



An Update on Global Satellite-Based Precipitation Products and Services at NASA GES DISC

Zhong Liu^{1,2}, A. Savtchenko^{1,3}, D. Ostrenga^{1,3}, B. DeShong^{1,3}, F. Fang^{1,3}, M. Greene^{1,4}, R. Albayrak^{1,3}, P. Huwe^{1,3}, J. Su^{1,3}, C.-L. Shie^{1,5}, J. Adams^{1,3}, J. Acker^{1,3}, A. Li¹, W. Teng^{1,3}, J. Wei¹, Guang-Dih Lei^{1,3} and D. Meyer¹

¹GES DISC; ²CSISS, George Mason University; ³ADNET Systems, Inc.; ⁴Telophase Corp; ⁵Univ. of Maryland at Baltimore County

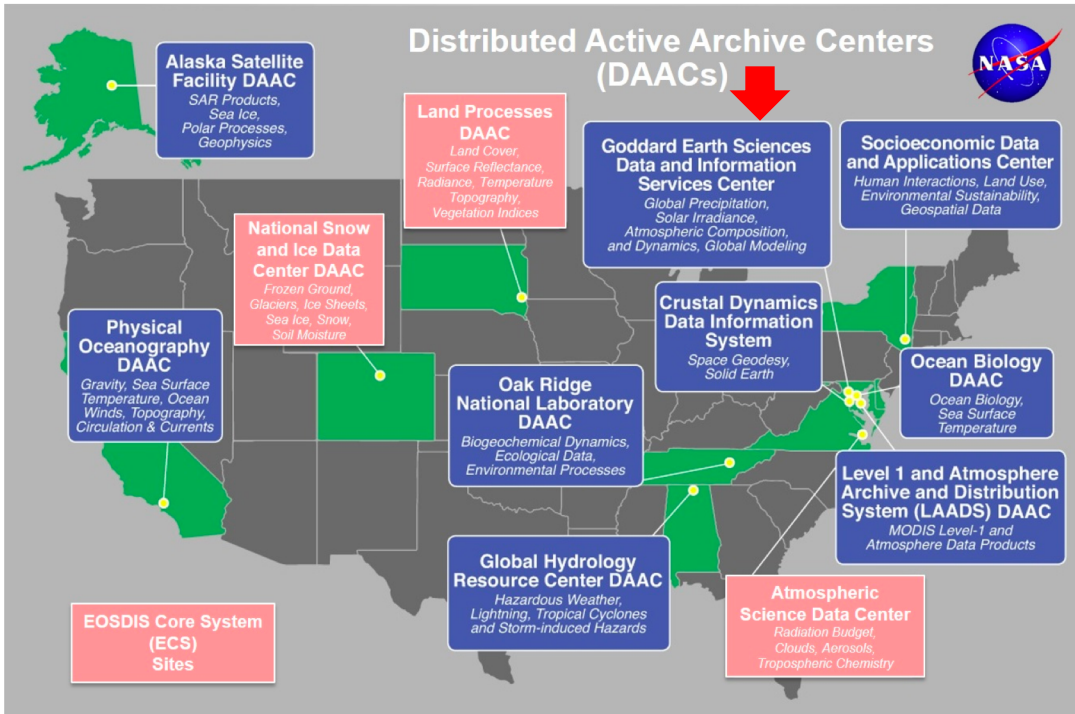


Outline

- About NASA GES DISC
- GES DISC Data Holdings
- Data services
- Giovanni (*easy-to-use online tool without downloading data and software*)
- Global and regional precipitation products
- Summary



About NASA GES DISC

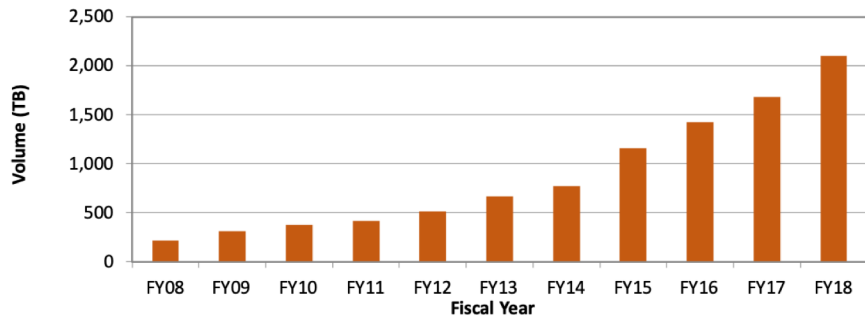


The GES DISC, located in Greenbelt, Maryland, USA, is one of the **12 NASA ESDIS DAACs** that manage, archive and distribute Earth science data as part of the NASA's Earth Science Data Information Systems Program (ESDIS).

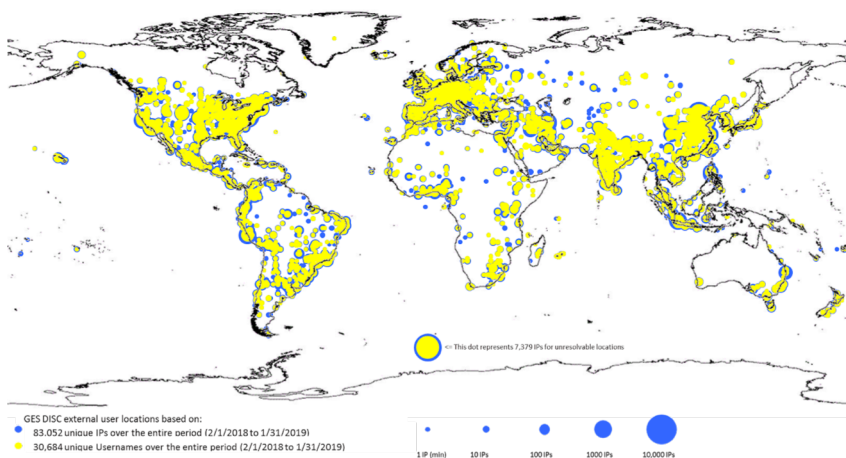
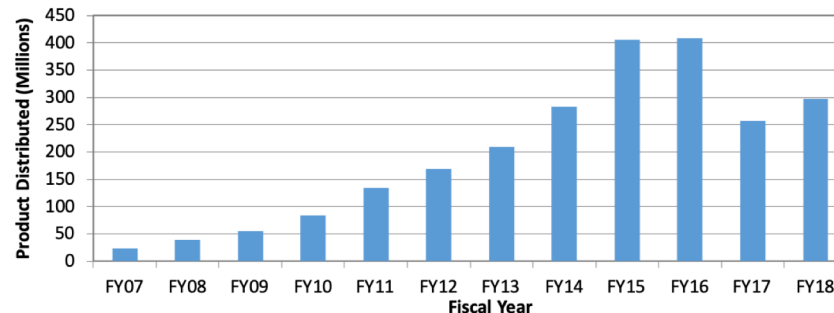


About NASA GES DISC (cont.)

GESDISC Multi-Year Total Archive Volume Trend



GESDISC Multi-Year Product Distribution Trend



Archive Size: **2,296.372 TB**

Archived Data Files: **117,565,233**

(Single copy does not include backup copies)

Files Distributed*: 2,446,913,954

Data Volume Distributed*: 23,480.012 TB

User locations from 2/1/2018 to 1/31/2019
 83,052 unique IPs over the entire period
 30,684 unique Usernames over the entire period

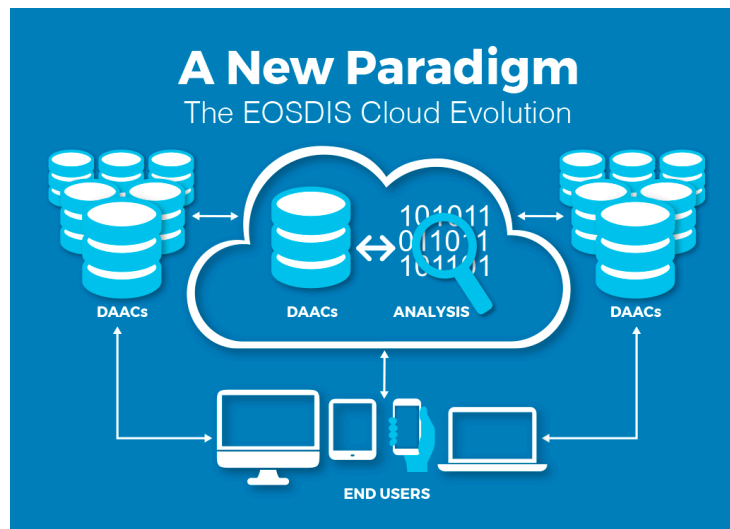
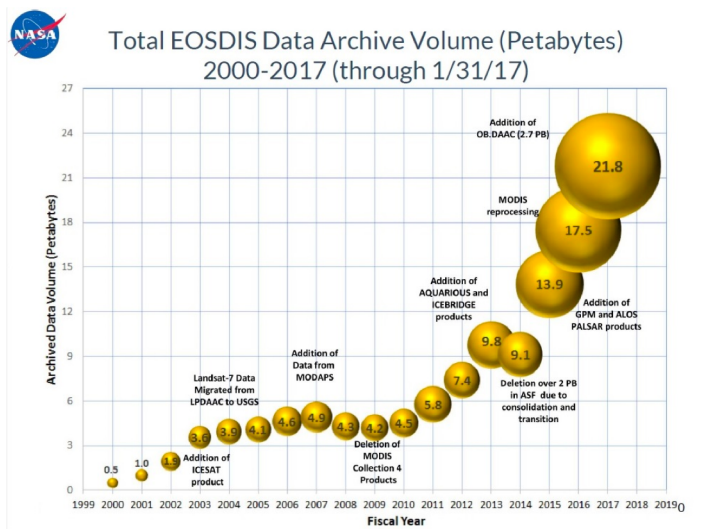
As of 02/20/2019

** Since 2010*



About NASA GES DISC (cont.)

Earth Science Data in the Cloud: The EOSDIS Cumulus Project



Source: <https://earthdata.nasa.gov/learn/articles/eosdis-cumulus-project>

Many **challenges** such as:

- Increasing data volume and variety (e.g. data discovery, access, big data, machine learning)
- Supporting interdisciplinary research and applications with data archived and distributed across the 12 DAACs



About NASA GES DISC (cont.)

- The GES DISC is a **certified trusted repository** as a Regular Member of the International Council for Science (ICSU) World Data System (WDS)
- We provide the support for the archive and distribution of the data for **over 35** multiple satellite sensors, ground measurements, field campaigns, models; as well as data developed by science community members.
- **Multi-disciplinary archive** in the 5 of 6 NASA Earth science focus areas of atmospheric composition, weather and atmospheric dynamics, climate variability and change, water and energy cycle, and carbon cycle.
- Archive over **2.3 PB** of data, **2500 data products** and have disseminated over **23 PB** of data, including precipitation products from NASA missions/projects (GPM, TRMM, MERRA-2, NLDAS, GLDAS, FLDAS, GPCP, etc.)
- Follows data publication process and ESDIS standards for metadata, format and citation recommendations including **Digital Object Identifiers (DOIs)**



GES DISC Data Holdings

1200+ data collections being curated

Atmospheric composition missions:

- Nimbus 1-7* BUV, SBUV, TOMS
- Shuttle SBUV*
- UARS*
- Aqua AIRS
- Aura HIRDLS*, OMI, MLS
- ACOS*
- SNPP Sounder, OMPS
- JPSS-1 Sounder, OMPS
- OCO-2
- OCO-3
- Copernicus Sentinel 5P
- TOVS Pathfinder*

Water cycle/precipitation missions:

- TRMM*
- GPM
- SMERGE

Climate variability/solar missions:

- SORCE
- TCTE
- TSIS
- CAR

Model data:

- MERRA*/MERRA-2
- NLDAS, GLDAS, FLDAS, NCA-LDAS

Research-derived data:

- MEaSUREs
- CMS

Near-real time:

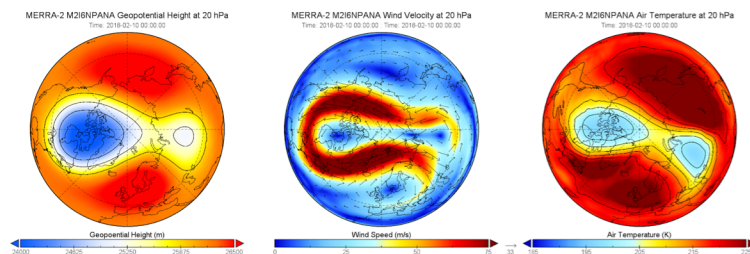
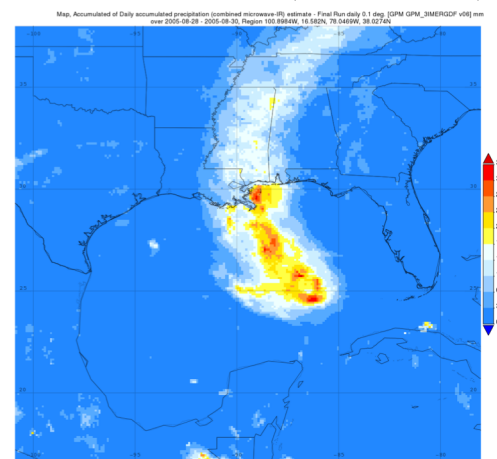
- AIRS
- MLS
- TMPA
- IMERG

Future assigned missions:

- TROPICS
- Copernicus Sentinel 6
- GeoCarb
- Radio Occultation from GNSS

* end-of-mission/project

Hurricane Katrina (GPM IMERG)



polar vortex from MERRA-2



Data Services and Support

- **Metadata support, documentation, metrics:**
 - Assignment of DOIs
 - Includes recommended data set citation, hosting of data set landing pages, documentation
 - Generation of metadata records, publication to the EOSDIS Common Metadata Repository (CMR)
 - Publication of data **distribution metrics** to the EOSDIS Metrics System (EMS)
- **Web-based discovery and access to products**
- **Value added services on data**
 - Giovanni
 - Sub-setting, reformatting and re-gridding
 - Access protocols (e.g., OPeNDAP)
 - USDA Crop Explorer; Anomalies and extremes (temperature, precipitation)
- **User Services** – provide tiered support in data access and use:
 - GES DISC User Services (first tier)
 - GES DISC science data specialist (second tier)
 - Collaboration with science team subject matter experts (third tier)
- **Community Engagement:**
 - Workshops and webinars on the use of data and relevant services
 - Conference participation, publications, news releases
 - Engagement with Applications Community
 - Applied Remote Sensing Training Group (ARSET), Disasters Working Group, Heath and Air Quality Applied Sciences Team (HAQAST), Land and Atmospheres near real time Capabilities for EOS (LANCE).



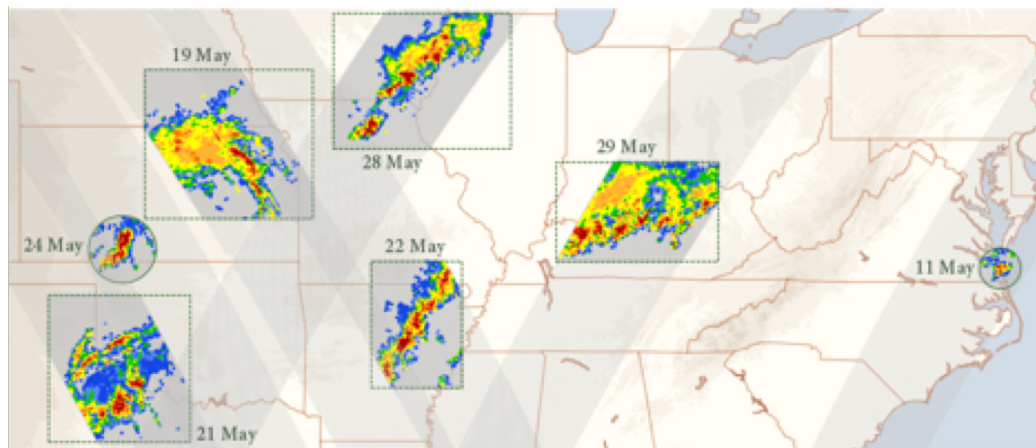
Tools and Services

GES DISC spatial and reformatting services for L2 and L3/4 data allow users to create subsets of the data to reduce download volume and get only what they need for their research, including:

- Spatial sub-setting
- Temporal search
- Temporal sub-setting
- Variable sub-setting
- Vertical sub-setting
- Calculate daily means
- File format conversion
- Re-grid L3/4 data from native grid to user-specified grid

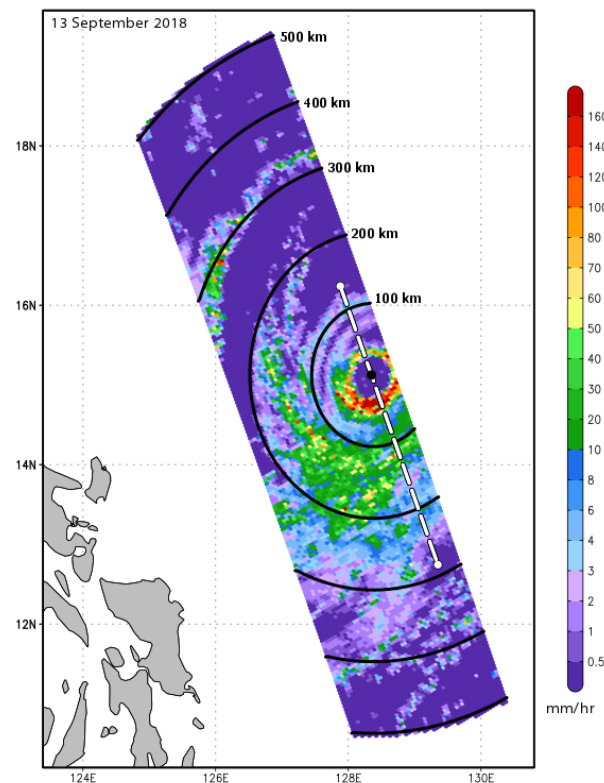


Tools and Services (cont.)



Top Left: GPM Dual-Frequency Precipitation Radar (DPR) observed occurrences of tornado outbreaks in the Midwestern and Eastern United States in May 2019. The image shows extreme rainfall accompanying the tornadoes reported on the dates shown. Red indicates rain rates greater than 25 millimeters (~1 inch) per hour. The light grey regions show the entire swath over the geographical area; darker grey regions containing precipitation contours show the subsetted portions of the full swaths. The data from May 19, 21, 22, 28, and 29 use a box subset, and the data from May 11 and 24 use a point/radius search subset.

Radial Subset of GPM Surface Precipitation Rate



Top Right: GPM_2ADPR Near-Surface Precipitation Rate ("`/NS/SLV/precipRateNearSurface`") subset within 500 km of the eye of Typhoon Mangkhut on 13 September 2018.



Tools and Services (cont.)

Get [GPM IMERG Early Precipitation L3 1 day 0.1 degree x 0.1 degree V06 data](#)

Estimated size of results

7,075 days, 7,075 links, 179.05 GB

Refine Search [?](#)

▶ Refine Date Range: 2000-06-01 to 2019-10-14 [Reset](#)

Subset Options [?](#)

▶ Spatial Subset: -180, -90, 180, 90 [Reset](#)

▶ Variables: Get all variables [Reset](#)

▼ Grid: None [Reset](#)

Remapping Type:

Select remapping type

Grid:

Select a grid

[Reset](#)

Output format [?](#)

▶ File Format: NetCDF [Reset](#)

[Reset All](#)

[Get Data](#)

Remapping Type:

- Select remapping type
- Bilinear Interpolation
- Bicubic Interpolation
- Distance-weighted average remapping
- Nearest neighbor remapping

Grid:

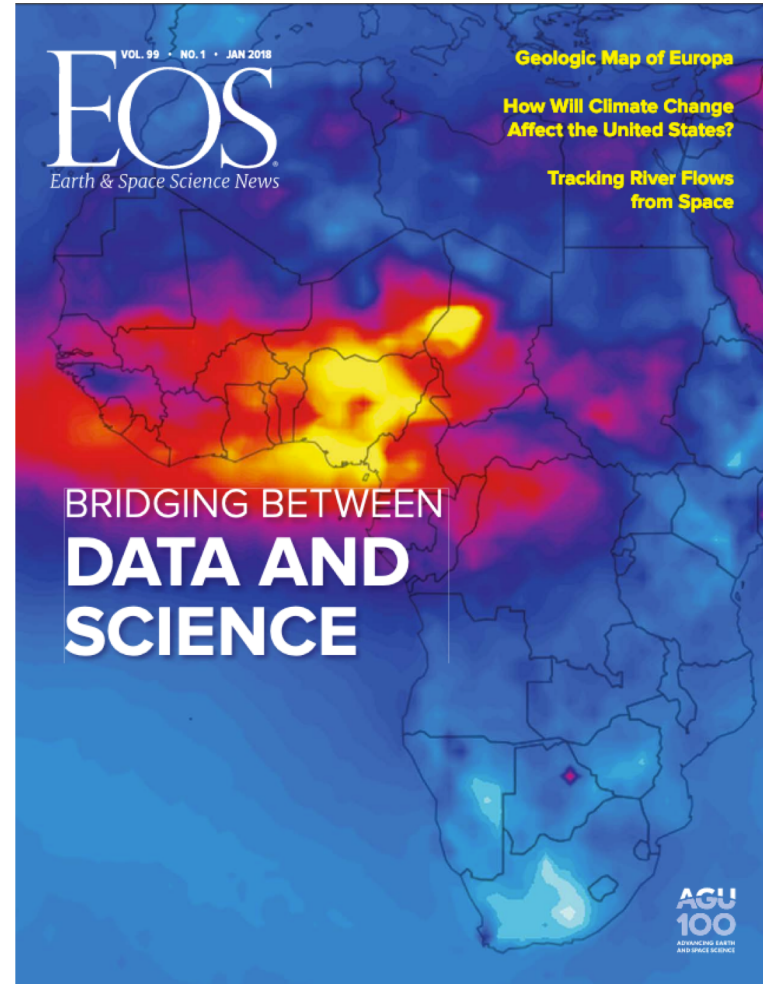
- Select a grid
- GPCP-3
- TMPA
- JRA-55
- 20cr2x2
- MERRA0.5
- MERRA1.25
- gpcp2.5
- cfsr1.0
- cfsr2.5
- ncepncar2.5
- geos1x125
- geos1x1
- geos4x5
- geos2x25
- geos0.25
- geos0.5
- fv1x125
- fv2x25
- fv4x5



NASA GES DISC Giovanni

The Geospatial Interactive Online Visualization and Analysis Infrastructure (Giovanni) provides the means to perform 22 visualizations on ~1450 variables from six different DAACs.

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



GIOVANNI The Bridge Between Data and Science v 4.31

Select Plot: Maps: Time Averaged Map * Comparisons: Select... Vertical: Select... Time Series: Select... Miscellaneous: Select...

Select Date Range (UTC): YYYY-MM-DD HH:mm to YYYY-MM-DD HH:mm
Valid Range: 1948-01-01 to 2019-10-15

Select Region (Bounding Box or Shape): Format: West, South, East, North

Please specify a start date.

Select Variables: Number of matching Variables: 11 of 1818 Total Variable(s) included in Plot: 0
Please select at least 1 variable

Keyword: IMERG V06 Search Clear

Variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date	End Date
<input type="checkbox"/> Multi-satellite precipitation estimate with climatological gauge calibration - Early Run (GPM_3IMERGHH_v06)	mm/hr	GPM	Half-Hourly	0.1°	2000-06-01	2019-10-15
<input type="checkbox"/> Multi-satellite precipitation estimate with gauge calibration - Final Run (recommended for general use) (GPM_3IMERGHH_v06)	mm/hr	GPM	Half-Hourly	0.1°	2000-06-01	2019-06-30
<input type="checkbox"/> Random error for gauge-calibrated multi-satellite precipitation - Final Run (GPM_3IMERGHH_v06)	mm/hr	GPM	Half-Hourly	0.1°	2000-06-01	2019-06-30
<input type="checkbox"/> Multi-satellite precipitation estimate with climatological gauge calibration - Late Run (GPM_3IMERGHH_v06)	mm/hr	GPM	Half-Hourly	0.1°	2000-06-01	2019-10-15
<input type="checkbox"/> Random Error for multi-satellite precipitation with climatological gauge calibration - Late Run (GPM_3IMERGHH_v06)	mm/hr	GPM	Half-Hourly	0.1°	2014-06-01	2019-10-15
<input type="checkbox"/> Random Error for multi-satellite precipitation with climatological gauge calibration - Early Run (GPM_3IMERGHH_v06)	mm/hr	GPM	Half-Hourly	0.1°	2000-06-01	2019-10-15
<input type="checkbox"/> Daily accumulated precipitation (combined microwave-IR) estimate - Final Run (GPM_3IMERGDV_v06)	mm	GPM	Daily	0.1°	2000-06-01	2019-06-30
<input type="checkbox"/> Daily accumulated precipitation (combined microwave-IR) estimate - Early Run (GPM_3IMERGDV_v06)	mm	GPM	Daily	0.1°	2000-06-01	2019-10-14
<input type="checkbox"/> Daily accumulated precipitation (combined microwave-IR) estimate - Late Run (GPM_3IMERGDV_v06)	mm	GPM	Daily	0.1°	2000-06-01	2019-10-14
<input type="checkbox"/> Merged satellite-gauge precipitation estimate - Final Run (recommended for general use) (GPM_3IMERGM_v06)	mm/hr	GPM	Monthly	0.1°	2000-06-01	2019-06-30
<input type="checkbox"/> Random error for merged satellite-gauge precipitation - Final Run (GPM_3IMERGM_v06)	mm/hr	GPM	Monthly	0.1°	2000-06-01	2019-06-30

Responsible NASA Official: Angela Li Privacy Powered By Contact Us
Web Curator: M. Hegde

Reset Plot Data Go to Results



Precipitation Product Overview

- GPM (Global Precipitation Measurement)
- TRMM (Tropical Rainfall Measuring Mission)
- GPCP (Global Precipitation Climatology Project) of MEaSUREs
- MERRA-2 (Modern-Era Retrospective analysis for Research and Applications, Version 2)
- NLDAS (North America Land Data Assimilation System)
- FLDAS (Famine Early Warning System Network Land Data Assimilation System)
- GLDAS (Global Land Data Assimilation System).



Global Precipitation Products (Level-3)

- TRMM Multi-satellite Precipitation Analysis (TMPA, 0.25-deg. 3-hr, monthly, 1998 – present; 50° (60° NRT) N-S) – (production ended on Dec. 31, 2019)
- Integrated Multi-satellite Retrievals for GPM (IMERG, NRT and research, 0.1-deg., 0.5-hr, monthly, 06/2000 – present), Version 06
- GPCP (Global Precipitation Climatology Project). Version 3.0 (1983 – 2016)
- GLDAS (Global Land Data Assimilation System, 0.25-deg., 3-hourly and 1-deg., monthly, 1948-2010 (v 2.0), 2000-present (v 2.1))
- NLDAS (North America Land Data Assimilation System, 0.125-deg., hourly and monthly, 1979 - present)
- FLDAS (Famine Early Warning System Network Land Data Assimilation System, 0.1 deg., daily, monthly, 1982 – present)
- MERRA-2 (Modern-Era Retrospective analysis for Research and Applications, Version-2, 0.5 x 0.625 deg. hourly, 3-hourly, monthly, 1980-present)



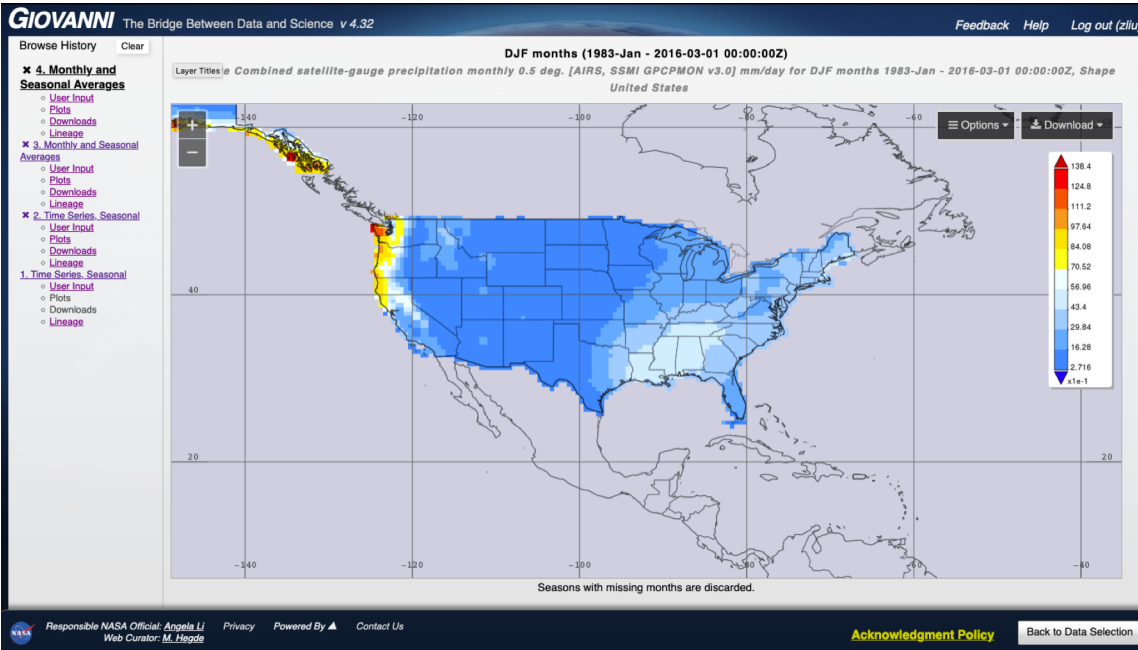
Global Precipitation Products (Level-2)

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

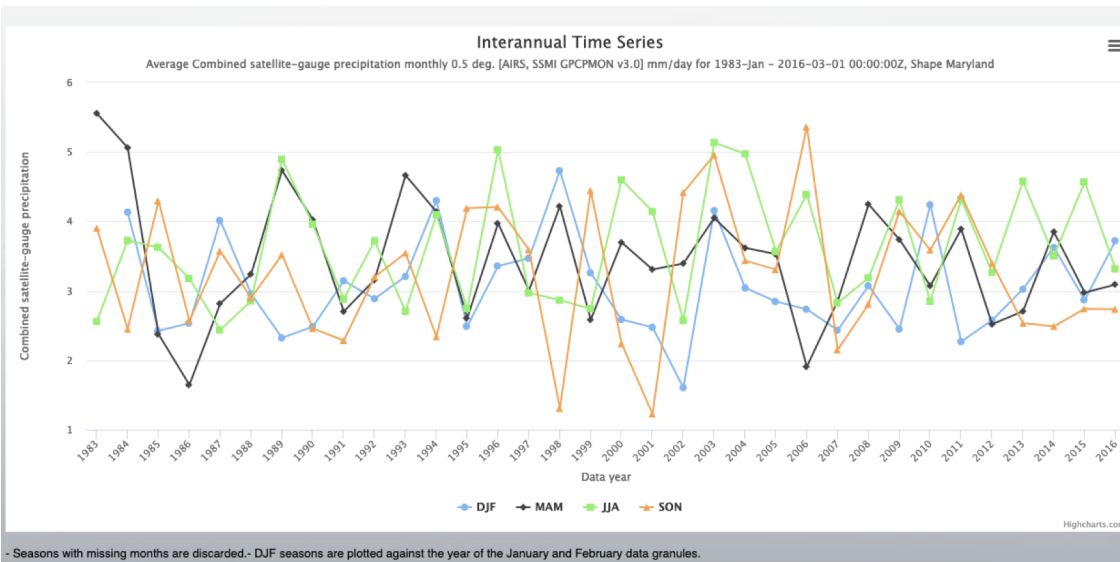
- Goddard profiling algorithm (GPROF) datasets from the GPM constellation (GPM, TRMM, DMSP, NOAA15-20, SUOMI-NPP, GCOM-W1, METOP-A, METOP-B, MT1 SAPHIR, AQUA AMSR-E, etc.)
- TRMM PR, GPM DPR, GPM Ka, GPM Ku
- Combined products: TRMM PR and TMI, GPM DPR and GMI
- Latent heating products



Precipitation Products in Giovanni



CONUS

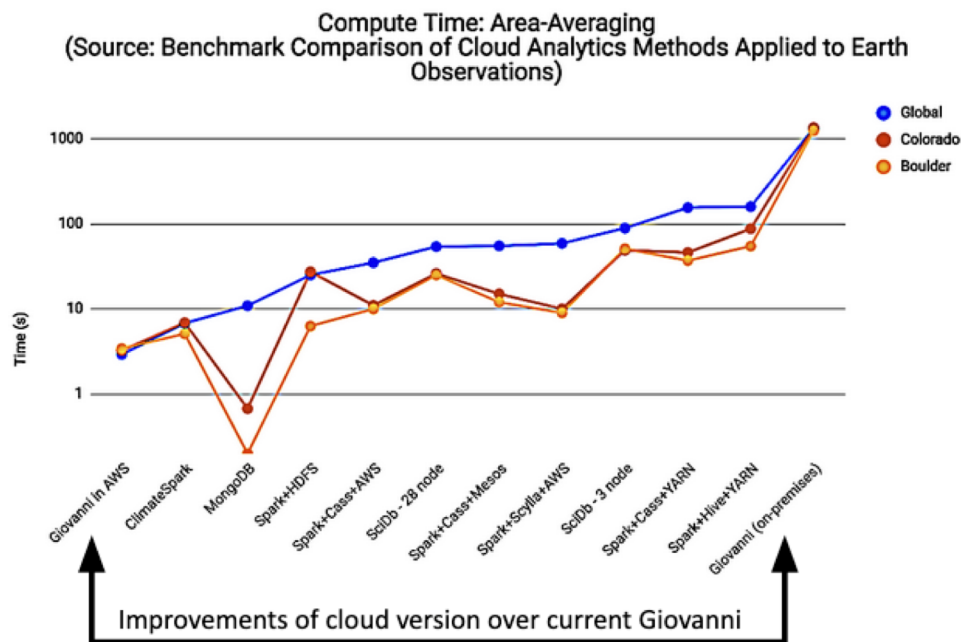


Maryland



Ongoing and Future Plans

- IMERG in the Cloud
- Giovanni in the Cloud
- Requirements for analysis ready data services
- Support AI/ML data services (e.g. training data)
- Interdisciplinary data services
- Simplify data access (e.g. natural language processing)



Daily time series
Variable: MOD08_D3_6_Aerosol_Optical_Depth_Land_Ocean_Mean
Spatial coverage: global
Time coverage: 16 years (~6000 time steps)



Summary

- Global and regional precipitation datasets (satellite-based and data assimilation)
- Other datasets are available (temperature, wind, soil moisture, etc.)
- Data services (search, subsetting, format conversion, GIS, DOIs, etc.)
- Giovanni (online tool for visualization, analysis, evaluation, etc.)
- User services



Acknowledgements:

We thank scientists and engineers at GES DISC for their contributions to data management, distribution, and development of data services. We also thank scientific investigators and many users for their feedback and suggestions that improve our data services. GES DISC is funded by NASA's Science Mission Directorate.



Information

- Data information and services:
<https://disc.gsfc.nasa.gov/> Search for: TRMM (GPM, TRMM, IMERG, NLDAS, GLDAS, MERRA)
- Giovanni: <https://giovanni.gsfc.nasa.gov> or Google search “NASA giovanni” Search for “GPM”, “TRMM”, “MERRA”, “GLDAS”
- NASA PMM: <https://pmm.nasa.gov>
- Comments and suggestions: gsfc-help-disc@lists.nasa.gov