

BRINGING REMOTE SENSING OF
PRECIPITATION INTO YOUR CLASSROOM:
TRMM— TROPICAL RAINFALL
MEASURING MISSION

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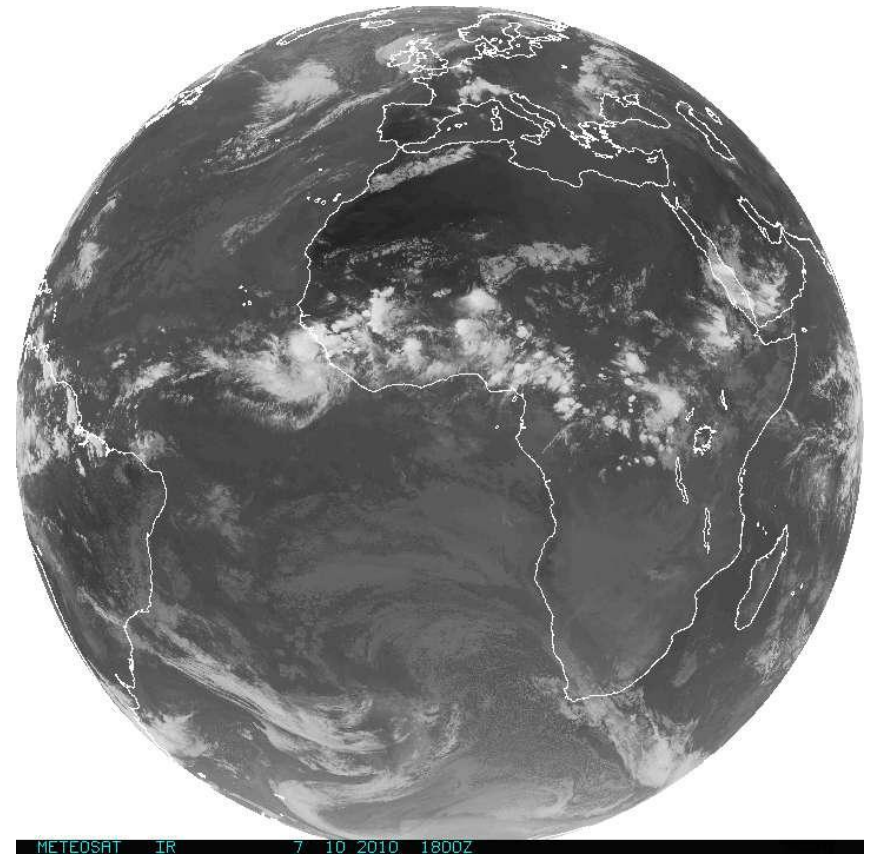
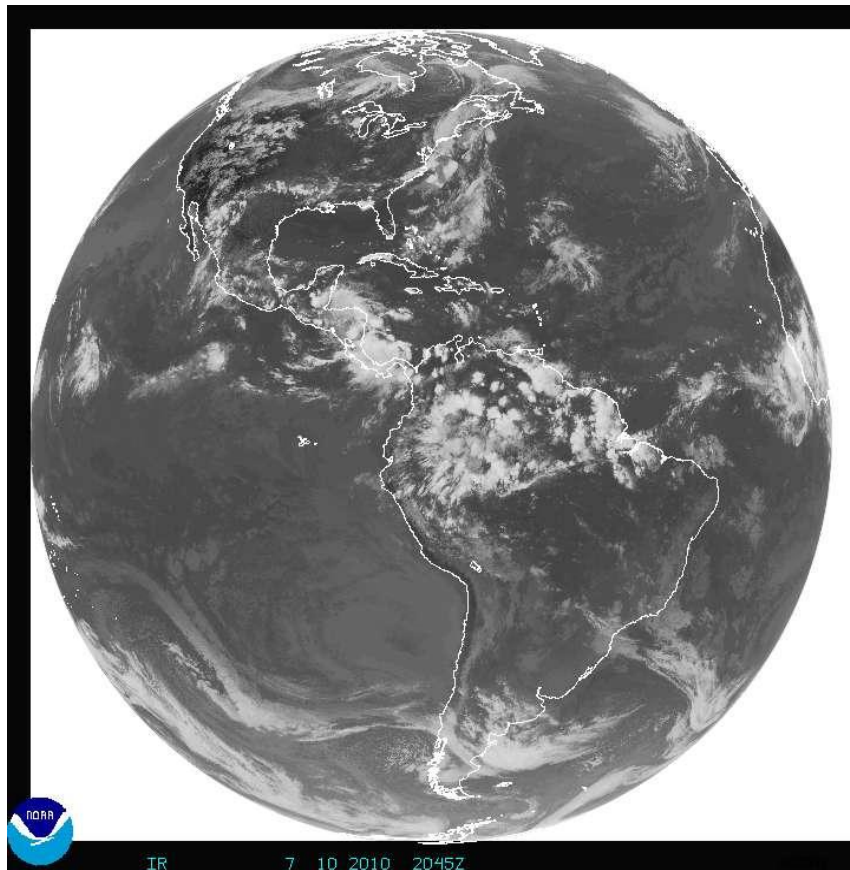
- “**Weather** is felt locally, created globally, and best understood regionally.”
Each of us is affected by the weather around us.
- Our weather is part of the global atmospheric conditions, which in turn are part of the entire **Earth System**.



To understand why we have the weather we do, it is necessarily to look on a regional scale.

- In some parts of the world, **weather measurement** is accomplished routinely and comprehensively as part of modern, computer-based monitoring and forecasting networks.
- But over much of the world—including almost all of the three-quarters of our planet covered by ocean—the only way to observe weather is through **remote sensing**, primarily by satellites.

Every minute of every day, **geosynchronous environmental satellites** (GOES) monitor atmospheric conditions around the globe



<http://www.goes.noaa.gov/FULLDISK/GEIR.JPG>

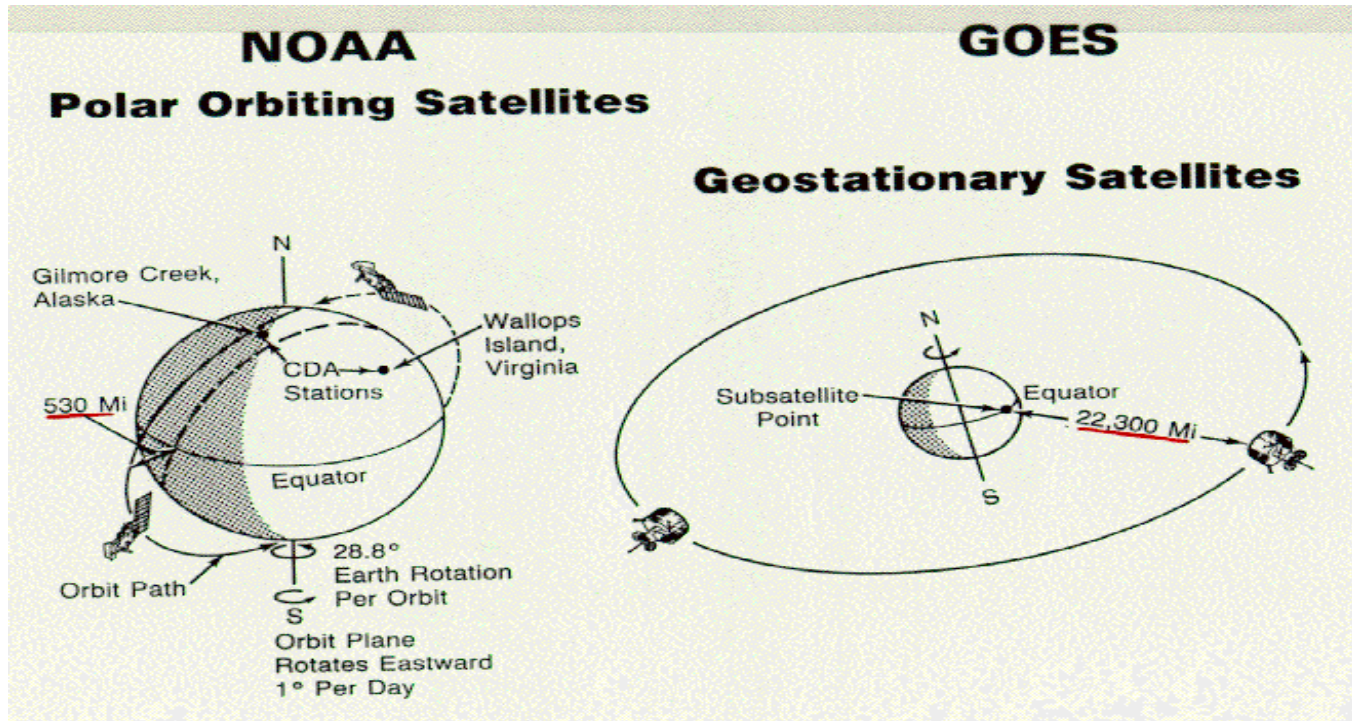
<http://www.goes.noaa.gov/FULLDISK/GMIR.JPG>

More detailed imaging comes through **polar-orbiting environmental satellites (POES)**

- This name is somewhat misleading because these types of satellites travel not only from pole-to-pole, but also may fly in tropical latitudes
- They are at lower altitudes, making one orbit in about 90 minutes, about 14 – 16 orbits every day



POES and GOES Orbits

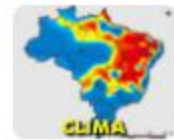


530 mi = 850 km

22,300 mi = 35,680 km

Satellite Imagery for Brasil

<http://www.inmet.gov.br/>



IMAGENS DE SATÉLITE

- FENG YUN
 - [Infravermelho](#)
 - [Visível](#)
- GOES Global
 - [Infravermelho](#)
 - [Visível](#)
 - [Vapor de Água](#)
 - [Topo de Nuvens](#)
- América do Sul
 - [Infravermelho](#)
 - [Vapor de Água](#)
 - [Visível](#)
 - [Topo de Nuvens](#)
- NOAA
 - [Infravermelho](#)
 - [Visível](#)
- NASA/MSFC/EUMETSAT
 - [Europa](#)
 - [Africa](#)
 - [Caribe](#)
 - [América Central e Golfo](#)
- MTSAT/JMA
 - [Japão e Leste China](#)
 - [Austrália](#)

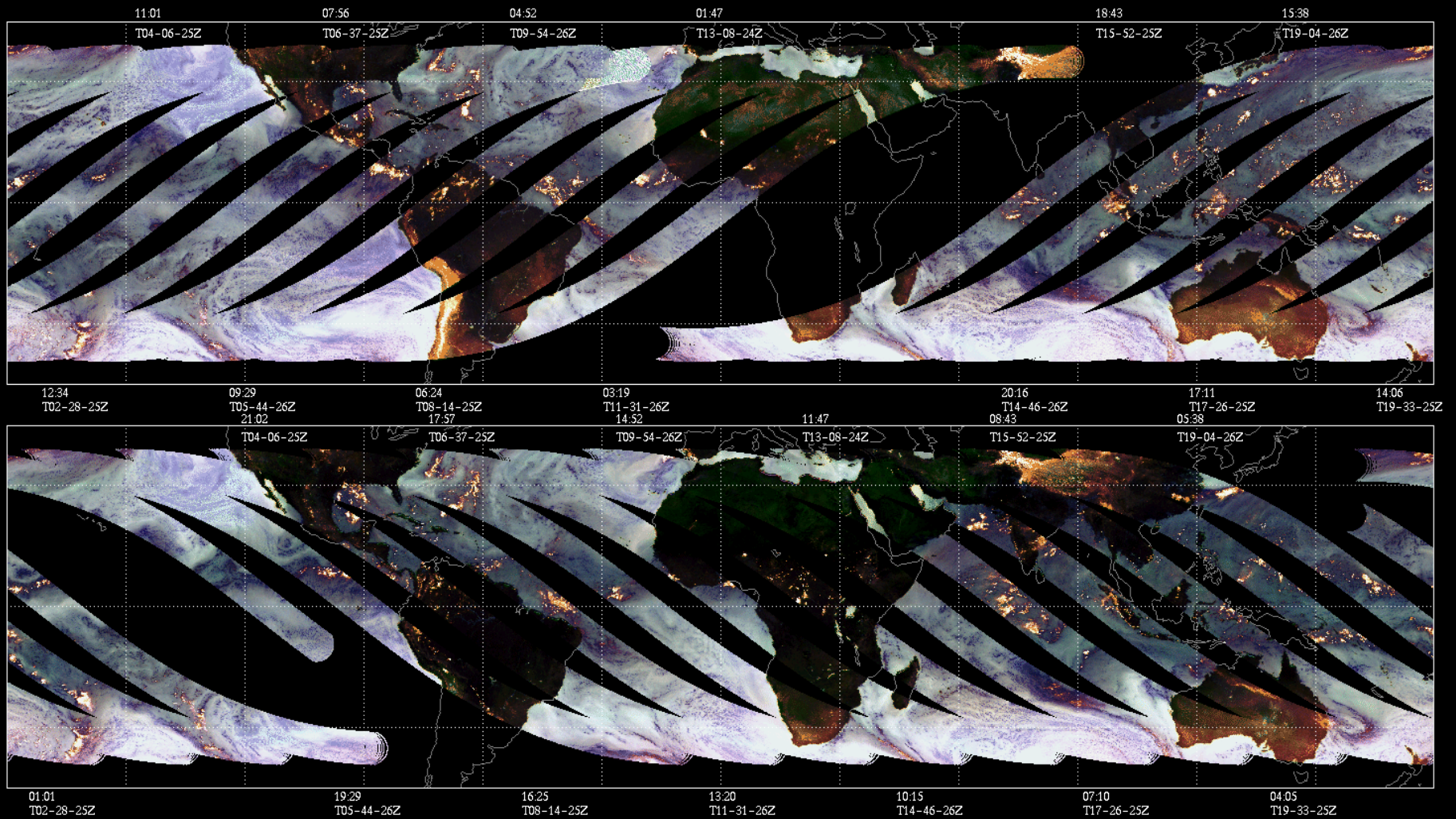
Group Discussion:
How could you use these images
in your class?

TRMM—Tropical Rainfall Measuring Mission—

provides some of the most valuable monitoring for forecasting and analyzing precipitation



- Launched in 1997 as a joint experimental satellite by NASA and the Japan Aerospace Exploration Agency (JAXA).
- Flies between approx. 35° +/- latitude on either side of the equator, 16 orbits each day.



TMI data for Wednesday, 07 July 2010



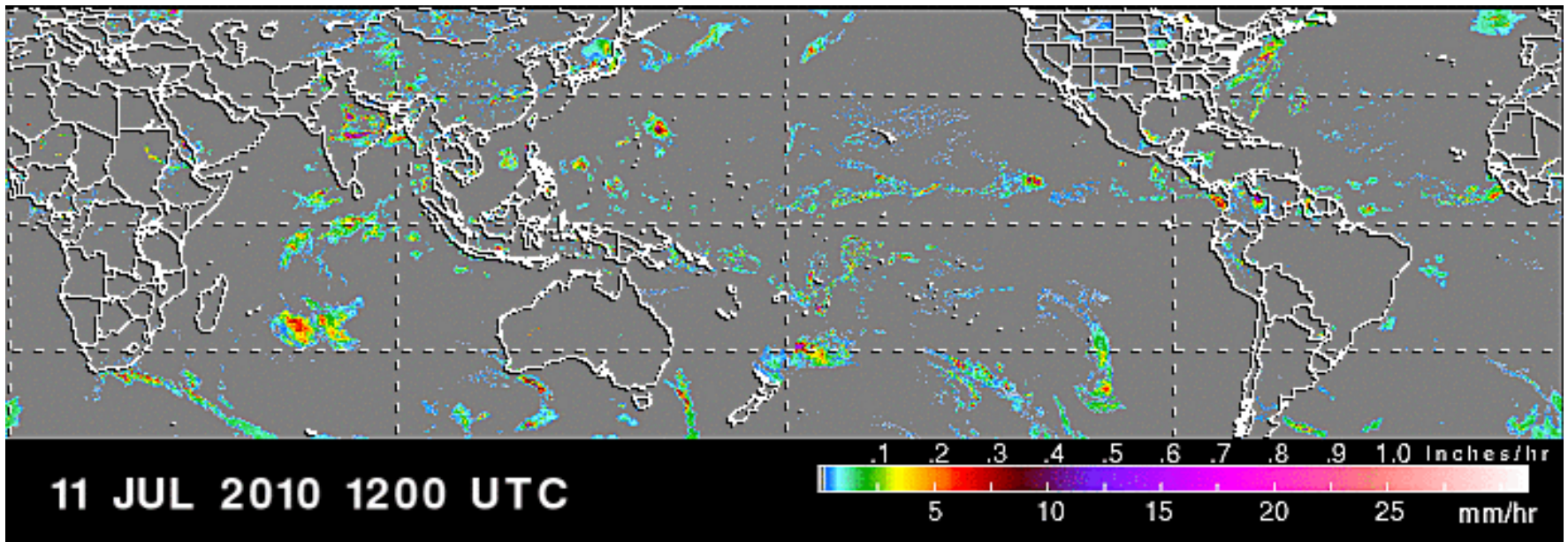
Example of daily coverage patterns

http://trmm.gsfc.nasa.gov/data/quicklook/last_2_cal.html

The imagery collection on the TRMM website provides resources for creating exciting lessons.

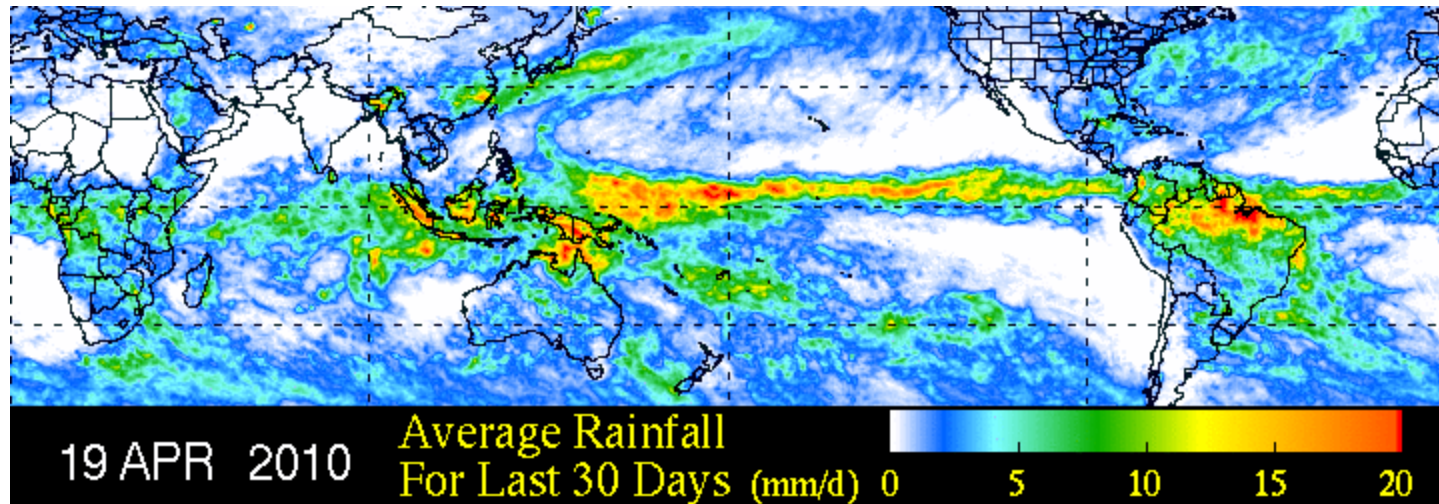
- Geography – **Latitude** and **Longitude**

What are the **coordinate lines**? Why were these used?



http://trmm.gsfc.nasa.gov/images_dir/images.html

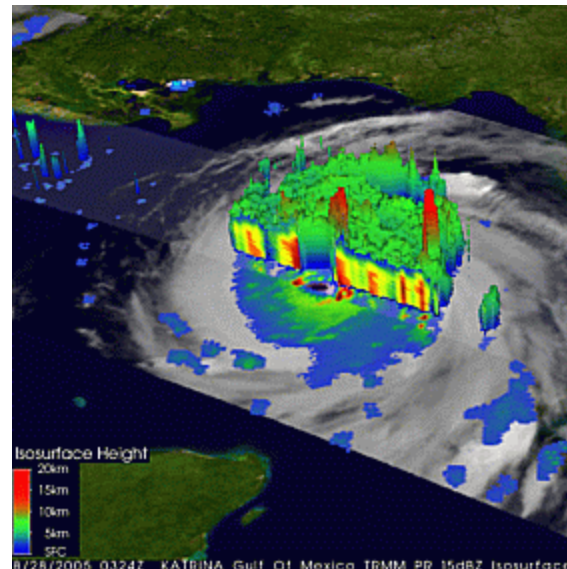
TRMM data are often shown in **color-coded images**.



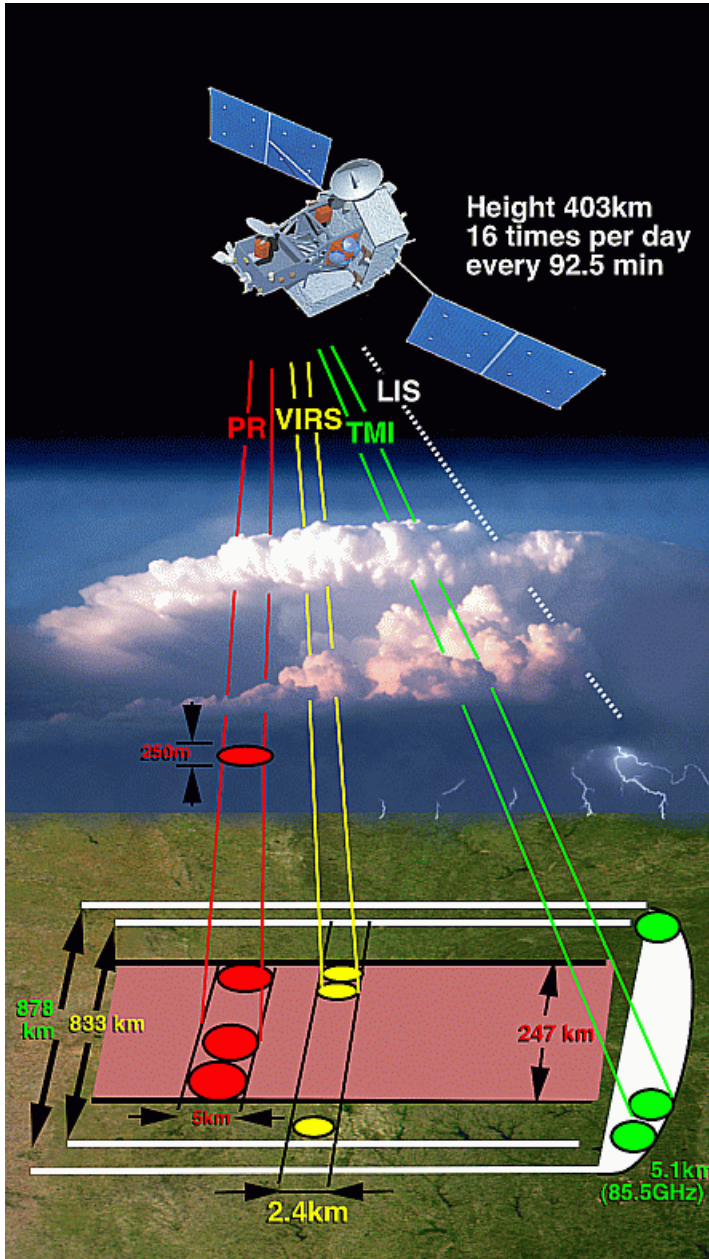
- Estimate of monthly precipitation is expressed as a **rate** (average millimeters of accumulated precipitation per day). Not only does most of the Earth's precipitation fall in the Tropics, a fair amount is concentrated in a narrow band roughly paralleling the Equator, the **Intertropical Convergence Zone (ITCZ)**
- http://trmm.gsfc.nasa.gov/images_dir/images.html

On-board instruments monitor **precipitation, clouds, lightning,** and other components of the **Water Cycle**

- Data can create what amount to **3-D CAT-scan-like** images of storms, instead of the more typical 2-D X-ray-like images.
- TRMM so exceeded expectations that it became a key operational satellite used to aid forecasts, particularly for hurricanes.



Why TRMM Is Valuable



- Precipitation Radar (PR)
- TRMM Microwave Imager (TMI)
- Visible and InfraRed Scanner (VIRS)
- Cloud and Earth Radiant Energy Sensor (CERES)
- Lightning Imaging Sensor (LIS)

Accessing Archived TRMM Data

NASA Goddard Earth Sciences

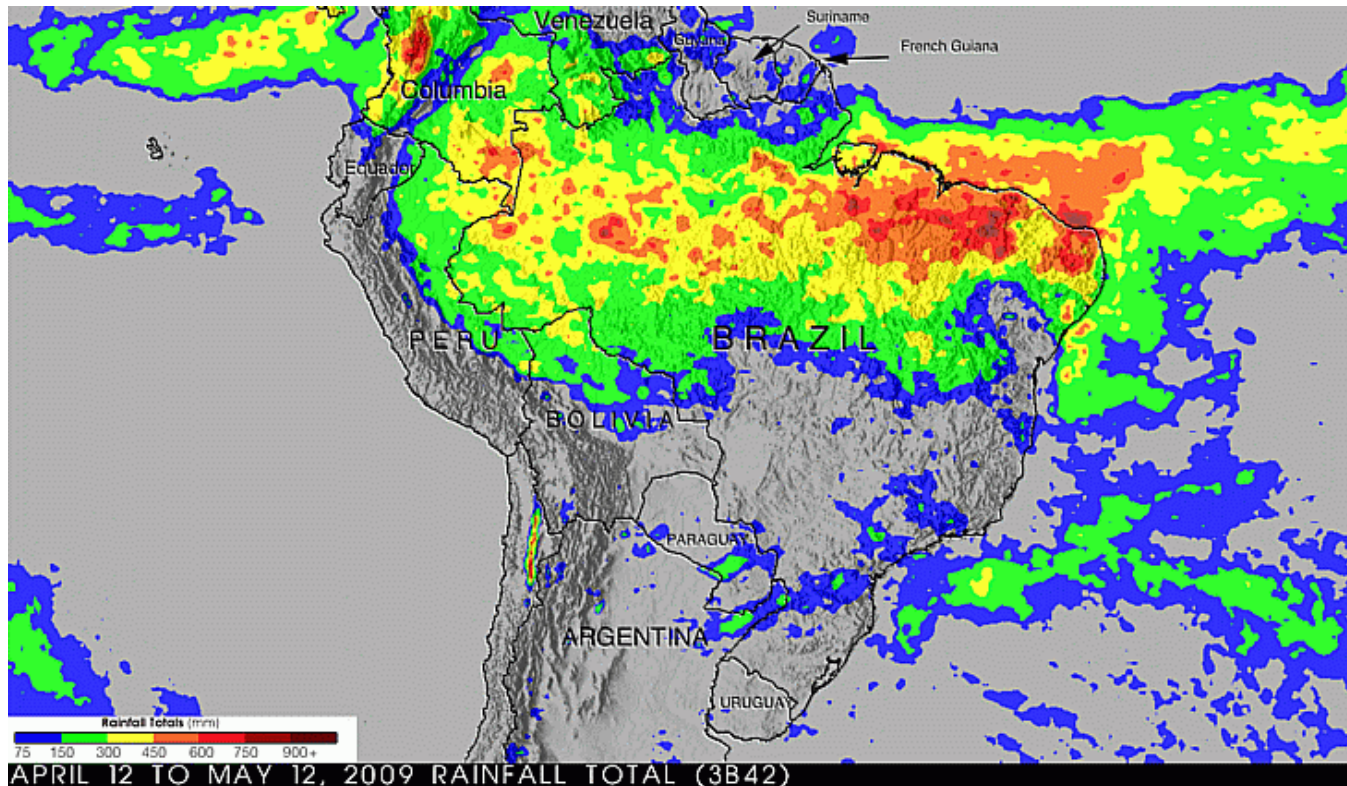
Data and Information Service Center

<http://mirador.gsfc.nasa.gov/cgi-bin/mirador/presentNavigation.pl?project=TRMM&tree=project>

Using Google Earth with your Students

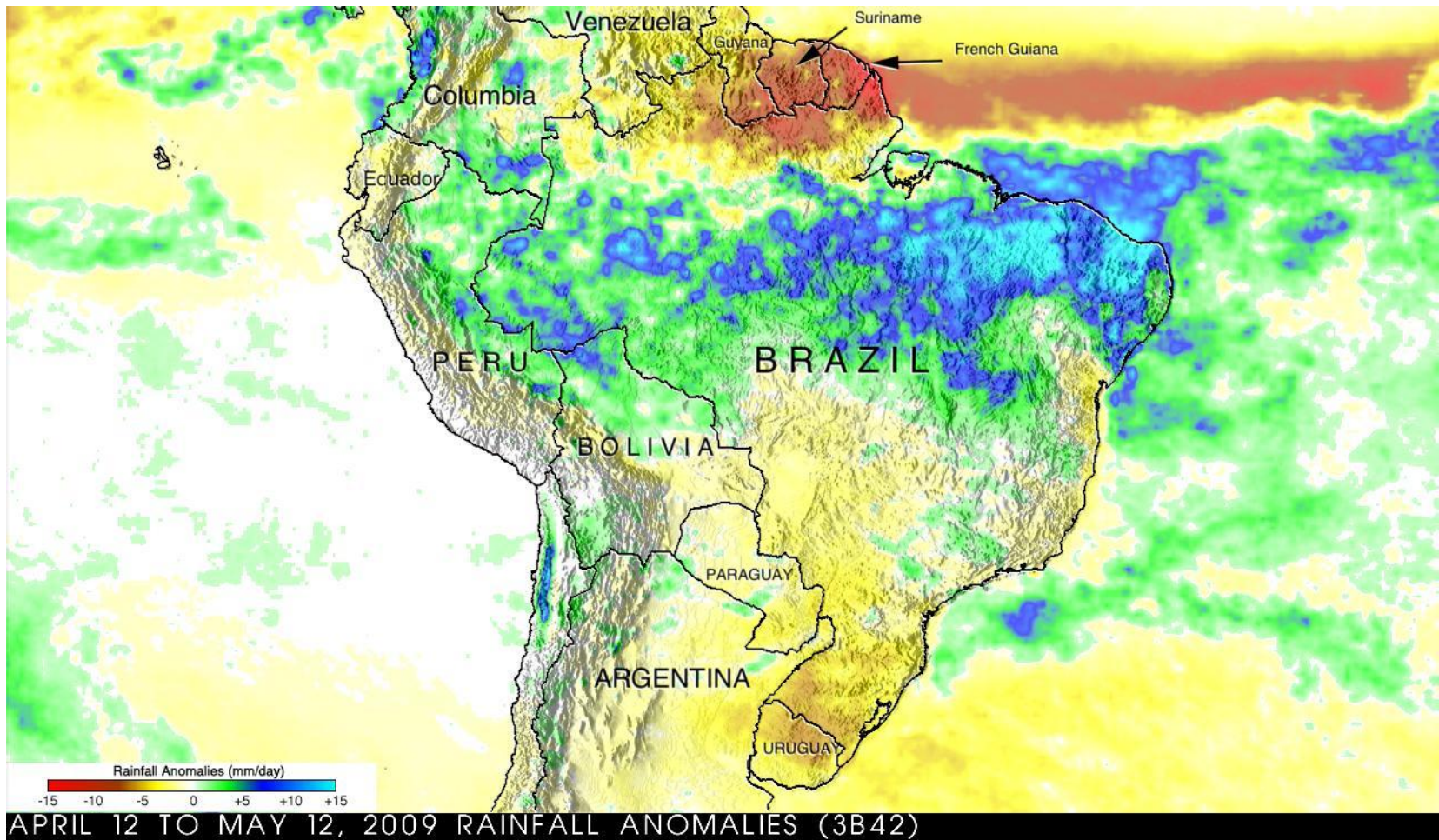
Group Discussion:
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TRMM data can focus on “extreme” events



2009 Extreme Rainfall in Brasil

1-month period 12 April to 12 May 2009 for Brazil and the surrounding region. Most prominent feature is the large east-west band of very heavy rain stretching from the Atlantic Ocean to the northern Andes mountains. This band is a direct result of the ITCZ. http://trmm.gsfc.nasa.gov/publications_dir/brazil_may09_flooding.html



2009 Brasil Rainfall **Anomalies**

Rainfall in relation to the climatological average for the same period. Anomalies (or deviations from the climatological average) show well-above-normal rainfall over most of northeastern Brazil (light blue areas). Overall anomaly pattern shows that the ITCZ remained locked over northeastern Brazil instead of migrating back northward as it would normally do.

http://trmm.gsfc.nasa.gov/trmm_rain/Events/anomaly_12apr-12may09.jpg

Other Ways to Use TRMM Imagery

- **Seeking patterns** in natural events
[Jan 1998 – Mar 2004 monthly rainfall totals](#)
[Jan 1998 – Mar 2004 rainfall anomalies](#)
- **Comparing and contrasting** world conditions
[Extreme Events](#)
- **Understanding “3-D” imagery**
- **Research** about El Nino, sea surface temperature, and other natural processes

Problem-Based Classroom Modules

“Investigating the Climate System”

Developed by the Institute for Global Environmental Strategies

- [Energy](#)
- [Winds](#)
- [Clouds](#)
- [Precipitation](#)
- [Weather](#)

Other educational resources:

http://trmm.gsfc.nasa.gov/education_dir/education.html

Other Sources for Activities

Satellite Observations for Science Education

<http://www.ssec.wisc.edu/sose/>

- [Principles in Remote Sensing](#)
- Learn about the principles in remote sensing.

- [Great Lakes Weather and Climate](#)
- Discover the unique weather systems and patterns of the Great Lakes Region.

- [Water Vapor Imagery](#)
- Identify and analyze jet streams using water vapor imagery.

- [Hunting Icebergs](#)
- Identify, measure, and track icebergs through satellite imagery.

- [Coastal Upwelling](#)
- Explore physical drivers and biological consequences of coastal upwelling.

AMNH Science Bulletins

“Space Weather: Storms from the Sun”

To continue our discussion,
please send me an e-mail

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