amounts of liquid water, and indicate clouds that are thinner. The beauty of the CPR is that you can often see places where clouds high in the sky are covering lower clouds, unlike any other satellite.

To get started with your own Quicklooks, go to http://cloudsat.atmos.colostate.edu and select the link on the right for Quicklooks. The granules represent different orbits (keep in mind that the time listed is in UTC and you will need to convert to your local time first). It also may be helpful to remember that CloudSat crosses the equator at nearly 1:30 p.m. local and 1:30 a.m. local at your latitude. If you ever need help, please contact us and we'll help you find the images you are looking for.

TROPICAL CYCLONES AND HURRICANES FROM CLOUDSAT

One of the most amazing ways that CloudSat quicklooks have been used since its launch has been the examination of hurricanes and other tropical cyclones around the world. These images, which are always available on the CloudSat home page – http://cloudsat.atmos.colostate.edu – show the structure of the clouds in these amazing storms. Captured by CEN team member Natalie Tourville, these images can be a valuable learning tool for understanding how these storms work.

As an example, the figure to the right shows Typhoon Nida in the W. Pacific Ocean. Some of the features you can see are that that the eye gets wider as you go up, that the rainfall is so heavy that CloudSat radar can't see all the way to the surface, and that under those high clouds, low level clouds and storms were working in toward the center, bringing more energy to the storm. Come check out our collection of hurricanes and use them in your classes as well! And if you have questions, contact us and we can help you understand what you're seeing!
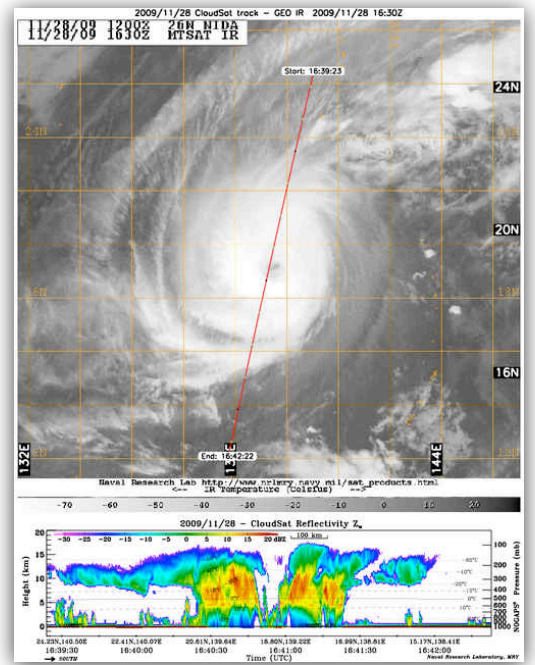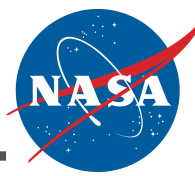
THE CLOUDSAT DOWNLINK - YOUR CONNECTION TO EDUCATIONAL RESOURCES

Look at all those CEN schools in Estonia! Now you can find out exactly where they are with a Google Earth file on our CEN website!

This newsletter, the CloudSat Downlink, is the sixth edition of our quarterly newsletter. In this newsletter, we try to keep you up to date with happenings with CloudSat and the CEN. We also provide you with reviews of recent books about clouds and weather, cool Quicklooks (with interpretation provided by a CEN scientist), and cloud or weather related demonstrations or mini-lessons that you can use in your classroom.

We encourage you to go to our website at http://cloudsat.atmos.colostate.edu/education where you can find an archive of our newsletters and their activities. And if you have ideas for cloud related activities, we encourage you to send them to us. Please email Dr. Todd Ellis at ellistd@oneonta.edu if you would like to contribute or if you would like more information about an article or activity.

JOINING THE CEN - BE A PART OF A NASA MISSION AND LEARN ABOUT THE CLOUDS

The CloudSat Education Network (CEN) is the Education and Public Outreach arm of the NASA CloudSat mission. Our goal is to help more people understand clouds and how they affect our weather and climate. This newsletter and the Education link on the CloudSat website are part of what we do. You can also find us at many national science and science teaching conferences throughout the year.

But perhaps the most important thing we do is to train interested schools to participate in the CloudSat mission by coming a CEN partner school. CEN partner schools, located all over the world, are GLOBE-trained schools that take special observations when CloudSat passes overhead. These special observations, including identifying different kinds of clouds in each direction as well as digital pictures

Students in Thailand observing clouds for the CEN

of the sky, are uploaded to the CEN where scientists can use them to see how well CloudSat identifies clouds from space. What's more is that we encourage and assist CEN schools in asking and answering their own questions about clouds use CloudSat and GLOBE observations.

So how do you join the CEN? First, you need to be GLOBE trained and report those observations for a few months regularly. At that point, we can train you in the additional cloud and rainfall observations that we require. This additional work happens only when CloudSat passes overhead, perhaps a few times a month at most.

Even if you aren't yet GLOBE trained, please contact Dr. Todd Ellis at ellistd@oneonta.edu if you are interested. Many of us are GLOBE trainers as well, and we are happy to work with you to get started as GLOBE and CEN schools and to help you study the clouds!

CLOUD RESOURCES - COURTESY OF THE CEN

Especially since the advent of the Internet, there have been a ridiculous number of resources about the weather for teachers to choose from. But finding the needles of good resources amongst all the hay makes finding what you need in a hurry a challenge. We at the CEN thought we would try to help by collecting some of our favorite cloud teaching and learning resources in one spot.

- First of all, if you want to learn about CloudSat and the A-Train, we have collected lots of NASA resources for teachers at http://cloudsat.atmos.colostate.edu/education/cloudsat_resources

- If you're interested in pictures of clouds for help in teaching about how to observe the sky, we have collected some top notch cloud imagery at: http://cloudsat.atmos.colostate.edu/education/cloud_resources

- Of course, for CloudSat Quicklooks, you can get to it from the CloudSat webpage: http://cloudsat.atmos.colostate.edu or directly at http://www.cloudsat.cira.colostate.edu/dpcstatusQL.php

- If you've not discovered it yet, please check out the Digital Library for Earth System Education (DLESE) with it's massive collection of activities and lesson plans for understand Earth and the atmosphere: http://www.dlese.org

- For more information on climate and climate change, and particularly about NASA research and observations, go to NASA's climate page: http://climate.nasa.gov. Especially check out the Jet Propulsion Lab (JPL) Eyes on the Earth 3D where you can see the satellites in orbit around the Earth!

- If you want to use real NASA data in your classroom, check out MyNASAData at http://mynasadata.larc.nasa.gov. Many of the lesson plans available here are developed by teachers for use in the classroom, and you may contribute some of your own as well!

Don't forget to send your cloud and CloudSat related questions to askascientist@atmos.colostate.edu
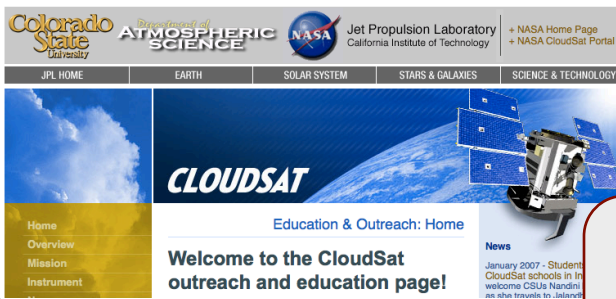

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These links and more can be found at the CEN webpage at http://cloudsat.atmos.colostate.edu/education