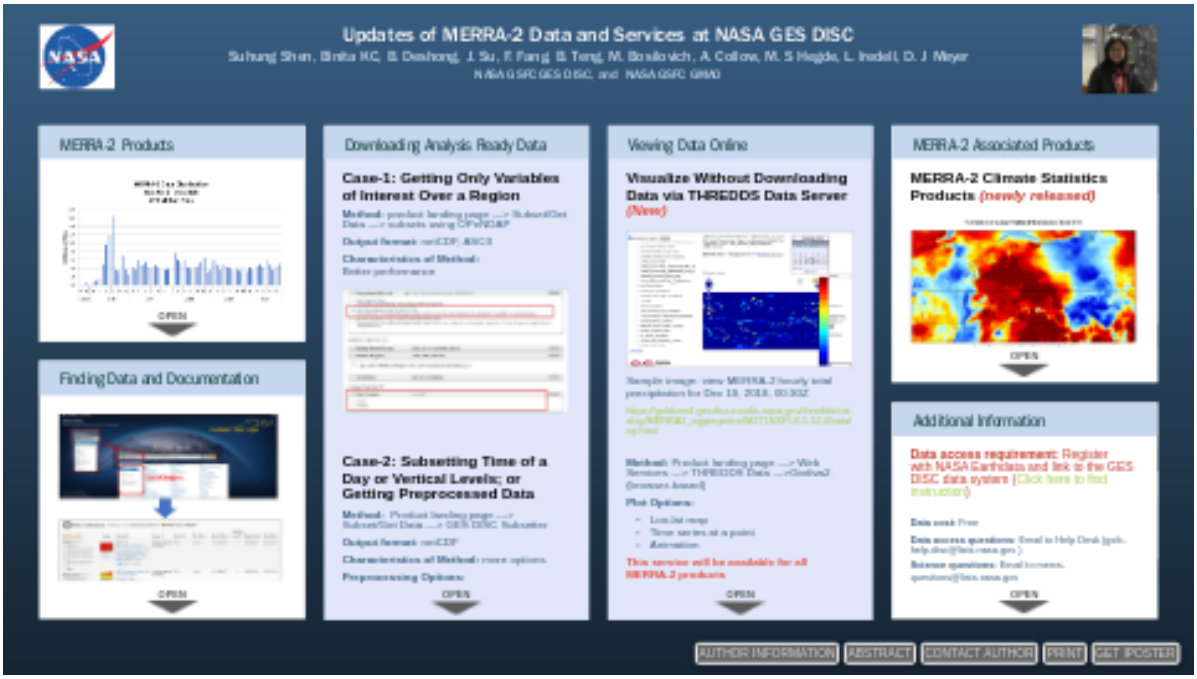
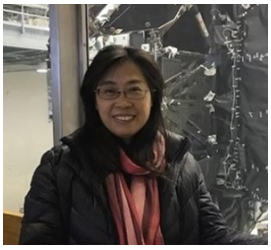
Updates of MERRA-2 Data and Services at NASA GES DISC

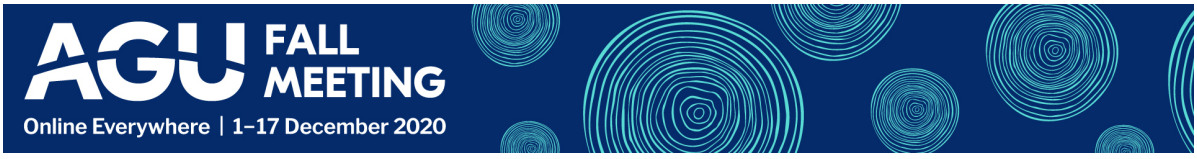


Suhung Shen, Binita KC, B. Deshong, J. Su, F. Fang, B. Teng, M. Bosilovich, A. Collow, M. S Hegde, L. Iredell, D. J Meyer

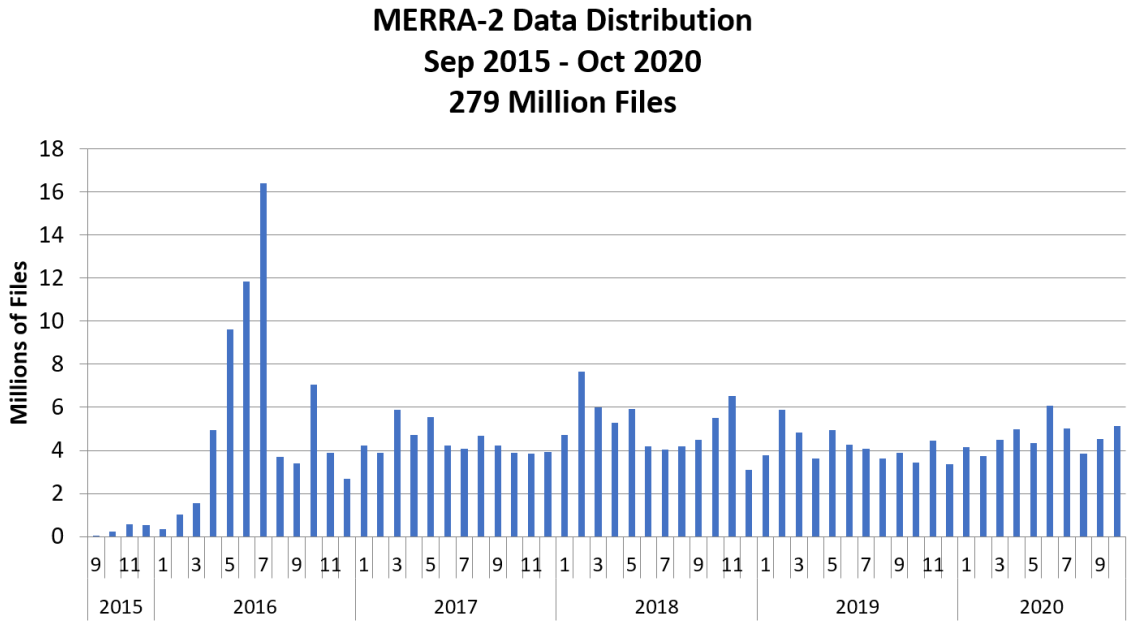
NASA GSFC GES DISC, and NASA GSFC GMAO



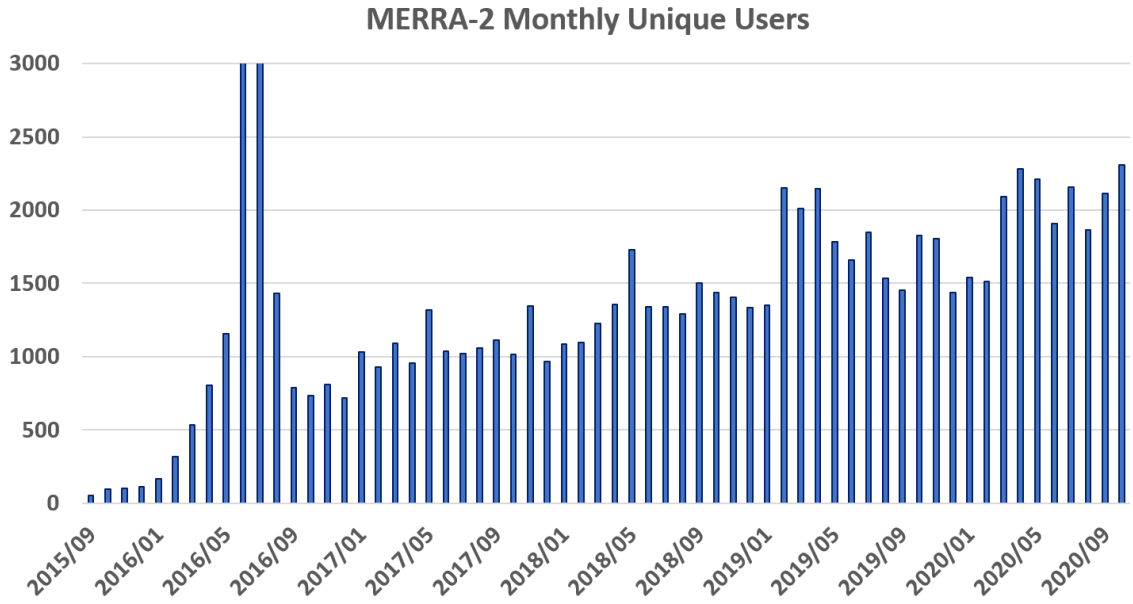
PRESENTED AT:



MERRA-2 PRODUCTS



MERRA-2 data distribution rate is about 4 million files per month. About 279 million files have been distributed.



MERRA-2 data have been used broadly in both traditional Earth science and application communities. The unique user numbers have grown continuously from several hundred to over 2000 per month.

MERRA-2 Data Basics

MERRA-2 is a NASA Global Modeling and Assimilation Office (GMAO) generated reanalysis data set for the satellite era focused on historical analyses of meteorology, atmospheric chemistry, land, ocean, and aerosols data. The data are available for a broad range of weather and climate time scales.

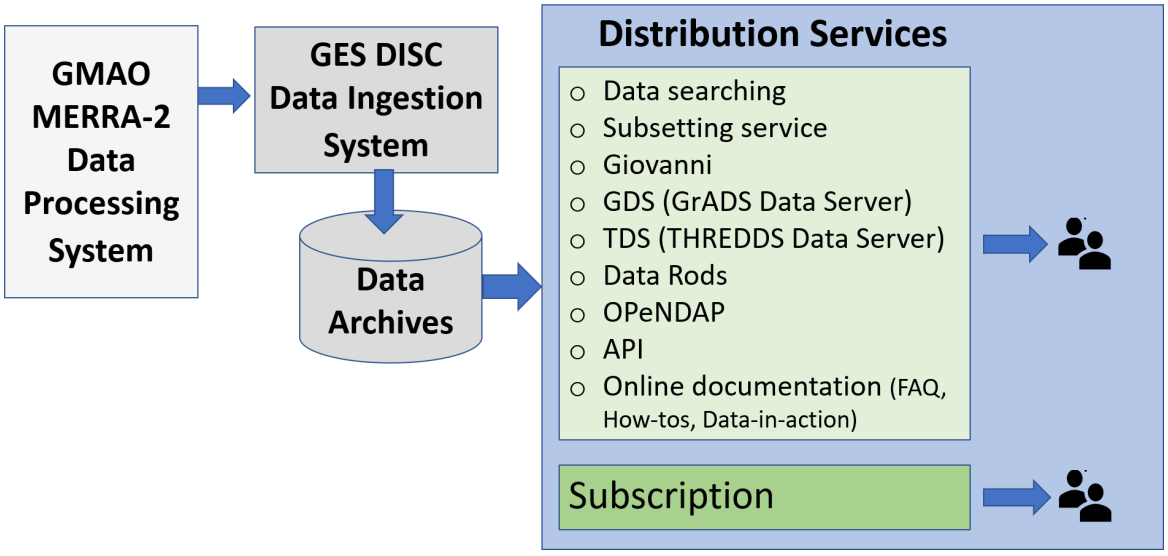
- Number of Data Collections: 95
- Temporal Coverage: 1980-present
- Temporal Resolution: Hourly, 3-Hourly, Monthly, Monthly diurnal
- Spatial Coverage: Global
- Spatial Resolution: 0.5^{o} x 0.625^{o} (361x576, L1, L42, L72, L73)
- Data Format: NetCDF-4
- Data Latency: ~ 3 weeks after the end of the month

Click on the followings for:

MERRA-2 File Specific Document (https://gmao.gsfc.nasa.gov/pubs/docs/Bosilovich785.pdf)

MERRA-2 Science Documentation (https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/docs/)

Schematic Diagram of Data Flows



FINDING DATA AND DOCUMENTATION

Example: Click here (http://disc.gsfc.nasa.gov/datasets/M2T1NXSLV_5.12.4/summary) to see the product landing page of M2T1NXSLV.5.12.4

Data search start: **https://disc.gsfc.nasa.gov (https://disc.gsfc.nasa.gov)**

Use Case: Hourly wind at 50-meter

Search Keywords: "MERRA-2"+wind+"50-meter“

Refine by: Temporal Resolution = 1 hour

Determine variables: read MERRA-2 File Specific document and more MERRA-2 documentation (linked from the product landing page)

Download data: use a data access method (read next section)

Cite Data: Follow the instructions in "Data Citation" to cite the data in a paper

Data Searching Rules: https://disc.gsfc.nasa.gov/help#searching (https://disc.gsfc.nasa.gov/help#searching)

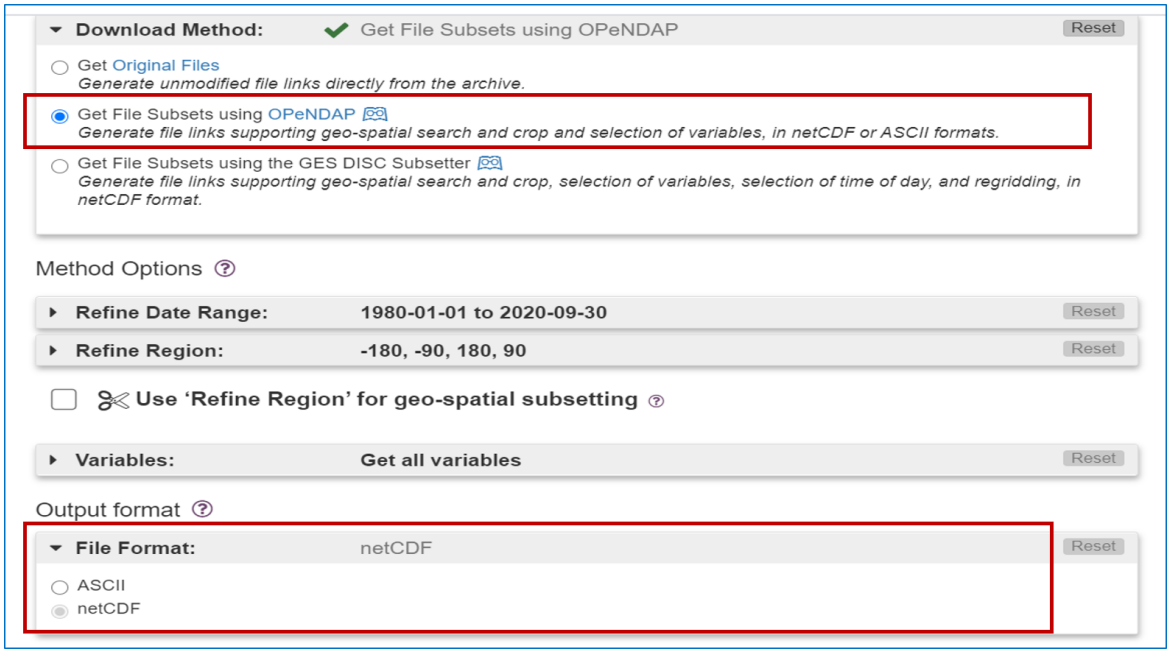
DOWNLOADING ANALYSIS READY DATA

Case-1: Getting Only Variables of Interest Over a Region

Method: product landing page ---> Subset/Get Data ---> subsets using OPeNDAP

Output format: netCDF, ASCII

Characteristics of Method: Better performance



Case-2: Subsetting Time of a Day or Vertical Levels; or Getting Preprocessed Data

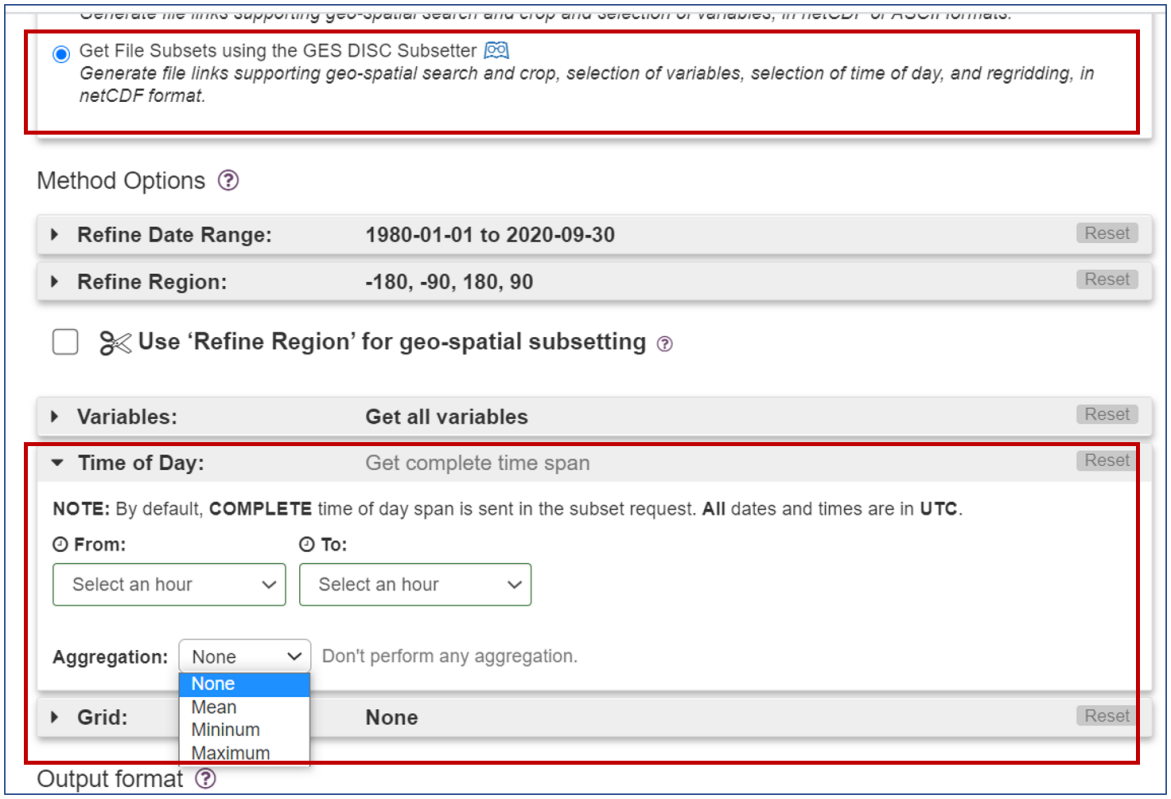
Method: Product landing page ---> Subset/Get Data ---> GES DISC Subsetter

Output format: netCDF

Characteristics of Method: more options

Preprocessing Options:

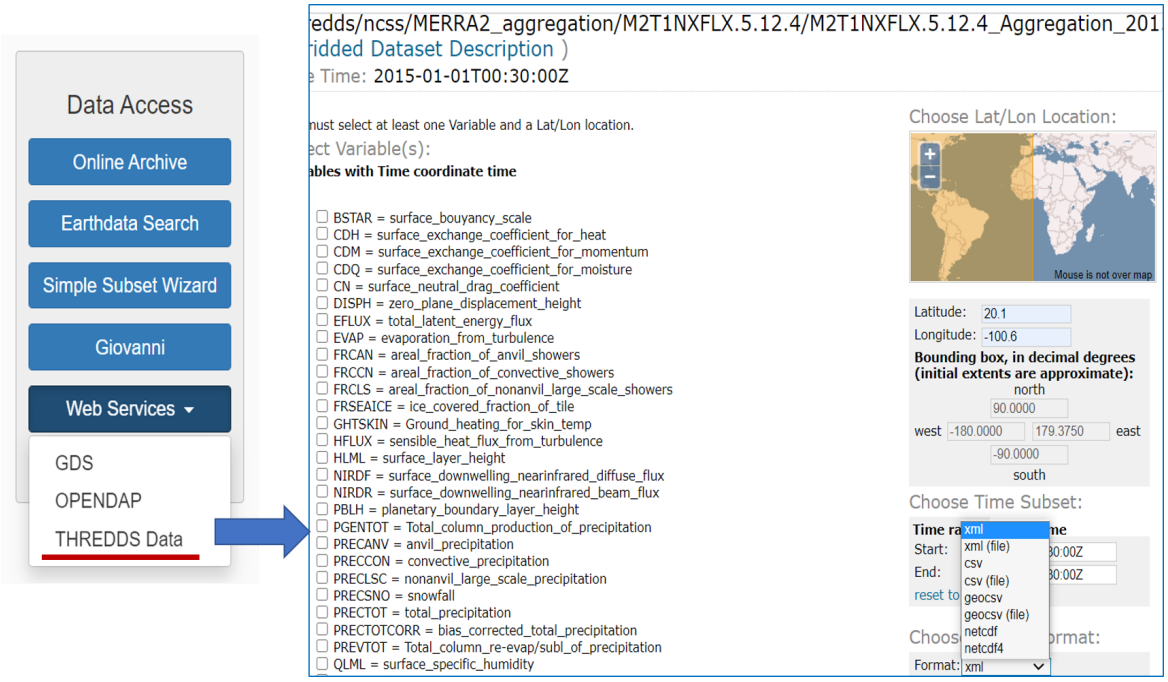
- daily mean
- daily minimum and maximum *(New)*
- horizontal regridding



Case 3: Downloading a Long Time Series at a Location, Save into a Single File *(New)*

Method-1: Product landing page ---> Web Services ---> THREDDS Data ---> NetcdfSubset ---> Grid as Point Dataset

Output format: CSV, geocsv, xml, netCDF



Performance testing: ~2.5 min to download one variable for one year of hourly data.

Example data:
https://goldsmr4.gesdisc.eosdis.nasa.gov/thredds/catalog/MERRA2_aggregation/M2T1NXFLX.5.12.4/catalog.html

Note: The THREDDS Data Server may be used to download regional time series into a single file as well. Performance testing shows that it takes ~1 min to download one variable for 20 years global monthly data.

Method-2: Data Rods

https://disc.gsfc.nasa.gov/information/tools?title=Hydrology%20Data%20Rods
(https://disc.gsfc.nasa.gov/information/tools?title=Hydrology%20Data%20Rods)

Output format: time series plot, CSV, netCDF

Note: available for selected variables

		Instantaneous			
MERRA-2 2D, 1-Hourly, Instantaneous, Single-Level, Assimilation, Land Surface Forcings V5.12.4 (M2I1NXLFO)	TLML	Surface air temperature over land, Instantaneous	K	plot	asc2
	SPEEDLML	Surface wind speed, Instantaneous	m/s	plot	asc2
MERRA-2 2D, 1-Hourly, Time-Averaged, Single-Level, Assimilation, Surface Flux Diagnostics V5.12.4 (M2T1NXFLX)	ULML	Surface eastward wind, time average	m/s	plot	asc2
	VLML	Surface northward wind, time average	m/s	plot	asc2
MERRA-2 2D, 1-Hourly, Time-Averaged, Single-Level, Assimilation, Land Surface Forcings V5.12.4 (M2T1NXLFO)	LWGAB	Surface absorbed longwave radiation, time average	W/m^2	plot	asc2
	SWGDN	Incident shortwave radiation land, time average	W/m^2	plot	asc2
MERRA-2 2D, 1-Hourly, Time-Averaged, Single-Level, Assimilation, Single-Level Diagnostics V5.12.4 (M2T1NXSLV)	U50M	50-meter eastward wind, time average	m/s	plot	asc2
		50-meter			

Performance testing: ~0.5 min to download one variable for 20-year hourly data.

Case 4: Automating Data Search and Download

The GES DISC provides an Application Program Interface (API) for users who prefer to employ our data search and subsetting services using scripts instead of the Web browser interface. The API is a communication protocol that allows users to find the datasets and data granules they need and download any desired subsets. Information is passed back and forth in JavaScript Object Notation (JSON) format.

Complete reference documentation for the GES DISC Subsetting Service API
(https://disc.gsfc.nasa.gov/service/subset)

Example Links:

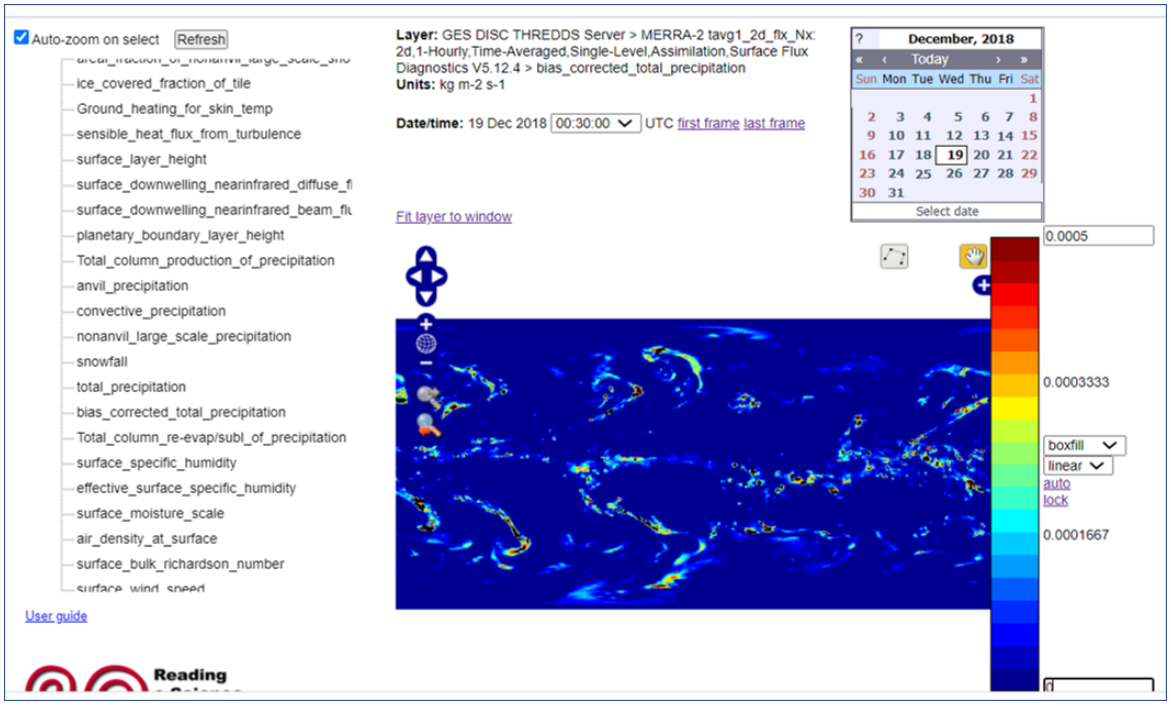
How to Use the Web Services API for Subsetting MERRA-2 Data (https://disc.gsfc.nasa.gov/information/howto?keywords=API&title=How%20to%20Use%20the%20Web%20Services%20API%20for%20Subsetting%20MERRA-2%20Data)

How to Use the Web Services API for Dataset Searching (https://disc.gsfc.nasa.gov/information/howto?keywords=API&title=How%20to%20Use%20the%20Web%20Services%20API%20for%20Dataset%20Searching)

How to Use the Web Services API for Subsetting (https://disc.gsfc.nasa.gov/information/howto?keywords=API&title=How%20to%20Use%20the%20Web%20Services%20API%20for%20Subsetting)

VIEWING DATA ONLINE

Visualize Without Downloading Data via THREDDS Data Server *(New)*



Sample image: view MERRA-2 hourly total precipitation for Dec 19, 2018, 00:30Z

https://goldsmr4.gesdisc.eosdis.nasa.gov/thredds/catalog/MERRA2_aggregation/M2T1NXFLX.5.12.4/catalog.html (https://goldsmr4.gesdisc.eosdis.nasa.gov/thredds/catalog/MERRA2_aggregation/M2T1NXFLX.5.12.4/catalog.html)

Method: Product landing page ---> Web Services ---> THREDDS Data --->Godiva2 (browser-based)

Plot Options:

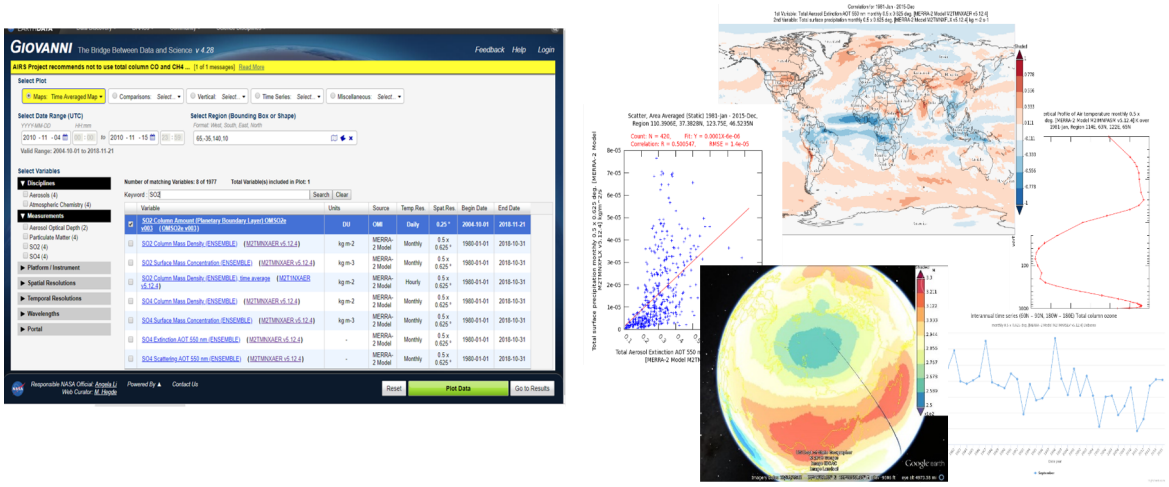
- Lon-lat map
- Time series at a point
- Animation

This service will be available for all MERRA-2 products

Visualize and Analyze Without Downloading Data via Giovanni

https://giovanni.gsfc.nasa.gov (https://giovanni.gsfc.nasa.gov)

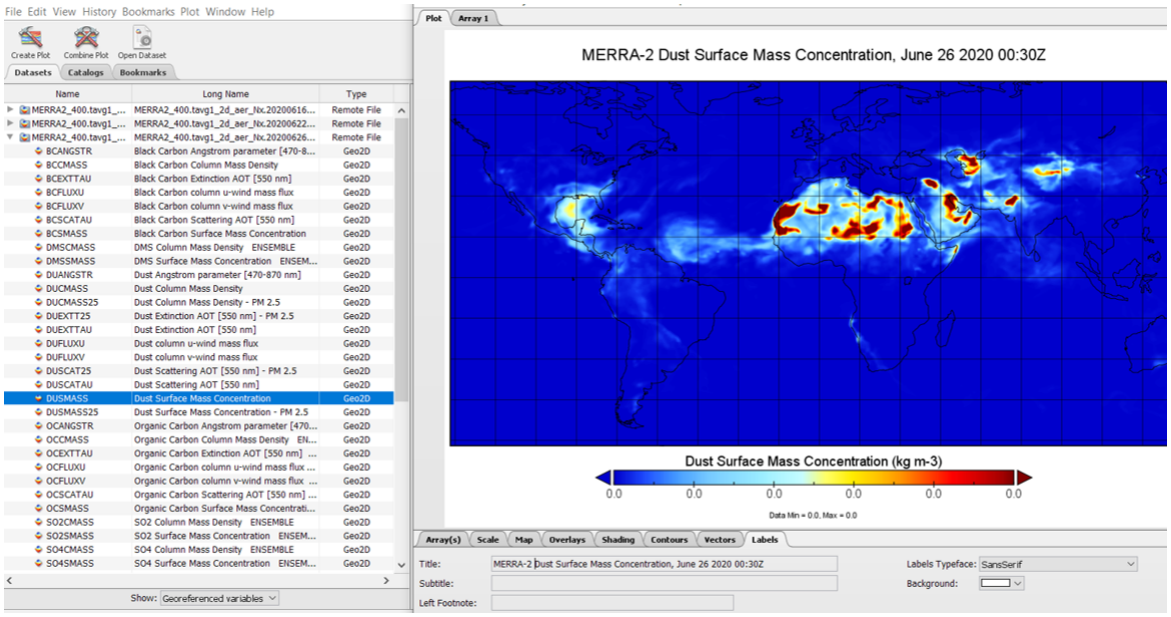
Giovanni is a GES DISC developed online tool. It consists of over twenty plot functions.



684 MERRA-2 variables, including all monthly variables and selected hourly variables, are available in Giovanni.

Visualize Without Downloading Data by Using Panoply

Panoply (http://(http://www.giss.nasa.gov/tools/panoply/) is free software developed by the NASA Goddard Institute for Space Studies. It can access and display remotely the geo-referenced data in the OPeNDAP service



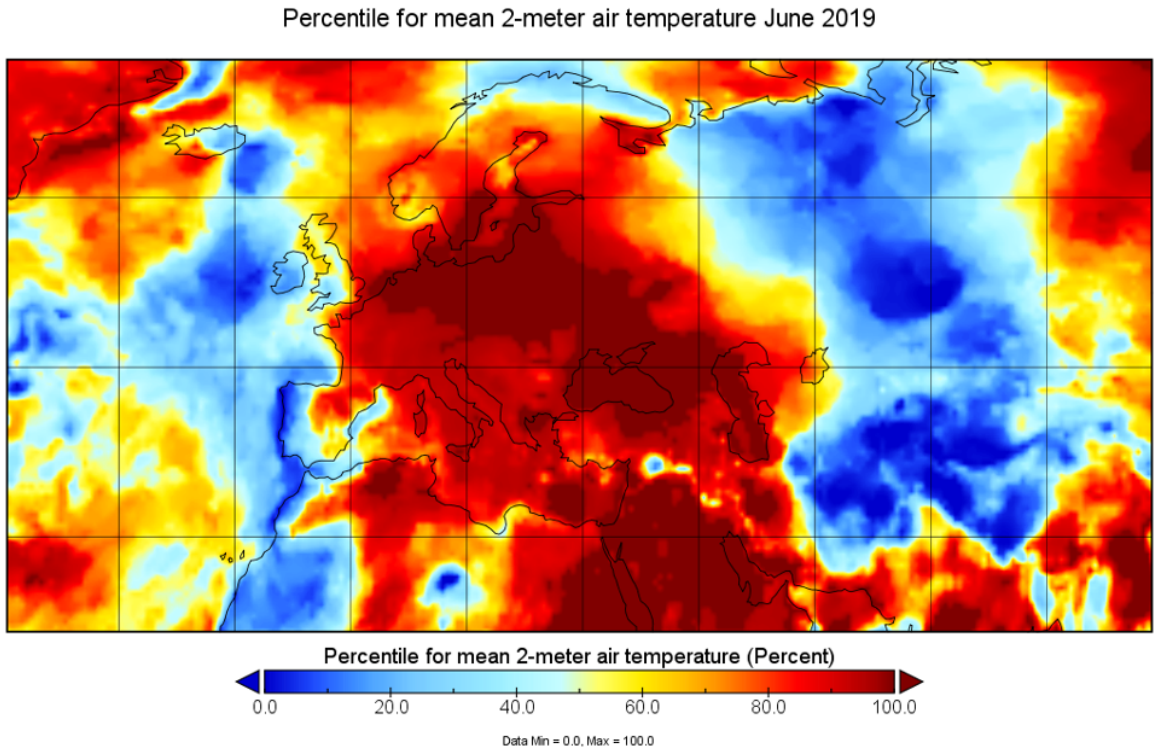
Example image: View of MERRA-2 aerosol on Jun 26 2020 00:30Z for the extreme dust event. The heavy dust was transported from the Sahara Desert westward to the Gulf of Mexico.

Example data: https://goldsmr4.gesdisc.eosdis.nasa.gov:443/opendap/MERRA2/M2T1NXAER.5.12.4/2020/06 (https://goldsmr4.gesdisc.eosdis.nasa.gov:443/opendap/MERRA2/M2T1NXAER.5.12.4/2020/06)

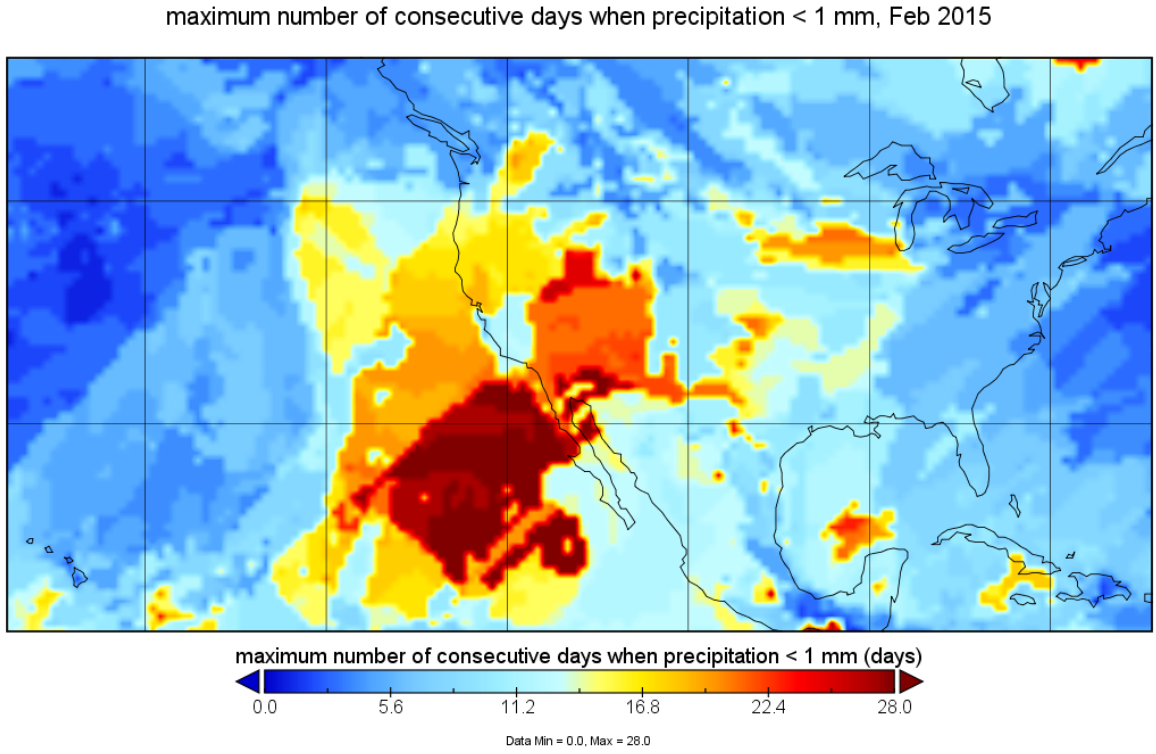
Read more: How to View Remote Data in OPeNDAP with Panoply (https://disc.gsfc.nasa.gov/information/howto?keywords=panoply&title=How%20to%20View%20Remote%20Data%20in%20OPeNDAP%20with%20Panoply)

MERRA-2 ASSOCIATED PRODUCTS

MERRA-2 Climate Statistics Products *(newly released)*



Example image: Percentile of 2-meter temperature, indicating the extreme heat event over Europe in June 2019.



Example image: Maximum number of consecutive days when precipitation < 1 mm for February 2015, indicating dry weather over California.

This dataset consists of monthly products (1980-present):

- Extreme detection indices and percentiles derived from MERRA-2 daily mean to assist in the analysis of extreme temperature and precipitation events
- 30-year climatology for 1981-2010

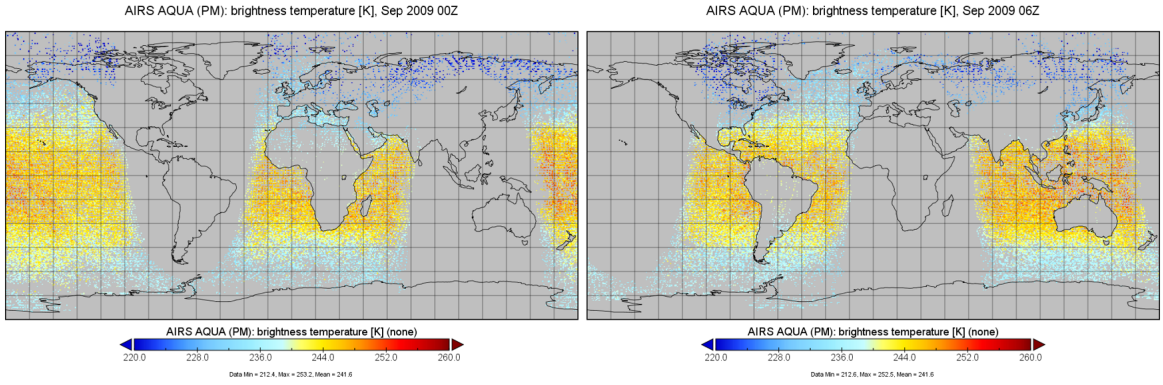
Click here to view all products (https://disc.gsfc.nasa.gov/datasets?keywords=MERRA2-Climate&page=1)

MERRA-2 Gridded Innovations and Observations *(coming soon)*

This dataset provides monthly mean gridded data based on the observations assimilated in MERRA-2 every 6 hours, to assist with understanding the quality of MERRA-2.

The observations include :

- Conventional observations
- Satellite retrieved observations from 85 instruments or channels, including AIRS, MLS, ATMS, HIRS, MSU, SSM/I, and AMSU, etc.



Example images: Gridded brightness temperature from The Atmospheric Infrared Sounder (AIRS).

ADDITIONAL INFORMATION

Data access requirement: Register with NASA Earthdata and link to the GES DISC data system (https://disc.gsfc.nasa.gov/data-access)(Click here to find instruction (https://disc.gsfc.nasa.gov/data-access))

Data cost: Free

Data access questions: Email to Help Desk (gsfc-help-disc@lists.nasa.gov)

Science questions: Email to merra-questions@lists.nasa.gov

MERRA-2 Mailing List: Sign up by sending an email to Help Desk to get data and service information

Online Help Documentation:

Data How-to: https://disc.gsfc.nasa.gov/information/howto?keywords=MERRA&page=1 (https://disc.gsfc.nasa.gov/information/howto?keywords=MERRA&page=1)

FAQ: https://disc.gsfc.nasa.gov/information/faqs?keywords=MERRA&page=1 (https://disc.gsfc.nasa.gov/information/faqs?keywords=MERRA-2&page=1)

Data How-to Videos: https://www.youtube.com/user/NASAGESDISC?fs=1&modestbranding=1&rel=0&showinfo=0 (https://www.youtube.com/user/NASAGESDISC?fs=1&modestbranding=1&rel=0&showinfo=0)

Data Searching Rules: https://disc.gsfc.nasa.gov/help#searching (https://disc.gsfc.nasa.gov/help#searching)

MERRA-2 Documentation:

MERRA-2 File Specific https://gmao.gsfc.nasa.gov/pubs/docs/Bosilovich785.pdf (https://gmao.gsfc.nasa.gov/pubs/docs/Bosilovich785.pdf)

MERRA-2 Science Documentation

https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/docs/ (https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/docs/)

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[5] Universities Space Research Association

ABSTRACT

Over 40 years of NASA climate reanalysis datasets from the Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) are available at the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC). In addition to being used in traditional weather and climate research, MERRA-2 is also widely used in application studies of, e.g., wind and solar energy, air quality and health, flood and drought, and heat waves.

Two new MERRA-2 datasets were recently added at the GES DISC: (1) climate statistics derived from MERRA-2 daily data to assist in the analysis of extreme temperature and precipitation events and of large-scale meteorological patterns from 1980 to the present and (2) gridded satellite and conventional observations processed in the MERRA-2 system, along with key statistics derived from the data assimilation, to help better understand how the quality of observations directly affect the reanalysis data.

The GES DISC focuses its efforts on continually improving existing data services and to develop new data tools to satisfy various user communities. The newly added features include the following:

- **Time series service:** This is a new service for MERRA-2 data, which enables the easy and fast access of long-term hourly or daily time series at a location for popular parameters. The data is saved in a single file in Ascii format with a user- friendly structure.
- **New analytic functions in the subsetter interface:** Options for downloading daily minimum and maximum values have been added into the subsetter interface, in addition to the existing daily mean option, for all MERRA-2 and MERRA sub-daily products. Data format conversion to GeoTIFF has been implemented.
- **New variables in Giovanni:** Most monthly variables have been integrated into Giovanni, GES DISC's online visualization and analysis tool. Due to the large data volume, hourly variables were selected based on user requests.
- **More online information:** New MERRA-2 documentation has been added: Data How-To, Data in Action, and FAQ.

This presentation overviews two new MERRA-2 datasets and illustrates the new features of data services through a number of case studies. MERRA-2 data and services can be found at https://disc.gsfc.nasa.gov/datasets?project=MERRA-2 (https://disc.gsfc.nasa.gov/datasets?project=MERRA-2).