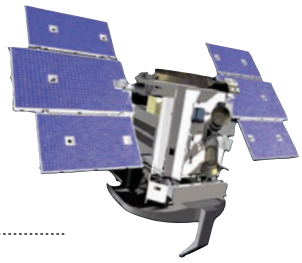
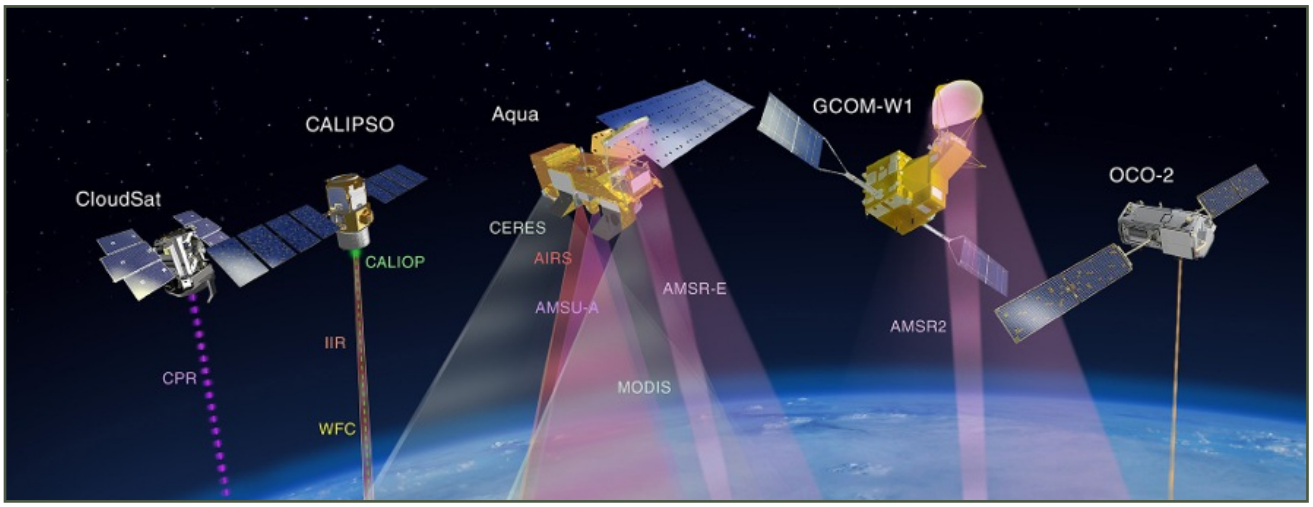
The CloudSat Downlink

CloudSat Battery Anomaly



The amazing story of recovery and saving a satellite while still in orbit 705 km above Earth – by Natalie Tourville

On April 17, 2011, NASA's cloud profiling radar (CPR) satellite, CloudSat experienced a battery anomaly that placed the spacecraft into emergency mode. In emergency mode, the spacecraft could not even power on the heaters as that simple action would draw too much power. Communication with the spacecraft was limited, a 10-minute window to upload commands was only available a few times per day and sometimes only every couple of days. The spacecraft kept faulting into emergency mode after each eclipse (when CloudSat would pass into nighttime observations) and require use of the survival heaters to keep the spacecraft heated at minimum levels.



A-Train satellite constellation.

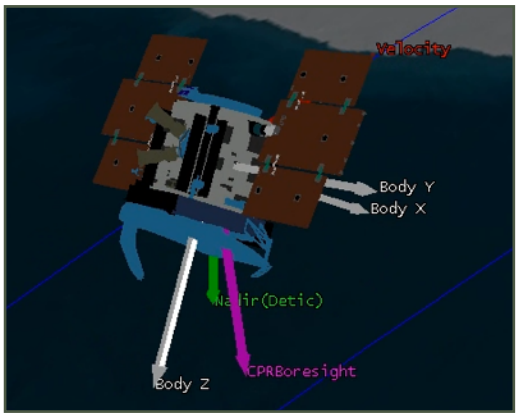
The team quickly decided that the first priority was to stabilize the spacecraft by reprogramming how the system responded to battery faults and changing thresholds for minimum operating voltage. CloudSat was built with a redundant power control system, engineers were able to use both of these power controls to operate the spacecraft in a new configuration. These new system parameters allowed the battery temperature to increase and limited the frequency of battery faults.

Once they were able to stabilize the satellite from constantly battery faulting, another factor impacting CloudSat was formation flying with other A-Train satellites. CloudSat was drifting outside of it's control box and in danger of impacting other satellites. CloudSat's spin rate was unstable and firing the system's thrusters to change position would endanger the already delicate power system. The team came up with a solution to manually control the heaters so they would not power on during eclipse operations, a pre-heating strategy.

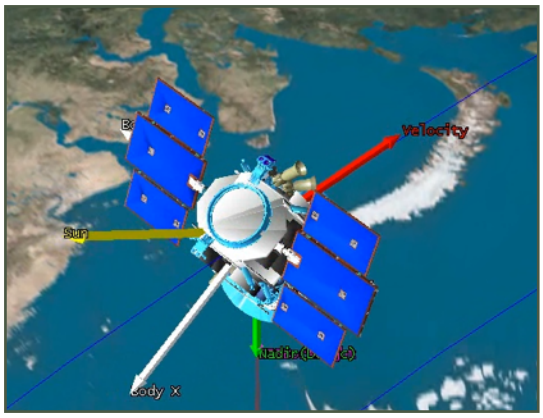
If the spacecraft could keep the temperatures warm enough during eclipse so the survival heaters wouldn't power on and fault the battery during eclipse that would give the spacecraft enough time to execute the sequence of steps to exit the A-Train. In mid-June of 2011, CloudSat successfully lowered it's orbit and exited the A-Train.

The success of pre-heating strategy paved the way for operations towards recovering the satellite from emergency mode. Engineers examining the system found the (CPR) was perfectly healthy and able to continue observations. But the battery onboard the spacecraft was unable to power the CPR during eclipse and only the power source available was from the solar arrays. The team then spent the next few months developing and testing a new operational mode that CloudSat would function in - Daylight Only Operations (DO-OP). DO-OP mode would require the CPR to cycle into a standby sequence when overpassing Earth while in eclipse (non-daylight portions of the orbit) and the solar panels bring in the energy to power the CPR during daylight portions.

CloudSat successfully resumed science operations on October 27, 2011 and re-entered the A-Train on May 15, 2012. None of this would be possible without the ingenuity, perseverance and dedication from CloudSat team.



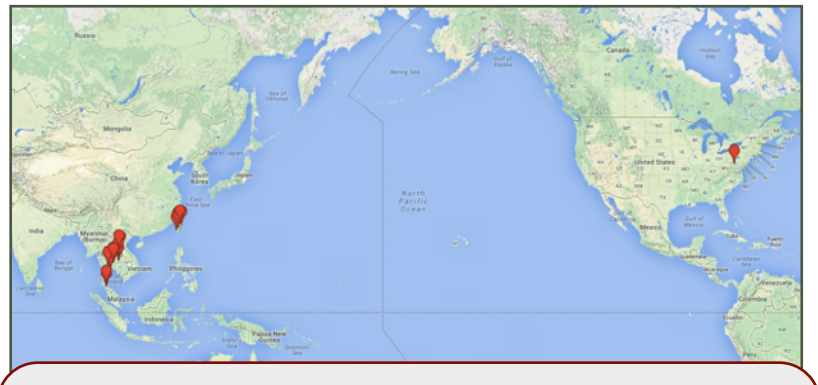
CloudSat during nighttime observations (solar panels pointed down).



CloudSat during daylight observations.

Check out our website http://cloudsat.atmos.colostate.edu/education where you can find an archive of our newsletters and their activities. If you have any ideas for cloud related activities let us know! 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.

THE CLOUDSAT DOWNLINK - YOUR



26 new CEN schools in Thailand, United States, and Taiwan were added in 2013-14!

INTERVIEW WITH A TEACHER: MRS.BRUCKER

We often speak of the importance of education in the development of young scientists. Good teachers help nurture curiosity and inspire students to pursue their interests and develop passions for different fields.

So how can a teacher help students develop such interests?

Annalisa Brucker of Wagner Ranch Elementary School is part of the CloudSat Education Network (CEN), a NASA funded education program based on student observations of clouds and collaboration with scientists in the field.

Mrs. Brucker learned of the program through a former colleague at Wagner Ranch, Carmen Gonzalez. Mrs. Gonzalez was part of the Global Learning and Observation to Benefit the Environment program (GLOBE), which is a hands-on science education program for primary and secondary school students. After having attended a GLOBE training session, Mrs. Gonzalez was excited to share her experiences and new knowledge – especially about CloudSat.

"It's not often that one can have their students become real scientists. CloudSat brings science to life. The students are actually interacting with the natural world around them – not just reading about in a book. "

With a better understanding of the world around them, students are able to connect what they learn in the classroom and field with real life. They develop a sense of appreciation for the natural world and so have bright futures in becoming future caretakers of the environment.

"I do not think that there are not too many children that don't find science interesting. I think we just need to spark their interests and then they're off. Science is the one subject that I have found a 'sea of hands' raised in the classroom – asking question upon question."

For some students, programs such as the CEN help shape their goals and futures. Mrs. Brucker recalls one student in particular that developed a great interest in weather and climate change and would return to present her middle school projects and share data. Such stories are a highlight of the potential educational programs can have on students.

"...several years ago I had a fifth grade student that CloudSat 'spoke to'... She would either present her project to my class or she would gather data from my students. During such moments I knew that CloudSat had been a change agent in her life. "

The next generation of scientists are often students who never stop asking questions and wondering more about the world around them. Teachers play a large role in nurturing their wonder and too often it is lost through static curriculums or textbook based lessons that do not appeal to many students. (continued on page 3...)

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"It would be wonderful if districts provided more in-service training incorporating or focusing on science... Globe and NASA have so many wonderful programs. I wonder how aware teachers are of these programs and resources. Time is something always needed in the field of education. I know my peers always appreciate good recommendations."

The CEN program not only helps the students find new interests and possibilities but also helps teachers learn more about how the world works along with helping them develop and renew their interests as well.

"I have learned a lot (content wise) from the program, but I also find such opportunities renew my interests, fueling me to be a better teacher."

Teaching is often considered an under-appreciated profession. We've all had teachers, good and not so good, some of which inspired us to greatness, and others not as memorable, whether they were teachers in our classrooms or not. What they impart on us along the way lasts longer than we realize. We do not always remember the math, science, or literature they teach us but we cannot deny that they have an influence over what we do now and where we might go.

When asked what she would be doing when not teaching?

".... I would be a stay home mom traversing the globe, but with a reality check I would do something with earth science – maybe be a geologist."

And the all-important question of which type of cloud is her favorite?

"Cumulus."

INTERVIEW WITH A SCIENTIST: DR. SUZUKI

The CloudSat mission provides important and unique data for scientists to work with. One such scientist is Dr. Kentaro Suzuki.

Dr. Suzuki is a research scientist here at JPL using and analyzing CloudSat data to study cloud microphysics, the fundamental process governing how clouds are formed and how precipitation occurs from the clouds. He evaluates computer climate models and compares the results to observation-based analyses in order to help

improve the models. Climate models often suffer from uncertainty of cloud processes so it is important to understand of how clouds function, and when and where they precipitate.

(continued on page 4...)

(Continued from page 3...)

With a Ph.D in Earth and Planetary Science from the University of Tokyo, Dr. Suzuki started out being interested in problem solving. Having been challenged by tricky geometry classes in junior high, his interest in problem solving coincided with his appreciation for the beauty of how mathematical procedures connect with the physical world. Thus he chose to study physics.

"I was attracted by beautiful patterns in some statistics of cloud variables obtained from satellite remote sensing, and my goal was to explain them using a numerical cloud model. This still is an important source of motivation for me to pursue research even now. I think I've learned how to find a motivation and how to enjoy scientific research from this experience."

Specializing in clouds came later during graduate school. Realizing he preferred studying physical rather than abstract topics, climate science was a natural step in his academic pursuit.

"I was so attracted at that time by how simply and beautifully different physical laws are connected through mathematical procedures such as differential equations."

His initial interest in science stemmed from a sight that many of us relate to: the stars.

"The first encounter to my interest in scientific thing[s] goes back to my kid time – I was attracted to see[ing] stars through telescope that my dad purchased for me to watch the Halley's Comet."

When asked what he would be doing if he wasn't a scientist, Dr. Suzuki's love for science and math is clear – he'd be a science or math teacher.

Developing an Appreciation for Science in Students

Modern technology has made it easy for people around the world to communicate with each other. The advancement of technology has also increased the need and reliance of it in science. However, Dr. Suzuki believes the key to developing young students' interest in science involves using less technology.

"Using IT (information technology) too much has a danger of making students dependent on information – such dependency on information may kill the sense of wonder for nature and also may lose the ability of producing [their] own idea[s], which both are critical for science."

Still, learning the basics of relevant technology is important. Dr. Suzuki suggests providing the opportunities for students' to learn the basics along with developing their appreciation for nature in classrooms and school activities.

As for aspiring young scientists? Study the fundamental subjects.

"...in particular, basic mathematics and physics, which are building blocks for modern sciences of our field. I would also suggest [finding] what in particular interests you – this would help you identify your motivation to pursue research in the future. "

SOCIAL MEDIA - COURTESY OF THE CEN

Follow the CloudSat mission on Facebook and Twitter:

Facebook: http://www.facebook.com/CloudSat

Twitter: http://www.twitter.com/CloudSat

CloudSpotter: https://cloudspotterapp.com/

NASA and the Cloud Appreciation Society have turned to the public to help collect data important to understanding the effects of clouds on global climate.

Clouds come in various shapes and sizes, determined by factors such as wind, humidity, and air pressure. The CloudSpotter app helps users learn more about the various types of clouds they see and will also help calibrate NASA's CERES, the Clouds and Earth's Radiant Energy System, satellites. The system of three satellites measures the solar-reflected and Earth-emitted radiation from the top of the atmosphere to Earth's surface. Clouds help reflect sunlight which in turn, affects local weather and climate.

CloudSpotter helps reduce the error of the satellites' measurements by using observations taken on the ground to make sure data from the instruments match up with data from the ground.

The app features a CloudStream that allows users to see photos taken by other Cloudspot users from around the world. It also allows users to rate these photos and adds some competition by ranking users based their number of Stars and Badges they have collected. Each new cloud type spotted earns a Star. Completing challenges such as spotting a rainbow after spotting a rain cloud earns CloudSpotters badges.

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