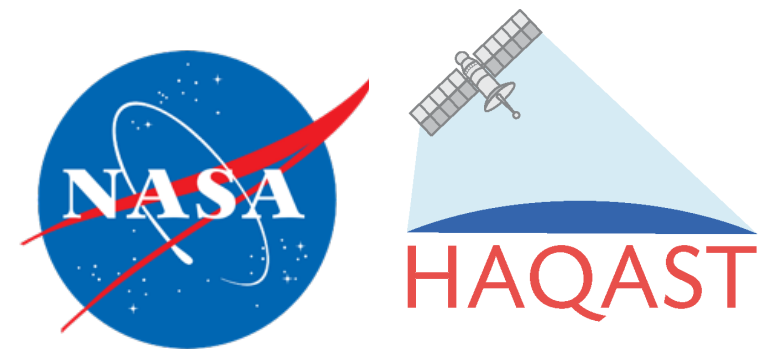
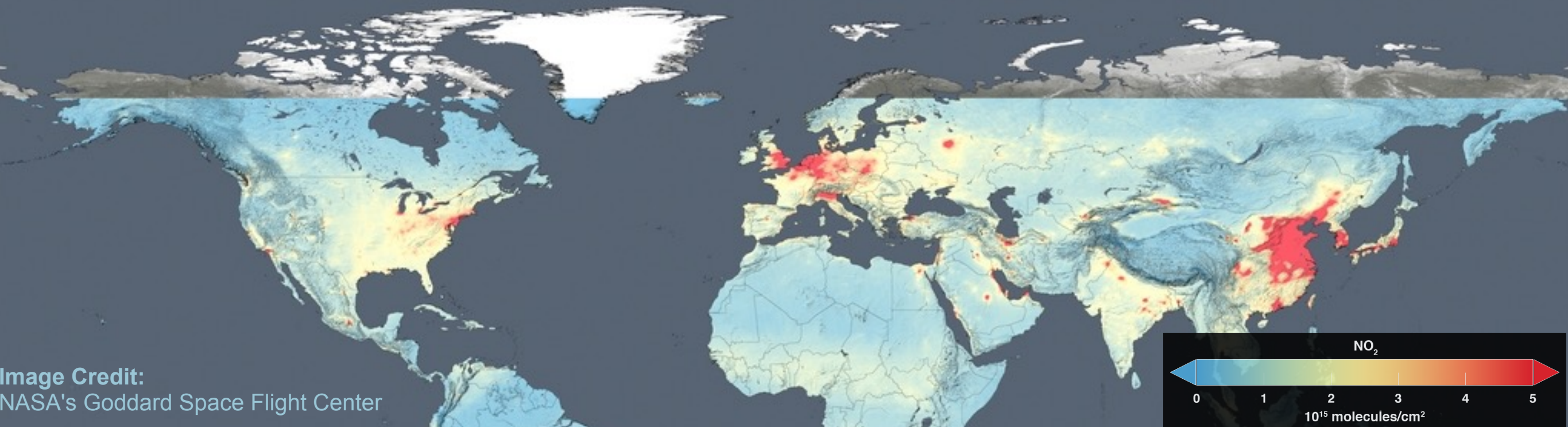




Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE



Visualizing satellite data: How to use NASA's Giovanni data visualizer?

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HAQAST6 Meeting, Pasadena, CA
July 12, 2019

Acknowledgement:

Arlene Fiore, Daniel Tong, Suhung Shen, Jennifer Wei, Rhianna Miles, Tracey Holloway

Select Plot

☒ Maps: Time Averaged Map * ▾ ☐ Comparisons: Select... ▾ ☐ Vertical: Select... ▾ ☐ Time Series: Select... ▾ ☐ Miscellaneous: Select... ▾

Select Date Range (UTC)

YYYY-MM-DD. HH:mm
- -  00 : 00 to - -  23 : 59

Valid Range: 1948-01-01 to 2019-07-04

Select Region (Bounding Box or Shape)

Format: West, South, East, North
   

Select Variables

▼ Disciplines

- ☐ Aerosols (188)
- ☐ Atmospheric Chemistry (76)
- ☐ Atmospheric Dynamics (424)
- ☐ Cryosphere (13)
- ☐ Hydrology (1209)
- ☐ Ocean Biology (59)
- ☐ Oceanography (162)
- ☐ Water and Energy Cycle (1272)

Number of matching Variables: 0 of 2007

Total Variable(s) included in Plot: 0

Keyword :

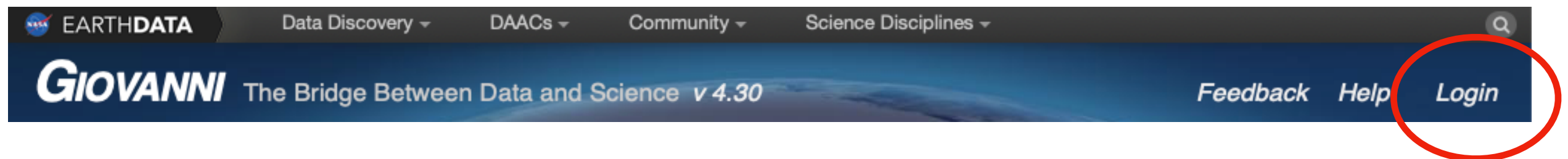
▼ Measurements

- ☐ Aerosol Index (6)
- ☐ Aerosol Optical Depth (88)
- ☐ Air Pressure Anomaly (1)
- ☐ Air Pressure (58)
- ☐ Air Temperature Anomaly (2)
- ☐ Air Temperature (105)
- ☐ Albedo (25)
- ☐ Altitude (8)
- ☐ Angstrom Exponent (20)
- ☐ Atmospheric Moisture (122)

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

First step: Register for an account on NASA EarthData

- You can use Giovanni as a guest, but limited to 4 time steps.
- Register your account at: <https://urs.earthdata.nasa.gov/users/new>
- Go to Giovanni website (<https://giovanni.gsfc.nasa.gov/giovanni/>), click on Login at the upper right corner.



- You may need to allow popup windows in your web browser.

What can you do with Giovanni?

- Make time-averaged maps (e.g. monthly, seasonal, annual average, or select your own time range).
- Make an animation.
- Make time series.
- Compare two variables: map of correlation, scatter plots.
- Make vertical profiles.
- Zonal mean maps.
- Histograms.

Limitations of Giovanni

- Cannot define data selection criteria.
- Map/graph customization is limited.
- Not easy to automate the jobs.
- Sometimes it can be slow, especially for large calculation (e.g. multiple years).
- Cannot compare between two time periods.
- Only Level-3 data are supported.
- Some species (e.g. HCHO) are not supported.
- You can only download the results, not the original data. (To download original data, click on the product landing page or data lineage).

1

Select Plot

Maps: Time Averaged Map *

Comparisons: Select...

Vertical: Select...

Time Series: Select...

Miscellaneous: Select...

2

Select Date Range (UTC)

YYYY-MM-DD

HH:mm

2011 - 01 - 01

00 : 00

to

2011 - 12 - 31

23 : 59

Valid Range: 2004-10-01 to 2019-07-02

3

Select Region (Bounding Box or Shape)

Format: West, South, East, North

Countries : United States;

4a

Select Variables

Disciplines

☐ Aerosols (188)

☒ Atmospheric Chemistry (76)

☐ Atmospheric Dynamics (424)

☐ Cryosphere (13)

☐ Hydrology (1209)

☐ Ocean Biology (59)

☐ Oceanography (62)

☐ Water and Energy Cycle (1272)

Measurements

☐ Aerosol Index (2)

☐ Aerosol Optical Depth (7)

☐ Air Temperature (1)

☐ Angstrom Exponent (2)

☐ CH4 (8)

☐ CO (22)

☐ CO2 (2)

☐ Emissivity (1)

☐ NO2 (2)

☐ Ozone (30)

Number of matching Variables: 76 of 2007

Total Variable(s) included in Plot: 1

Keyword :

	Variable	Units	Source	Temp.Res.	Spat.Res.	Begin
4b ☒	NO2 Tropospheric Column (30% Cloud Screened) (OMNO2d v003)	1/cm2	OMI	Daily	0.25 °	2004
☐	Ozone Total Column (Daytime/Ascending) (AIRX3STD v006)	DU	AIRS	Daily	1 °	2002
☐	Ozone Total Column (Nighttime/Descending) (AIRX3STD v006)	DU	AIRS	Daily	1 °	2002
☐	Ozone Total Column (Daytime/Ascending) (AIRX3STM v006)	DU	AIRS	Monthly	1 °	2002
☐	Ozone Total Column (Nighttime/Descending) (AIRX3STM v006)	DU	AIRS	Monthly	1 °	2002
☐	Ozone Total Column (DOAS) (OMDOAO3e v003)	DU	OMI	Daily	0.25 °	2004
☐	NO2 Total Column (30% Cloud Screened) (OMNO2t v003)	1/cm2	OMI	Daily	0.25 °	2004

5

Reset

Plot Data

Go to Results

Variables available at Giovanni

Select Variables

▼ Disciplines

- ☐ Aerosols (188)
- ☒ Atmospheric Chemistry (76)
- ☐ Atmospheric Dynamics (424)
- ☐ Cryosphere (13)
- ☐ Hydrology (1209)
- ☐ Ocean Biology (59)
- ☐ Oceanography (62)
- ☐ Water and Energy Cycle (1272)

▼ Measurements

- ☐ Aerosol Index (2)
- ☐ Aerosol Optical Depth (7)
- ☐ Air Temperature (1)
- ☐ Angstrom Exponent (2)
- ☐ CH₄ (8)
- ☐ CO (22)
- ☐ CO₂ (2)
- ☐ Emissivity (1)
- ☐ NO₂ (2)
- ☐ Ozone (30)
- ☐ SO₂ (4)
- ☐ Total Aerosol Optical Depth (2)

► Platform / Instrument

► Spatial Resolutions

► Temporal Resolutions

► Wavelengths

► Portal

▼ Platform / Instrument

- ☐ AIRS (35)
- ☐ MERRA Model (2)
- ☐ MERRA-2 Model (14)
- ☐ MODIS-Aqua (5)
- ☐ MODIS-Terra (2)
- ☐ MOPITT (9)
- ☐ OMI (6)
- ☐ TOMS EP (1)
- ☐ TOMS Meteor-3 (1)
- ☐ TOMS Nimbus-7 (1)

▼ Spatial Resolutions

- ☐ 0.25 ° (5)
- ☐ 0.5 x 0.625 ° (14)
- ☐ 1 ° (39)
- ☐ 1.0 ° (9)
- ☐ 1.0 x 1.25 ° (3)
- ☐ 1.25 ° (2)
- ☐ 2 x 2.5 ° (2)
- ☐ 4 km (2)

▼ Temporal Resolutions

- ☐ 3-hourly (2)
- ☐ 8-daily (2)
- ☐ daily (28)
- ☐ hourly (2)
- ☐ monthly (42)

▼ Wavelengths

- ☐ 550.0 (5)
- ☐ 869.0 (1)

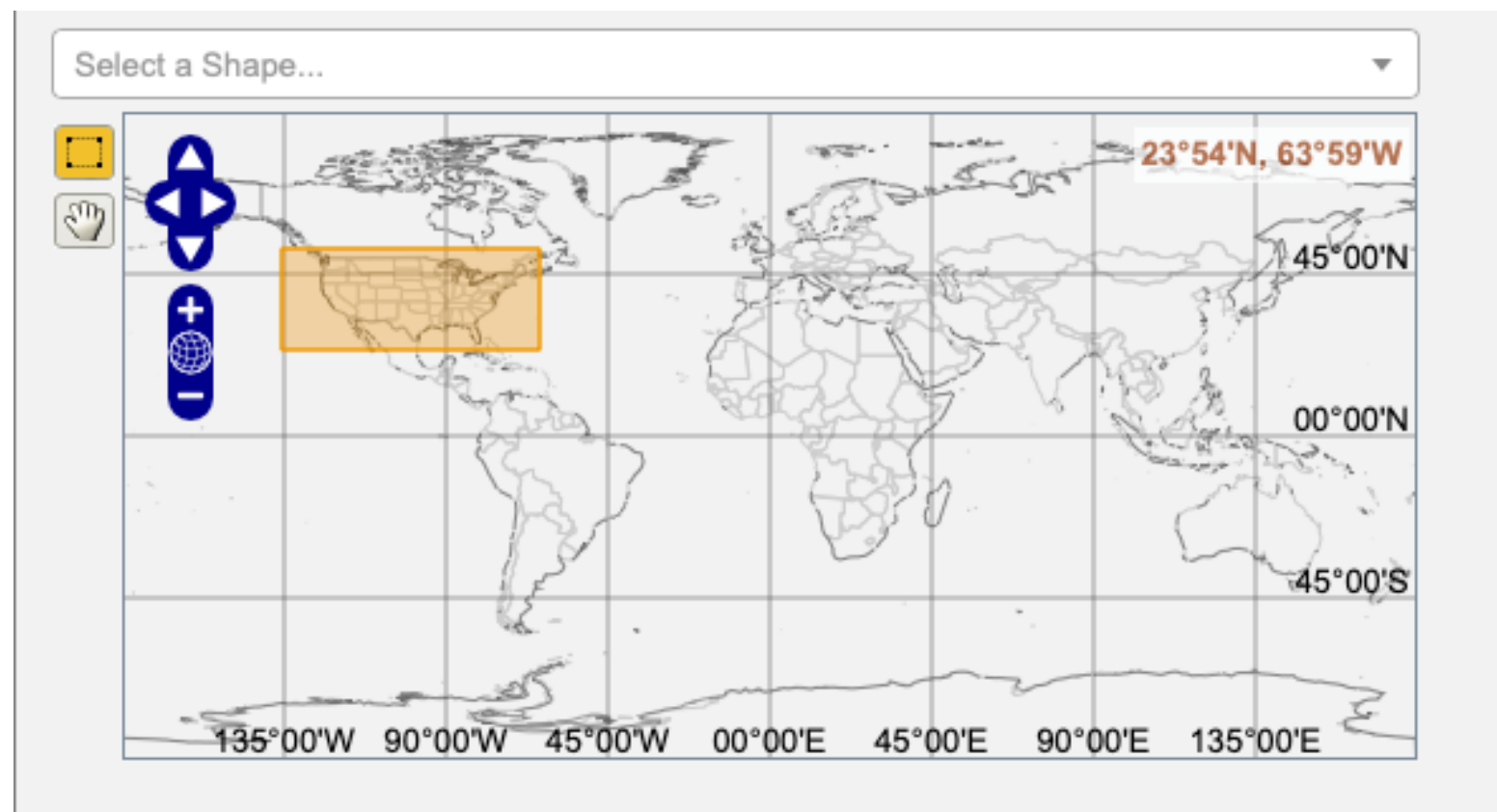
Options for selecting regions

Option 1: Type in the Latitude/Longitude Range

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

Option 2: Use the cursor to select a region on map.



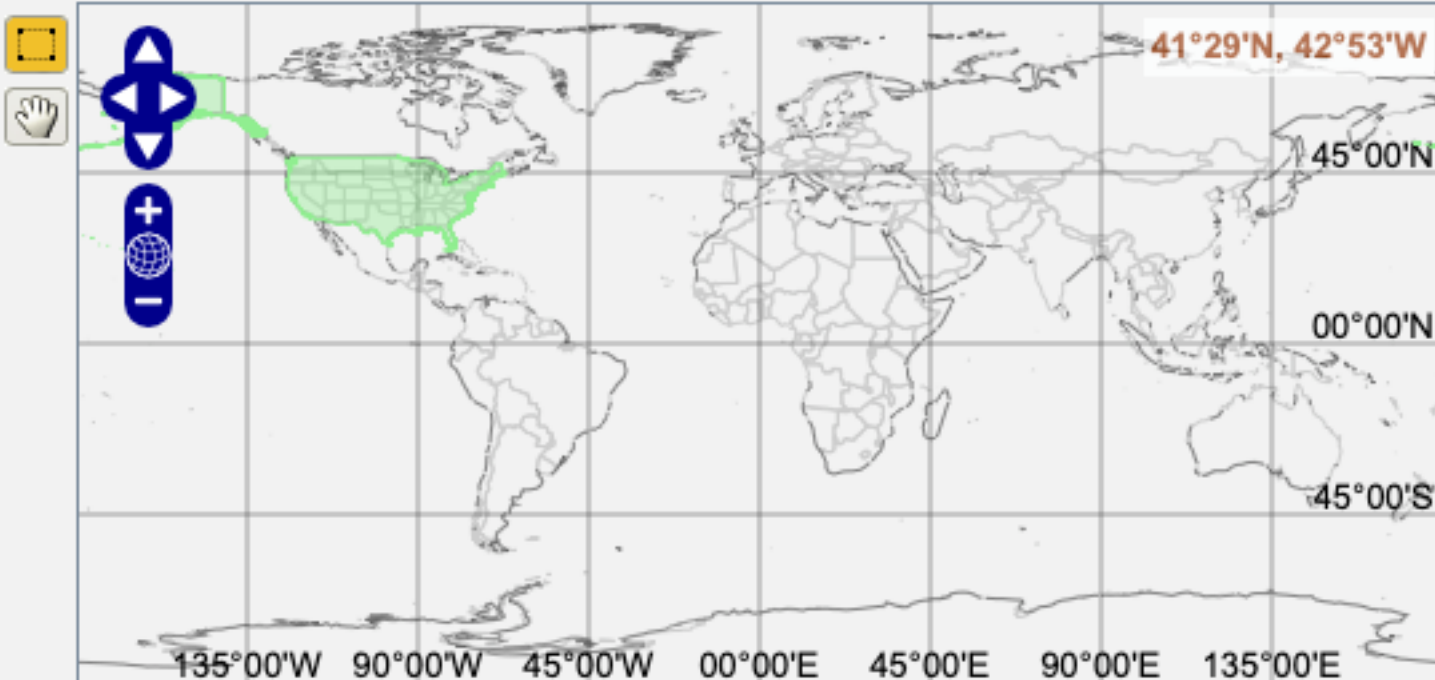
Options for selecting regions

Approach 3: Select by country, land/sea, US States, Watersheds.

Select a Shape...

- ▶ **Countries** (source: [HIU, US State Department](#))
- ▶ **Land Only file** (source: [GES DISC](#))
- ▶ **Sea Only file** (source: [GES DISC](#))
- ▶ **US States** (source: [TIGER/Line, US Census Bureau](#))
- ▶ **Watersheds** (source: [Major Hydrological Basins, FAO \(United Nations\)](#))

United States



Working with time averaged maps

EARTHDATA Data Discovery ▼ DAACs ▼ Community ▼ Science Disciplines ▼

GIOVANNI The Bridge Between Data and Science v 4.30 Feedback Help Log out (xjin0406)

1 Select Plot

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

2 Select Date Range (UTC)

YYYY-MM-DD HH:mm

2011 -01 -01 00 :00 to 2011 -12 -31 23 :59

Valid Range: 2004-10-01 to 2019-07-02

3 Select Region (Bounding Box or Shape)

Format: West, South, East, North

Countries : United States;   

4a Select Variables

▼ Disciplines

☒ Atmospheric Chemistry (2)

▼ Measurements

☐ Aerosol Index (2)

☐ Aerosol Optical Depth (7)

☐ Air Temperature (1)

☐ Angstrom Exponent (2)

☐ CH4 (8)

☐ CO (22)

☐ CO2 (2)

☐ Emissivity (1)

☒ NO2 (2)

☐ Ozone (30)

☐ SO2 (4)

☐ Total Aerosol Optical Depth (2)

▼ Platform / Instrument

☐ OMI (2)

▼ Spatial Resolutions

☐ 0.25 ° (2)

Number of matching Variables: 2 of 2007 Total Variable(s) included in Plot: 1

Keyword : Search Clear

	Variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date	End Date
☒	NO2 Tropospheric Column (30% Cloud Screened) (OMNO2d v003)	1/cm2	OMI	Daily	0.25 °	2004-10-01	2019-07-02
☐	NO2 Total Column (30% Cloud Screened) (OMNO2d v003)	1/cm2	OMI	Daily	0.25 °	2004-10-01	2019-07-02

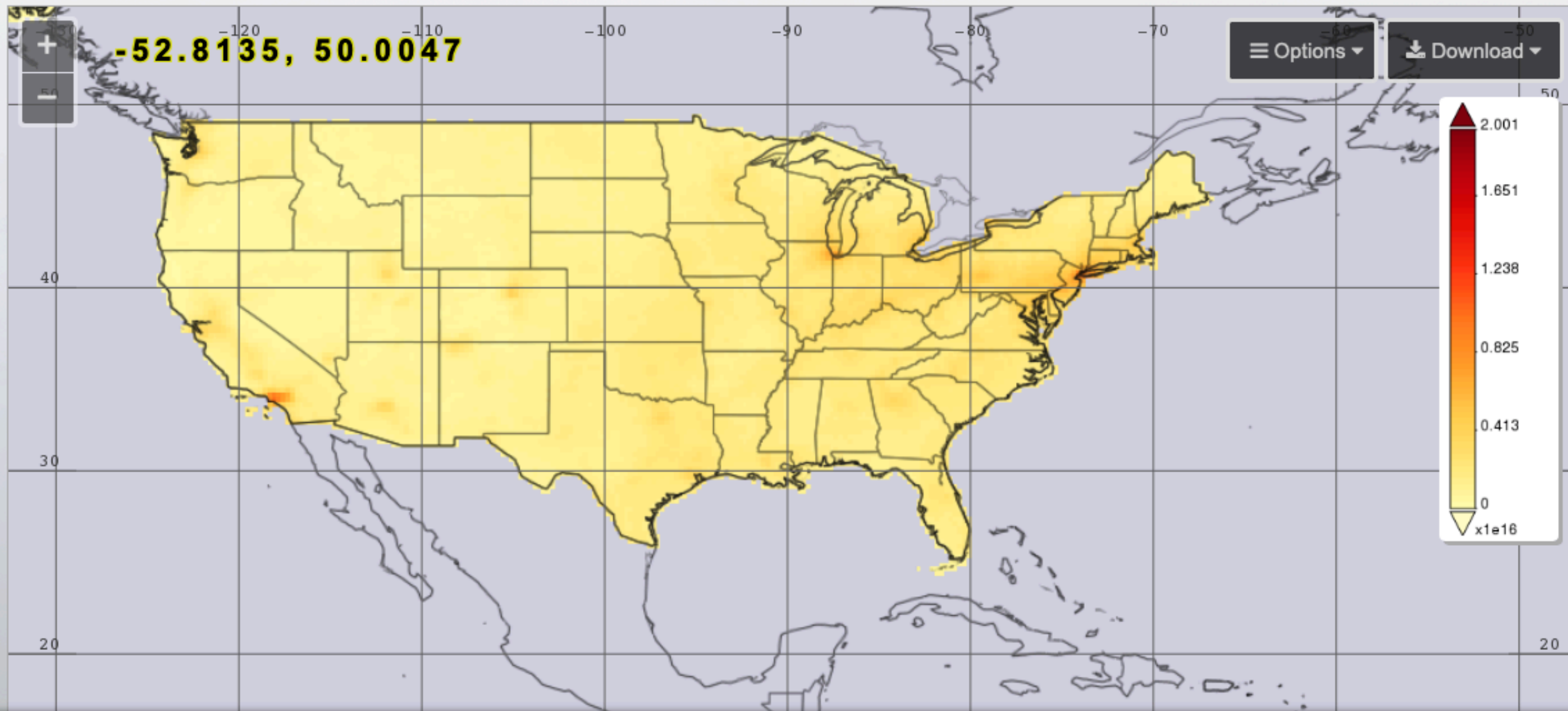
5 Reset Plot Data Go to Results

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

Annual average NO₂ tropospheric column density

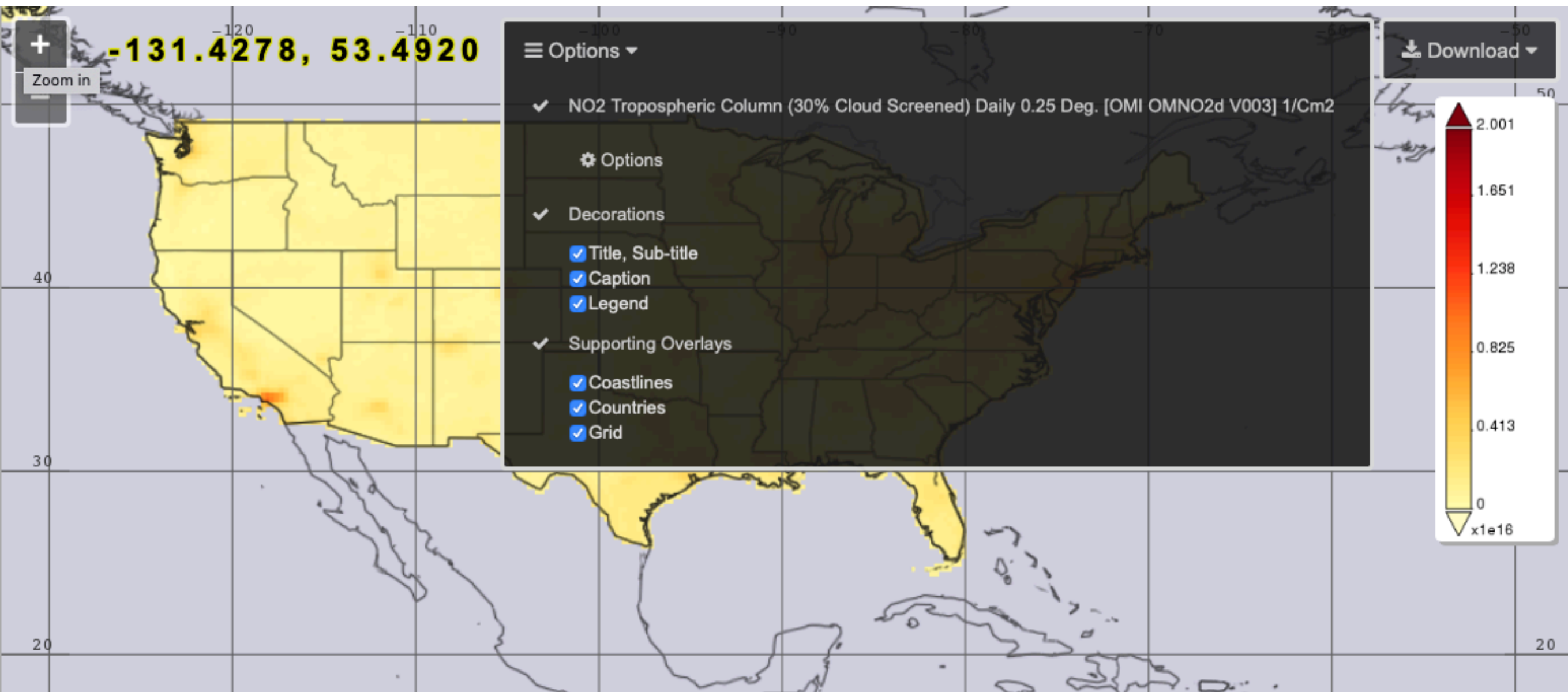
.....

Time Averaged Map of NO₂ Tropospheric Column (30% Cloud Screened) daily 0.25 deg. [OMI OMNO2d v003] 1/cm²
over 2011-01-01 - 2011-12-31, Shape United States



How to customize maps?

.....



How to customize maps: More options

Map Options [X]

*NO2 Tropospheric Column (30% Cloud Screened) daily 0.25 deg.
[OMI OMNO2d v003] 1/cm2*

Data Range

0 Minimum

2.00000005e+16 Maximum

Palette

☒ Yellow-Orange-Red (Seq), 65

[View All Palettes](#)

Smoothing

☐ On ☒ Off

Scaling

☒ Linear ☐ Log

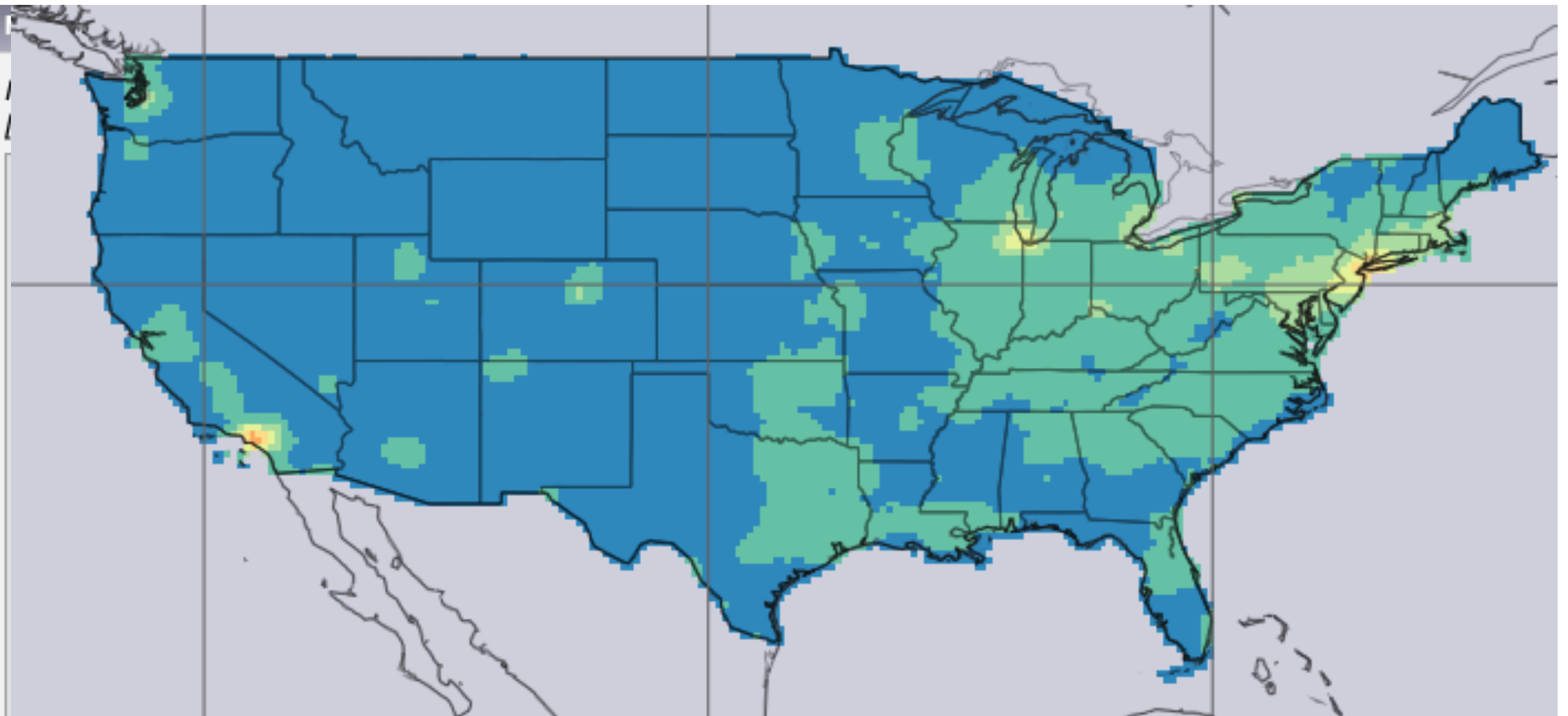
Palette Options [X]

	Preview	Name
☐		Air Quality Index (Cust), 8
☐		Blue-Green-Yellow (Seq), 9
☐		Blue-Pink (Seq), 65
☐		Blue-Red (Div), 10
☐		Blue-Red (Div), 11
☐		Blue-Yellow-Red (Div), 10
☐		Blue-Yellow-Red (Div), 11
☐		Blue-Yellow-Red (Div), 12
☐		Blue-Yellow-Red (Div), 12 (Source: Panoply)
☐		Blue-Yellow-Red (Div), 65
☐		Blues (Seq), 65

[Close](#) [Add Palette](#)

[Restore Defaults](#) [Re-Plot](#)

Customized map



Equidistant Cylindrical 

Scaling

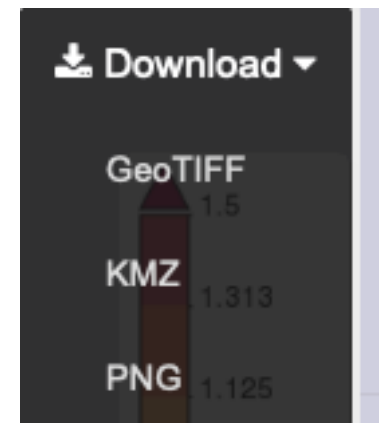
☒ Linear ☐ Log

Restore Defaults

Re-Plot

Four options to save results

- NetCDF: for further analysis in other tools (e.g. Panoply, programming).
- PNG: Ready to present!
- GEOTIFF: tiff with geographic information (e.g. use in ArcGIS).
- KMZ: plot in Google Earth.



Browse History

6. Time Averaged Map

..... User Input

..... Plots

..... **Downloads**

..... Lineage

5. Time Series, Area-Averaged

..... User Input

Click on file links to download. Files contain data portrayed in the plot images.

NetCDF:

[g4.timeAvgMap.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20110101-20111231.180W_90S_180E_90N.nc](#)

PNG:

[OMNO2d_003_ColumnAmountNO2TropCloudScreened.20110101-20111231.180W_90S_180E_90N.png](#)

GEOTIFF:

[OMNO2d_003_ColumnAmountNO2TropCloudScreened.20110101-20111231.180W_90S_180E_90N.tif](#)

KMZ:

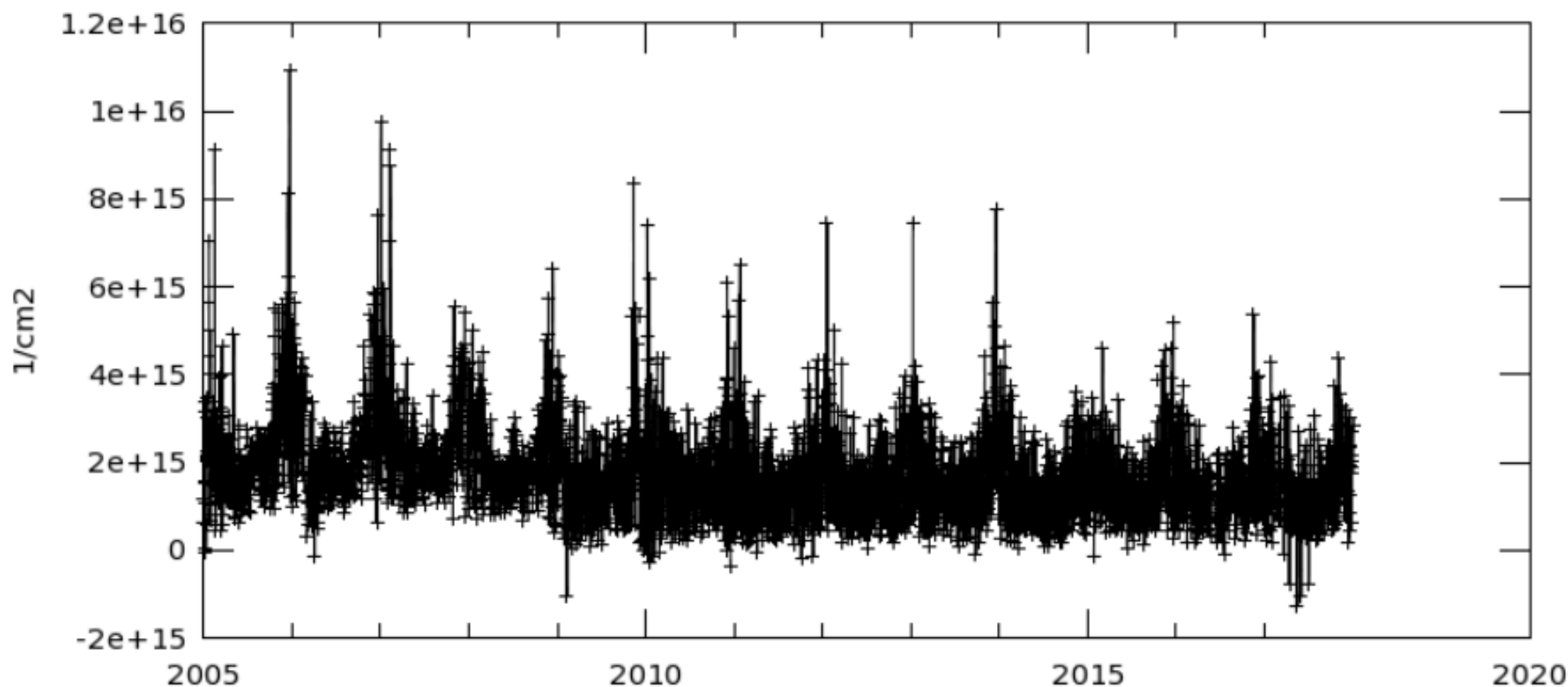
[OMNO2d_003_ColumnAmountNO2TropCloudScreened.20110101-20111231.180W_90S_180E_90N.kmz](#)

.....


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

NO₂ tropospheric column density over LA region

Time Series, Area-Averaged of NO₂ Tropospheric Column (30% Cloud Screened) daily 0.25 deg.
[OMI OMNO2d v003] 1/cm² over 2005-01-01 - 2017-12-31, Region 122.7832W, 32.7832N,
116.6309W, 36.2109N



Image

Options

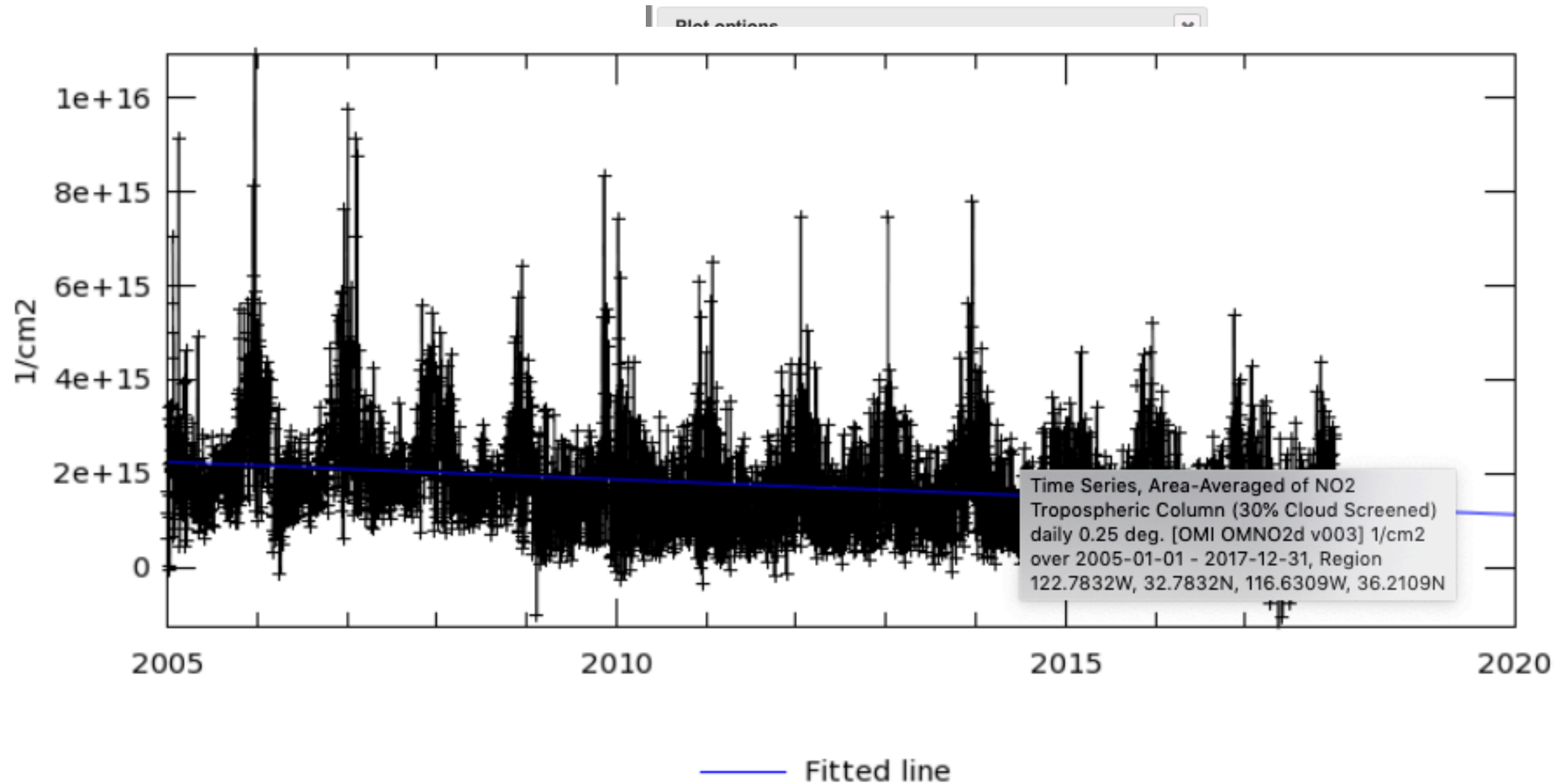
Re-Plot Options

☒ Show title

☒ Show caption

- The user-selected region was defined by 122.7832W, 32.7832N, 116.6309W, 36.2109N. The data grid also limits the analyzable region to the following bounding points: 122.625W, 32.875N, 116.875W, 36.125N. This analyzable region indicates the spatial limits of the subsetted granules that went into making this visualization result.

Fit a trend line



Save figure and data

 Browse History

 7. Time Series, Area-Averaged

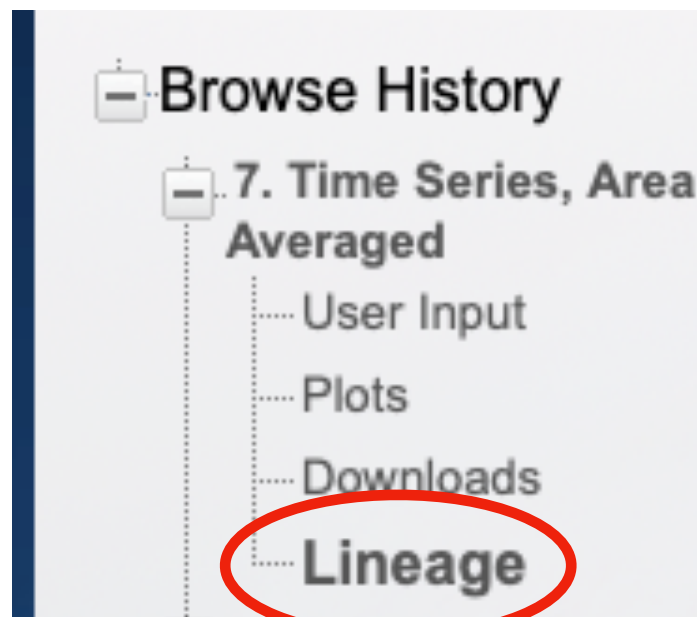
- User Input
- Plots
- Downloads**
- Lineage

Click on file links to download. Files contain data portrayed in the plot images.

ASCII CSV:
[g4.areaAvgTimeSeries.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050101-20171231.122W_32N_116W_36N.csv](#)

PNG:
[g4.areaAvgTimeSeries.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050101-20171231.122W_32N_116W_36N.png](#)

To download the original data



Data File Search (Time taken: 47.92 s)	
Output	
Data URL	http://acdisc.gesdisc.eosdis.nasa.gov/opensap/HDF-EOS5/ncml/Aura_OMI_Level3/OMNO2d.003/2005/OMI-Aura_L3-OMNO2d_2005m0101_v003-2018m0626t144023.he5.ncml.nc?ColumnAmountNO2TropCloudScreened[0:719][0:1439].lat[0:719].lon[0:1439]
Data URL	http://acdisc.gesdisc.eosdis.nasa.gov/opensap/HDF-EOS5/ncml/Aura_OMI_Level3/OMNO2d.003/2005/OMI-Aura_L3-OMNO2d_2005m0102_v003-2018m0626t143459.he5.ncml.nc?ColumnAmountNO2TropCloudScreened[0:719][0:1439].lat[0:719].lon[0:1439]
Data URL	http://acdisc.gesdisc.eosdis.nasa.gov/opensap/HDF-EOS5/ncml/Aura_OMI_Level3/OMNO2d.003/2005/OMI-Aura_L3-OMNO2d_2005m0103_v003-2018m0626t143501.he5.ncml.nc?ColumnAmountNO2TropCloudScreened[0:719][0:1439].lat[0:719].lon[0:1439]
Data URL	http://acdisc.gesdisc.eosdis.nasa.gov/opensap/HDF-EOS5/ncml/Aura_OMI_Level3/OMNO2d.003/2005/OMI-Aura_L3-OMNO2d_2005m0104_v003-2018m0626t143504.he5.ncml.nc?ColumnAmountNO2TropCloudScreened[0:719][0:1439].lat[0:719].lon[0:1439]
Data URL	http://acdisc.gesdisc.eosdis.nasa.gov/opensap/HDF-EOS5/ncml/Aura_OMI_Level3/OMNO2d.003/2005/OMI-Aura_L3-OMNO2d_2005m0105_v003-2018m0626t144014.he5.ncml.nc?ColumnAmountNO2TropCloudScreened[0:719][0:1439].lat[0:719].lon[0:1439]
Data URL	http://acdisc.gesdisc.eosdis.nasa.gov/opensap/HDF-EOS5/ncml/Aura_OMI_Level3/OMNO2d.003/2005/OMI-Aura_L3-OMNO2d_2005m0106_v003-2018m0626t143501.he5.ncml.nc?ColumnAmountNO2TropCloudScreened[0:719][0:1439].lat[0:719].lon[0:1439]
Data URL	http://acdisc.gesdisc.eosdis.nasa.gov/opensap/HDF-EOS5/ncml/Aura_OMI_Level3/OMNO2d.003/2005/OMI-Aura_L3-OMNO2d_2005m0107_v003-2018m0626t143458.he5.ncml.nc?ColumnAmountNO2TropCloudScreened[0:719][0:1439].lat[0:719].lon[0:1439]
Data URL	http://acdisc.gesdisc.eosdis.nasa.gov/opensap/HDF-EOS5/ncml/Aura_OMI_Level3/OMNO2d.003/2005/OMI-Aura_L3-OMNO2d_2005m0108_v003-2018m0626t144018.he5.ncml.nc?ColumnAmountNO2TropCloudScreened[0:719][0:1439].lat[0:719].lon[0:1439]
Data URL	http://acdisc.gesdisc.eosdis.nasa.gov/opensap/HDF-EOS5/ncml/Aura_OMI_Level3/OMNO2d.003/2005/OMI-Aura_L3-OMNO2d_2005m0109_v003-2018m0626t144018.he5.ncml.nc?ColumnAmountNO2TropCloudScreened[0:719][0:1439].lat[0:719].lon[0:1439]
Too many URLs to display. Download list of all URLs in step	
Data File Staging (Time taken: 4.45 s)	
Output	
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050101.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050102.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050103.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050104.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050105.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050106.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050107.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050108.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050109.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050110.nc
Too many URLs to display. Download list of all URLs in step	

If you selected multiple files, it's recommended to download the URLs, and use other tools (e.g. wget) to download data.

Bookmarking and data sharing

- You can bookmark the analysis by saving the URL of the Giovanni page. In the future you can always reload this analysis by copying and pasting the saved Giovanni URL into a browser.
- If you like the plot and want to share it with other people, you can also save the URL and they will be able to see your selections and figure.

Other figures: Histograms

Select Plot

☐ Maps: *Select...* ☐ Comparisons: *Select...* ☐ Vertical: *Select...* ☐ Time Series: *Select...*

☒ Miscellaneous: Histogram *

Select Date Range (UTC)

YYYY-MM-DD

HH:mm

2011 -01 -01

00 :00

to

2011 -02 -01

23 :59

Valid Range: 2004-10-01 to 2019-07-02

Select Region (Bounding Box or Shape)

Format: West, South, East, North

-130.7812,24.6094,-68.9062,53.4375

Miscellaneous Choices

☐ Zonal Mean

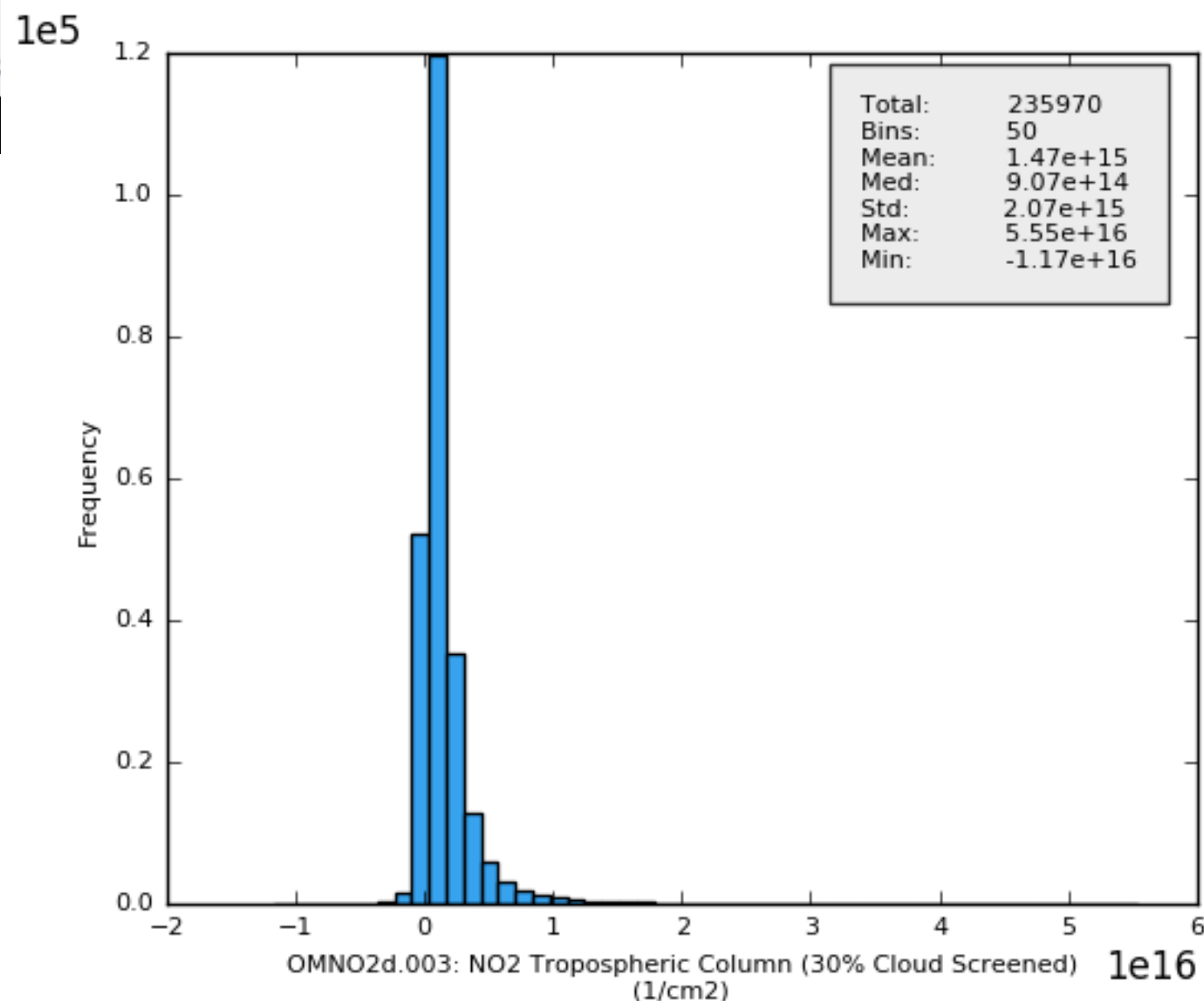
Zonal mean plot, averaged values are plotted over latitude zones

[Details...](#)

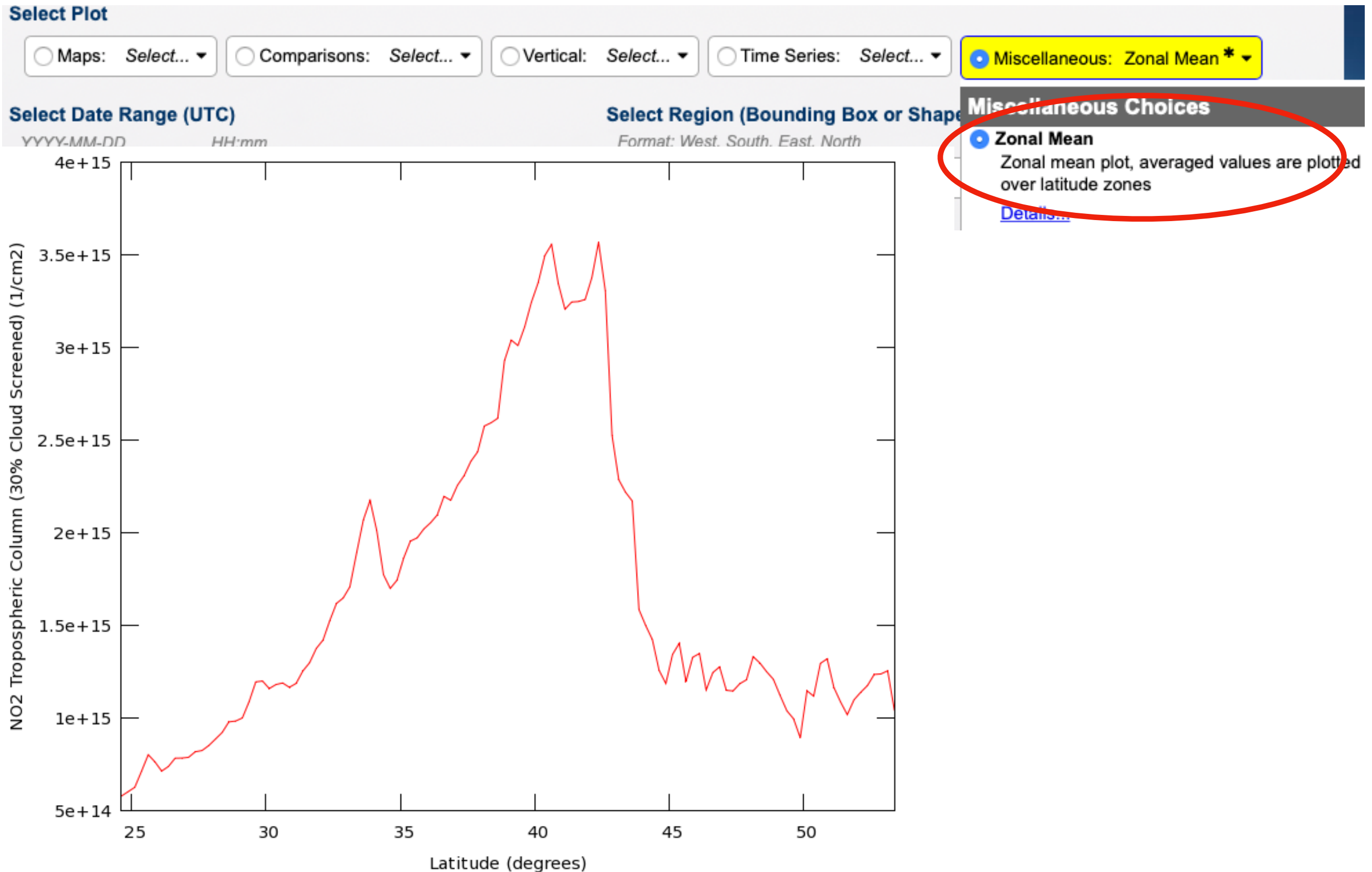
☒ Histogram

Distribution of values over time and space

[Details...](#)



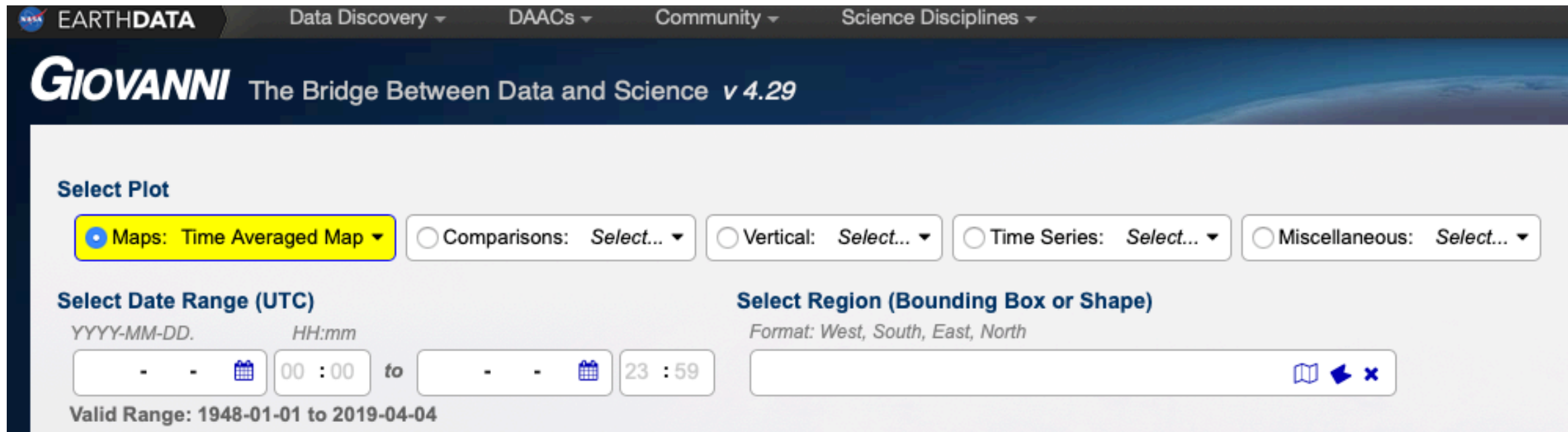
Other figures: Zonal Average Maps (Averaging across longitude)



Mini Project: Linking OMI tropospheric NO₂ with ground-level NO₂

.....

- Part I: Visualize and analyze OMI tropospheric NO₂ data using Giovanni (<https://giovanni.gsfc.nasa.gov/giovanni/>)



The screenshot shows the GIOVANNI web interface. At the top is the NASA EARTHDATA logo and navigation links: Data Discovery, DAACs, Community, and Science Disciplines. Below this is the GIOVANNI logo and the tagline 'The Bridge Between Data and Science v 4.29'. The main section is titled 'Select Plot' and contains five radio button options: 'Maps: Time Averaged Map' (selected), 'Comparisons: Select...', 'Vertical: Select...', 'Time Series: Select...', and 'Miscellaneous: Select...'. Below the plot selection are two sections: 'Select Date Range (UTC)' and 'Select Region (Bounding Box or Shape)'. The date range section has input fields for 'YYYY-MM-DD.' and 'HH:mm', with a 'Valid Range: 1948-01-01 to 2019-04-04' note. The region section has a text input field and a 'Format: West, South, East, North' note. There are also icons for map, back, and close.

- Part II: Compare OMI NO₂ with EPA AQS ground-based measurements of NO₂ (<https://www.epa.gov/outdoor-air-quality-data>) using Excel.



Environmental Topics

Laws & Regulations

About EPA

Outdoor Air Quality Data