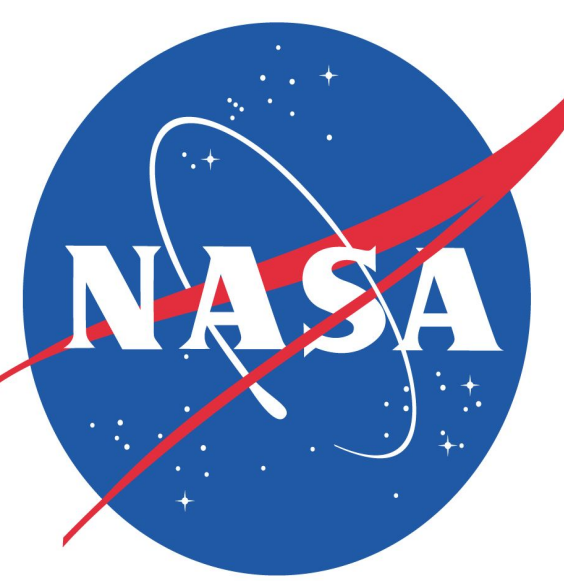




The NASA MERRA-2 Reanalysis Products: Data and Tools Used for Aerosol and Air Quality Studies

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GESDISC



NASA/Goddard EARTH SCIENCES DATA and INFORMATION SERVICES CENTER (GES DISC). Website: <https://disc.gsfc.nasa.gov/>. Contact us at gsfc-dl-help-disc@mail.nasa.gov, xiaohua.pan@nasa.gov

1. Introduction

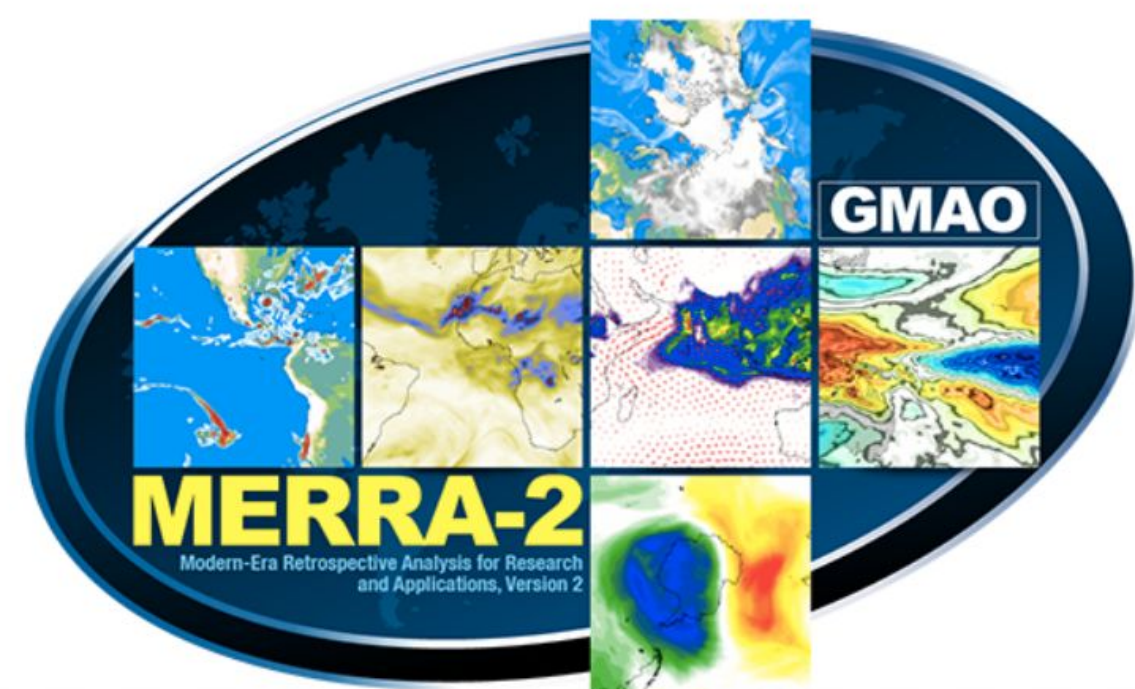
The NASA Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2) is reanalysis data spanning from 1980 to the present. It is produced by the NASA Global Modeling and Assimilation Office (GMAO) and distributed by the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC). MERRA-2 data has 100 collections, including Earth system variables (mainly from an atmospheric model) such as meteorological, radiation, and aerosol fields. MERRA-2 data has been one of the most popular datasets from NASA that are widely used in interdisciplinary research and applications, with a consistently increasing number of users. For example, more than 7000 unique users accessing the MERRA-2 data at GES DISC in 2021.

This presentation will introduce the MERRA-2 data sets associated with aerosol and air quality studies. We will also update the status of the cloud migration of the MERRA-2 data to Amazon Web Services (AWS).

2. MERRA-2 Data

General features:

- Generated by NASA GMAO (<https://gmao.gsfc.nasa.gov/reanalysis/>)
- Archived and curated at NASA GES DISC (<https://disc.gsfc.nasa.gov/>)
- Model Version: 5.12.4
- Total of 100 collections (95 standard collections, 4 derived climate statistical collections, and 1 value-added collection - monthly PM_{2.5} at country level)
- Format: NetCDF4
- Temporal Range: 1980-01-01 to Present
- Temporal Resolution: Hourly, 3-Hourly, Daily, Monthly, and Monthly Diurnal
- Spatial Coverage: Global
- Spatial Resolution:
 - 2D: 0.5° × 0.625°
 - 3D: 0.5° × 0.625° × 72 model levels or 0.5° × 0.625° × 42 pressure levels
- Data Latency: ~3 weeks
- Users: Nearly 7,000 in 2022



New products:

- Monthly PM_{2.5} at country level (read [data release news](#))
- Four version 2 of monthly statistical collections based on 1991-2020 climatology (read [data release news](#))



Products in the AWS Cloud:

- 99 MERRA-2 collections are in AWS US west-2 region as of May 25, 2023. [Earthdata Cloud](#)



Recommendation to users:

- Please cite the dataset DOI when using MERRA-2 data (see example shown below). We collect and promote your paper in our publication database

Global Modeling and Assimilation Office (GMAO) (2022), MERRA-2 statM_2d_edi_Nx: 2d, Single-Level, Monthly Extremes Detection Indices based on 1991-2020 V2, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], 10.5067/O8AX56DO60MI

3. Key MERRA-2 Collections and Variables Useful for Aerosol and Air Quality Studies

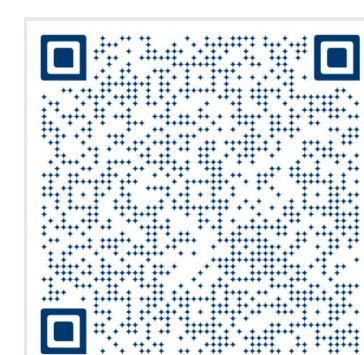
Measurements	Data Collection	Parameters (variable long-name in the collection)	Temporal Feature
Aerosol Optical Depth (AOD)	M2T1NXAER 5.12.4 (i.e., tavg1_2d_aer_Nx)	total aerosol extinction aot [550 nm]	1 hourly averaged
	M2TMNXAER 5.12.4 (i.e., tavgM_2d_aer_Nx)	total aerosol extinction aot [550 nm]	monthly mean
& PM _{2.5}	M2T1NXAER 5.12.4 (i.e., tavg1_2d_aer_Nx)	surface mass concentration of SO ₄ , BC, OC, dust, and sea salt	1 hourly averaged
	M2TMNXAER 5.12.4 (i.e., tavgM_2d_aer_Nx)	surface mass concentration of SO ₄ , BC, OC, dust, and sea salt	monthly mean
@ PM _{1.0} & PM ₁₀	M2I3NVAER 5.12.4 * (i.e., inst3_3d_aer_Nv)	mixing ratio of SO ₄ , BC, OC, dust, and sea salt	3 hourly instantaneous
Carbon Monoxide (CO)	M2T1NXCHM 5.12.4 (i.e., tavg1_2d_chm_Nx)	CO surface concentration	1 hourly averaged
	M2TMNXCHM 5.12.4 (i.e., tavgM_2d_chm_Nx)	CO surface concentration	monthly mean
Meteorological Conditions	M2T1NXSLV 5.12.4 (i.e., tavg1_2d_slv_Nx)	wind, specific humidity, air temperature at 2-meter, 10-meter, 850 hPa	1 hourly averaged
	M2TMNXSLV 5.12.4 (i.e., tavgM_2d_slv_Nx)	wind, specific humidity, air temperature at 2-meter, 10-meter, 850 hPa	monthly mean
	M2T1NXFLX 5.12.4 (i.e., tavg1_2d_slv_Nx)	PBL height, precipitation	1 hourly averaged
	M2TMNXFLX 5.12.4 (i.e., tavgM_2d_slv_Nx)	PBL height, precipitation	monthly mean
	M2T3NVASM 5.12.4 * (i.e., tavg3_3d_asm_Nv)	wind, relative humidity, air temperature, pressure, height at model levels	3 hourly averaged

& Surface PM_{2.5} can be derived by variables listed in that collection:
TOTSPM25 = OCSMASS+ BCMASS+ SO4MASS*1.375+ DUSMASS25 + SSSMASS25.
@ PM_{1.0} and PM₁₀ the formula can be found at the MERRA-2 project [FAQ](#) .
* In 3D (the rest collections in this table are in 2D).

4. GES DISC Data Services and User Support

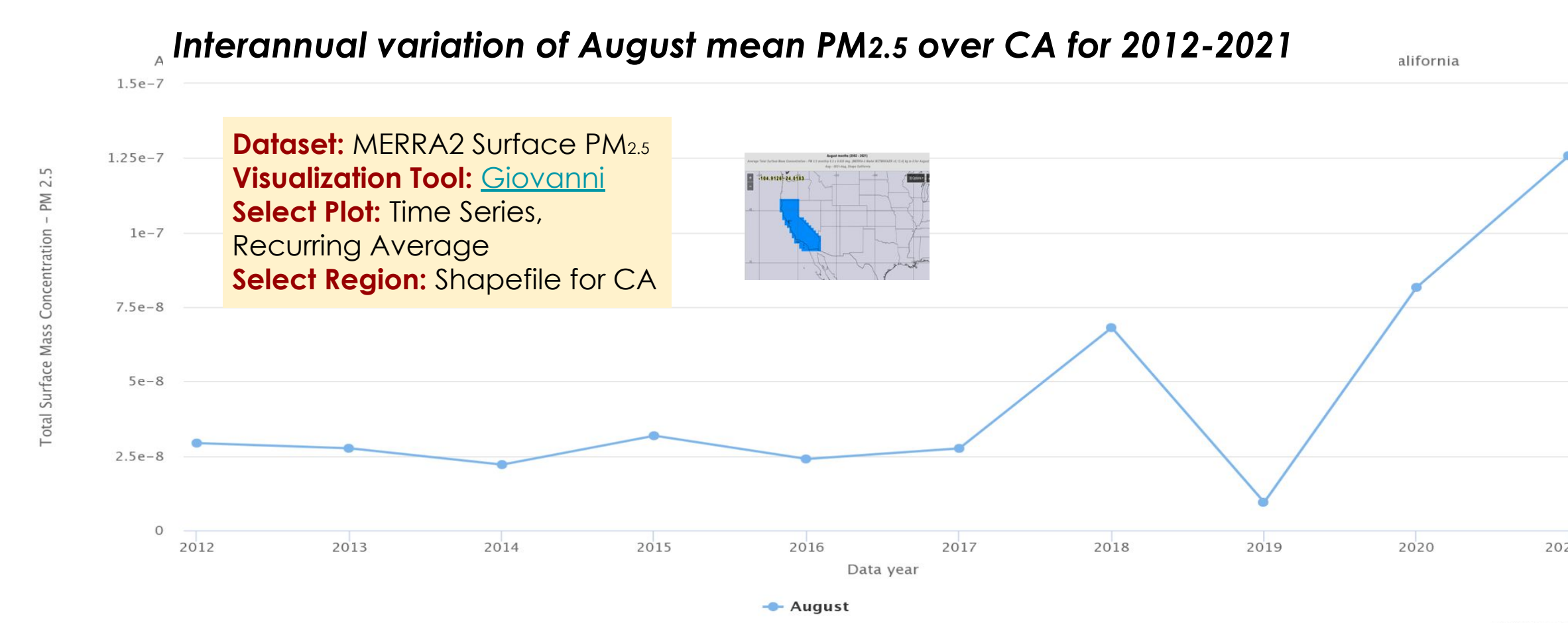
Value-added services for data

- Giovanni
- Subsetting, reformatting, and regridding
- [Cloud dashboard](#)



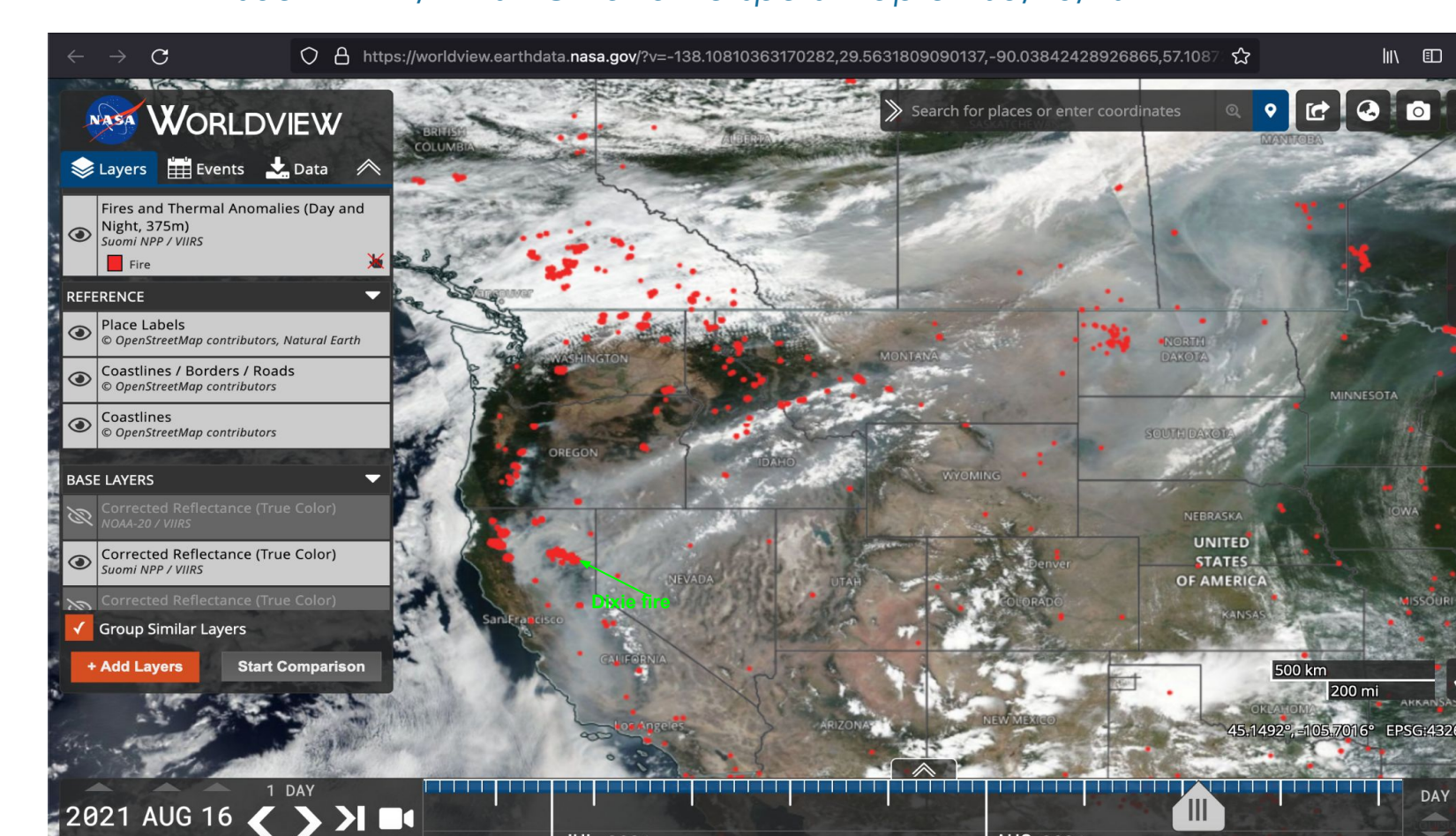
Multi-tiered user support

- GES DISC Help Desk: Contact us at gsfc-dl-help-disc@mail.nasa.gov
- Forum: forum.earthdata.nasa.gov
- Social Media Platform (e.g., Twitter @NASAEarthdata, and Youtube [NASA Earthdata channel](#))

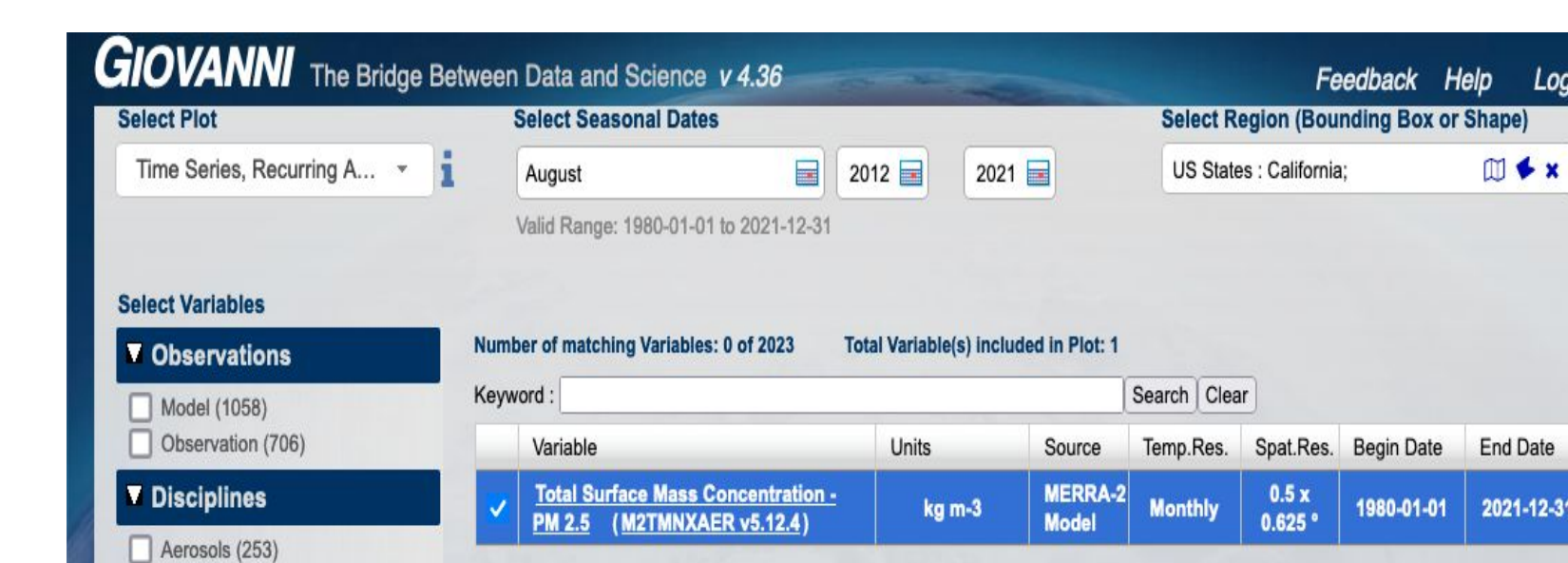


Case Study with Giovanni

Suomi NPP/VIIRS RGB and Hotspots Map on 08/16/2021



Screenshot from NASA [Worldview](#)



Documentation:

- MERRA-2 Project Page

Data How-to:

- How to remotely access MERRA-2 with Python3 and calculate monthly average surface PM_{2.5} for world countries ([link](#))
- How to Use the Web Services API for Subsetting MERRA-2 Data - revised ([link](#))
- How to Access MERRA-2 Data using OPeNDAP with Python3 and Calculate Daily/Weekly/Monthly Statistics from Hourly Data ([link](#))
- How to Compile Your Own Variable List from Multiple GES DISC's Products using My Dashboard ([link](#))
- How to Directly Access MERRA-2 Data from an S3 Bucket with Python from a Cloud Environment ([link](#))

Data Tutorial:

- ARSET training, "Tools for Analyzing NASA Air Quality Model Output", showing how to search for MERRA-2 variables and documents on the GES DISC website, and demonstrating how to use data tools for the MERRA-2 data such as Giovanni and the Level 3 and Level 4 subsetter (Part 1 of the training series)

