

SHORT TUTORIAL

On using NASA's GIOVANNI web tool to create regional-scale time series

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Giovanni is an on-line visualization tool developed and operated by GES DISC. Analyses and visualizations used in this tutorial were produced with the Giovanni online data system, developed and maintained by the NASA GES DISC.

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How can I use satellite data to rapidly assess NO₂ trends over my area?

Overview:

Satellite observations can provide useful information on long term changes in air quality. One of the most widely used satellite products is tropospheric NO₂, which has been retrieved from several different satellite sensors. We provide here a quick tutorial on using Giovanni to analyze an air quality trend in NO₂ data from the NASA Ozone Monitoring Instrument (OMI) sensor, over a region of interest.

Caveat:

Be sure to select a region that includes multiple OMI pixels. The fewer the number of pixels selected, the more likely the analysis will be influenced by missing data due to cloud screening or other quality controls. Users are advised to carefully consider the quality of the underlying datasets and the associated uncertainty and robustness of any trends calculated using Giovanni.

Example:

The following example is to show how you can use Giovanni to generate a time series of tropospheric column NO₂ retrieved from OMI over New York city from January 1 2005 to December 31 2017, shown in Figure 1.

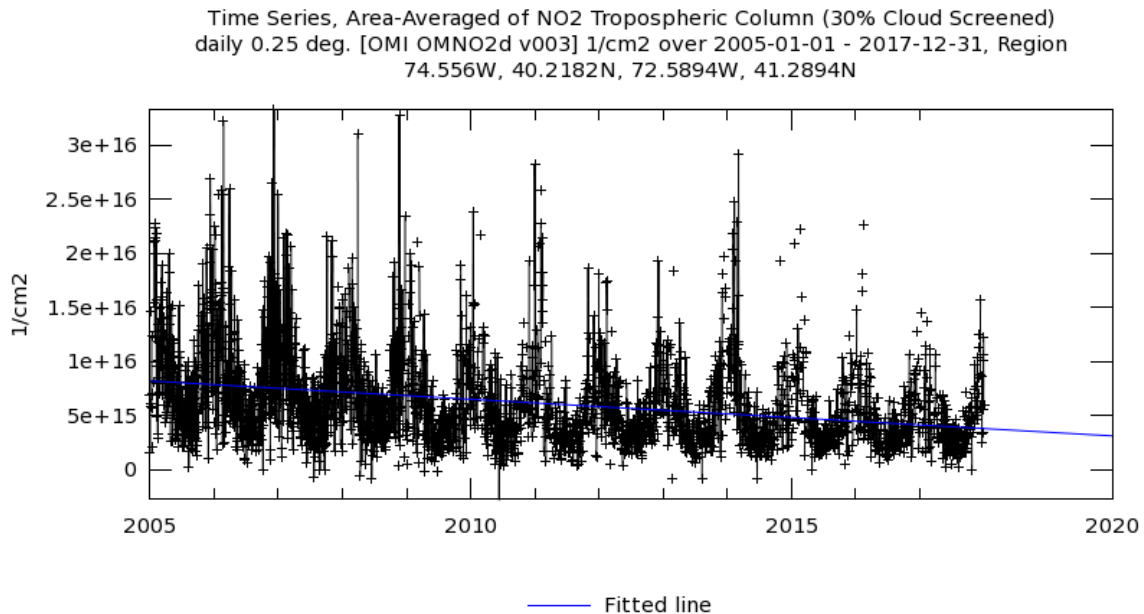


Figure 1. Long-term trend of NO₂ (1/cm²) over New York City, NY from 2005 to 2017. The time series was plotted from daily tropospheric column NO₂ (30% cloud screened) from OMI (OMNO2d v003) over a region (74.556°W, 40.218°N, 72.589°W, 41.289°N)

Procedures:

1. If you do not have a NASA Earthdata account,

- Register yourself at NASA: <https://urs.earthdata.nasa.gov/users/new>
 - Link your account to the application named “NASA GESDISC DATA ARCHIVE “ (Read example in <https://disc.gsfc.nasa.gov/earthdata-login>)
2. Go to NASA Giovanni website: <https://giovanni.gsfc.nasa.gov>
 3. **Select Plot.** For the long term trend analysis, you can select “Time Series”, and then “Area Averaged”. Note: You can find out more detail on each plotting function by clicking “Details ...” under the plot function name (Figure 2)

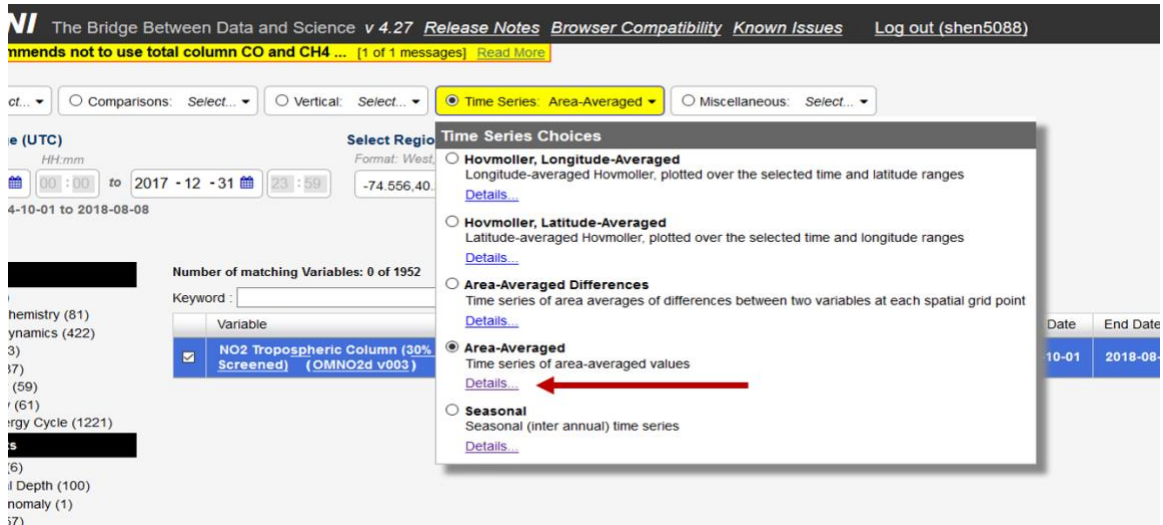


Figure 2. Sample interface to select plot type. Clicking ‘Details ...’ for more information of this plotting type.

4. **Select Data Date Range.** Here you define the temporal range of your analysis. OMI NO2 are available as daily mean values from October 2004 to present. It is recommended that your analysis time period covering full years of data (e.g., January 1 2005 to December 31 2017) to avoid the influence of the seasonal cycle in the trend. For monthly data, Giovanni has a function to plot the time series for a single month or season by selecting the plot type as ‘Seasonal’

Note: You will have to wait for a few minutes if your selected range covers multiple years, since it is very time consuming to extract and process large volume satellite data.

5. **Select Spatial Region.** You can define the spatial coverage of your city by either giving latitude and longitude coordinates of a box, or selecting the region or Shape using the Map tool (see Figure 3). Use the Zoom In/Out functionality and the Mover (Palm shape button) to choose your city. Since air pollution moves around, it is useful to select an area larger than the city itself. Below is an example for a box (e.g. -74.556,40.2182,-72.5894,41.2894) to define New York City (Figure 3):

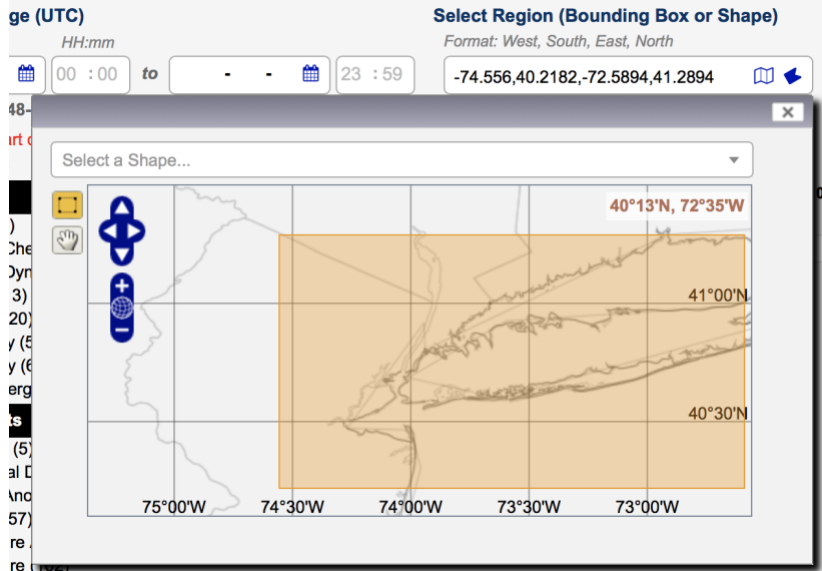


Figure 3. Sample of spatial selection feature in Giovanni system

6. **Find the right product.** You can choose a product from the categories on the left panel, or use the keyword search function. In this case, we search “NO2” and select the “NO2 Tropospheric Column (30% Cloud Screened)” product (see Figure 4). The other product, “NO2 Total Column”, includes both tropospheric and stratospheric NO2. “30% Cloud Screened” means that only the pixels (satellite data points) with less than 30% cloud cover are considered here. Pixels with more than 30% cloud cover, which interferes with the quality of the retrieval, will be discarded.

Note: It is recommended to read the documentation provided from Giovanni. You can mouse-over to see the parameter’s information, or click on the variable (e.g., NO2 Tropospheric Column (30% Cloud Screened) or click on the Product (e.g., OMNO2d_v003).

Product name, Links to product landing page

Product temporal coverage

Number of matching Variables: 3 of 1912 Total Variable(s) included in Plot: 1

Keyword : NO2 Search Clear

	Variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date	End Date
<input checked="" type="checkbox"/>	NO2 Tropospheric Column (30% Cloud Screened) (OMNO2d_v003)	1/cm2	OMI	Daily	0.25 °	2004-10-01	2018-06-10
<input type="checkbox"/>	NO2 Total Column (30% Cloud Screened) (OMNO2d_v003)	1/cm2	OMI	Daily	0.25 °	2004-10-01	2018-06-10
<input type="checkbox"/>	Upwelling longwave flux at toa (clear sky and no aerosol) (M2TMNXRAD v5.12.4)	W m-2	MERRA-2 Model	Monthly	0.5 x 0.625 °	1980-01-01	2018-04-30

Figure 4: Sample of searched variable list in Giovanni, including variable name and product name that links to the product landing page of more information; Units, temporal and spatial resolution; and temporal coverage.

7. **Click “Plot Data”**. The system will start to pull off data for you. It may take several minutes, depending on your data range. A good time to get a cup of coffee or do some stretching. You will be able to monitor the progress of this workflow.

Once the job is done, a plot with your time series will show up (See Figure 1).

- There is an option that allows you to overlay a linear fitting line on the time series by clicking the “Options “ on the right side of the plot, and then checking “Fit a line”. You may change the plot title and justify Y-axis range as shown in Figure 5.
- You can save the picture as shown in above Figure 1

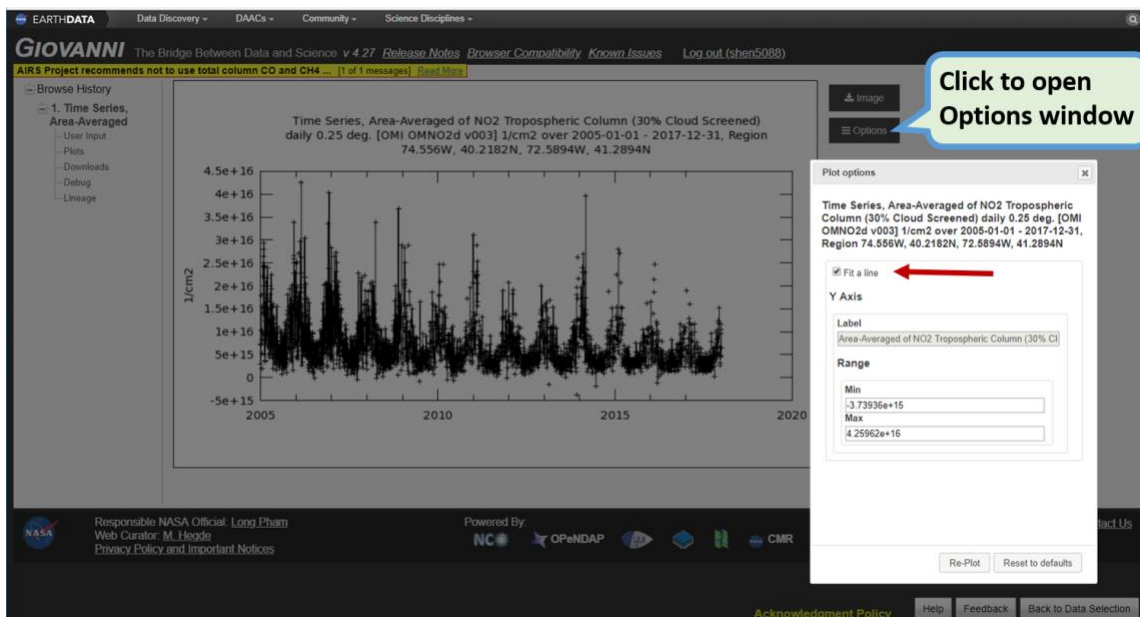


Figure 5. Sample illustration of ‘Options’ window for time series plot: Select ‘Fit a line’ to overlay a linear fitting line.

9. You can also download the raw satellite data or area-averaged daily NO₂ data for New York City from the left panel, see Figure 6 below

- Click “**Downloads**” to download daily NO₂ data (as shown in plot) in ASCII CSV format, or the plot in PNG format.
- Click “**Lineage**” to download URLs to the original archived satellite data under the section “Data File Search”. Note this feature was designed for downloading sample original files to make verification. If interested to download long-term original data from archive, it is better to do the following:
 - go back to ‘User Input’ interface as shown in Figure 4

- Click on the product name in the parenthesis
- Select data access method as 'Subset/Get Data'

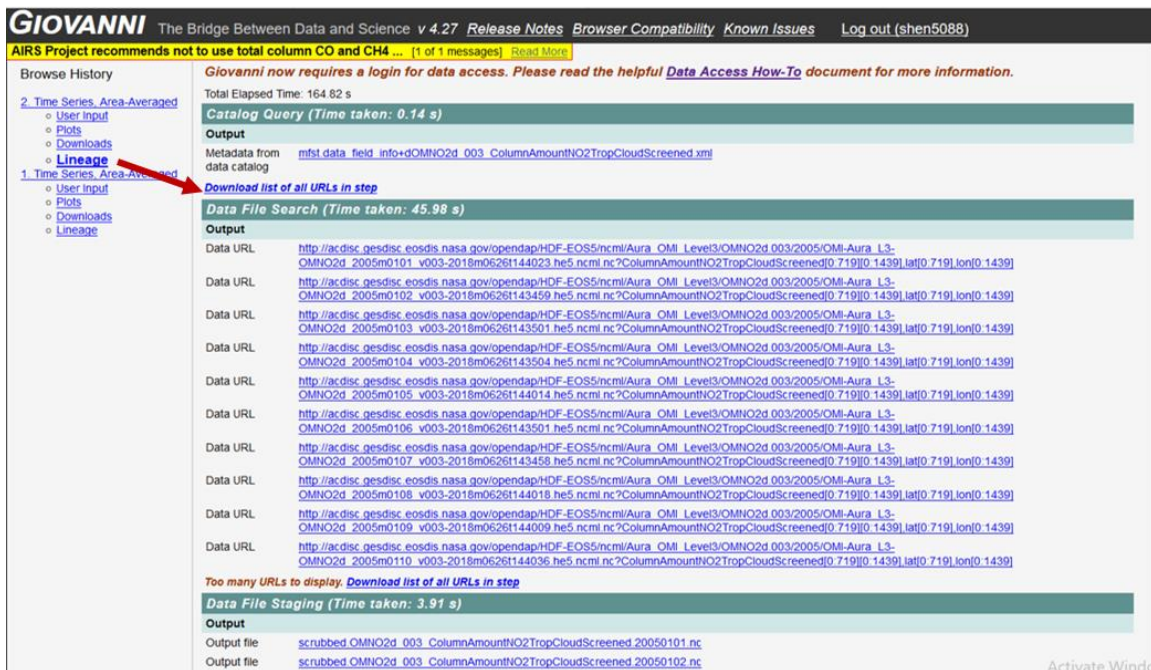


Figure 6. Example of 'Download' page (upper panel) to download time series data and 'Lineage' page (lower panel) to download original and intermediate data.

10. Bookmarking and data sharing. You can bookmark the analysis, by saving the URL of the Giovanni page at the last step (Step 9). In the future you can always reload this analysis, including all the selections you made through Step 2-7, 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. For instance, here is the link of this example:

<https://giovanni.gsfc.nasa.gov/giovanni/#service=ArAvTs&starttime=2005-01-01T00:00:00Z&endtime=2017-12-31T23:59:59Z&bbox=-74.556,40.2182,->

[72.5894,41.2894&data=OMNO2d_003_ColumnAmountNO2TropCloudScreened](#)

Additional Info:

If you are interested in learning more about Giovanni and the OMI NO₂ (and other) satellite products, more information can be found:

Giovanni User manual:

<https://giovanni.gsfc.nasa.gov/giovanni/doc/UsersManualworkingdocument.docx.html>

Videos about using Giovanni and other services at GES DISC:

<https://www.youtube.com/channel/UCQloC07ADoKnfyJA7eGFhzw>

Giovanni related How-to documents:

<https://disc.gsfc.nasa.gov/information/howto?keywords=Giovanni>