



**WELCOME TO
NASA APPLIED REMOTE SENSING TRAINING
(ARSET)
WEBINAR SERIES**

**INTRODUCTION TO GLOBAL PRECIPITATION
MEASUREMENTS (GPM) DATA AND APPLICATIONS**

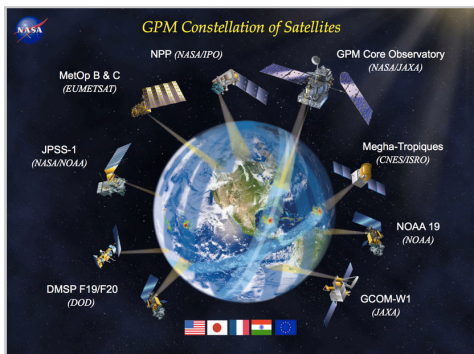
**COURSE DATES: EVERY TUESDAY, MARCH 17, 24, 31
TIME: 8 TO 9 AM AND 1 TO 2 PM EDT**

Applied Remote Sensing Training



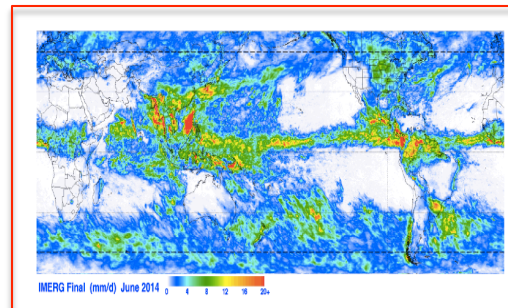
Webinar Outline

Week 1



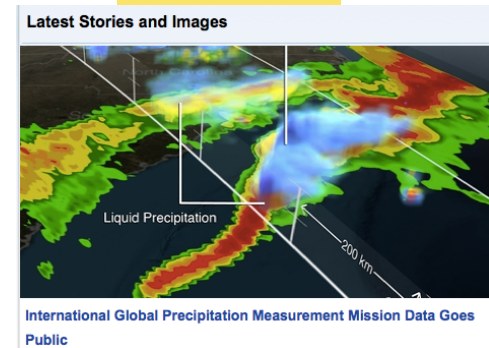
**Precipitation
Remote Sensing
Overview of TRMM and GPM**

Week 3



**GPM-IMERG Data
Demonstration of Data
Access and GIS
Applications**

Week 2



**TRMM/GPM Data
Products and Data
Access Tools**

ARSET Webinars Website

<http://arset.gsfc.nasa.gov>



The screenshot displays the ARSET website interface. At the top, there is a navigation bar with categories: **DISASTERS**, **ECO FORECASTING**, **HEALTH & AIR QUALITY**, and **WATER RESOURCES**. A sidebar on the left contains a menu with items: **Webinars** (circled in red), **Workshops**, **Apply for Training**, **Personnel**, **Links**, and **Upcoming Webinar**. A red arrow points from the 'Webinars' link to a larger, detailed view of the website content.

The main content area features a header for the webinar: **Introduction to Global Precipitation Measurement (GPM) Data and Applications**. Below this, it specifies the dates: **Tuesday, March 17, 2015 to Tuesday, March 31, 2015**. The application area is listed as **Disasters, Water Resources**, and keywords include **Flooding, Satellite Imagery, Tools**. Instruments/missions mentioned are **GPM, TRMM**. A **Read more** button is present.

An agenda section titled **Presentations and Recordings** includes a table with the following data:

Week	Date	Title	Presentation	Recording	Homework
1	March 17, 2015	Precipitation Remote Sensing Overview of TRMM and GPM	Week 1 (English) Week 1 (Spanish)		N/A
2	March 24, 2015	TRMM/GPM Data Products and Data Access Tools			N/A
3	March 31, 2015	GPM-IMERG Data Demonstration of Data Access and GIS Applications			



Training Instructors

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- Brock Blevins (ARSET): bblevins37@gmail.com
- David Barbato (ARSET): barbato1@umbc.edu
(*Spanish Translator*)
- George Huffman (week 3): (NASA-GSFC):
george.j.huffman@nasa.gov

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Ana Prados (ARSET) aprados@umbc.edu

ARSET ListServ



For information on upcoming courses and program updates sign up to the listserv

<https://lists.nasa.gov/mailman/listinfo/arset>



Important Information

Certificate of Completion (upon request):

You must attend all 3 live sessions

You must submit the homework assignment

(homework assignment link will be provided after Week-3)

Contact : Marines Martins

Email: marines.martins@ssaiha.com



Week 2 Agenda

- Review of Week 1

- Overview of GPM Rainfall Data
 - Data Processing Levels*
 - Data Formats*

- GPM Data Access Tools
 - Demonstration of GPM Data Visualization*



Review of Week-1



Remote Sensing of Precipitation

- ❑ Inferred indirectly from reflected solar radiation and emitted Infrared radiation by clouds (**Passive Remote Sensing**)
- ❑ Estimated from microwave radiation emitted or scattered by surface and precipitation particles (**Passive Remote Sensing**)
- ❑ Estimated from back-scattered microwave radiation transmitted by radars (**Active Remote Sensing**)

TRMM

One active and two passive rain sensors
Precipitation Radar (PR)
TRMM Microwave Imager (TMI)
Visible and Infrared Scanner (VIRS)

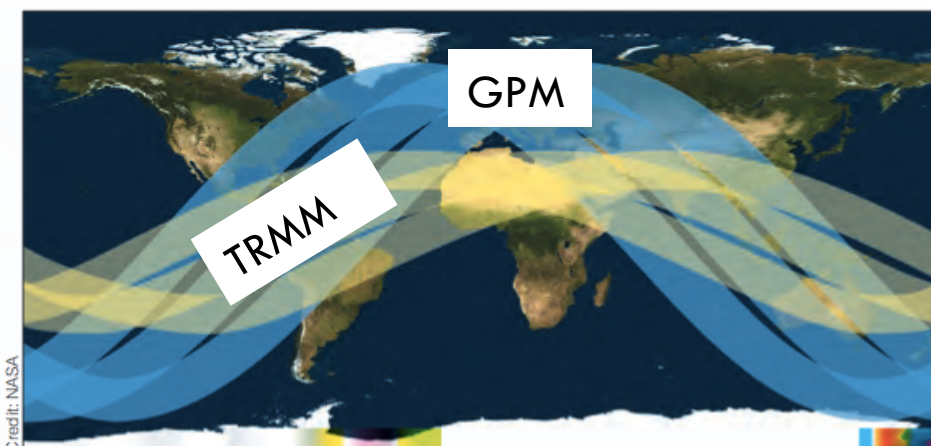
GPM

One active and one passive rain sensors
Dual-frequency Precipitation Radar (DPR)
GPM Microwave Imager (GMI)

TRMM and GPM Orbits and Spatial Coverage



- Both are in non-polar, low inclination orbit with 16 orbits per day
- **TRMM observes global tropics between 35° S to 35°N latitudes**
- **GPM observes global region between 65° S to 65°N latitudes**



the area covered by three TRMM orbits [yellow] versus orbits of the GPM Core Observatory [blue]

GPM measurements span middle and high latitudes

Global Precipitation Measurement Mission (GPM)

Designed to extend, enhance, and improve TRMM Precipitation Data



TRMM Data Limitations:

Does not provide measurements beyond 35°S-35°N

TRMM sampling frequency is 15 hours to 4 days at any point which introduces substantial uncertainties in rain estimates

TRMM provides rain measurements but not frozen precipitation, also can not detect light rain (<0.5 mm/hr)

GPM was designed to obtain measurements over the tropics and higher latitudes, with the advancement of observing light rain and snow

GPM GMI and DPR Measurements



<http://pmm.nasa.gov/GPM>

GMI

- ❑ Higher frequency channels, not included in TMI, for improved light rain and snow detection
- ❑ Higher spatial resolutions
- ❑ Reference for constellation radiometers calibration

GPM constellation satellites have revisit times of 1-2 hours over land

DPR

- ❑ Higher sensitivity to light rain and snow compared to TRMM-PR
- ❑ Better accuracy of measurements
- ❑ Better identification of liquid, ice, mixed-phase precipitation particles
- ❑ Reference standard for inter-calibration of constellation precipitation measurements



TMPA: TRMM Multi-satellite Precipitation Analysis

IMERG: Integrated Multi-satellite Retrievals for GPM

IMERG is Conceptually similar to TRMM TMPA, combines GPM GMI/DPR data with the GPM constellation satellites to yield improved spatial/temporal precipitation estimates:

	IMERG	TMPA
Temporal Resolution :	30-minutes	3 hours
Spatial Resolution:	0.1°x0.1°	0.25°x0.25°
Spatial Coverage:	Global 60°S to 60°N	Global 50°S to 50°N

Week-3 will focus on IMERG Data, Access, and GIS Analysis

Constellation Satellites:

GCOM-W, DMSP, Megha-Tropiques, MetOp-B, NOAA-N', NPP, NPOESS



Overview of GPM Precipitation Data Products

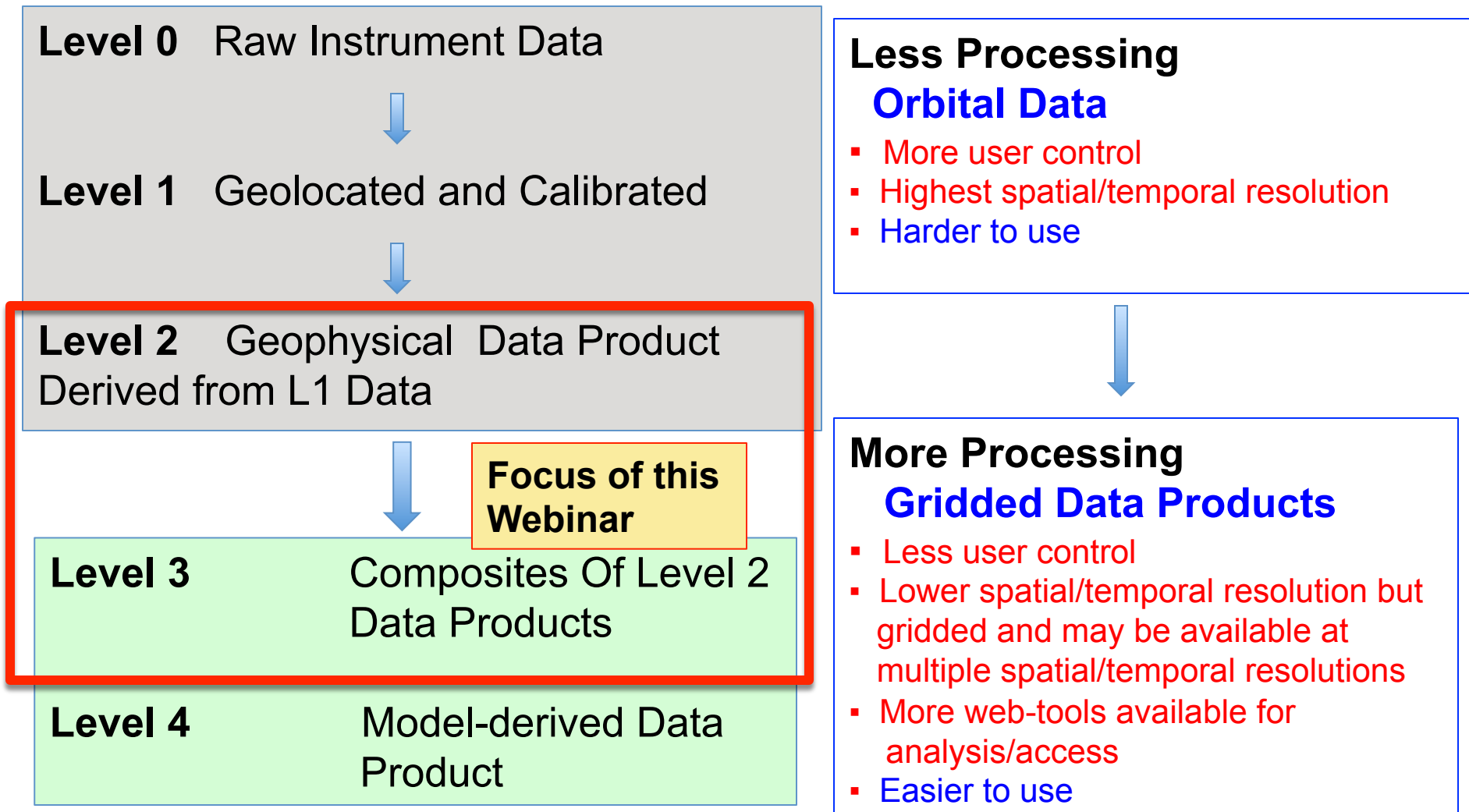


About Remote Sensing Data

- Data Processing Levels
- Data Formats



Remote Sensing Data Processing Levels





Remote Sensing Data and Products

GPM/TRMM Satellite Images or L1 Data are either in the form of brightness temperatures or radar reflectivity



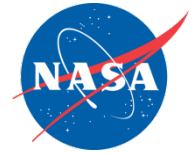
Algorithms

L2 and L3 Precipitation Products are derived from L1 Data



The Precipitation Products are used in various applications

Any information can be referred to as 'Data' and often 'Data' and 'Data Products' are used synonymously – this webinar focuses on 'Precipitation Data Products'



Remote Sensing Data Formats

- **Text/ASCII**

pros: easy to read and examine the data right away (can be read with tools such as excel and GIS software)

cons: large data files, not always available.

- **Binary – HDF, NetCDF, OpenDAP**

pros: takes less space, more information (metadata, SDS)

cons: need specific tools or code to read the data

- **KML or KMZ (zipped KML)**

pros - easy 2D and 3D visualization of the data

through free tools such as Google Earth. Data files are smaller in size and easier to download

- **Shapefiles/Geotiff:** GIS Applications. May or may not work with open source

GPM/TRMM Data Products are available in these formats



GPM/TRMM Data Information from
Precipitation Measurement Missions (PMM)

[**http://pmm.nasa.gov**](http://pmm.nasa.gov)

Precipitation Measurement Missions Data Information



<http://pmm.nasa.gov>

Details about TRMM and GPM Missions, Data Products, Access

PRECIPITATION MEASUREMENT MISSIONS

Home GPM TRMM Science Applications Meetings **Data Access** Resources Education

3D Views of February Snow Storms from GPM

The Global Precipitation Measurement (GPM) Core Observatory captured a 3-D image of a winter storm on Feb. 17, 2015, that left 6 to 12 inches of snow over much of Kentucky, southwestern West Virginia and northwestern North Carolina. The shades of blue indicate rates of snowfall, with more intense snowfall shown in darker blue. Intense rainfall is shown in red. The imagery shows great variation in precipitation types over the southeastern United States.

TRMM
TROPICAL RAINFALL MEASURING MISSION
Launched by NASA and JAXA in 1997, TRMM carries the first on-orbit active/passive instrument package to study the intensity and structure of tropical rainfall. [Get data](#)

GPM
GLOBAL PRECIPITATION MEASUREMENT
An international satellite mission launched by NASA and JAXA on Feb. 27, 2014, that will set new standards for precipitation measurements worldwide using a network of satellites united by the GPM Core Observatory. [Get data](#)

MISSION UPDATES
Thursday, December 4, 2014
Updated GPM Radiometer Products

LATEST TRMM RAINFALL DATA

Precipitation Measurement Missions

TRMM and GPM Data Products



<http://pmm.nasa.gov/data-access>

TRMM and GPM Data Products and Access

PRECIPITATION MEASUREMENT MISSIONS

Home | GPM | TRMM | Science | Applications | Meetings | Data Access | Resources | Education

Data Access

- Data Sources
- Data Downloads & Documentation
 - TRMM
 - GPM
- Ground Validation
- Data Recipes
- Data Updates
- Google Earth

Connect With Us

- Twitter
- Facebook
- Youtube

Need Help?

- View Frequently Asked Questions

How to Access TRMM & GPM Precipitation Data

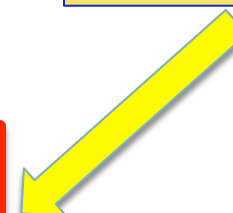
Precipitation data from the GPM and TRMM missions is made available free to the public in a variety of formats from several sources at NASA Goddard Space Flight Center. This section outlines the different types of data available, the levels of processing, the sources to download the data, and some helpful tips for utilizing precipitation data in your research.

QUICK DATA LINKS

- TRMM Downloads
- GPM Downloads
- Precipitation Processing System (PPS) Home
- GES DISC Home
- Giovanni TOVAS Data Viewer

This session will focus primarily on GPM data

Easy Data Links





GPM Data Products

<http://pmm.nasa.gov/data-access/downloads/gpm>

Home | GPM | TRMM | Science | Applications | Meetings | Data Access | Resources | Education

Data Access

- Data Sources
- Data Downloads & Documentation
 - TRMM
 - GPM**
 - Ground Validation
- Data Recipes
- Data Updates
- Google Earth

Connect With Us

- Twitter
- Facebook
- Youtube

Need Help?

- View Frequently Asked Questions
- View the PMM Glossary
- Contact Us

GPM Data Downloads

NOTE: The GPM Core Observatory launched on February 27th 2014 and the pipeline for generating data products is still being developed, therefore not all planned GPM data products are currently available. Click here for a projected schedule of when these products will be released. Please check back at <http://pmm.nasa.gov> and http://twitter.com/NASA_Rain for the latest news.

Level 3 | **Level 2** | Level 1

Derived geophysical parameters at the same resolution and location as those of the Level 1 data.

2A-CMB: Combined GMI + DPR single orbit rainfall estimates

The GPM Combined Radar-Radiometer Algorithm performs two basic functions: first, it provides, in principle, the most accurate, high resolution estimates of surface rainfall rate and precipitation vertical distributions that can be achieved from a spaceborne platform, and it is therefore valuable for applications where information regarding instantaneous storm structure are vital. Second, a global, representative collection of combined algorithm estimates will yield a single common reference dataset that can be used to "cross-calibrate" rain rate estimates from all of the passive microwave radiometers in the GPM constellation. The cross-calibration of radiometer estimates is crucial for developing a consistent, high time-resolution precipitation record for climate science and prediction model validation applications. Full Documentation

Resolution	Region - Dates	Latency	Format	Source	DL
orbital		3 hours (RT); 40 hours (Prod)	HDF5	Prod: FTP (PPS)*	↓
			HDF5	Prod: STORM	↓
			HDF5	Mirador	↓
			OPeNDAP	OPeNDAP	
			HDF5	Prod: FTP (GES DISC)	

- 2A-Ku: DPR Ku-only single orbit rainfall estimates
- 2A-Ka: DPR Ka-only single orbit rainfall estimates
- 2A-DPR: DPR Ka&Ku single orbit rainfall estimates
- 2A-GPROF-constellation: Single-orbit rainfall estimates from each passive-microwave instrument in the GPM constellation
- 2A-GPROF-GMI: GMI single-orbit rainfall estimates

Data Products

- Level-2 data have higher resolution than Level-3
- But are not continuous in space
- Multiple Products
- Useful for observing precipitation events, storms



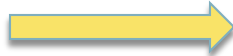
GPM Level-2 Data Product Information

<http://pmm.nasa.gov/data-access/downloads/gpm>

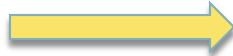
Data Product Name



Data Product Documentation



Data Product Summary



Multiple Data Products Useful for Research and Applications



Level 3 **Level 2** Level 1

Derived geophysical parameters at the same resolution and location as those of the Level 1 data.

▾ 2A-CMB: Combined GMI + DPR single orbit rainfall estimates

The GPM Combined Radar-Radiometer Algorithm performs two basic functions: first, it provides, in principle, the most accurate, high resolution estimates of surface rainfall rate and precipitation vertical distributions that can be achieved from a spaceborne platform, and it is therefore valuable for applications where information regarding instantaneous storm structure are vital. Second, a global, representative collection of combined algorithm estimates will yield a single common reference dataset that can be used to "cross-calibrate" rain rate estimates from all of the passive microwave radiometers in the GPM constellation. The cross-calibration of radiometer estimates is crucial for developing a consistent, high time-resolution precipitation record for climate science and prediction model validation applications. [Full Documentation](#)

Resolution	Region - Dates	Latency	Format	Source	DL
orbital		3 hours (RT); 40 hours (Prod)	HDF5	Prod: FTP (PPS)*	↓ ↓ ↓
			HDF5	Prod: STORM	
			HDF5	Mirador	
			OPeNDAP	OPeNDAP	
			HDF5	Prod: FTP (GES DISC)	

▾ 2A-Ku: DPR Ku-only single orbit rainfall estimates

▾ 2A-Ka: DPR Ka-only single orbit rainfall estimates

▾ 2A-DPR: DPR Ka&Ku single orbit rainfall estimates

▾ 2A-GPROF-constellation: Single-orbit rainfall estimates from each passive-microwave instrument in the GPM constellation

▾ 2A-GPROF-GMI: GMI single-orbit rainfall estimates


Multiple Formats and Options for Data Download



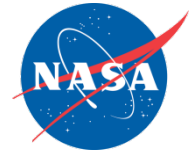
Summary of GPM Level-2 Precipitation Products

*Surface Rainfall Rate in mm/hour

GPM data are available from March 2014 to present

Sensor/Product Name	Spatial Resolution and Coverage	Temporal Resolution	Data Format
DPR Ku-only/ 2A-Ku DPR Ka-only/2A-Ka DPR KU & Ka/ 2A-DPR	5.2 km x125 m Single Orbit and 16 orbits per day (70°S-70°N)	20-120 minutes 24 hours	HDF5 and OPenDAP
GMI/2A-GPROF	4 km x 4 km Orbital and 16 orbits per day (70°S-70°N)	2 – 40 hours	
Combined GMI and DPR/2A-CMB	Orbital (70°S-70°N) 5 km x 5 km, Coincident Ku-Ka-GMI footprints	3 – 40 hours	

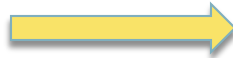
*In addition to surface rainfall rate in mm//hour, vertical precipitation profiles and latent heating are available in these data products



GPM Level-3 Data Product Information

<http://pmm.nasa.gov/data-access/downloads/gpm>

Data Product Name



Data Product Documentation



Data Product Summary



Multiple Data Products – Level-2 orbital data averaged over regular grids



Level 3 | Level 2 | Level 1

Geophysical parameters that have been spatially and/or temporally resampled from Level 1 or Level 2 data.

IMERG: Rainfall estimates combining data from all passive-microwave instruments in the GPM Constellation

This algorithm is intended to intercalibrate, merge, and interpolate "all" satellite microwave precipitation estimates, together with microwave-calibrated infrared (IR) satellite estimates, precipitation gauge analyses, and potentially other precipitation estimators at fine time and space scales for the TRMM and GPM eras over the entire globe. The system is run several times for each observation time, first giving a quick estimate and successively providing better estimates as more data arrive. The final step uses monthly gauge data to create research-level products.

Documentation:

- IMERG Technical Documentation
- IMERG Algorithm Theoretical Basis Document (ATBD)
- IMERG Day 1 Final Run Release Notes
- Transitioning from TMPA (3B32x) to IMERG

Resolution	Regions - Dates	Latency	Format	Source	DL	
0.1° - 30 minute	Gridded, 90°N-90°S, March 2014 to present	4 hours (RT)	HDF5	RT: FTP (PPS)*		
			HDF5	Mirador		
			Giovanni	Giovanni TOVAS		
0.1° - 30 minute	Gridded, 90°N-90°S, March 2014 to present	12 hours (RT)	HDF5	RT: FTP (PPS)*		
			OPeNDAP	OPeNDAP		
			GDS	GrADS Data Server (GDS)		
0.1° - 30 minute	Gridded, 90°N-90°S, March 2014 to present	4 months (Prod)	HDF5	Prod: FTP (PPS)*		
			HDF5	Prod: STORM		↓
			HDF5	Prod: FTP (GES DISC)		

▶ 3-CMB: Combined GMI + DPR Rainfall Averages

▶ 3-DPR: DPR rainfall averages

▶ 3-GPROF: GMI rainfall averages

- IMERG is derived from multiple satellites
- Available every half hour at about 10 km resolution in near-real time (4-hour latency)


Multiple Formats and Options for Data Download



Summary of GPM Level-3 Precipitation Products

*Surface Rainfall Rate in mm/hour

GPM data are available from March 2014 to present

Sensor/Product Name	Spatial Resolution and Coverage	Temporal Resolution	Data Format
IMERG	0.1°x0.1° (90°S-90°N)	30-minutes(Near Real Time) with 4-hour latency, 12-hour latency and 4-months latency	HDF4, NetCDF, OPenDAP, ASCII GIF, PNG Images KML for Google Earth
3-CMB Combined GMI + DPR rainfall Averages	0.1°x0.1° (70°S-70°N)	Monthly	
3-DPR rainfall Averages	0.25°x0.25° 5.0°x5.0° (67°S-67°N) for Daily (70°S-70°N) for Monthly	Daily and Monthly Daily and Monthly	
3-GPROF GMI rainfall Averages	0.25°x0.25° (90°S-90°N)	Daily and Monthly	

*In addition to surface rainfall rate in mm//hour, vertical precipitation profiles and latent heating are available in these data products



GPM Data File Names

<http://pps.gsfc.nasa.gov/Documents/FileNamingConventionForPrecipitationProductsForGPMMissionV1.4.pdf>

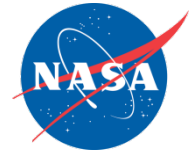
GPM Data files use following convention for data type and temporal attributes:

Type	Description
1A	Instrument count, geolocated, at instantaneous field of view (IFOV).
1B	Geolocated, calibrated T_b or radar power at IFOV.
1C	Intercalibrated brightness temperatures T_c at IFOV.
2A	Geolocated geophysical parameters at IFOV from a single instrument.
2B	Geolocated geophysical parameters at IFOV from multiple instruments.
3A	Space/time averaged geophysical parameters from a single instrument.
3B	Space/time averaged geophysical parameters from multiple instruments.
4	Combined satellite, ground and/or model data.

The second subfield for data type is optional and is an indication of accumulation. This is separated from the data level by a hyphen '-'. Table 2 lists the indicators currently supported.

Table 2. Indication of Accumulation Subfield Examples

Name	Description
HR	The product accumulates data for 1 hour.
HHR	The product accumulates data every half hour
DAY	The product accumulates data for a single day.
PENT	The product accumulates data for a 5-day period.
7DAY	The product accumulates data for a 7-day period.
MO	The product accumulates data for a designated month.

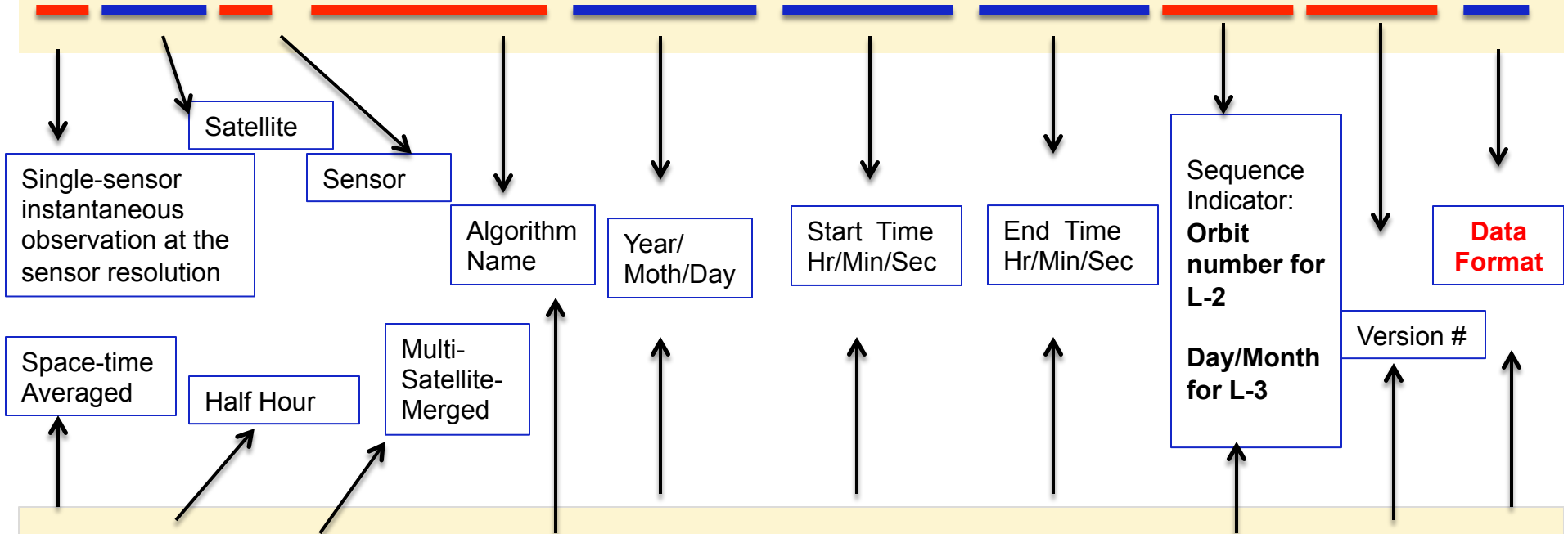


GPM Data File Name Convention

<http://pps.gsfc.nasa.gov/Documents/FileNamingConventionForPrecipitationProductsForGPMMissionV1.4.pdf>

Level-2 File Name

2A.GPM.GMI.GPROF2008.20131101-S235152-E012400.000352.V01A.HDF5



3B-HHR.MS.MRG.3IMERG.20140805-S043000-E045959.0270.V03D.HDF5

Level-3 File Name



GPM Data Validation Information



GPM Data Product Validation

<http://pmm.nasa.gov/data-access/downloads/ground-validation>

GPM Data are currently being validated with a variety of ground-based measurements

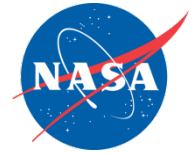
Ground Validation Data Downloads

Ground Validation Data

<http://gpm-gv.gsfc.nasa.gov/>

The goal of this site is to provide a one-stop-shopping portal for accessing the various radar, disdrometer, gauge and other instrument data sets supporting GPM GV activities. Use the tabs above to access the various datasets, including:

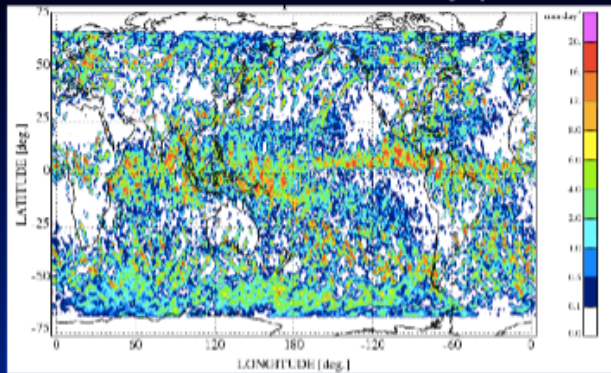
- Radar
- Gauge
- Disdrometer
- NOAA/NMQ
- Field Campaigns
- Validation Network
- Wallops Precipitation Research Facility



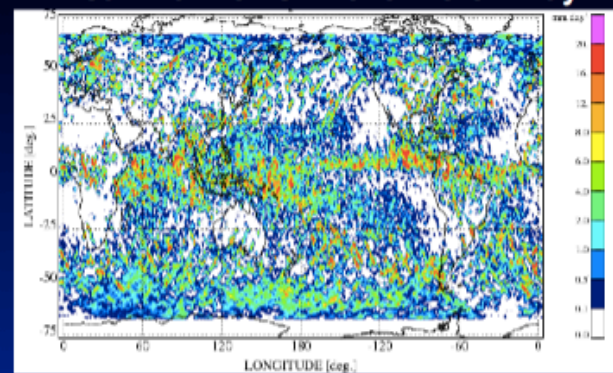
GPM and TRMM Level-2 Data Products Comparison

Comparison of GPM Mean Precip. vs TRMM

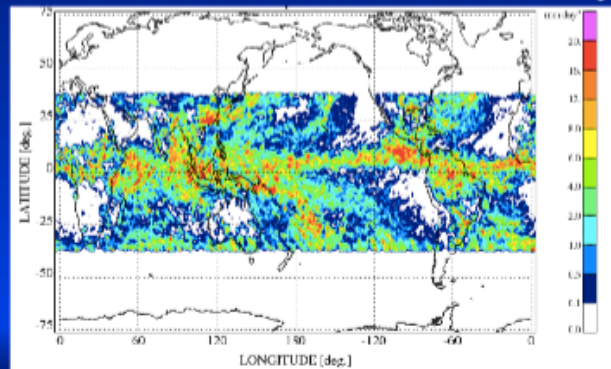
Mean Ku+GMI over 16-31 May (Ka swath)



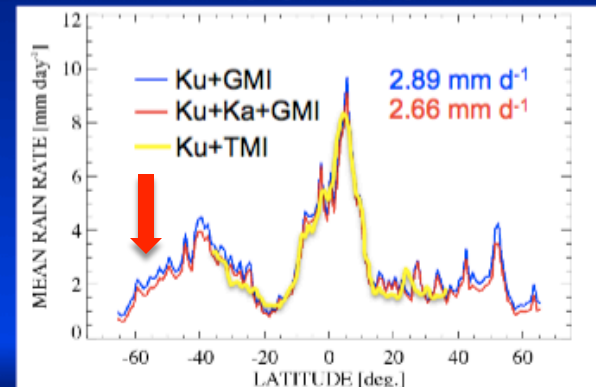
Mean Ku+Ka+GMI over 16-31 May



Mean of TRMM Ku+TMI over 16-31 May



Zonal Means

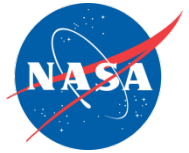


Higher spatial resolution, coverage, and details in GPM Products

Light rain captured by GPM

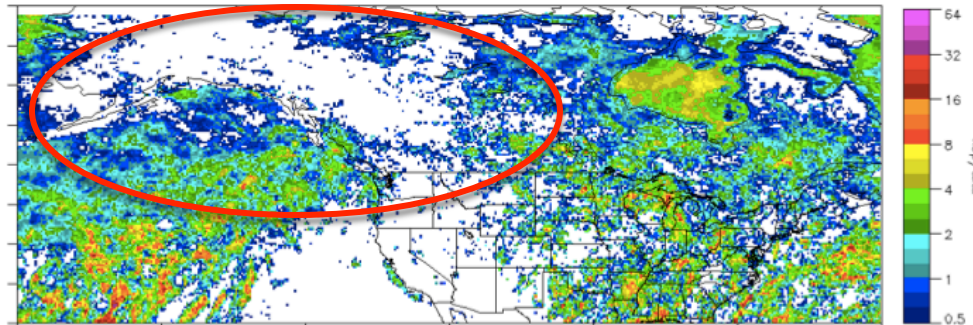
Courtesy: William Olson (PMM Investigator), NASA Mesoscale Atmospheric Processes

GPM and TRMM Level-2 Data Products Comparison

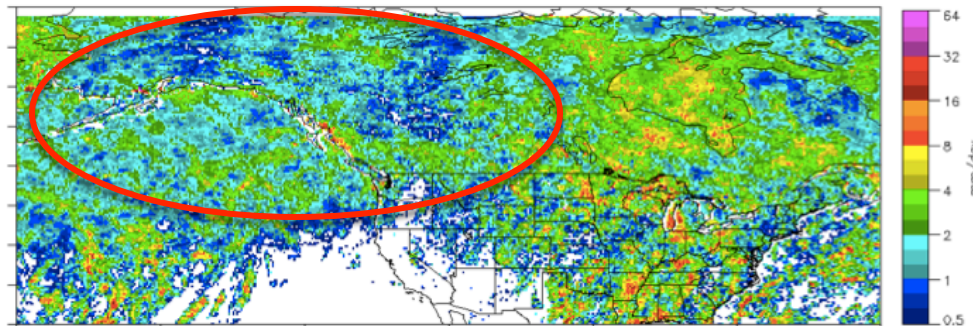


GMI GPROF2014 Retrieval - April, 2014

V1 (TRMM/NEXRAD based) Database



V2 (GPM based) Database



Improved Coverage in GPM GMI Product

Courtesy: Christian Kummerow (PMM Investigator), Colorado State University



Data Access Tools

Summary of GPM Data Access Tools



Tools	Data Products and Formats	Analysis and/or Visualization	Data Download
<p>Mirador http://mirador.gsfc.nasa.gov</p>	<p>L1B, L2, and L3 GMI-GPROF IMERG Half-hourly, Monthly Orbital and Gridded Daily, Monthly HDF5, OPenDAP (can be converted to ASCII, Binary, NetCDF)</p>	<p>N/A</p>	<p>Batch Download</p>
<p>Giovanni http://giovanni.gsfc.nasa.gov/giovanni/</p>	<p>IMERG Half-hourly, Monthly NetCDF, GeoTIFF, PNG</p>	<p>Visualization: Map, Time Series, Scatter Plot, Histogram Analysis: Time-averaged Maps, Time Series, Scatter Plot, Map Correlations, Vertical Profiles, Time-averaged Differences</p>	<p>Download by Select and Click on Data Files</p>
<p>PPS/STORM https://storm.pps.eosdis.nasa.gov/storm</p>	<p>L1B and 1C, L2, L3 GMI, DPR, GMI-DPR Combined Data, Orbital and Gridded Daily, Monthly IMERG Half-hourly, Monthly HDF5, PNG</p>	<p>Map Visualization, Interactive Latitude/Longitude Point Data Value Display</p>	<p>FTP</p>



Mirador: Data Search and Access

<http://mirador.gsfc.nasa.gov/>

The screenshot shows the Mirador website interface with several callouts highlighting key features:

- Search Data using Keyword:** A yellow callout box pointing to the search input field containing the keyword "IMERG".
- Temporal Selection:** A yellow callout box pointing to the "Time Span" field, which is set to "2014-07-15" to "2014-07-16".
- Spatial Selection by latitude-longitude:** A yellow callout box pointing to the "Location" field, which contains the coordinates "(14.07,-138.50),(53.84,-48.50)".
- Spatial Selection from Map:** A yellow callout box pointing to a map of North America, with a red box highlighting a specific region.
- Search:** A blue callout box pointing to the "Search GES-DISC" button.

Additional features and information visible on the page include:

- Navigation menu: EARTH DATA, Data Discovery, Data Centers, Community, Science Disciplines.
- Search bar: Search GES DISC, Search, Advanced Search.
- Navigation tabs: GES DISC Home, Data Services, Science Portals, Mission Portals.
- Mirador logo: Data Access Made Simple.
- Left sidebar: OVERVIEW, HELP CENTER, DATA HOLDINGS, VIEW CART, Additional Features (News, Restricted Data, Feedback, FAQ).
- Search filters: Keyword, Projects, Science Areas.
- Map controls: Update Map, Map dropdown, Terms of Use, Report a map error, Advanced Search.

**gazetteer locations such as Kansas or Ice Shelf; OR
a bounding box: (minLat,minLon),(maxLat,maxLon)
(LL),(UR) (Mirador will choose smallest area)
OR 80N 20s 120east 20wes OR
a partial Lat/Lon: of 22n is equivalent to (22,180),(-90,-180)**

Mirador: Data Search and Access



<http://mirador.gsfc.nasa.gov/>

Data Search Results for GPM IMERG in terms of Data Files

The screenshot displays the Mirador 1.55 interface. At the top, there are navigation links for 'GES DISC Home', 'Data Services', 'Science Portals', and 'Mission Portals'. The main header features the Mirador logo and the tagline 'Data Access Made Simple'. A search bar on the left contains the keyword 'IMERG'. Below the search bar, there are links for 'More Search Options' and 'Search GES-DISC'. The search results are displayed in a table-like format under the heading 'Data Sets'. The first result is 'GPM Level 3 IMERG Monthly 0.1 x 0.1 degree (GPM_3IMERGM)', which is selected. This result shows 'Approx. 1 files found (Avg Size: 28.86 MB)' and lists parameters: 'PRECIPITATION AMOUNT, PRECIPITATION RATE, RAIN, SNOW'. The second result is 'GPM Level 3 IMERG Half Hourly 0.1 x 0.1 degree (GPM_3IMERGHH)', which is not selected. This result shows 'Approx. 96 files found (Avg Size: 2.53 MB)' and lists parameters: 'CYCLONES, DROUGHT, HURRICANES, MONSOONS, STORMS, TYPHOONS, SNOW...'. A yellow callout box on the right contains the text '1 Monthly and 95 Half-hourly Files', with red arrows pointing to the search results. At the bottom of the page, there is a 'NASA Search Results' section with the note '(Number of files found may not be entirely accurate)' and 'Page: 1'.

Mirador: Data Search and Access



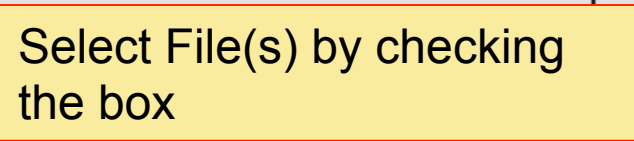
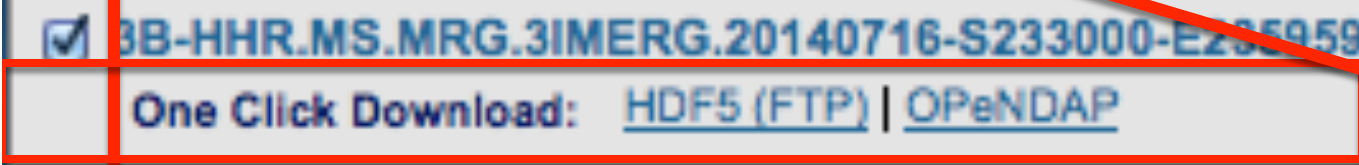
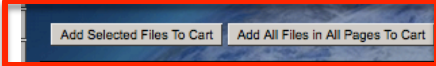
<http://mirador.gsfc.nasa.gov/>

IMERG Half-hourly Data Files List

GPM Level 3 IMERG Half Hourly 0.1 x 0.1 degree Info		
<input type="checkbox"/> Add Selected Files To Cart <input type="checkbox"/> Add All Files in All Pages To Cart		
<input type="checkbox"/> Select All in Page	File Names/Descriptive File Names	Start Time
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S233000-E235959.1410.V03D.HDF5 (2.53 MB) One Click Download: HDF5 (FTP) OPeNDAP	2014-07-16 23:30:00 Metadata
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S233000-E232959.1380.V03D.HDF5 (2.43 MB)	2014-07-16 23:00:00
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S233000-E235959.1410.V03D.HDF5 (2.53 MB)	
One Click Download: HDF5 (FTP) OPeNDAP		
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S210000-E212959.1260.V03D.HDF5 (2.56 MB) One Click Download: HDF5 (FTP) OPeNDAP	
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S203000-E205959.1230.V03D.HDF5 (2.49 MB) One Click Download: HDF5 (FTP) OPeNDAP	
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S200000-E202959.1200.V03D.HDF5 (2.42 MB) One Click Download: HDF5 (FTP) OPeNDAP	
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S193000-E195959.1170.V03D.HDF5 (2.49 MB) One Click Download: HDF5 (FTP) OPeNDAP	2014-07-16 19:30:00 Metadata
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S190000-E192959.1140.V03D.HDF5 (2.52 MB) One Click Download: HDF5 (FTP) OPeNDAP	2014-07-16 19:00:00 Metadata
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S183000-E185959.1110.V03D.HDF5 (2.52 MB) One Click Download: HDF5 (FTP) OPeNDAP	2014-07-16 18:30:00 Metadata
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S180000-E182959.1080.V03D.HDF5 (2.48 MB) One Click Download: HDF5 (FTP) OPeNDAP	2014-07-16 18:00:00 Metadata
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S173000-E175959.1050.V03D.HDF5 (2.44 MB) One Click Download: HDF5 (FTP) OPeNDAP	2014-07-16 17:30:00 Metadata
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S170000-E172959.1020.V03D.HDF5 (2.41 MB) One Click Download: HDF5 (FTP) OPeNDAP	2014-07-16 17:00:00 Metadata
<input checked="" type="checkbox"/>	3B-HHR.MS.MRG.3IMERG.20140716-S163000-E165959.0990.V03D.HDF5 (2.50 MB) One Click Download: HDF5 (FTP) OPeNDAP	2014-07-16 16:30:00 Metadata

Download each file by clicking on HDF5 or OPeNDAP
OR Select Multiple files and add to cart

Select File(s) by checking the box



Mirador: Data Search and Access



<http://mirador.gsfc.nasa.gov/>

Data Checkout

Mirador 1.55
Data Access Made Simple

Keyword: IMERG
More Search Options
Search GES-DISC

Shopping Cart
Sort by: Data Set
Continue Searching

Your cart contains 96 items (239.51 MB)

Checkout

Delete GPM Level 3 IMERG Half Hourly 0.1 x 0.1 degree (GPM_3IMERGHH v.03): 96 Items
Empty Entire Cart

Page: 1

Download Data by using these scripts

Keyword: IMERG
More Search Options
Search GES-DISC

Shopping Cart
Sort by: Data Set
Continue Searching

Your cart will automatically be emptied when you select any download option unless you choose to keep the items.
 Keep items in the cart after selecting a download option

Basic Download More Download Options

DOWNLOAD DATA (WITH WGET, CURL, ETC.)

URL List (Data) URL List (Metadata) URL List (Data and Metadata)

Instructions:

wget:
Save the list of URLs in one of the above links to your local workstation as myfile.dat
On your command line:
wget -i myfile.dat

a UNIX curl example:
Save the list of URLs in one of the above links to your local workstation as myfile.dat
On your command line:
xargs -n 1 curl -O -u anonymous:curl@example.com < myfile.dat

+ NASA Privacy Policy and Important Notices
+ Contact Us
NASA Official: Steve Kempner

Mirador: Data Search and Access



<http://mirador.gsfc.nasa.gov/>

Mirador is useful for searching data and downloading multiple data files

**Live overview of
Mirador**



Giovanni Version 4

<http://giovanni.gsfc.nasa.gov/giovanni/>



Select Plot

Maps: Time-Averaged Comparisons: *Select...* Time Series: *Select...* Vertical: *Select...* Miscellaneous: *Select...*

Analysis/Plot Options

Select Date Range (UTC) **Select Region (Bounding Box or Shapefile)**

YYYY-MM-DD. HH:mm to - - :59 *Format: West, South, East, North*

- - :00 to - - :59 -180, -90, 180, 90

Valid Range: 1979-01-01 to 2015-03-10

Temporal and Spatial Search
Map and Shapefile Selection for various countries or US States

Select Variables

Number of matching Variables: 0 of 327 Total Variable(s) included in Plot: 0

Disciplines

- Aerosols (117)
- Atmospheric Chemistry (18)
- Atmospheric Dynamics (64)
- Hydrology (110)
- Water and Energy Cycle (120)

Measurements

- Aerosol Index (1)
- Air Pressure (6)
- Air Temperature (15)
- Albedo (8)
- Altitude (4)
- Angstrom Exponent (16)
- Atmospheric Moisture (23)
- CH4 (4)
- CO (4)
- Cloud Fraction (4)

Keyword:

Search data by keyword

Plot Data



Giovanni Version 4

<http://giovanni.gsfc.nasa.gov/giovanni/>

Search GPM data and Select Spatial, Temporal, Plot Options

Select Plot

Maps: Time-Averaged Comparisons: Select... Time Series: Select... Vertical: Select... Miscellaneous: Select...

Select Date Range (UTC) Select Region (Bounding Box or Shapefile)

YYYY-MM HH:mm Format: West, South, East, North

2014 -07 -01 00:00 to 2014 -07 -31 23:59 -132.1875, 13.2656, -53.4375, 61.0°

Valid Range: 2014-03-12 to 2014-10-31

Select Variables

Number of matching Variables: 9 of 327

Keyword : GPM

	Variable Name	Source	Temp. Res.	Spat. Res.	Begin Date	End Date	Vert. Slice
<input checked="" type="checkbox"/>	Gauge relative weighting (GPM_3IMERGM v03)	GPM	Monthly	0.1 °	2014-03-12	2014-10-31	-
<input type="checkbox"/>	Probability of liquid precipitation phase (GPM_3IMERGM v03)	GPM	Monthly	0.1 °	2014-03-12	2014-10-31	-
<input type="checkbox"/>	Satellite-precipitation random error (GPM_3IMERGM v03)	GPM	Monthly	0.1 °	2014-03-12	2014-10-31	-
<input type="checkbox"/>	Satellite and gauge precipitation (GPM_3IMERGM v03)	GPM	Monthly	0.1 °	2014-03-12	2014-10-31	-
<input type="checkbox"/>	Instantaneous Precipitation - High Quality (GPM_3IMERGHH v03)	GPM	Half-Hourly	0.1 °	2014-03-12	2014-10-31	-
<input type="checkbox"/>	Passive microwave source	GPM	Half-Hourly	0.1 °	2014-03-12	2014-10-31	-

July, 2014
Monthly IMERG
over the US



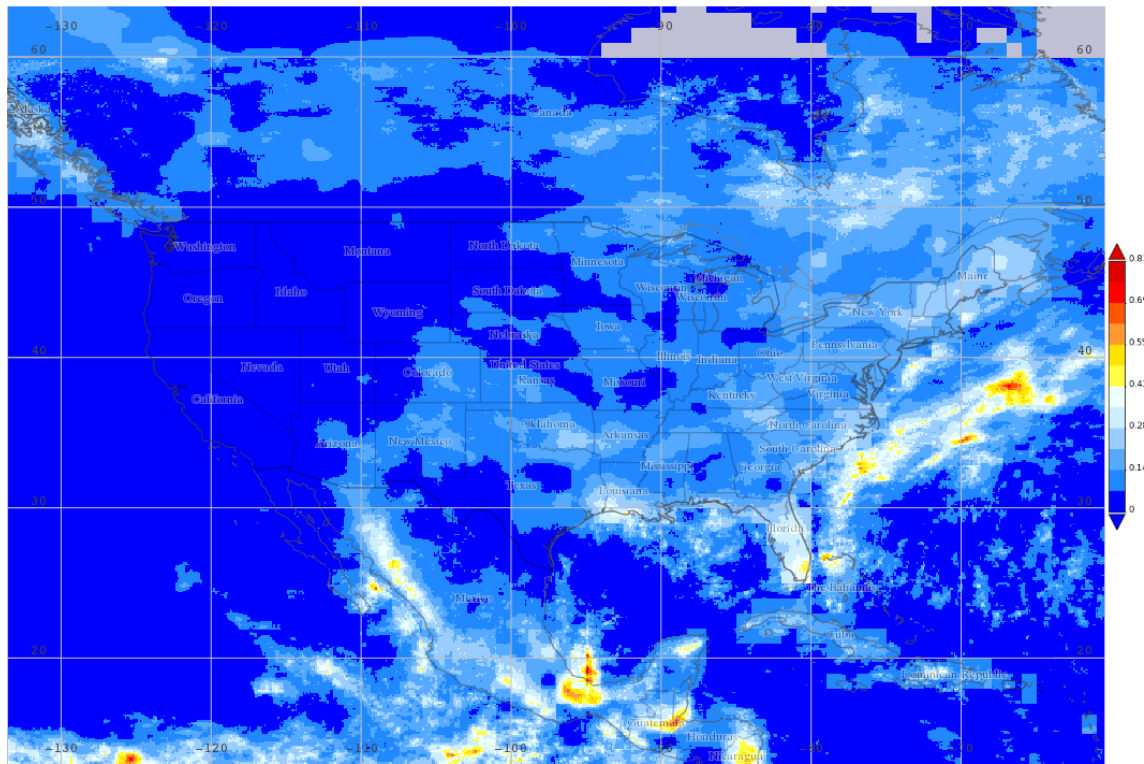
Giovanni Version 4



<http://giovanni.gsfc.nasa.gov/giovanni/>

Search and Plot Result: IMERG Rain Rate for July 2014 over the US

Time Averaged Map of Satellite and gauge precipitation monthly 0.1 deg. [GPM GPM_3IMERGM v03] mm/hr
over 2014-Jul - 2014-Jul, Region 133.5937W, 12.7734N, 60.4687W, 63.3984N



- Selected date range was 2014-07-01 04:00Z - 2014-07-31 04:00Z. Title reflects the date range of the granules that went into making this result.

- **1. Time Averaged Map**
 - [User Input](#)
 - [Plots](#)
 - [Plot Options](#)
 - [Downloads](#)
 - [Lineage](#)

Data and Image
Download
Options



Giovanni Version 4

<http://giovanni.gsfc.nasa.gov/giovanni/>

Giovanni is:

- 1) useful for searching and downloading data files in multiple formats
- 2) very convenient for data visualization

Live Overview of Giovanni

Precipitation Processing System (PPS) Science Team On-Line Request Module (STORM)



<https://storm-pps.gsfc.nasa.gov/storm/>

NASA National Aeronautics and Space Administration

+ PPS Contacts
+ Related Links

STORM

- HOME + DATA ACCESS + TOOLS + PRODUCT INFORMATION + REGISTRATION

Home

PPS Data Access - to search for GPM and TRMM data, order custom subsets and set up subscriptions.

PPS Public Archive - to access GPM and TRMM standard products via online ftp.

These are the products available to the public. To retrieve data go to **PPS Data Access** or **PPS Public Archive**.

Data Type	Algorithm	Satellite	Instrument	Primary Content
1A	1A01	TRMM	VIRS	Counts
1A	1A11	TRMM	TMI	Counts
1A	1A21	TRMM	PR	Counts
1A	1A21	TRMM	PR	Counts
1A	1AGMI	GPM	GMI	Counts
1B	1B01	TRMM	VIRS	Radiance
1B	1B11	TRMM	TMI	Brightness Temperature
1B	1B21	TRMM	PR	Radar Power
1B	1B21	TRMM	PR	Radar Power
1B	1BGMI	GPM	GMI	Brightness Temperature
1B	1BKa	GPM	PRR_KA	Radar Power

Need Help?

- STORM User Guide
- helpdesk@pps-mail.nascom.nasa.gov

News

2/18/2015 - TRMM/PR data distribution during experimental operation period

1/15/2015 - PPS is releasing the first public version IMERG products

PPS Precipitation Processing System (PPS)

Global Precipitation Measurement Mission (GPM)

Tropical Rainfall Measuring Mission (TRMM)

STORM is specifically designed for GPM and TRMM Precipitation data search, selection, download, and visualization

Precipitation Processing System (PPS) Science Team On-Line Request Module (STORM)



<https://storm-pps.gsfc.nasa.gov/storm/>



Requires User Registration

The screenshot shows the STORM web interface. At the top left is the NASA logo and 'National Aeronautics and Space Administration'. On the right are links for '+ PPS Contacts' and '+ Related Links'. The main header features the 'STORM' logo and a 'Precipitation Radar' visualization. Below the header are four navigation tabs: '+ DATA ACCESS', '+ TOOLS', '+ PRODUCT INFORMATION', and '+ REGISTRATION'. A yellow callout box with an arrow points to the '+ REGISTRATION' tab, stating 'Requires User Registration'. On the left side, there is a 'Need Help?' section with links to 'STORM User Guide' and 'helpdesk@pps-mail.nascom.nasa.gov', and a 'News' section with two recent announcements. The main content area includes 'PPS Data Access' (for searching and ordering data) and 'PPS Public Archive' (for accessing standard products via ftp). Below this is a table of available products with columns for Data Type, Algorithm, Satellite, Instrument, and Primary Content. A red box highlights the column headers of this table. On the right side, there are three promotional boxes for 'PPS Precipitation Processing System (PPS)', 'Global Precipitation Measurement Mission (GPM)', and 'Tropical Rainfall Measuring Mission (TRMM)'. A yellow callout box with an arrow points to the table, stating 'Data Product Search'.

Data Type	Algorithm	Satellite	Instrument	Primary Content
1A	1A01	TRMM	VIRS	Counts
1A	1A11	TRMM	TMI	Counts
1A	1A21	TRMM	PR	Counts
1A	1A21	TRMM	PR	Counts
1A	1AGMI	GPM	GMI	Counts
1B	1B01	TRMM	VIRS	Radiance
1B	1B11	TRMM	TMI	Brightness Temperature
1B	1B21	TRMM	PR	Radar Power
1B	1B21	TRMM	PR	Radar Power
1B	1BGMI	GPM	GMI	Brightness Temperature
1B	1BKa	GPM	PRR_KA	Radar Power

STORM is specifically designed for GPM and TRMM Precipitation data search, selection, download, and visualization

Precipitation Processing System (PPS) Science Team On-Line Request Module (STORM)



<https://storm-pps.gsfc.nasa.gov/storm/>

The screenshot displays the STORM web interface. At the top, the NASA logo and "National Aeronautics and Space Administration" are on the left, and "+ PPS Contacts" and "+ Related Links" are on the right. Below this is a banner with the word "STORM" in large letters, flanked by a satellite image and a "Precipitation Radar" plot. A navigation bar contains buttons for "+ HOME", "- DATA ACCESS", "+ TOOLS", "+ PRODUCT INFORMATION", and "+ REGISTRATION".

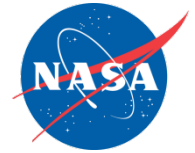
On the left side, there is a "Data Access" menu with options: "+ BROWSE ARCHIVE", "- SEARCH ARCHIVE / ORDER", "+ SAT - SAT COINCIDENCE", and "+ TRACK ORDER STATUS". Below that is a "Need Help?" section with links to context-specific help, the "STORM User Guide", and the email "helpdesk@pps-mail.nascom.nasa.gov".

The main content area shows an "Email" field with a red warning icon and the text "Required". A red arrow points from a yellow callout box to this field. Below the field are "Submit Request" and "Clear Form" buttons, with another red arrow pointing from the callout box to the "Clear Form" button.

Enter email address to Register Or Request Registration

SECURITY
NASA / PPS may provide links to Web pages that are not part of the NASA Web family or nasa.gov domain. These sites are managed by organizations, companies, or individuals and not under NASA control, and NASA is not responsible for the information or links you may find there. NASA provides links to these sites merely as a convenience. NASA is not responsible for the information collection practices of non-NASA sites. Once you link to another site, you are subject to the privacy policy of the new site, and you should read that site's policies on privacy and information collection.

Precipitation Processing System (PPS) Science Team On-Line Request Module (STORM)



<https://storm-pps.gsfc.nasa.gov/storm/>

Product Type

Required

Product Selection

Left click on the header to sort rows. Right click to show/hide columns

Select	Data Type	Algorithm	Start Time	Frequency	Satellite or Ground Validation Site	Instrument	Primary Content	Spatial Extent
<input type="checkbox"/>	3B				GPM			
<input type="checkbox"/>	3B	3CMB	2014-03-01 00:00:00	MONTH	GPM	DPR, GMI	Precipitation	[70.0,-70.0,180.0,-180.0], [67.0,-67.0,180.0,-180.0]
<input type="checkbox"/>	3B	3CMB	2014-12-02 00:00:00	DAY	GPM	DPR, GMI	Precipitation	[70.0,-70.0,180.0,-180.0], [67.0,-67.0,180.0,-180.0]
<input type="checkbox"/>	3B	3IMERGHH	2014-03-12 00:00:00	30_MINUTE	GPM	DPR	Precipitation	[90.0,-90.0,180.0,-180.0]
<input type="checkbox"/>	3B	3IMERGM	2014-03-12 00:00:00	MONTH	GPM	DPR	Precipitation	[90.0,-90.0,180.0,-180.0]

Total Product Types selected: 0

Note: Some selected Product Types might not be visible if filters are used

Temporal Criteria

Date Range Orbit Numbers

Valid range is between 20140312 and 20150310

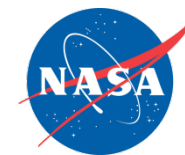
YYYYMMDD [HH:MM]
[] = optional fields

Start Date/Time 20150130 00:00

Stop Date/Time 20150130 23:59

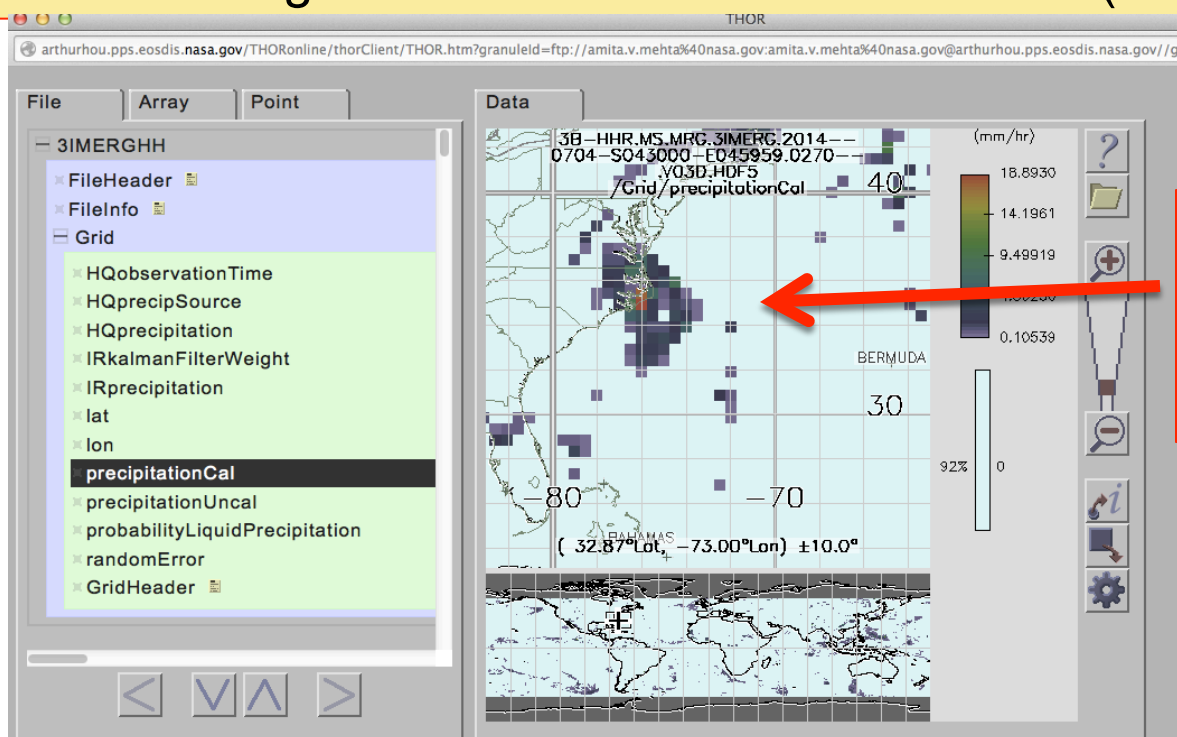
Temporal Selection

Precipitation Processing System (PPS) Science Team On-Line Request Module (STORM)



<https://storm-pps.gsfc.nasa.gov/storm/>

Product Selection, Download, and Visualization by using
Tool for High-resolution Observation Review (THOR)



Precipitation
Associated with
Hurricane Arthur
July 4, 2014

STORM Live Demo!

Precipitation Processing System (PPS) Science Team On-Line Request Module (STORM)



<https://storm-pps.gsfc.nasa.gov/storm/>

STORM:

- 1) Is dedicated to access and visualization of GPM and TRMM data
- 2) Level-2 (orbital) and Level-3 (Gridded) data easily accessible
- 3) Regional precipitation image and precipitation value at any latitude-longitude point can be obtained by using THOR

Summary of GPM Data Access Tools



Tools	Data Products and Formats	Analysis and/or Visualization	Data Download
<p>Mirador http://mirador.gsfc.nasa.gov</p>	<p>L1B, L2, and L3 GMI-GPROF IMERG Half-hourly, Monthly Orbital and Gridded Daily, Monthly HDF5, OPenDAP (can be converted to ASCII, Binary, NetCDF)</p>	<p>N/A</p>	<p>Batch Download</p>
<p>Giovanni http://giovanni.gsfc.nasa.gov/giovanni/</p>	<p>IMERG Half-hourly, Monthly NetCDF, GeoTIFF, PNG</p>	<p>Visualization: Map, Time Series, Scatter Plot, Histogram Analysis: Time-averaged Maps, Time Series, Scatter Plot, Map Correlations, Vertical Profiles, Time-averaged Differences</p>	<p>Download by Select and Click on Data Files</p>
<p>PPS/STORM https://storm.pps.eosdis.nasa.gov/storm</p>	<p>L1B and 1C, L2, L3 GMI, DPR, GMI-DPR Combined Data, Orbital and Gridded Daily, Monthly IMERG Half-hourly, Monthly HDF5, PNG</p>	<p>Map Visualization, Interactive Latitude/Longitude Point Data Value Display</p>	<p>FTP</p>

Data Access Tools and GIS

Mirador and Giovanni allow GPM Precipitation data to be downloaded in NetCDF format which can be used in GIS – ArcMAP with ease



Coming up next week!

Week 3: IMERG Precipitation Product
Demonstration of GIS Applications of IMERG



Thank You!

Appendix


TRMM Level-2 and Level-3 Data Summary



Summary of TRMM Level-2 Precipitation Products

*Surface Rainfall Rate in mm/hour

TRMM data are available from December 1997 to present

Sensor/Product Name	Spatial Resolution and Coverage	Temporal Resolution	Data Format
TMI/2A12	5 km x 5 km Orbital and 16 orbits per day (38°S-38°N)	3-hour, 2-day 15 days	HDF4 and OPenDAP
PR/2A25	5 km x 5 km Orbital and 16 orbits per day (38°S-38°N)	3-hour, 2-day 5 days	
Combined TMI and PR /2B31	5 km x 5 km Orbital and (38°S-38°N)	3-hour, 2-day 5 days	


*In addition to surface rainfall rate in mm//hour, vertical precipitation profiles and latent heating are available in these data products



Summary of TRMM Level-3 Precipitation Products

*Surface Rainfall Rate in mm/hour

TRMM data are available from January 1998 to present

Sensor/Product Name	Spatial Resolution and Coverage	Temporal Resolution	Data Format
TMPA/3B42 RT	0.25°x0.25° (50°S-50°N)	3-hourly (Near Real Time) daily, 10-day and 30-day Averages	HDF4, NetCDF, OPenDAP, ASCII GIF, PNG Images KML for Google Earth
TMPA/3B42 (Gauge Adjusted Research Version)	0.25°x0.25° (50°S-50°N)	3-hourly, daily	
TMPA/3B43	0.25°x0.25° (50°S-50°N)	Monthly	

*In addition to surface rainfall rate in mm//hour, vertical precipitation profiles and latent heating are available in these data products