Multi-Decadal Nitrogen Dioxide and Derived Products from Satellites (MINDS) Datasets Released by NASA GES DISC and Their Applications for Air Quality

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Multi-Decadal Nitrogen Dioxide and Derived Products from Satellites (MINDS)

- A NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs) Project
- Goal: To develop long-term (1995 to present) NO_2 global data records by adapting a consistent retrieval algorithm to multiple instrument measurements
- Multiple instruments:

1. Global Ozone Monitoring Experiment (GOME, 1995-2003) onboard the second European Remote Sensing satellite (ERS-2)
2. GOME-2 on the Meteorological Operational satellites (MetOp-A and MetOp-B, 2006 -)
3. Ozone Monitoring Instrument (OMI, 2004 -) onboard the Aura satellite
4. TROPOspheric Monitoring Instrument (TROPOMI, 2017 -) onboard the Copernicus Sentinel-5 Precursor (S5P)
5. Scanning Imaging Spectrometer for Atmospheric Cartography (SCIAMACHY, 2002-2012) onboard the ENVIronmental SATellite (ENVISAT)

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Challenges and Approach

- Challenges

1. Differences in instrument & measurement characteristics
2. Differences in retrieval algorithms & inputs, affecting data accuracy and inter-satellite data consistency

- Approach

Apply coupled surface reflectivity-cloud-NO_2 algorithms for all sensors and enhance the quality of auxiliary data, including model-derived *a priori* information

(Courtesy of Lok Lamsal et al., 2021 AGU Fall Meeting)

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Published MINDS V1.1 Products

Product	Spatial Resolution	Short Name	Temporal Coverage	DOI
OMI/Aura NO2 Tropospheric, Stratospheric and Total Columns MINDS 1-Orbit L2 Swath	13 km x 24 km	OMI_MINDS_NO2	2004 -	10.5067/MEASURES/MINDS/DATA204
OMI/Aura NO2 Tropospheric, Stratospheric and Total Columns MINDS Daily L2 Global Gridded	0.25 degree x 0.25 degree	OMI_MINDS_NO2G	2004 -	10.5067/MEASURES/MINDS/DATA214
OMI/Aura NO2 Tropospheric, Stratospheric and Total Columns MINDS Daily L3 Global Gridded	0.25 degree x 0.25 degree	OMI_MINDS_NO2d	2004 -	10.5067/MEASURES/MINDS/DATA304
TROPOMI/S5P NO2 Tropospheric, Stratospheric and Total Columns MINDS 1-Orbit L2 Swath	5.5 km x 3.5 km	TROPOMI_MINDS_NO2	2018 -	10.5067/MEASURES/MINDS/DATA203
GOME/ERS-2 NO2 Tropospheric, Stratospheric and Total Columns MINDS 1-Orbit L2 Swath	40 km x 320 km	GOME_MINDS_NO2	1995 - 2003	10.5067/MEASURES/MINDS/DATA202

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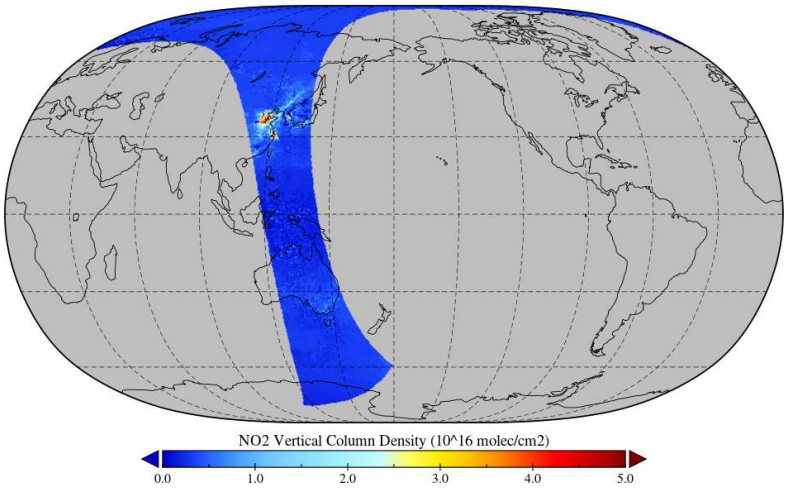
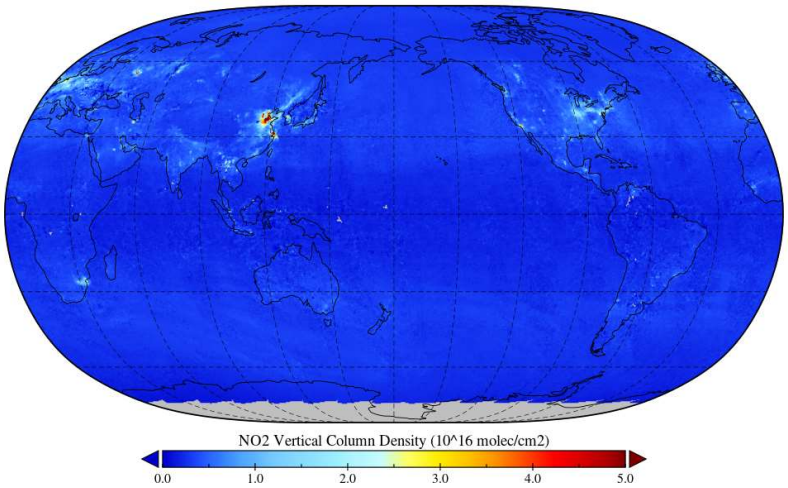
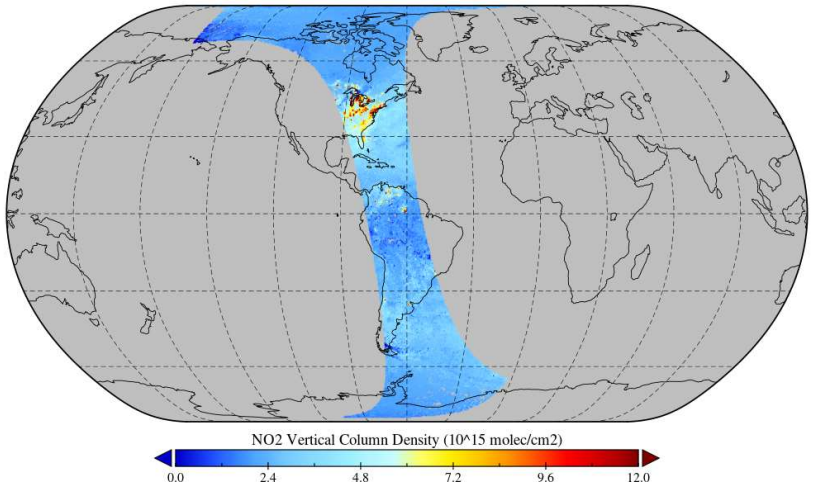
OMI_MINDS_NO2 NO2 Total Column Amount for 2005-04-12 (Orbit 3945)



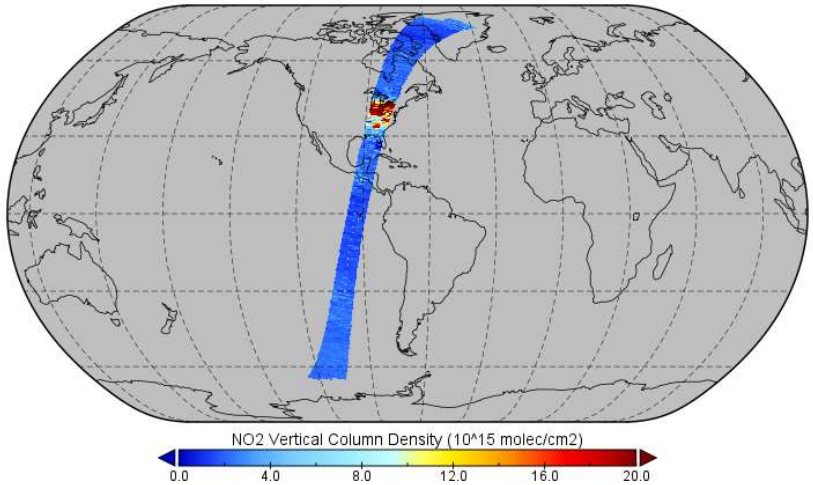
OMI_MINDS_NO2d NO2 Total Column Amount for 2005-04-12



TROPOMI_MINDS_NO2 NO2 Total Column Amount for 2019-03-27 (Orbit 07524)

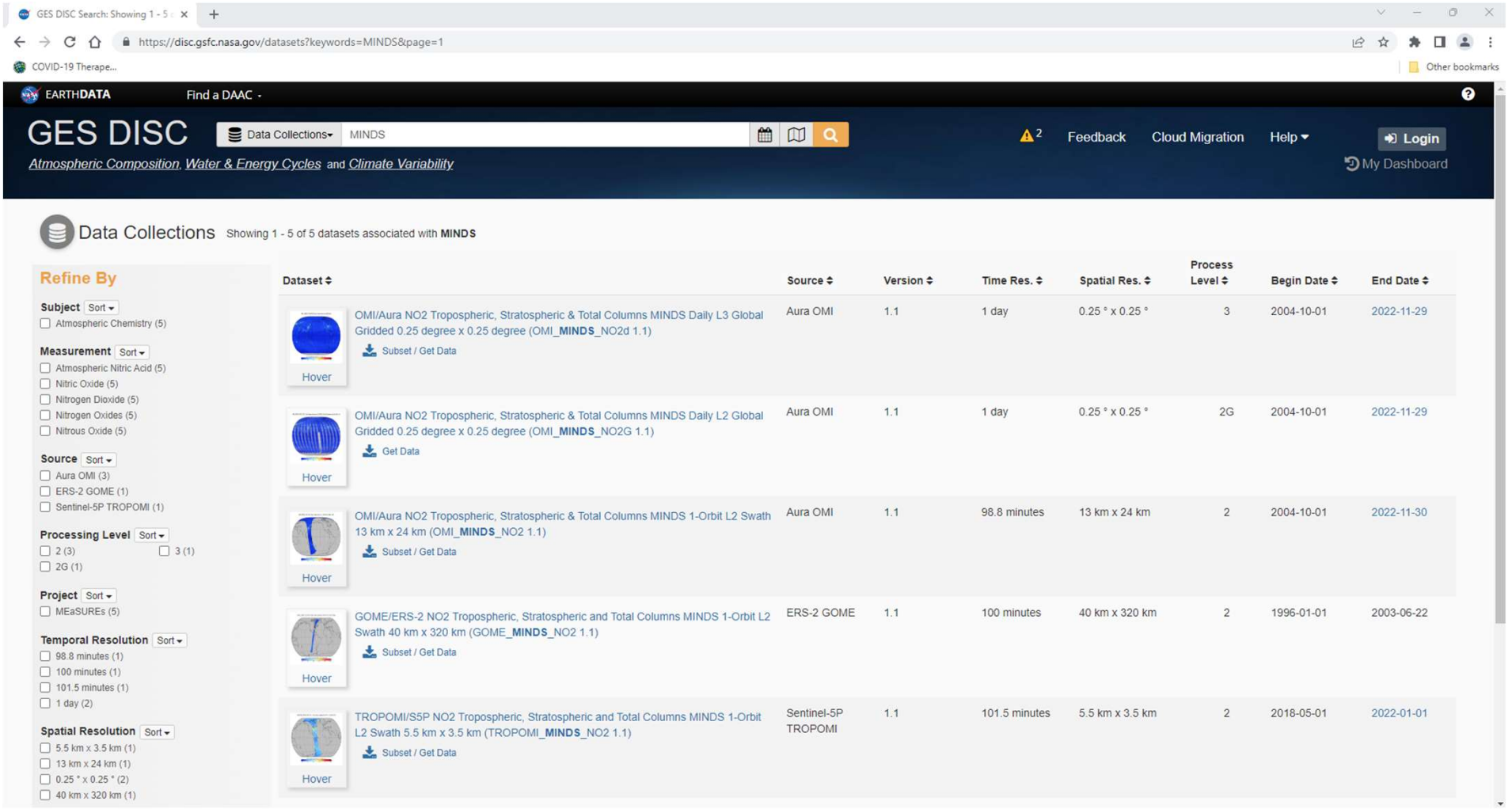


GOME_MINDS_NO2 NO2 Total Column Amount for 2002-03-07 (Orbit 35966)



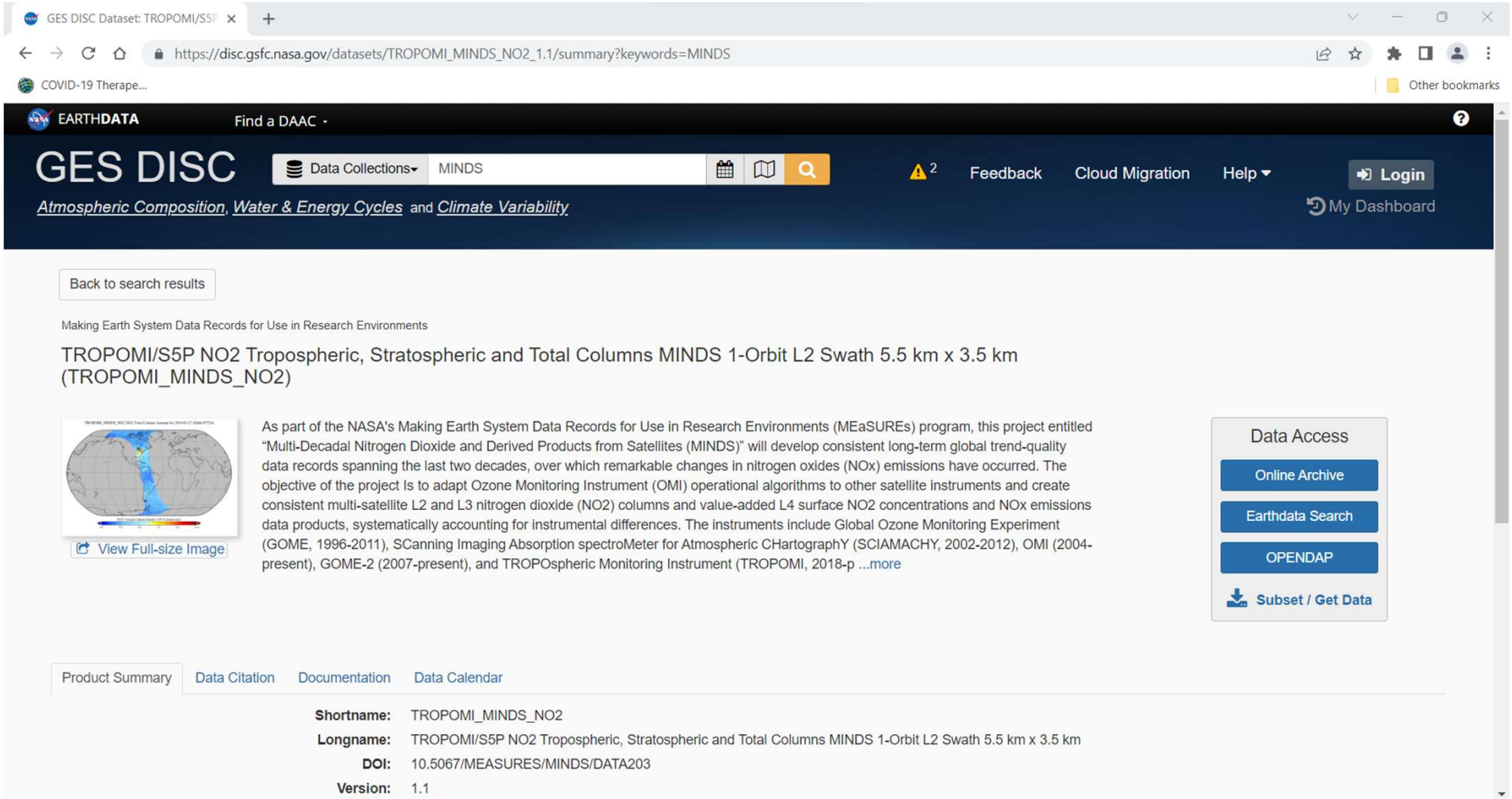
MINDS Data Products Sample Images

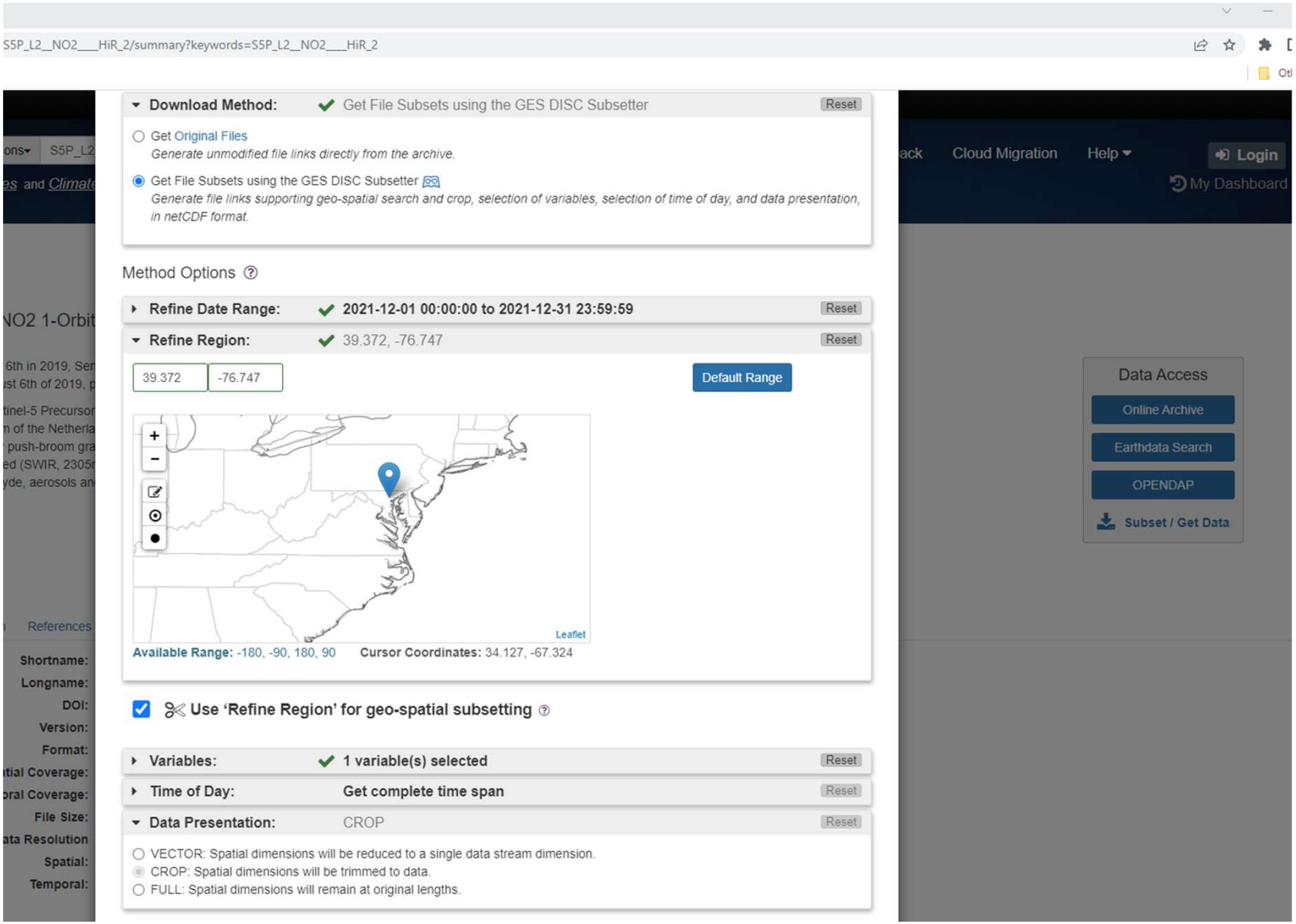
Search MINDS Products on GES DISC Webpage https://disc.gsfc.nasa.gov/



TROPOMI MINDS L2 Dataset Landing Page

Level 2 Subsetter to Collocate L2 Pixel with In-situ Surface Observation



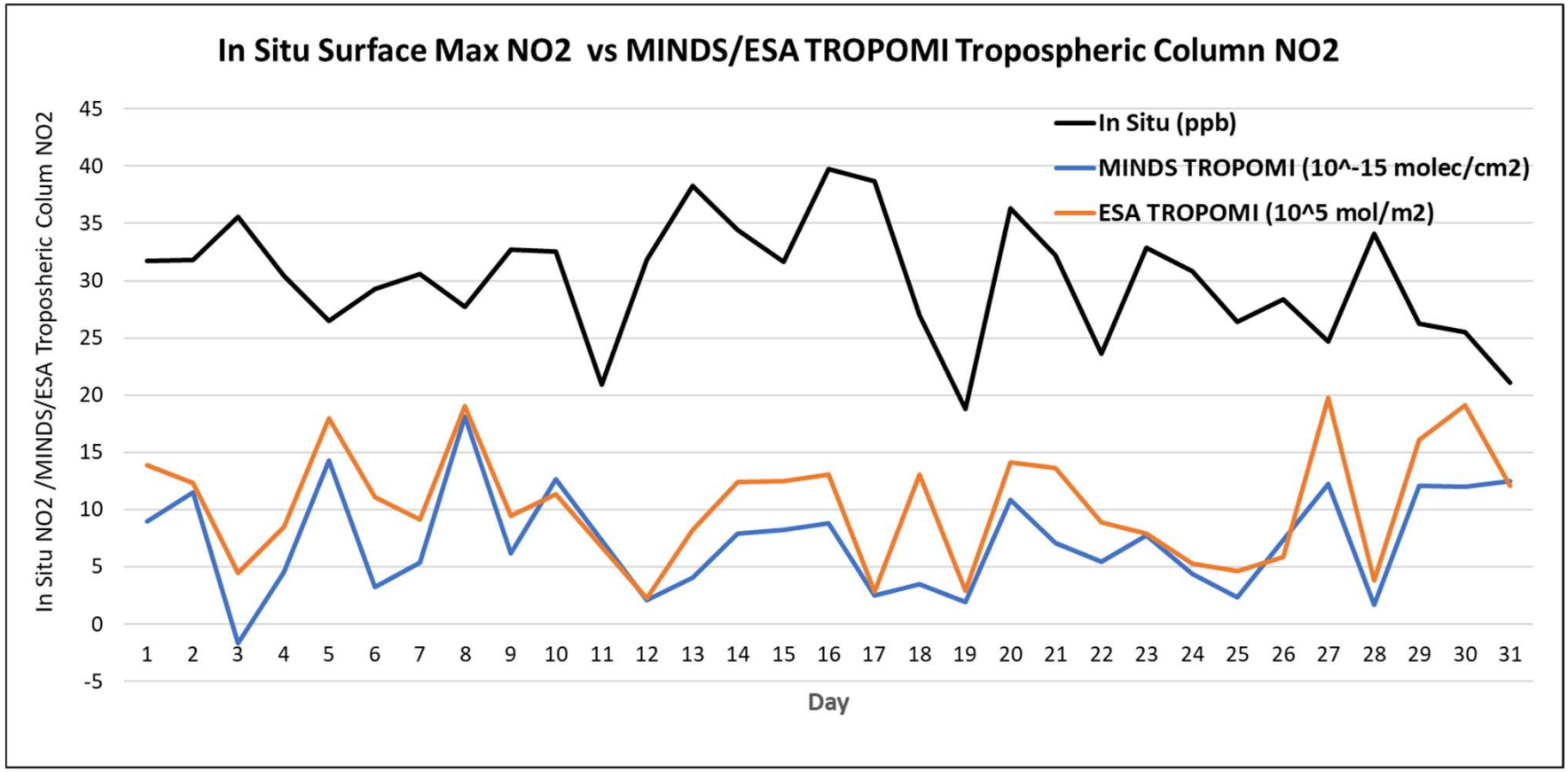


Subset/Get Data: A Level-2 Subsetter Use Case

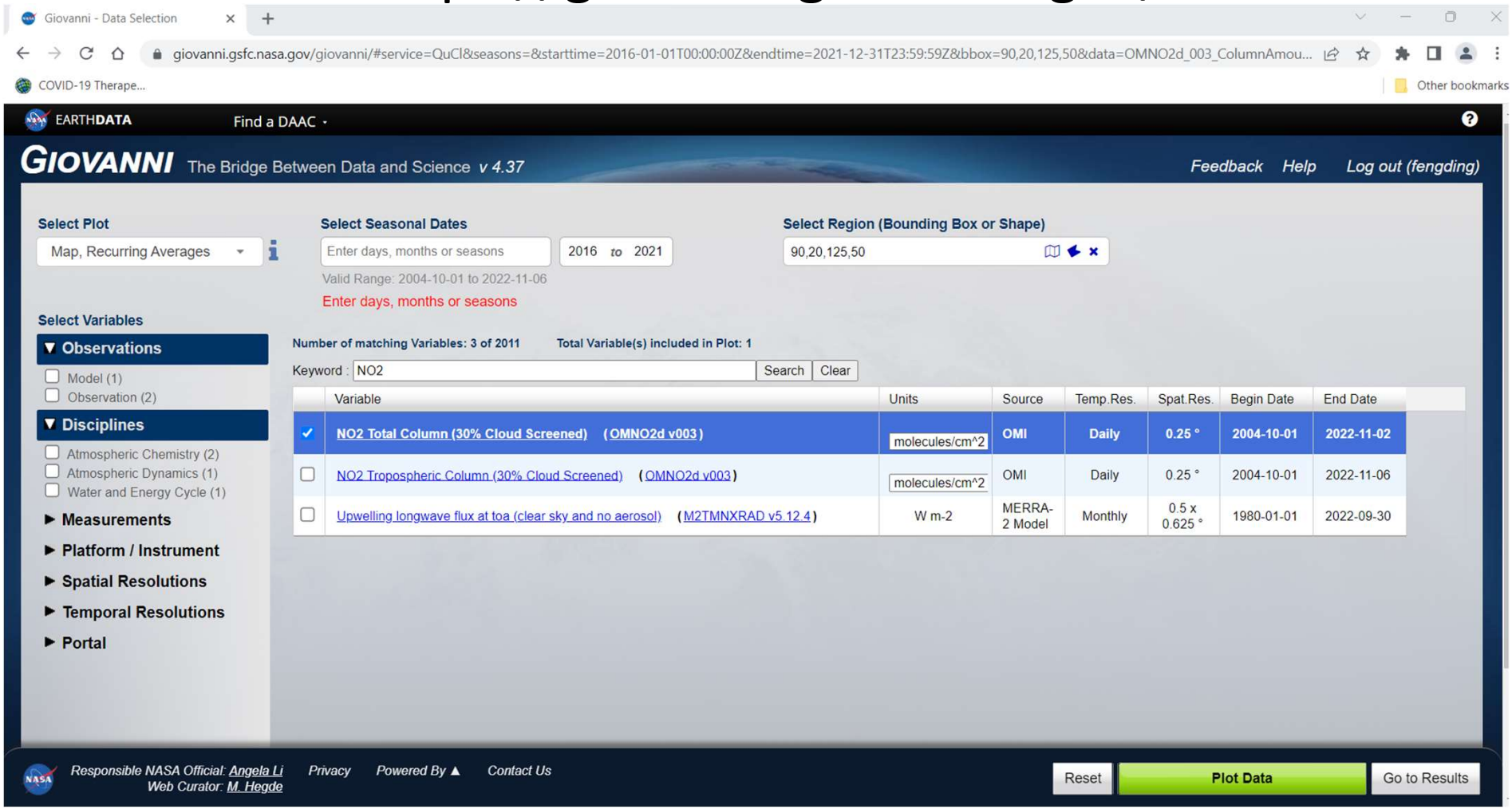
How to Subset Level-2 Data

https://disc.gsfc.nasa.gov/information/howto?keywords=Level%202%20subsetter&title=How%20to%20Subset%20Level-2%20Data

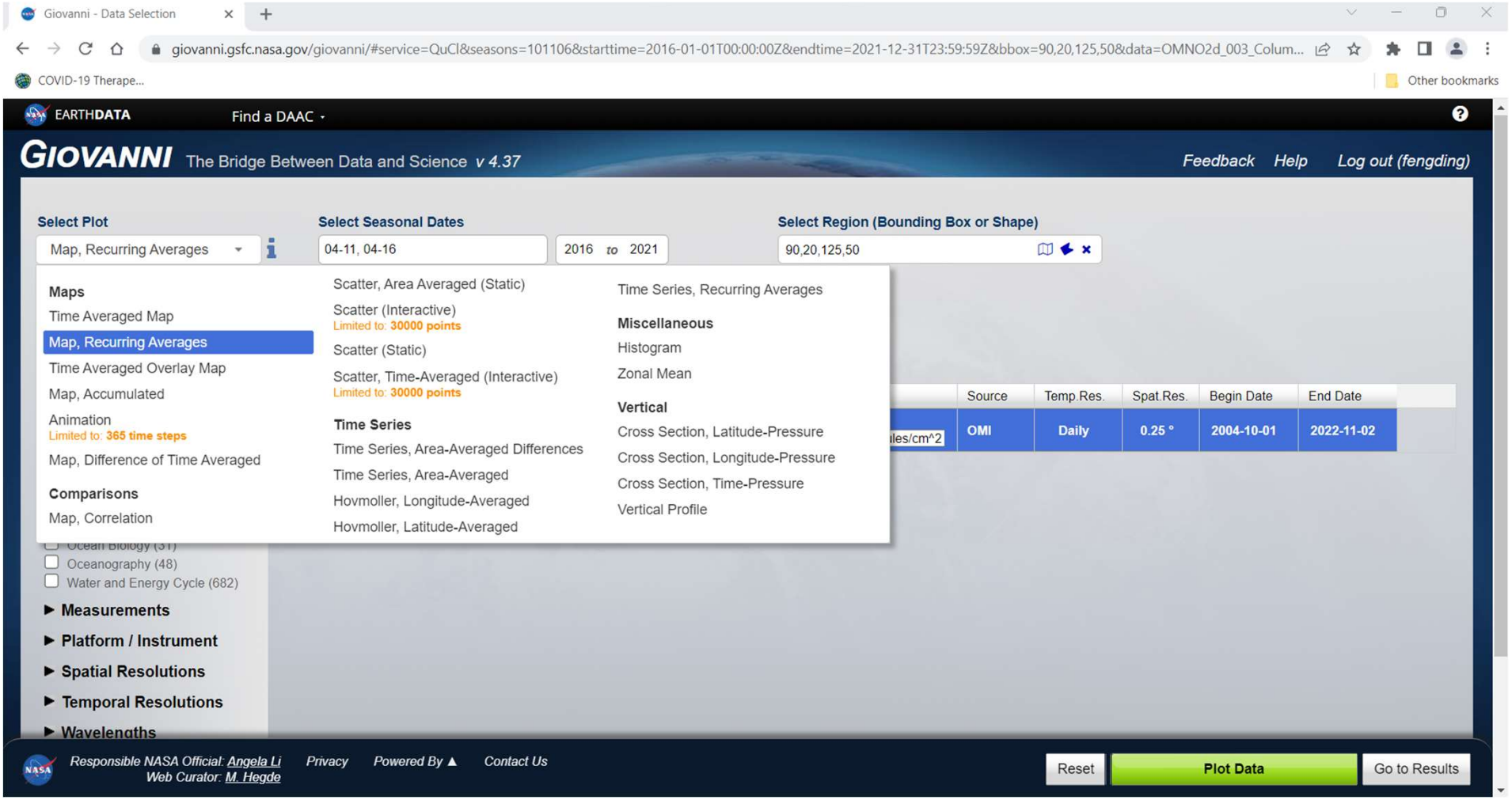
NO_2 Daily Change at Baltimore County, MD (EPA Site ID 24005009) in December 2021



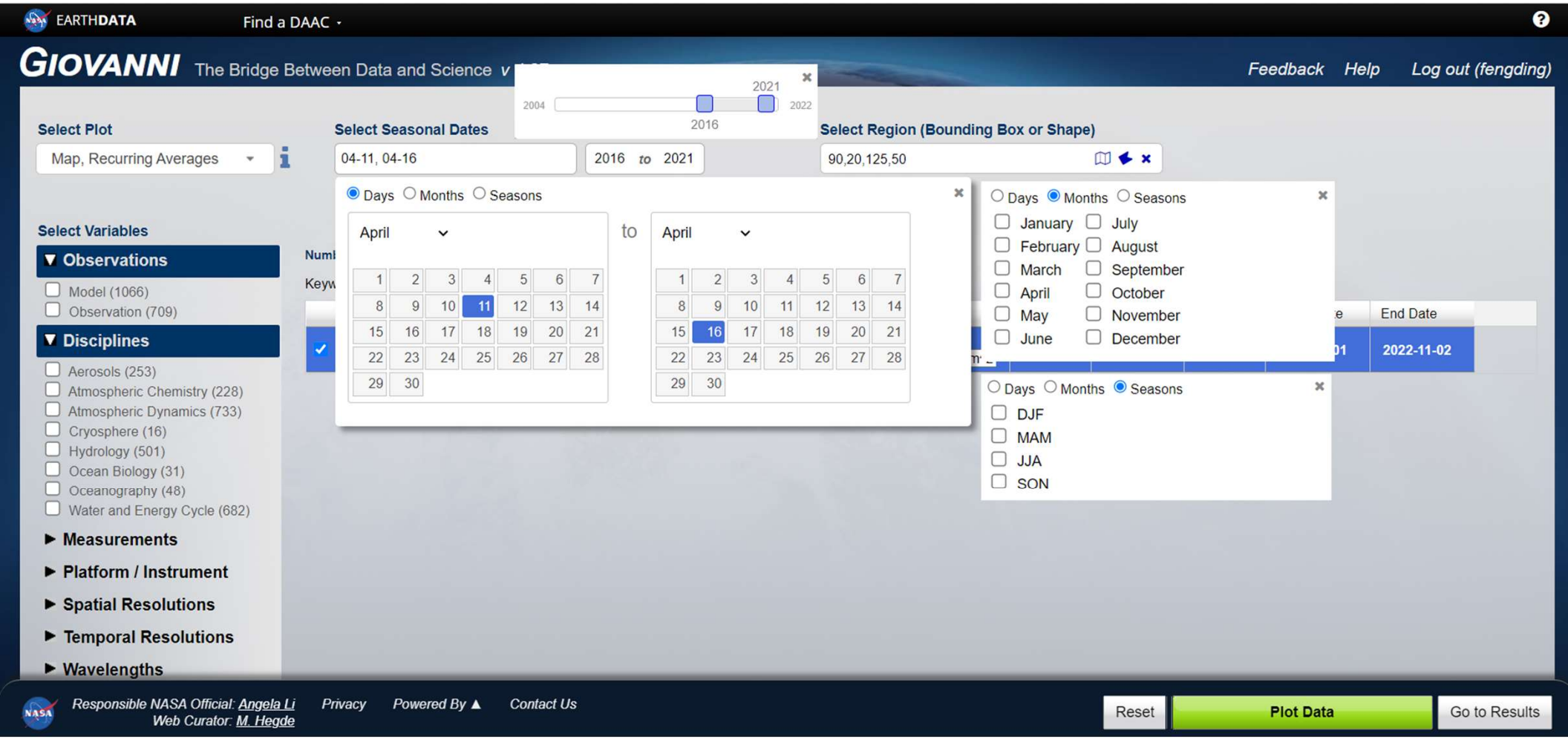
Giovanni - Exploring/Analyzing L3/L4 Data
https://giovanni.gsfc.nasa.gov/



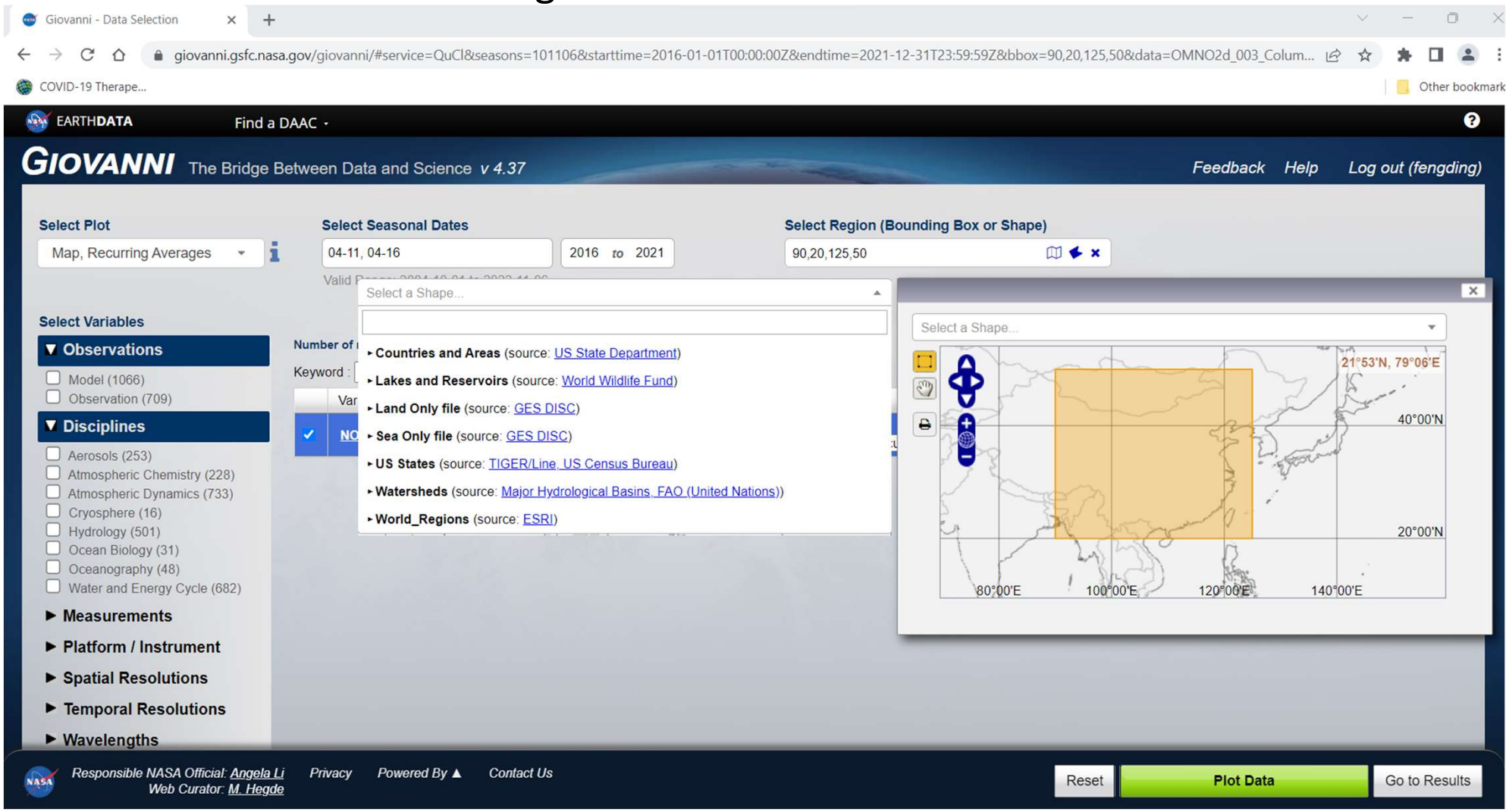
Giovanni: Recurring Averages Map
Study COVID-19 Impact on NO_2 in April 2022, Eastern China



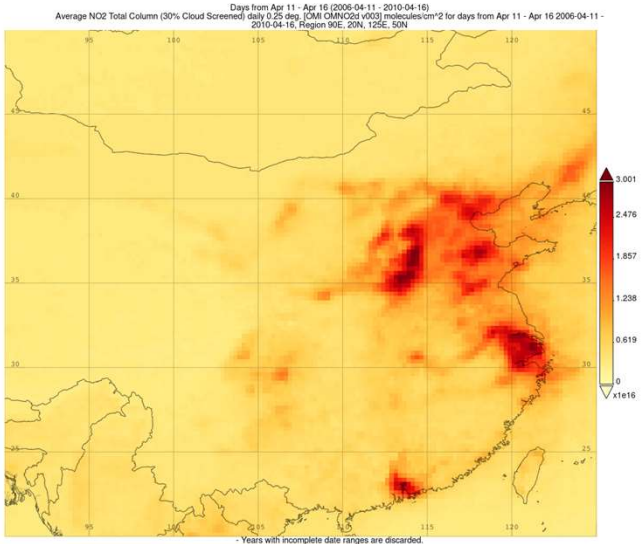
Giovanni – Select Days, Months, Seasons, Year Range
Days: 4/11–04/16 Year Range: 2006-2010, 2011-2015, 2016-2021, 2022



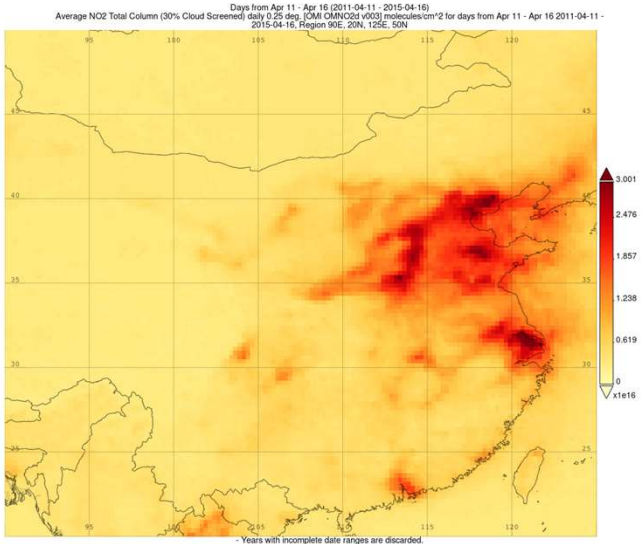
Giovanni – Select Region (Bounding Box or Shape)
Bounding Box: Central and Eastern China



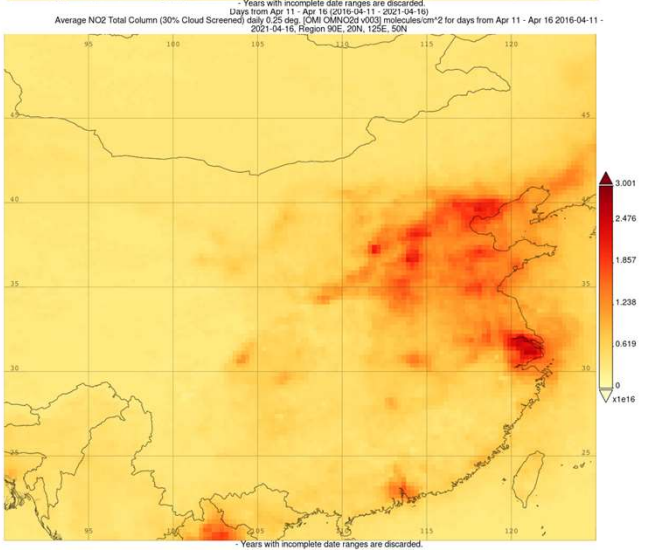
Six-Day (4/11 – 4/16) NO_2 Average



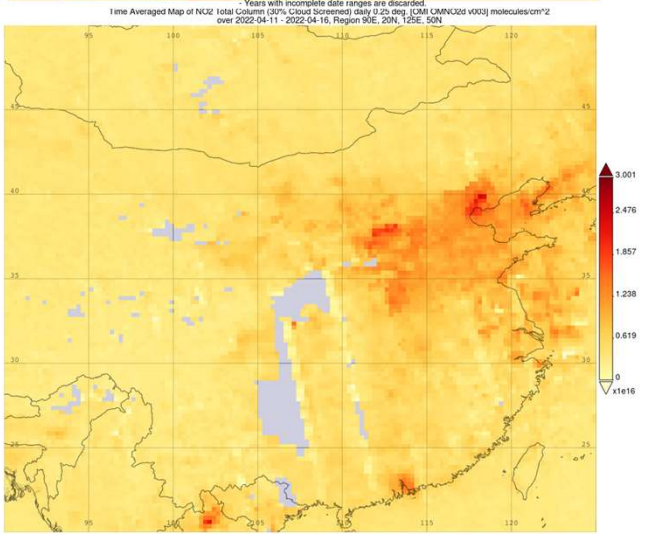
2006 - 2010



2011 - 2015



2016 - 2021



2022

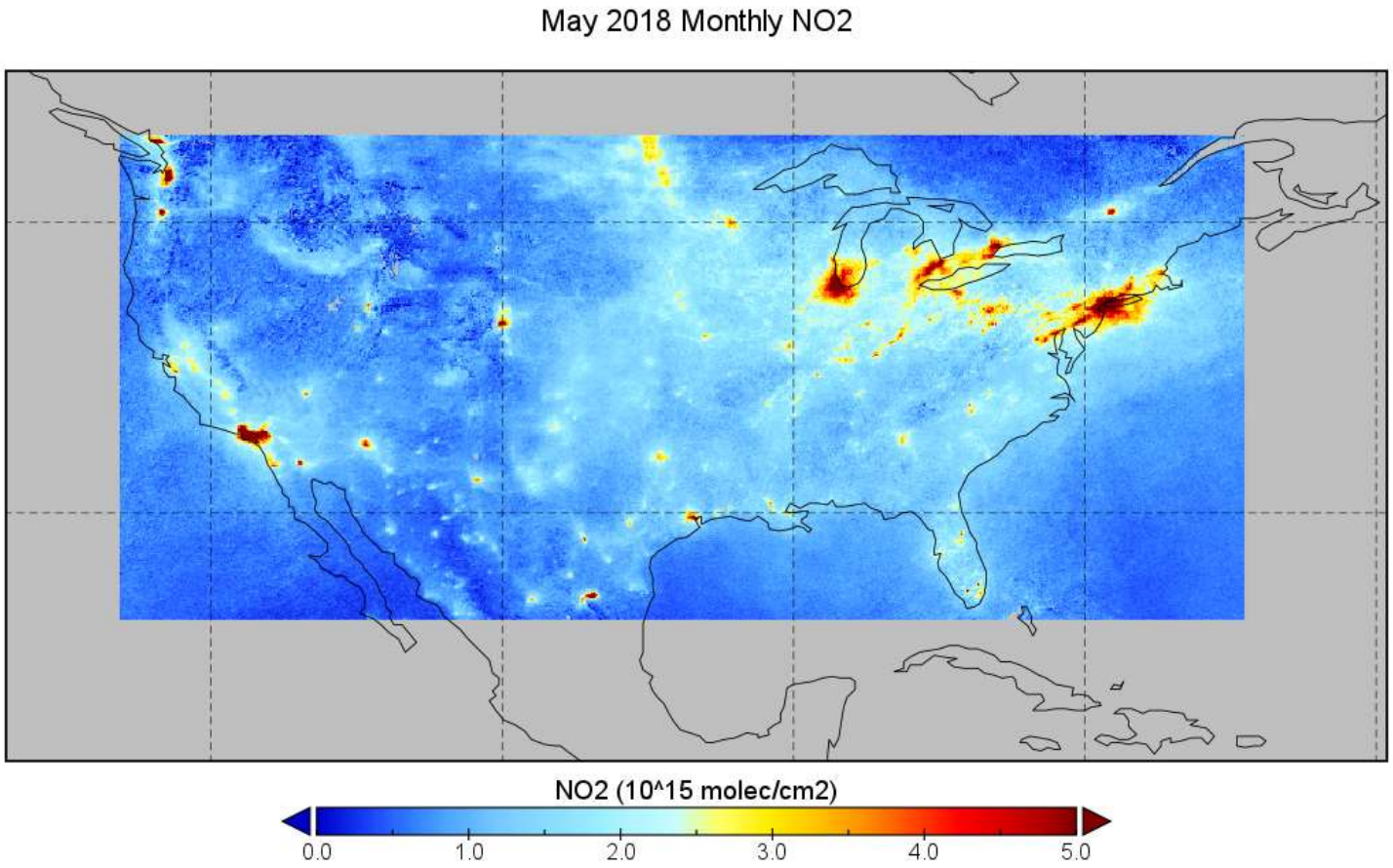
GES DISC Data Migration to Cloud

- Data migration to cloud is ongoing and updates are posted on the GES DISC Cloud Migration Page: https://disc.gsfc.nasa.gov/information/documents?title=Migrating%20to%20the%20Cloud
- All of GES DISC's traditional services and download methods are still available
- Free data download will continue and won't change, i.e., a user only pays cloud computing service but not NASA data
- In-cloud AWS direct S3 access is available

  No need to download the data for research and application

One example: generating user-defined Level 3/Level 4 products by directly accessing Level 2 data without downloading

User-defined L3 TROPOMI Gridded Monthly NO2 with QC over CONUS from NASA HAQAST (Health and Air Quality Application Science Team)



Summary

- In addition to many already distributed products (OMI, TROPOMI, MERRA-2), GES DISC released new products from MINDS project for air quality research and application communities
- Level 2 Subsetter and Giovanni are valuable tools to download, explore, and analyze data
- GES DISC data migration to cloud is ongoing and will add more convenient ways to access data
- User feedback is very welcome:
  https://disc.gsfc.nasa.gov gsfc-dl-help-disc@mail.nasa.gov

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