

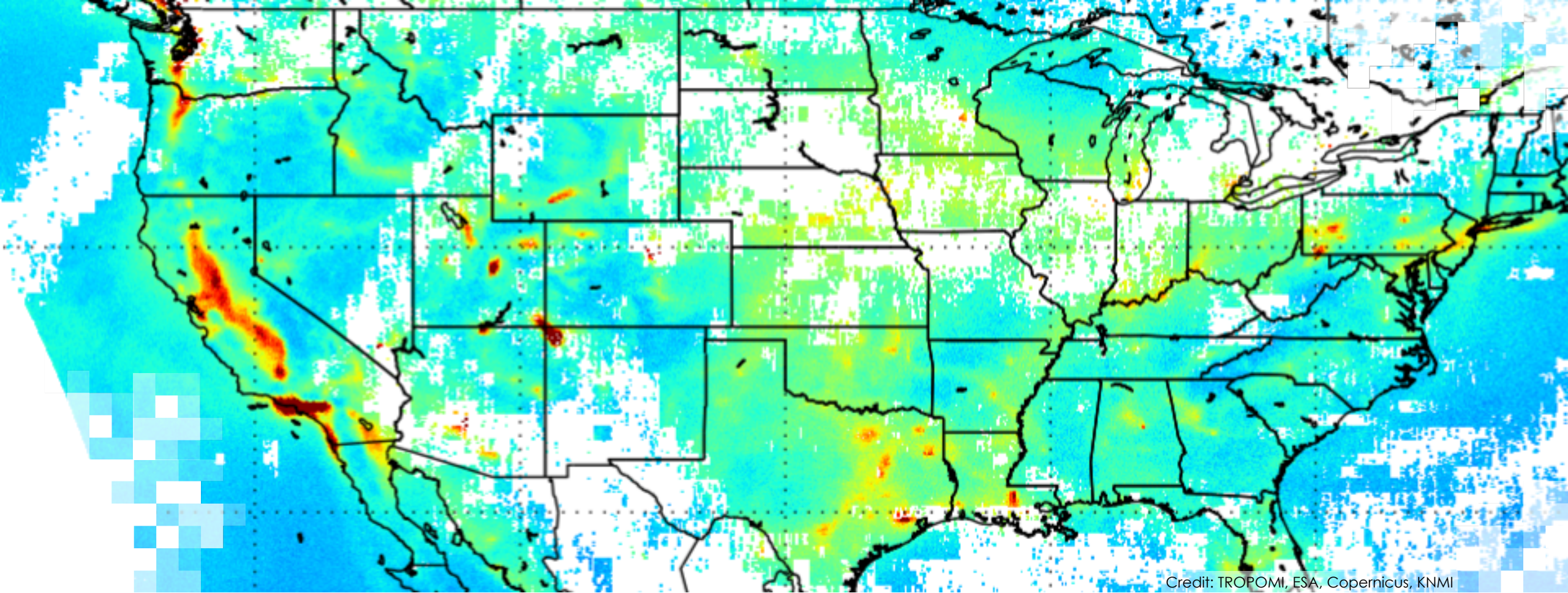
Credit: TROPOMI, ESA, Copernicus, KNMI



TROPOMI Data Download and Visualization using Panoply

Melanie Follette-Cook and Pawan Gupta

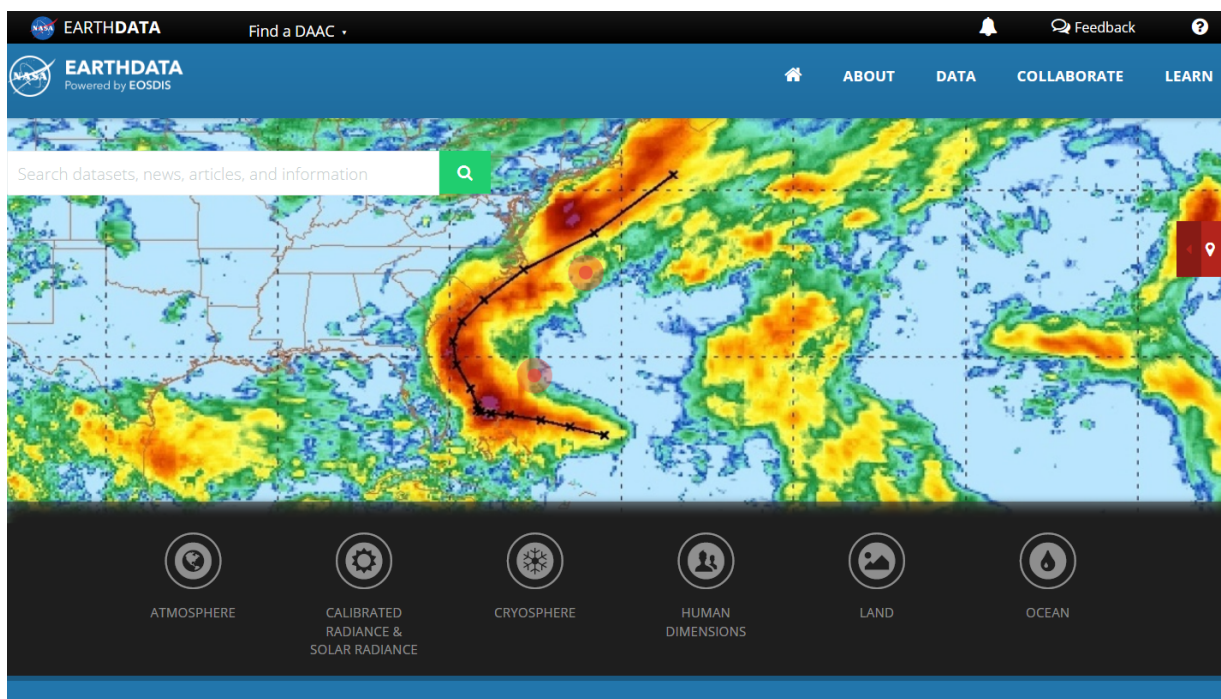
Application of Satellite Observations for Air Quality and Health Exposure, Oct 9 and 11, 2019



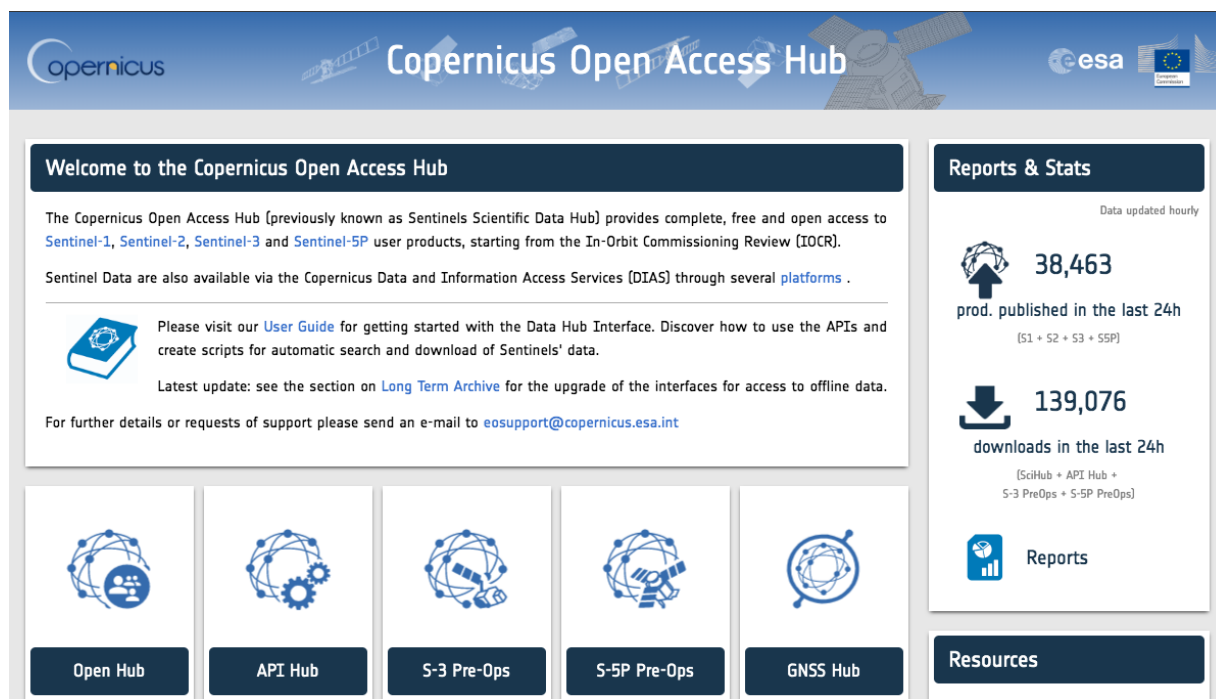
Data Access

Data Access

NASA – Earthdata
<https://earthdata.nasa.gov/>



ESA – Copernicus Open Access Hub
<https://scihub.copernicus.eu/>



Click Find Data to Access Earthdata Search

The screenshot shows the NASA Earthdata website interface. At the top, there is a navigation bar with the NASA logo, 'EARTHDATA', and 'Powered by EOSDIS'. A search bar is located below the navigation bar. The main content area features a large satellite-style map of the Earth with a search bar overlaid. Below the map, there are six circular icons representing different data categories: ATMOSPHERE, CALIBRATED RADIANCE & SOLAR RADIANCE, CRYOSPHERE, HUMAN DIMENSIONS, LAND, and OCEAN. At the bottom, there is a blue banner with the text 'ACCESS NASA EARTH SCIENCE DATA' and a sub-header 'NASA's data policy ensures that all NASA data are available fully, openly, and without restrictions. [Here's what this means to you.](#)'. Three green buttons are positioned below the banner: 'FIND DATA', 'VISUALIZE DATA', and 'GETTING STARTED'. The 'FIND DATA' button is circled in red.

Enter TROPOMI and Use the Clock Icon to Select 2018-08-16

The screenshot shows the NASA Earthdata Search interface. The search bar contains the text "TROPOMI". A date selection dialog is open, showing the date "2018-08-16" selected. The "Apply Filter" button is highlighted in red. A red arrow points to the clock icon in the search bar. The interface shows 41 matching collections, with the first two results being Sentinel-5P TROPOMI Aerosol Index data.

Search Results:

- Sentinel-5P TROPOMI Aerosol Index 1-Orbit L2 7km x 3.5km V1 (S5P_L2_AER_AI) at GES DISC**
5,674 Granules • 2018-06-28 ongoing • The 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 Netherlands and the ESA. The sole payload on Sentinel-5P is the TROPospheric Monitoring I...
S5P_L2_AER_AI v1 - NASA/GSFC/SED/ESD/GCDC/GESDISC
- Sentinel-5P TROPOMI Aerosol Index 1-Orbit L2 5.5km x 3.5km V1 (S5P_L2_AER_AI_HiR) at GES DISC**
630 Granules • 2019-08-06 ongoing • Starting from August 6th in 2019, Sentinel-5P TROPOMI along-track high spatial resolution (~5.5km at nadir) has been implemented. S5P_L2_AER_AI_HiR data collection contains the high spatial resolution products. For data prior to August 6th of 2019, please check S5P_L2_AER_AI da...
S5P_L2_AER_AI_HiR v1 - NASA/GSFC/SED/ESD/GCDC/GESDISC

Scroll Through Options Until You Find Tropospheric NO₂

The screenshot shows the NASA Earthdata Search interface. The search bar contains the text "TROPOMI". Below the search bar, the start and stop dates are displayed: "Start: 2018-08-16 00:00:00 Stop: 2018-08-16 23:59:59". A map of the Middle East and surrounding regions is visible in the background. The search results section shows "21 Matching Collections". The first result is "15 Granules • 2018-05-14 ongoing • The 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 Netherlands and the ESA. The sole payload on Sentinel-5P is the TROPospheric Monitoring I...". The second result, "Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 7km x 3.5km V1 (S5P_L2_NO2_...) at GES DISC", is circled in red. The third result is "Sentinel-5P TROPOMI SNPP VIIRS cloud product band 3 (UVIS detector) 1-Orbit L2 7km x 3.5km V1 (S5P_L2_NP_BD3) at GES DISC".

Zoom Out and Click Swath over Central US

NASA EARTHDATA Find a DAAC

TROPOMI

Start: 2018-08-16 00:00:00 Stop: 2018-08-16 23:59:59

Back to Collections

Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 7km x 3.5km V1 (S5P_L2_NO2___) at GES DISC [View detail](#)

Sort by: Start Date, Newest first Granule Search: Search Single or Multiple Granule IDs... Granule filters

S5P_RPRO_L2_NO2___20180816T233346_20180817T011713_04364_01_010202_20190218T071628.nc	S5P_RPRO_L2_NO2___20180816T215251_20180816T233544_04363_01_010202_20190218T071143.nc	S5P_RPRO_L2_NO2___20180816T201047_20180816T215414_04362_01_010202_20190218T070750.nc	S5P_RPRO_L2_NO2___20180816T1817_20180816T201245_04361_01_010202_20190218T070149.nc	S5P_RPRO_L2_NO2___20180816T1710_20180816T183115_04360_01_010202_20190218T063927.nc
START 2018-08-16 23:56:19	START 2018-08-16 22:14:50	START 2018-08-16 20:33:21	START 2018-08-16 18:51:51	START 2018-08-16 17:10:21
END 2018-08-17 00:54:43	END 2018-08-16 23:07:06	END 2018-08-16 21:31:44	END 2018-08-16 19:50:14	END 2018-08-16 18:08:44

MONTH: Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 7km x 3.5km V1 (S5P_L2_NO2___) at GES DISC

Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan 2019 Feb

v 1.101.0 • Search Time: 0.4s • NASA Official: Stephen Berrick • FOIA • NASA Privacy Policy • USA.gov

Earthdata Access: A Section 508 accessible alternative

When you click on an orbit on the map, its granule is highlighted

Click the Download Button to Download the Granule

The download button will download a single granule. You can also download all 15 granules for this day.

Sort by: Start Date, Newest first Granule Search: Search Single or Multiple Granule IDs... Granule filters

Granule ID	START	END	Download
S5P_RPRO_L2_NO2__20180816T233346_20180817T011713_04364_01_010202_20190218T071628.nc	2018-08-16 23:56:19	2018-08-17 00:54:43	[Download]
S5P_RPRO_L2_NO2__20180816T215251_20180816T233544_04363_01_010202_20190218T071143.nc	2018-08-16 22:14:50	2018-08-16 23:07:06	[Download]
S5P_RPRO_L2_NO2__20180816T201047_20180816T215414_04362_01_010202_20190218T070750.nc	2018-08-16 20:33:21	2018-08-16 21:31:44	[Download]
S5P_RPRO_L2_NO2__20180816T182917_20180816T201047_04361_01_010202_20190218T070750.nc	2018-08-16 18:51:51	2018-08-16 19:50:14	[Download]
S5P_RPRO_L2_NO2__20180816T164748_20180816T183115_04360_01_010202_20190218T063927.nc	2018-08-16 17:10:21	2018-08-16 18:08:44	[Download]

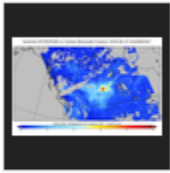
Download All 15 Granules

MONTH: Sentinel-5P TROPOMI Tropospheric NO2 1-Orbit L2 7km x 3.5km V1 (S5P_L2_NO2__) at GES DISC

v 1.101.0 • Search Time: 0.4s • NASA Official: Stephen Berrick • FOIA • NASA Privacy Policy • USA.gov Earthdata Access: A Section 508 accessible alternative

Exercise

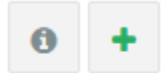
- Repeat the steps above and download the CO data for the same day and orbit

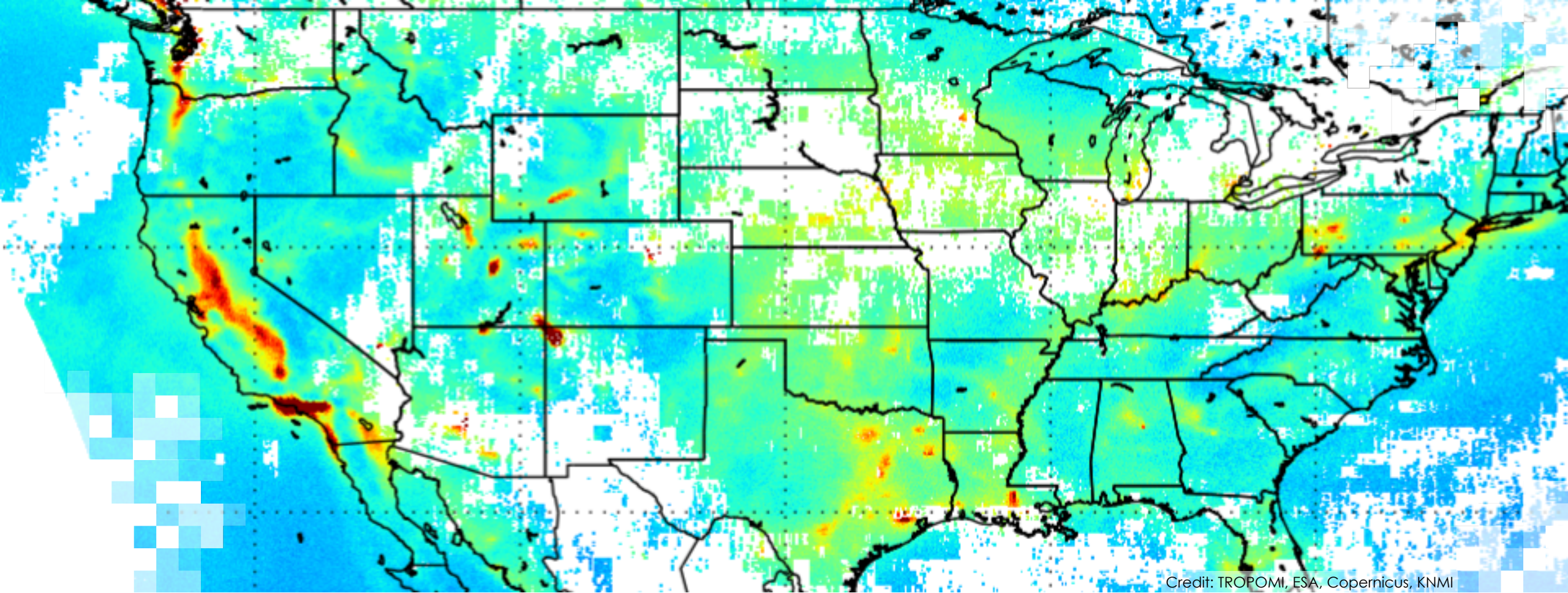


Sentinel-5P TROPOMI Carbon Monoxide CO Column 1-Orbit L2 7km x 7km V1 (S5P_L2_CO___) at GES DISC

15 Granules • 2018-04-30 ongoing • The 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 Netherlands and the ESA. The sole payload on Sentinel-5P is the TROPospheric Monitoring I...

S5P_L2_CO___v1 - NASA/GSFC/SED/ESD/GCDC/GESDISC





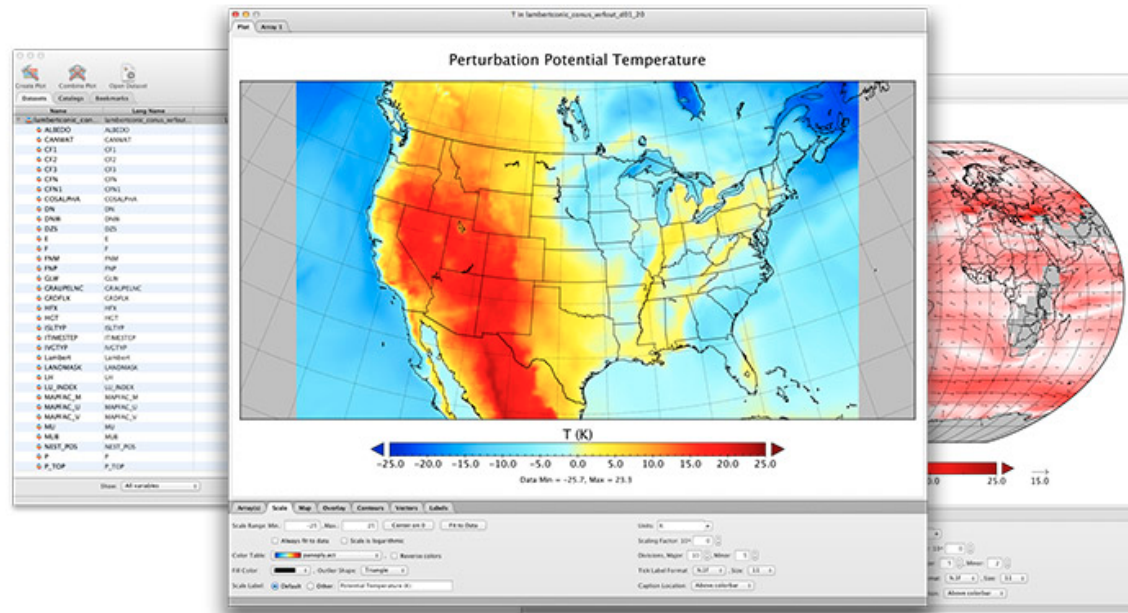
Panoply

Panoply

<https://www.giss.nasa.gov/tools/panoply/>

Panoply netCDF, HDF and GRIB Data Viewer

panoply \PAN-uh-plee\, noun: 1. A splendid or impressive array. ...

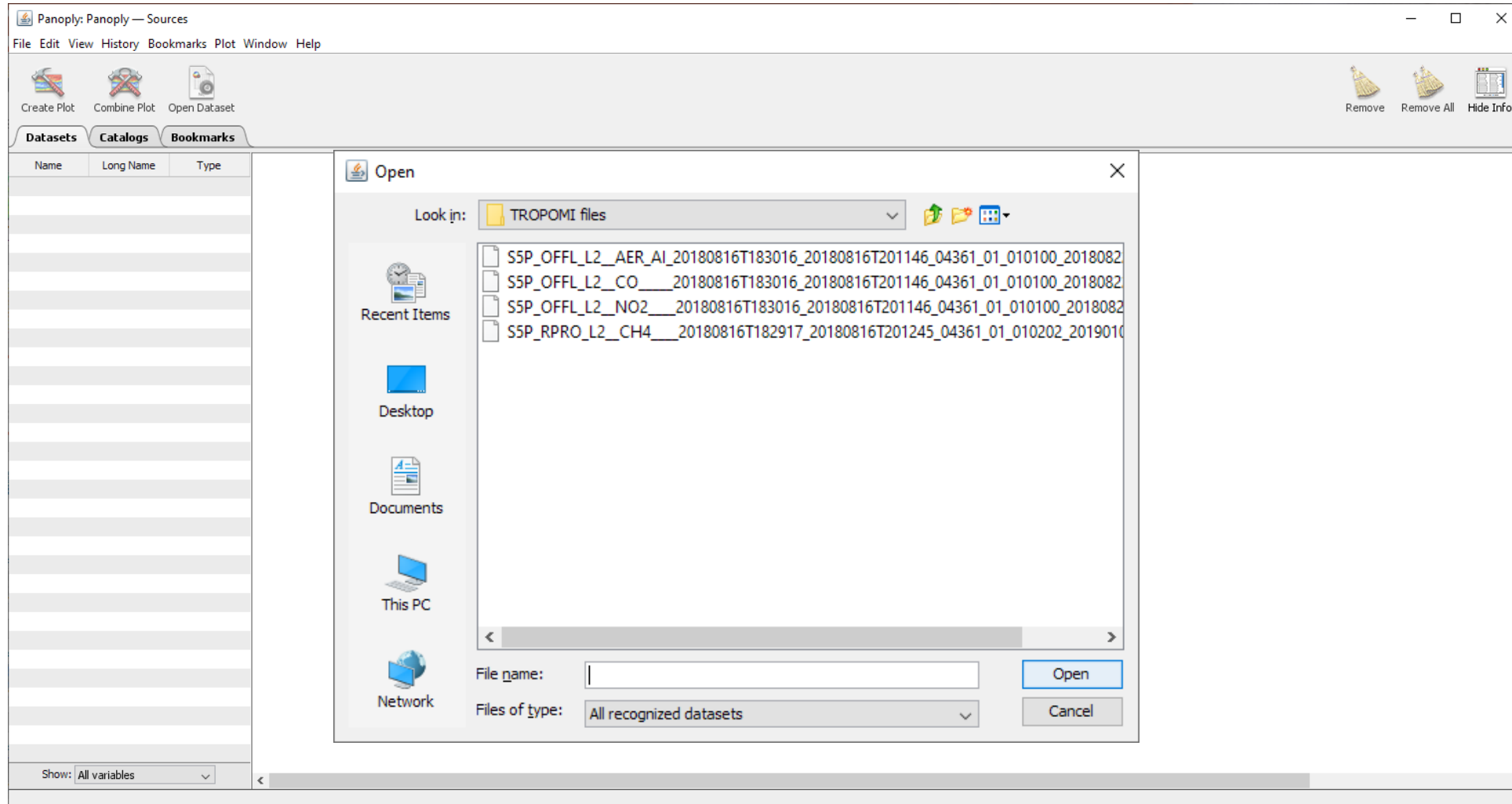


Can analyze NetCDF, HDF, GRIB, and more
Runs on Mac, Windows, and Linux

With Panoply 4 you can:

- Plot variety of 2D and 1D arrays
- Combine two arrays in one plot by differencing, summing or averaging.
- Plot maps using any of 100+ map projections
- Change color tables, or apply your own (ACT, CPT, or RGB)
- Save plots as GIF, JPEG, PNG or TIFF bitmap images or as PDF or PS
- Export map plots in KMZ format.
- Export animations as MP4 video or as a collection of individual frame images.

Open Panoply and Navigate to Directory



View Metadata and Products

Panoply: Panoply — Sources

File Edit View History Bookmarks Plot Window Help

Create Plot Combine Plot Open Dataset

Remove Remove All Hide Info

Datasets Catalogs Bookmarks

Name	Long Name	Type
▼ S5P_OFFL_L2__AER_AI_...	TROPOMI/S5P Aerosol Index 1-O...	Local File
▼ METADATA	METADATA	—
▶ ALGORITHM_SET...	METADATA/ALGORITHM_SETTINGS	—
▶ EOP_METADATA	METADATA/EOP_METADATA	—
▶ ESA_METADATA	METADATA/ESA_METADATA	—
▶ GRANULE_DESC...	METADATA/GRANULE_DESCRIP...	—
▶ ISO_METADATA	METADATA/ISO_METADATA	—
▶ QA_STATISTICS	METADATA/QA_STATISTICS	—
▼ PRODUCT	PRODUCT	—
▶ aerosol_index_3...	Aerosol index from 380 and 340 nm	Geo2D
▶ aerosol_index_3...	Precision of aerosol index from 3...	Geo2D
▶ aerosol_index_3...	Aerosol index from 388 and 354 nm	Geo2D
▶ aerosol_index_3...	Precision of aerosol index from 3...	Geo2D
▶ corner	pixel corner index	1D
▶ delta_time	offset from reference start time ...	1D
▶ ground_pixel	across-track dimension index	1D
▶ latitude	pixel center latitude	Geo2D
▶ longitude	pixel center longitude	Geo2D
▶ qa_value	data quality value	Geo2D
▶ scanline	along-track dimension index	1D
▶ SUPPORT_DATA	PRODUCT/SUPPORT_DATA	—
▶ time	reference time for the measurem...	—
▶ time_utc	Time of observation as ISO 8601 ...	—

Show: All variables

File "S5P_OFFL_L2__AER_AI_20180816T183016_20180816T201146_04361_01_010100_20180822T174822.nc"

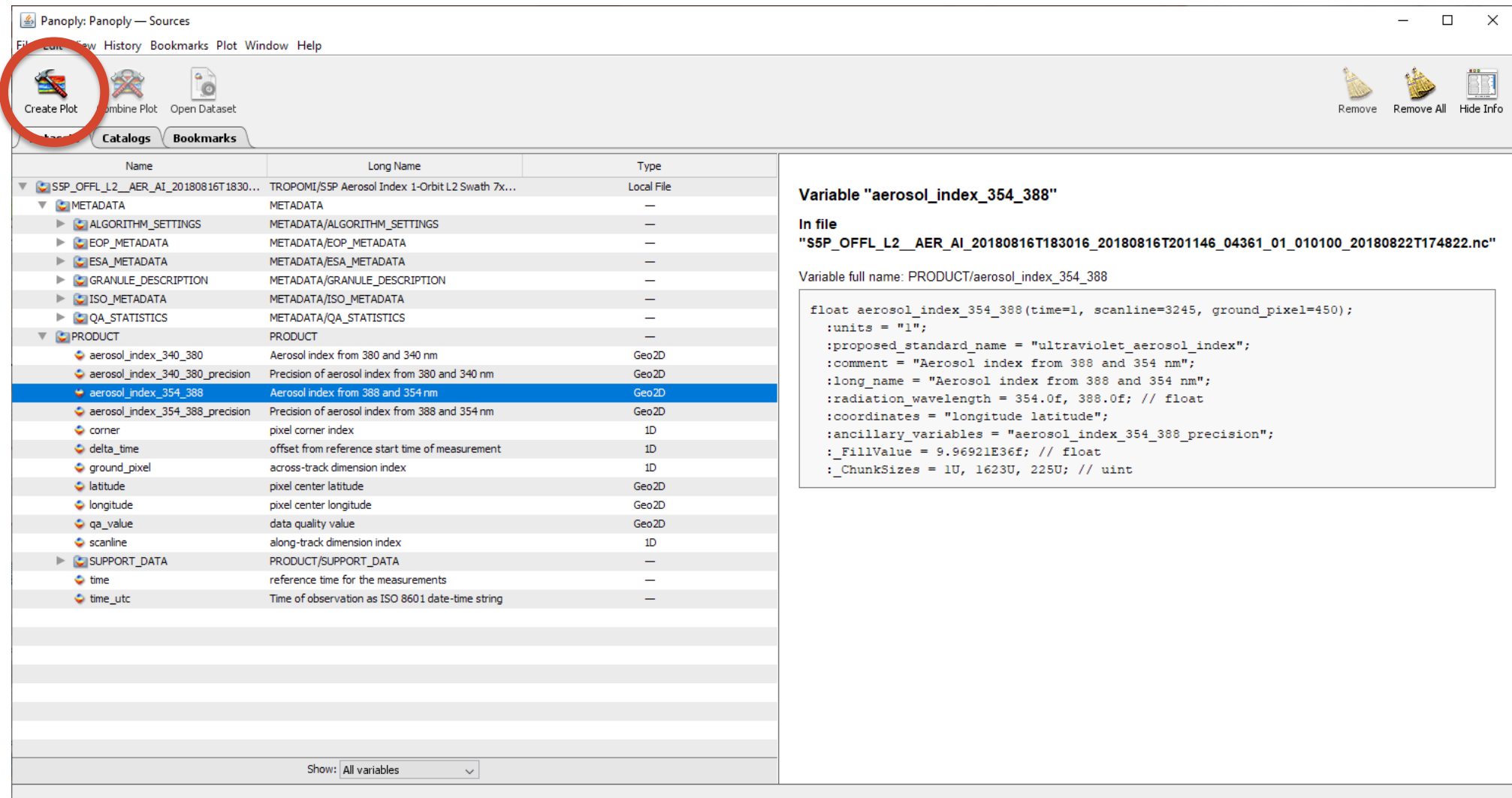
File type: Hierarchical Data Format, version 5

```
netcdf file:/C:/Users/mfcook/Documents/ARSET/Trainings%20-%20Current/TEMPO/TROPOMI%20files/S5P_OFFL_L2__AER_AI_20180816T183016_20180816T201146_04361_01_010100_20180822T174822.nc {
  group: METADATA {
    group: QA_STATISTICS {
      dimensions:
        vertices = 2;
        aerosol_index_354_388_histogram_axis = 100;
        aerosol_index_354_388_pdf_axis = 400;
        aerosol_index_340_380_histogram_axis = 100;
        aerosol_index_340_380_pdf_axis = 400;
      variables:
        float aerosol_index_354_388_histogram_axis(aerosol_index_354_388_histogram_axis=100);
          :units = "1";
          :comment = "Histogram axis of the aerosol index";
          :long_name = "Histogram axis of the aerosol index";
          :bounds = "aerosol_index_354_388_histogram_bounds";
          :_FillValue = 9.96921E36f; // float
          :_ChunkSizes = 100U; // uint

        float aerosol_index_354_388_pdf_axis(aerosol_index_354_388_pdf_axis=400);
          :units = "1";
          :comment = "Probability density function of the aerosol index";
          :long_name = "Probability density function of the aerosol index";
          :bounds = "aerosol_index_pdf_bounds";
          :_FillValue = 9.96921E36f; // float
          :_ChunkSizes = 400U; // uint

        float aerosol_index_354_388_histogram_bounds(aerosol_index_354_388_histogram_axis=100, vertices=2);
          :_FillValue = 9.96921E36f; // float
          :_ChunkSizes = 100U; // uint
    }
  }
}
```

Select Variable and Click "Create Plot"



The screenshot shows the Panoply software interface. The 'Sources' window displays a table of variables. The 'Create Plot' button is circled in red. The selected variable is 'aerosol_index_354_388'. The metadata panel on the right shows the variable's full name and its metadata.

Name	Long Name	Type
SSP_OFFL_L2_AER_AI_20180816T1830...	TROPOMI/SSP Aerosol Index 1-Orbit L2 Swath 7x...	Local File
METADATA	METADATA	—
ALGORITHM_SETTINGS	METADATA/ALGORITHM_SETTINGS	—
EOP_METADATA	METADATA/EOP_METADATA	—
ESA_METADATA	METADATA/ESA_METADATA	—
GRANULE_DESCRIPTION	METADATA/GRANULE_DESCRIPTION	—
ISO_METADATA	METADATA/ISO_METADATA	—
QA_STATISTICS	METADATA/QA_STATISTICS	—
PRODUCT	PRODUCT	—
aerosol_index_340_380	Aerosol index from 380 and 340 nm	Geo2D
aerosol_index_340_380_precision	Precision of aerosol index from 380 and 340 nm	Geo2D
aerosol_index_354_388	Aerosol index from 388 and 354 nm	Geo2D
aerosol_index_354_388_precision	Precision of aerosol index from 388 and 354 nm	Geo2D
corner	pixel corner index	1D
delta_time	offset from reference start time of measurement	1D
ground_pixel	across-track dimension index	1D
latitude	pixel center latitude	Geo2D
longitude	pixel center longitude	Geo2D
qa_value	data quality value	Geo2D
scanline	along-track dimension index	1D
SUPPORT_DATA	PRODUCT/SUPPORT_DATA	—
time	reference time for the measurements	—
time_utc	Time of observation as ISO 8601 date-time string	—

Variable "aerosol_index_354_388"

In file
"SSP_OFFL_L2_AER_AI_20180816T183016_20180816T201146_04361_01_010100_20180822T174822.nc"

Variable full name: PRODUCT/aerosol_index_354_388

```
float aerosol_index_354_388(time=1, scanline=3245, ground_pixel=450);
:units = "1";
:proposed_standard_name = "ultraviolet_aerosol_index";
:comment = "Aerosol index from 388 and 354 nm";
:long_name = "Aerosol index from 388 and 354 nm";
:radiation_wavelength = 354.0f, 388.0f; // float
:coordinates = "longitude latitude";
:ancillary_variables = "aerosol_index_354_388_precision";
:_FillValue = 9.96921E36f; // float
:_ChunkSizes = 1U, 1623U, 225U; // uint
```

Select Georeferenced Lon-Lat Plot

Panoply: Panoply — Sources

File Edit View History Bookmarks Plot Window Help

Create Plot Combine Plot Open Dataset Remove Remove All Hide Info

Datasets Catalogs Bookmarks

Name	Long Name	Type
SSP_OFFL_L2_AER_AI_20180816T1830...	TROPOMI/SSP Aerosol Index 1-Orbit L2 Swath 7x...	Local File
METADATA	METADATA	—
ALGORITHM_SETTINGS	METADATA/ALGORITHM_SETTINGS	—
EOP_METADATA	METADATA/EOP_METADATA	—
ESA_METADATA	METADATA/ESA_M...	—
GRANULE_DESCRIPTION	METADATA/GRANUL...	—
ISO_METADATA	METADATA/ISO_M...	—
QA_STATISTICS	METADATA/QA_ST...	—
PRODUCT	PRODUCT	—
aerosol_index_340_380	Aerosol index from...	—
aerosol_index_340_380_precision	Precision of aerosol...	—
aerosol_index_354_388	Aerosol index from...	—
aerosol_index_354_388_precision	Precision of aerosol...	—
corner	pixel corner index	—
delta_time	offset from referen...	—
ground_pixel	across-track dimen...	—
latitude	pixel center latitude	—
longitude	pixel center longitu...	—
qa_value	data quality value	—
scanline	along-track dimens...	—
SUPPORT_DATA	PRODUCT/SUPPORT_DATA	—
time	reference time for the measurements	—
time_utc	Time of observation as ISO 8601 date-time string	—

Variable "aerosol_index_354_388"

In file
"SSP_OFFL_L2_AER_AI_20180816T183016_20180816T201146_04361_01_010100_20180822T174822.nc"

3245, ground_pixel=450);
sol_index";
nm";
4 nm";
Float
38_precision";

Create Plot

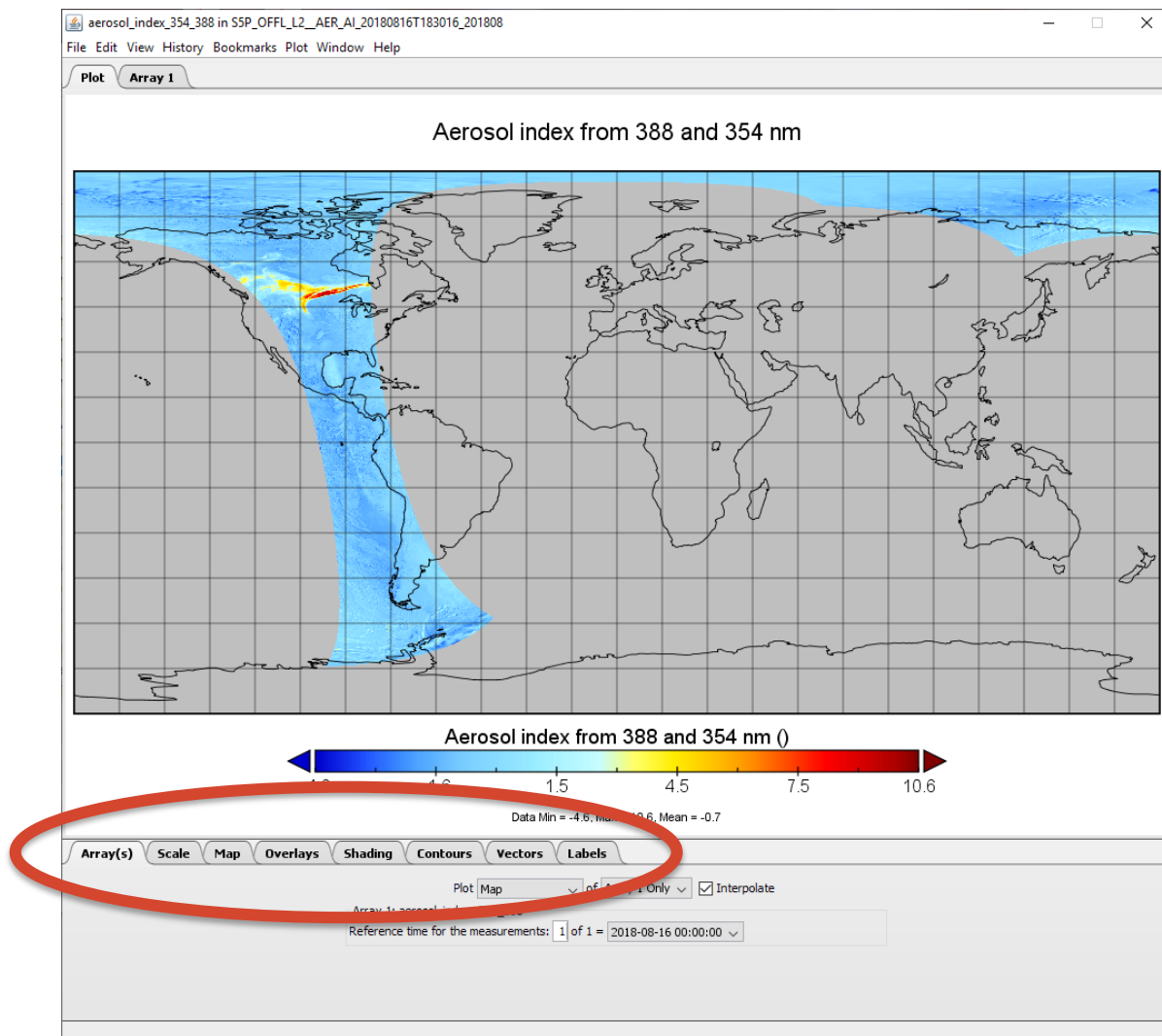
More than one type of plot can be created from the variable 'aerosol_index_354_388'. What type would you like to create?

- Create a georeferenced Longitude-Latitude plot
- Create a 2D plot using ground_pixel for X axis and scanline for Y axis
- Create a horizontal line plot along ground_pixel axis

Create Cancel

Show: All variables

Explore Plotting Options

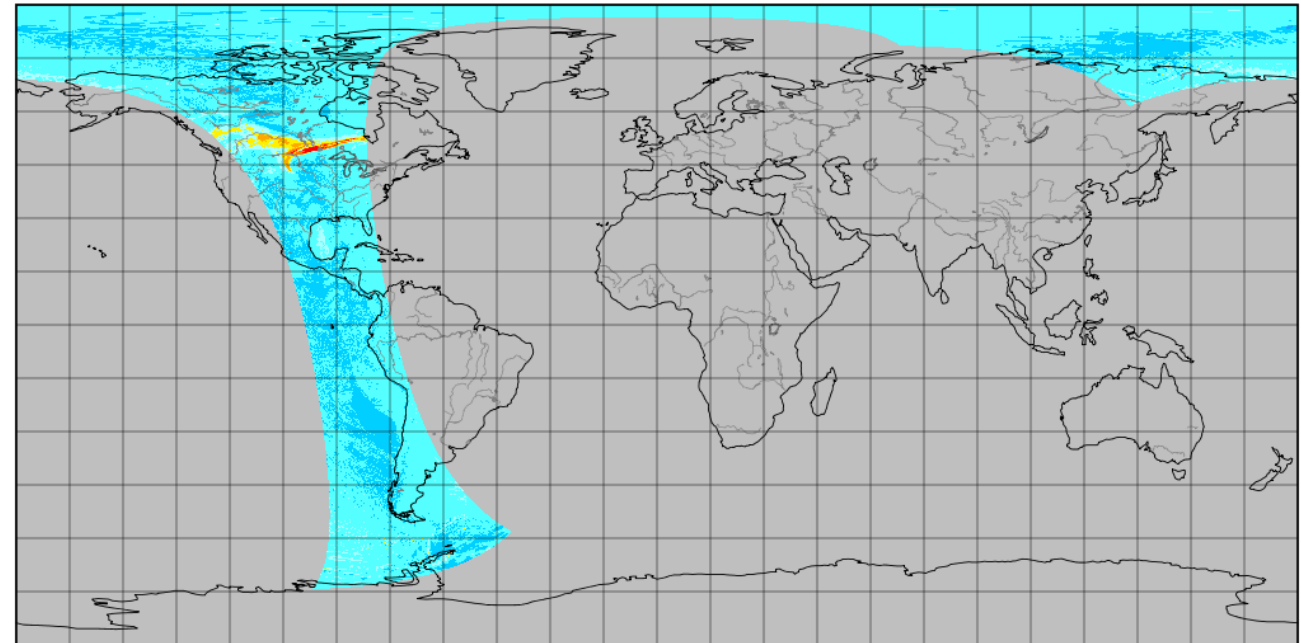


- **Scale:** Change min/max, apply a scale factor, change color scheme, format colorbar
- **Map:** Change projection, center lat/lon, change grid
- **Overlays:** Add overlays such as country boundaries, lakes, and rivers
- **Shading:** Add day/night boundary
- **Contours:** Add/edit contours
- **Labels:** Edit label names

Exercise – Map options

- Change the color scale and max min values to match the plot on the right
- Save this map as a .png file
- If not already downloaded, this data can be accessed here:
https://tropomi.gesdisc.eosdis.nasa.gov/data//S5P_TROPOMI_Level2/S5P_L2_AER_AI.1/2018/228/S5P_OFFL_L2_AER_AI_20180816T183016_20180816T201146_04361_01_010100_20180822T174822.nc

Aerosol index from 388 and 354 nm



Data Min = -4.6, Max = 10.6, Mean = -0.7

Array(s) Scale Map Overlays Shading Contours Vectors Labels

Scale Range: Min.: , Max.: Fit to Data

Scaling Factor: 10^{\wedge}

Units: of

Tick Format: Divisions, Major: , Minor: Size:

Scale Caption: Default Custom:

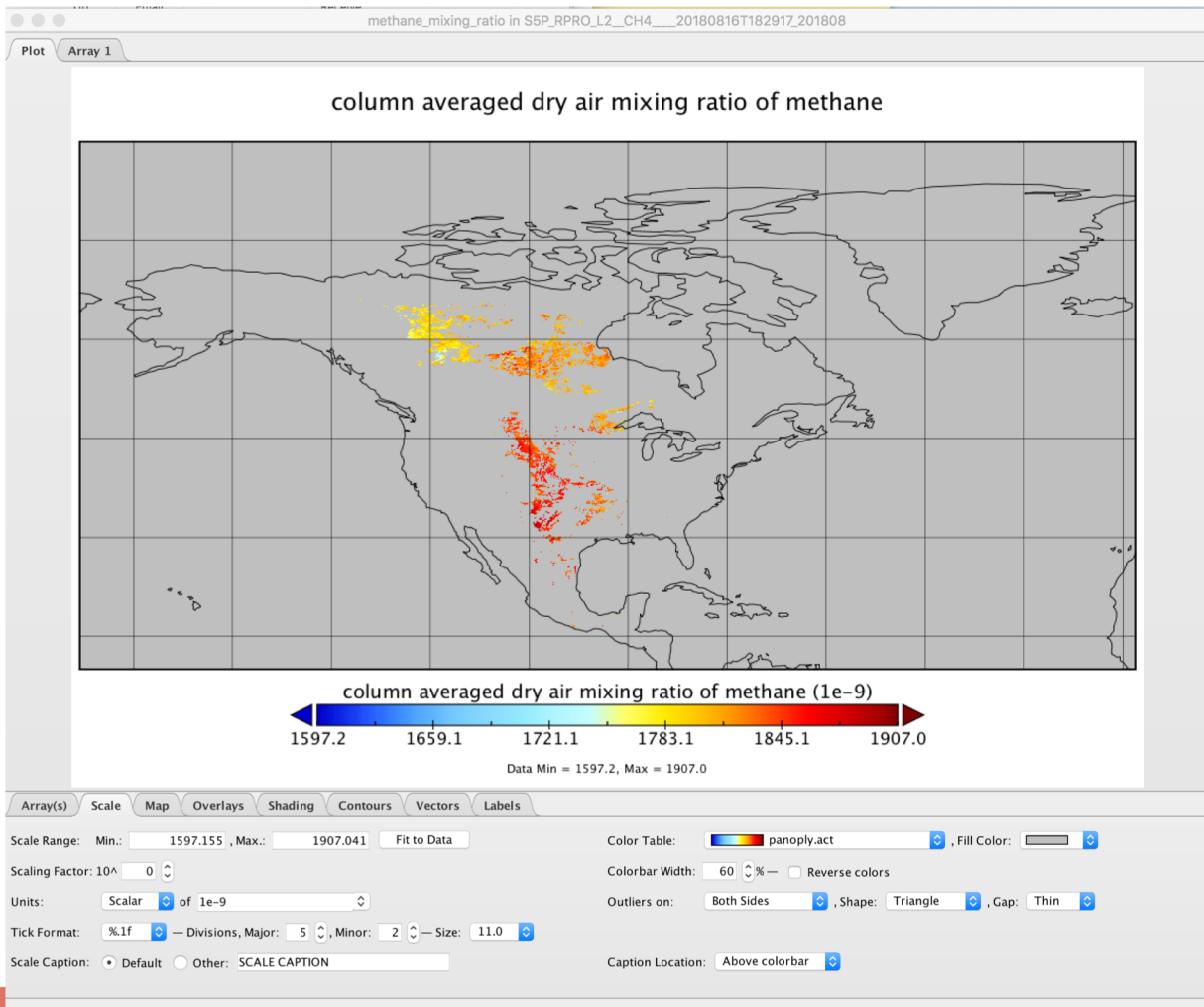
Color Table: Fill Color:

Colorbar Length: Reverse colors

Outliers on: Shape: Gap:

Caption Location:

Exercise – CH₄

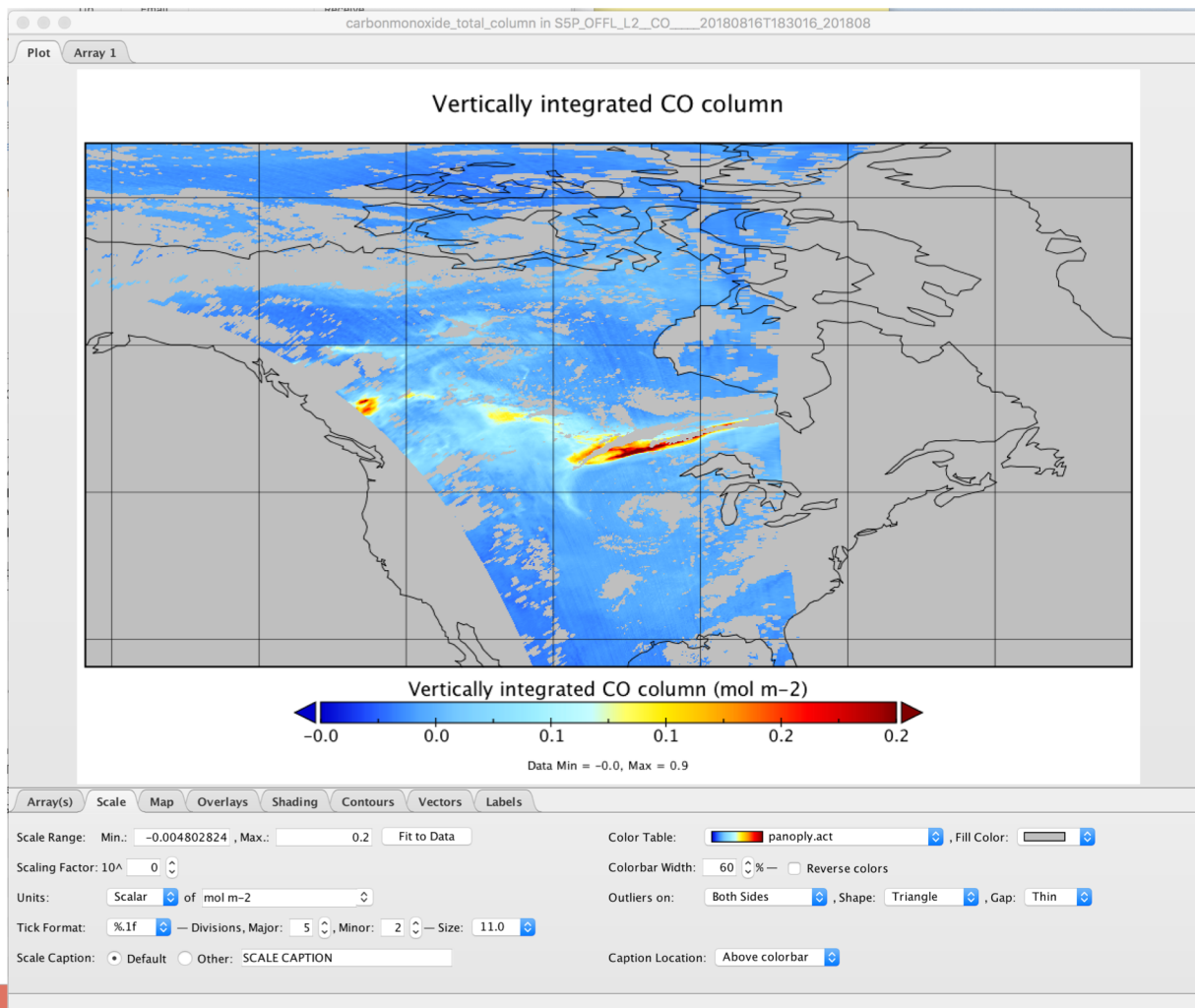


- Open and view the TROPOMI methane data
- Zoom into a region of interest
- Save the plot as a .png

• Methane data:

https://tropomi.gesdisc.eosdis.nasa.gov/data//S5P_TROPOMI_Level2/S5P_L2_CH4_20180816T182917_20180816T201245_04361_01_010202_20190101T194705.nc

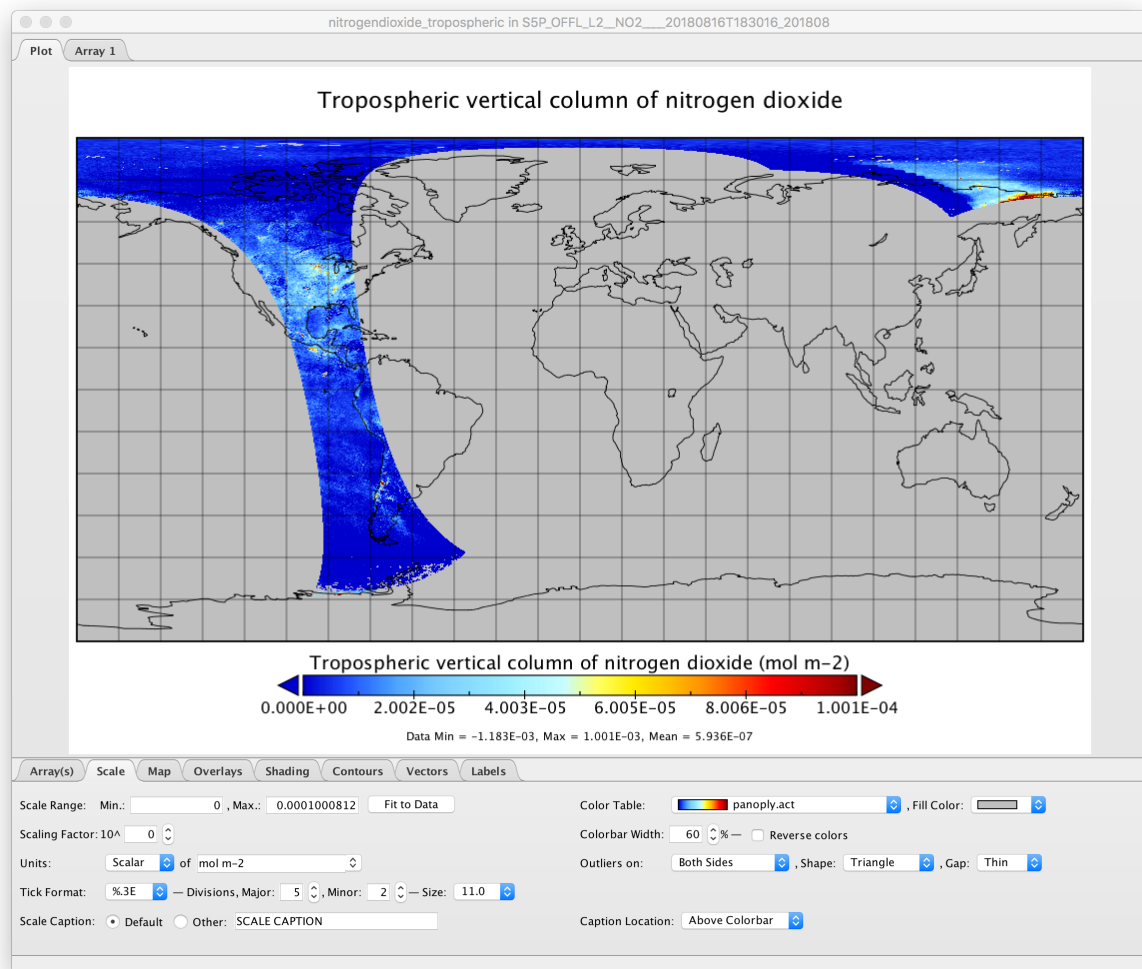
Exercise – CO



- Next plot the CO data
- Save the plot as a .png
- The TROPOMI CO data plotted here can be found at:

https://tropomi.gesdisc.eosdis.nasa.gov/data//S5P_TROPOMI_Level2/S5P_L2_CO_20180816T183016_20180816T201146_04361_01_010100_20180822T174815.nc

Exercise – NO₂



- Next plot the NO₂ data
- Save the plot as a .png
- The TROPOMI NO₂ data plotted here can be found at:
https://tropomi.gesdisc.eosdis.nasa.gov/data/S5P_TROPOMI_Level2/S5P_L2_NO2_20180816T182917_20180816T201245_04361_01_010202_20190218T070149.nc