

# Trace Gas Data Access & Analysis

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NASA Air Quality Remote Sensing Training for EPA, March 21-23, 2023

# Learning Objectives

By the end of this exercise, you will be:

- Able to download Level 2 data using NASA Earthdata Search
- Able to perform online Level 3 data analysis and plot figures in NASA Giovanni
- Familiar with proxy datasets for the upcoming TEMPO mission

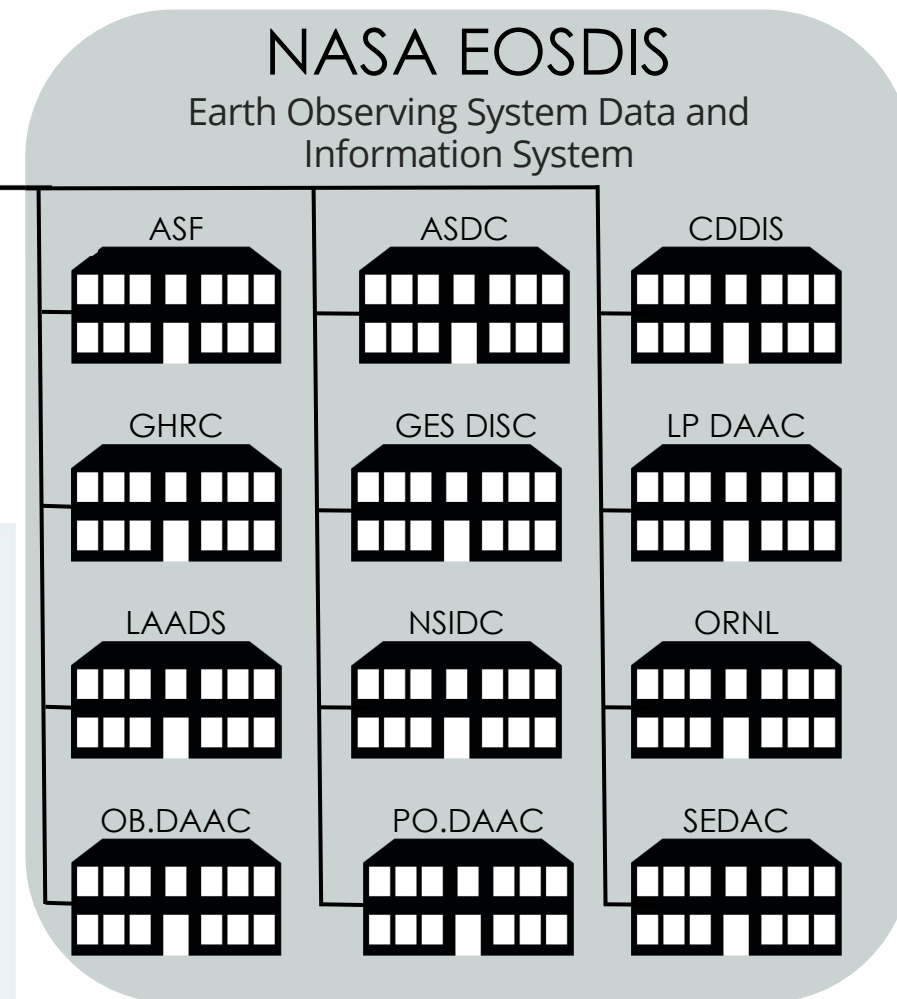
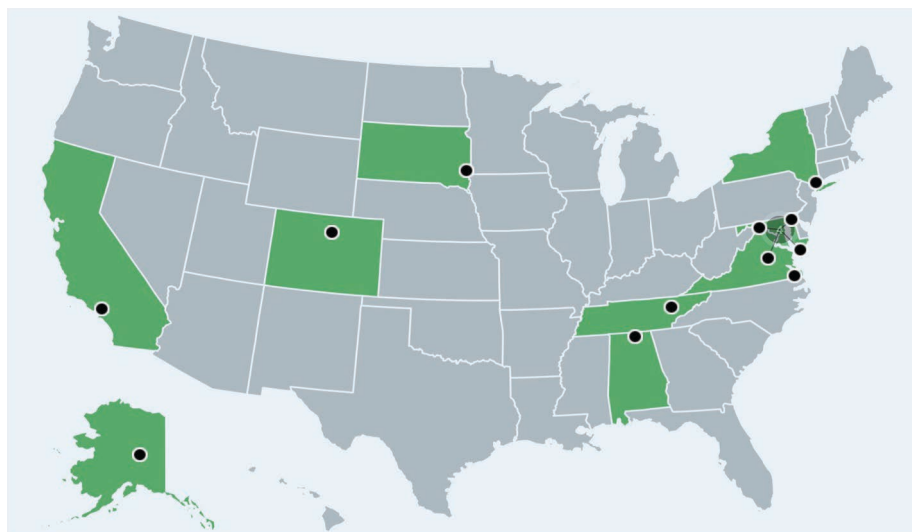
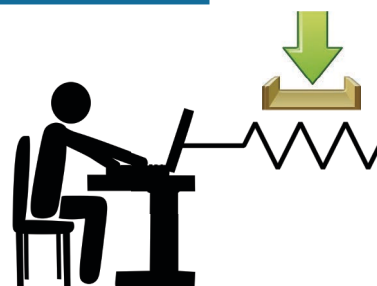


# Where the Data Live: EOSDIS & the NASA DAACs

## NASA EOSDIS Distributed Active Archive Centers (DAAC)

<https://www.earthdata.nasa.gov/eosdis/daacs>

- Download data from any DAAC's webpage.
- DAACs may share common services and tools, or host unique ones.
- Common Metadata Repository (CMR) allows API-enabled queries across all DAACs.

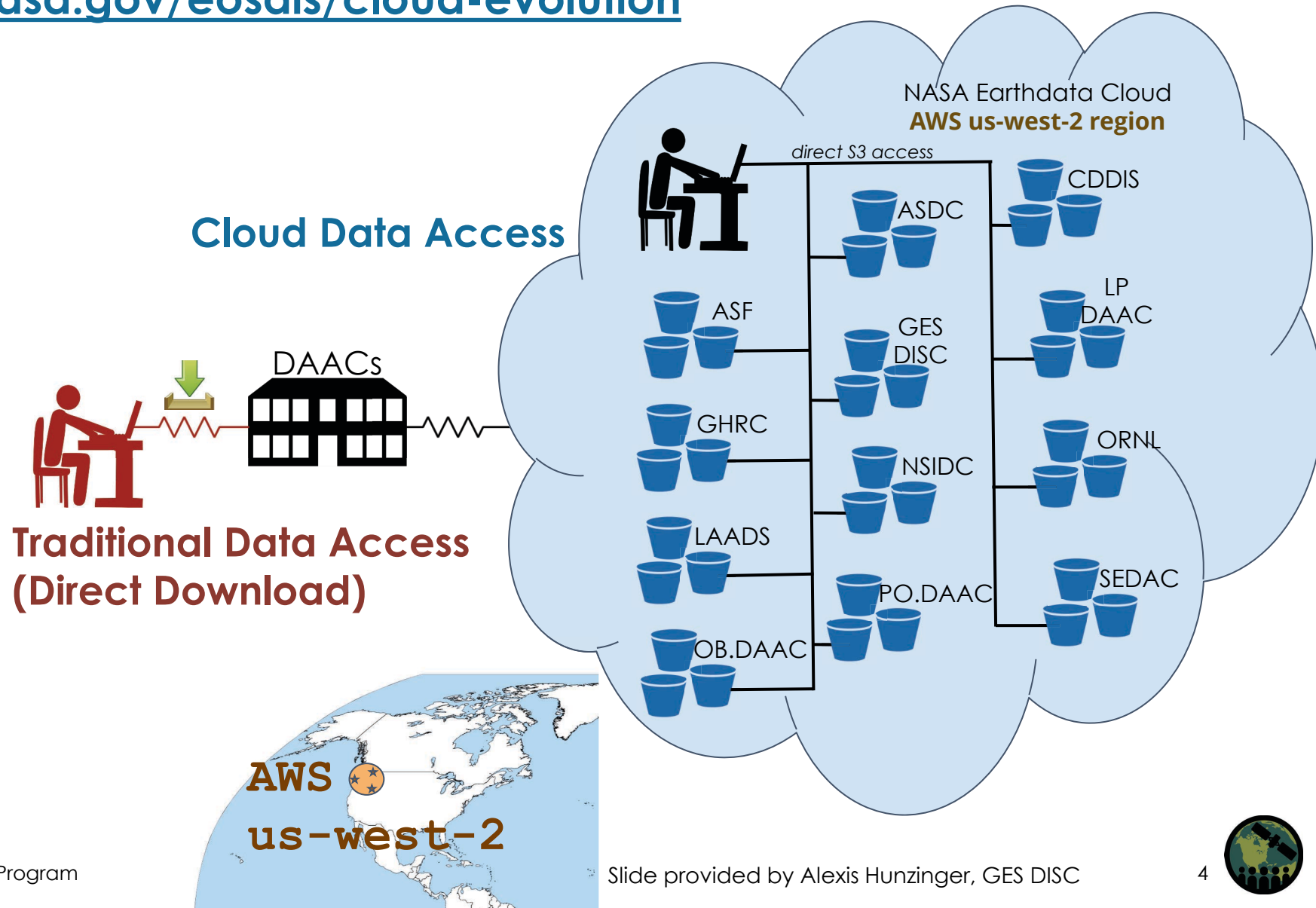




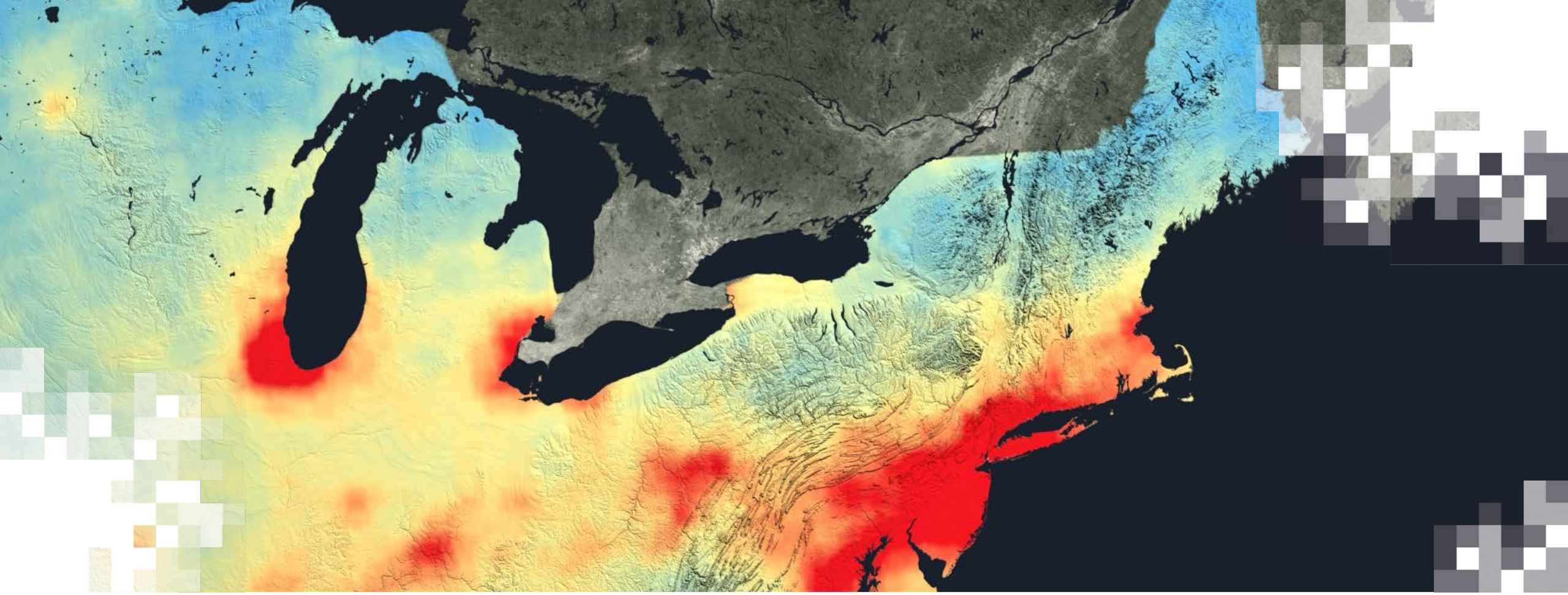
# Remote Data Access with the Earthdata Cloud

<https://www.earthdata.nasa.gov/eosdis/cloud-evolution>

- DAAC data holdings are all in the AWS us-west-2 region.
- DAACs store data in their own S3 buckets within this region.
- Combining cloud computing with cloud storage can make large-scale data analysis more efficient.





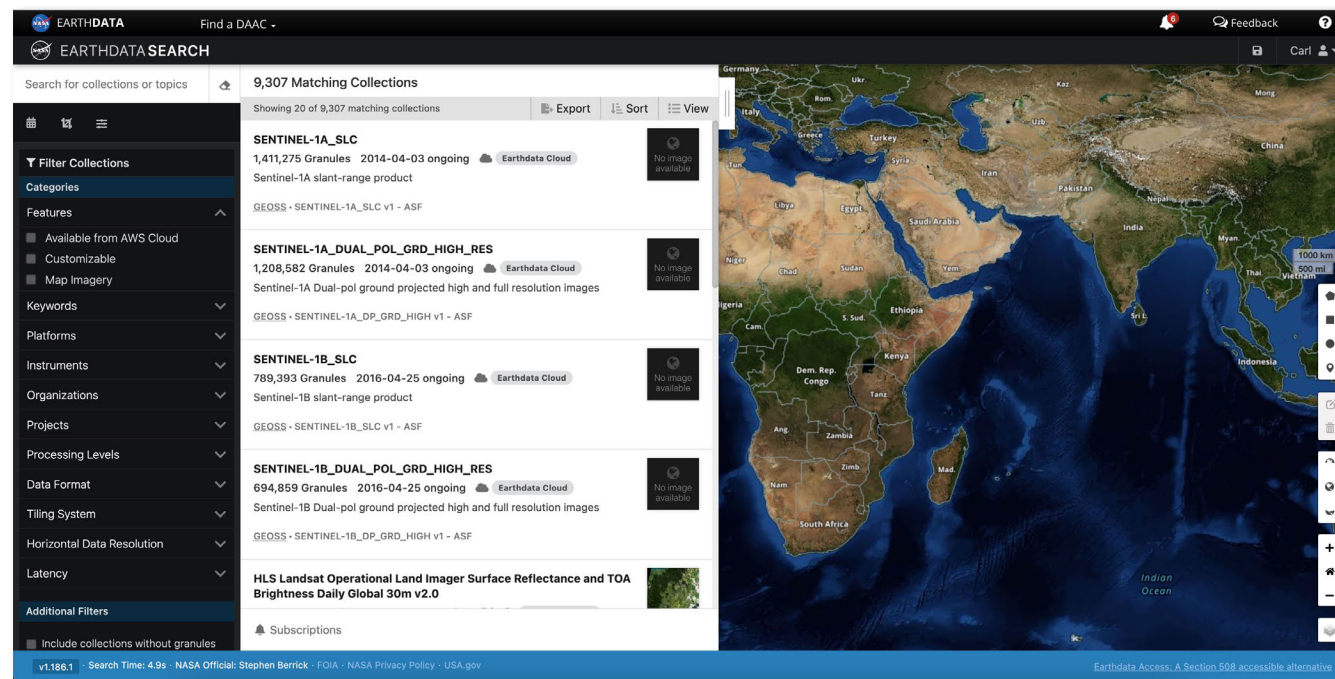


NASA Earthdata

# NASA Earthdata Search

<https://search.earthdata.nasa.gov/search>

- A “one stop shop” for searching and downloading NASA Earth datasets
  - Filter & Search data products by keyword, instrument, processing level, etc.
  - Subset datasets in space and time
  - Generate lists of file names for download



The screenshot displays the NASA Earthdata Search web application. The interface includes a search bar at the top with the text "Find a DAAC" and "EARTHDATA SEARCH". Below the search bar, it indicates "9,307 Matching Collections" and "Showing 20 of 9,307 matching collections". The results are listed in a table-like format with columns for collection name, granule count, date, and availability. The first four results are Sentinel-1A and Sentinel-1B datasets, each with a "No image available" icon. The fifth result is the HLS Landsat Operational Land Imager Surface Reflectance and TOA Brightness Daily Global 30m v2.0, which has a small satellite image icon. A sidebar on the left contains filter options such as "Filter Collections", "Categories", "Features", "Keywords", "Platforms", "Instruments", "Organizations", "Projects", "Processing Levels", "Data Format", "Tiling System", "Horizontal Data Resolution", "Latency", and "Additional Filters". The bottom of the page shows the version "v1.186.1", search time "4.9s", and NASA contact information. A map of the world is visible on the right side of the interface.





# Earthdata Controls

Help /Info

The screenshot shows the Earthdata search interface with several key components highlighted:

- Keyword Search:** Located at the top left, it includes a search bar and a "Find a DAAC" dropdown menu.
- Search Filters:** A sidebar on the left containing "Filter Collections" with categories, features, keywords, and platforms.
- Temporal/Spatial Subsetting:** A central box highlighting the search results list, which includes details like "9,338 Matching Collections" and "Showing 24 items per page".
- Details on Available Datasets:** A box highlighting a specific dataset entry: "SENTINEL-1B\_SLC" with 789,393 granules, dated 2016-04-25, and a description of the slant-range product.
- Map:** A satellite map of the Middle East and surrounding regions, used for spatial subsetting.
- Map Controls:** A vertical toolbar on the right side of the map, including icons for home, full screen, subsetting, edit/delete, projection, zoom, and layer options.
- Save & Access Past Searches:** A button in the top right corner.
- Login to Earthdata Account:** A button in the top right corner, next to the user name "Carl".



# Step 1: Find Collection

The screenshot displays the EarthData Search interface. At the top, it says "EARTHDATA SEARCH" and "Find a DAAC". Below this, there's a search bar and a list of 39 matching collections. The first collection is "Global Fire Emissions Database, Version 4.1 (GFEDv4)" with 5,952 granules from 1995-06-01 to 2016-12-31. The second is "ATom: L2 In Situ Measurements from NOAA Nitrogen Oxides and Ozone (NOyO3) Instrument" with 192 granules from 2016-07-29 to 2018-05-21. The third is "ATom: Global Modeling Initiative (GMI) Chemical Transport Model (CTM) Output" with 96 granules from 2016-07-29 to 2018-05-21. The fourth is "ATom: Simulated Data Stream for Modeling ATom-like Measurements" with 66 granules from 1997-08-01 to 2016-08-21. On the left, a sidebar titled "Filter Collections" shows various categories and features. The "Keywords" section is highlighted with a yellow box, showing a list of filters with "3 Selected" items: Atmosphere, Air Quality, and Nitrogen Oxides. A yellow callout box with the text "Keyword Filters e.g., Atmosphere > Air Quality > Nitrogen Oxides" points to these filters. The right side of the interface shows a satellite map of the Indian Ocean region with various countries labeled.



# Step 1: Find Collection

The screenshot displays the NASA Earthdata Search interface. At the top, the search bar contains 'EARTHDATA SEARCH' and 'Find a DAAC'. Below the search bar, there are 30 matching collections listed. The first collection is 'ATom: L2 In Situ Measurements from NOAA Nitrogen Oxides and Ozone (NOyO3) Instrument', which has 192 granules and covers the period from 2016-07-29 to 2018-05-21. The second collection is 'ATom: Global Modeling Initiative (GMI) Chemical Transport Model (CTM) Output', with 96 granules and the same time period. The third collection is 'DISCOVER-AQ California Deployment San Joaquin Valley Air Pollution Control District Ground Site Data', with 30 granules and a time period from 2013-08-29 to 2013-10-01. The fourth collection is 'DISCOVER-AQ Texas Deployment Galveston Ground Site Data', with 30 granules and the same time period. A yellow box highlights the 'Processing Levels' section on the left, which shows a list of processing levels: 1A - Radiance (1), 2 - Geophys. Variables, Senso... (30), 3 - Gridded Observations (6), and 4 - Gridded Model Output (2). A yellow box also highlights the text 'Additional Filters e.g., Processing Level' overlaid on the search results. The right side of the interface shows a map of the world with a scale bar indicating 1000 km and 500 mi. The bottom of the interface shows the version number 'v1.188.0', search time '3.0s', and various links including 'NASA Official: Stephen Berrick', 'FOIA', 'NASA Privacy Policy', and 'USA.gov'. The footer of the slide contains the text 'NASA's Applied Remote Sensing Training Program' and the number '9'.





# Step 1: Find Collection

The screenshot displays the Earthdata Search interface. At the top, the search bar contains the text "S5P\_L2\_NO2". A yellow box highlights the search bar and the text "Topic Search (name of data product if known)". Below the search bar, the results are listed under the heading "Showing 3 of 3 matching collections".

**Search Results:**

- Collection 1:** Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V2 (S5P\_L2\_\_NO2\_\_HiR) at GES DISC. 8,607 Granules. 2018-04-30 ongoing.
- Collection 2:** Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V1 (S5P\_L2\_\_NO2\_\_HiR) at GES DISC. 9,849 Granules. 2019-08-06 to 2021-07-01.
- Collection 3:** Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 7km x 3.5km V1 (S5P\_L2\_\_NO2\_\_) at GES DISC. 6,480 Granules. 2018-04-30 to 2019-08-06.

The interface also includes a left sidebar with filter options such as "Filter Collections", "Categories", "Features", "Keywords", "Platforms", "Instruments", "Organizations", "Projects", "Processing Levels", "Data Format", "Tiling System", "Horizontal Data Resolution", "Latency", and "Additional Filters". A map of the Indian Ocean region is visible on the right side of the interface.





# Step 2: Choose Collection(s)

The screenshot displays the Earthdata Search interface. At the top, the NASA Earthdata logo and search bar are visible. The search results show 3 matching collections for the query 'S5P\_L2\_NO2'. The first collection is 'Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V2 (S5P\_L2\_NO2\_\_\_V2) at GES DISC', which is highlighted as a 'Cloud-Enabled Dataset'. The second collection is 'Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V1 (S5P\_L2\_NO2\_\_\_V1) at GES DISC', with an annotation pointing to its information icon and a plus sign button labeled 'Add Collection'. The third collection is 'Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 7km x 3.5km V1 (S5P\_L2\_NO2\_\_\_) at GES DISC'. A sidebar on the left contains various filters such as 'Filter Collections', 'Categories', 'Features', 'Keywords', 'Platforms', 'Instruments', 'Organizations', 'Projects', 'Processing Levels', 'Data Format', 'Tiling System', 'Horizontal Data Resolution', 'Latency', and 'Additional Filters'. A map of the Indian Ocean region is shown on the right side of the interface.



# Step 2: Choose Collection(s)

**Search Results (3 Collections)** → **Back to Search**

**Data Set Landing Page** → **DAAC Website (GES DISC)**

**More Information About Collection**

**Search Results:** Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V2 (S5P\_L2\_NO2\_\_HiR) at GES DISC

**Granules:** Showing 5 of 8,607 matching granules

Granule ID	START	END
S5P_L2_NO2__HiR.2:S5P_OFFL_L2_NO2__20230228T222010_20230301T000140_27872_03_020400_20230302T140715.nc	2023-02-28 22:41:44	2023-02-28 23:40:08
S5P_L2_NO2__HiR.2:S5P_OFFL_L2_NO2__20230228T203839_20230228T222010_27871_03_020400_20230302T123114.nc	2023-02-28 21:00:14	2023-02-28 21:58:37
S5P_L2_NO2__HiR.2:S5P_OFFL_L2_NO2__20230228T185709_20230228T203839_27870_03_020400_20230302T111438.nc	2023-02-28 19:18:43	2023-02-28 20:17:07
S5P_L2_NO2__HiR.2:S5P_OFFL_L2_NO2__20230228T171539_20230228T185709_27869_03_020400_20230302T092956.nc	2023-02-28 17:37:14	2023-02-28 18:35:37

**Collection Details:** S5P\_L2\_NO2\_\_HiR | Version 2 | DOI: 10.5270/S5P-9bnp8q8

**Related URLs:** [Data Set Landing Page](#) | [View More Info](#)

**Temporal Extent:** 2018-04-30 ongoing

**Native Format:** netCDF

**Reformatting Options:** HDF5 → NETCDF-4 | NETCDF-4 → NETCDF-4

**GIBS Imagery Projection Availability:** None

**Science Keywords:** EARTH SCIENCE | ATMOSPHERE | ATMOSPHERIC CHEMISTRY

**For Developers:** [Expandable section]





# Step 2: Choose Collection(s)

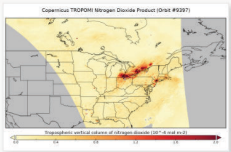
The screenshot shows the top navigation bar of the NASA Earthdata GES DISC website. It includes the NASA logo, the text 'EARTHDATA', a search bar with the placeholder 'Find a DAAC', and a 'Data Collections' dropdown menu. The main header features the 'GES DISC' logo and a search input field with the placeholder 'Enter search (e.g., rainfall, GPM, TRMM\_3B42)'. Navigation links for 'Feedback', 'Cloud Migration', and 'Help' are present, along with a 'Login' button and a 'My Dashboard' link. A blue announcement banner at the bottom reads 'Announcement: NASA's Terra, Aqua, and Aura Data Continuity Workshop RFI'.


Product Summary

**Copernicus Sentinel-5 Precursor**  
**Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km (S5P\_L2\_NO2\_HiR)**

Starting from August 6th in 2019, Sentinel-5P TROPOMI along-track high spatial resolution (~5.5km at nadir) has been implemented. For data before August 6th of 2019, please check S5P\_L2\_NO2\_\_1 data collection.

The Copernicus Sentinel-5 Precursor (Sentinel-5P or S5P) satellite mission is one of the European Space Agency's (ESA) new mission family - Sentinels, and it is a joint initiative between the Kingdom of the Netherlands and the ESA. The sole payload on Sentinel-5P is the TROPospheric Monitoring Instrument (TROPOMI), which is a nadir-viewing 108 degree Field-of-View push-broom grating hyperspectral spectrometer, covering the wavelength of ultraviolet-visible (UV-VIS, 270nm to 495nm), near infrared (NIR, 675nm to 775nm), and shortwave infrared (SWIR, 2305nm-2385nm). Sentinel-5P is the first of the Atmospheric Composition Sentinels and is expected to provide measurements of ozone, NO2, SO2, CH4, CO, formaldehyde, aerosols and cloud at high spatial, temporal and spectral resolutio ...more

 [View Full-size Image](#)

 **Cloud Enabled**

**Data Access**

- [Online Archive](#)
- [Earthdata Search](#)
- [OPENDAP](#)
- [Subset / Get Data](#)

Access Options via DAAC

Product Summary | Variables | Data Citation | Documentation | References | Data Calendar

**Shortname:** S5P\_L2\_NO2\_\_HiR  
**Longname:** Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km  
**DOI:** 10.5270/S5P-9bnp8q8  
**Version:** 2  
**Format:** netCDF  
**Spatial Coverage:** -180.0,-90.0,180.0,90.0  
**Temporal Coverage:** 2021-07-01 to 2023-02-28  
**File Size:** 437 MB per file  
**Data Resolution**  
**Spatial:** 5.5 km x 3.5 km

Additional Product Details and Documentation





# Step 3: Subset Collections by Time

**EARTHDATA SEARCH**

Search Results (3 Collections)

Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V2 (S5P\_L2\_NO2\_HiR) at GES DISC

**Choose Start and End Times  
Click "Apply"**

**Start** 2022-03-20 00:00:00 **End** 2022-03-24 23:59:59

Recurring?

**Apply** **Clear**

**Cloud Access**

Available for access in-region with AWS Cloud

Region  
**us-west-2**

Bucket/Object Prefix  
**s3://gesdisc-cumulus-prod-protected/S5P\_TROPOMI\_Level2/S5P\_L2\_NO2\_HiR.2/**

AWS S3 Credentials  
[Get AWS S3 Credentials](#) | [Documentation](#)

**You might also be interested in...**

Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V1 (S5P\_L2\_NO2\_HiR) at GES DISC

Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 7km x 3.5km V1 (S5P\_L2\_NO2\_) at GES DISC

For Developers

v1.188.0 · NASA Official: Stephen Berrick · FOIA · NASA Privacy Policy · USA.gov

Earthdata Access: A Section 508 accessible alternative



# Step 4: Subset Collections by Space

**EARTHDATA SEARCH**

Find a DAAC

My Project Carl

S5P\_L2\_NO2

Search Results (1 Collection)

Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V2 (S5P\_L2\_NO2\_\_\_HiR) at GES DISC

**Spatial Subsetting Options**

- Rectangle
- Point
- Circle
- Polygon
- Upload Shapefile

**Intersecting Data Granules**

**Search Domain**

**Additional Controls**

Showing 5 of 8 matching granules

Granule ID	START	END
S5P_L2_NO2___HiR.2:S5P_OFFL_L2_NO2___20220324T171106_20220324T185236_23031_02_020301_20220326T090606.nc	2022-03-24 17:32:41	2022-03-24 18:31:04
S5P_L2_NO2___HiR.2:S5P_OFFL_L2_NO2___20220323T173001_20220323T191131_23017_02_020301_20220325T092619.nc	2022-03-23 17:51:35	2022-03-23 18:49:59
S5P_L2_NO2___HiR.2:S5P_OFFL_L2_NO2___20220322T174856_20220322T193026_23003_02_020301_20220324T094909.nc	2022-03-22 18:10:30	

NETCDF-4 → NETCDF-4

GIBS Imagery Projection Availability: None

Science Keywords: EARTH SCIENCE, ATMOSPHERE, ATMOSPHERIC CHEMISTRY

For Developers

v1.188.0 · NASA Official: Stephen Berrick · FOIA · NASA Privacy Policy · USA.gov

Earthdata Access: A Section 508 accessible alternative





# Step 5: Examine Selected Collections in Project

The screenshot displays the EarthData Search interface. On the left, there are filters for Spatial (Rectangle) and Temporal (Start: 2022-03-20 00:00:00, Stop: 2022-03-24 23:59:59). The main panel shows search results for "Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V2 (S5P\_L2\_NO2\_\_\_HIR) at GES DISC". Below this, there are links for "Data Set Landing Page", "User's Guide", and "View All Related URLs". The "Temporal Extent" is listed as "2018-04-30 ongoing". The "Native Format" is "netCDF", and "Reformatting Options" include "HDF5 -> NETCDF-4" and "NETCDF-4 -> NETCDF-4". The "Science Keywords" are "EARTH SCIENCE", "ATMOSPHERE", and "ATMOSPHERIC CHEMISTRY". A world map is shown at the bottom of the results panel. On the right, a satellite imagery map of the Americas is displayed with a green grid overlay. A callout box with an orange border and text says: "Select 'My Project' once all desired Collections have been added." The "My Project" button is highlighted in the top right corner of the interface. The bottom of the page shows the version "v1.188.0" and links to "NASA Official: Stephen Berrick", "FOIA", "NASA Privacy Policy", and "USA.gov". The footer text reads "Earthdata Access: A Section 508 accessible alternative".





# Step 5: Examine Selected Collections in Project

The screenshot displays the Earthdata Search interface for a selected data collection. The interface includes a search bar at the top, a summary of the selected data, and two main configuration sections: '1 Select a data access method' and '2 Configure data customization options'. A map of the United States is visible in the background, overlaid with a green grid representing the data collection's spatial extent. A timeline at the bottom shows the data's temporal coverage from October 2022 to January 2023.

**Summary of the Selected Data**

**1 Select a data access method**  
The selected access method will determine which customization and output options are available.

- Customize** Harmony  
Select options like variables, transformations, and output formats for in-region cloud access.  
More Info
- Direct Download**  
Direct download of all data associated with the selected granules.  
More Info

**2 Configure data customization options**  
Edit the options below to configure the customization and output options for the selected data product.

No customization options are available for the selected access method.

**Download Data**

**Download Selected Data**

**Add a project title and save for future reference.**

**Return to Search**

**Data Access Options (If Available)**

**Data Post-Processing Options (If Available)**



# Step 6: Download Data

**Download Status**

This page will automatically update as your orders are processed. The Download Status page can be accessed later by visiting <https://search.earthdata.nasa.gov/downloads/6376548243> or the [Download Status and History](#) page.

**Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V2 (S5P\_L2\_\_NO2\_\_HiR) at GES DISC**

Status	Access Method	Granules
Complete (100%)	Download	8 Granules

Download your data directly from the links below, or use the provided download script.

Download Files    AWS S3 Access    Download Script

Retrieved 8 files for 8 granules

100%

Copy    Save    Expand

- [https://data.gesdisc.earthdata.nasa.gov/data/S5P\\_TROPOMI\\_Level2/S5P\\_L2\\_\\_NO2\\_\\_HiR.2/2022/083/S5P\\_OFFL\\_L2\\_\\_NO2\\_\\_20220](https://data.gesdisc.earthdata.nasa.gov/data/S5P_TROPOMI_Level2/S5P_L2__NO2__HiR.2/2022/083/S5P_OFFL_L2__NO2__20220)
- [https://data.gesdisc.earthdata.nasa.gov/data/S5P\\_TROPOMI\\_Level2/S5P\\_L2\\_\\_NO2\\_\\_HiR.2/2022/082/S5P\\_OFFL\\_L2\\_\\_NO2\\_\\_20220](https://data.gesdisc.earthdata.nasa.gov/data/S5P_TROPOMI_Level2/S5P_L2__NO2__HiR.2/2022/082/S5P_OFFL_L2__NO2__20220)
- [https://data.gesdisc.earthdata.nasa.gov/data/S5P\\_TROPOMI\\_Level2/S5P\\_L2\\_\\_NO2\\_\\_HiR.2/2022/081/S5P\\_OFFL\\_L2\\_\\_NO2\\_\\_20220](https://data.gesdisc.earthdata.nasa.gov/data/S5P_TROPOMI_Level2/S5P_L2__NO2__HiR.2/2022/081/S5P_OFFL_L2__NO2__20220)
- [https://data.gesdisc.earthdata.nasa.gov/data/S5P\\_TROPOMI\\_Level2/S5P\\_L2\\_\\_NO2\\_\\_HiR.2/2022/081/S5P\\_OFFL\\_L2\\_\\_NO2\\_\\_20220](https://data.gesdisc.earthdata.nasa.gov/data/S5P_TROPOMI_Level2/S5P_L2__NO2__HiR.2/2022/081/S5P_OFFL_L2__NO2__20220)
- [https://data.gesdisc.earthdata.nasa.gov/data/S5P\\_TROPOMI\\_Level2/S5P\\_L2\\_\\_NO2\\_\\_HiR.2/2022/080/S5P\\_OFFL\\_L2\\_\\_NO2\\_\\_20220](https://data.gesdisc.earthdata.nasa.gov/data/S5P_TROPOMI_Level2/S5P_L2__NO2__HiR.2/2022/080/S5P_OFFL_L2__NO2__20220)
- [https://data.gesdisc.earthdata.nasa.gov/data/S5P\\_TROPOMI\\_Level2/S5P\\_L2\\_\\_NO2\\_\\_HiR.2/2022/080/S5P\\_OFFL\\_L2\\_\\_NO2\\_\\_20220](https://data.gesdisc.earthdata.nasa.gov/data/S5P_TROPOMI_Level2/S5P_L2__NO2__HiR.2/2022/080/S5P_OFFL_L2__NO2__20220)
- [https://data.gesdisc.earthdata.nasa.gov/data/S5P\\_TROPOMI\\_Level2/S5P\\_L2\\_\\_NO2\\_\\_HiR.2/2022/079/S5P\\_OFFL\\_L2\\_\\_NO2\\_\\_20220](https://data.gesdisc.earthdata.nasa.gov/data/S5P_TROPOMI_Level2/S5P_L2__NO2__HiR.2/2022/079/S5P_OFFL_L2__NO2__20220)
- [https://data.gesdisc.earthdata.nasa.gov/data/S5P\\_TROPOMI\\_Level2/S5P\\_L2\\_\\_NO2\\_\\_HiR.2/2022/079/S5P\\_OFFL\\_L2\\_\\_NO2\\_\\_20220](https://data.gesdisc.earthdata.nasa.gov/data/S5P_TROPOMI_Level2/S5P_L2__NO2__HiR.2/2022/079/S5P_OFFL_L2__NO2__20220)

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Earthdata Access: A Section 508 accessible alternative

Return to Project Summary

Copy/Save List of Links

Click Links for Direct Download





# Step 6: Download Data

**EARTHDATA** Find a DAAC Feedback Back to Project Carl

## Download Status

This page will automatically update as your orders are processed. The Download Status page can be accessed later by visiting <https://search.earthdata.nasa.gov/downloads/6376548243> or the [Download Status and History](#) page.

**Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V2 (S5P\_L2\_NO2\_\_\_HiR) at GES DISC**

Status: **Complete (100%)** Download 8 Granules

Download your data directly from the links below, or use the provided download script.

Download Files: **AWS S3 Access** | Download Script

Direct cloud access for this collection is available in the us-west-2 region in AWS S3.

Region	Bucket/Object Prefix
us-west-2	s3://gesdisc-cumulus-prod-protected/S5P_TROPOMI_Level2/S5P_L2_NO2___HiR.2/

AWS S3 Credentials  
[Get AWS S3 Credentials](#) | [View Documentation](#)

Retrieved 8 objects for 8 granules

```
s3://gesdisc-cumulus-prod-protected/S5P_TROPOMI_Level2/S5P_L2_NO2___HiR.2/2022/083/S5P_OFFL_L2_NO2___20220324T1
s3://gesdisc-cumulus-prod-protected/S5P_TROPOMI_Level2/S5P_L2_NO2___HiR.2/2022/082/S5P_OFFL_L2_NO2___20220323T1
s3://gesdisc-cumulus-prod-protected/S5P_TROPOMI_Level2/S5P_L2_NO2___HiR.2/2022/081/S5P_OFFL_L2_NO2___20220322T1;
s3://gesdisc-cumulus-prod-protected/S5P_TROPOMI_Level2/S5P_L2_NO2___HiR.2/2022/081/S5P_OFFL_L2_NO2___20220322T1f
s3://gesdisc-cumulus-prod-protected/S5P_TROPOMI_Level2/S5P_L2_NO2___HiR.2/2022/080/S5P_OFFL_L2_NO2___20220321T1f
s3://gesdisc-cumulus-prod-protected/S5P_TROPOMI_Level2/S5P_L2_NO2___HiR.2/2022/080/S5P_OFFL_L2_NO2___20220321T1f
s3://gesdisc-cumulus-prod-protected/S5P_TROPOMI_Level2/S5P_L2_NO2___HiR.2/2022/079/S5P_OFFL_L2_NO2___20220320T1f
```



# Step 6: Download Data

**EARTHDATA** Find a DAAC Feedback 4 Carl

**EARTHDATA SEARCH** Back to Project

## Download Status

This page will automatically update as your orders are processed. The Download Status page can be accessed later by visiting <https://search.earthdata.nasa.gov/downloads/6376548243> or the [Download Status and History](#) page.

**Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 5.5km x 3.5km V2 (S5P\_L2\_NO2\_HIR) at GES DISC**

Status	Access Method	Granules
<span>Complete (100%)</span>	Download	8 Granules

Download your data directly from the links below, or use the [provided download script](#).

[Download Files](#) [AWS S3 Access](#) **[Download Script](#)**

**Linux:** You must first make the script an executable by running the line 'chmod 777 download.sh' from the command line. After that is complete, the file can be executed by typing './download.sh'. For a detailed walk through of this process, please reference this [How To guide](#).

**Windows:** The file can be executed within Windows by first installing a Unix-like command line utility such as [Cygwin](#). After installing Cygwin (or a similar utility), run the line 'chmod 777 download.sh' from the utility's command line, and then execute by typing './download.sh'.

*Retrieved 8 files for 8 granules*

```
#!/bin/bash

GREP_OPTIONS=''

cookiejar=$(mktemp cookies.XXXXXXXXXX)
netrc=$(mktemp netrc.XXXXXXXXXX)
chmod 0600 "$cookiejar" "$netrc"
function finish {
  rm -rf "$cookiejar" "$netrc"
}

# Additional script content would follow here
```

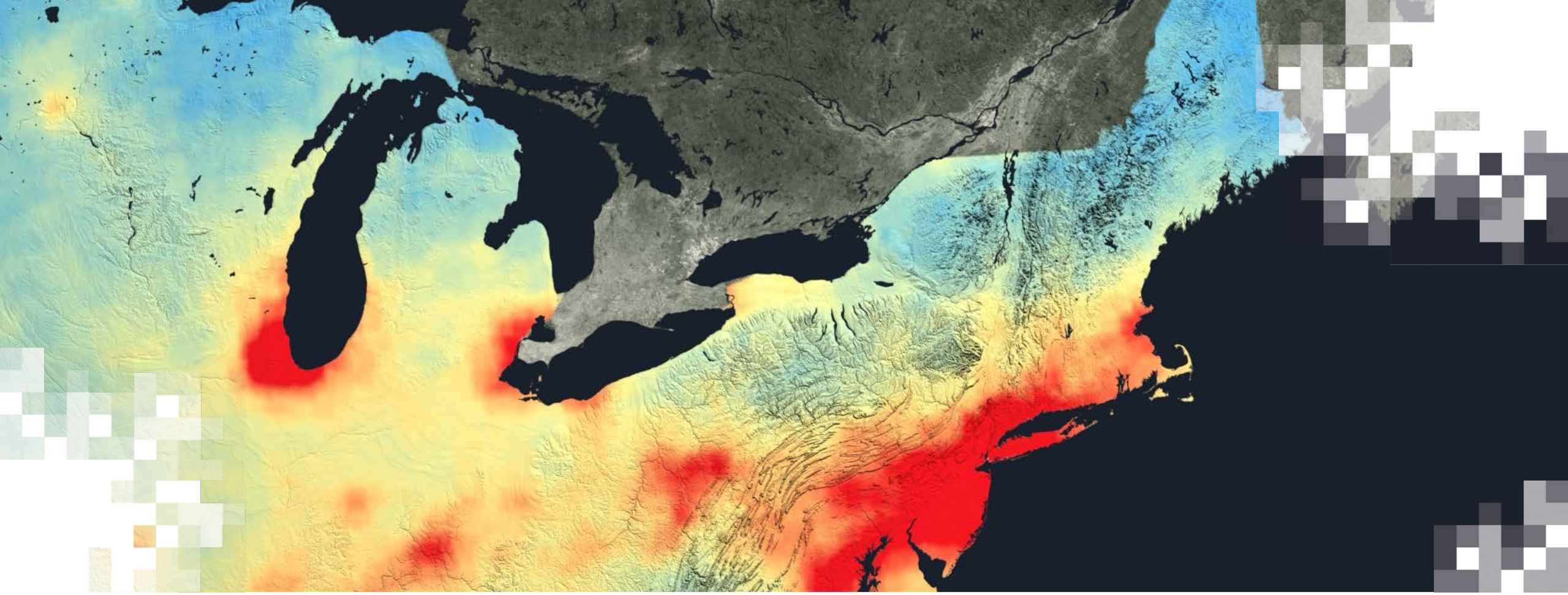
v1.188.0 · NASA Official: Stephen Berrick · FOIA · NASA Privacy Policy · USA.gov Earthdata Access: A Section 508 accessible alternative

Script for Automated Downloading

Download Script







NASA Giovanni

# NASA Giovanni

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

- Application that allows the user to:
  - Select & subset Level 3 (gridded) NASA data products
  - Perform simple analysis (spatial & temporal averaging, differences) and plot results (e.g., area colormaps, time series, scatterplots, correlation plots)

The screenshot displays the NASA Giovanni web interface. At the top, it says "GIOVANNI The Bridge Between Data and Science v 4.38". Below this, there's a yellow banner with a message: "Giovanni downtime planned for 1600 UTC (11:00 AM) EST, Thursday February 9, 2023 ... [1 of 2 messages] Read More".

The main interface is divided into several sections:

- Select Plot:** A dropdown menu set to "Time Averaged Map".
- Select Date Range (UTC):** A date range selector showing "2020 - 01 - 01 00 : 00" to "2020 - 12 - 31 23 : 59". Below it, it says "Valid Range: 1948-01-01 to 2023-02-08".
- Select Region (Bounding Box or Shape):** A text input field containing "-180,-90,180,90".
- Select Variables:** A sidebar on the left with expandable sections: "Observations" (Model (140), Observation (92)), "Disciplines" (Aerosols (266), Atmospheric Chemistry (232), Atmospheric Dynamics (772), Cryosphere (18), Hydrology (646), Ocean Biology (43), Oceanography (73), Water and Energy Cycle (798)), "Measurements", "Platform / Instrument", "Spatial Resolutions", "Temporal Resolutions", "Wavelengths", and "Portal".
- Search Results:** A table listing variables with columns: Variable, Units, Source, Temp. Res., Spat. Res., Begin Date, End Date, and Vert. Slice. The table shows 232 of 2004 matching variables. A "Keyword" search bar is present above the table.

At the bottom of the interface, there are links for "Reset", "Plot Data", and "Go to Results". The footer includes "Responsible NASA Official: Angela Li" and "Web Curator: M. Hegde".





# Giovanni Controls

EARTHDATA Find a Dataset  
**GIOVANNI** The Bridge Between Data and Science v 4.38  
 Giovanni downtime planned for 1600 UTC (11:00 AM) EST, Thursday February 9, 2023 ... [1 of 2 messages] [Read More](#)

Feedback [Help](#) Log out (carl\_malings)

**Choose Plot or Analysis Type**  
 Select Plot: Time Averaged Map

**Choose Date and time**  
 Select Date Range (UTC): 2020 - 01 - 01 00 : 00 to 2020 - 12 - 31 23 : 59  
 Valid Range: 1948-01-01 to 2023-02-08

**Choose Region of Interest**  
 Select Region (Bounding Box or Shape): -180, -90, 180, 90

**Help/Info**

**Filter Datasets**  
 Select Variables  
 Observations  
 Model (140)  
 Observation (92)  
 Disciplines  
 Aerosols (266)  
 Atmospheric Chemistry (232)  
 Atmospheric Dynamics (772)  
 Cryosphere (18)  
 Hydrology (646)  
 Ocean Biology (43)  
 Oceanography (73)  
 Water and Energy Cycle (798)  
 Measurements  
 Platform / Instrument  
 Spatial Resolutions  
 Temporal Resolutions  
 Wavelengths  
 Portal

Number of matching Variables: 232 of 2004 Total Variable(s) included in Plot: 0

**Keyword Search**  
 Keyword:  Search Clear

variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date	End Date	Vert. Slice
<input type="checkbox"/> <a href="#">Ozone Total Column (Daytime/Ascending)</a> (AIRX3STD v006)	DU	AIRS	Daily	1 °	20C2-08-31	2016-09-25	-
<input type="checkbox"/> <a href="#">Ozone Total Column (Nighttime/Descending)</a> (AIRX3STD v006)	DU	AIRS	Daily	1 °	20C2-08-31	2016-09-25	-
<input type="checkbox"/> <a href="#">Ozone Total Column (Daytime/Ascending)</a> (AIRX3STM v006)	DU	AIRS	Monthly	1 °	20C2-09-01	2016-10-01	-
<input type="checkbox"/> <a href="#">Ozone Total Column (Nighttime/Descending)</a> (AIRX3STM v006)	DU	AIRS	Monthly	1 °	2002-09-01	2016-10-01	-
<input type="checkbox"/> <a href="#">Ozone Total Column (DOAS)</a> (OMDOAO3e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-06	-
<input type="checkbox"/> <a href="#">NO2 Total Column (30% Cloud Screened)</a> (OMNO2d v003)	molecules/cm^2	OMI	Daily	0.25 °	2004-10-01	2023-02-06	-
<input type="checkbox"/> <a href="#">NO2 Tropospheric Column (30% Cloud Screened)</a> (OMN02d v003)	molecules/cm^2	OMI	Daily	0.25 °	2004-10-01	2023-02-06	-
<input type="checkbox"/> <a href="#">Ozone Total Column (TOMS-like)</a> (OMTO3d v003)	DU	OMI	Daily	1 °	2004-10-01	2023-02-06	-
<input type="checkbox"/> <a href="#">Ozone Total Column (TOMS-like)</a> (OMTO3e v003)	DU	OMI	Daily	0.25 °	20C4-10-01	2023-02-06	-
<input type="checkbox"/> <a href="#">Carbon Dioxide, Mole Fraction in Free Troposphere</a> (AIRX3C2M v005)	PPM	AIRS	Monthly	2 x 2.5 °	20C2-09-01	2012-02-29	-
<input type="checkbox"/> <a href="#">Carbon Dioxide, Mole Fraction in Free Troposphere, IR-Only</a> (AIRX3C2M v005)	PPM	AIRS	Monthly	2 x 2.5 °	2010-01-01	2017-02-28	-
<input type="checkbox"/> <a href="#">Ozone Total Column</a> (TOMSEPL3 v008)	DU	TOMS EP	Daily	1.0 x 1.25 °	1986-07-22	2005-12-14	-
<input type="checkbox"/> <a href="#">Ozone Total Column</a> (TOMSMLS v006)	DU	TOMS Meteor-3	Daily	1.0 x 1.25 °	1981-08-22	1994-11-24	-

**Dataset Details (Units, Resolution, Coverage)**

**Add Datasets for Analysis**

Reset Plot Data Go to Results

Responsible NASA Official: [Angela Li](#) Privacy Powered By ▲ Contact Us  
 Web Curator: [M. Hegde](#)



# Step 1: Select Plot Type

The screenshot shows the GIOVANNI web interface. At the top, there is a navigation bar with the NASA logo, 'EARTHDATA', and 'Find a DAAC'. Below this is the 'GIOVANNI' logo and the tagline 'The Bridge Between Data and Science v 4.38'. A yellow banner at the top right contains the text 'Giovanni downtime planned for 1600 UTC (11:00 AM) EST, Thursday February 9, 2023 ... [1 of 2 messages] Read More'. The main interface has three input fields: 'Select Plot', 'Select Date Range (UTC)', and 'Select Region (Bounding Box or Shape)'. The 'Select Plot' dropdown menu is open, showing a list of plot types categorized into 'Maps', 'Comparisons', 'Time Series', 'Miscellaneous', and 'Vertical'. The 'Time Averaged Map' option is highlighted. Below the plot type list, there are checkboxes for various data categories like 'Ocean Biology (43)', 'Oceanography (73)', and 'Water and Energy Cycle (798)'. At the bottom, there is a footer with the NASA logo, contact information for Angela Li and M. Hegde, and buttons for 'Reset', 'Plot Data', and 'Go to Results'.

**Select Plot**

- Time Averaged Map
- Map, Recurring Averages
- Time Averaged Overlay Map
- Map, Accumulated
- Animation  
Limited to: 365 time steps
- Map, Difference of Time Averaged
- Comparisons**
- Map, Correlation

**Time Series**

- Scatter, Area Averaged (Static)
- Scatter (Interactive)  
Limited to: 30000 points
- Scatter (Static)
- Scatter, Time-Averaged (Interactive)  
Limited to: 30000 points
- Time Series, Area-Averaged Differences
- Time Series, Area-Averaged
- Hovmoller, Longitude-Averaged
- Hovmoller, Latitude-Averaged

**Miscellaneous**

- Time Series, Recurring Averages
- Histogram
- Zonal Mean

**Vertical**

- Cross Section, Latitude-Pressure
- Cross Section, Longitude-Pressure
- Cross Section, Time-Pressure
- Vertical Profile





# Step 2: Select Date Range

The screenshot shows the GIOVANNI web interface. At the top, there is a navigation bar with the NASA logo, 'EARTHDATA', and a search for DAAC. Below this is the 'GIOVANNI' logo and the tagline 'The Bridge Between Data and Science v 4.38'. A yellow banner at the top right contains a message: 'Giovanni downtime planned for 1600 UTC (11:00 AM) EST, Thursday February 9, 2023 ... [1 of 2 messages] Read More'. The main interface is divided into several sections:

- Select Plot:** A dropdown menu set to 'Time Averaged Map'.
- Select Date Range (UTC):** A date range selector showing '2022 - 03 - 01 00 : 00' to '2022 - 03 - 31 23 : 59'. Below it, a note states 'Valid Range: 1948-01-01 to 2023-02-08'.
- Select Region (Bounding Box or Shape):** A text input field containing '-180, -90, 180, 90'.
- Select Variables:** A sidebar on the left with two main sections:
  - Observations:** Includes checkboxes for 'Model (1260)' and 'Observation (744)'. Below this, it shows 'Number of matching Variables: 0 of 2004' and 'Total Variable(s) included in Plot: 0'. A red message says 'Please select at least 1 variable'. A 'Keyword' search bar with 'Search' and 'Clear' buttons is also present.
  - Disciplines:** A list of categories with checkboxes:
    - Aerosols (266)
    - Atmospheric Chemistry (232)
    - Atmospheric Dynamics (772)
    - Cryosphere (18)
    - Hydrology (646)
    - Ocean Biology (43)
    - Oceanography (73)
    - Water and Energy Cycle (798)
  - Measurements**
  - Platform / Instrument**
  - Spatial Resolutions**
  - Temporal Resolutions**
  - Wavelengths**
  - Depths**
  - Special Features**
  - Portal**

At the bottom of the interface, there is a footer with the NASA logo, contact information for Angela Li and M. Hegde, and a row of buttons: 'Reset', 'Plot Data', and 'Go to Results'.



# Step 3: Select Region of Interest

**Step 3: Select Region of Interest**

The screenshot shows the GIOVANNI web interface. The main area is titled "Select Region (Bounding Box or Shape)". A map of the United States is displayed with a bounding box highlighting a region. The bounding box coordinates are 20°04'N, 60°12'W at the top right, and 20°00'N, 40°00'N on the right side. The x-axis shows 120°00'W, 100°00'W, 80°00'W, and 60°00'W.

The interface includes a sidebar with "Select Variables" (Observations, Disciplines, Measurements, Platform / Instrument, Spatial Resolutions, Temporal Resolutions, Wavelengths, Depths, Special Features, Portal) and a main area with "Select Plot" (Time Averaged Map), "Select Date Range (UTC)" (2022-03-01 to 2022-03-31), and "Select Region (Bounding Box or Shape)".

A yellow banner at the top indicates "GIOVANNI downtime planned for 1600 UTC (11:00 AM) EST, Thursday February 9, 2023".

The bottom of the interface has a footer with "Responsible NASA Official: Angela Li", "Web Curator: M. Hegde", and buttons for "Reset", "Plot Data", and "Go to Results".





# Step 4: Refine Search

**GIOVANNI** The Bridge Between Data and Science v 4.38 Feedback Help Log out (carl\_malings)

**Giovanni downtime planned for 1600 UTC (11:00 AM) EST, Thursday February 9, 2023 ...** [1 of 2 messages] [Read More](#)

**Select Plot:** Time Averaged Map **Select Date Range (UTC):** 2022 - 03 - 01 00 : 00 to 2022 - 03 - 31 23 : 59 **Select Region (Bounding Box or Shape):** -125,20,-65,50

Valid Range: 1948-01-01 to 2023-02-08

**Select Variables:**

Number of matching Variables: 7 of 2004    Total Variable(s) included in Plot: 0

Please select at least 1 variable

Keyword :

Variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date	End Date
<input type="checkbox"/> <a href="#">Ozone Total Column (DOAS)</a> (OMDOAQ3e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> <a href="#">NO2 Total Column (30% Cloud Screened)</a> (OMNO2d v003)	molecules/cm <sup>2</sup>	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> <a href="#">NO2 Tropospheric Column (30% Cloud Screened)</a> (OMNO2d v003)	molecules/cm <sup>2</sup>	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> <a href="#">Ozone Total Column (TOMS-like)</a> (OMTO3d v003)	DU	OMI	Daily	1 °	2004-10-01	2023-02-06
<input type="checkbox"/> <a href="#">Ozone Total Column (TOMS-like)</a> (OMTO3e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> <a href="#">HCHO column amount</a> (OMHCHOd v003)	molecules/cm <sup>2</sup>	OMI	Daily	0.1 °	2004-10-01	2022-06-22
<input type="checkbox"/> <a href="#">SO2 Column Amount</a> (OMSO2e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-05

**Observations**  
 Observation (7)

**Disciplines**  
 Aerosols (26)  
 Atmospheric Chemistry (7)  
 Atmospheric Dynamics (2)  
 Water and Energy Cycle (7)

**Measurements**

**Platform / Instrument**  
 AIRS (68)  
 MODIS-Aqua (3)  
 MODIS-Terra (2)  
 MOPITT (9)  
 OMI (7)  
 TOMS EP (1)  
 TOMS Meteor-3 (1)  
 TOMS Nimbus-7 (1)

**Spatial Resolutions**  
**Temporal Resolutions**  
**Portal**

Responsible NASA Official: [Angela Li](#)    Privacy    Powered By ▲    Contact Us



# Step 5: Select Data Product

**GIOVANNI** The Bridge Between Data and Science v 4.38 Feedback Help Log out (carl\_malings)

**Giovanni downtime planned for 1600 UTC (11:00 AM) EST, Thursday February 9, 2023 ...** [1 of 2 messages] [Read More](#)

**Select Plot:** Time Averaged Map

**Select Date Range (UTC):** 2022 - 03 - 01 00 : 00 to 2022 - 03 - 31 23 : 59  
Valid Range: 2004-10-01 to 2023-02-06

**Select Region (Bounding Box or Shape):** -125,20,-65,50

**Select Variables:**

- Observations**
  - Observation (7)
- Disciplines**
  - Aerosols (26)
  - Atmospheric Chemistry (7)
  - Atmospheric Dynamics (2)
  - Water and Energy Cycle (7)
- Measurements**
- Platform / Instrument**
  - AIRS (68)
  - MODIS-Aqua (3)
  - MODIS-Terra (2)
  - MOPITT (9)
  - OMI (7)
  - TOMS EP (1)
  - TOMS Meteor-3 (1)
  - TOMS Nimbus-7 (1)
- Spatial Resolutions**
- Temporal Resolutions**
- Portal**

Number of matching Variables: 7 of 2004    Total Variable(s) included in Plot: 1

Keyword :

Variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date	End Date
<input type="checkbox"/> Ozone Total Column (DOAS) (OMDOAO3e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> NO2 Total Column (30% Cloud Screened) (OMNO2d v003)	molecules/cm <sup>2</sup>	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input checked="" type="checkbox"/> NO2 Tropospheric Column (30% Cloud Screened) (OMNO2d v003)	molecules/cm <sup>2</sup>	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> Ozone Total Column (TOMS-like) (OMTO3e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> Ozone Total Column (TOMS-like) (OMTO3e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> HCHO column amount (OMHCHOd v003)	molecules/cm <sup>2</sup>	OMI	Daily	0.1 °	2004-10-01	2022-06-22
<input type="checkbox"/> SO2 Column Amount (OMSO2e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-05





# Step 6: Plot Data

NASA EARTHDATA Find a DAAC ?

**GIOVANNI** The Bridge Between Data and Science v 4.38 Feedback Help Log out (carl\_malings)

Giovanni downtime planned for 1600 UTC (11:00 AM) EST, Thursday February 9, 2023 ... [1 of 2 messages] [Read More](#)

**Select Plot** Time Averaged Map **Select Date Range (UTC)** 2022 - 03 - 01 00 : 00 to 2022 - 03 - 31 23 : 59 **Select Region (Bounding Box or Shape)** -125,20,-65,50

Valid Range: 2004-10-01 to 2023-02-06

**Select Variables**

Number of matching Variables: 7 of 2004 Total Variable(s) included in Plot: 1

Keyword :

Variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date	End Date
<input type="checkbox"/> Ozone Total Column (DOAS) (OMDOAO3e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> NO2 Total Column (30% Cloud Screened) (OMNO2d v003)	molecules/cm <sup>2</sup>	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input checked="" type="checkbox"/> NO2 Tropospheric Column (30% Cloud Screened) (OMNO2d v003)	molecules/cm <sup>2</sup>	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> Ozone Total Column (TOMS-like) (OMTO3d v003)	DU	OMI	Daily	1 °	2004-10-01	2023-02-06
<input type="checkbox"/> Ozone Total Column (TOMS-like) (OMTO3e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-06
<input type="checkbox"/> HCHO column amount (OMHCHOd v003)	molecules/cm <sup>2</sup>	OMI	Daily	0.1 °	2004-10-01	2022-06-22
<input type="checkbox"/> SO2 Column Amount (OMSO2e v003)	DU	OMI	Daily	0.25 °	2004-10-01	2023-02-05

**Observations**

Observation (7)

**Disciplines**

Aerosols (26)

Atmospheric Chemistry (7)

Atmospheric Dynamics (2)

Water and Energy Cycle (7)

**Measurements**

**Platform / Instrument**

AIRS (68)

MODIS-Aqua (3)

MODIS-Terra (2)

MOPITT (9)

OMI (7)

TOMS EP (1)

TOMS Meteor-3 (1)

TOMS Nimbus-7 (1)

**Spatial Resolutions**

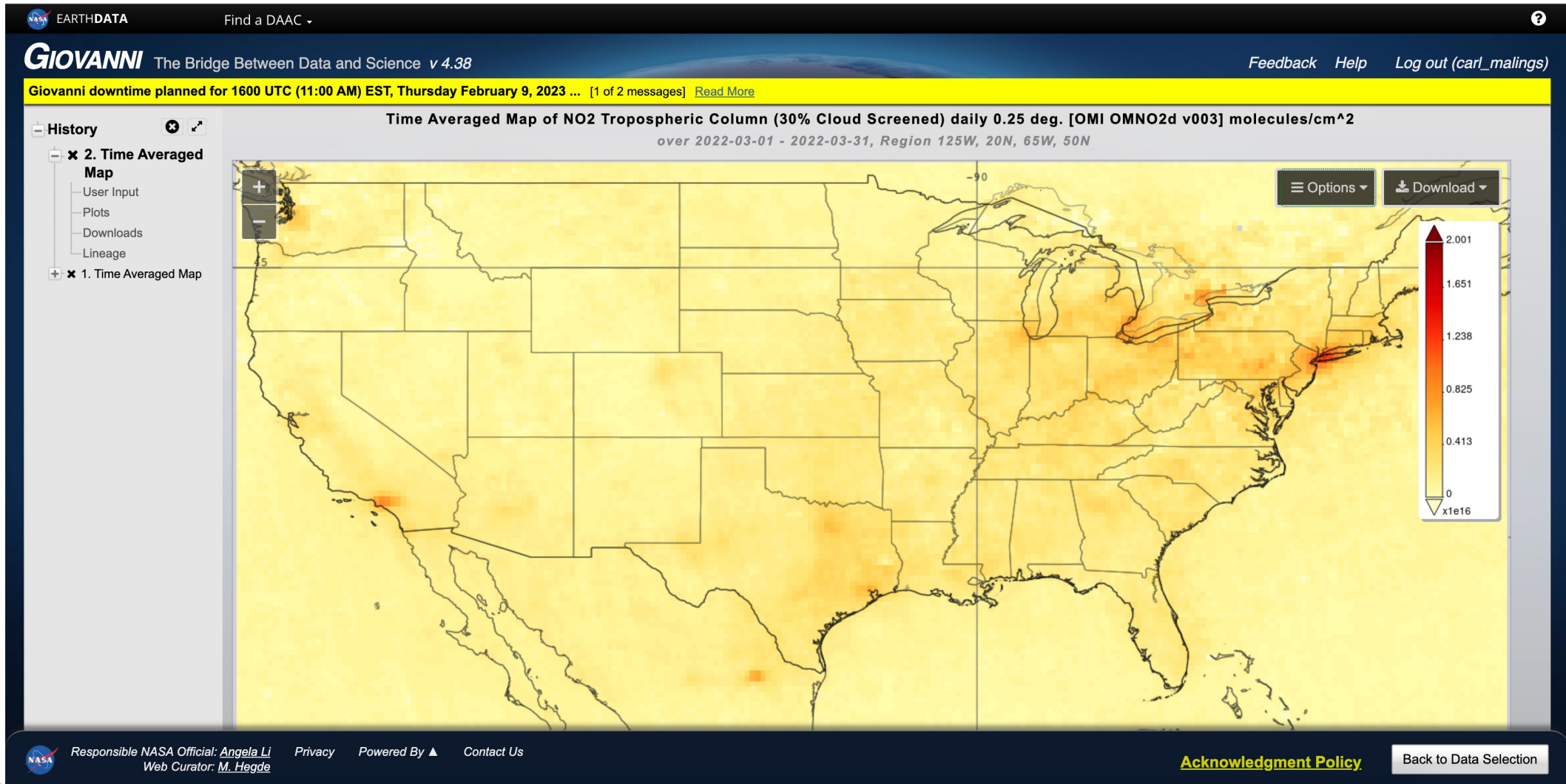
**Temporal Resolutions**

**Portal**

Responsible NASA Official: [Angela Li](#) Privacy Powered By Contact Us  
Web Curator: [M. Hegde](#)

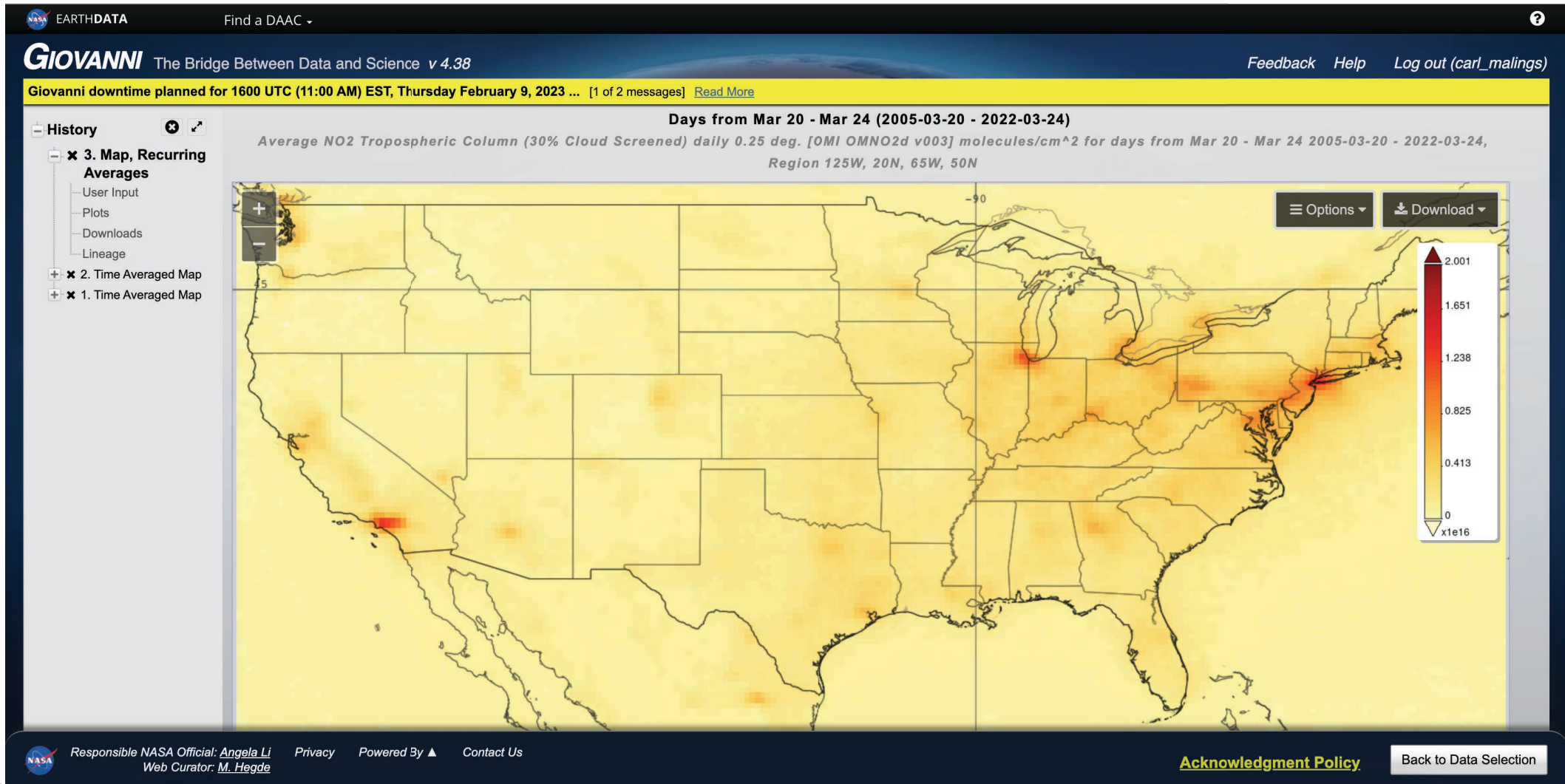


# Time-Averaged Map

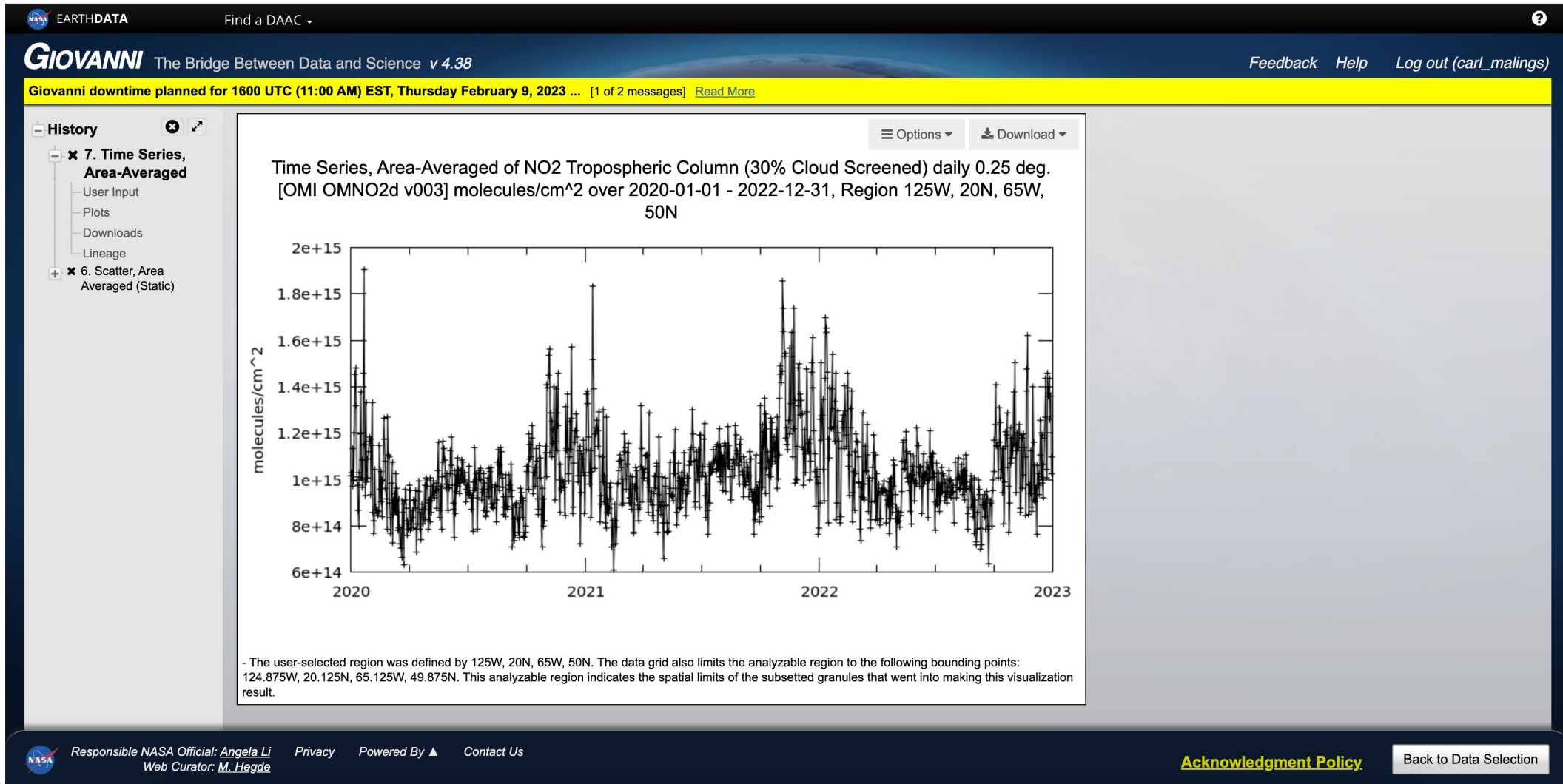




# Recurring Average Map

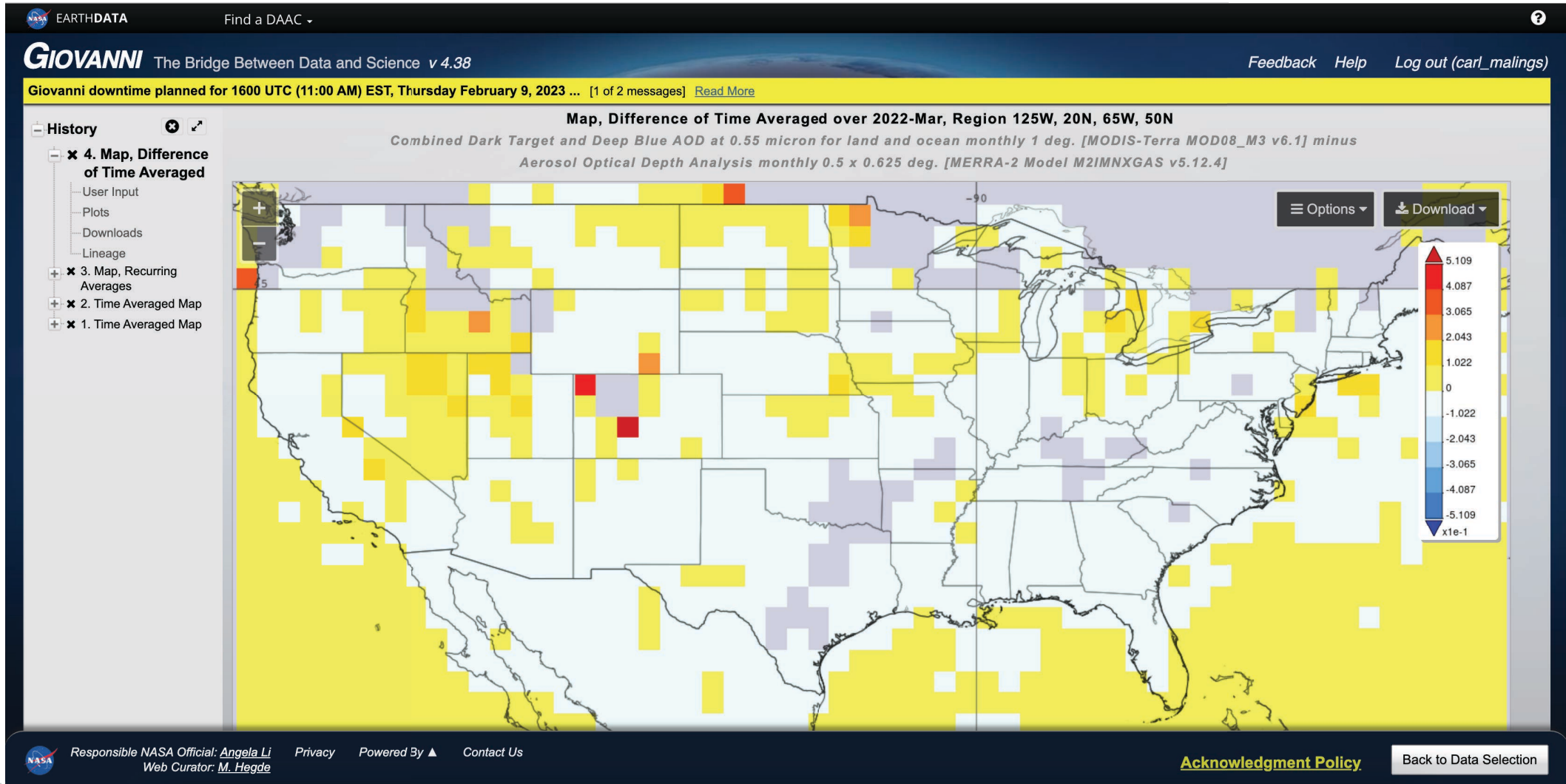


# Area-Average Time Series Plot

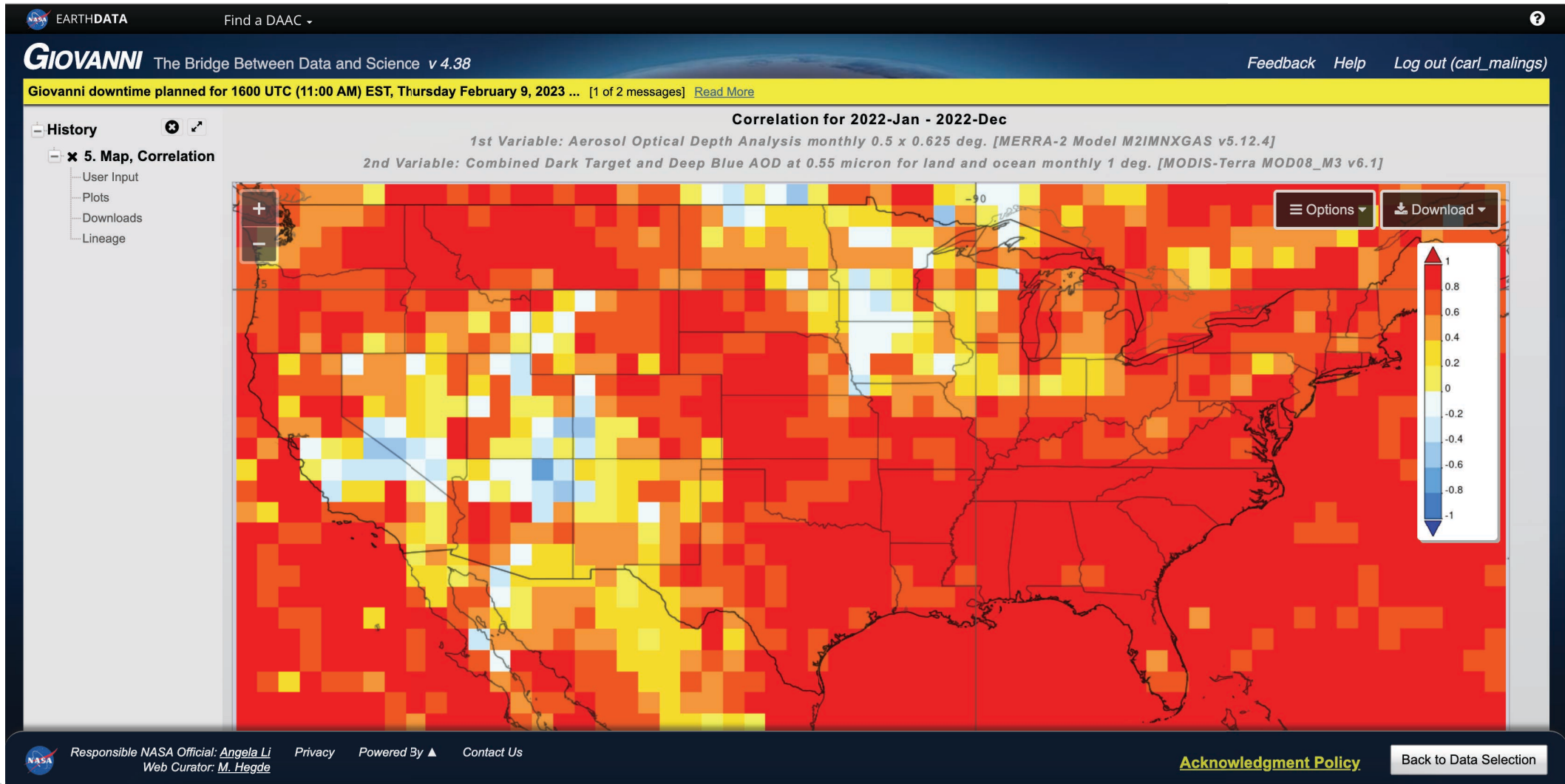




# Time-Averaged Difference Map



# Correlation Map





# Area-Average or Time-Average Scatter Plot

NASA EARTHDATA Find a DAAC ?

**GIOVANNI** The Bridge Between Data and Science v 4.38 Feedback Help Log out (carl\_malings)

**Giovanni downtime planned for 1600 UTC (11:00 AM) EST, Thursday February 9, 2023 ...** [1 of 2 messages] [Read More](#)

**History** + +

- 8. Scatter, Time-Averaged (Interactive)**
  - User Input
  - Plots
  - Downloads
  - Lineage
- 7. Time Series, Area-Averaged
- 6. Scatter, Area-Averaged (Static)

Drag bounding box on plot to subset data

2020-01 - 2022-12  
Latitude: 20.5 to 49.5  
Longitude: -124.5 to -65.5

Regression:  $y = 0.995x + 0.00377$ , R: 0.687, N: 1800

Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean monthly 1 deg. [MODIS-Terra MOD08\_M3 v6.1]

Aerosol Optical Depth Analysis monthly 0.5 x 0.625 deg. [MERRA-2 Model M2IMNXGAS v5.12.4]

Highcharts.com

Drag bounding box on map to subset data

Lon: ---- Lat: ----

Reset Map and Chart

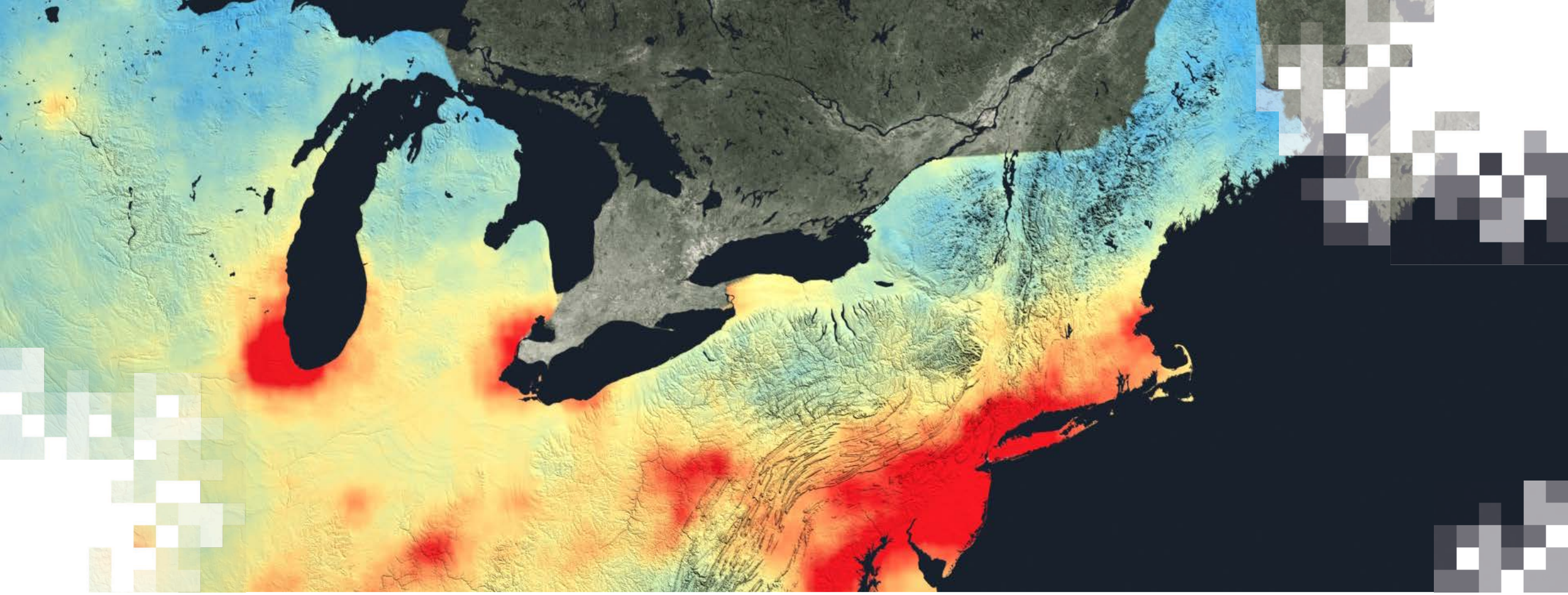
Responsible NASA Official: [Angela Li](#) Privacy Powered By Contact Us  
Web Curator: [M. Heide](#)

<https://giovanni.gsfc.nasa.gov/giovanni/doc/UsersManualworkingdocument.docx.html#h.765ut7soz9is>

[Acknowledgment Policy](#) [Back to Data Selection](#)

Policy regarding publication using Giovanni data





# TEMPO Proxy Data Products

Dr. Aaron Naeger, TEMPO Deputy Program Applications Lead