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

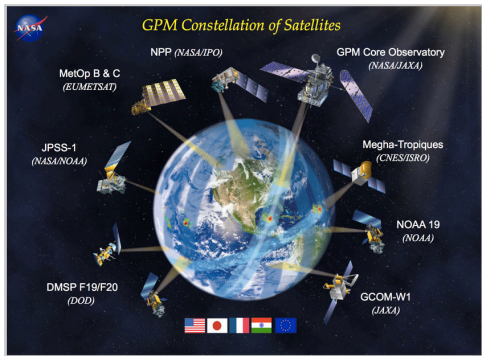
INTRODUCTION TO GLOBAL PRECIPITATION MEASUREMENTS (GPM) DATA AND APPLICATIONS

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

Applied Remote Sensing Training

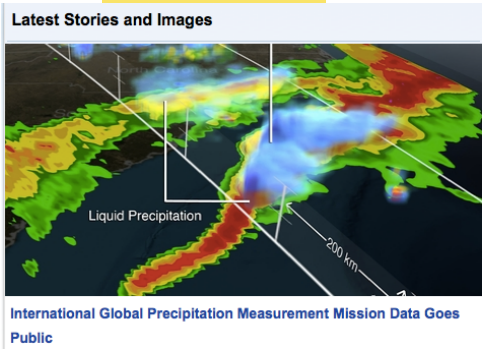
Webinar Outline

Week 1



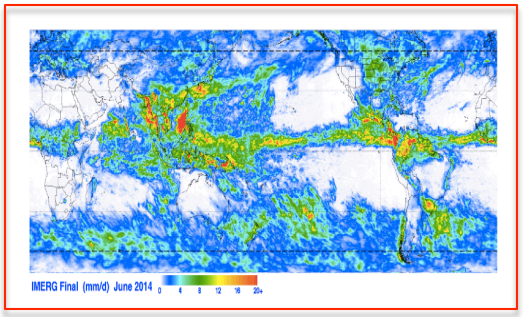
Precipitation Remote Sensing Overview of TRMM and GPM

Week 2



TRMM/GPM Data Products and Data Access Tools

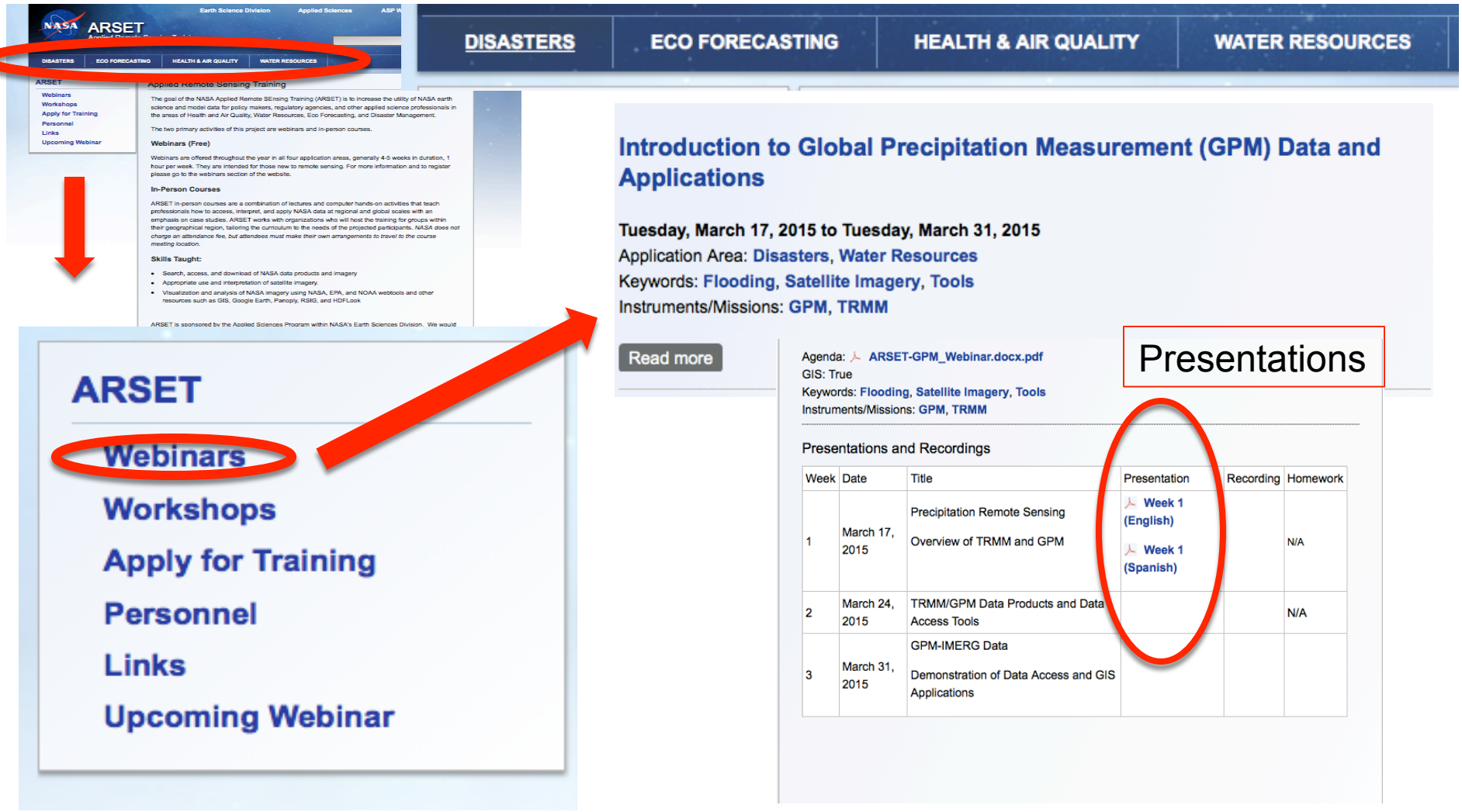
Week 3



GPM-IMERG Data Demonstration of Data Access and GIS Applications

ARSET Webinars Website

http://arset.gsfc.nasa.gov



Training Instructors

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- Brock Blevins (ARSET): bblevins37@gmail.com
- David Barbato (ARSET): barbato1@umbc.edu
  (Spanish Translator)
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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

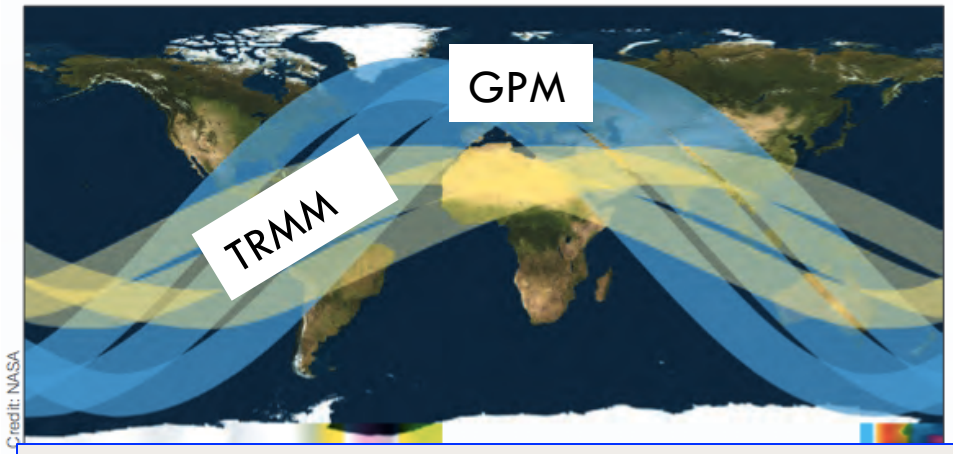
One active and two passive rain sensors
*Precipitation Radar (**PR**)*
*TRMM Microwave Imager (**TMI**)*
*Visible and Infrared Scanner (**VIRS**)*

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

Level 0 Raw Instrument Data

Level 1 Geolocated and Calibrated

Level 2 Geophysical Data Product Derived from L1 Data

Level 3 Composites Of Level 2 Data Products

Level 4 Model-derived Data Product

Focus of this Webinar

Less Processing

Orbital Data

- More user control
- Highest spatial/temporal resolution
- Harder to use

More Processing

Gridded Data Products

- Less user control
- Lower spatial/temporal resolution but gridded and may be available at multiple spatial/temporal resolutions
- More web-tools available for analysis/access
- Easier to use

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

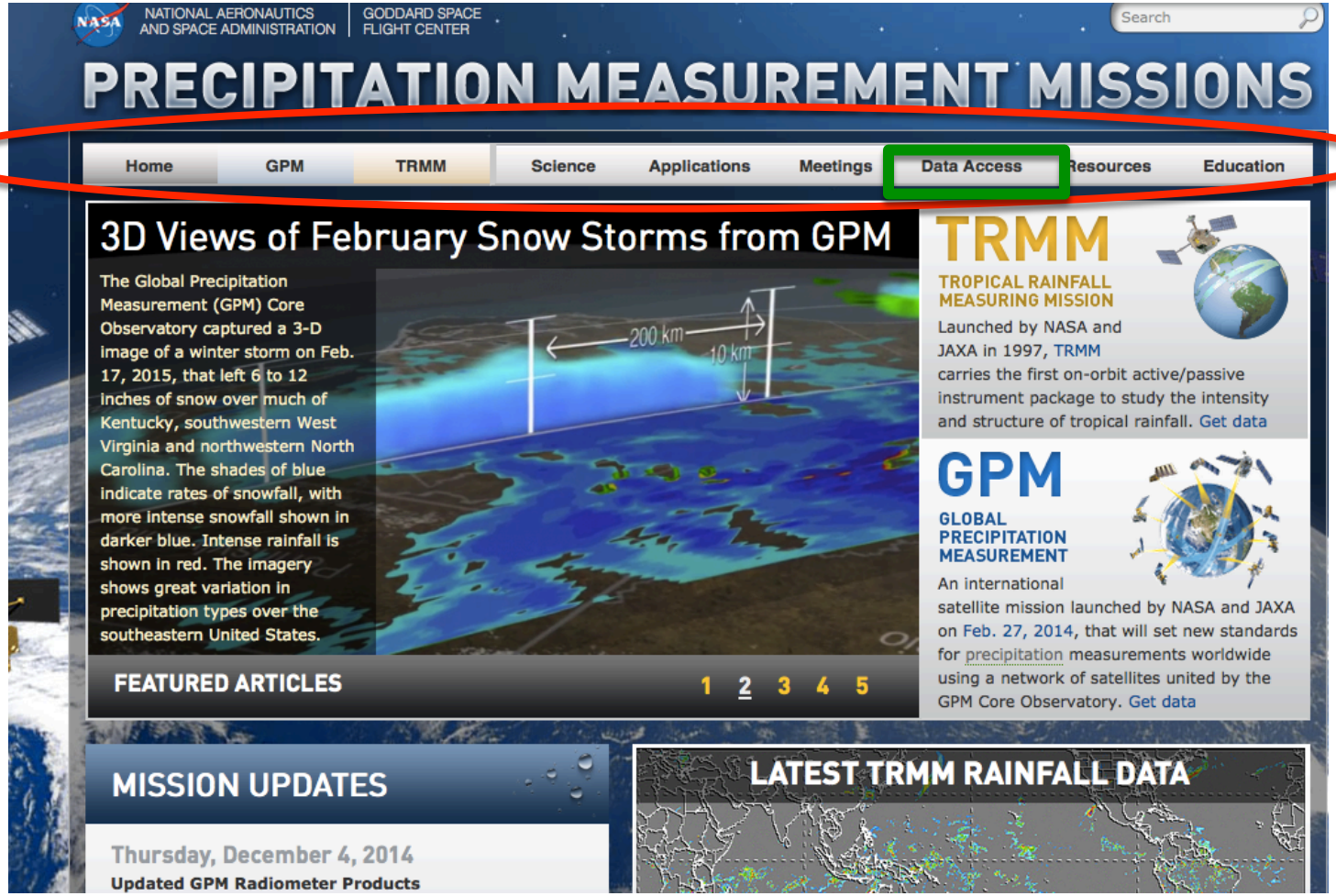
GPM/TRMM Data Information from Precipitation Measurement Missions (PMM)

http://pmm.nasa.gov

Precipitation Measurement Missions Data Information

http://pmm.nasa.gov

Details about TRMM and GPM Missions, Data Products, Access



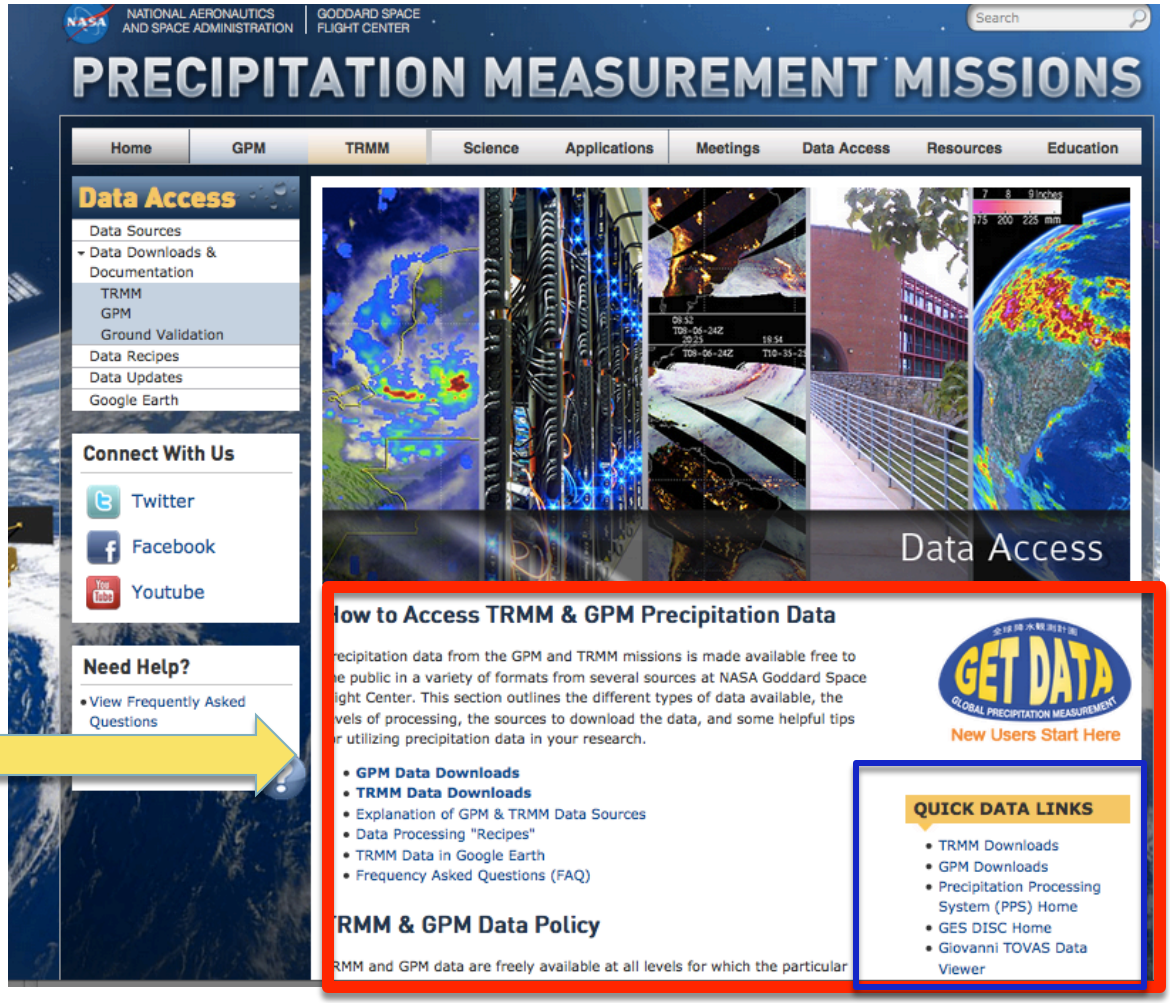
Precipitation Measurement Missions
TRMM and GPM Data Products

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

TRMM and GPM Data Products and Access

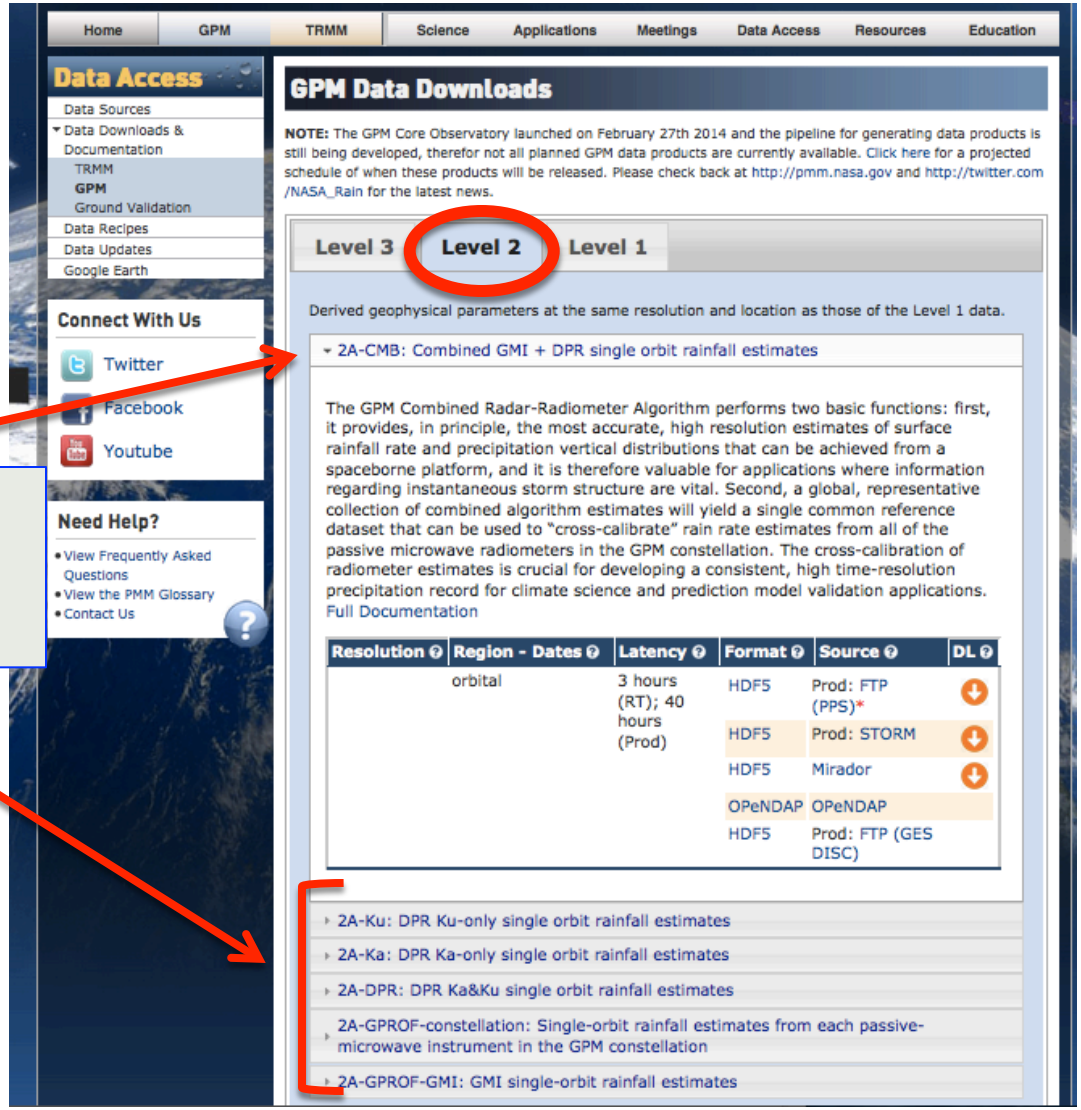
This session will focus primarily on GPM data

Easy Data Links



GPM Data Products

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

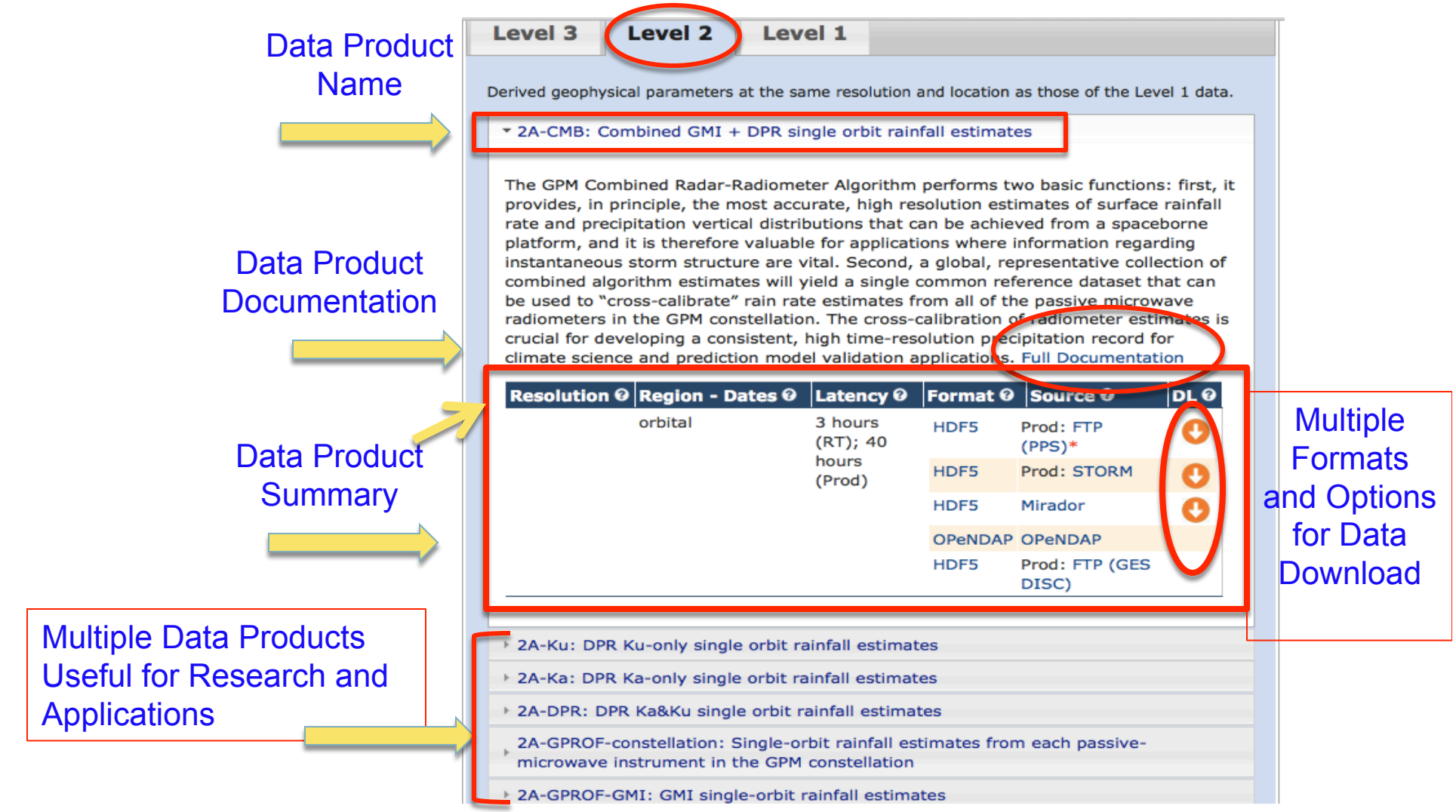


Data Products

- 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



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

- 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.

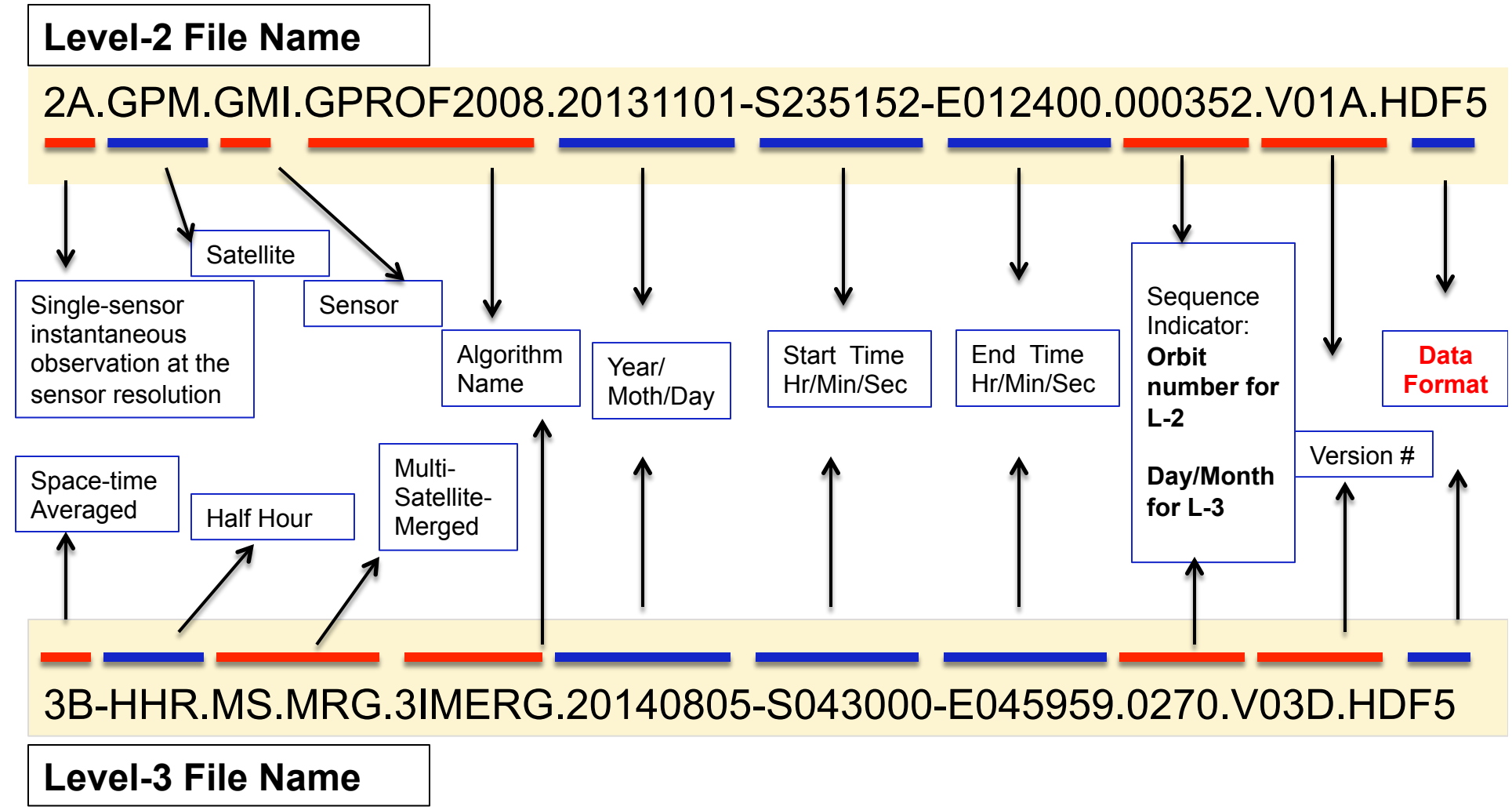
The second subfield for data type is optional and is an indication of accumulation. This is separated from the data level by a hyphen '-'. Table 2 lists the indicators currently supported.

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

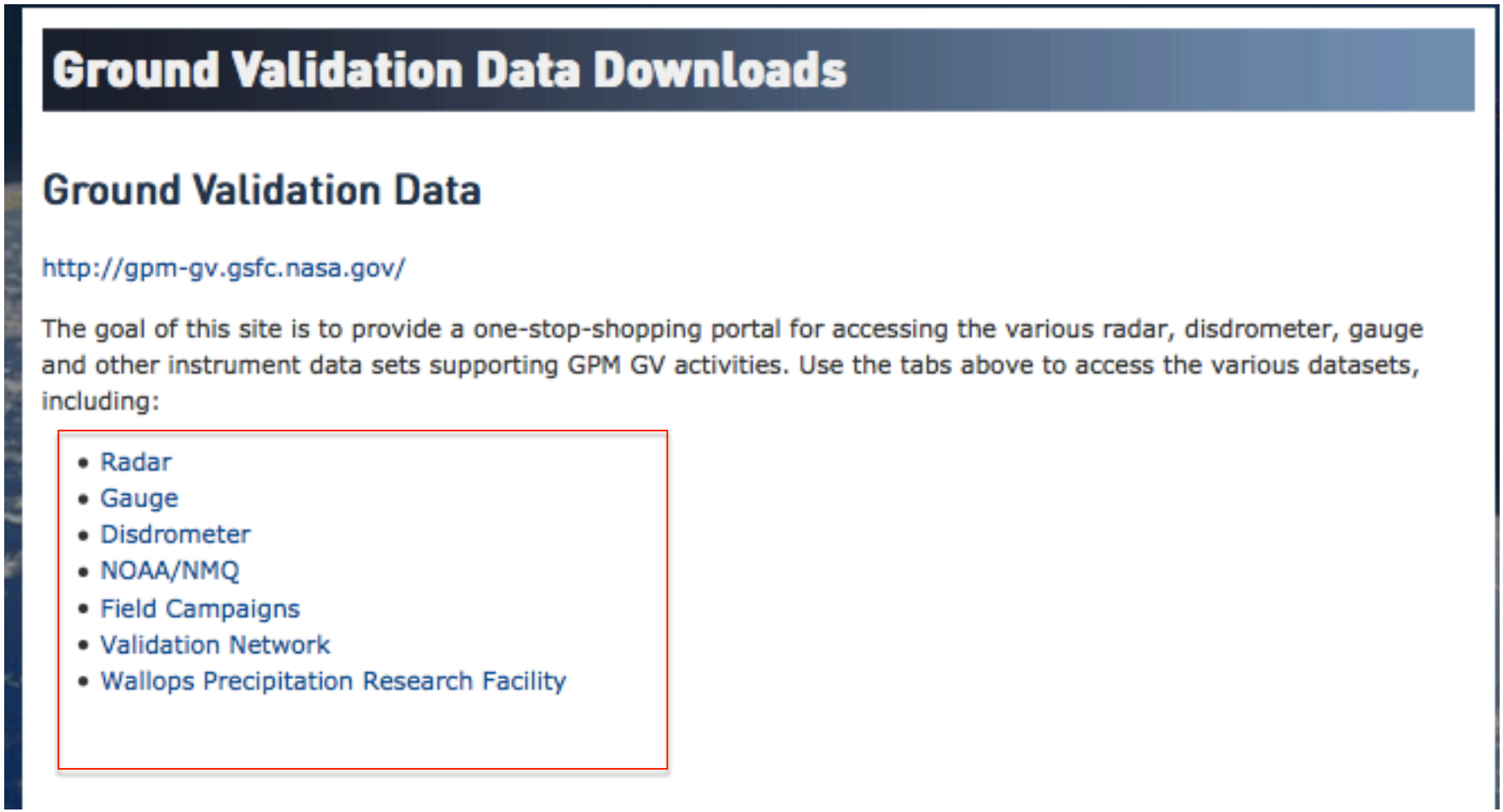


GPM Data Validation Information

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



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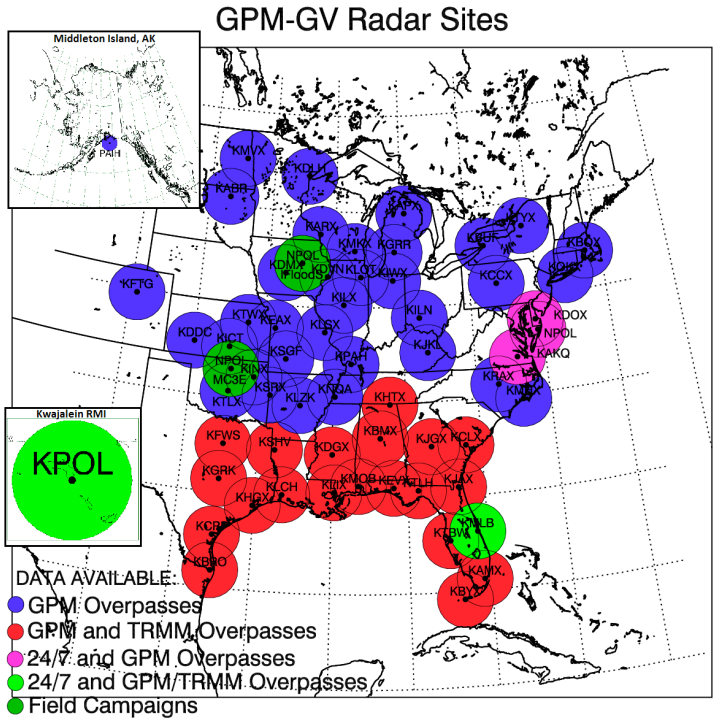
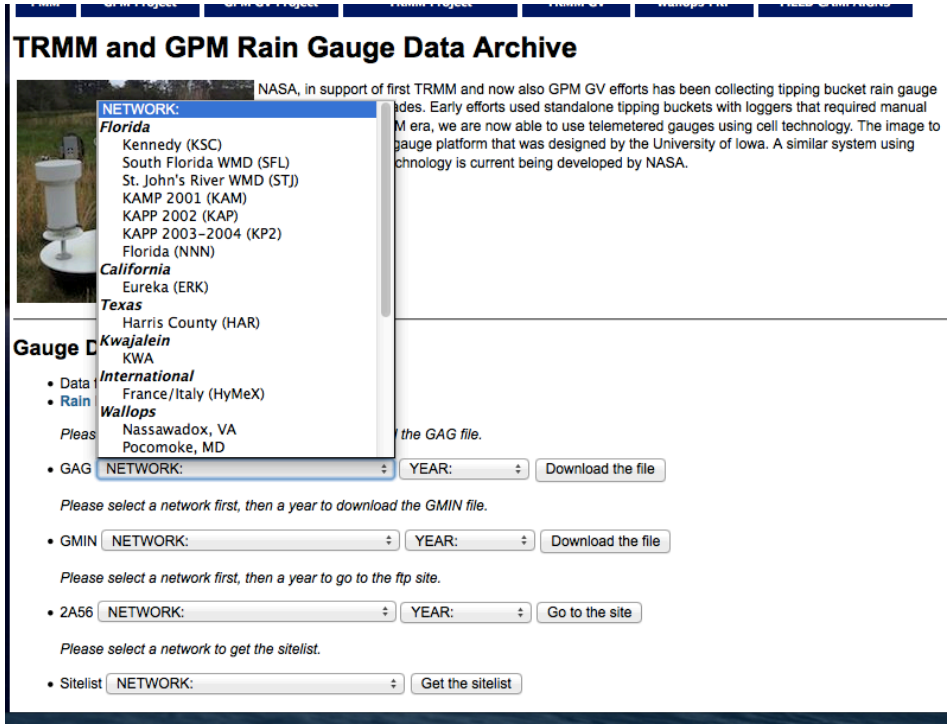
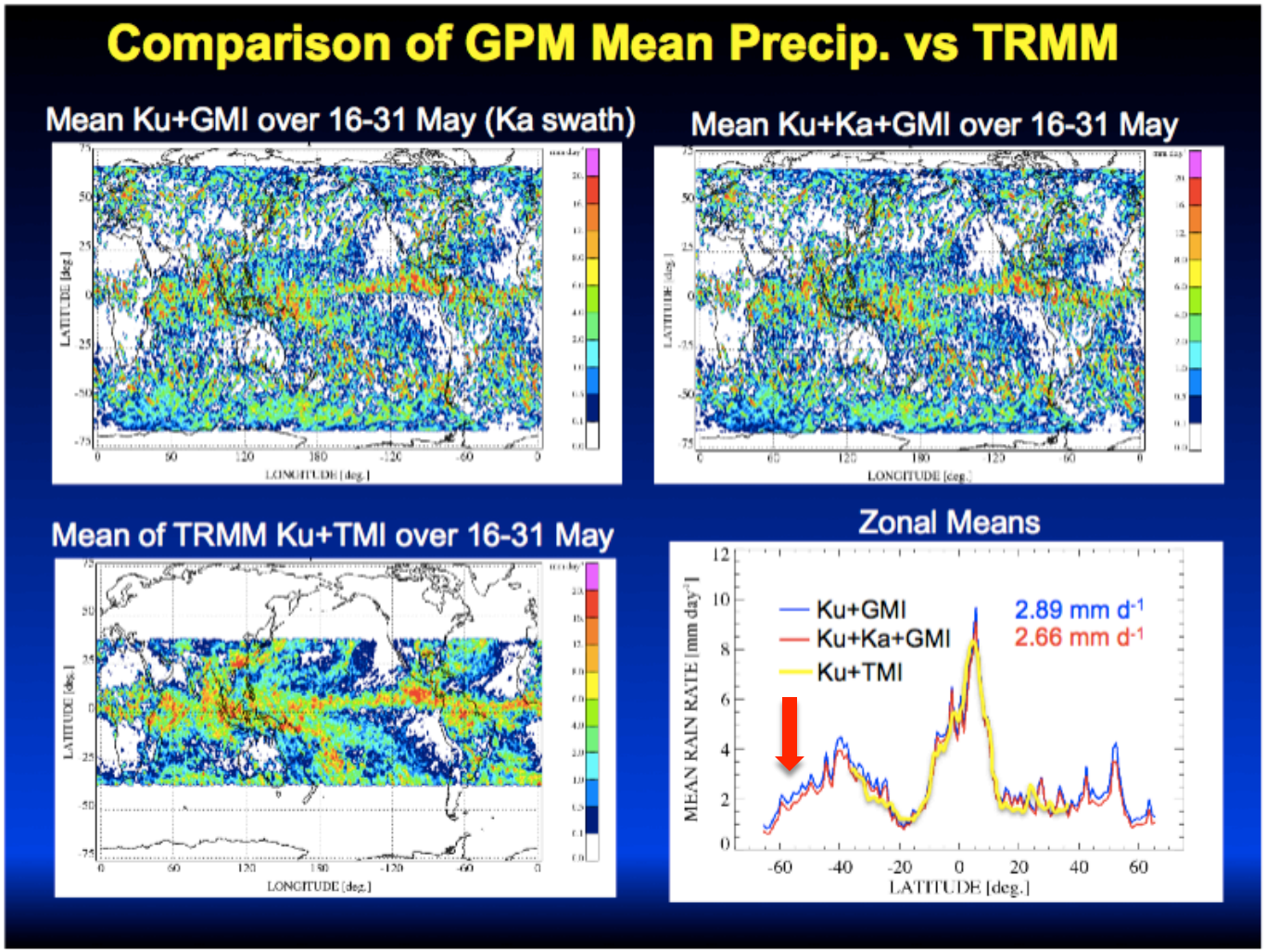




GPM and TRMM Level-2 Data Products Comparison

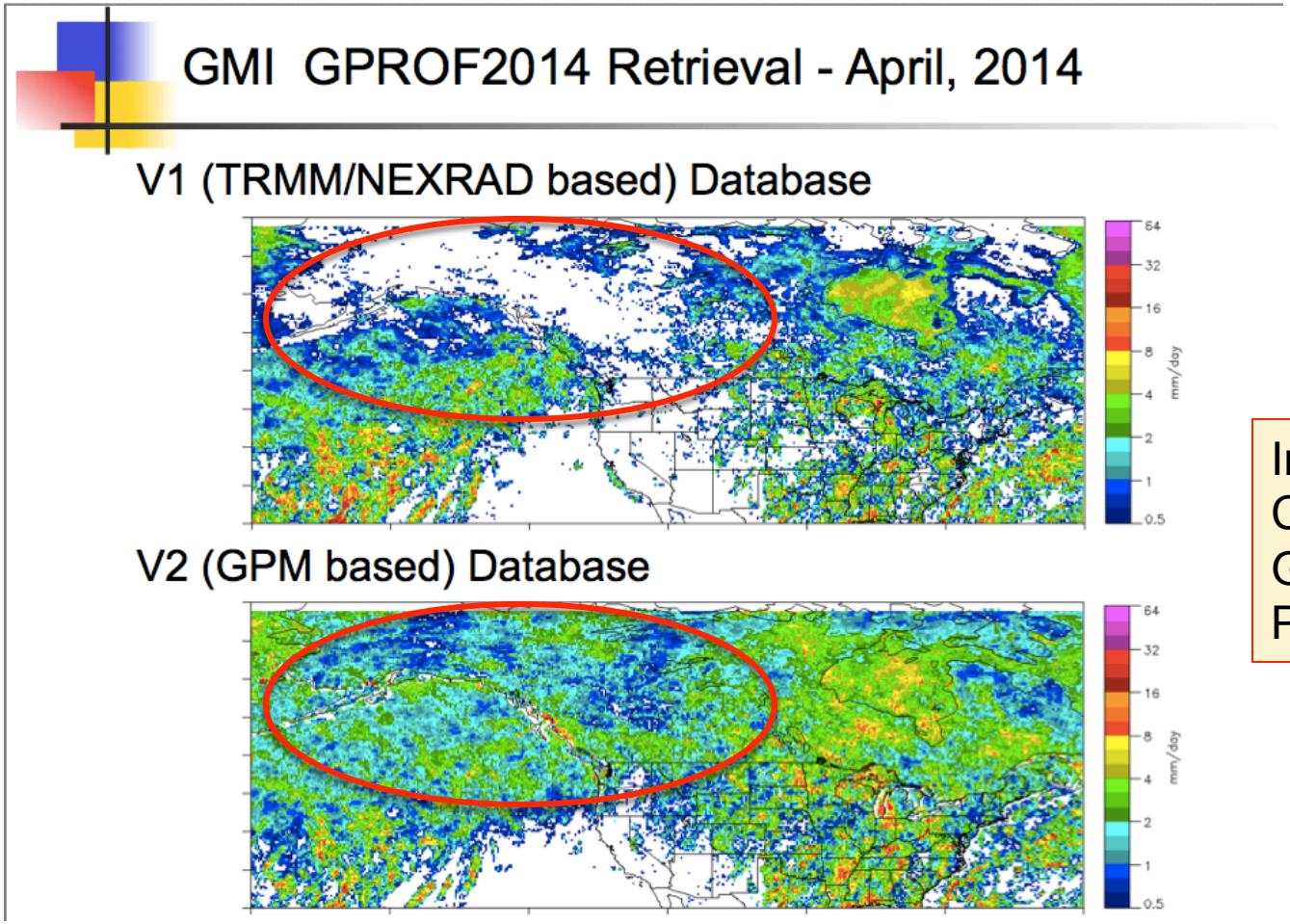


Higher spatial resolution, coverage, and details in GPM Products

Light rain captured by GPM

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

GPM and TRMM Level-2 Data Products Comparison

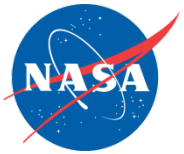


Improved Coverage in GPM GMI Product

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

Data Access Tools

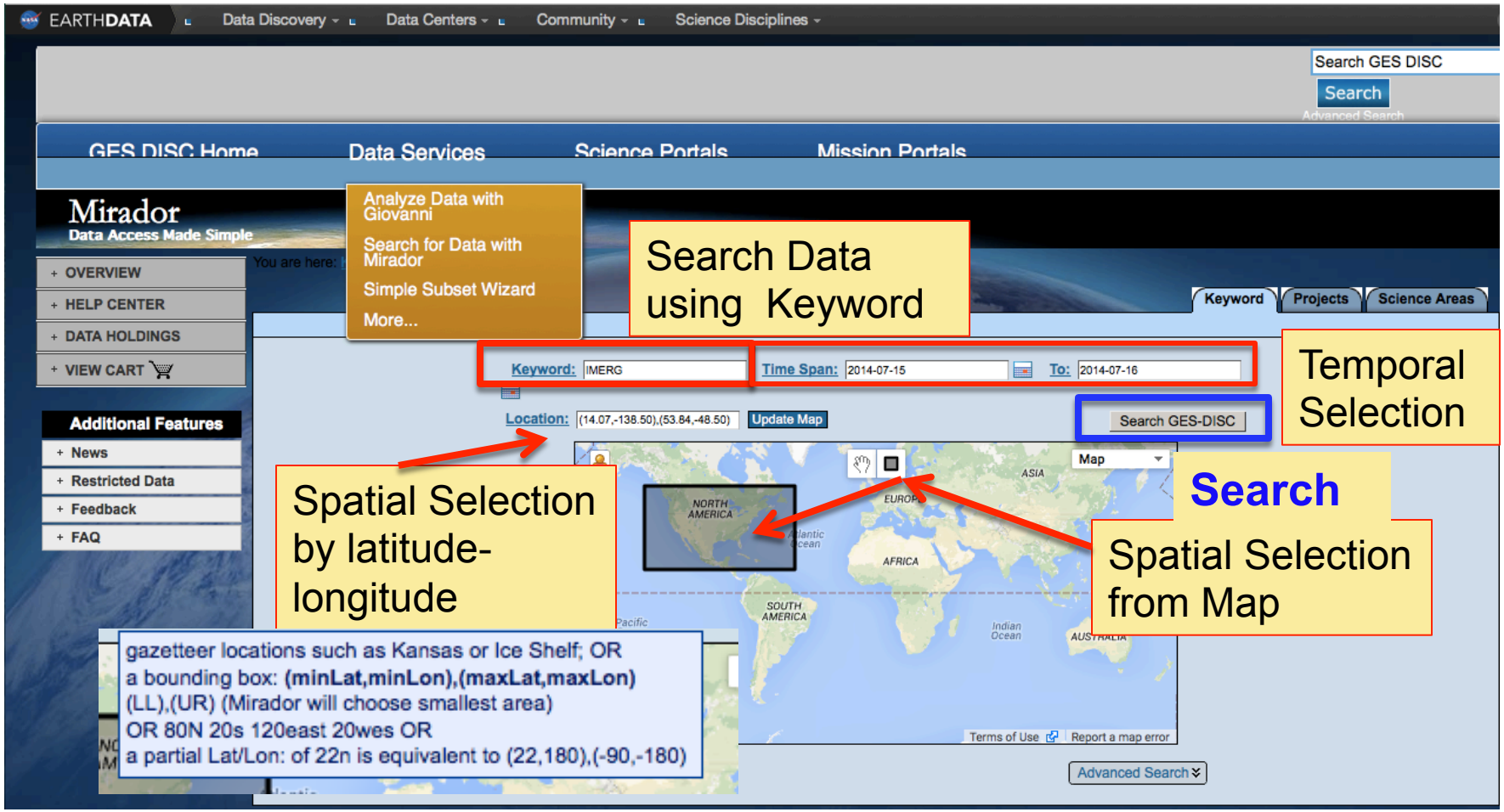
Summary of GPM Data Access Tools



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

Mirador: Data Search and Access

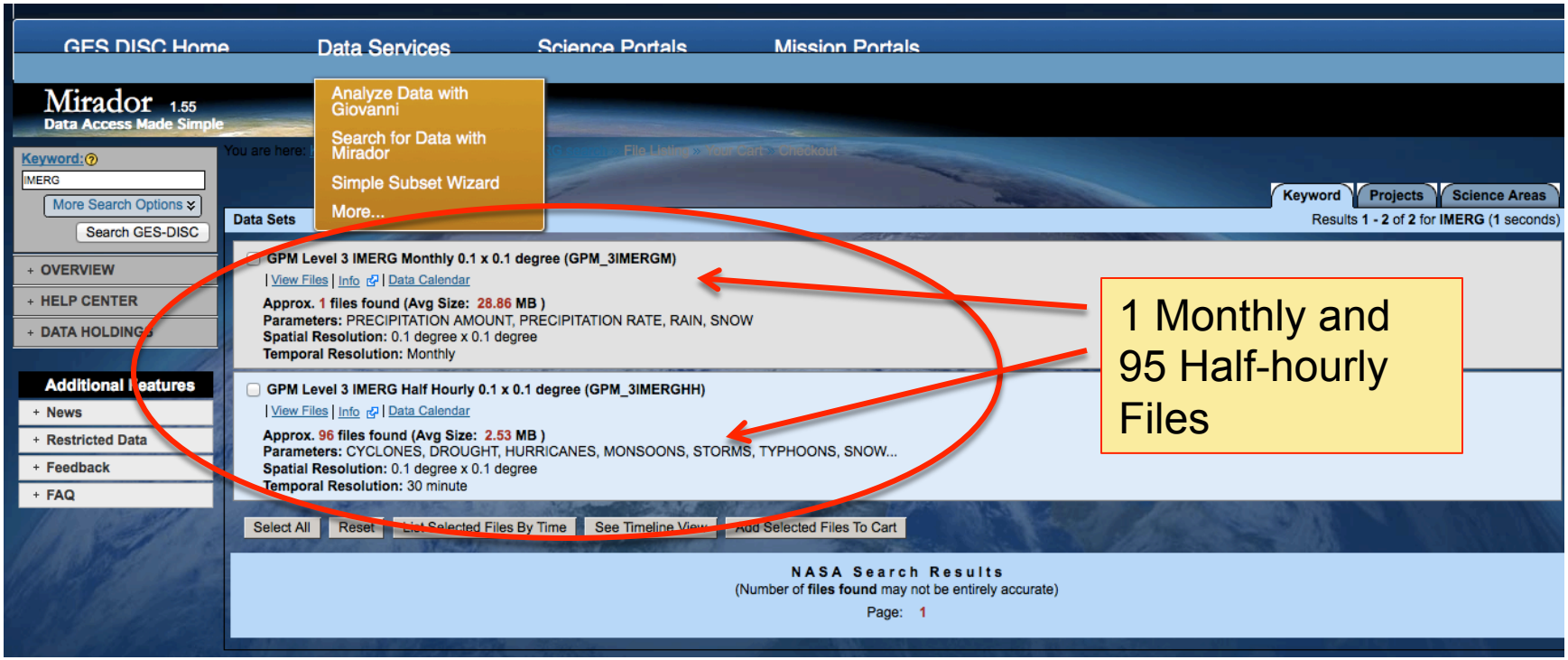
http://mirador.gsfc.nasa.gov/



Mirador: Data Search and Access

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

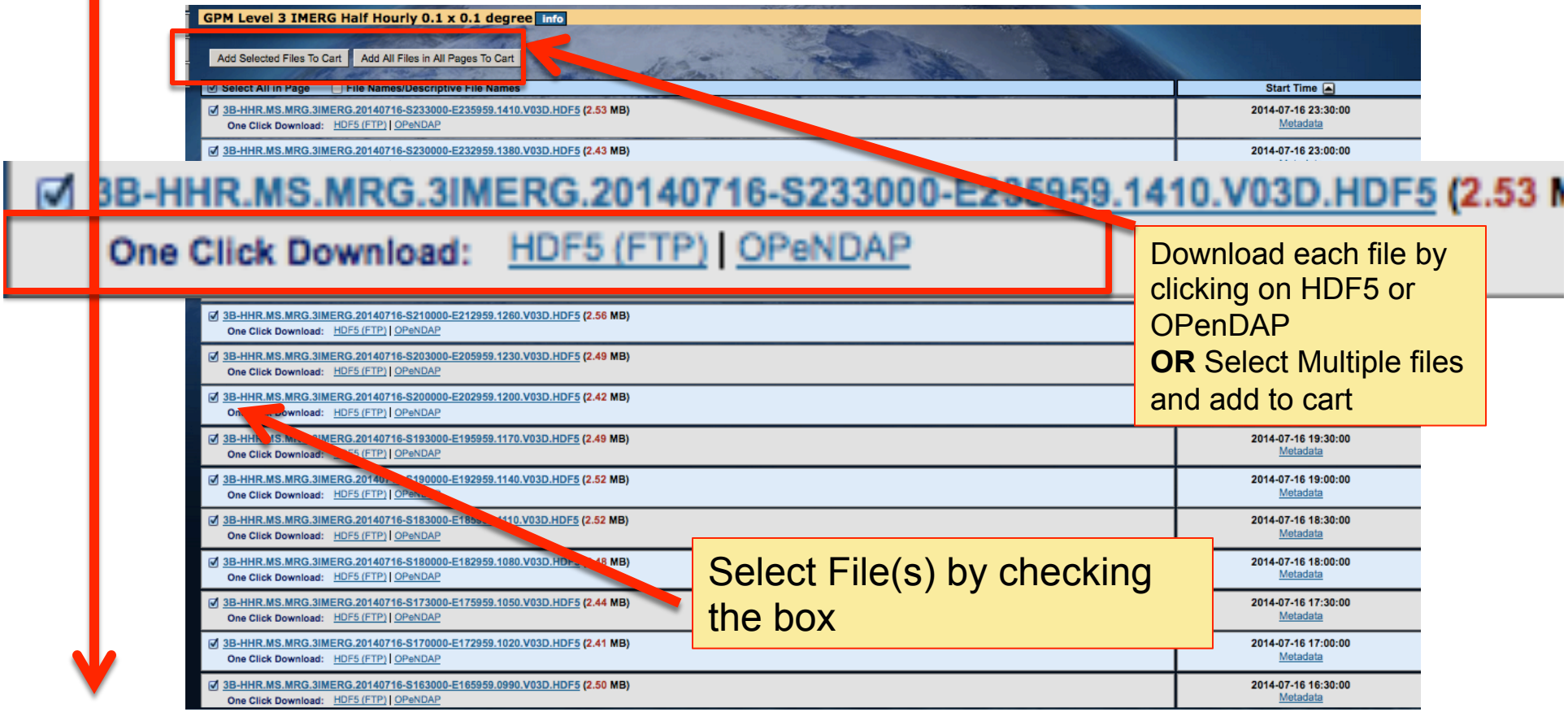
Data Search Results for GPM IMERG in terms of Data Files



Mirador: Data Search and Access

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

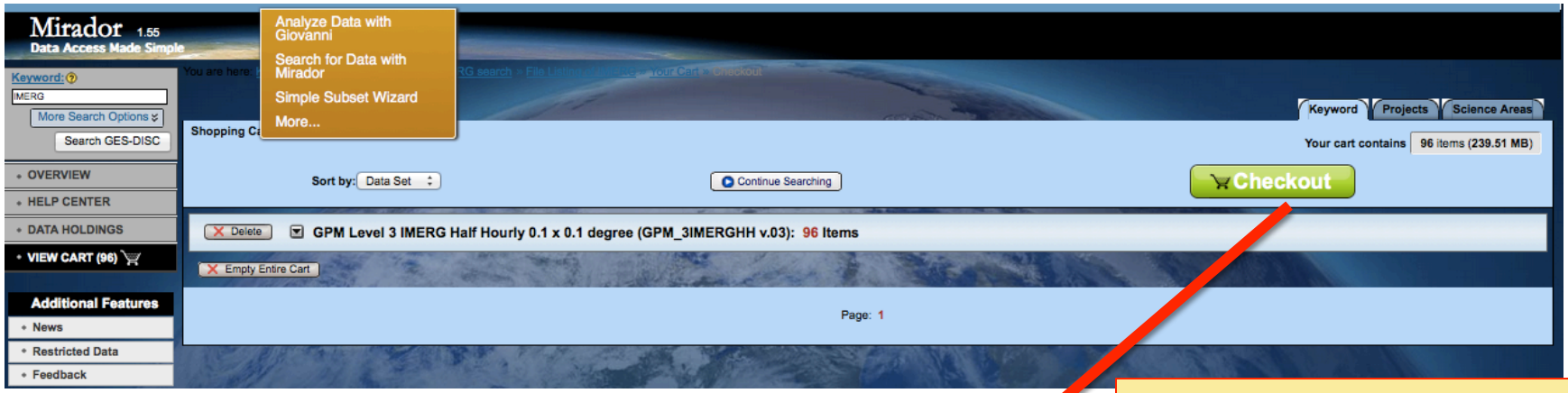
IMERG Half-hourly Data Files List

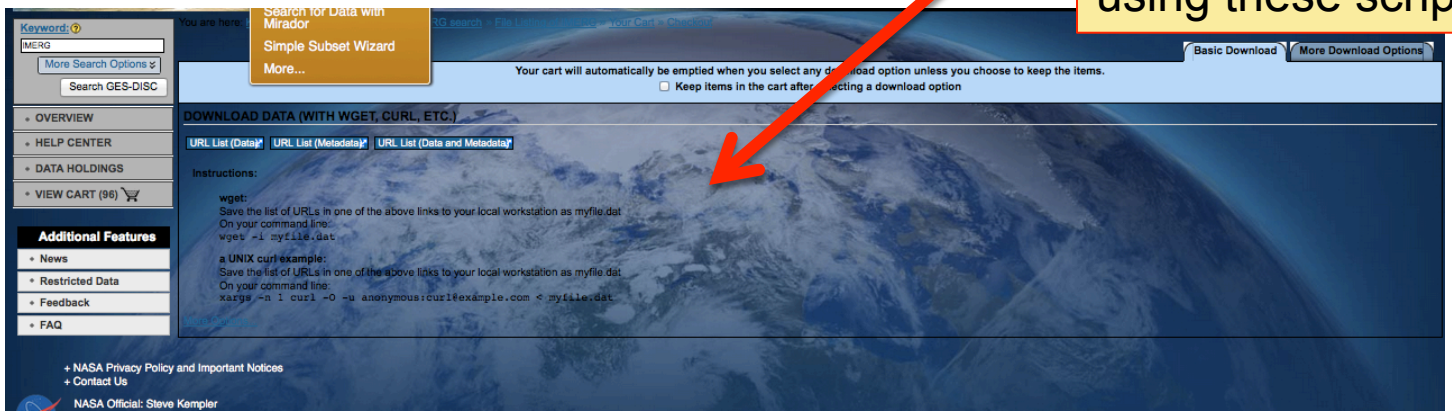


Mirador: Data Search and Access

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

Data Checkout





Download Data by using these scripts

Mirador: Data Search and Access

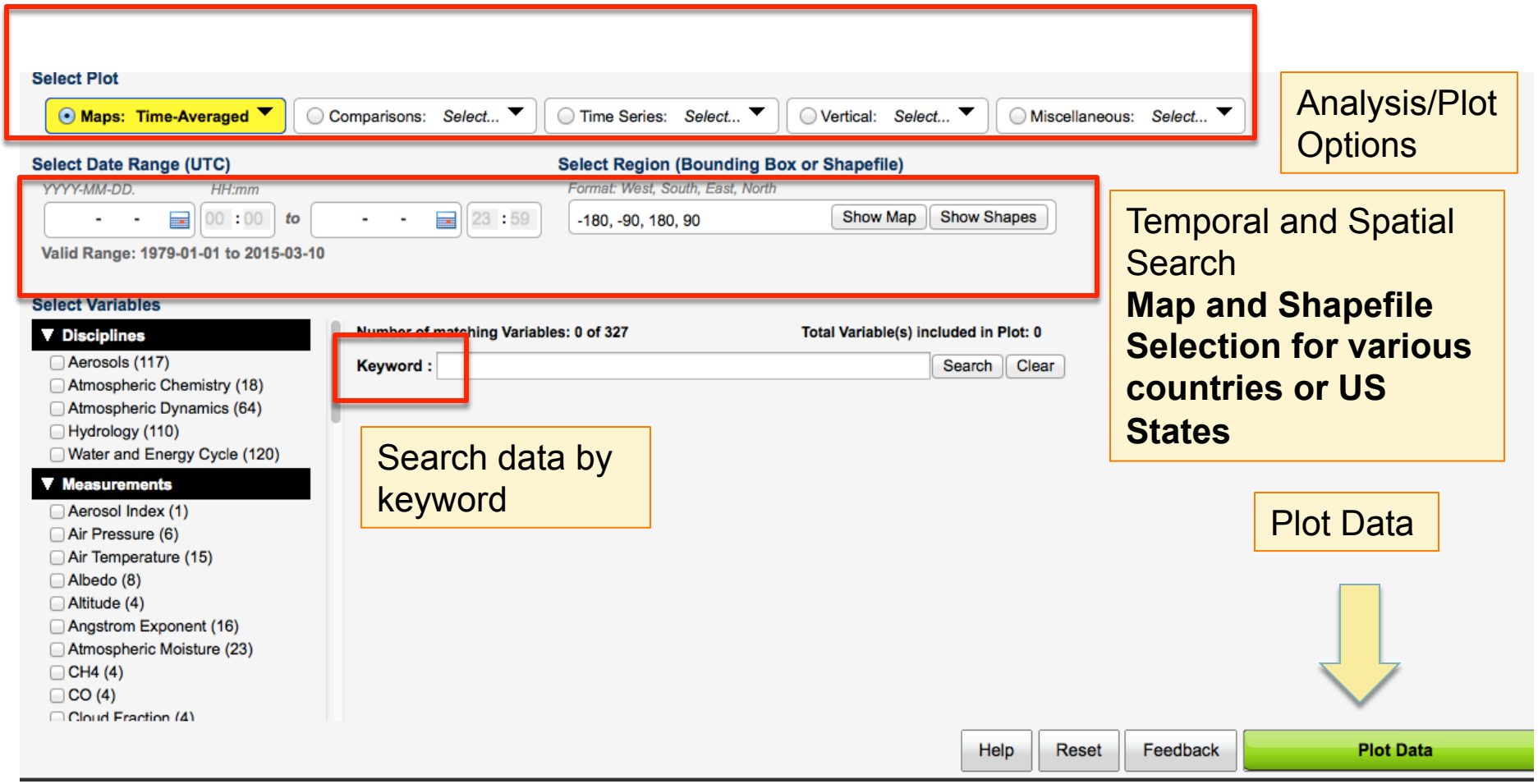
http://mirador.gsfc.nasa.gov/

Mirador is useful for searching data and downloading multiple data files

Live overview of Mirador

Giovanni Version 4

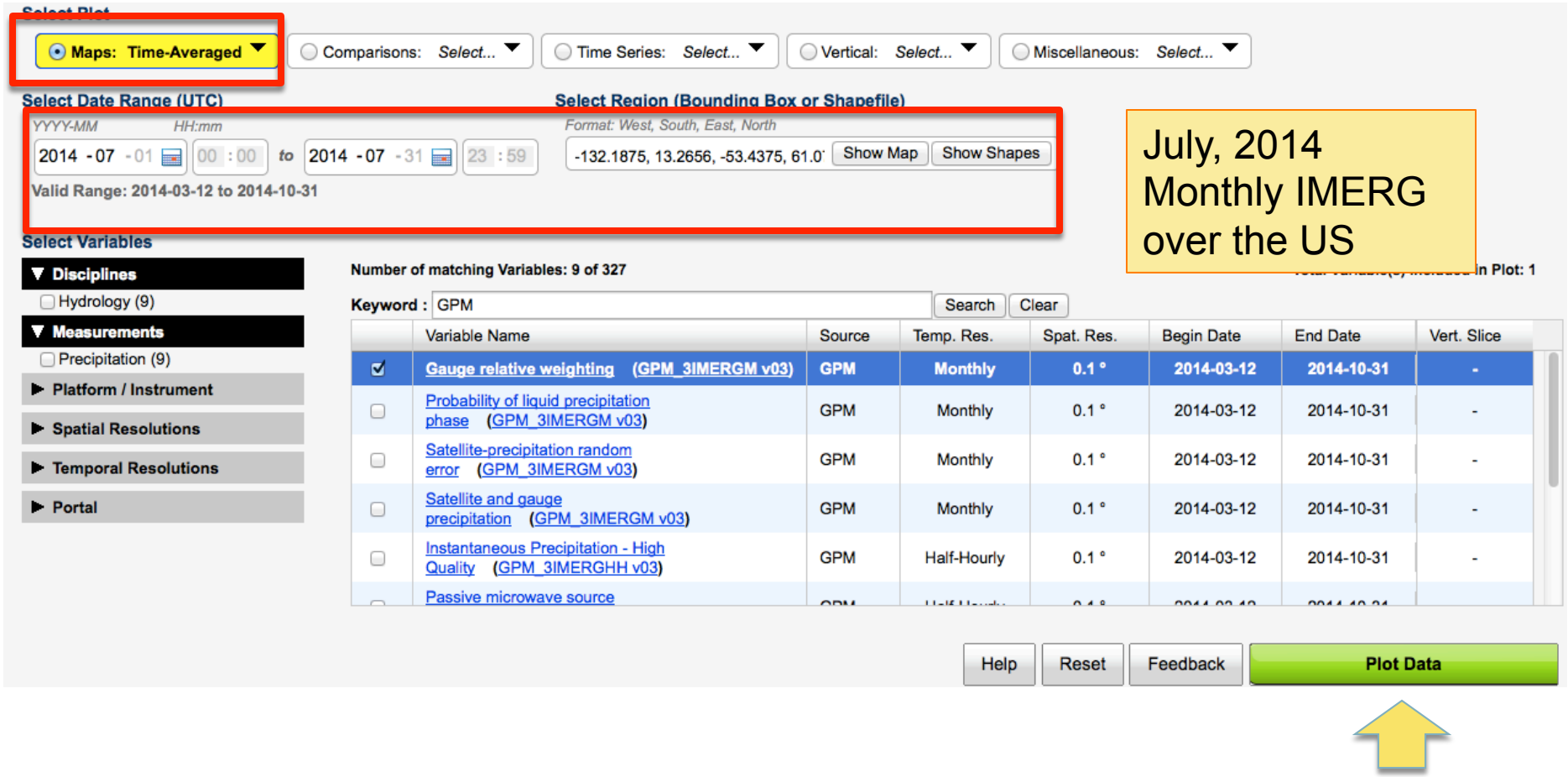
http://giovanni.gsfc.nasa.gov/giovanni/



Giovanni Version 4

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

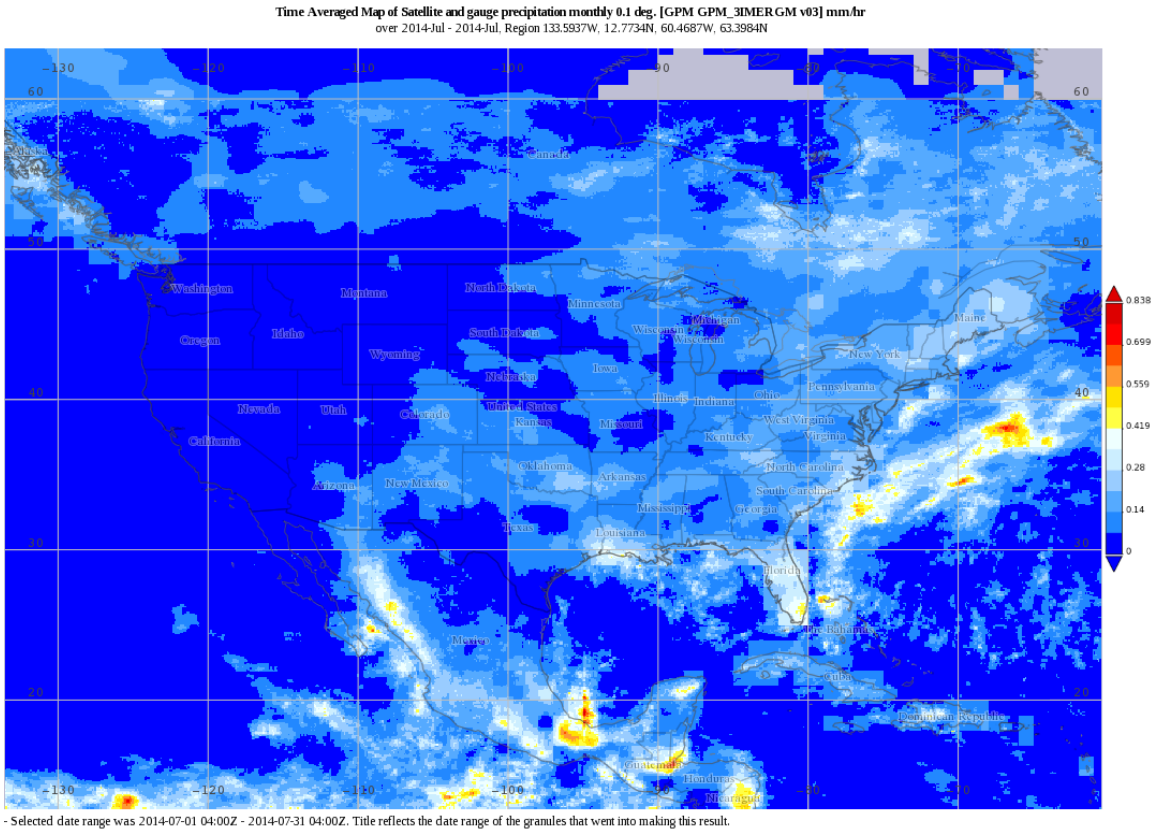
Search GPM data and Select Spatial, Temporal, Plot Options



Giovanni Version 4

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

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



- 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:

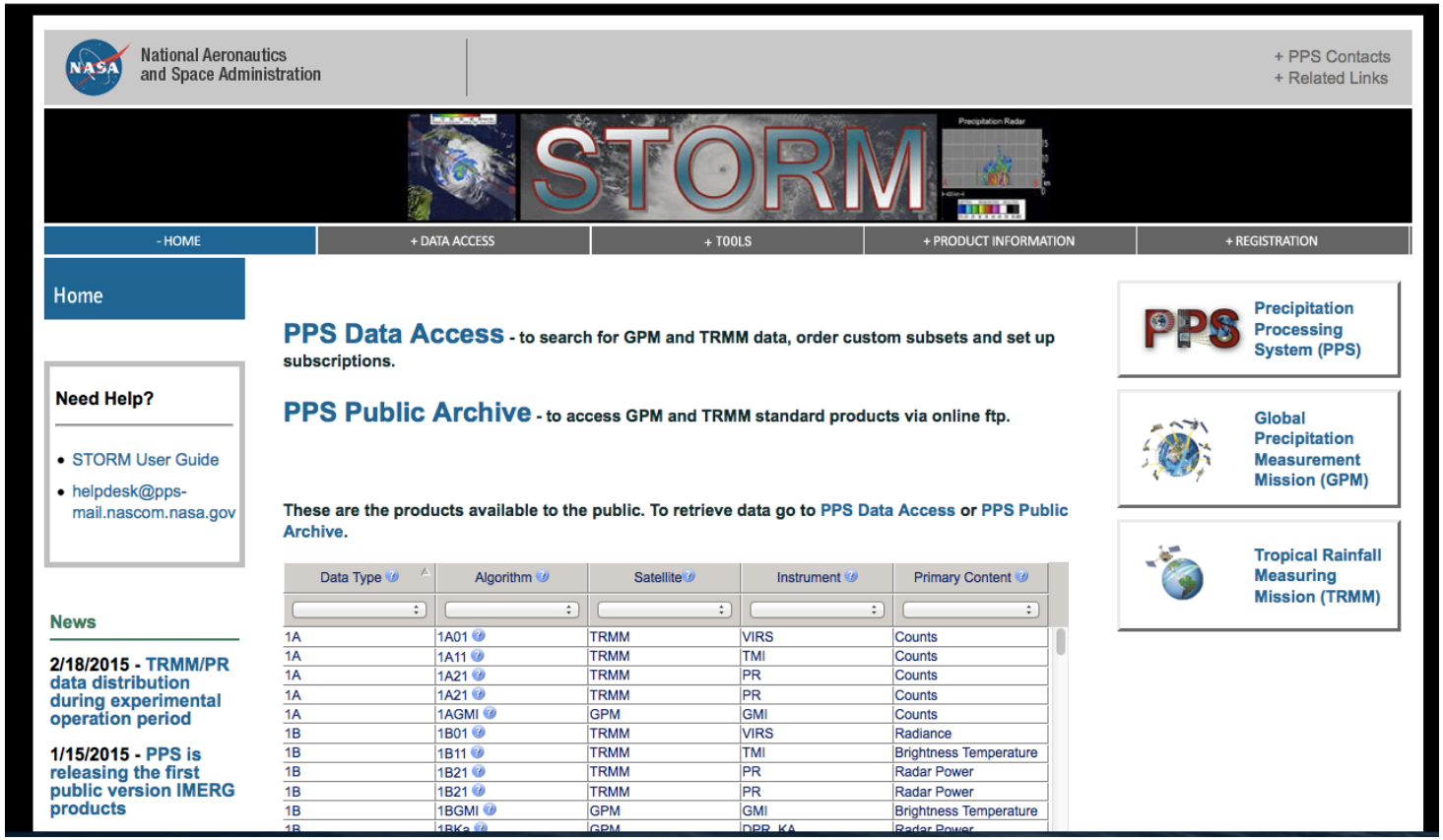
1) useful for searching and downloading data files in multiple formats

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/

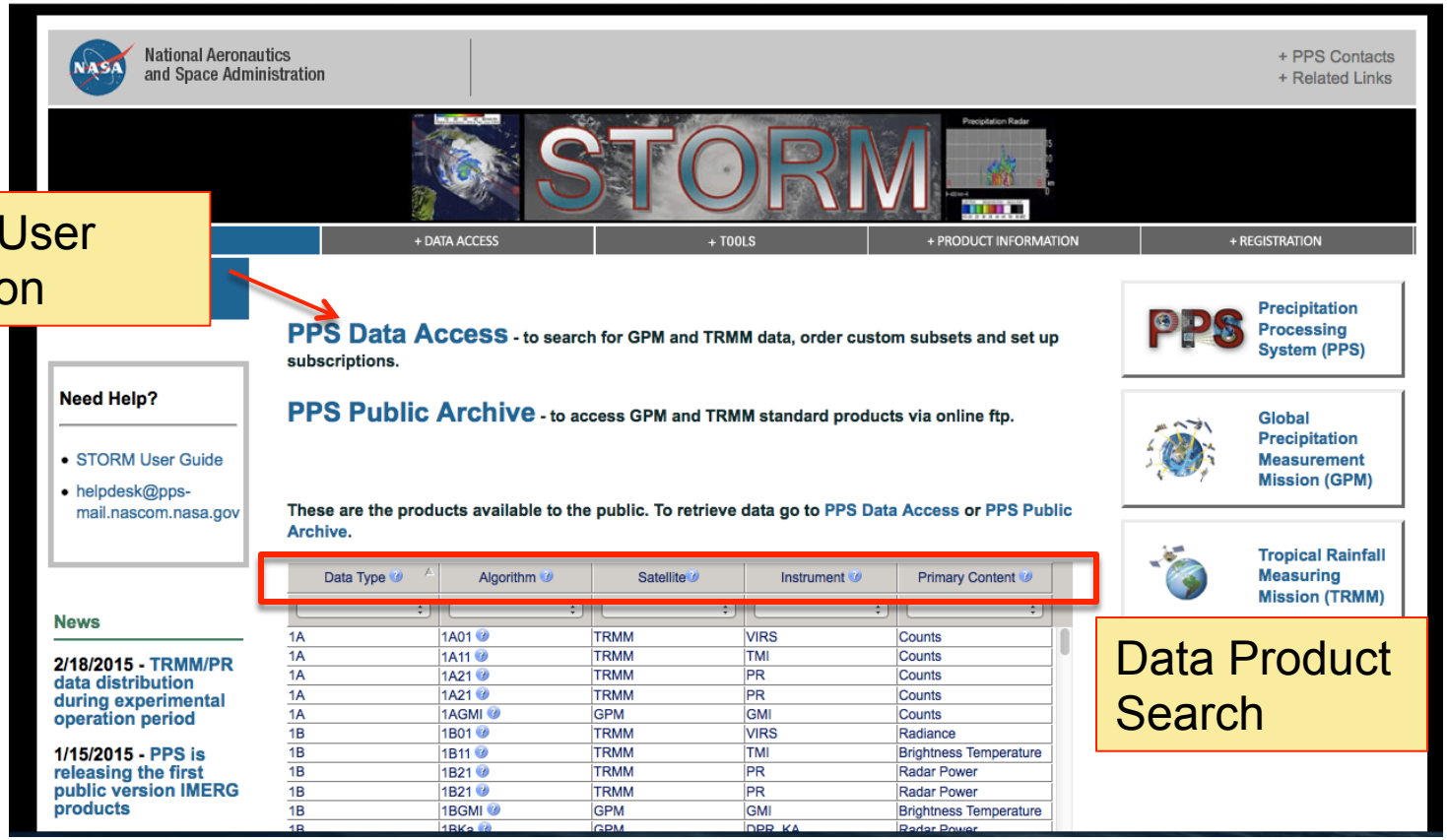


STORM is specifically designed for GPM and TRMM Precipitation data search, selection, download, and visualization

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

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

Requires User Registration

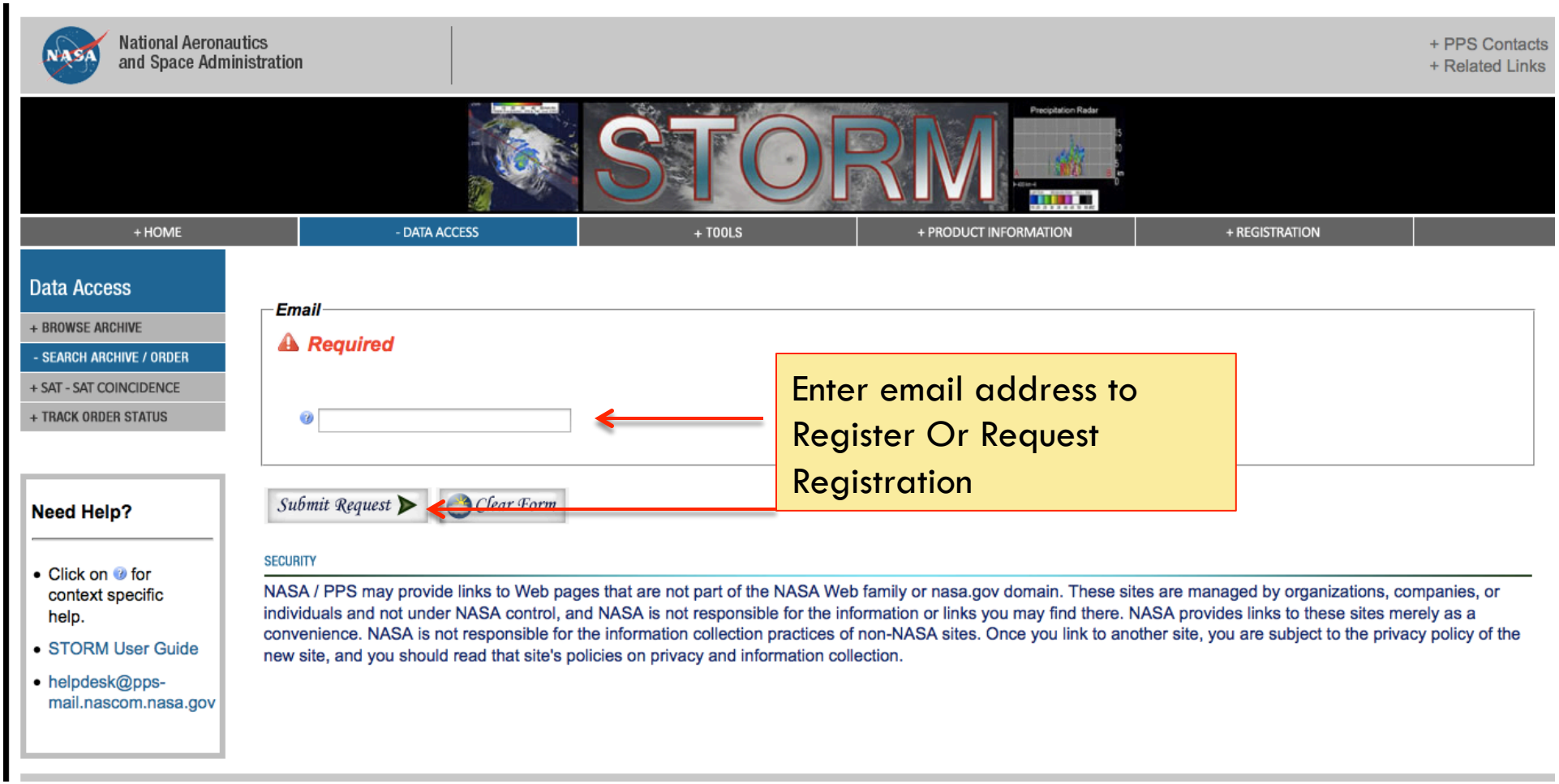


Data Product Search

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/



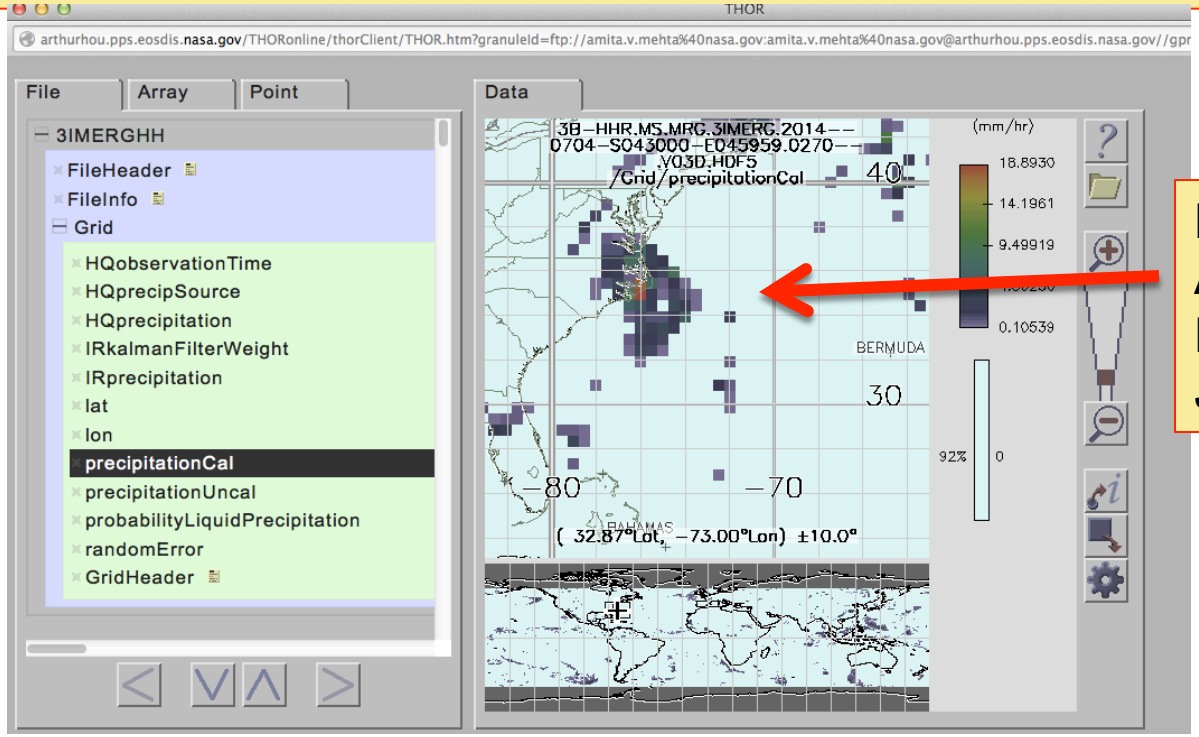
Precipitation Processing System (PPS)
Science Team On-Line Request Module (STORM)

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

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/

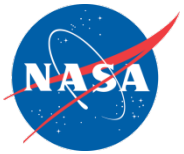
STORM:

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

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!

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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