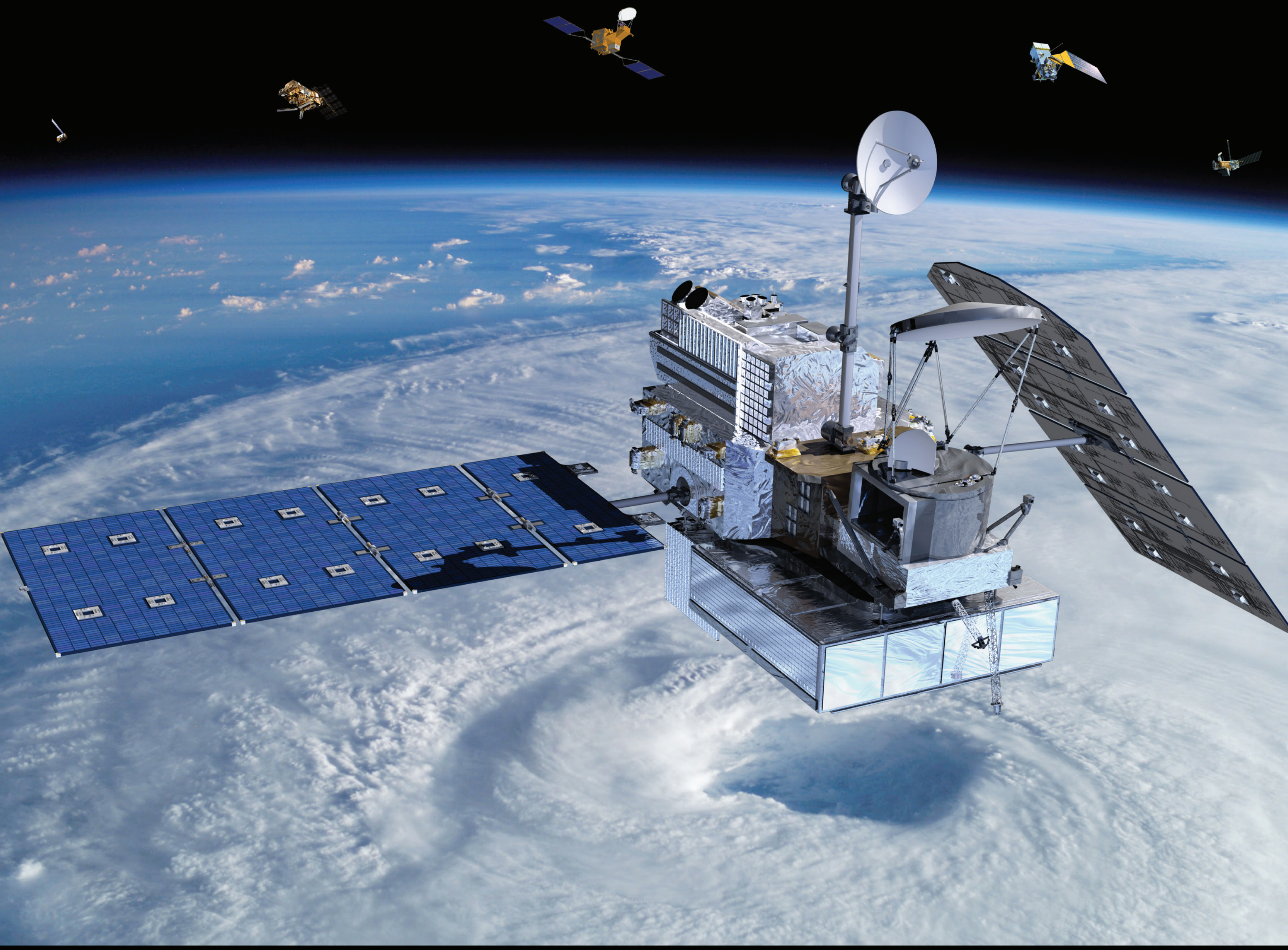
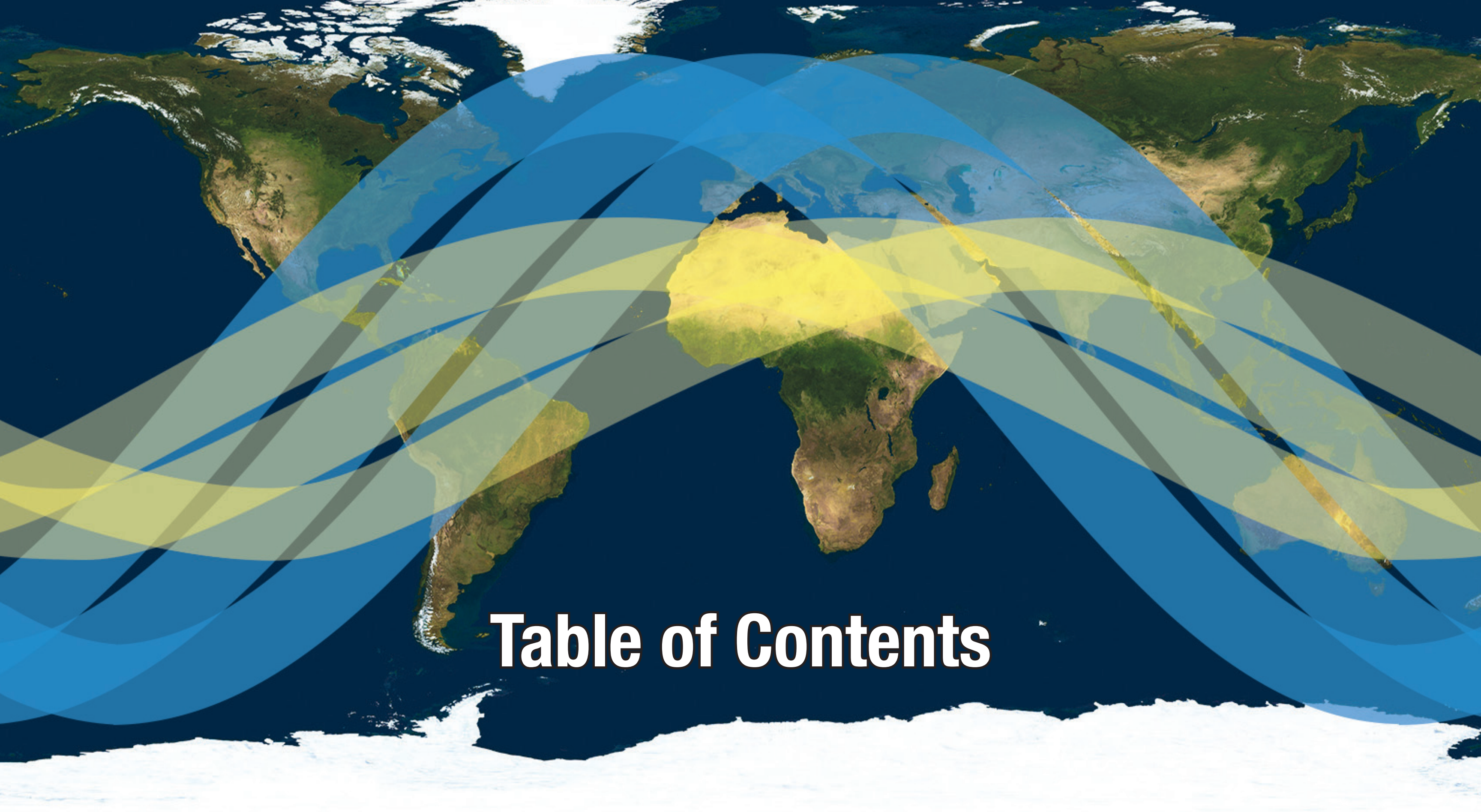
Global Precipitation Measurement

Press Kit



February 2014



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Media Contacts

National Aeronautics and Space Administration

NASA Headquarters
Stephen Cole
NASA Headquarters, Washington
Office of Communications
(202) 358-0918
stephen.e.cole@nasa.gov

NASA Goddard Space Flight Center
Rani Gran
NASA GSFC, Greenbelt, Md.
(301) 286-2483 (office)
rani.c.gran@nasa.gov

Japan Aerospace Exploration Agency, Tokyo

+81-50-3362-4374
proffice@jaxa.jp

GPM Contractors

Roz Brown
Media Relations Manager
Ball Aerospace & Technologies Corp.
(303) 533-6059
(720) 581-3135
rbrown@ball.com

Press Release

NASA, JAXA Prepare Rain and Snow Satellite for Launch

The world enters a new era of global weather observing and climate science in February with the launch of the Global Precipitation Measurement (GPM) Core Observatory, a new international science satellite built by NASA.

GPM, a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA), is scheduled to launch Feb. 27 from Tanegashima Space Center in Japan. The observatory will link data from a constellation of current and planned satellites to produce next-generation global measurements of rainfall and snowfall from space.

The GPM mission is the first coordinated international satellite network to provide near real-time observations of rain and snow every three hours anywhere on the globe. The GPM Core Observatory anchors this network by providing observations on all types of precipitation. The observatory's data acts as the measuring stick by which partner observations can be combined into a unified data set. The data will be used by scientists to study climate change, freshwater resources, floods and droughts, and hurricane formation and tracking.

"The water-cycle, so familiar to all school-age young scientists, is one of the most interesting, dynamic, and important elements in our studies of the Earth's weather and climate," said John Grunsfeld, associate administrator for NASA's Science Mission Directorate in Washington. "GPM will provide scientists and forecasters critical information to help us understand and cope with future extreme weather events and fresh water resources."

The GPM Core Observatory will fly 253 miles (407 kilometers) above Earth in an orbit inclined 65-degrees to the equator. This orbit allows the Core Observatory to observe precipitation from the Arctic Circle to the Antarctic Circle at different times of day so it is able to observe changing storm and weather systems that behave differently during day and night. Normal operations will begin about 60 days after launch. Data will be downlinked through NASA's Tracking and Data Relay Satellite System to the agency's Goddard Space Flight Center's Precipitation Processing Center in Greenbelt, Md., where it will be processed and distributed over the Internet.

GPM's Core Observatory carries two instruments to measure rain and snowfall: the Dual-frequency Precipitation Radar (DPR), designed by JAXA and the National Institute of Information and Communications Technology in Japan, and built by NEC Toshiba Space Systems Ltd., Tokyo; and the GPM Microwave Imager (GMI), provided by NASA and built by Ball Aerospace & Technologies Corp. in Boulder, Colo. Together, these two instruments will collect improved observations that will allow scientists to better "see" inside clouds. In particular, they both provide new capabilities for observing smaller particles of rain, ice and snow.

"Knowledge of how water moves around the Earth system through precipitation is vital for monitoring freshwater resources," said Gail Skofronick-Jackson, GPM project scientist at Goddard. "The data from the GPM mission provides unprecedented measurements of global precipitation. The GPM Core Observatory will observe detailed characteristics of rain and snow systems that are also extremely important for improving weather and climate forecasts."

The DPR precipitation radar adds a new frequency with which to observe precipitation, allowing it to capture ice and light rain. It will return three-dimensional profiles and intensities of liquid and solid precipitation that will reveal the internal structure of storms within and below clouds.

The GMI is a microwave radiometer designed to sense the total precipitation within all cloud layers. In addition to collecting data on heavy to moderate rain, four new channels will be sensitive to light rain and snowfall, two types of precipitation that are especially prevalent in mountain regions and the higher latitudes over North America, Europe and Asia.

Together, DPR and GMI will provide observations on the size, intensity and distribution of raindrops and snowflakes. Scientists will be able to use this data to look at how precipitation behaves and influences weather and climate patterns. These patterns affect the distribution of fresh water around the world, impacting supplies for drinking water and agriculture.

The GPM Core Observatory, built by Goddard, will launch on an H-IIA rocket provided by JAXA. Mitsubishi Heavy Industries Ltd. is managing the launch.

GPM Core Observatory is the latest mission to support NASA's mission to monitor Earth's vital signs from land, air and space with a fleet of satellites and airborne and ground-based observation campaigns. NASA develops new ways to observe and study Earth's interconnected natural systems with long-term data records and computer analysis tools to better see how our planet is changing. The agency shares this unique knowledge with the global community and works with institutions in the United States and around the world that contribute to understanding and protecting our home planet.

Quick Facts

GPM Core Observatory
- Built by NASA's Goddard Space Flight Center

Dimensions
- 21.3 x 16.1 x 38.1ft (6.5 x 4.9 x 11.6m) (tip of solar array-top of deployed High Gain Antenna x tip of solar array – front of GMI x solar array tip-to-tip)
- Total Launch Weight: 8,488 lbs (3,850 kg), including fuel
- About the size of a small fire truck and twice as heavy.
- Average Power: 1950 W
- Data downlink: 300 kbps via TDRSS

Science Instruments
- GPM Microwave Imager (GMI) built by Ball Aerospace & Technologies Corp., Boulder Colo. under contract to NASA Goddard.
- Dual-frequency Precipitation Radar (DPR) designed by JAXA and the National Institute of Information and Communications Technology in Japan and built by NEC Toshiba Space Systems, Ltd.

Ka-band radar
- Dimensions: 3.9 x 4.6 x 2.3 ft (1.2 x 1.4 x 0.7 m)
- Weight: 741 lbs (336 kg)
- Ka-band ground swath: scans twice, once with swath of ~78 miles (125 km) and once with swath of 75 miles (120 kilometers)
- Power 344 W
- Data rate: 81 kbps via TDRSS Access link

Mission Lifetime
- The spacecraft has a design life of 3 years and enough fuel for 5 years minimum. The GMI and DPR each have a design lives of 3.

GPM Microwave Imager (GMI)
- GMI dimensions: 4.6 x 4.9 x 11.5 ft (1.4 x 1.5 x 3.5 m) (deployed)
- Weight: 366 lbs (166 kg)
- Ground Swath: 550 miles (885 kilometers)
- Power: 162 W
- Data rate: 34.9 kbps science (+ 4 kbps engineering) via TDRSS Access link

Dual-frequency Precipitation Radar (DPR)
- Ku-band radar dimensions: 8.2 x 7.9 x 2.0 ft (2.5 x 2.4 x 0.6 m)
- Weight: 1041 lbs (472 kg)
- Ku-band ground swath: 152 miles (245 kilometers)
- Power: 446 W
- Data rate: 109 kbps via TDRSS Access link

Launch Date/Window
- February 27, 2014 with a 2-hour launch window 1:07 to 3:07 p.m. EST (Feb. 28 3:07 to 5:07 a.m. Japan Standard Time). The launch time and the window will remain the same in the event of a launch slip.

Launch Vehicle
- H-IIA Launch Vehicle No. 23 provided by Mitsubishi

Spacecraft Separation Events
- L + 16 min 6 sec — spacecraft separation
- L + 26 min 15 sec — spacecraft solar array deployment begins
- L approx. +46 minutes — confirmation of power positive

First Satellite Signal Acquisition
- L + 10 min 20 sec

Spacecraft Orbit
- Circular, non-sun-synchronous, with an inclination of 65 degrees to the Equator
- Altitude: 407 kilometers (253 miles)
- Orbit time: 93 minutes

Launch Site
- Tanegashima Space Center, Tanegashima Island, Japan

Launch Operations
- Mitsubishi Heavy Industries, LTD

Spacecraft Operations Center
- NASA's Goddard Space Flight Center, Greenbelt, Md.

Spacecraft Provider and Observatory Testing
- NASA's Goddard Space Flight Center, Greenbelt, Md.

Mission Management
- NASA's Goddard Space Flight Center, Greenbelt, Md.

Mission Operations
- NASA's Goddard Space Flight Center, Greenbelt, Md.

NASA Investment
- $932.8 million

GPM Mission Overview

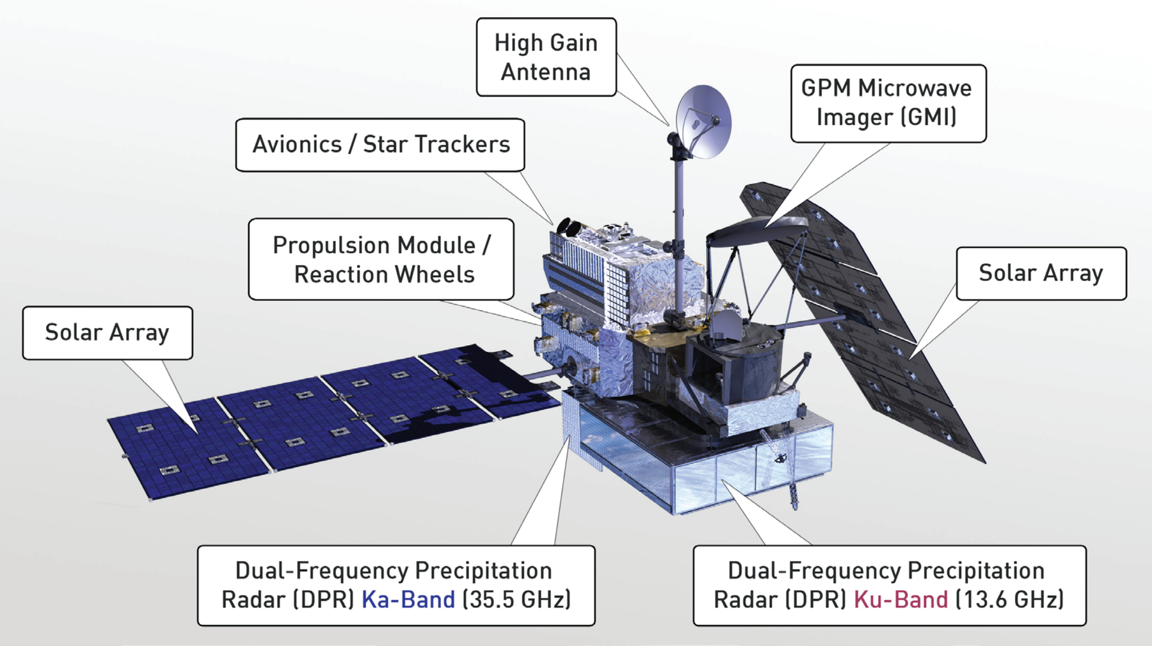
The Global Precipitation Measurement (GPM) mission is an international partnership co-led by NASA and the Japan Aerospace Exploration Agency (JAXA). The mission centers on the deployment of the GPM Core Observatory and consists of a network, or constellation, of additional satellites that together will provide next-generation global observations of precipitation from space. The GPM Core Observatory will carry an advanced radar/radiometer system and serve as a reference standard to unify precipitation measurements from all satellites that fly within the constellation.

The GPM mission concept builds on the success of the Tropical Rainfall Measuring Mission (TRMM), a joint NASA and JAXA satellite launched in 1997 that measures precipitation over tropical and subtropical regions, from approximately 35° north latitude (e.g., the Mediterranean Sea) to 35° south latitude (e.g., the southern tip of South Africa).

Measurements from the GPM Core Observatory, however, will provide even greater coverage—between approximately 65° north latitude (e.g., the Arctic Circle) and 65° south latitude (e.g., the Antarctic Circle). These measurements, combined with those from other satellites in the constellation, will provide global precipitation observations approximately every three hours. This integrated approach and unified dataset will help advance scientists' understanding of Earth's water and energy cycle.

GPM Core Observatory

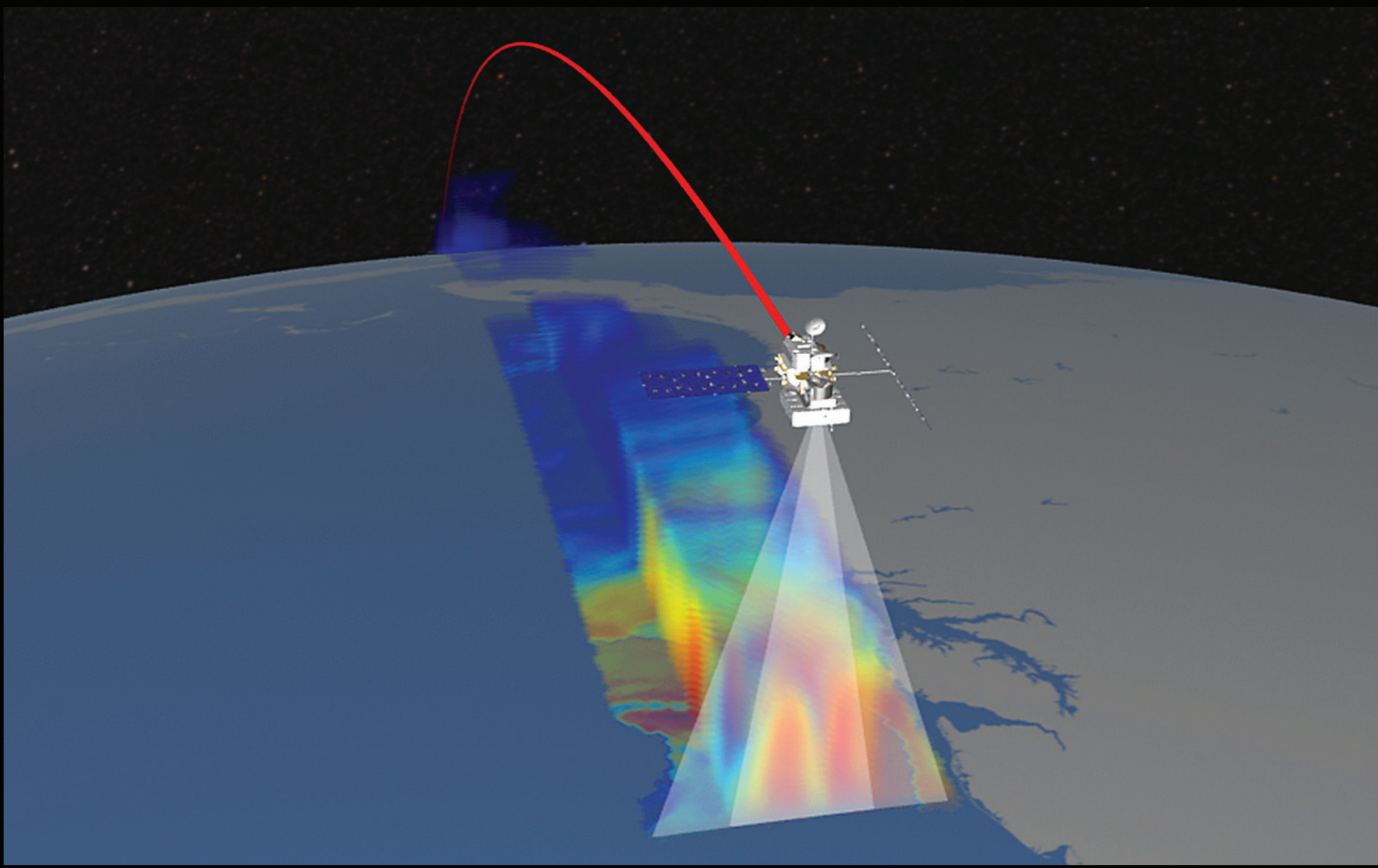
The GPM Core Observatory improves upon the capabilities of its predecessor, the TRMM satellite, with advanced precipitation instruments and expanded coverage of Earth's surface. The GPM Core will carry two instruments: the GPM Microwave Imager (GMI) and Dual-frequency Precipitation Radar (DPR). These instruments will collect improved observations that will allow scientists to better "see" inside clouds. The GMI has the capability to measure the amount, size, intensity and type of precipitation, from heavy-to-moderate rain to light rain and snowfall. The DPR will return three-dimensional profiles and intensities of liquid and solid precipitation. These data will reveal the internal structure of storms within and below clouds.

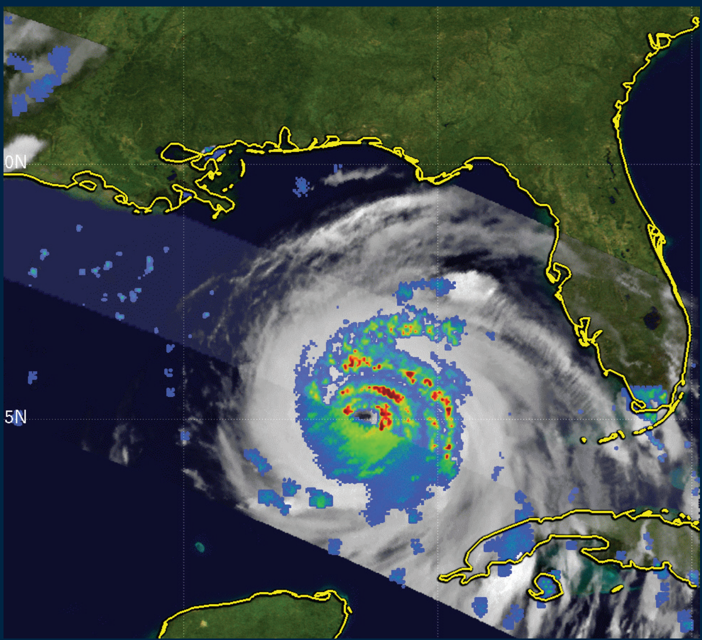


GPM Core Observatory

The GPM Core Observatory will be able to observe storms forming in the tropical oceans and track these storms as they move poleward into middle and high latitudes. With the advanced observations from the GMI and DPR, scientists will be able to study the internal structure of these storms throughout their life cycles, and view how they change over time. This capability will help scientists understand why some storms change in intensity as they transition from the tropics to the mid-latitudes.

In summary: What will GPM do?





TRMM data of Hurricane Katrina

The GPM constellation will provide measurements on the:

- intensity and variability of precipitation
- three-dimensional structure of cloud and storm systems
- microphysics of the ice and liquid particles within clouds
- amount of water falling to Earth's surface

Observations from the GPM constellation, combined with land-surface data, will improve:

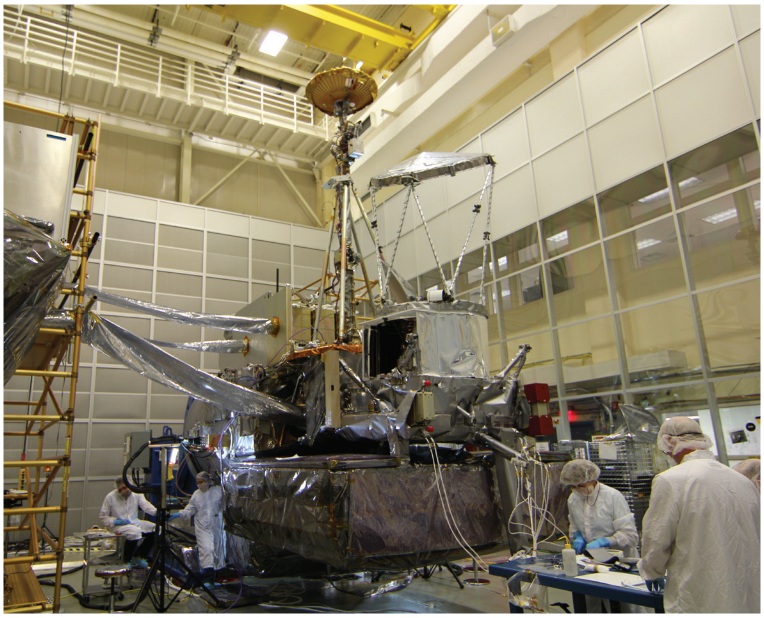
- weather forecast models
- climate models
- integrated hydrologic models of watersheds
- forecasts of hurricanes, landslides, floods and droughts

Above all, global observations from GPM mission satellites will continue and expand the data records that began with previous precipitation missions, such as TRMM, and improve precipitation estimates around the globe. The mission will help scientists understand how local, regional and global precipitation patterns change over time.

The Instruments

Together, the GPM Microwave Imager (GMI) and Dual-frequency Precipitation Radar (DPR) will provide a database of measurements against which other partner satellites' microwave observations can be meaningfully compared and combined to make uniform global precipitation datasets.

Measurements from the GMI will also serve as a reference standard for cross-calibration of other satellites in the GPM constellation. For example, when overlapping measurements of the same Earth scene are made, measurements from GMI will be used to calibrate precipitation estimates from GPM constellation sensors within a consistent framework.



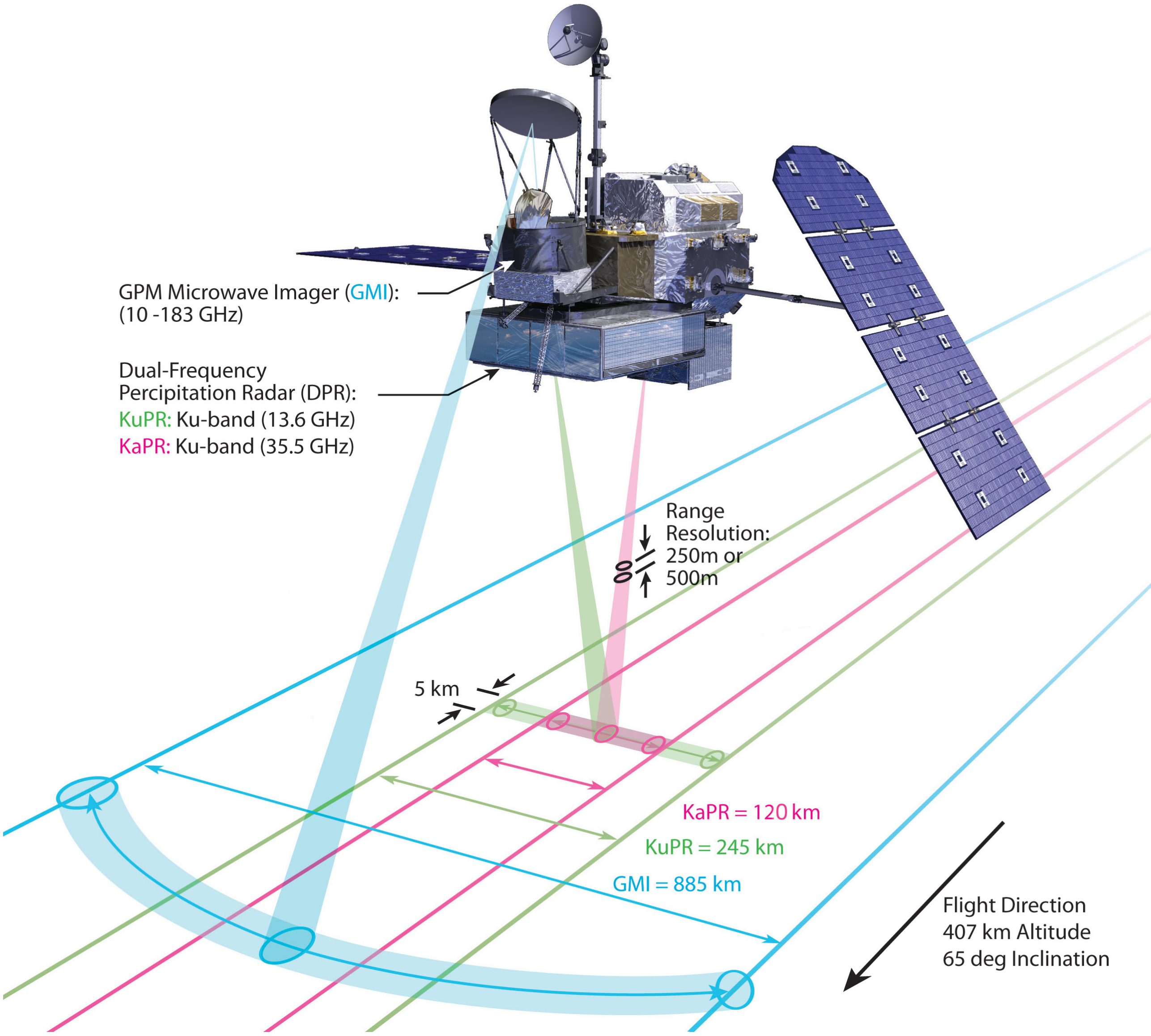


Diagram of swath coverage by GPM sensors

GMI : GPM Microwave Imager

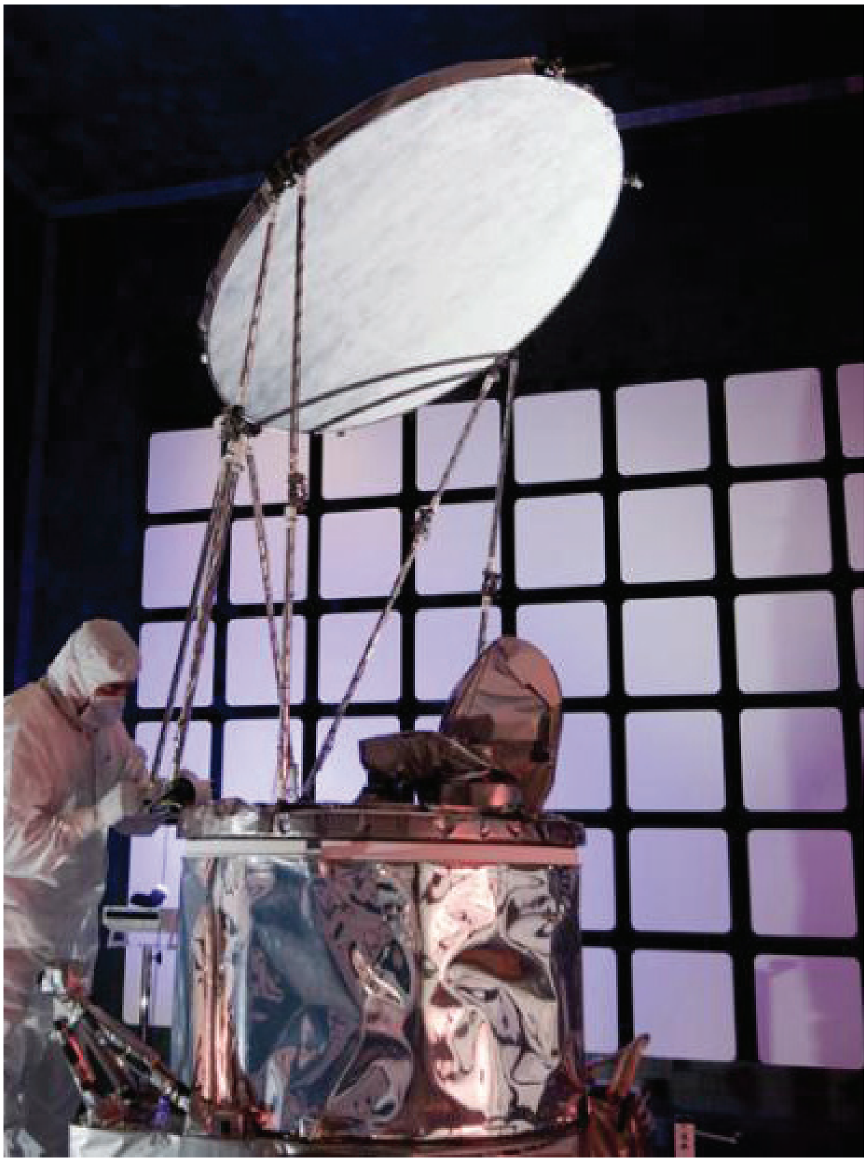
The GPM Microwave Imager (GMI)—built by Ball Aerospace & Technology Corp. in Boulder, Colo., under contract to NASA's Goddard Space Flight Center—is a multi-channel microwave radiometer designed to sense the total precipitation within all cloud layers, including light rain and snowfall. It does this by measuring the intensity of microwave energy that is constantly emitted by all parts of the Earth system, including rain and snow. Microwaves are part of the electromagnetic spectrum—the range of traveling waves of energy that include gamma and x-rays, ultraviolet light, microwaves and long radio waves. Human eyes can see a narrow band of this spectrum, called visible light. Using satellite sensors such as microwave radiometers, however, scientists can "see" additional wavelengths.

Specifically, GMI uses 13 channels to measure the intensity of microwave radiation emitted from Earth's surface and atmosphere. The lower frequency channels (10 to 89 gigahertz, similar to those of the microwave imager onboard the TRMM satellite) detect heavy- to-moderate rainfall. GMI's advancements include four additional high-frequency channels (166 to 183 gigahertz) that will measure moderate-to-light precipitation.

Each object, such as rain, snow and Earth's surfaces, emits or scatters energy differently based on the object's temperature and physical properties. Scientists use their knowledge and the contrast between the signals received by the different channels to distinguish between rain and snow and to calculate precipitation rates and quantify precipitation intensity.

How it Works

The GMI is a conical-scanning radiometer. It consists of two main parts: the detectors that measure microwave energy and the scanning antenna that collects the microwaves from the scene and reflects them to the detectors. The scanning antenna spins 32 rotations per minute to collect microwave data along the circular track it traces on the ground. When the antenna faces the arc away from the satellite, it collects data from the scene along the ground path as the satellite moves along. When the antenna faces towards the spacecraft, it does calibration checks to ensure that its measurements are accurate. The GMI's 1.2-meter-diameter antenna will provide significantly improved spatial resolution over the TRMM Microwave Imager.



GMI undergoes electromagnetic interference and compatibility testing at Ball Aerospace & Technologies Corp.

DPR : Duel-frequency Precipitation Radar

Ground-based weather radars emerged during World War II and have since been used to measure precipitation, mostly over land. The first spaceborne precipitation radar, however, did not launch until November 1997 onboard the TRMM satellite. The Precipitation Radar (PR) instrument onboard TRMM provides three-dimensional maps of tropical and subtropical rainfall over land and oceans, revolutionizing how scientists see storms.

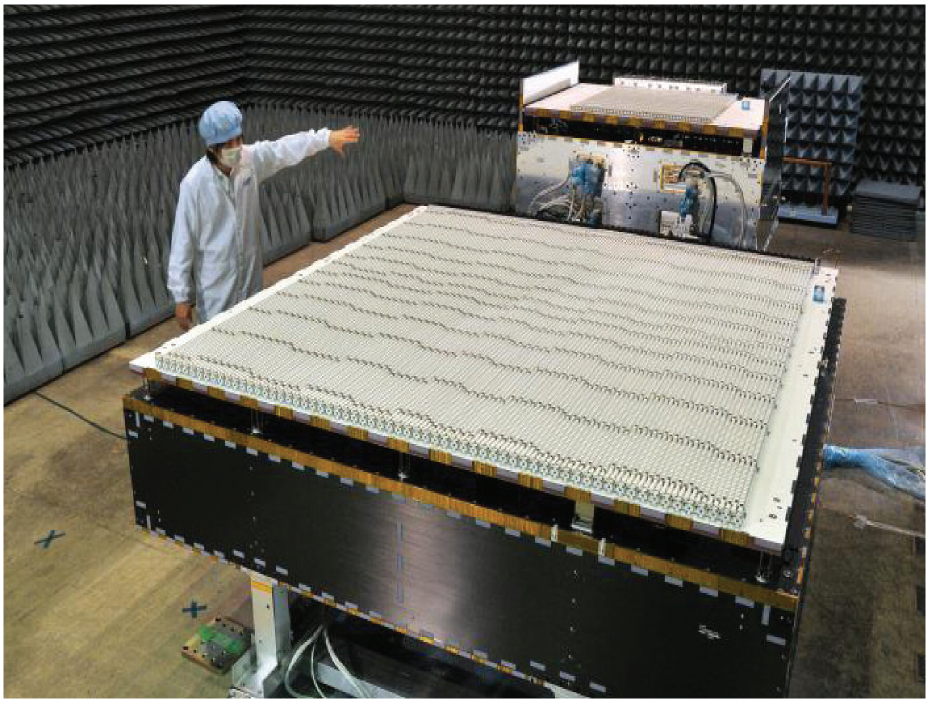
The GPM Core Observatory will carry the next- generation spaceborne precipitation radar— the Dual-frequency Precipitation Radar (DPR). The DPR will make detailed three-dimensional measurements of precipitation structures and rates, and with the Core's expanded coverage, will do so across much more of Earth's surface. NEC Toshiba Space Systems, Ltd. built the DPR, which was designed by JAXA and the National Institute of Information and Communications Technology in Japan.

One of the major advancements of the DPR is the second radar frequency. In addition to the DPR's Ku-band radar that will measure moderate-to-heavy rain at 13.6 gigahertz (similar to the PR), its Ka-band radar will measure frozen precipitation and light rain at 35.5 gigahertz. Simultaneous measurements from the overlapping swaths of Ka/Ku-band data will provide new information on particle drop size distributions—i.e., how many raindrops of different sizes are in the cloud layers and how they are spread throughout the storm system.

Improved observations of precipitation size, shape and distribution will offer scientists insight into the microphysical processes of precipitation and help to distinguish between regions of rain and snow. They will also provide bulk precipitation properties such as precipitation intensity, water fluxes and amount of water content. Information on the distribution and size of precipitation particles, together with microwave radiometer measurements made by the GMI, will improve the accuracy of rain and snowfall estimates.

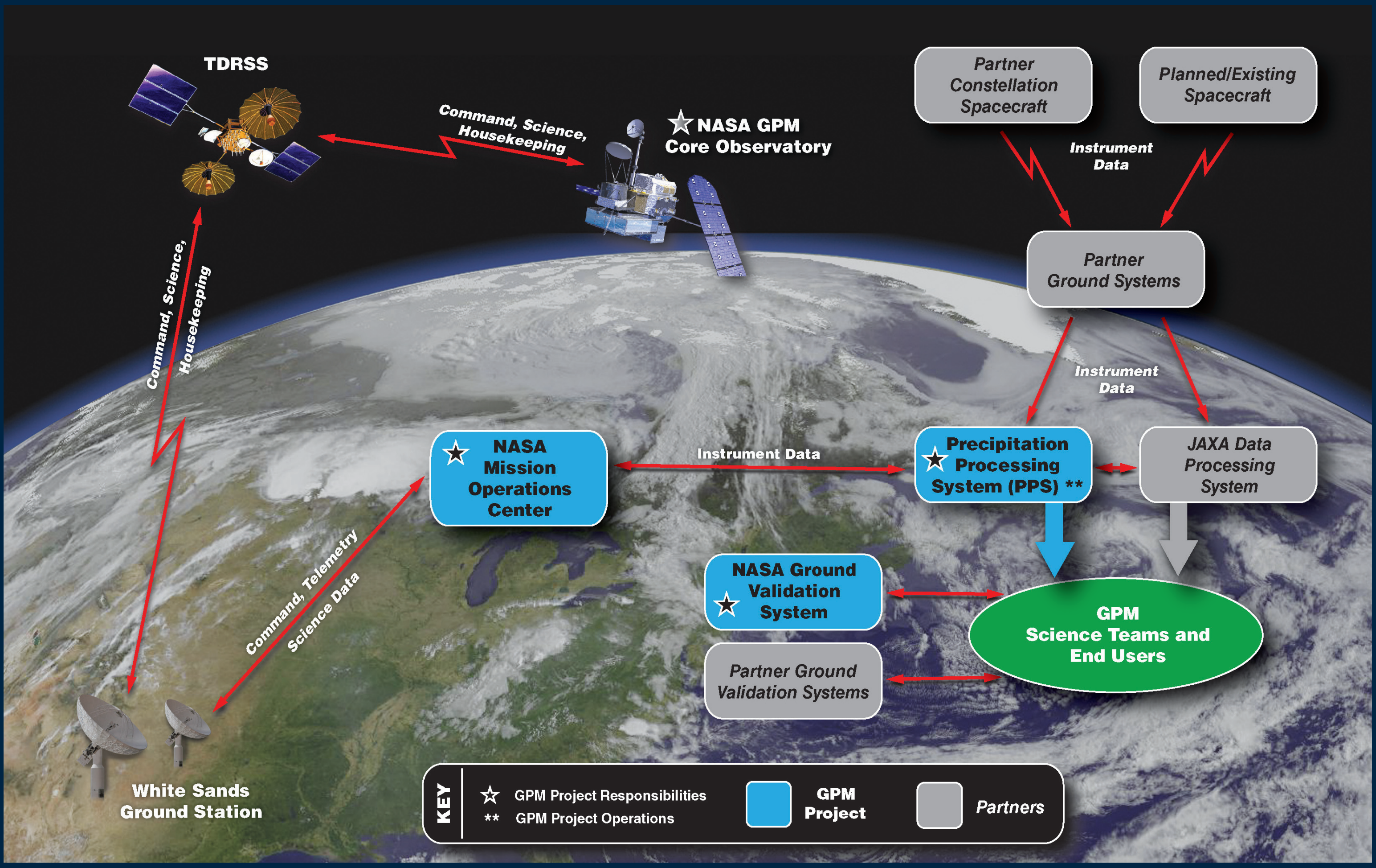
How it works

The DPR employs two cross-track scanning precipitation radars—a Ku- and Ka-band frequency radar. Both radars will have a spatial resolution of 5 kilometers (~3 miles) and emit 4100 to 4400 pulses per second, with 250-meter (~820-feet) pulse lengths. In the time that it takes the Ku-band frequency radar to measure its wider swath with 250-meter pulse lengths, the Ka-band frequency radar will measure its swath with both 250- and 500-meter (~1640-feet) pulse lengths. This will allow the Ka-band radar to collect measurements that require high sensitivity, crucial for observing smaller water droplets and ice particles. Each radar will return its own data that scientists can analyze separately or together. For example, distinguishing rain from snow is expected to be accomplished by using differences in how the Ku- and Ka-band radar pulses change intensity when they encounter different precipitation types.



A JAXA scientist standing next to the Dual-frequency Precipitation Radar (DPR) instrument. The Ku-band radar is in the foreground and the Ka-band radar is the smaller one in the background."

Ground System and PPS



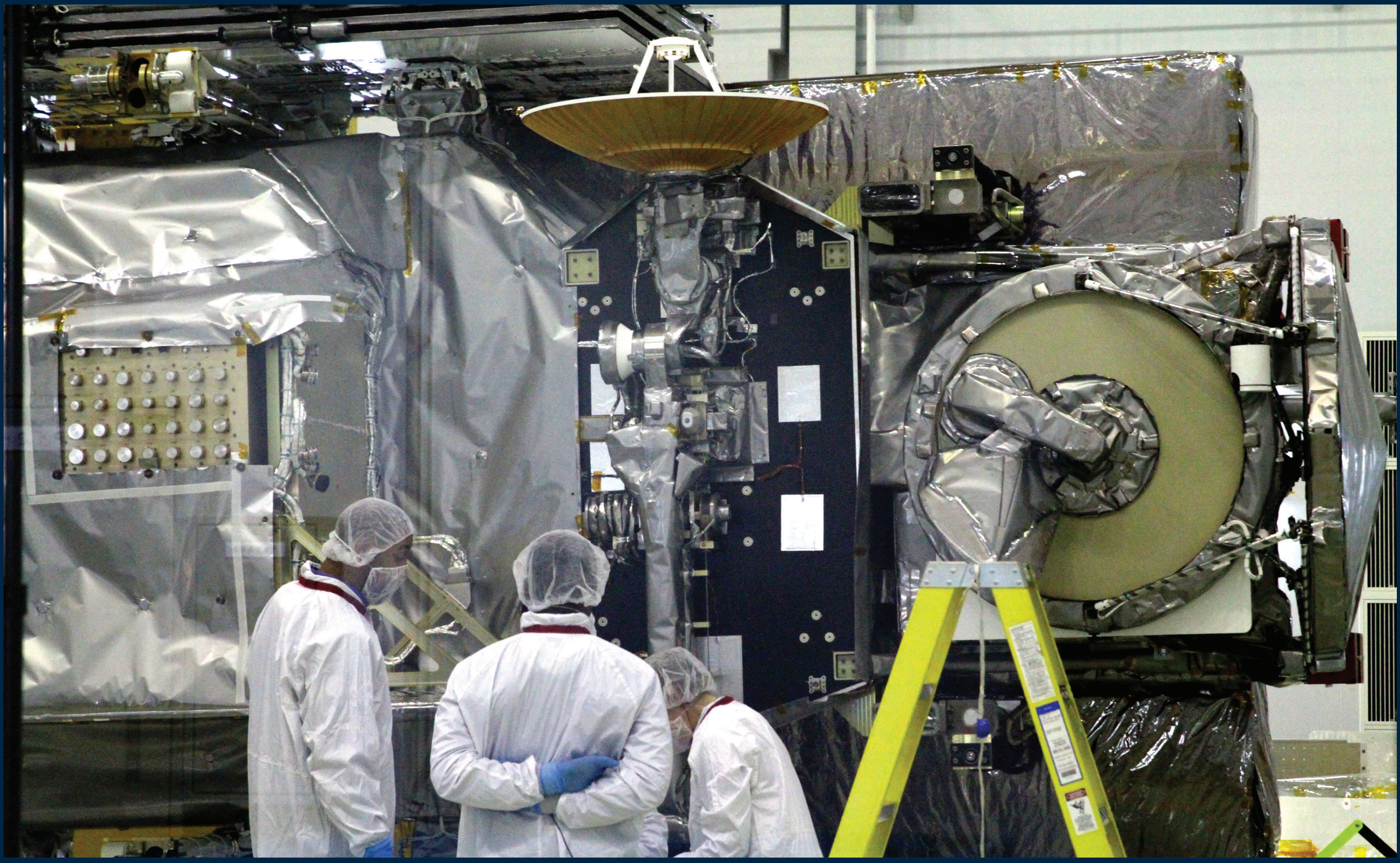
The GPM mission ground system includes all the assets needed to command and operate the GPM Core Observatory in orbit, as well as manage and distribute data received from the Core and other satellites in the constellation.

To communicate with the GPM Core Observatory, the Mission Operations Center, or MOC, at NASA's Goddard Space Flight Center sends software commands through the ground station in White Sands, N.M., to NASA's geosynchronous Tracking and Data Relay Satellite System (TDRSS). This system of three active satellites is used by NASA to communicate to and from other satellite platforms—in this case, the GPM Core Observatory. In return, the GPM Core Observatory transmits spacecraft and instrument telemetry, which report on the satellite's location and proper functioning, as well as science data from the instruments to TDRSS. Once data are transmitted to TDRSS, it sends the information to the White Sands ground station. From White Sands the data go to the MOC, which passes the science data to Goddard's Precipitation Processing System (PPS).

Data from the GPM Core Observatory's GMI instrument are returned continuously through the TDRSS Multiple Access link, while data from the DPR are returned once an orbit—approximately every 90 minutes— through the TDRSS Scheduled Access link. The partner agencies that control the other satellites in the GPM constellation send their respective satellite data to the PPS via their own data facilities.

The PPS processes all the data returned by GPM constellation satellites, with the exception of data from the DPR. DPR data are sent to JAXA's Mission Operations Systems for initial processing and returned to the PPS as a basic radar product for further processing and integration into global precipitation data products. GPM precipitation datasets will be freely available for download from the PPS website at pps.gsfc.nasa.gov.

GPM Spacecraft



The GPM Core Observatory in the clean room at Tanegashima Space Center, Japan

The GPM Core Observatory, developed and tested at NASA's Goddard Space Flight Center, will supply power, orbit and attitude control, communications and data storage for GMI and DPR. The spacecraft consists of the structural/ mechanical subsystem, solar array drive and deployment subsystem, power subsystem, attitude and thermal control subsystems, propulsion and guidance, navigation and control subsystems, high gain antenna and radio frequency communications subsystems, and command and data handling subsystem.

Two deployable solar arrays will charge the spacecraft's battery and power the observatory components through the power supply electronics. A solid-state data recorder will provide data storage aboard the spacecraft, and the S-band high gain antenna will transmit GMI and DPR data either in real time or played back from the data recorder.

As the GPM Core Observatory orbits 407 kilometers (253 miles) above Earth's surface, the GMI and DPR instruments will constantly scan coordinated areas of the surface below—called swaths. The GMI will scan an 885-kilometer-wide swath (550-mile- wide swath), while the DPR's Ku- and Ka-band frequency radars will take overlapping scans in the center of the GMI swath. Specifically, the Ka-band radar will scan across a region of 120 kilometers (~75 miles), nested within the wider scan of the Ku-band radar of 245 kilometers (~152 miles). Measurements within the overlapped swaths are important for improving precipitation retrievals of data.

An illustration of the GPM satellite constellation orbitting earth and taking measurements.

Launch in Japan

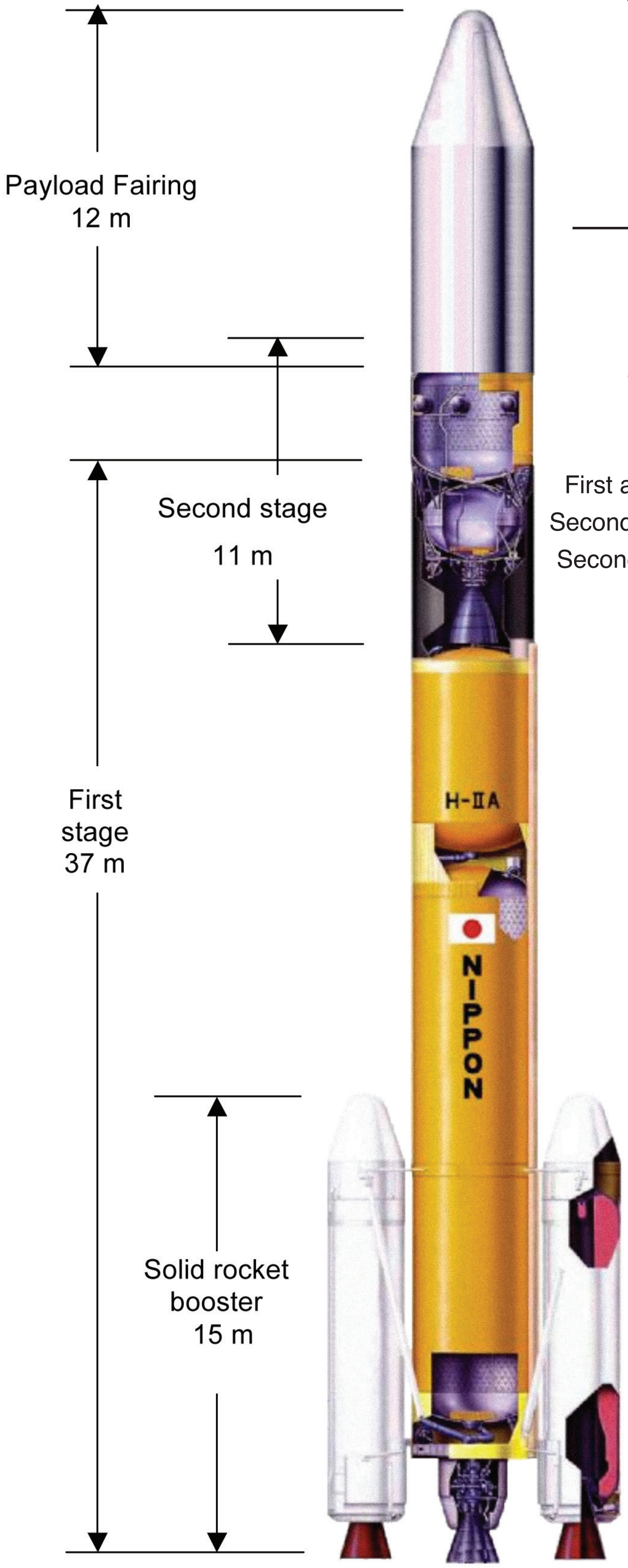
Tanegashima Space Center, Japan

Mitsubishi Heavy Industries Ltd., under contract to the Japan Aerospace Exploration Agency, is providing launch services for the GPM Core Observatory. Mitsubishi engineers oversee the launch vehicle's engineering, manufacture and the integration of the GPM Core Observatory onto the rocket. JAXA is in charge of the range and range safety management at Tanegashima Space Center, on Tanegashima Island, Japan.

H-IIA Launch Vehicle No. 23 will carry the GPM Core Observatory into orbit. The H-IIA is Japan's primary large-scale launch vehicle. It consists of two stages, each propelled by the combustion of liquid hydrogen with liquid oxygen. The H-IIA configuration for GPM also includes two solid rocket boosters propelled by polybutadiene composite solid propellant. The H-IIA has an excellent launch record of 21 successful launches out of 22.

For more information about launch services, visit:
http://www.jaxa.jp/projects/rockets/h2a/index_e.html

Flight Plan



Event	Time After Liftoff		Altitude	Inertial Speed
	Min	Sec	km	km/s
Liftoff	00	00	000	0.4
Solid rocket booster burnout*	01	39	047	1.5
Solid rocket booster jettison**	01	48	055	1.5
Payload Fairing jettison	04	05	148	2.5
Main engine cutoff (MECO)	06	36	230	5.0
First and second stages separation	06	44	236	5.0
Second stage engine ignition (SEIG)	06	50	239	5.0
Second stage engine cutoff (SECO)	14	58	399	7.7
GPM separation	15	49	398	7.7

*) At 2% of the maximum combustion chamber pressure
**) thrust strut cutting

EARTH *RIGHT* NOW

Your planet is changing. We're on it.

Of all the planets NASA has explored, none yet have matched the dynamic complexity of our own Earth. Earth teems with life and liquid water; massive storms rage over land and oceans; environments range from deserts to tropical forests to the icy poles. And amid all of that, seven billion people carve out a daily life.

And our planet is changing. Through the gradual build-up of more greenhouse gases in the atmosphere, Earth is warming. As Earth warms, ocean waters expand and ice melts to make sea levels rise. The cycle of rainfall and evaporation accelerates, leading to more severe droughts and more severe bouts of rainfall. Heat waves become more frequent and more intense.

It is this changing world that NASA continues to explore and strives to understand, so that societies can meet the challenges of the future.

Since the agency's inception in 1958, NASA has established itself a world leader in Earth science and climate studies. That will never be more apparent than in the next 12 months, when five NASA Earth-observing missions will be launched – more than NASA has conducted in a single year in over a decade. This is Earth Right Now.

- The launch of the **Global Precipitation Measurement Core Observatory** will inaugurate an unprecedented international satellite constellation to produce frequent global observations of rainfall and snowfall -- revolutionary new data that will help answer questions about our planet's life-sustaining water cycle and improve weather forecasting and water resource management.

- The **Soil Moisture Active Passive satellite** will take its place in the fleet of NASA satellites now observing every phase of Earth's critical water cycle, allowing the agency to "follow the water" from underground aquifers to the oceans to moisture and rainfall in the clouds. Scientists look to the changes in this cycle as a signature of climate change. Understanding how and how quickly those changes will happen will be vital toward allowing cities and countries to adapt.

- As carbon dioxide levels in Earth's atmosphere continue to rise, NASA will launch the **Orbiting Carbon Observatory-2** to make a completely new set of global, satellite measurements of the still mysterious ways that carbon moves through the atmosphere, land and ocean.

- The deployment of two new instruments on the International Space Station will for the first time convert the orbiting astronaut lab into a 24-7 platform for Earth science. The **ISS-RapidScat** instrument will observe how winds behave around the globe to benefit weather forecasts and hurricane monitoring, while the **Cloud-Aerosol Transport System**, or CATS, instrument will make critical measurements of clouds and aerosols – still the two climate change variables most difficult to measure and predict.

NASA does more than develop and build Earth-observing spacecraft and sensors. The agency's multi-disciplinary team of scientists, engineers and computer modelers also analyze vast archives of data for insights into Earth's interconnected systems -- atmosphere, ocean, ice, land, biosphere -- and openly provide that data to the global community. They design and deploy airborne, ground-based and ocean-going field campaigns to study Earth from the heights of the stratosphere to the depths of the ocean to the remote ice caps at the poles. And they work with other government agencies and partner organizations to apply NASA data and computer models to improve decision-making and solve problems.

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http://www.nasa.gov/content/earth-right-now/
#earthnow

http://www.nasa.gov/gpm
#GPM