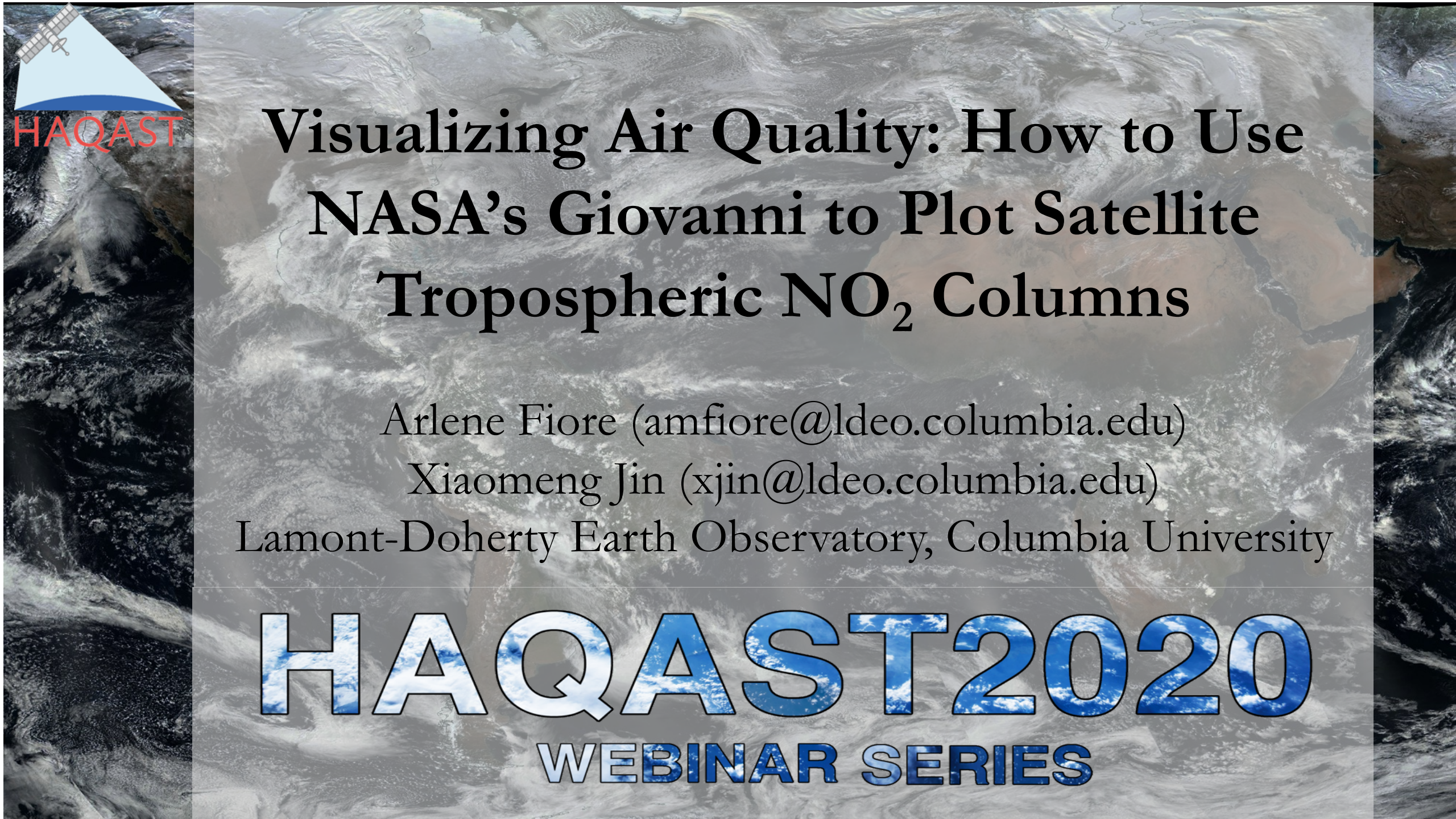


Visualizing Air Quality: How to Use NASA's Giovanni to Plot Satellite Tropospheric NO_2 Columns

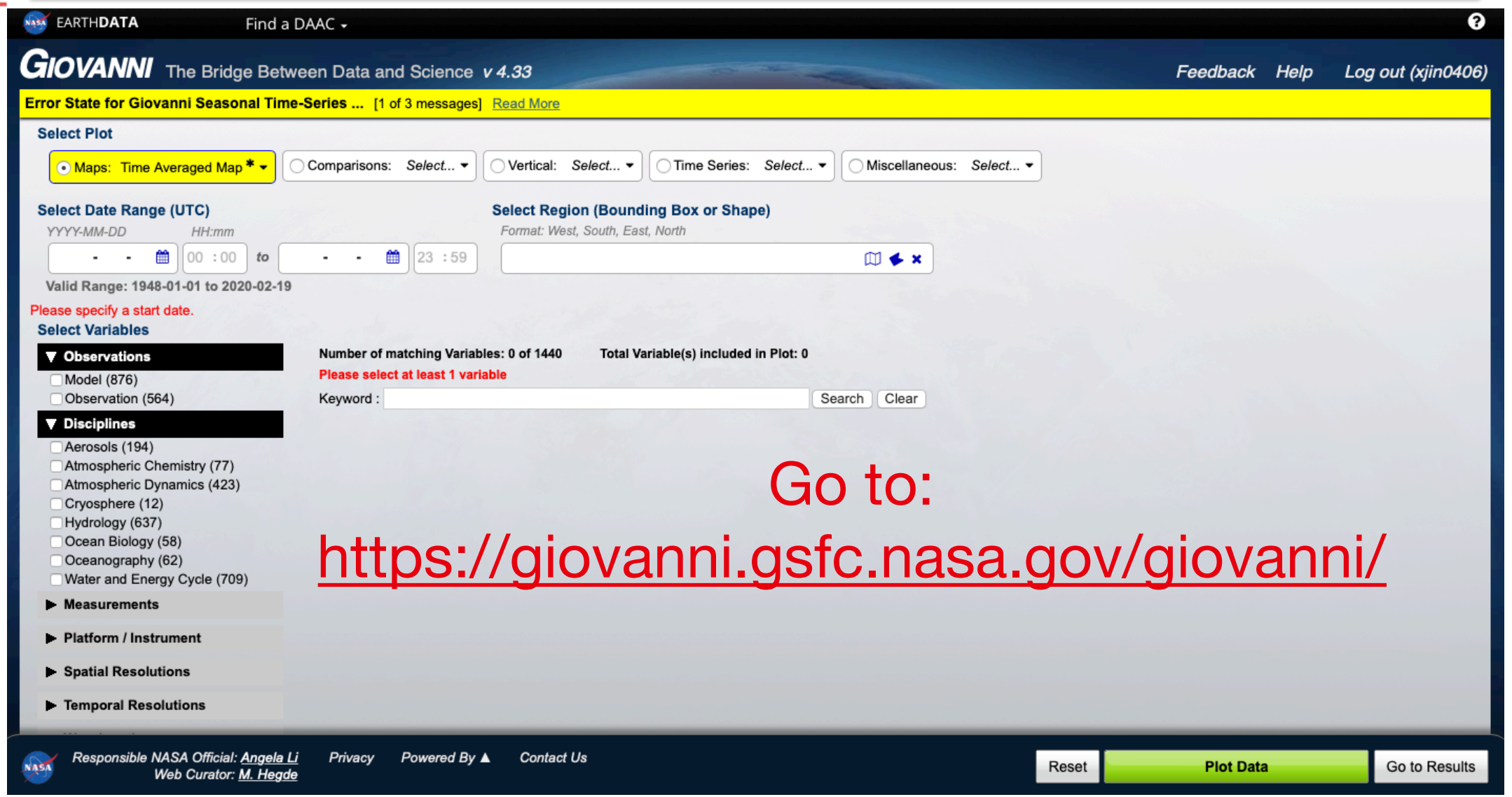
Arlene Fiore (amfiore@ldeo.columbia.edu)
Xiaomeng Jin (xjin@ldeo.columbia.edu)
Lamont-Doherty Earth Observatory, Columbia University

HAQAST2020
WEBINAR SERIES

Outline

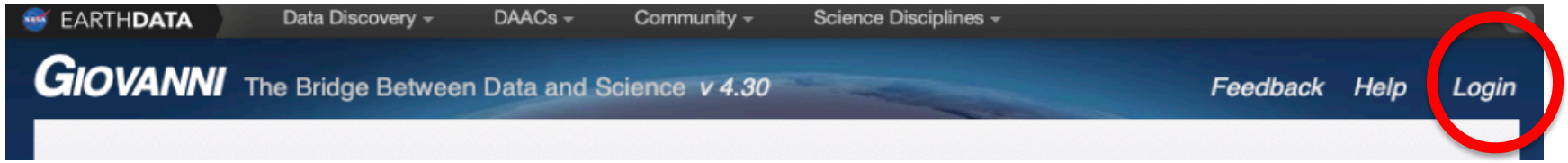
- Introduction to NASA's Giovanni online visualization tool
- Overview of guidance documents from a HAQAST Tiger Team ('Supporting the use of Satellite Data in SIPs')
- Q&A

Giovanni: The bridge between data and science



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.



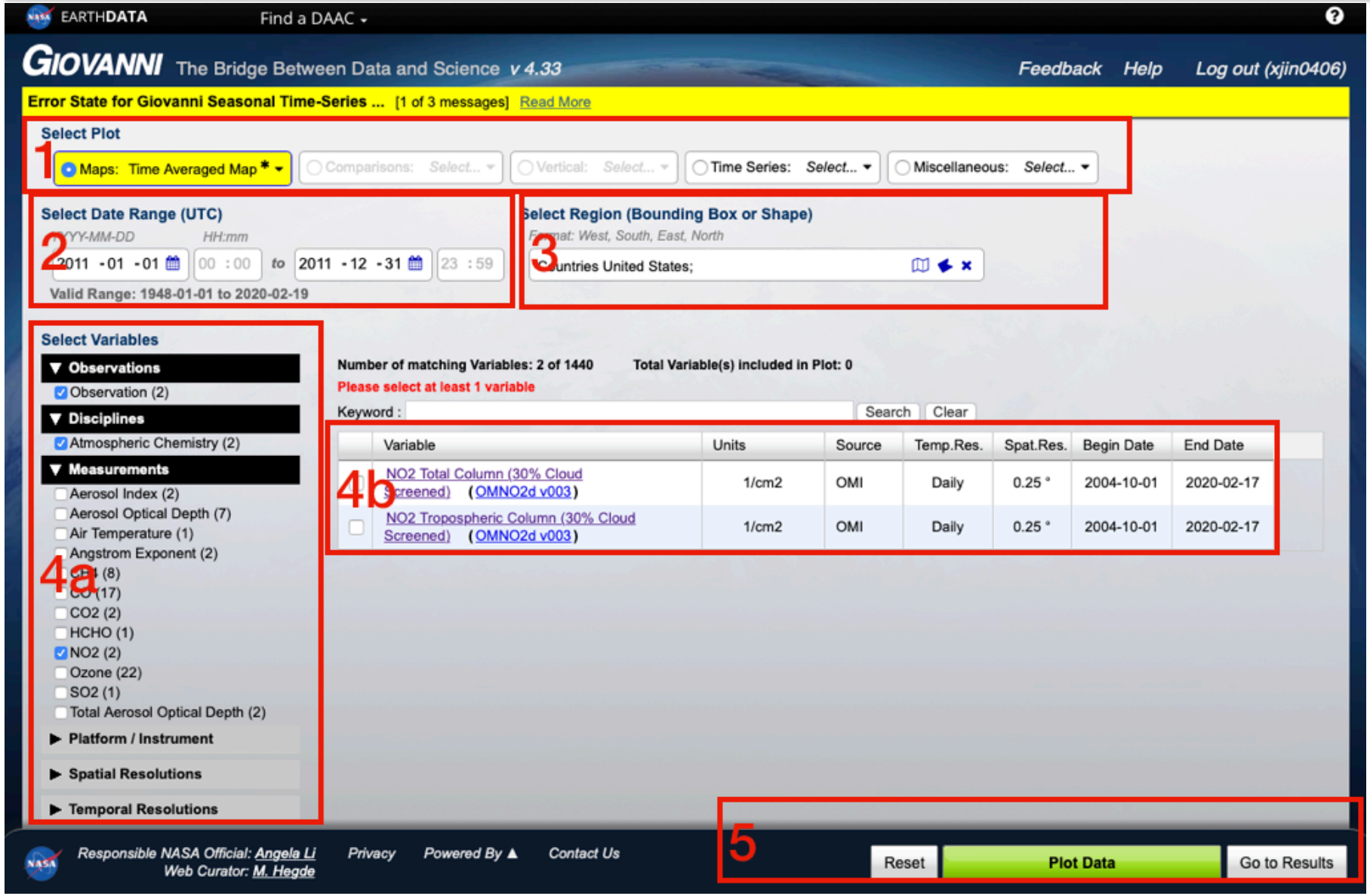
What can you do with Giovanni?

- 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.
- Multiple measurements: NO_2, SO_2, HCHO, CO, aerosol optical depth (AOD).
- Multiple instruments: OMI, MISR, MOPPIT, AIRS, MODIS.

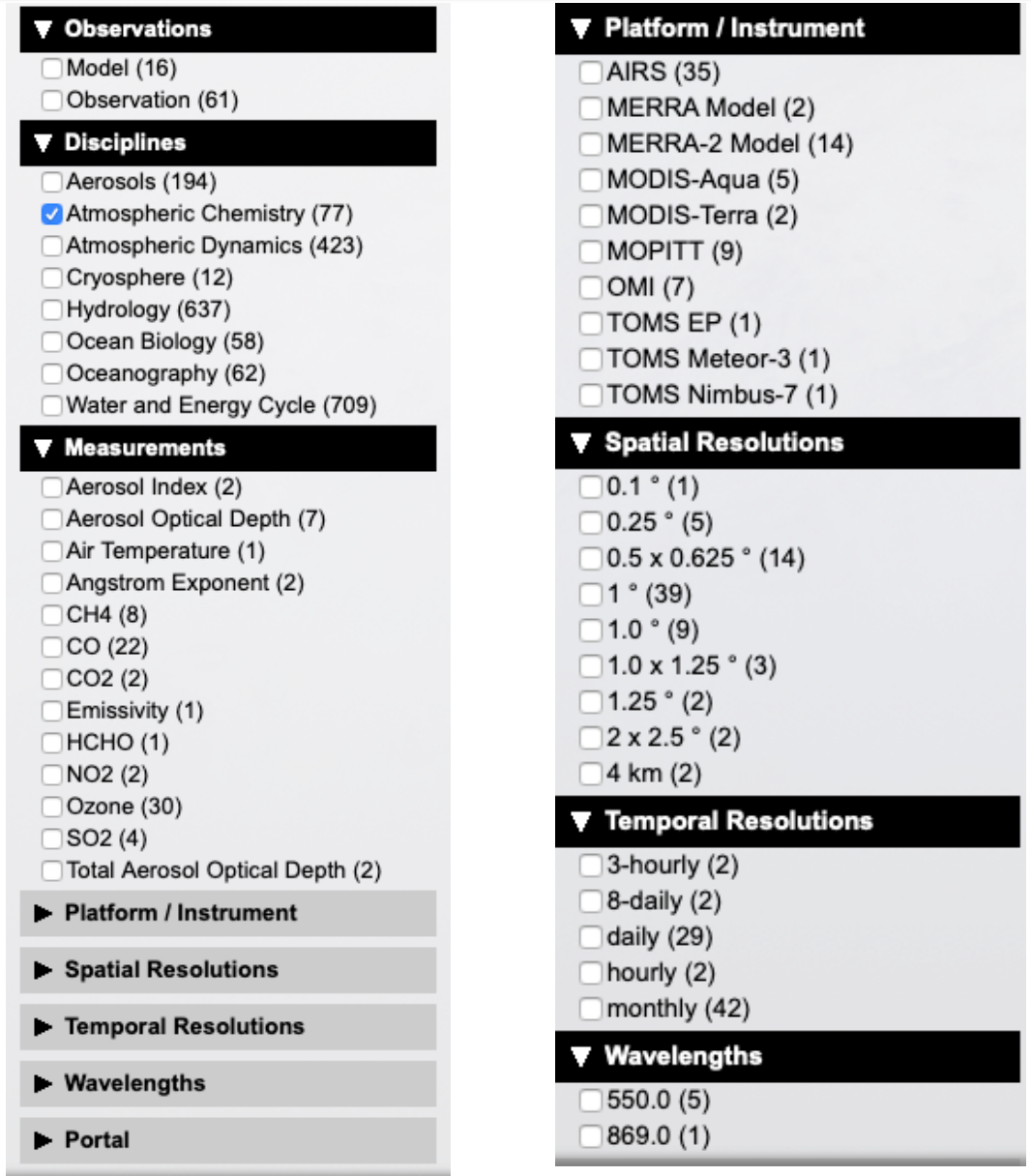
Limitations of Giovanni

- 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. NH_3) are not supported.
- TROPOMI data are still not included.
- You can only download the results, not the original data. (To download original data, click on the product landing page or data lineage).

Make a plot in five steps!

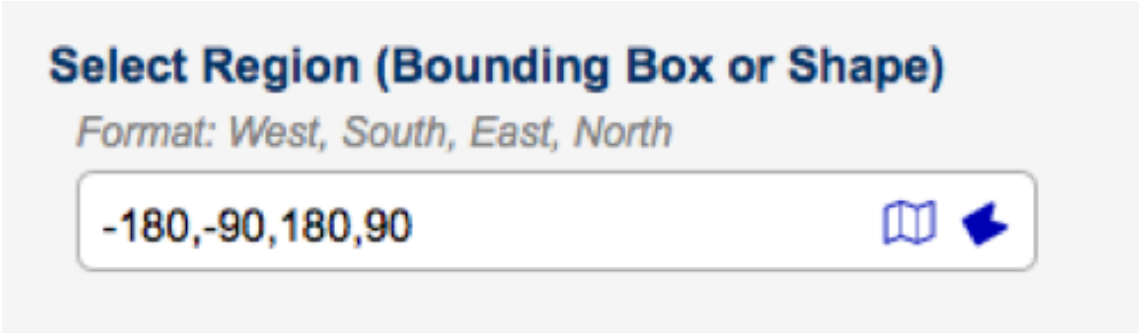


Select variables

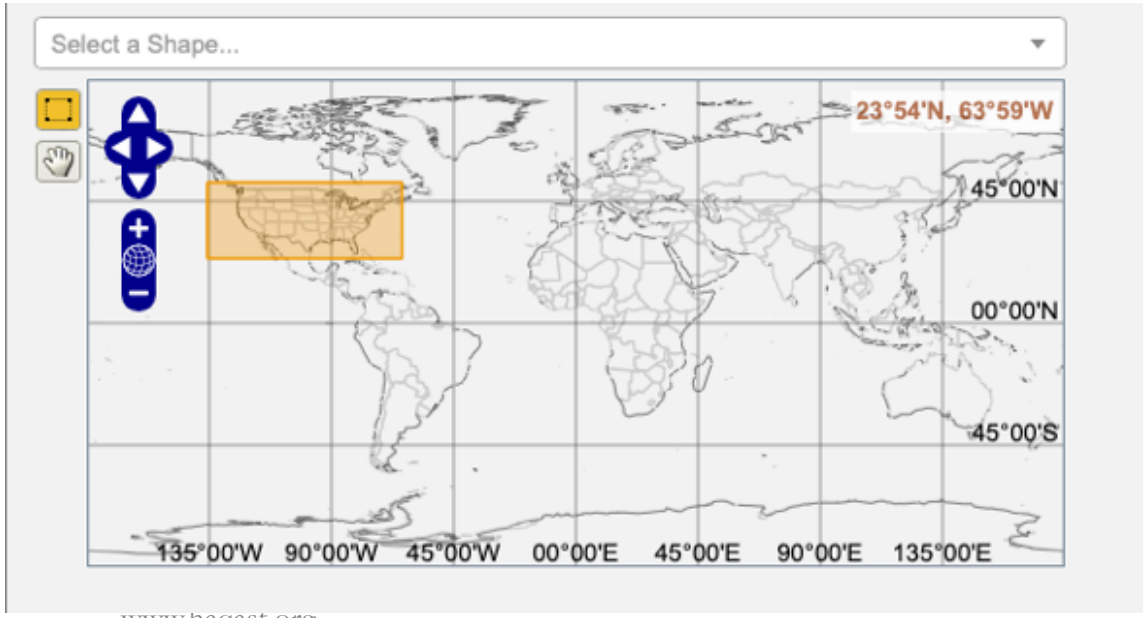


Options for selecting regions

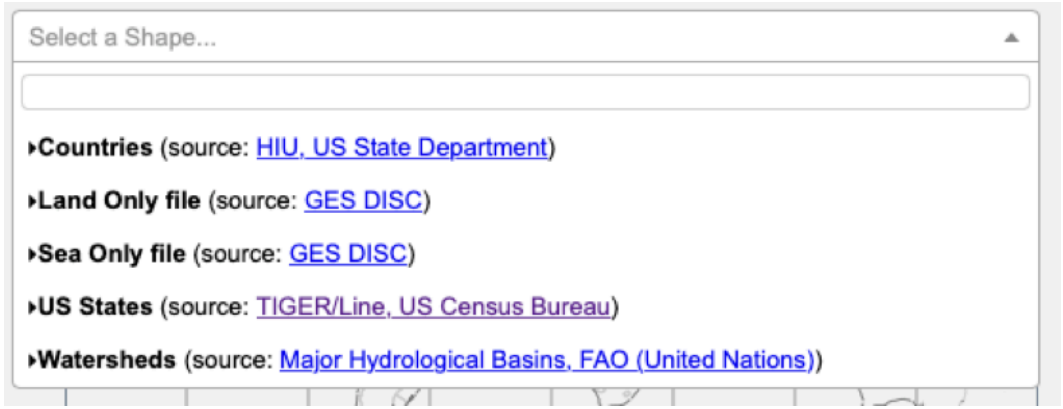
Option 1: Type in the Latitude/Longitude Range

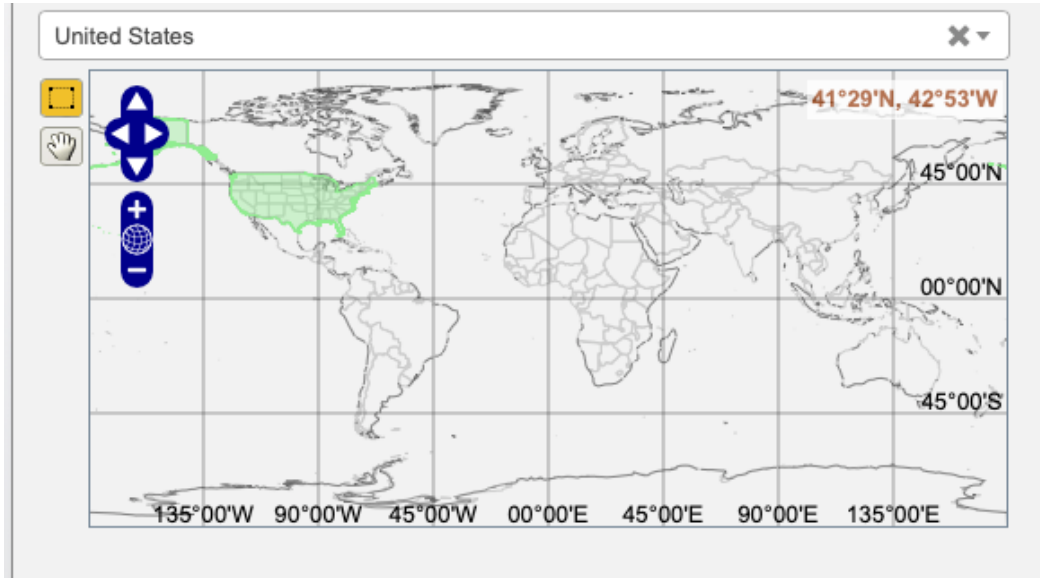


Option 2: Use the cursor to select a region on map

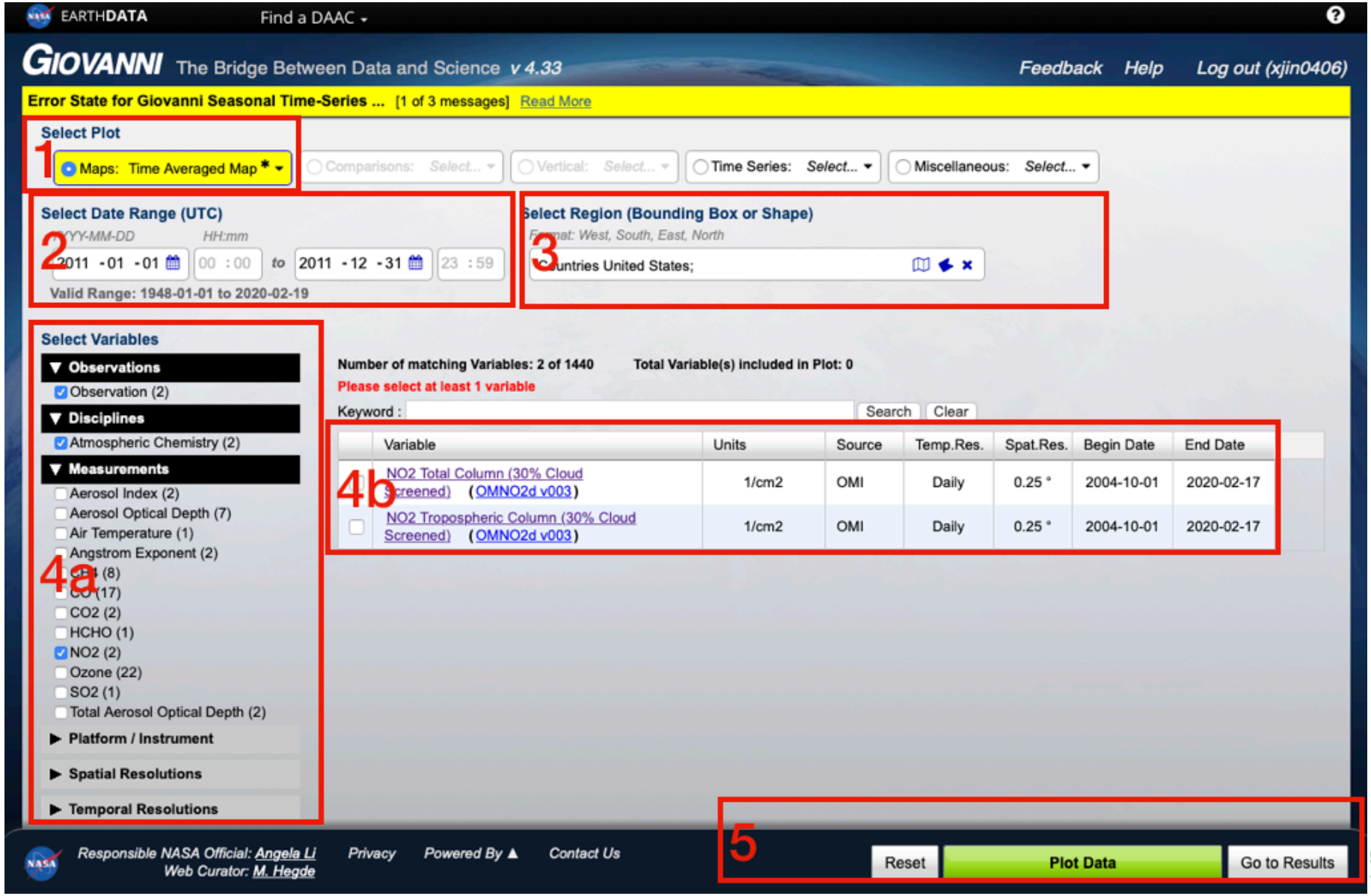


Option 3: Select by country, land/sea, US States, Watersheds.

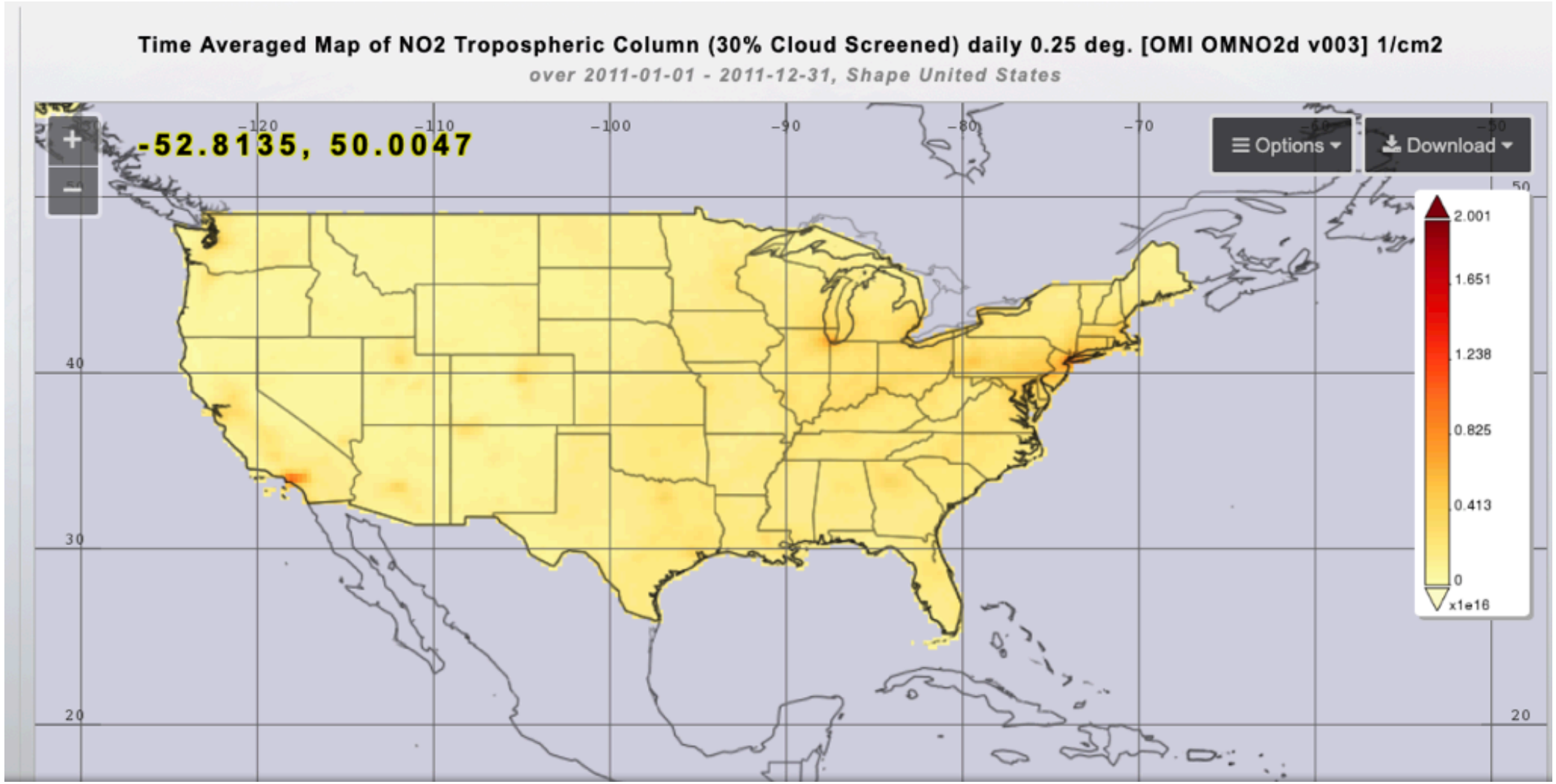




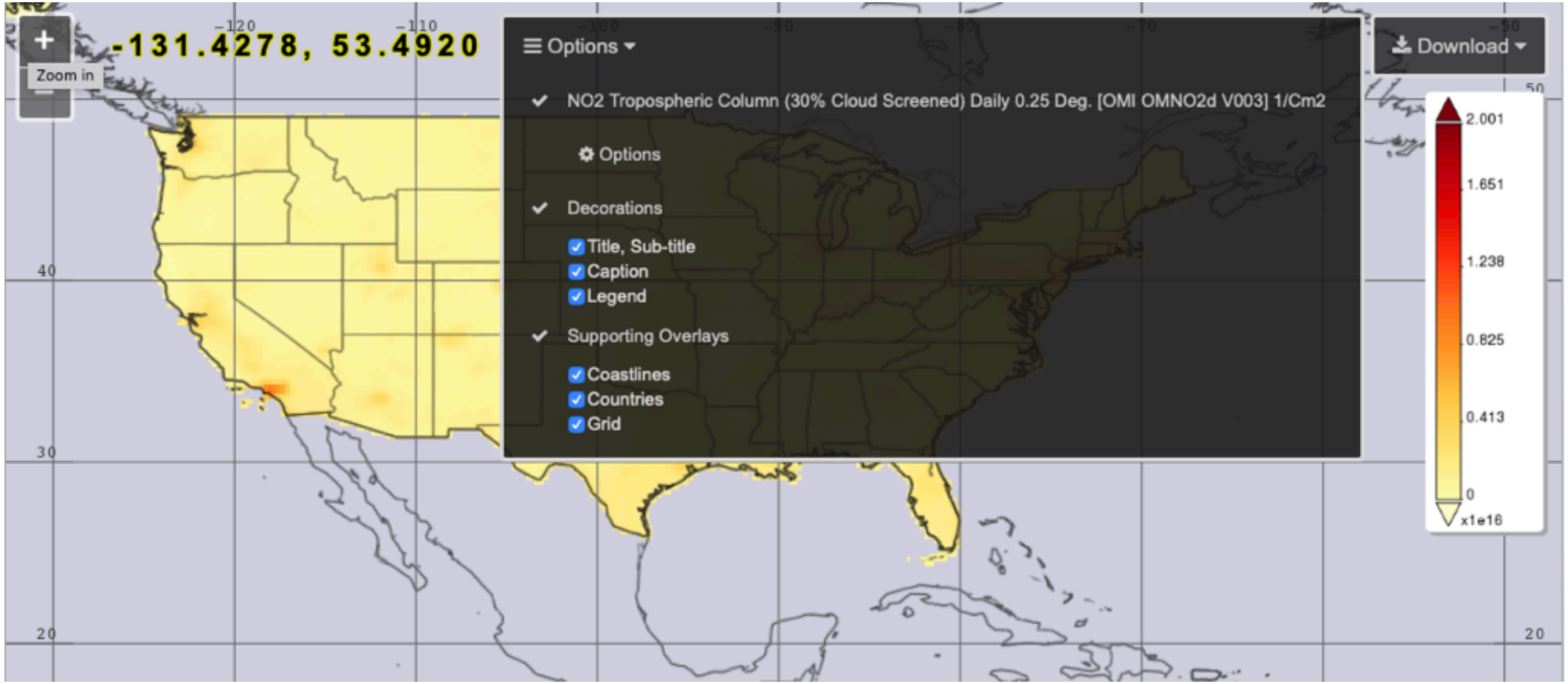
Working with time averaged maps



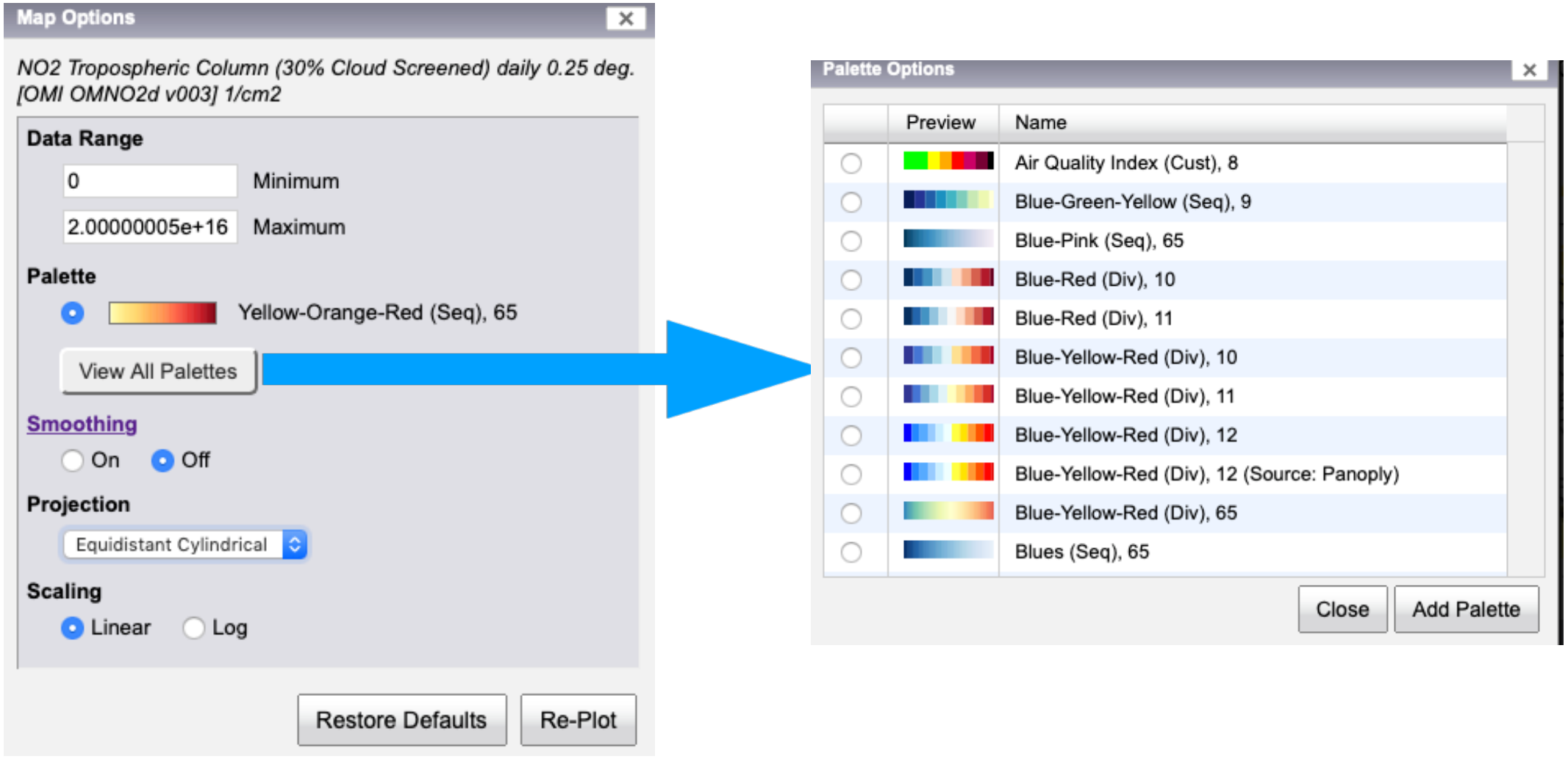
Annual average OMI NO_2 tropospheric column



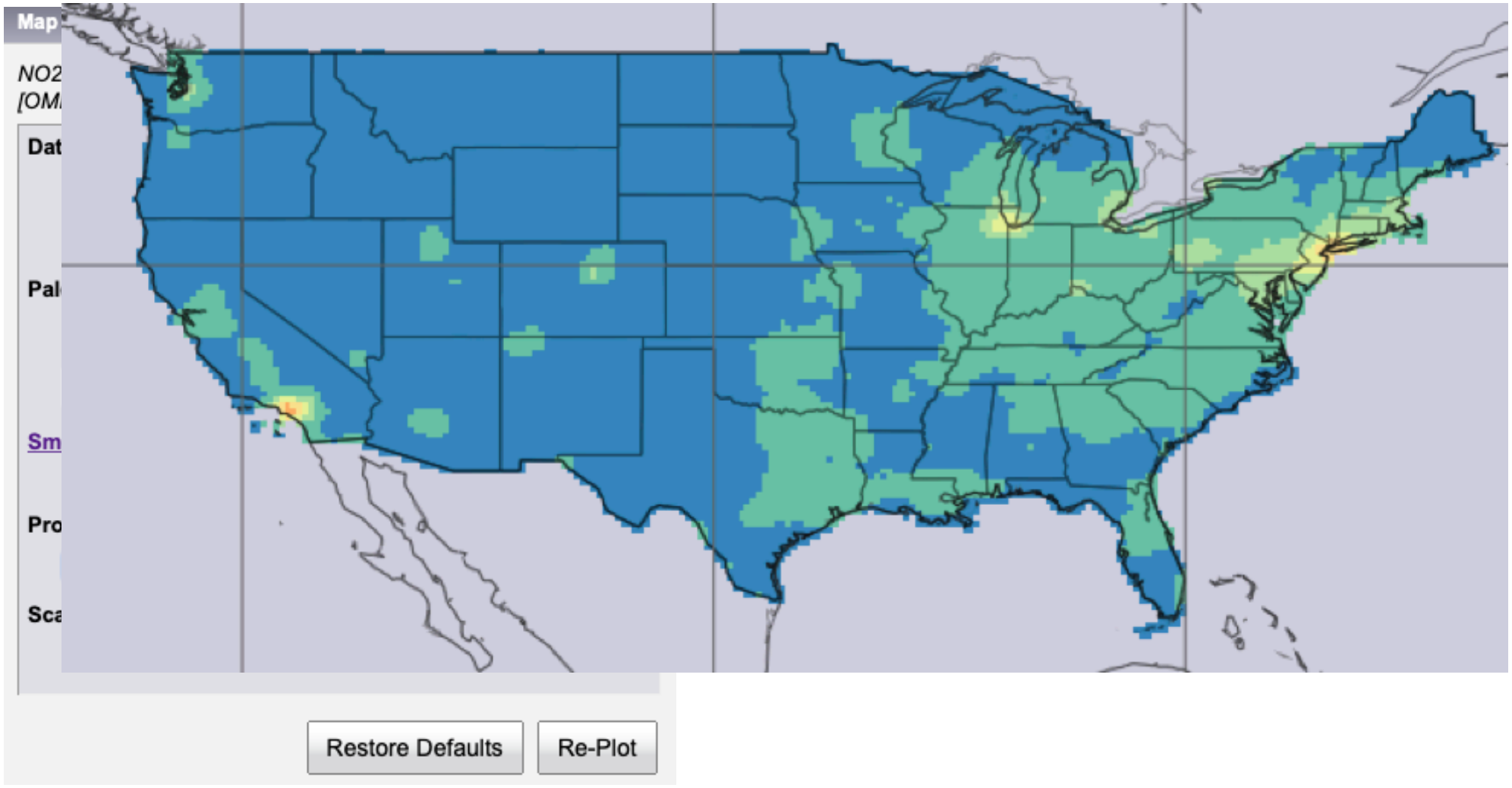
How to customize maps?



How to customize maps: More options

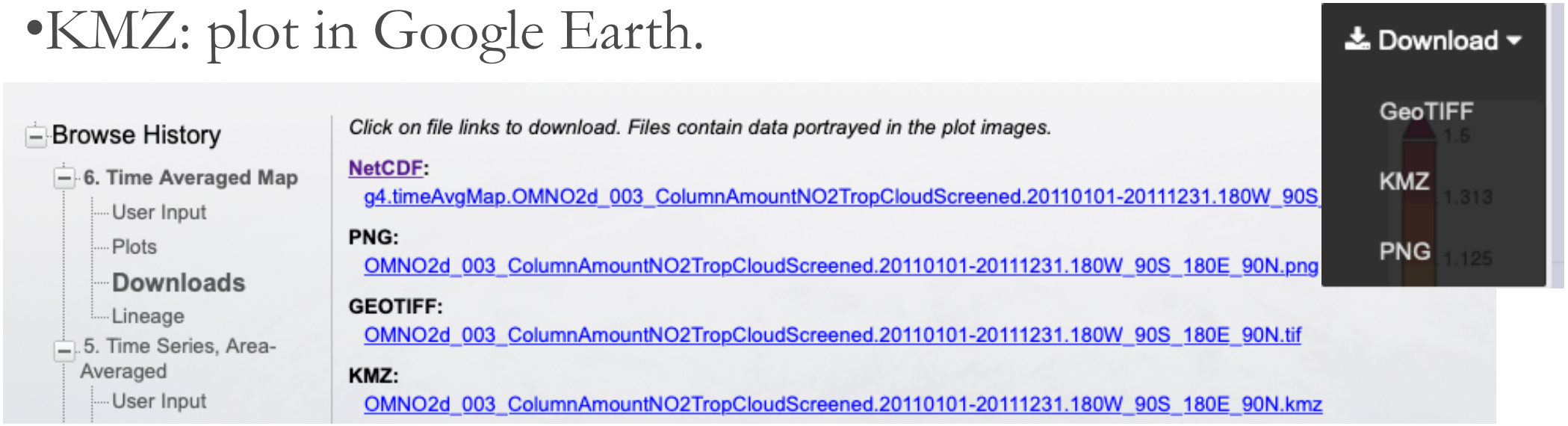


Customized map

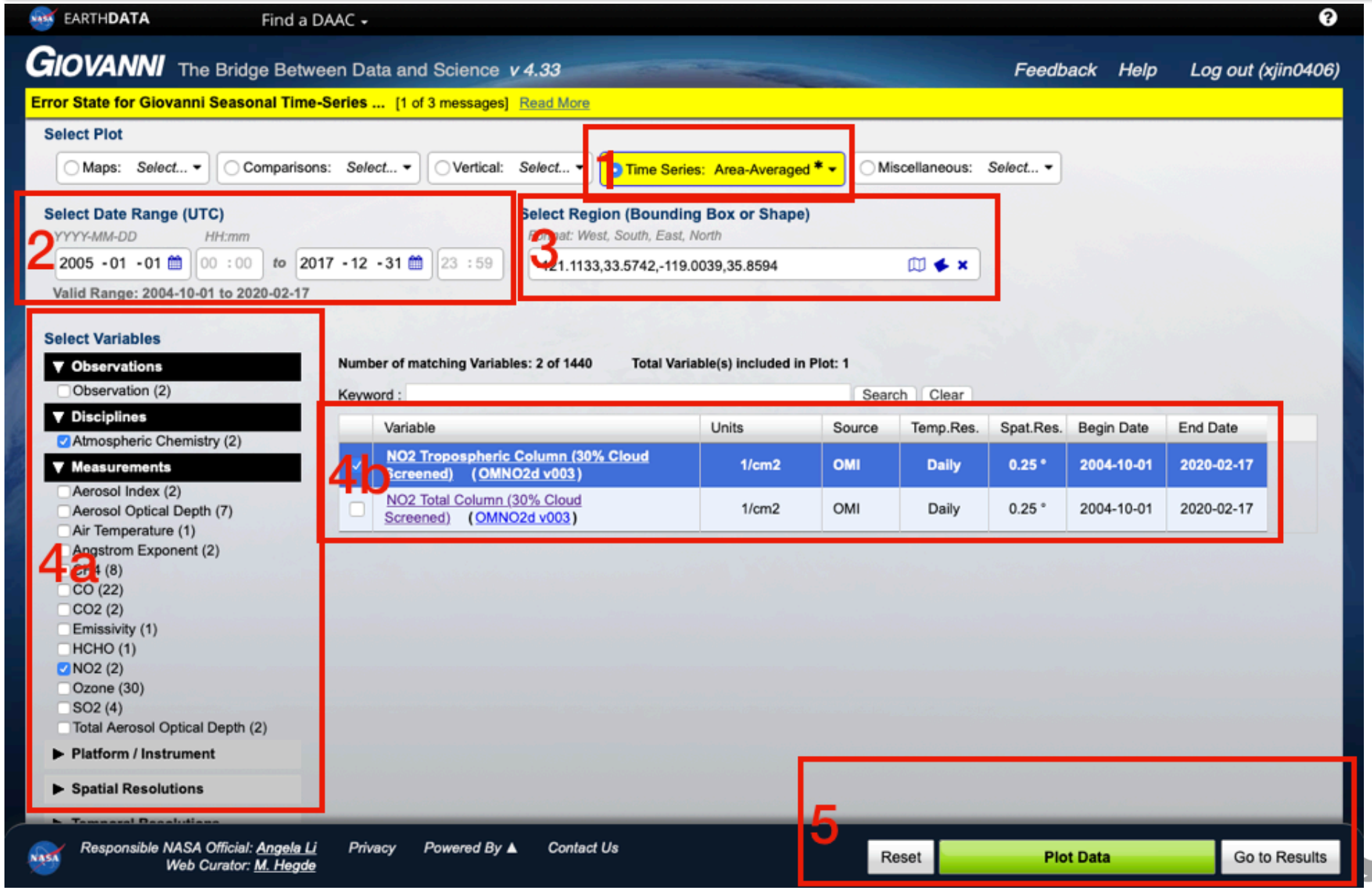


Four options to save results

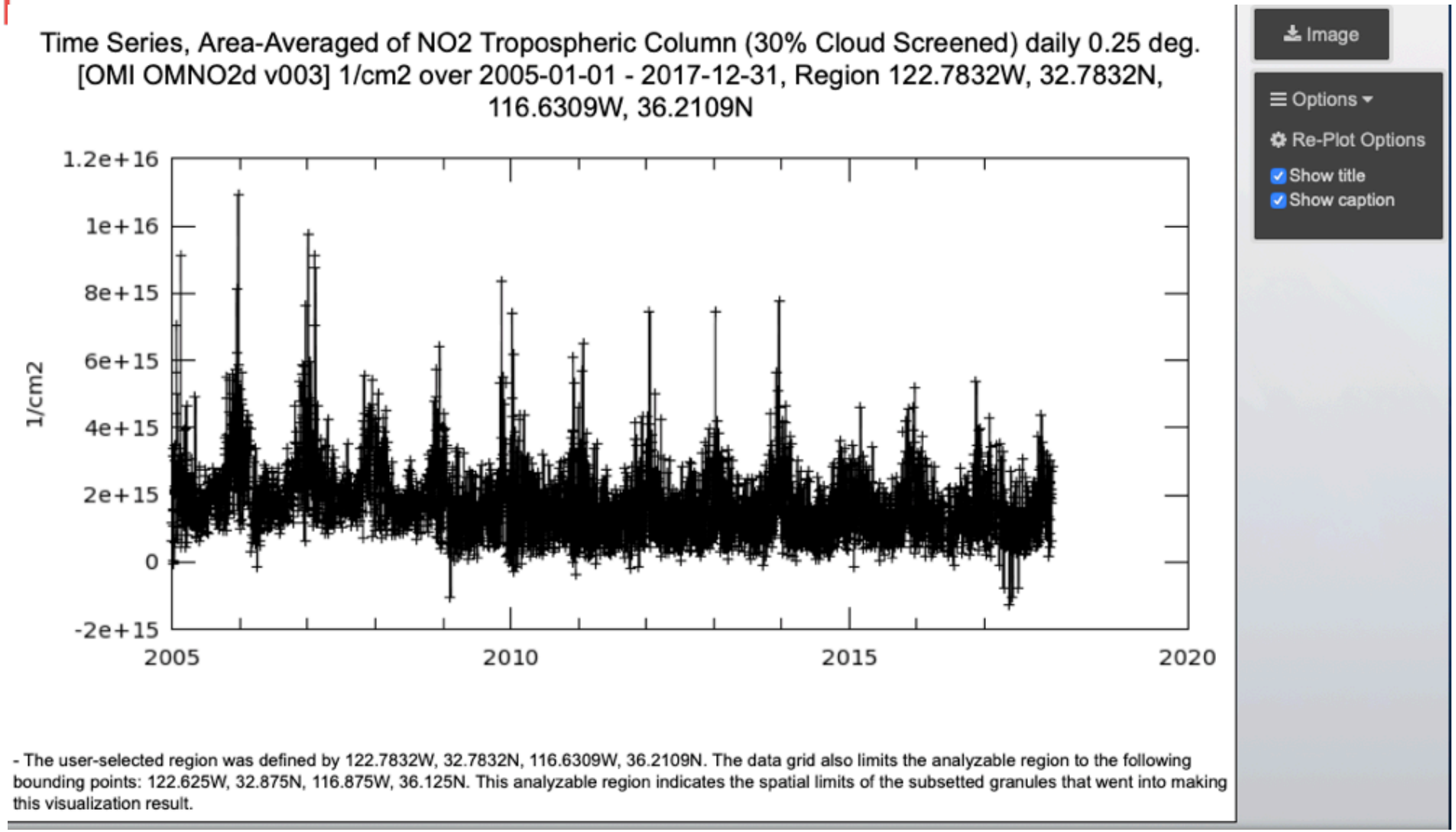
- NetCDF: for further analysis in other tools (e.g. Panoply, programming).
- PNG: Ready to present!
- GEOTIFF: tiff with geographic information (e.g. use in ArcGIS).
- KMZ: plot in Google Earth.



Working with time series



NO_2 tropospheric column density over LA region



Fit a trend line

Plot options

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

Fit a line

Y Axis

Label

Area-Averaged of NO2 Tropospheric Column (30% Cl

Range

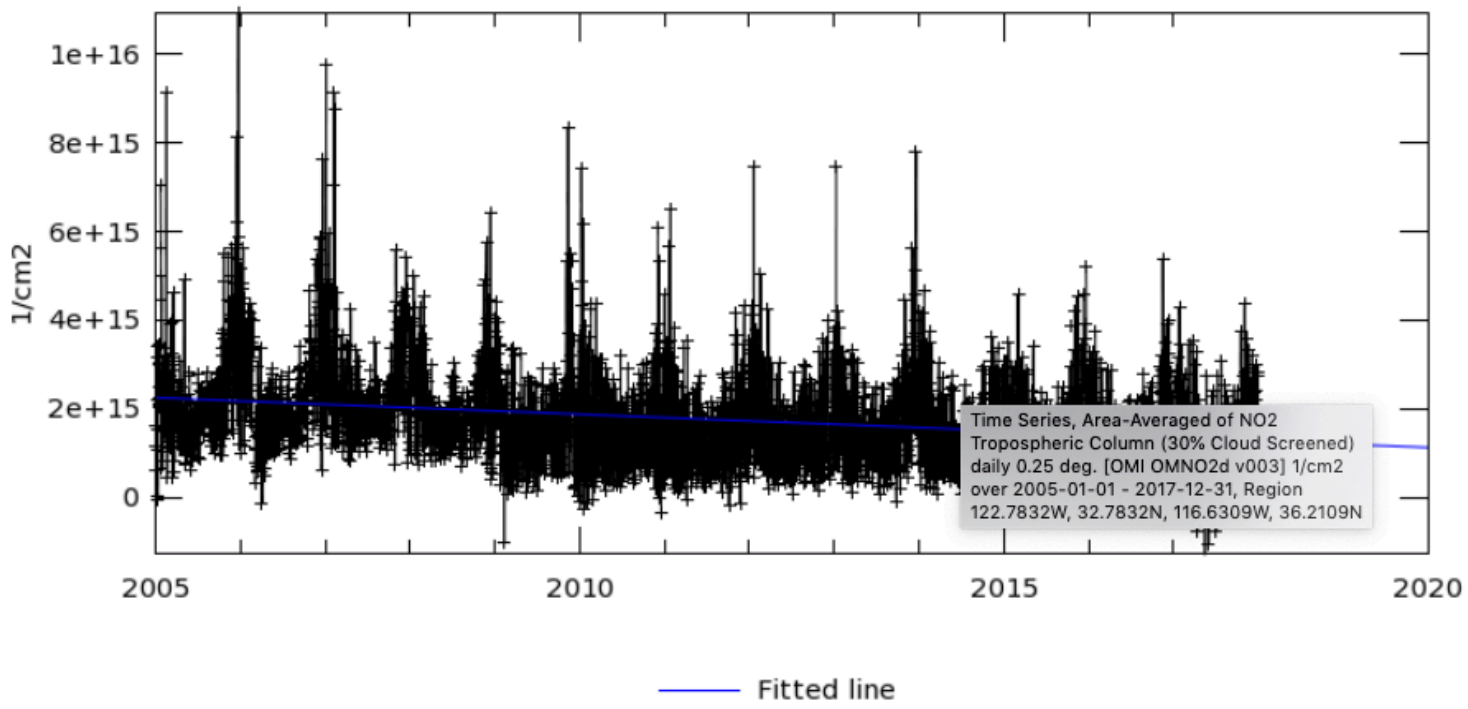
Min

0

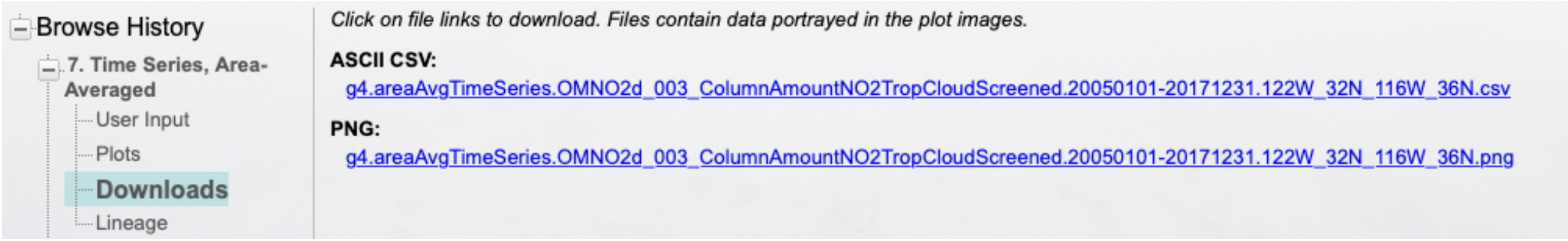
Max

1e+16

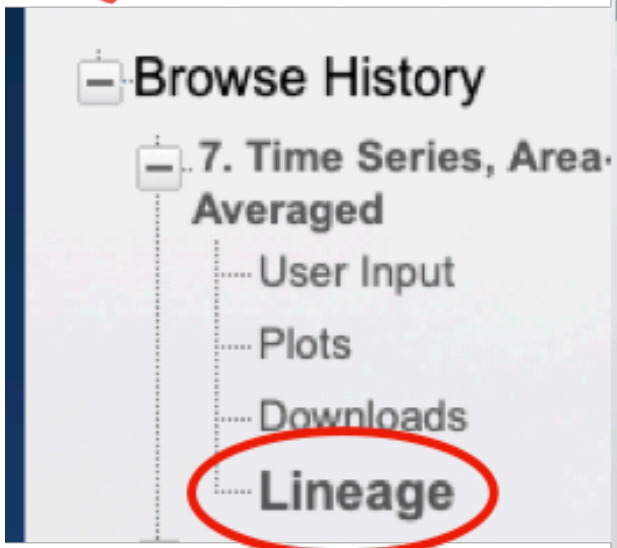
Re-Plot | Reset to defaults



Save figure and data



How to download the original satellite data?



Data File Search (Time taken: 47.92 s)

Output

Data URL	http://acdisc.gesdisc.eosdis.nasa.gov/opendap/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/opendap/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/opendap/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/opendap/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/opendap/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/opendap/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/opendap/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/opendap/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/opendap/HDF-EOS5/ncml/Aura_OMI_Level3/OMNO2d.003/2005/OMI-Aura_L3-OMNO2d_2005m0109_v003-

Too many URLs to display. ***Download list of all URLs in step***

Data File Staging (Time taken: 4.45 s)

Output

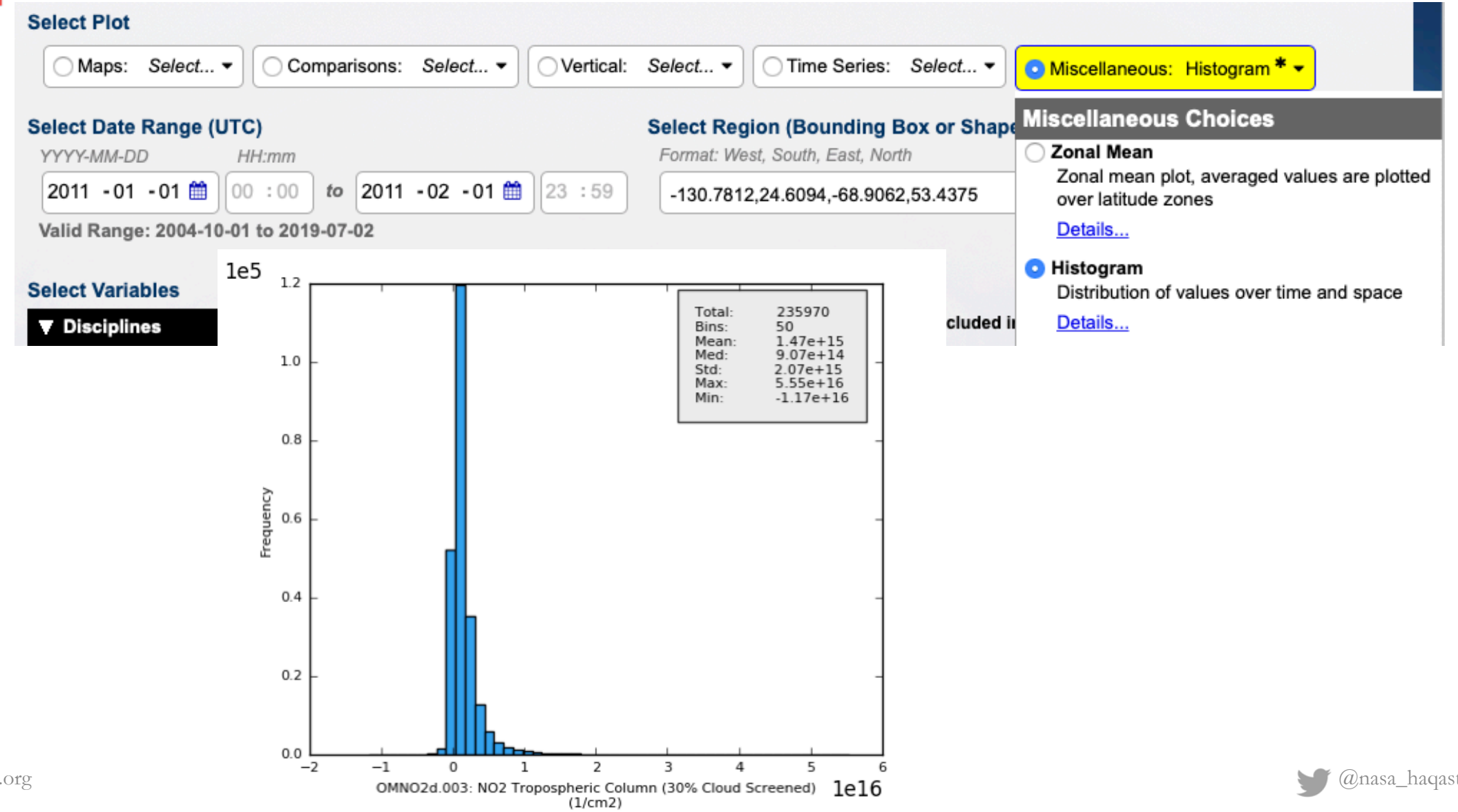
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050101.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050102.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050103.nc
Output file	scrubbed.OMNO2d_003_ColumnAmountNO2TropCloudScreened.20050104.nc
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***

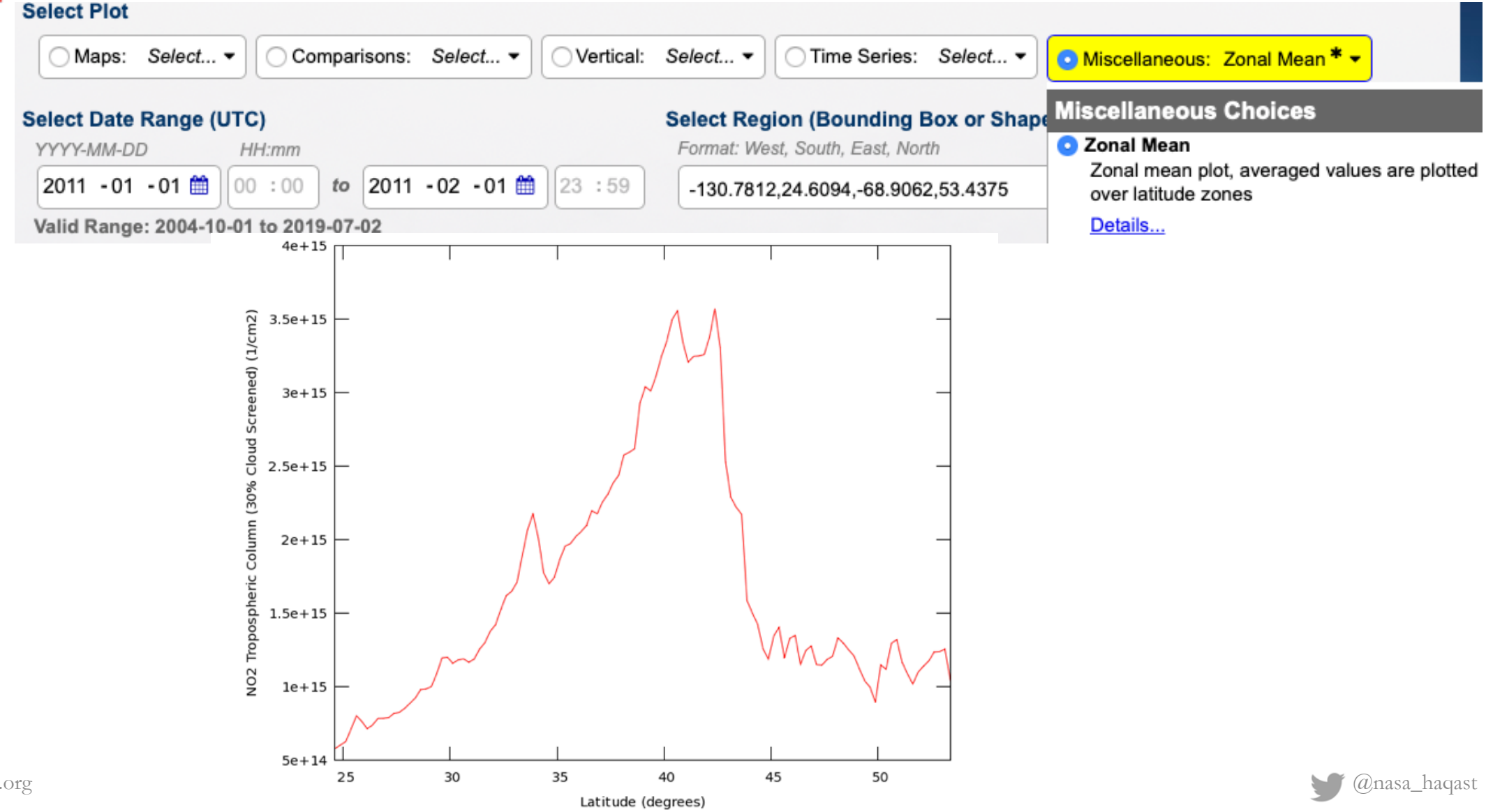
Bookmarking and data sharing

- 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



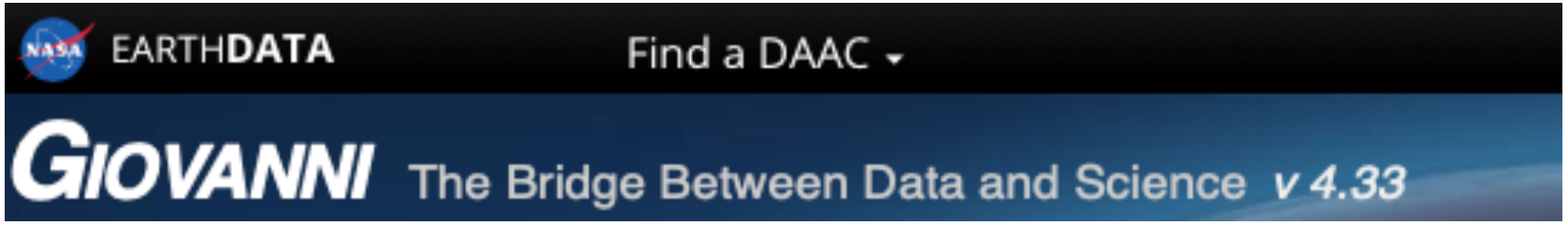
Other figures: Zonal Mean



Practice:
Linking OMI tropospheric NO_2 column with ground-level NO_2

Link: https://atmoschem.ldeo.columbia.edu/wp-content/uploads/2020/02/mini_project_XJin_HAQAST2020_Webinar.pdf

- Part I: Visualize and analyze OMI tropospheric NO_2 data using Giovanni (https://disc-beta.gsfc.nasa.gov/giovanni/)

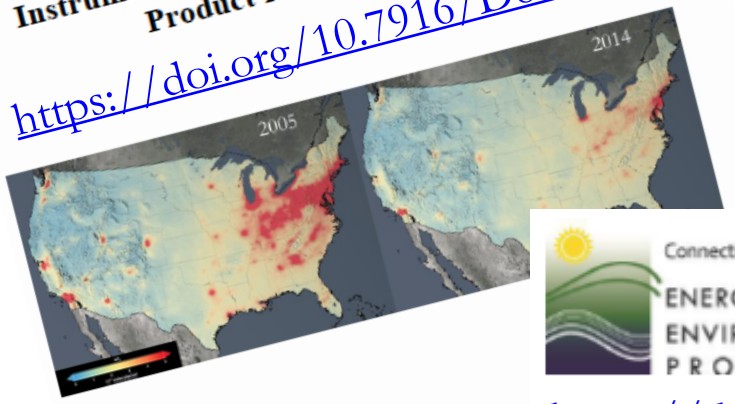


- Part II: Compare OMI NO_2 with EPA AQS ground-based measurements of NO_2 (https://www.epa.gov/outdoor-air-quality-data) using Excel.

Technical Guidance Documents produced by a HAQAST Tiger Team

A Brief Tutorial on Using the Ozone Monitoring Instrument (OMI) Nitrogen Dioxide (NO_2) Data Product for SIPS Preparation

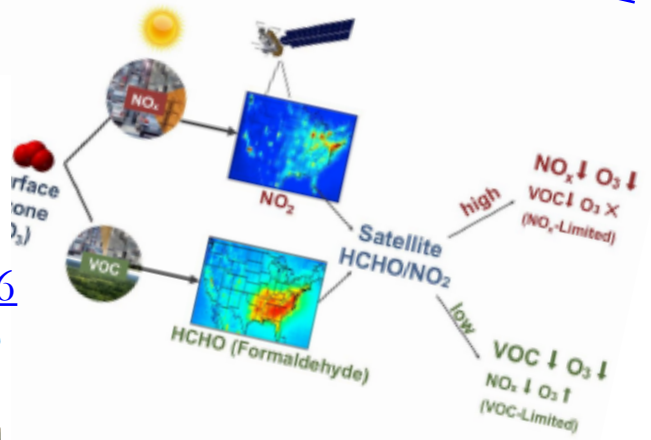
https://doi.org/10.7916/D80K3S3W



Lead Author: Bryan N. Duncan (NASA)
Contributing Authors: Michael Geigert (CT DEEP)

Using satellite observed formaldehyde (HCHO) and nitrogen dioxide (NO_2) as an indicator of ozone sensitivity in a SIP

https://doi.org/10.7916/D8M34C7V



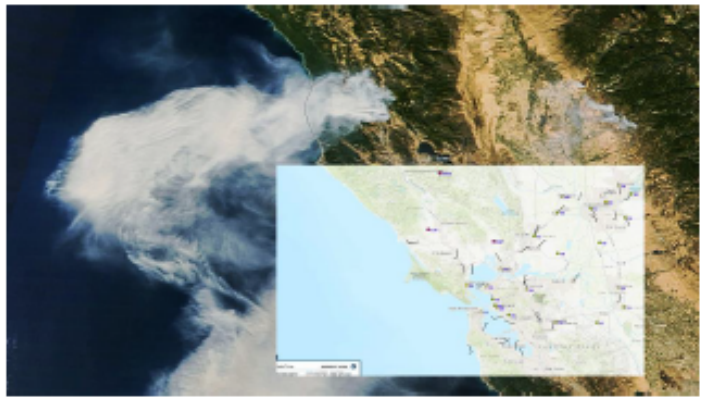
Xiaomeng Jin and Arlene Fiore (LDEO/Columbia)
Michael Geigert (CT DEEP)

ication Date: June 12, 2018

Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

https://doi.org/10.7916/D84B4HT6

Guide to Using Satellite Images in Support of Exceptional Event Demonstrations



Michael Geigert
CTDEEP
March 2018

Archived at Columbia U Academic Commons Repository

@nasa_haqast

Technical Guidance Document: Using space-based $HCHO/NO_2$ as an indicator of O_3 sensitivity

NASA HAQAST Team

Developed the methodology (Jin *et al.*, 2017)

Air Quality Agency Early Adopters

Delivered a technical guidance on using satellite $HCHO/NO_2$ in SIPs

Beta Testers

Agencies tried the approach outlined in the technical guidance and provided feedback

Other local, state, regional air quality and health agencies

The technical guidance is publicly available on "NASA air quality from Space"

HAQAST

Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

Environmental Protection Division
A Division of the Georgia Department of Natural Resources

South Coast AQMD

@nasa_haqast

Links to these documents are on NASA's air quality from space website https://airquality.gsfc.nasa.gov/ -- visit "Managers" tab

State Implementation Plans

Publicly available NASA satellite data can help with State Implementation Plans (SIPs)

NASA's Earth science program maintains a large fleet of earth-observing satellites, all of which offer free data products. A number of these can be used to illustrate NO_x emissions trends and their relevance to ozone attainment, as well as for weight-of-evidence under the EPA's Exceptional Events Rule. A collaborative team of NASA-funded scientists and public stakeholders has recently developed a suite of easy-to-follow technical guidance documents to support state and local air quality agencies that want to bring the power of NASA's satellites to bear on the documentation of exceptional events. This work is a product of the NASA **Health and Air Quality Applied Sciences Team (HAQAST)** Year 1 (2017-2018) Tiger Team "Supporting the Use of Satellite Data in State Implementation Plans (SIPs)"

Thanks to Bryan Duncan and his team for hosting these!

@nasa_haqast

Additional documents coming online:

Georgia Tech

Technical Guidance Document

NASA Health and Air Quality Applied Sciences Team
2017–18 Tiger Team Project

Supporting the use of satellite data in State Implementation Plans

Comparison of CMAQ Simulation to Satellite Observations: NO_2 Column versus OMI NO_2

https://doi.org/10.7916/d8-cfwm-5x30

Prepared by:

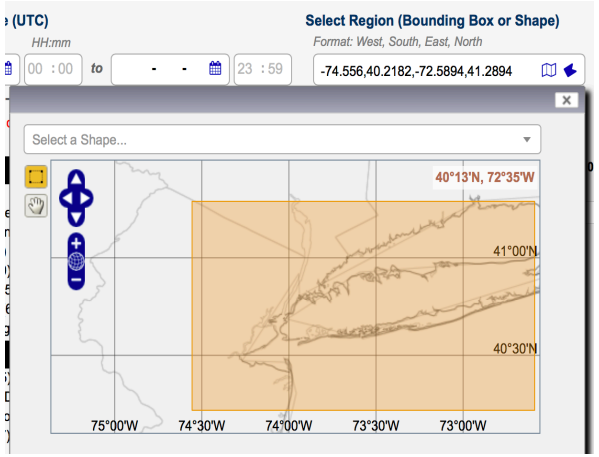
Momei Qin and Talat Odman
School of Civil & Environmental Engineering
Georgia Institute of Technology
311 Ferst Drive, Atlanta, GA 30332-0512

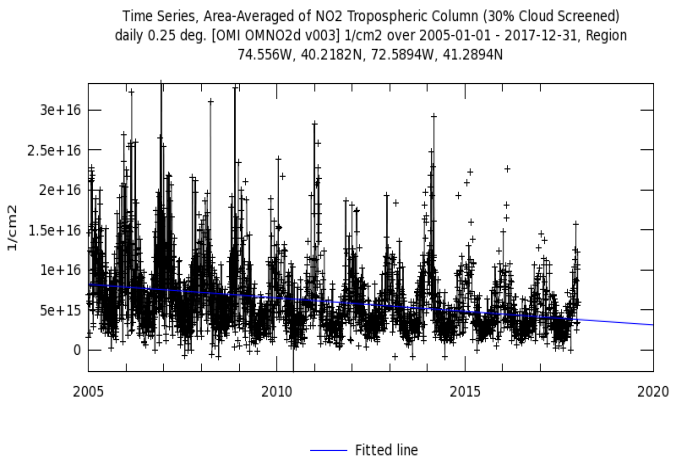
SHORT TUTORIAL*:

How do I create a timeseries of NO_2 tropospheric columns with Giovanni for my city?

Daniel Tong (GMU), Jennifer Wei (NASA) & Suhung Shen (GMU)

***includes other links to Giovanni resources**





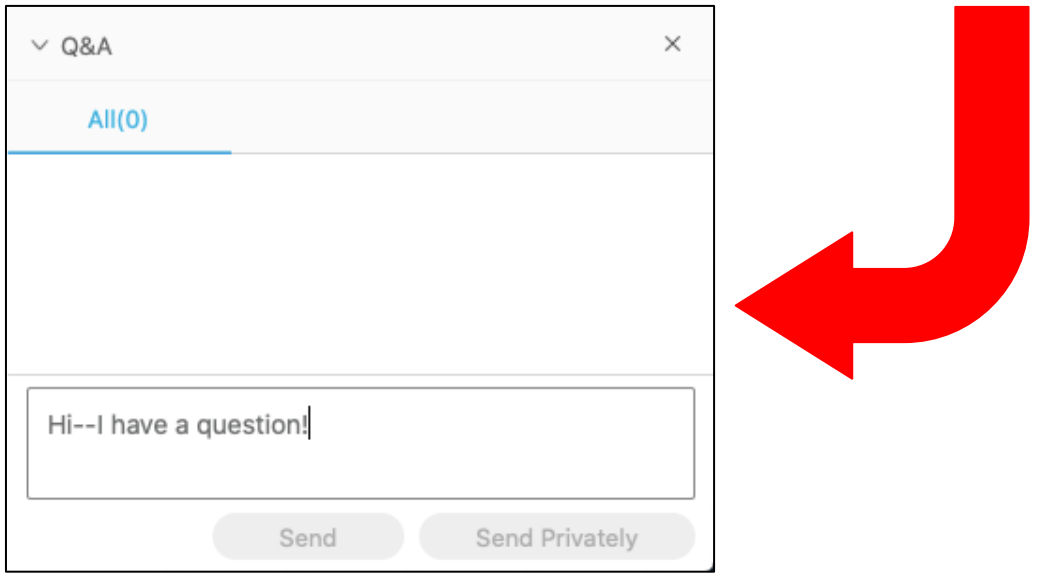
@nasa_haqast

Acknowledgments

Analyses and visualizations used in this presentation were produced with the Giovanni online data system, developed and maintained by the NASA GES DISC

Questions?

Use the question function at the lower right of your screen



Be sure to check out our upcoming webinars. For all info, visit haqast.org/haqast2020

HAQAST2020

WEBINAR SERIES