Familiarisation and Visualization of Aerosol data with Hands-on-Retrieval using iAOD software

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Operational AOD products

Satellite-based products	Ground-based measurements
MODIS* (DB, DT, combined, MAIAC)	AERONET*
OMI, GOME, TOMS, MERIS, OCM-2	ARFINET
AVHRR (1st satellite AOD product)	ICARB
POLDER, CALIPSO	EARLINET
Landsat, Sentinel 2[a]	ACE-1, SAFARI 2000

[a]Kumar, A., & Mehta, M. (2024). Global evaluation of sentinel 2 level 2A Sen2Cor aerosol optical thickness retrievals. *International Journal of Remote Sensing*, *46*(2), 728–744. https://doi.org/10.1080/01431161.2024.2421947

Part I: Products, Access and Visualization

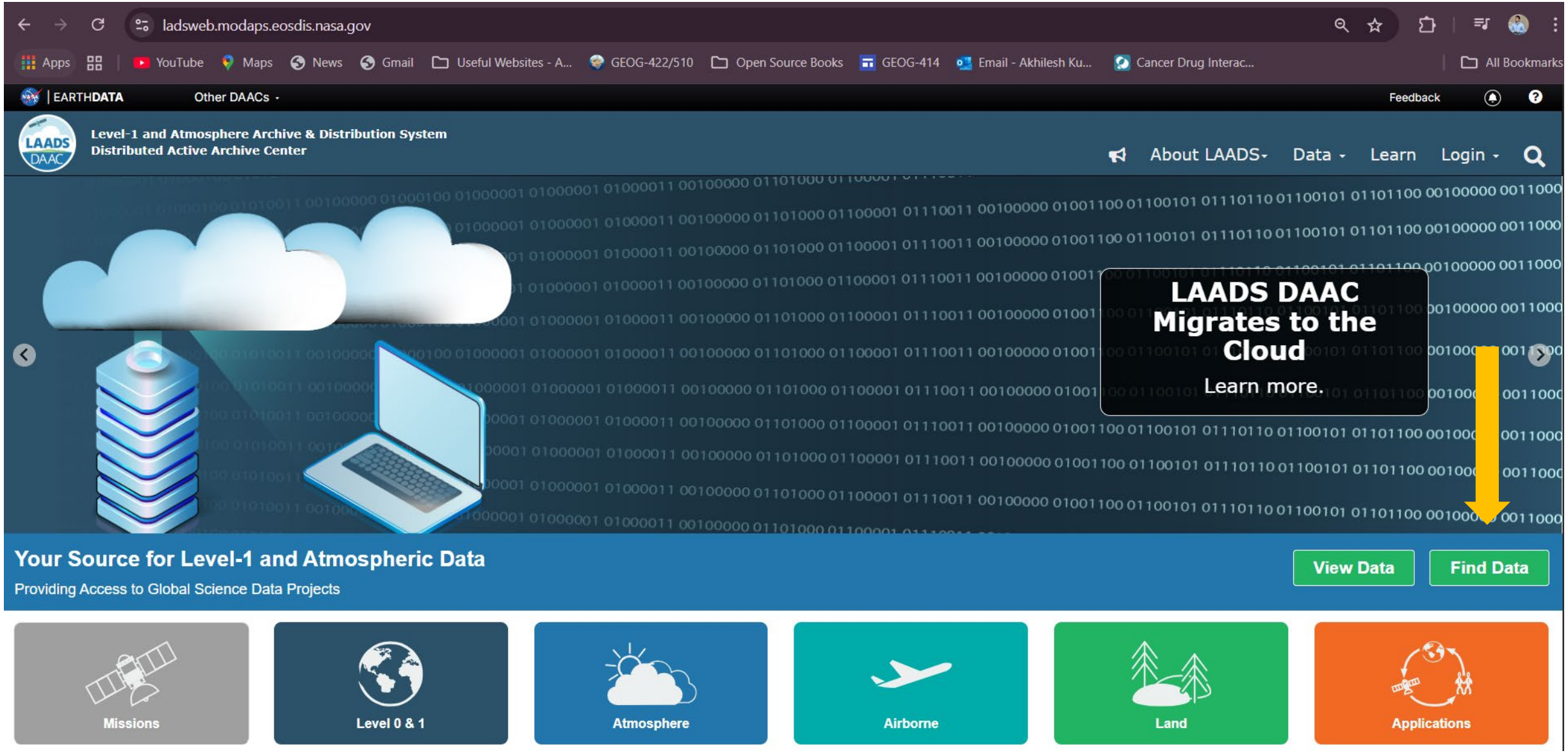
MODIS (DBDT & MAIAC), AERONET

MODIS Deep Blue – Dark Target (DB-DT)

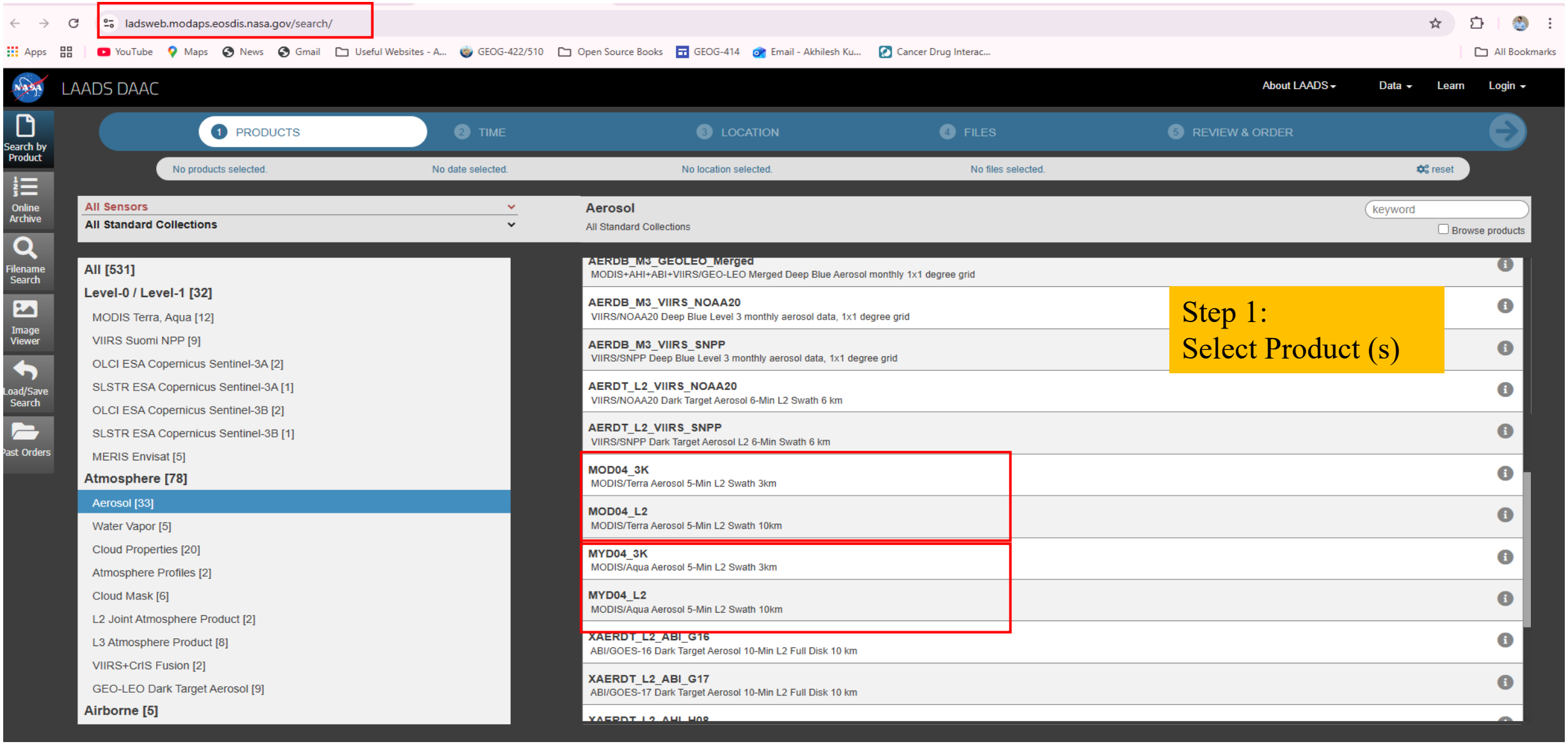
LAADS DAAC

https://ladsweb.modaps.eosdis.nasa.gov/

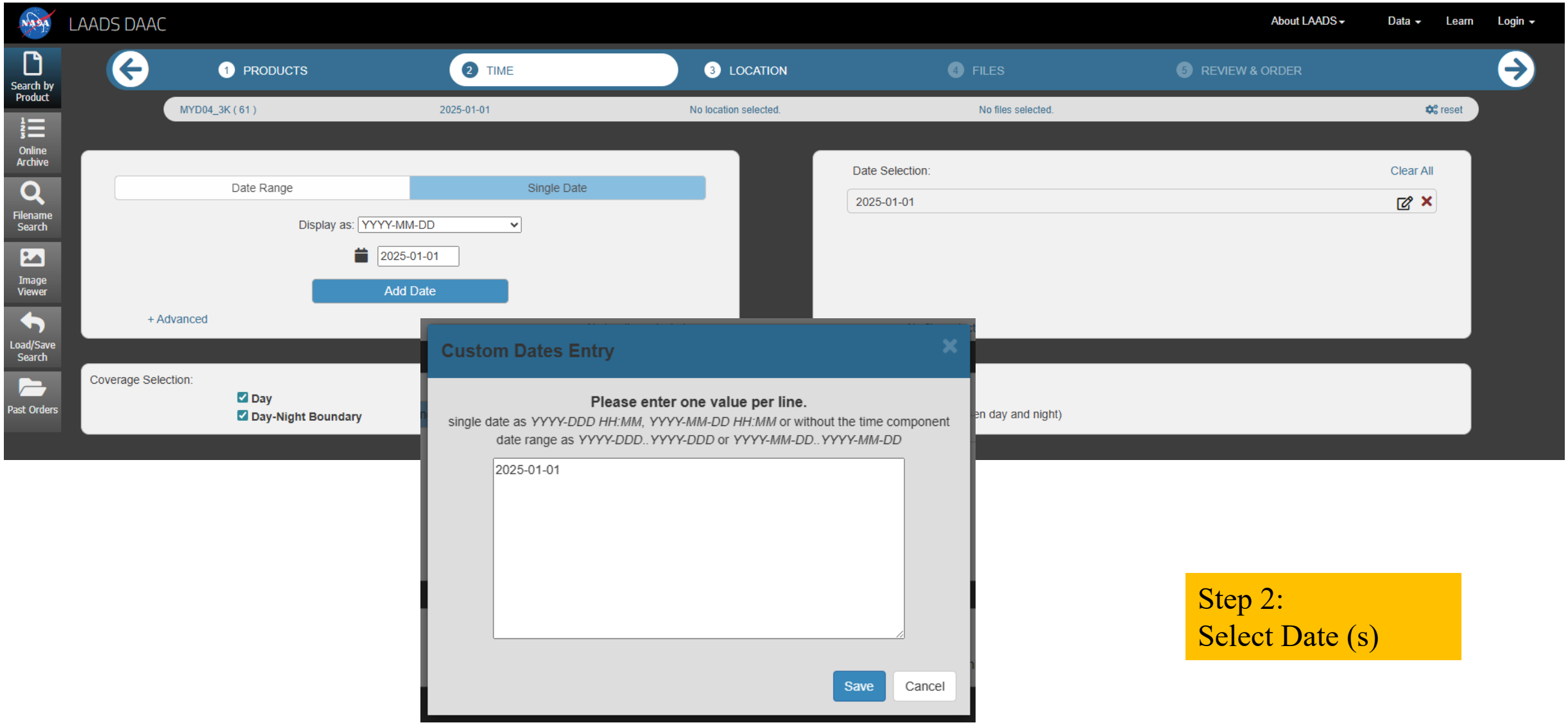
Access MODIS data (LAADS DAAC)



Access MODIS data …



Access MODIS data …



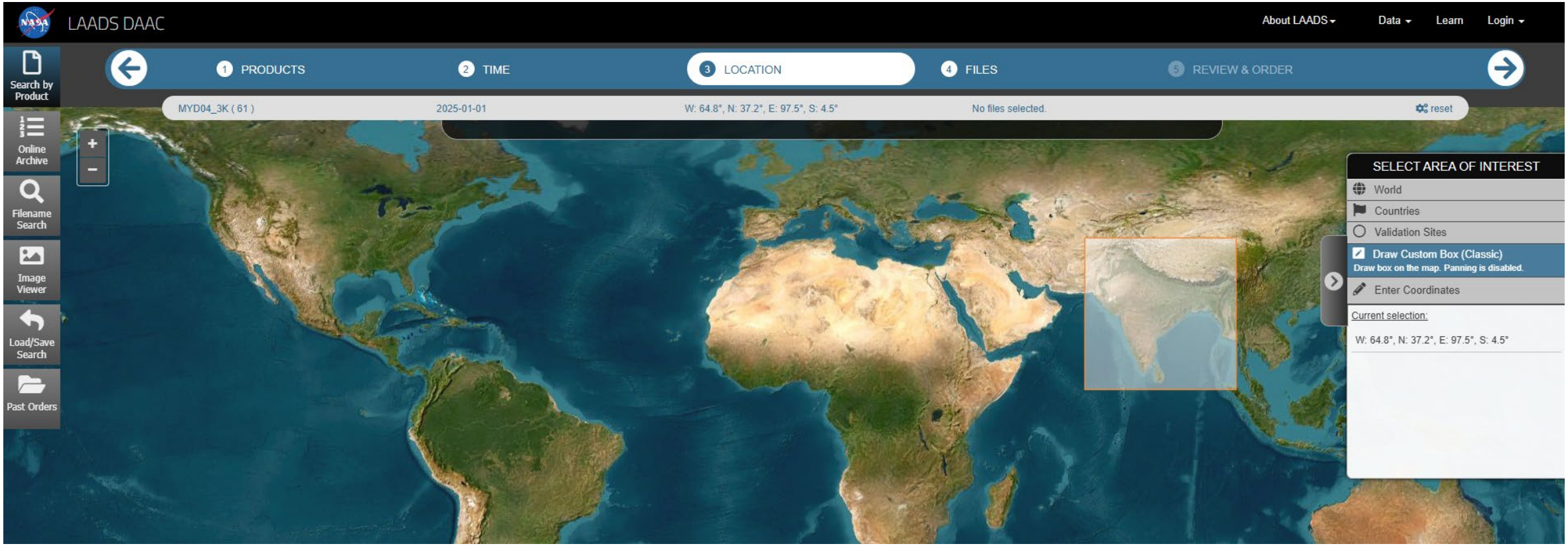
Step 2:
Select Date (s)

Access MODIS data …

Step 3: Select Location (s)
Using Validation Sites

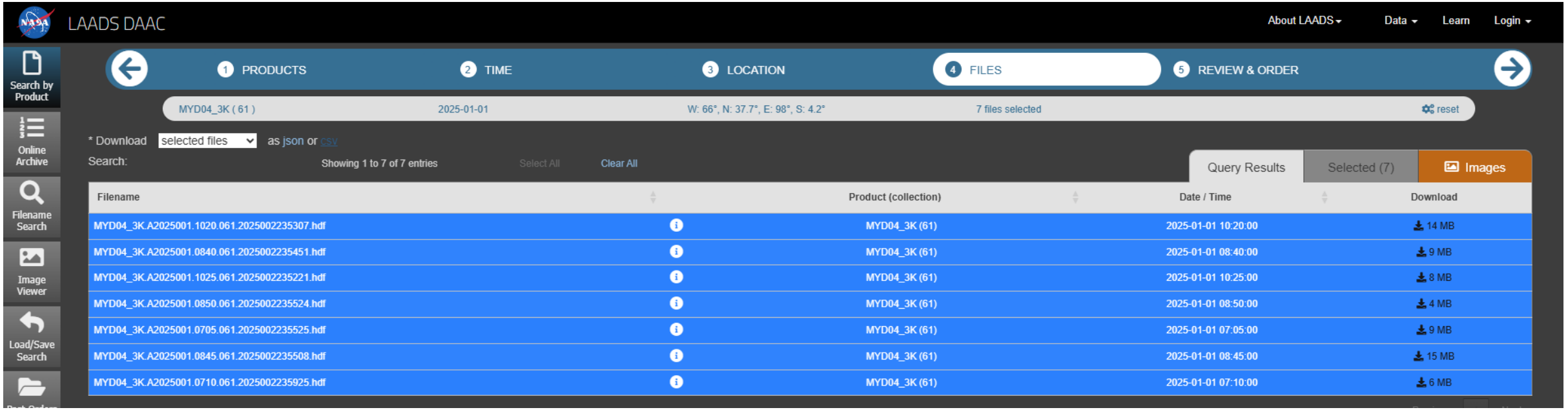
Access MODIS data …

Step 3: Select Location (s)
Using a bounding box



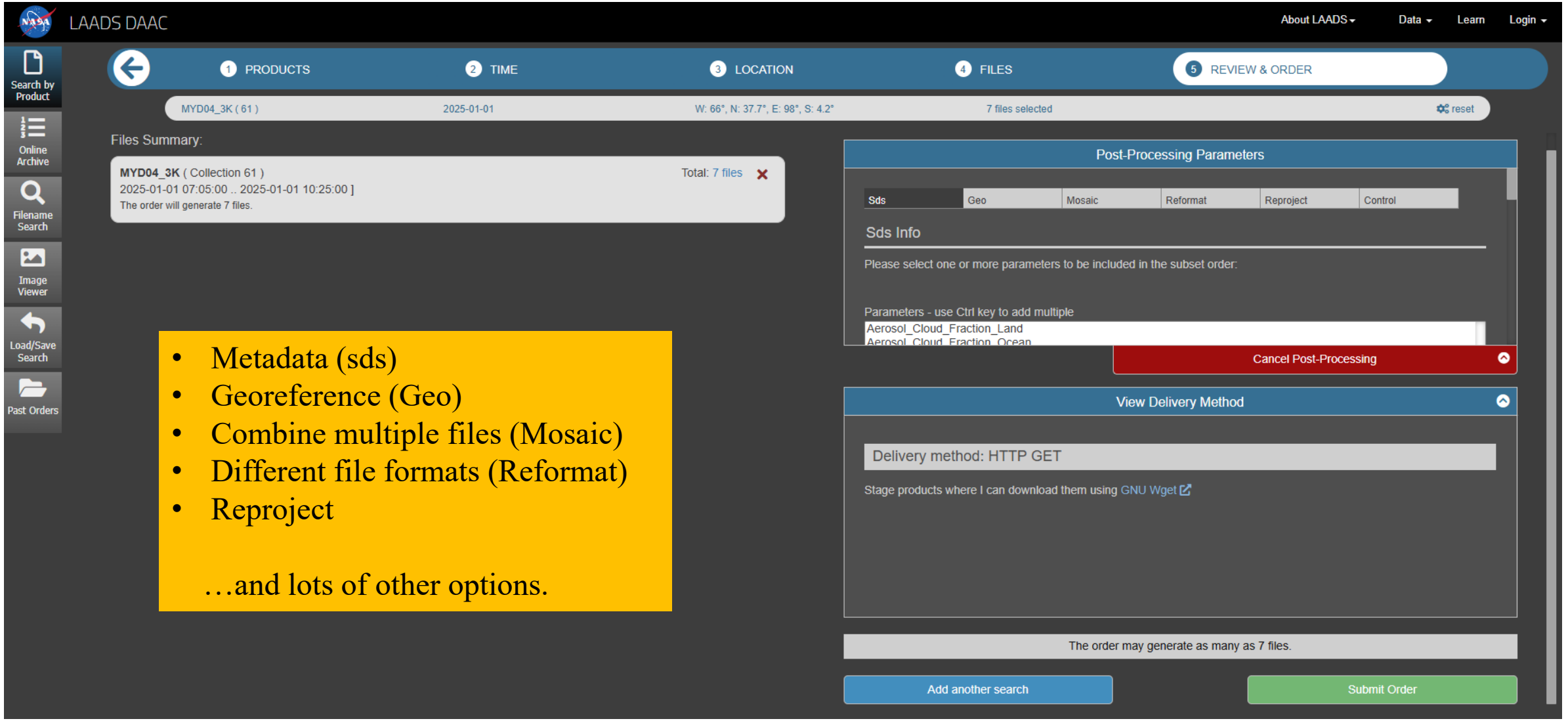
Access MODIS data …

Step 4: Select File (s)



Access MODIS data …

Step 5: Review and Order



- Metadata (sds)
- Georeference (Geo)
- Combine multiple files (Mosaic)
- Different file formats (Reformat)
- Reproject

…and lots of other options.

Access MODIS data …

Step 6: Download

LAADS Web Order Notification Inbox ×

v2lads <noreply@nasa.gov> 10:40 AM (0 minutes ago)
to me

Your Export ID is: 502424881
The data you ordered will be staged (in about 10 minutes), and you can retrieve the data through HTTP using GNU wget, as follows

wget -e robots=off -m -np -R .html,.tmp -nH --cut-dirs=3
https://ladsweb.modaps.eosdis.nasa.gov/archive/orders/502424881/
--header "Authorization: Bearer <YOUR_EDL_TOKEN>" -P <target dir>

Using Command Terminal

Replace the <YOUR_EDL_TOKEN> placeholder with your Earthdata Login token. EDL tokens can be created and retrieved by logging into your Earthdata account and selecting "Generate Token" from the menu.

Replace the <target dir> placeholder with the directory where you wish to save the files.

Explanation of additonal options used:
-e robots=off : Bypass the robots.txt file, to allow access to all files in the order
-m : Enable mirroring options (-r -N -l inf) for recursive download, timestamping & unlimited depth
-np : Do not recurse into the parent location
-R .html,.tmp : Reject (do not save) any .html or .tmp files (which are extraneous to the order)
-nH : Do not create a subdirectory with the Host name (ladsweb.modaps.eosdis.nasa.gov)
--cut-dirs=3 : Do not create subdirectories for the first 3 levels (archive/orders/502424881)
--header : Adds the header with your appKey (which is encrypted via SSL)
-P : Specify the directory prefix (may be relative or absolute)

If you do not have wget:
- Windows users can download it at https://eternallybored.org/misc/wget/
- Mac OS X users can install it using Homebrew (https://brew.sh) using the command `brew install wget`
- Additional information on wget is available at https://www.gnu.org/software/wget/faq.html

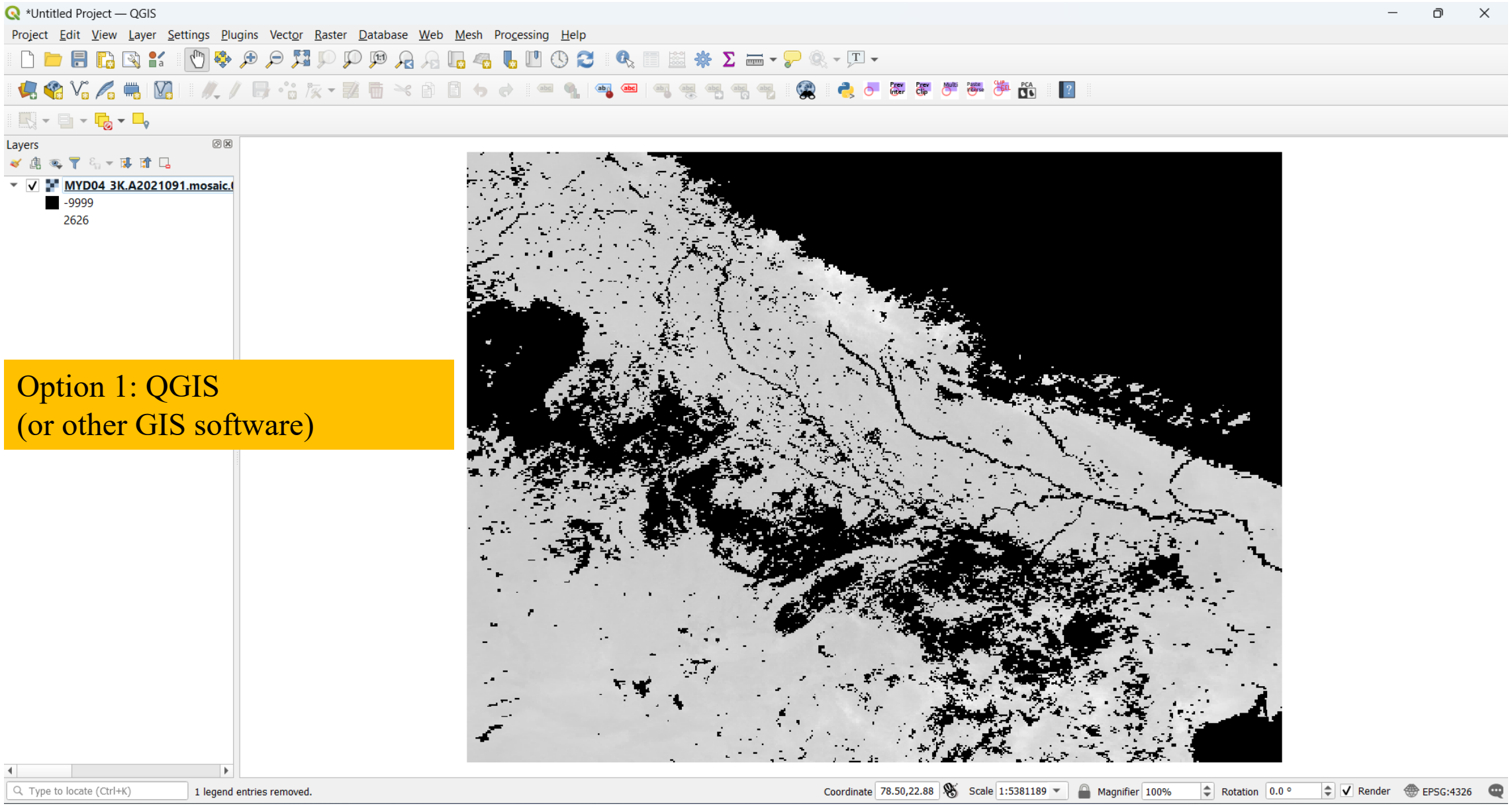
Alternatively, you can use an HTTP script from
https://ladsweb.modaps.eosdis.nasa.gov/tools-and-services/data-download-scripts/

Using HTTP scripts (site crawl)

or manually download all files from
https://ladsweb.modaps.eosdis.nasa.gov/archive/orders/502424881/

Manual

Visualizing MODIS data

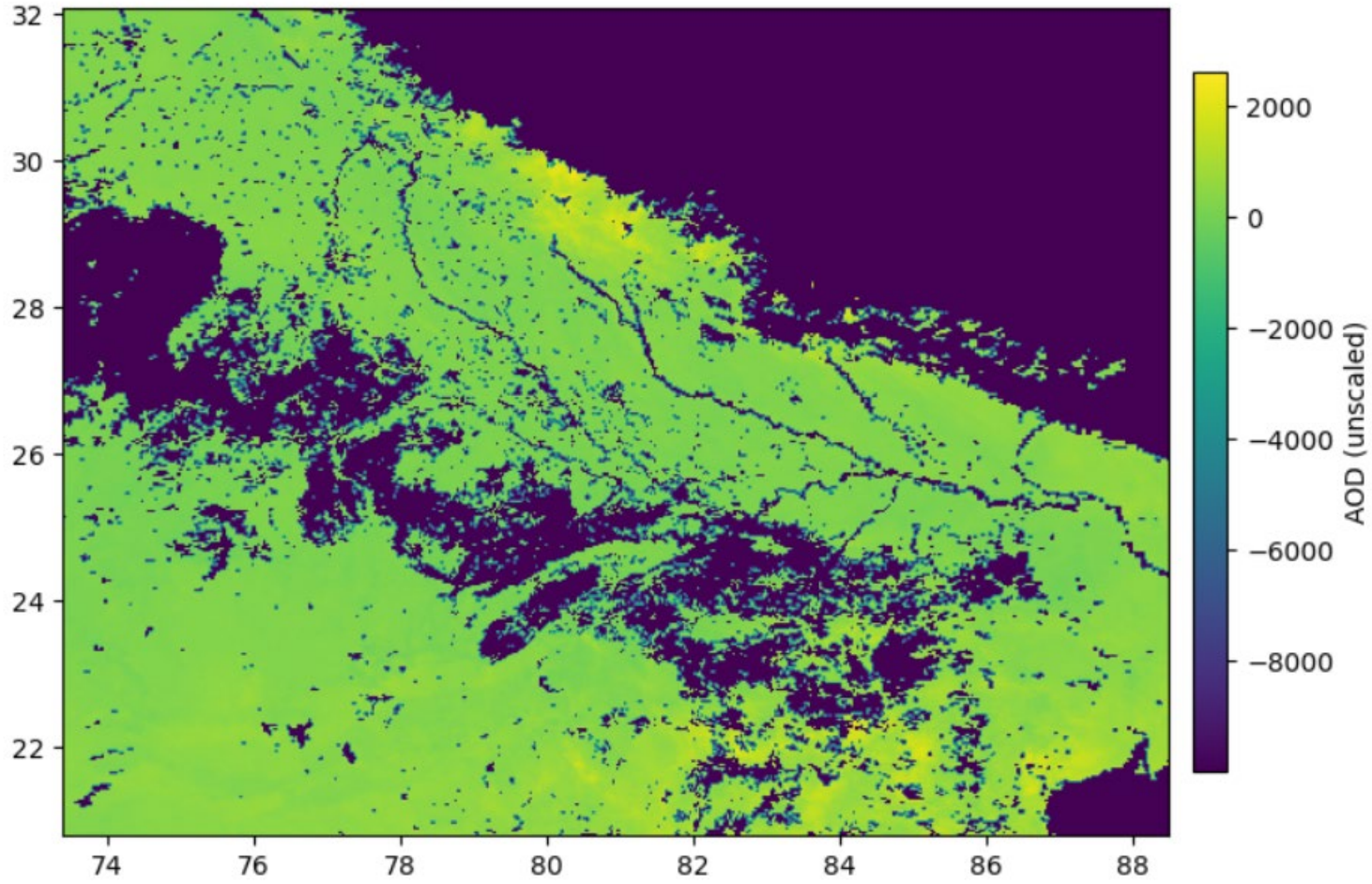


Option 1: QGIS
(or other GIS software)

Visualizing MODIS data …

```python
import rasterio
from rasterio.plot import show
import matplotlib.pyplot as plt

def display_geotiff(path):

    with rasterio.open(geotiff_path) as src:
        data = src.read(1)  # first band
        print("CRS:", src.crs)
        print("Bounds:", src.bounds)
        print("Resolution:", src.res)

        fig, ax = plt.subplots(figsize=(8, 8))
        img = show(data, transform=src.transform, ax=ax, cmap="viri

        cbar = plt.colorbar(img.get_images()[0], ax=ax, fraction=0.
        cbar.set_label("AOD (unscaled)")  # label for legend
        plt.show()


# Example
geotiff_path = r"D:\Aerosol Modelling\Validation_Data\MYD04_3K\MYD0
display_geotiff(geotiff_path)
```

```
CRS: EPSG:4326
Bounds: BoundingBox(left=73.4, bottom=20.8, right=88.5, top=32.1)
Resolution: (0.026916221033868083, 0.02703349282296651)
```



Option 2: Programming Language (Python (shown above), R, etc.)

Multi-angle Implementation of Atmospheric Correction (MAIAC)

Google Earth Engine

https://developers.google.com/earth-engine/datasets/catalog/MODIS_061_MCD19A2_GRANULES

Access MAIAC data ...

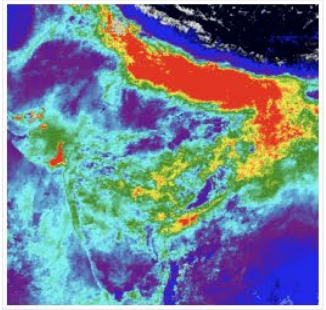
ata Catalog

Search /

All datasets | All tags | Landsat | MODIS | Sentinel | Publisher | Community | API Docs | Dataset status

MCD19A2.061: Terra & Aqua MAIAC Land Aerosol Optical Depth Daily 1km

AI-generated Key Takeaways



Dataset Availability
2000-02-24T00:00:00Z–2025-11-20T23:55:00Z

Dataset Provider
NASA LP DAAC at the USGS EROS Center

Earth Engine Snippet
`ee.ImageCollection("MODIS/061/MCD19A2_GRANULES")`

Cadence
1 Day

Tags
aerosol
usgs

Description | Bands | Terms of Use | Citations | DOIs

Citations:

- Please visit LP DAAC 'Citing Our Data' page for information on citing LP DAAC datasets.

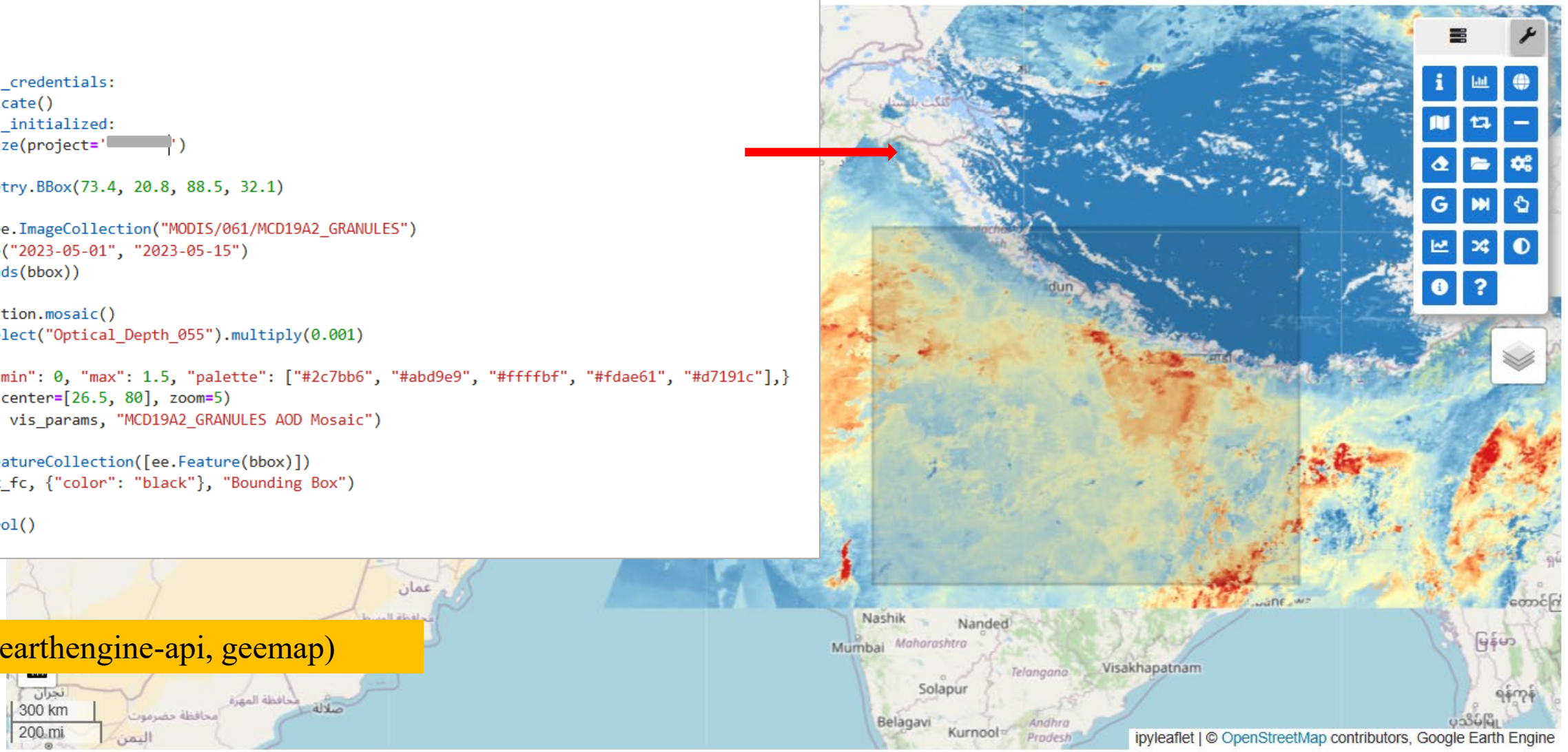
Data on: Google Earth Engine
Access: Python (earthengine-api)

```python
import ee

if not ee.data._credentials:
    ee.Authenticate()
if not ee.data._initialized:
    ee.Initialize(project='[redacted]')

bbox = ee.Geometry.BBox(73.4, 20.8, 88.5, 32.1)
collection = (ee.ImageCollection("MODIS/061/MCD19A2_GRANULES")
    .filterBounds(bbox)
    .filterDate("2023-01-01", "2023-01-31"))

image = collection.first()
image = image.select("Optical_Depth_055") # Optical depth at 550nm

image_clipped = image.clip(bbox)

# Download locally via URL
print("Generating download URL...")
url = image_clipped.getDownloadURL({"scale": 1000, # MODIS native resolution ~1km
    "crs": "EPSG:4326", "region": bbox})

print("Download link: ", url)
```

```
Generating download URL...
Download link:  https://earthengine.googleapis.com/v1alpha/projects/[redacted]/thumbnai
f5be9506:getPixels
```

Visualizing MAIAC data …

```python
import ee
import folium
import geemap

if not ee.data._credentials:
    ee.Authenticate()
if not ee.data._initialized:
    ee.Initialize(project='[redacted]')

bbox = ee.Geometry.BBox(73.4, 20.8, 88.5, 32.1)

collection = (ee.ImageCollection("MODIS/061/MCD19A2_GRANULES")
    .filterDate("2023-05-01", "2023-05-15")
    .filterBounds(bbox))

mosaic = collection.mosaic()
aod = mosaic.select("Optical_Depth_055").multiply(0.001)

vis_params = {"min": 0, "max": 1.5, "palette": ["#2c7bb6", "#abd9e9", "#ffffbf", "#fdae61", "#d7191c"],}
m = geemap.Map(center=[26.5, 80], zoom=5)
m.addLayer(aod, vis_params, "MCD19A2_GRANULES AOD Mosaic")

bbox_fc = ee.FeatureCollection([ee.Feature(bbox)])
m.addLayer(bbox_fc, {"color": "black"}, "Bounding Box")

m.addLayerControl()
m
```



Python (earthengine-api, geemap)

Aerosol Robotic Network (AERONET)

NASA AERONET

https://aeronet.gsfc.nasa.gov/

Access AERONET data (website)

+ AEROSOL OPTICAL DEPTH | + AEROSOL INVERSIONS | + SOLAR FLUX | + OCEAN COLOR | + MARITIME AEROSOL

For receiving updates on AERONET - subscribe to the mailing list by sending an email to aeronet-join@lists.nasa.gov

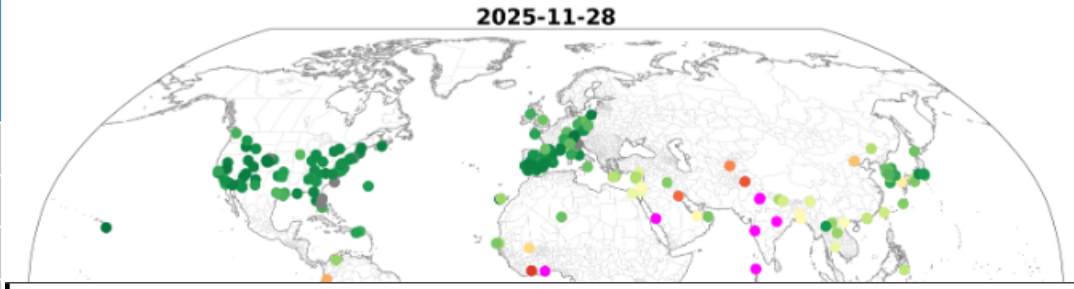
-Home

Home

+ AEROSOL/FLUX NETWORKS
+ CAMPAIGNS
+ COLLABORATORS
+ DATA
+ LOGISTICS
+ NASA PROJECTS
+ OPERATIONS
+ PUBLICATIONS
+ SITE INFORMATION
+ STAFF
+ SYSTEM DESCRIPTION

AERONET DATA ACCESS

DATA VISUALIZATION
+ Synergy Tool
+ Map Explorer



AERONET DATA ACCESS

DATA VISUALIZATION
+ Synergy Tool
+ Map Explorer
+ Air Quality
+ Diurnal Analysis

AEROSOL OPTICAL DEPTH (V3)-SOLAR
+ Data Display
+ Download Tool
+ Download All Sites
+ Climatology Tables
+ Web Service

About AERONET

The AERONET (AErosol RObotic NETwork) program is a federation of ground-based remote sensing aerosol networks established by NASA and PHOTONS (PHOtométrie pour le Traitement Opérationnel de Normalisation Satellitaire; Univ. of Lille 1, CNES, and CNRS-INSU) and is greatly expanded by networks, calibration centers, and collaborators (e.g., RIMA, AeroSpan, APAC, AEROCAN, AEROSPAIN, NEON, and CARSNET) from national agencies, institutes, universities, individual scientists, and partners. For more than 25 years, the project has provided long-term, continuous, and readily accessible public domain database of aerosol optical, microphysical and radiative properties for aerosol research and characterization, validation of satellite retrievals, and synergism with other databases. The network imposes standardization of instruments, calibration, processing and distribution.

AERONET collaboration provides globally distributed observations of spectral aerosol optical depth (AOD), inversion products, and precipitable water in diverse aerosol regimes. Version 3 AOD data are computed for three data quality levels: Level 1.0 (unscreened), Level 1.5 (cloud-screened and quality-controlled), and Level 2.0 (quality-assured). Inversions, precipitable water, and other AOD-dependent products are derived from these levels and may implement additional quality checks.

The AERONET - Ocean Color (AERONET-OC) is another component of the AERONET program, provides the additional capability of measuring the radiance emerging from the sea (i.e., normalized water-leaving radiance) with sun-photometers installed on offshore platforms like lighthouses, oceanographic and oil towers. Similarly, the Maritime Aerosol Network (MAN) component of the AERONET program provides ship-borne aerosol optical depth measurements from the Microtops II

https://aeronet.gsfc.nasa.gov/

↓

AERONET Data Access

↓

Aerosol Optical Depth (V3) - Solar

↓

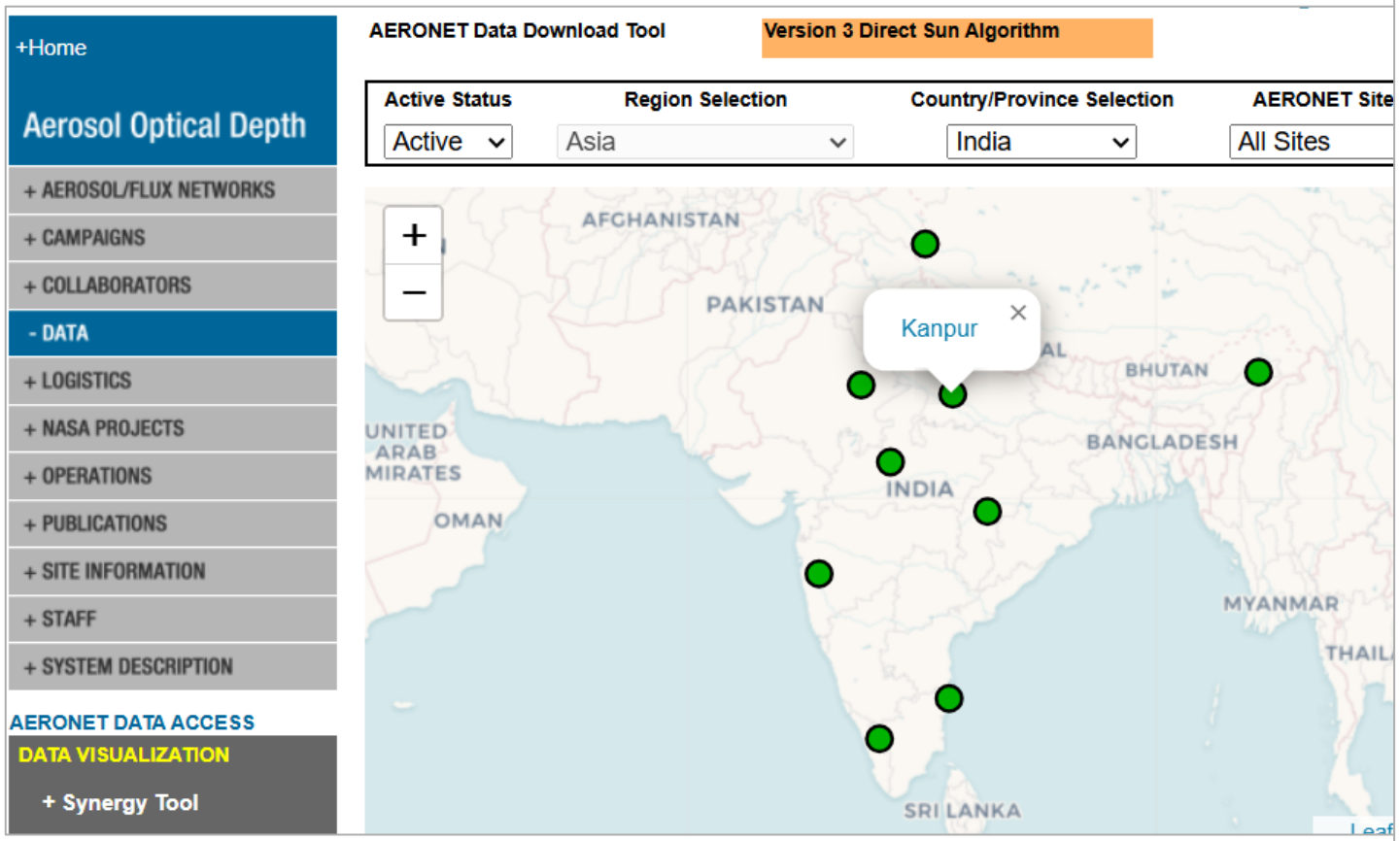
Download Tool

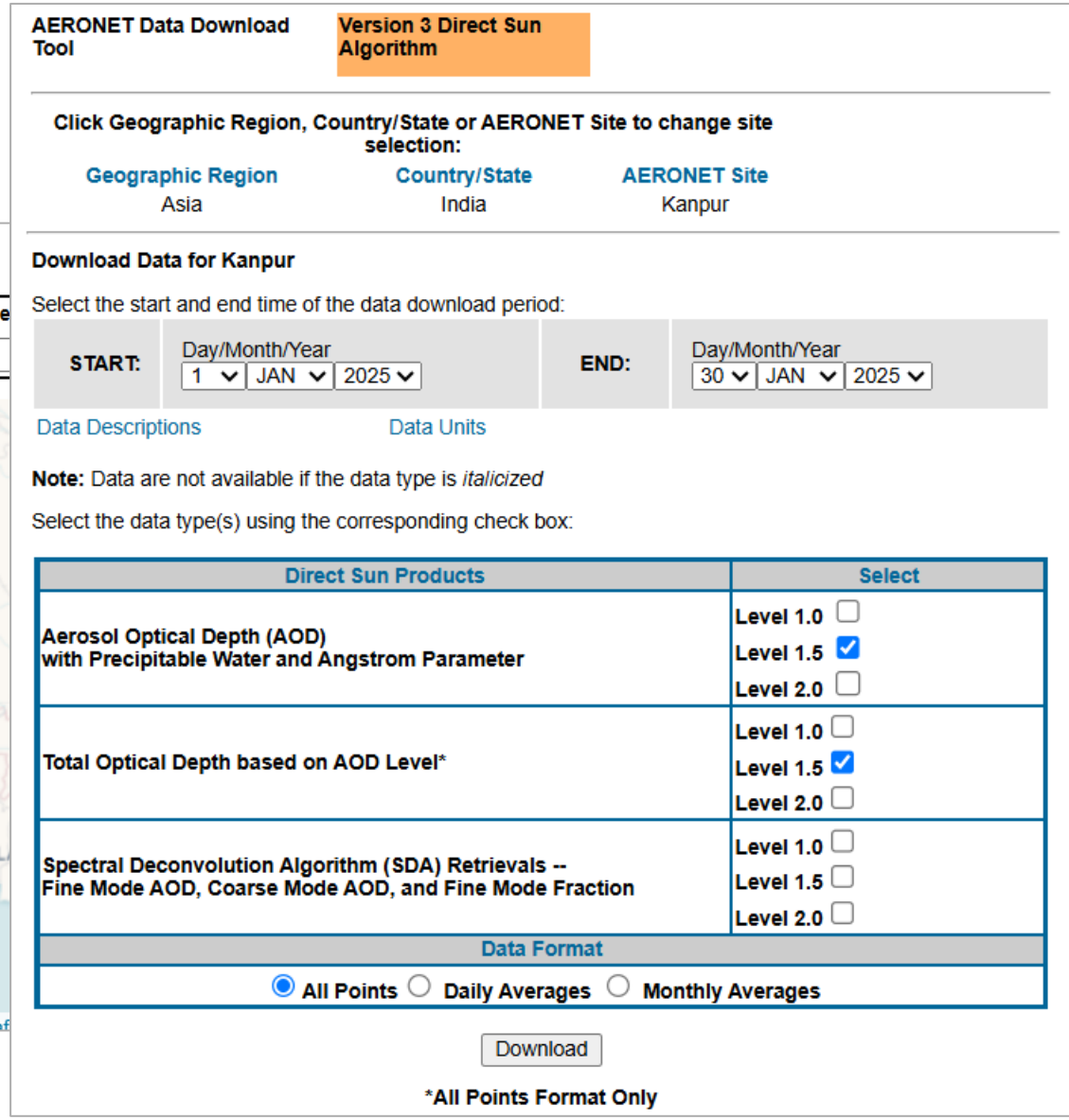
↓

Access AERONET data ....

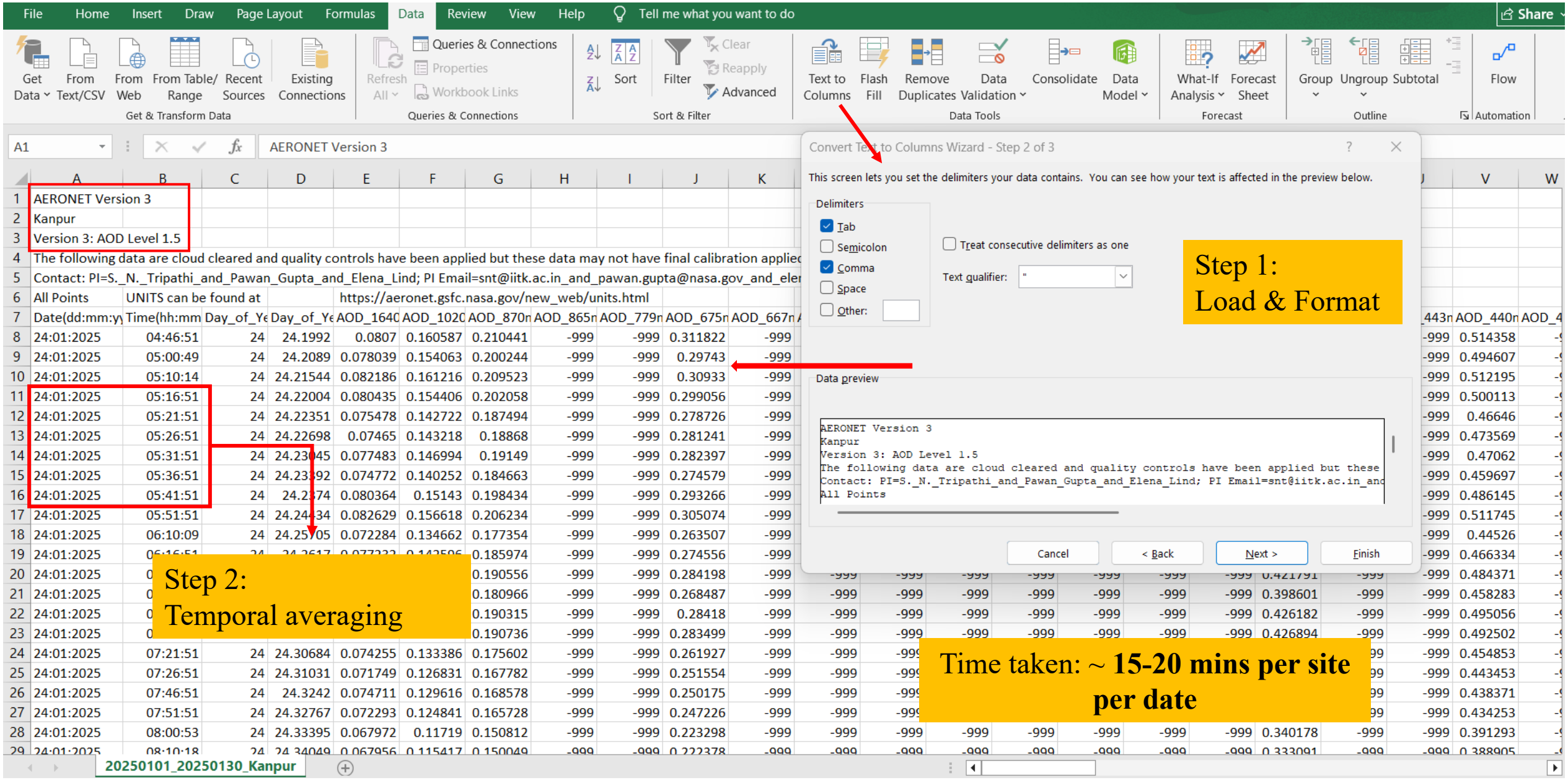
Step 1: Select site

Step 2:
Select date & product (s)

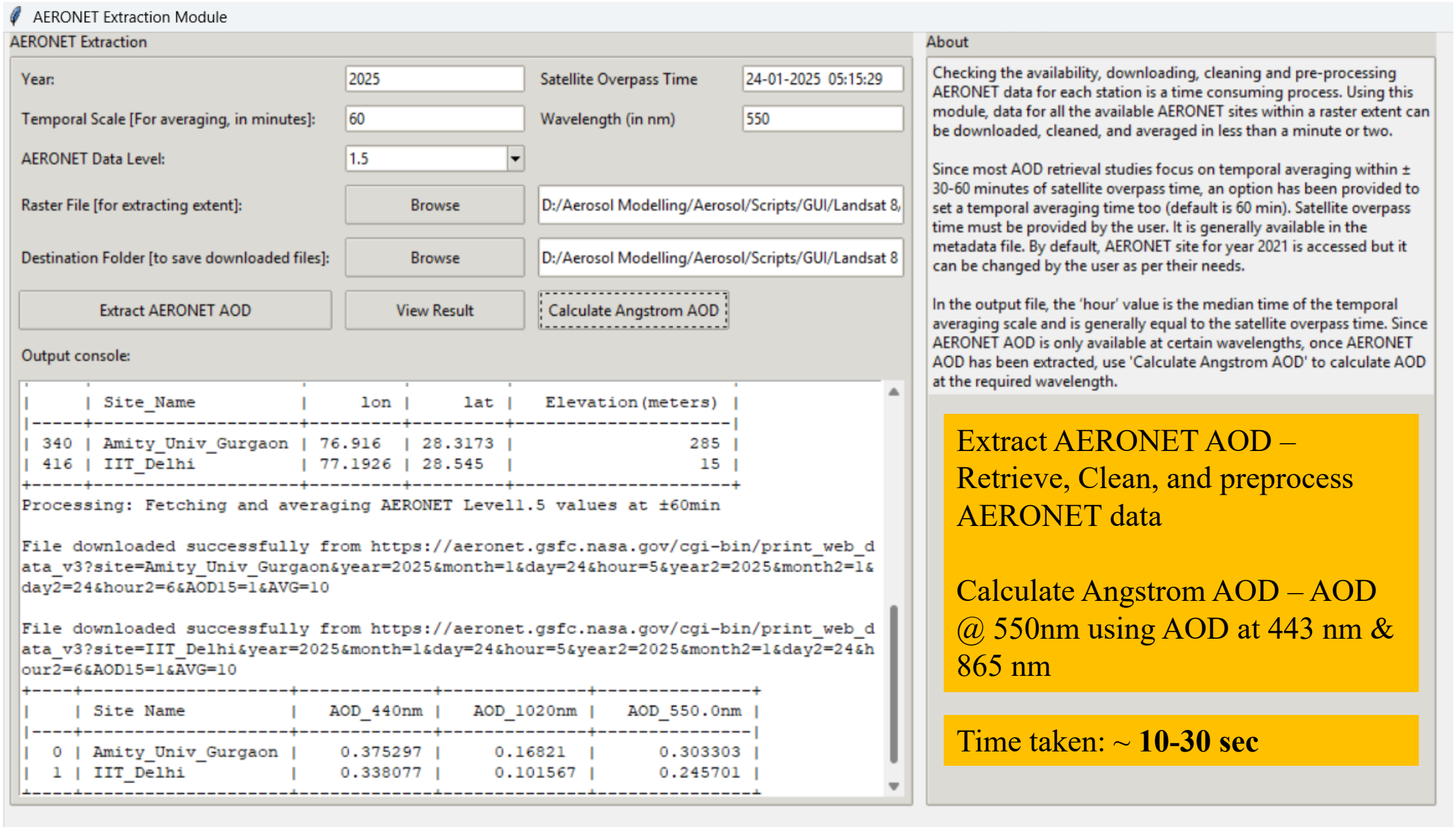




Process AERONET data (manual)



Download & Process AERONET data (iAOD)



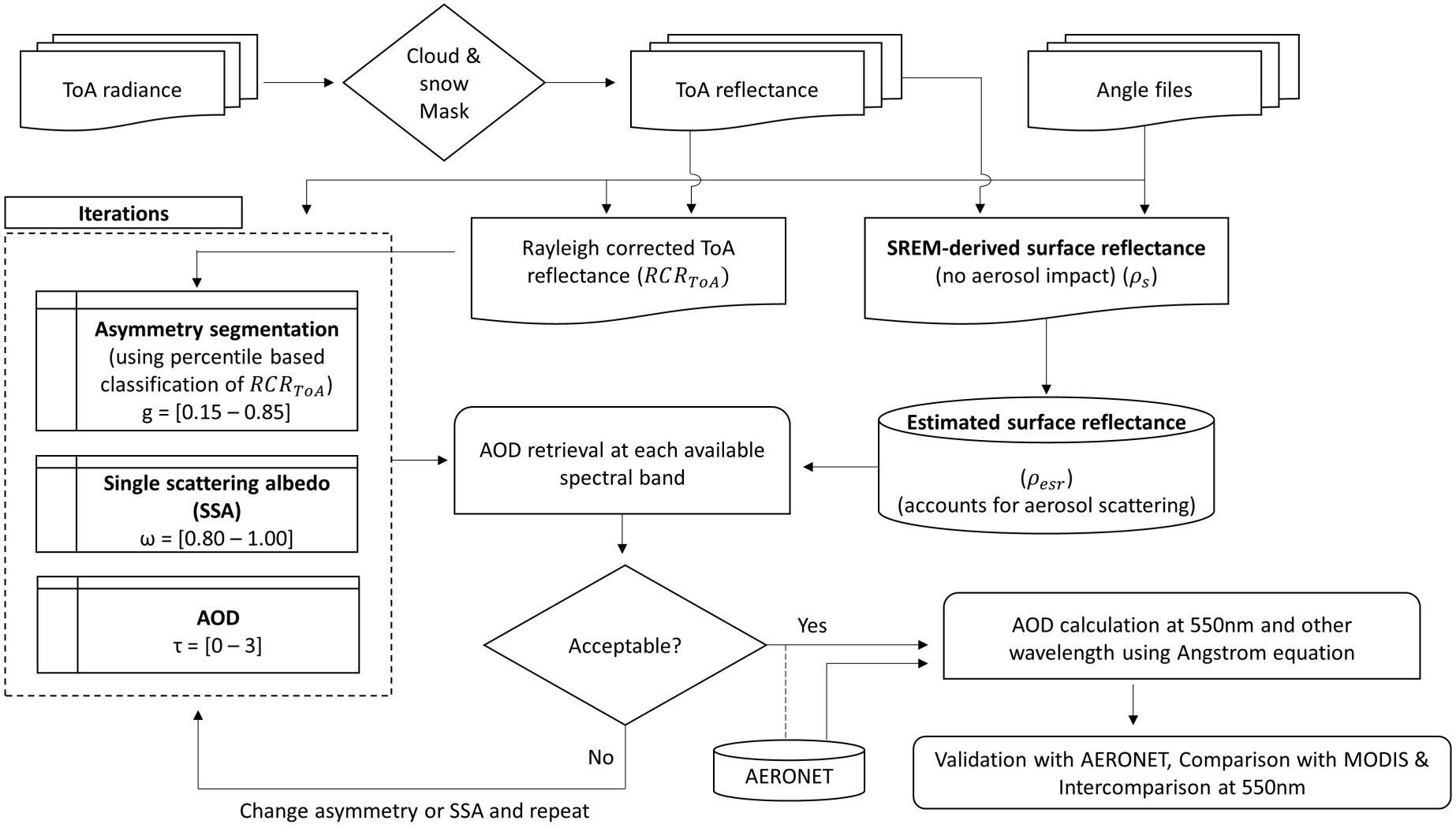
Extract AERONET AOD – Retrieve, Clean, and preprocess AERONET data

Calculate Angstrom AOD – AOD @ 550nm using AOD at 443 nm & 865 nm

Time taken: ~ **10-30 sec**

Part 2: iAOD Demonstration

iAOD Methodology (Kumar & Mehta, 2023)

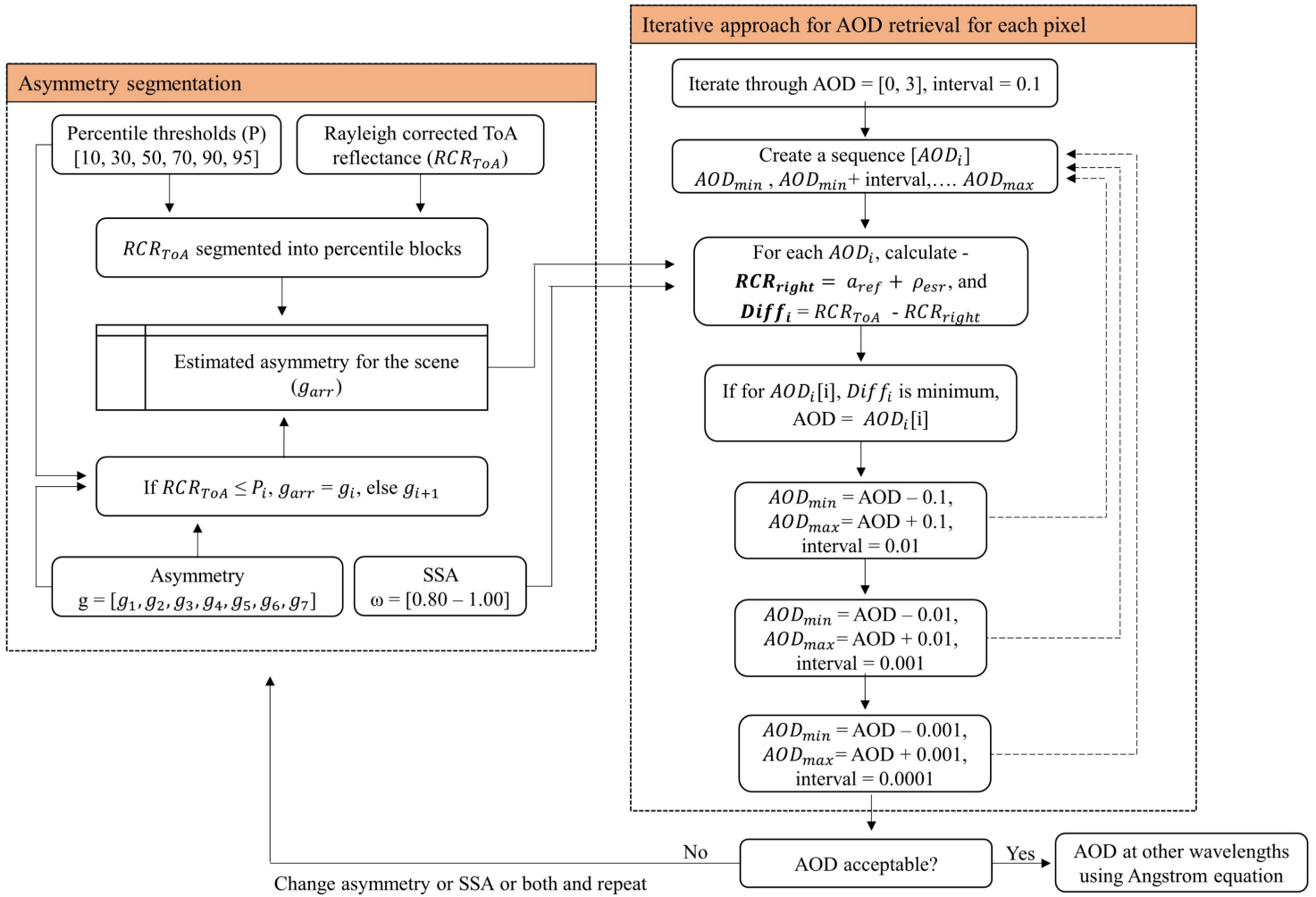


iAOD Methodology[b] (cont.)

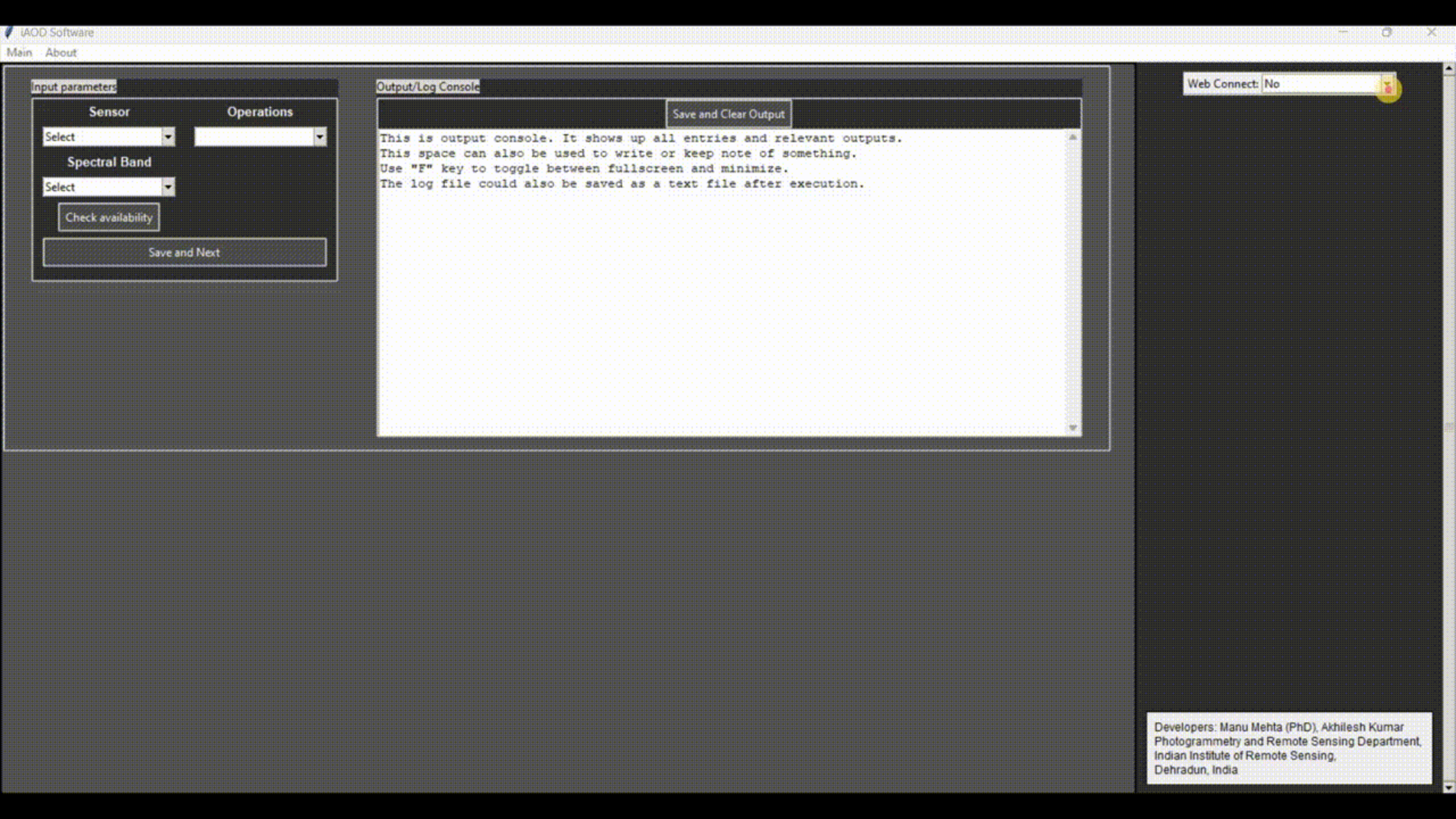
Percentile segmentation of Rayleigh corrected reflectance image

Asymmetry assignment to each segment

Single scattering albedo (SSA) assignment



[b]Kumar, A., & Mehta, M. (2023). Investigating the applicability of a simple iterative approach for aerosol optical depth (AOD) retrieval over diverse land surface types from Landsat 8 and Sentinel 2 using visible and near-infrared (VNIR) spectral bands. *Atmospheric Environment*, 314, 120082.


iAOD Software
Main
About
Input parameters
Sensor
Operations
Select
Spectral Band
Select
Check availability
Save and Next
Output/Log Console
Save and Clear Output
This is output console. It shows up all entries and relevant outputs.
This space can also be used to write or keep note of something.
Use "F" key to toggle between fullscreen and minimize.
The log file could also be saved as a text file after execution.
Web Connect: No
Developers: Manu Mehta (PhD), Akhilesh Kumar
Photogrammetry and Remote Sensing Department,
Indian Institute of Remote Sensing,
Dehradun, India

Thank you!

Reach me at:
akhilesh.kumar@unsw.edu.au

Missed presentation?
Scan QR for access