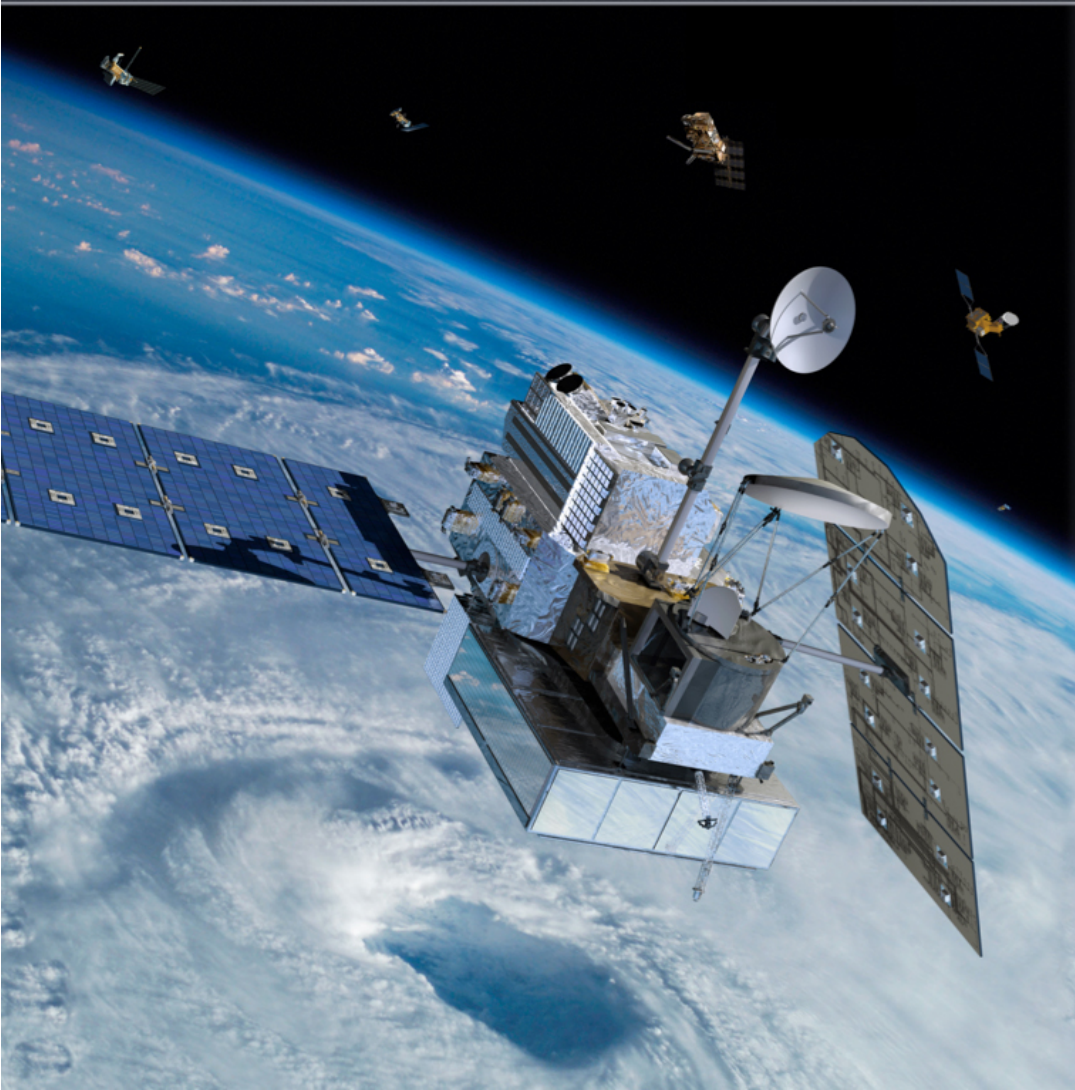




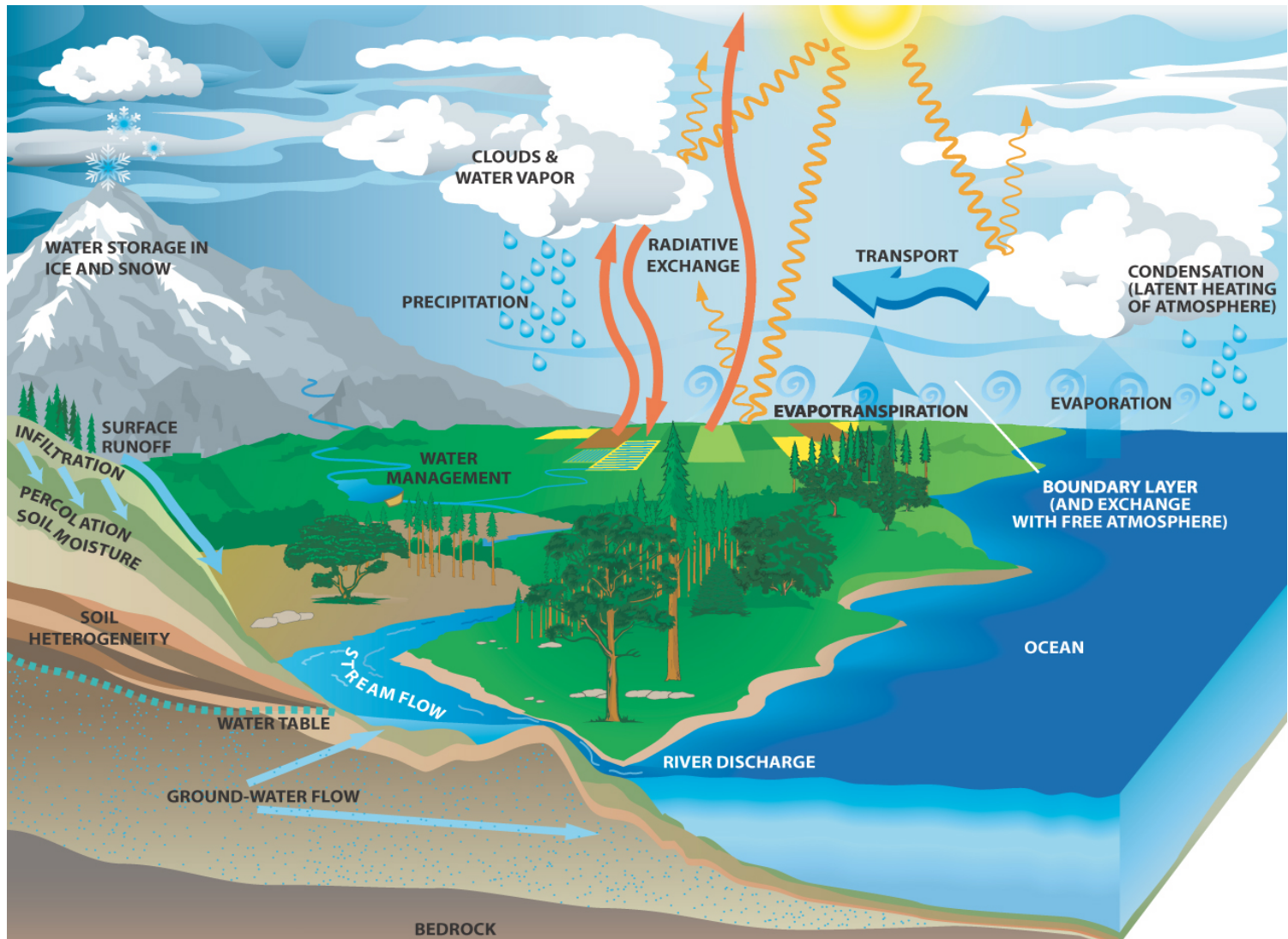
Keeping an eye on the Blue Marble: How NASA studies Earth's weather, climate and hydrology from space



Dalia Kirschbaum
*NASA Goddard Space
Flight Center*

3-27-2014

<http://pmm.nasa.gov>



Water Cycle Missions

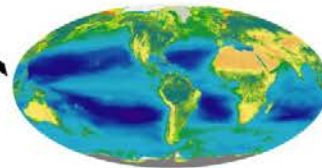
- ICESat**
 - Ice elevation
 - Cloud height
 - GRACE**
 - Column water-content
 - TRMM and GPM**
 - Global precipitation
 - HYDROS**
 - Surface wetness
 - Frozen soil
- (SMAP)

Water and Energy Cycle Missions

- EOS-Aura**
 - Atmospheric humidity
 - Clouds
- EOS-Terra**
 - Snow and ice
 - Vegetation
- CALIPSO**
 - Cloud properties
- CloudSAT**
 - Cloud profiler
- EOS-Aqua**
 - Atmospheric humidity
 - Water storage
 - Clouds
 - Snow and ice

Energy Cycle Missions

- TOMS**
 - Total column ozone
- SORCE**
 - Total Irradiance measurements
- SAGE**
 - Air quality
 - Climate change
- UARS**
 - Carbon management
 - Air quality



Planned (not Approved)

- SWOT (Streamflow)
- SCLP (Snowpack)

Complementary Water and Energy Cycle Missions

QuikSCAT
- Sea-surface wind velocity



EO-1 LANDSAT and NMP EO-1
- Land cover



NPOESS
- Global environmental conditions



GOES
- Weather



Aquarius
- Global sea surface salinity

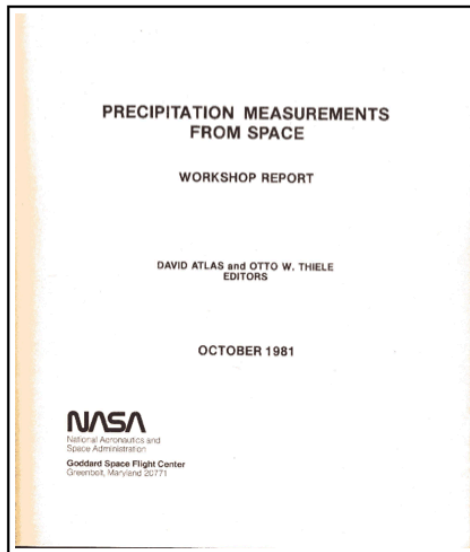


NASA Operating Missions

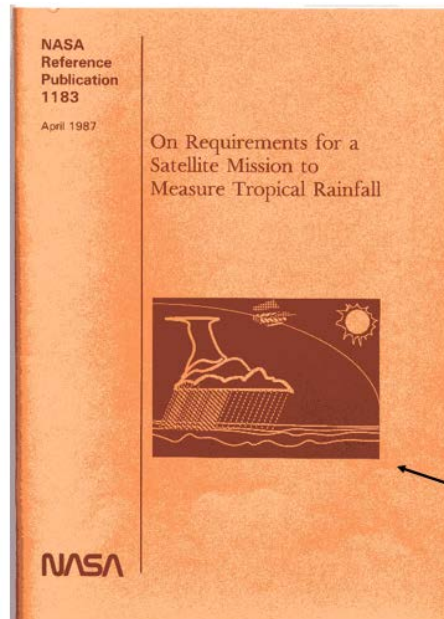


GLOBAL PRECIPITATION MEASUREMENT

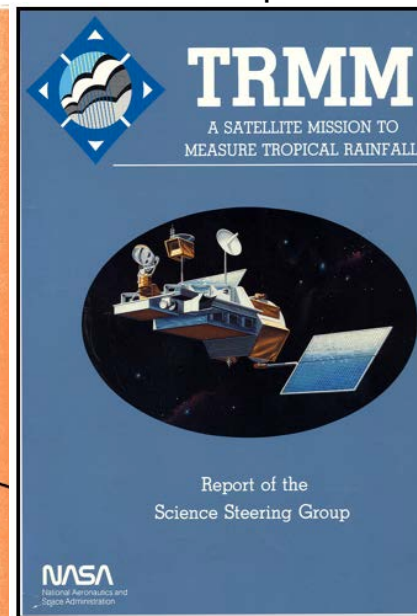
1981



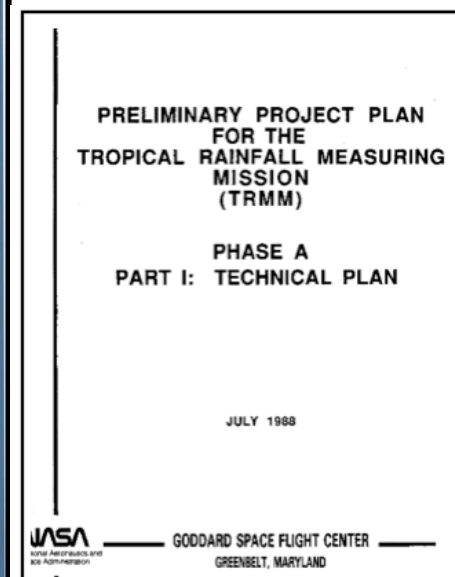
1987- TRMM concept
proposed



1988- TRMM Steering Group



1988- Phase A plan for TRMM



Instrument Payload:

TRMM Microwave Imager (TMI)

10, 19, 37, 86 GHz, conical scanning

Precipitation Radar (PR) [Japan]

14 GHz, cross-track scanning

Lightning Imaging Sensor (LIS) [MSFC]

Staring optical array

Visible IR Scanner (VIRS)

5-channel, cross-track scanning

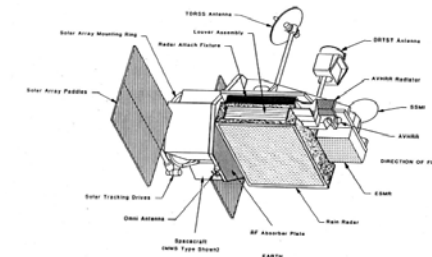
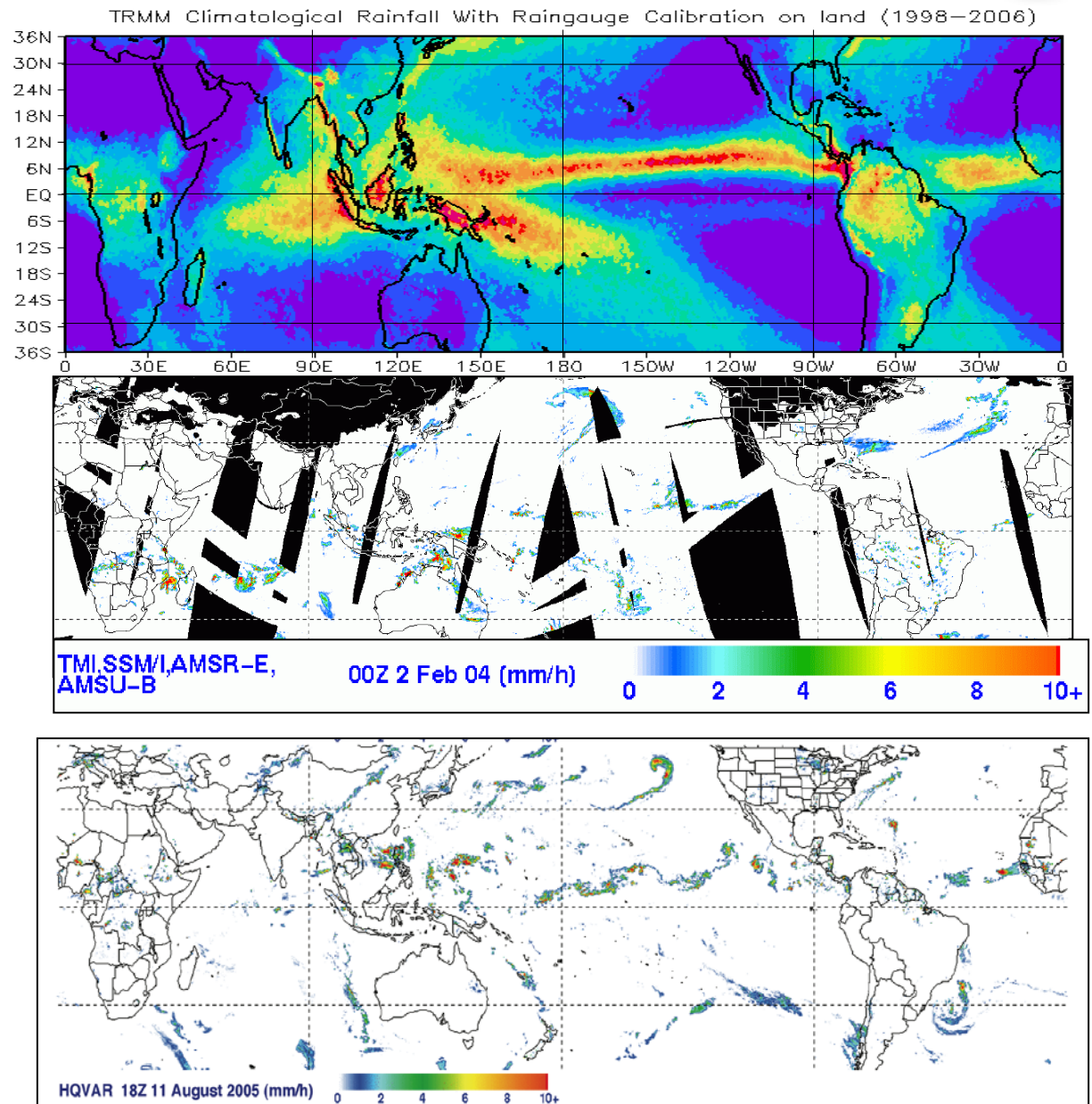


Figure 5-1. TRMM Spacecraft

TRMM Climatology
in the tropics and
subtropics. Now has
16+ years of data to
evaluate daily to
interannual cycles

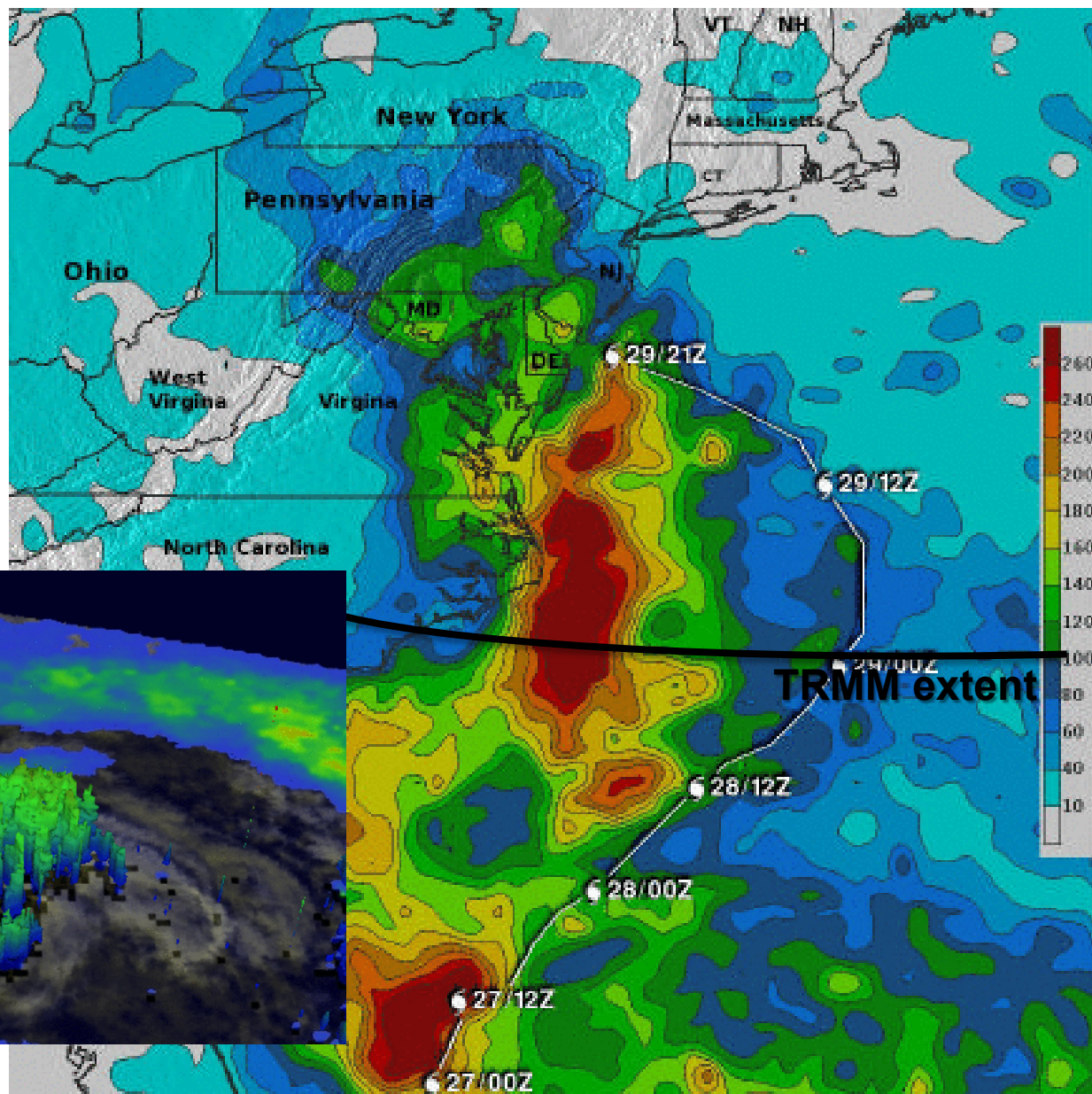
3-hour window with
passive microwave
information (gap filled
with Geo-IR)
Calibrated by TRMM

Near real-time product
available ~6-12 hours
after observation time



Hurricane Sandy
(Oct. 22-31st,
2012)

TRMM image on
Oct. 28th



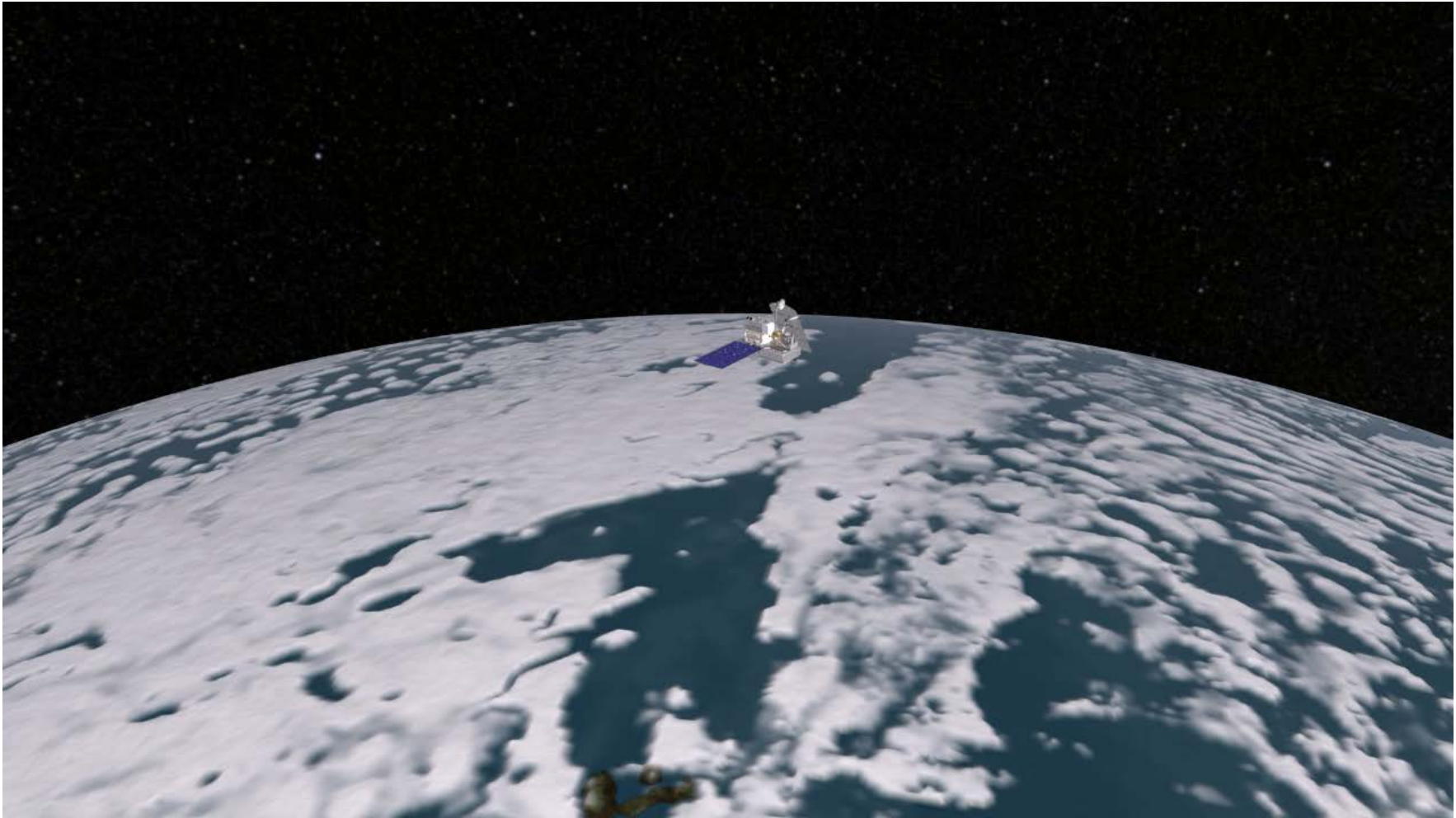
http://youtu.be/0_2pcVIJvBM



TRMM versus GPM coverage animation: <http://svs.gsfc.nasa.gov/goto?11165>

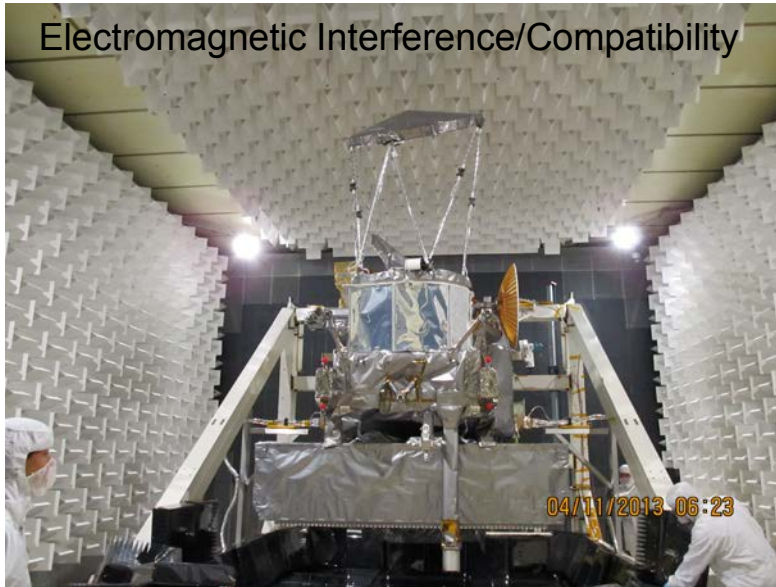
GPM constellation animation:

<http://gpm.nasa.gov/education/videos/global-precipitation-measurement-constellation>

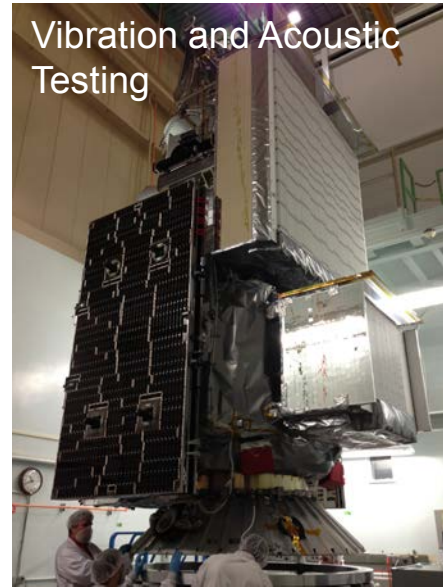


GPM instrument animation: <http://svs.gsfc.nasa.gov/goto?4016>

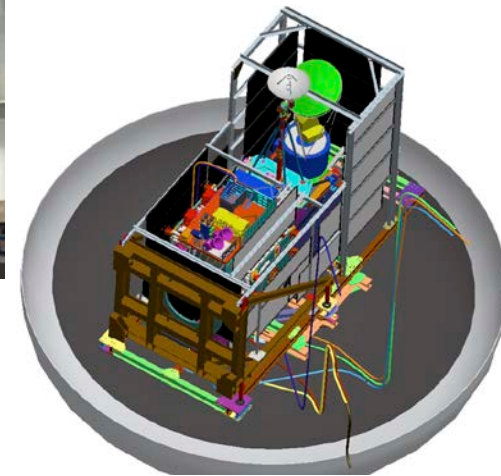
Electromagnetic Interference/Compatibility



Vibration and Acoustic Testing



GPM Core Observatory in the Space Environmental Simulator at Goddard Space Flight Center



Mission Operations Control



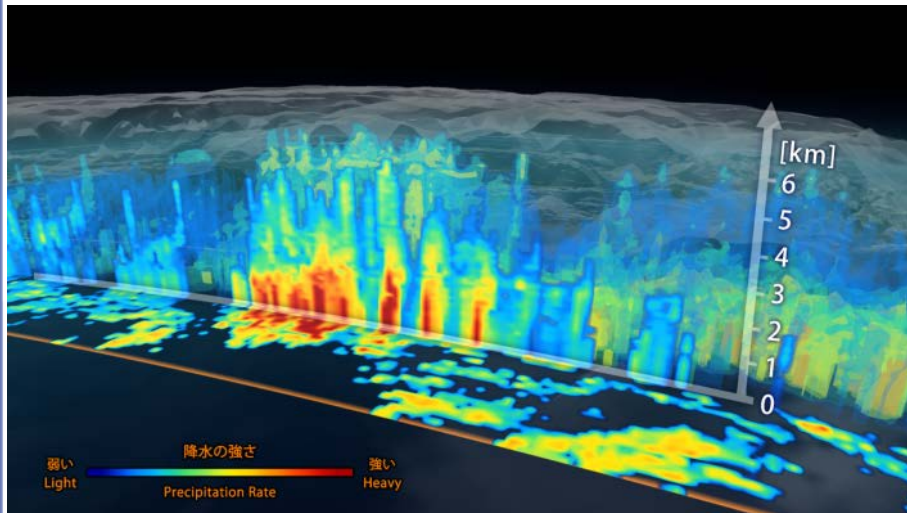
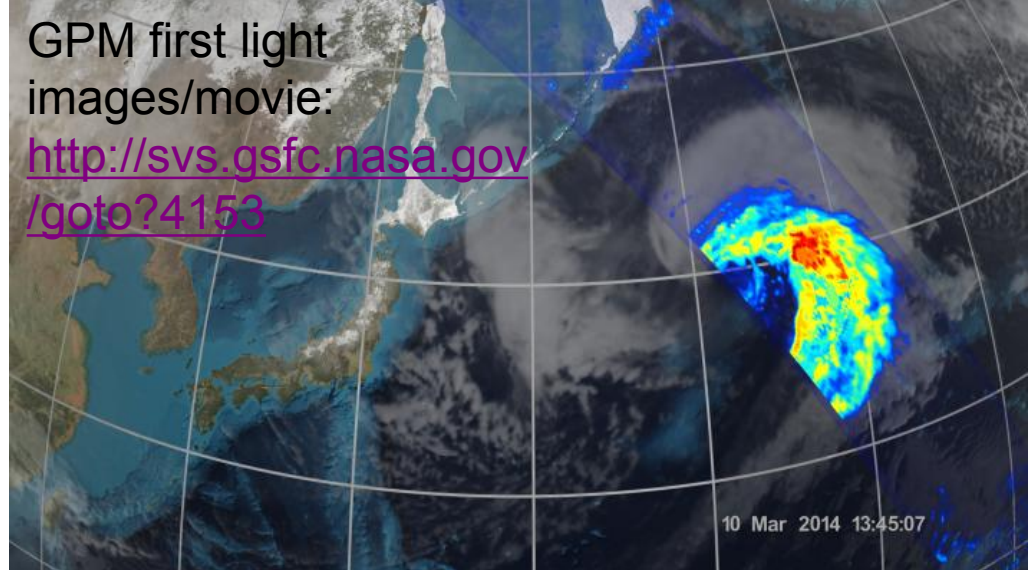


Launched at 1:37 p.m. EST, Feb 27, 2014

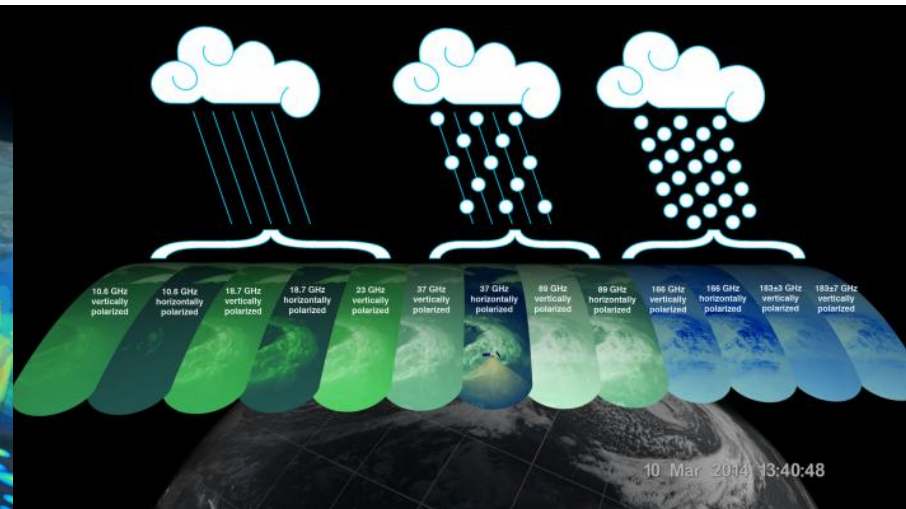
GPM launch video: <http://svs.gsfc.nasa.gov/goto?11496>

On March 10, the Core Observatory passed over an extra-tropical cyclone about 1055 mi (1700 km) due east of Japan's Honshu Island.

The storm contained heavy rain and snow and is the first time a satellite has been able to view an extratropical storm in 3D



Dual-frequency Precipitation Radar view inside the extra-tropical cyclone observed on March 10, 2014



GMI instrument showing 13 channels, each sensitive to different types of precipitation



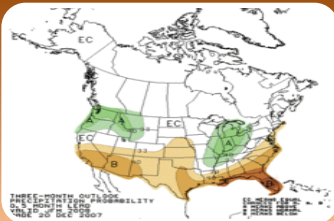
Extreme Events and Disasters

- Landslides
- Floods
- Tropical cyclones
- Re-insurance



Water Resources and Agriculture

- Famine Early Warning System
- Drought Monitoring
- Water resource management
- Agricultural monitoring



Weather, Climate & Land Surface Modeling

- Numerical Weather Prediction
- Land System Modeling
- Global Climate Modeling



Public Health and Ecology

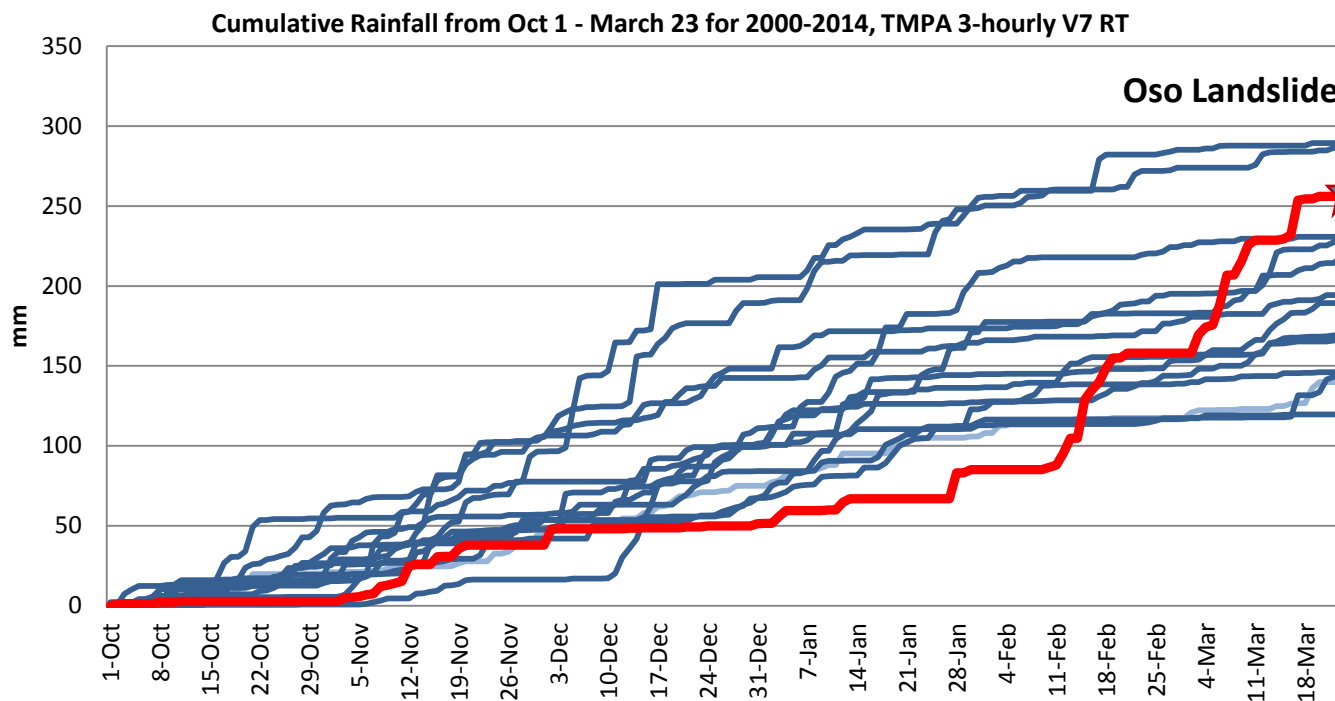
- Disease tracking
- Animal migration
- Food Security



Hurricane Katrina hot towers animation: <http://svs.gsfc.nasa.gov/goto?3253>



PHOTO BY TED S. WARREN /THE ASSOCIATED PRESS; GRAPHIC BY THE SEATTLE TIMES

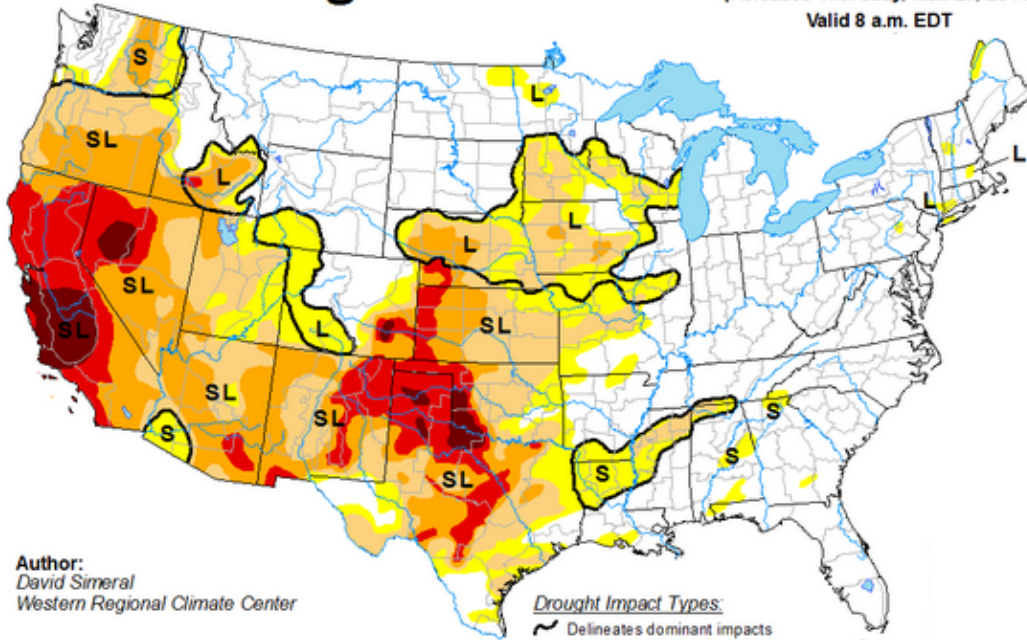


Above: Image from Landsat 8 pan-sharpened natural colour 15 m resolution data taken Sunday morning, March 23rd. Photo courtesy of Jesse Allan (Sigma Space Corp/NASA)

<http://earthobservatory.nasa.gov/IOTD/view.php?id=83124>

U.S. Drought Monitor

March 25, 2014
(Released Thursday, Mar. 27, 2014)
Valid 8 a.m. EDT

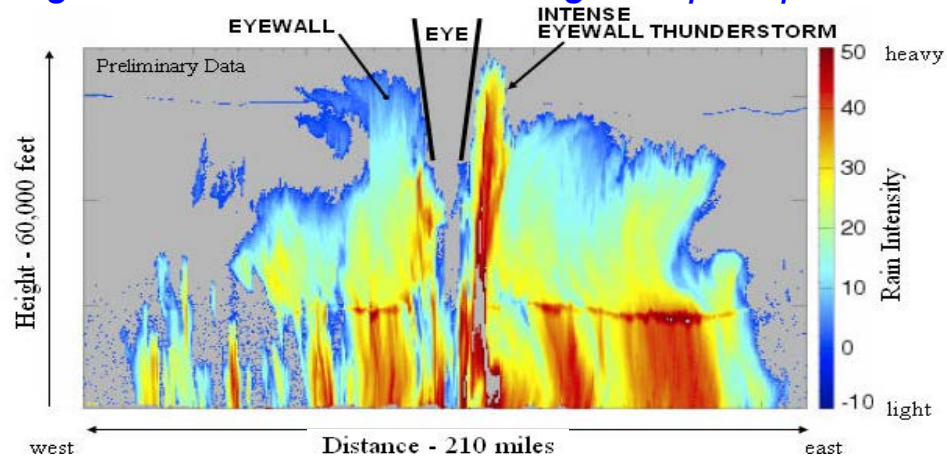


<http://droughtmonitor.unl.edu/>

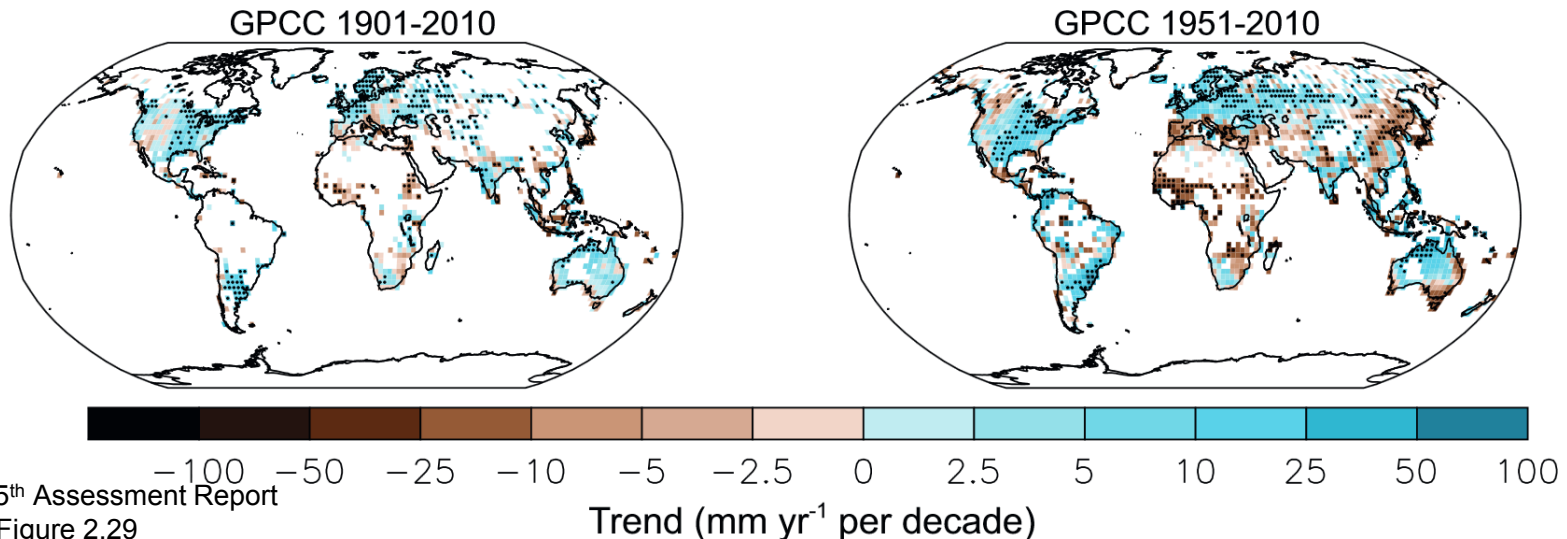


Impact of drought on California based on data from the [Moderate Resolution Imaging Spectroradiometer](#) (MODIS) on NASA's Terra and Aqua satellites, the map contrasts plant health from January 17 to February 1, 2014, against average conditions for the same period over the past decade.

Improving Weather Forecasts through assimilation of accurate global precipitation data

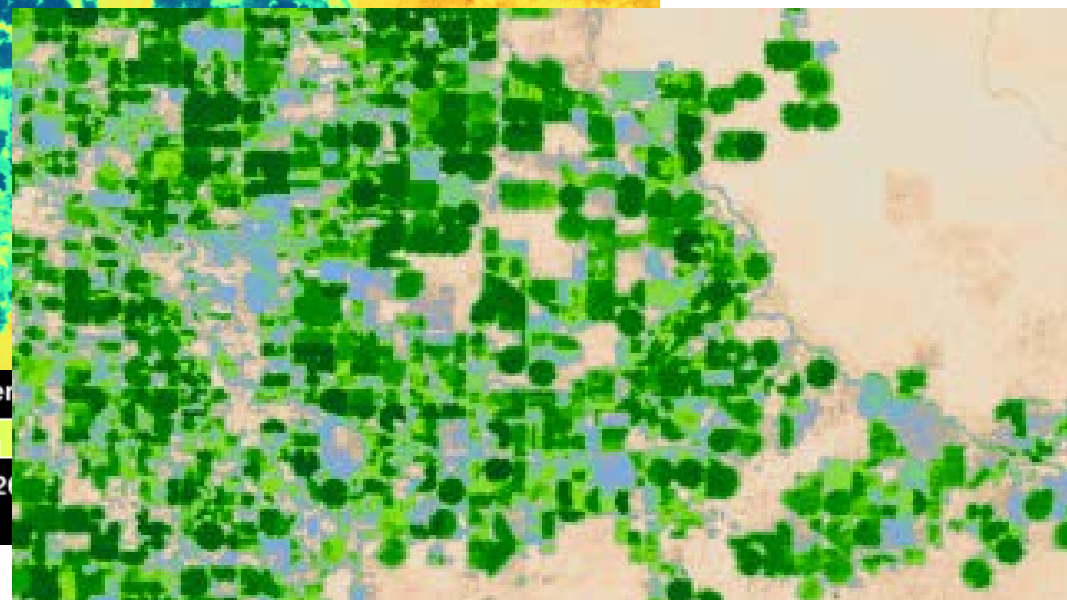
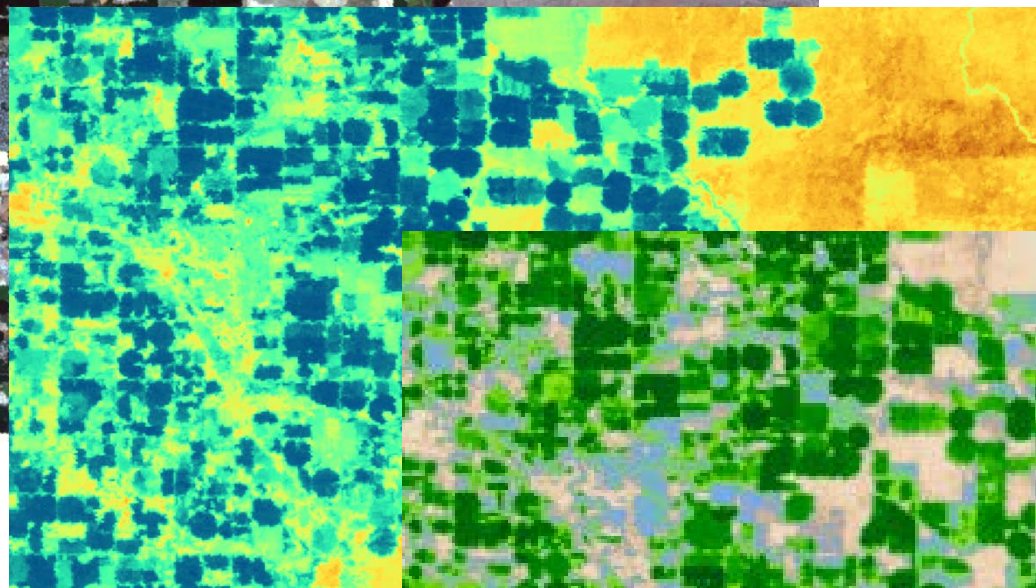
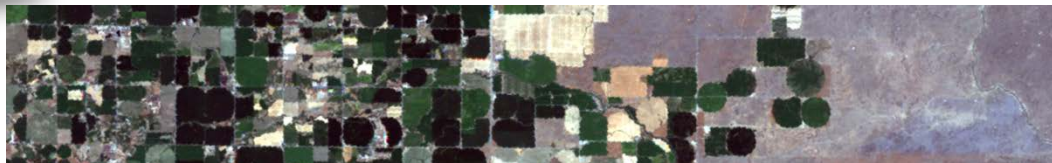


Understanding precipitation's role in a changing climate



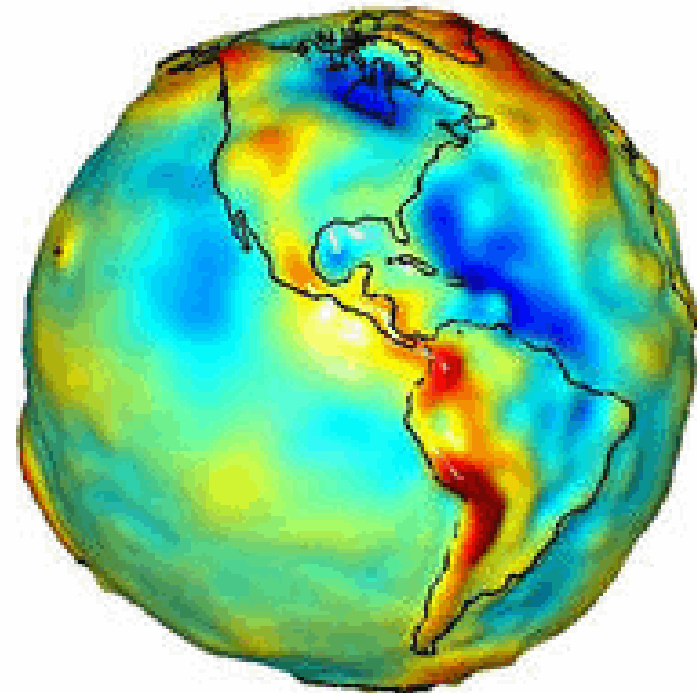
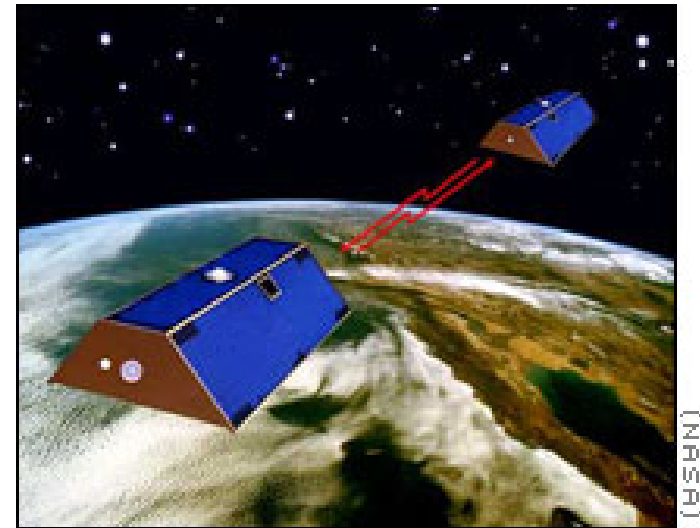
IPCC AR5 5th Assessment Report
Chapter 2, Figure 2.29

Global climate models predict significant changes in precipitation amount and intensity over the 21st century. We need global measurements to improve and validate these models.



Landsat 7 and 8 data
Visible, Infrared, Thermal
channels

- The Gravity Recovery and Climate Experiment (GRACE) is a joint satellite mission of NASA and German Aerospace Center (DLR) that can measure changes in total, column-integrated Terrestrial Water Storage (TWS) from space.
- GRACE is unique in its ability to monitor water at all levels, down to the deepest aquifer
- Provides a time-series of monthly time-variable gravity field estimates > mass changes in the ocean, of ice, and on land > affect the motion of all Earth satellites, including GRACE



ONE UP. FOUR TO GO.

#earthrightnow

In 2014, for the first time in more than a decade, five NASA Earth science missions are launching to space in a single year. The first, the GPM Core Observatory, launched on Feb. 27 (above).

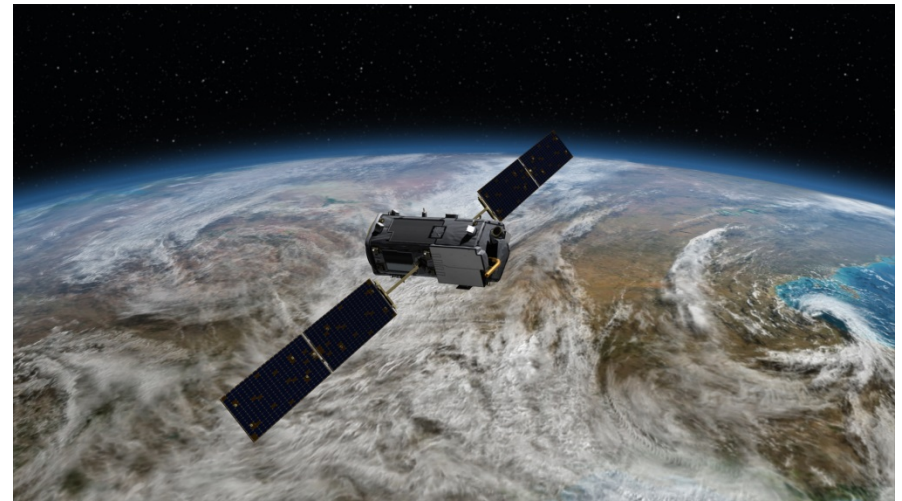


EARTH *RIGHT NOW*

www.nasa.gov/earthrightnow

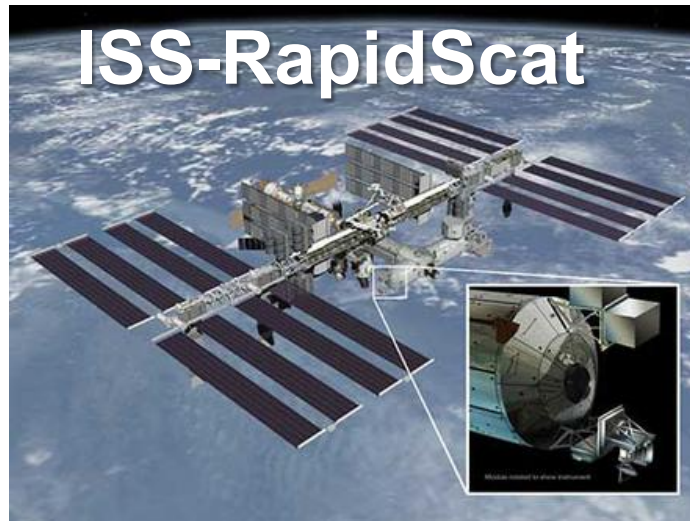
<http://www.nasa.gov/earthrightnow>

Orbiting Carbon Observatory-2 (OCO-2)



- Set to launch in July, 2014
- NASA's first dedicated remote sensing satellite to study atmospheric carbon dioxide
- Will be able to characterize CO₂ sinks and sources on a regional scale and quantify CO₂ seasonal variability

<http://oco.jpl.nasa.gov/>



ISS-RapidScat

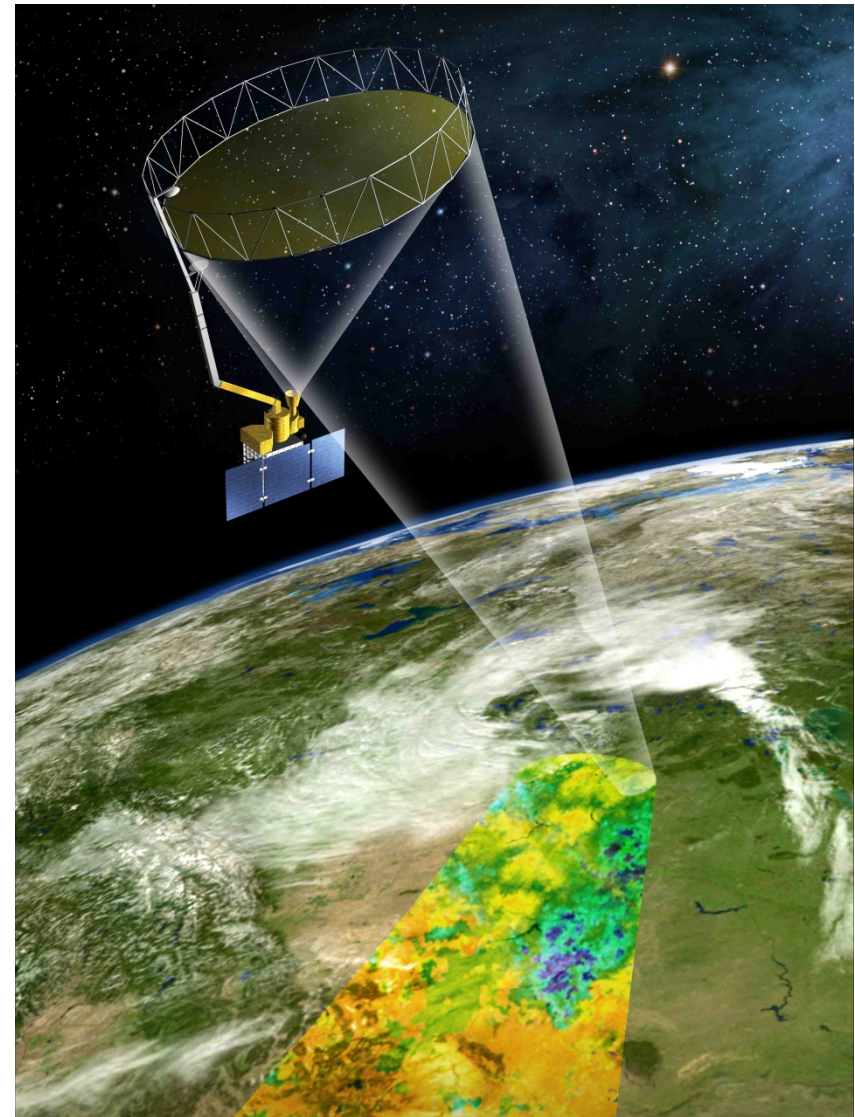
- Set to launch in August (will be added to ISS)
- Measures ocean surface wind speed and direction
- To replace NASA's QuikScat satellite, which stopped collecting data in 2009



Cloud Aerosol Transport System (CATS)

- Set to launch in September (will be added to the ISS)
- Measures the location, composition and distribution of pollution, dust, smoke, aerosols and other particulates in the atmosphere

- Set to launch in November, 2014
- Global mapping of soil moisture and freeze/thaw state
- Soil moisture data will help scientists understand the processes that link the water, energy and carbon cycles, and improve weather and climate models and forecasting



<http://smap.jpl.nasa.gov/>



www.nasa.gov/GPM

Twitter: @NASA_Rain

Facebook: NASA.Rain

More GPM videos, data visualizations, and animations:

<http://svs.gsfc.nasa.gov/Gallery/GPM.html>