Geospatial Data Visualization and Analysis in the Cloud: An Open-Source Approach

Qiusheng Wu
Associate Professor
Department of Geography & Sustainability
University of Tennessee, Knoxville
https://gishub.org

THE UNIVERSITY OF TENNESSEE KNOXVILLE

HGAC Geographic Data Workgroup (GDW) Meeting

Slides: https://bit.ly/GDW-Talk

slides

Outline

- Open Geospatial Solutions
- Geemap
- Leafmap
- Segment-Geospatial
- HyperCoast
- Interactive Web Apps
- Q&A

https://github.com/opengeos

Open Geospatial Solutions

https://github.com/opengeos

Open Geospatial Solutions

A collection of open-source software packages for the geospatial community

1.6k followers | https://open.gishub.org | @giswqs | in/giswqs | opengeos@outlook.com

Python Packages

- cookiecutter-pypackage
- earthformer
- geemap
- geoai
- geospatial
- geospatial-ml
- HyperCoast
- leafmap
- lidar
- mapwidget
- open-buildings
- pygis
- segment-anything-py
- segment-geospatial
- whitebox-python
- whiteboxgui

Data Catalogs

- geospatial-data-catalogs
- aws-open-data
- aws-open-data-geo
- aws-open-data-stac
- Earth-Engine-Catalog
- NASA-CMR-STAC
- NASA-Earth-Data
- stac-index-catalogs
- maxar-open-data
- datasets
- data
- ee-tile-layers

R Packages

- whiteboxR

ArcGIS Toolboxes

- WhiteboxTools-ArcGIS

Web Apps

- streamlit-geospatial
- streamlit-map-template
- solara-geemap
- solara-geospatial
- solara-template
- solara-maxar
- voila-geospatial
- geospatial-dataviz

Useful Resources

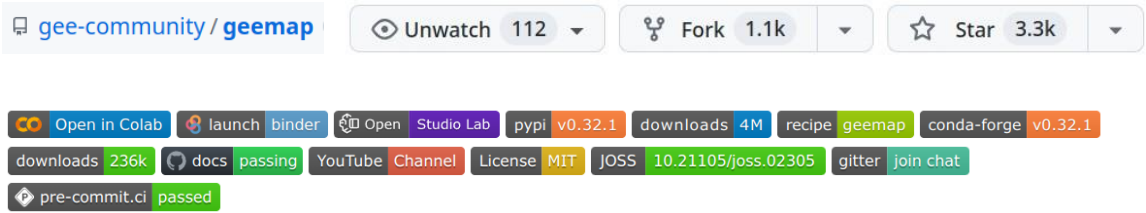
- Awesome-GEE
- python-geospatial

https://geemap.org

Geemap

Geemap

- GitHub: https://github.com/gee-community/geemap



A Python package for interactive geospatial analysis and visualization with Google Earth Engine

- GitHub repo: https://github.com/gee-community/geemap
- Documentation: https://geemap.org
- PyPI: https://pypi.org/project/geemap
- Conda-forge: https://anaconda.org/conda-forge/geemap
- 360+ GEE notebook examples: https://github.com/giswqs/earthengine-py-notebooks
- GEE Tutorials on YouTube: https://youtube.com/@giswqs
- Free software: MIT license

RGB composites

The following illustrates the use of parameters to style a Landsat 8 image as a false-color composite:

Code Editor (JavaScript) Colab (Python)

Python setup

See the Python Environment page for information on the Python API and using `geemap` for interactive development.

```
import ee
import geemap.core as geemap
```

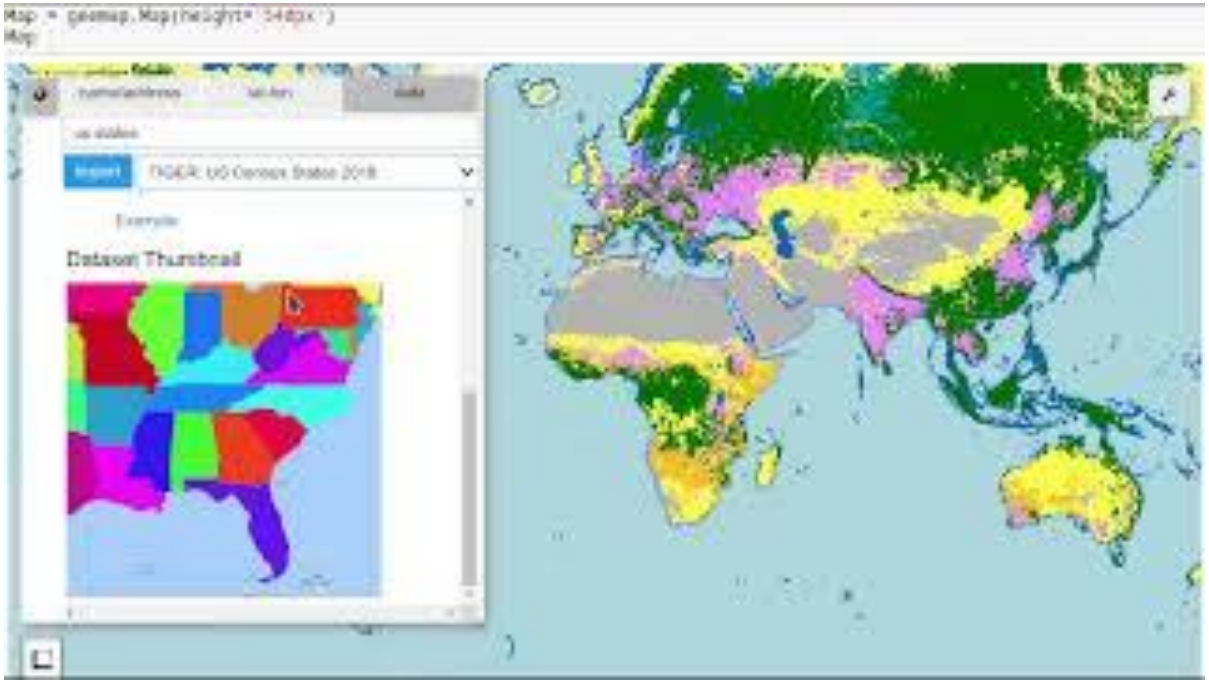
Geemap adopted by Google

```
# Load an image.
image = ee.Image('LANDSAT/LC08/C02/T1_TOA/LC08_044034_20140318')

# Define the visualization parameters.
image_viz_params = {
    'bands': ['B5', 'B4', 'B3'],
    'min': 0,
    'max': 0.5,
    'gamma': [0.95, 1.1, 1],
}

# Define a map centered on San Francisco Bay.
map_18 = geemap.Map(center=[37.5010, -122.1899], zoom=10)
```

Geemap Key Features

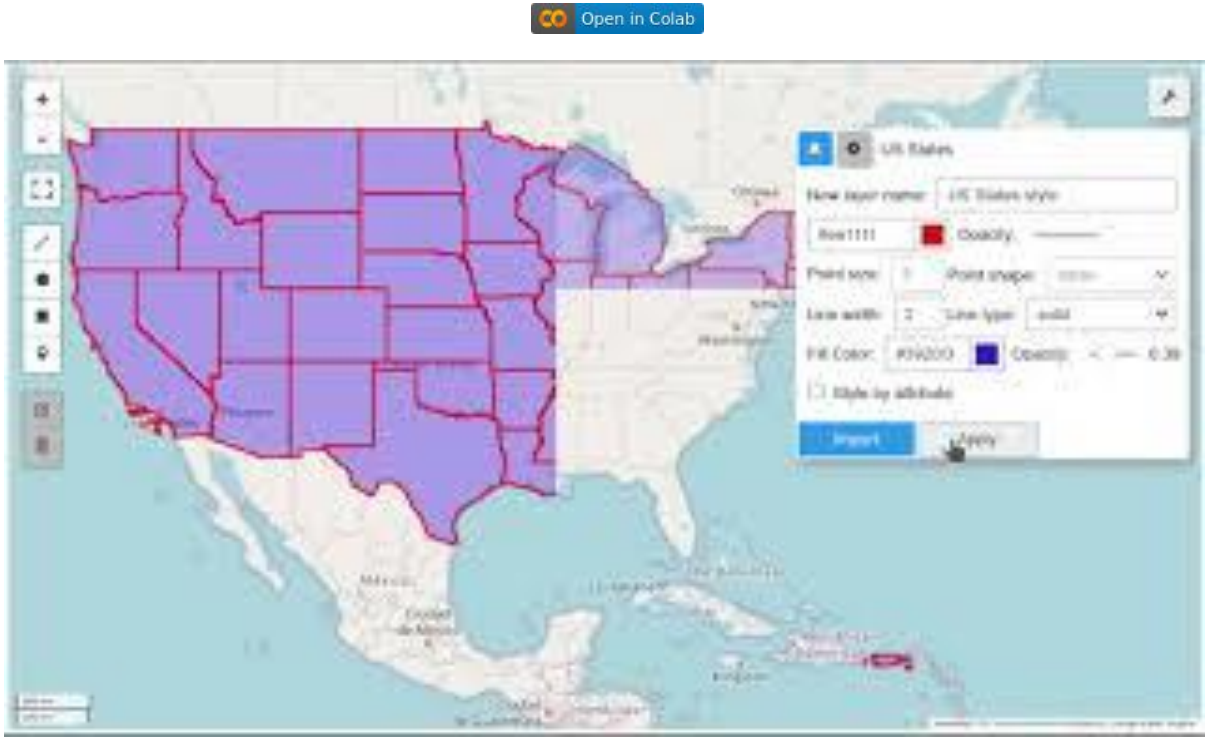
(video | gif | notebook)

- Explore the 100 PB+ Earth Engine Data Catalog



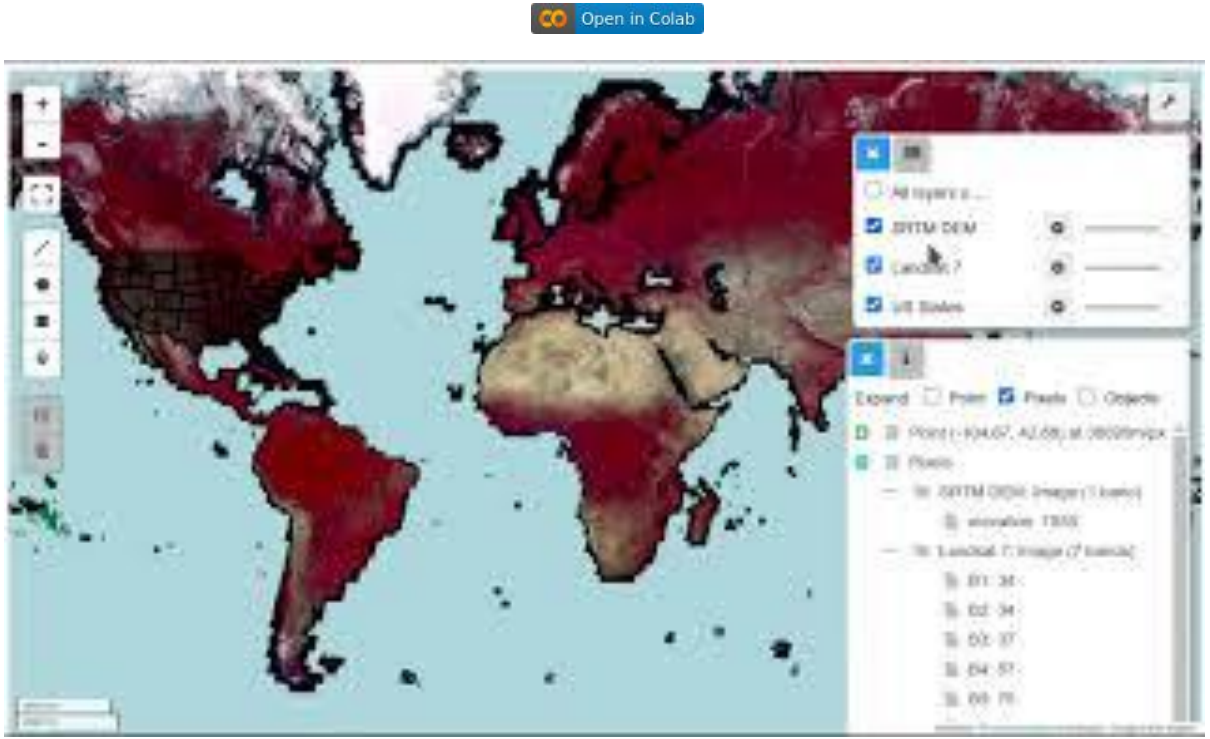
Geemap Key Features

- Visualize Earth Engine datasets interactively



Geemap Key Features

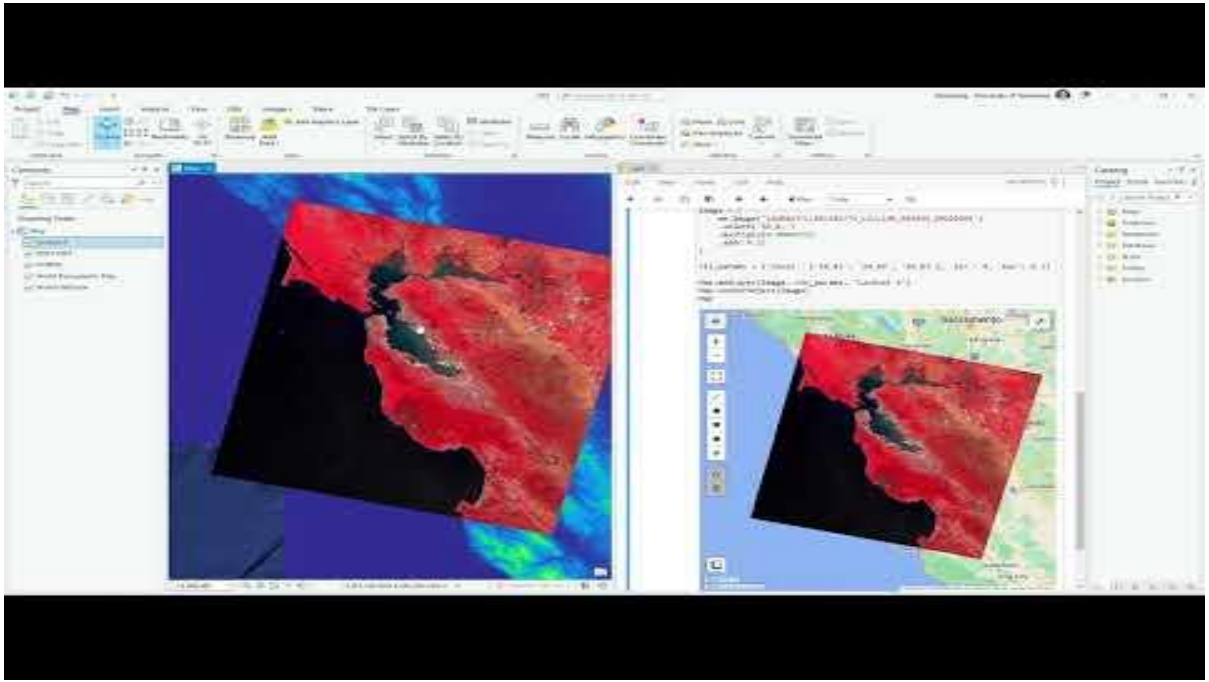
- Inspect Earth Engine objects interactively



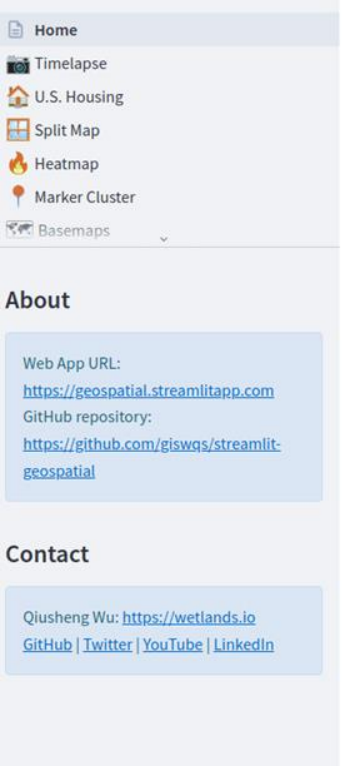
Geemap Key Features

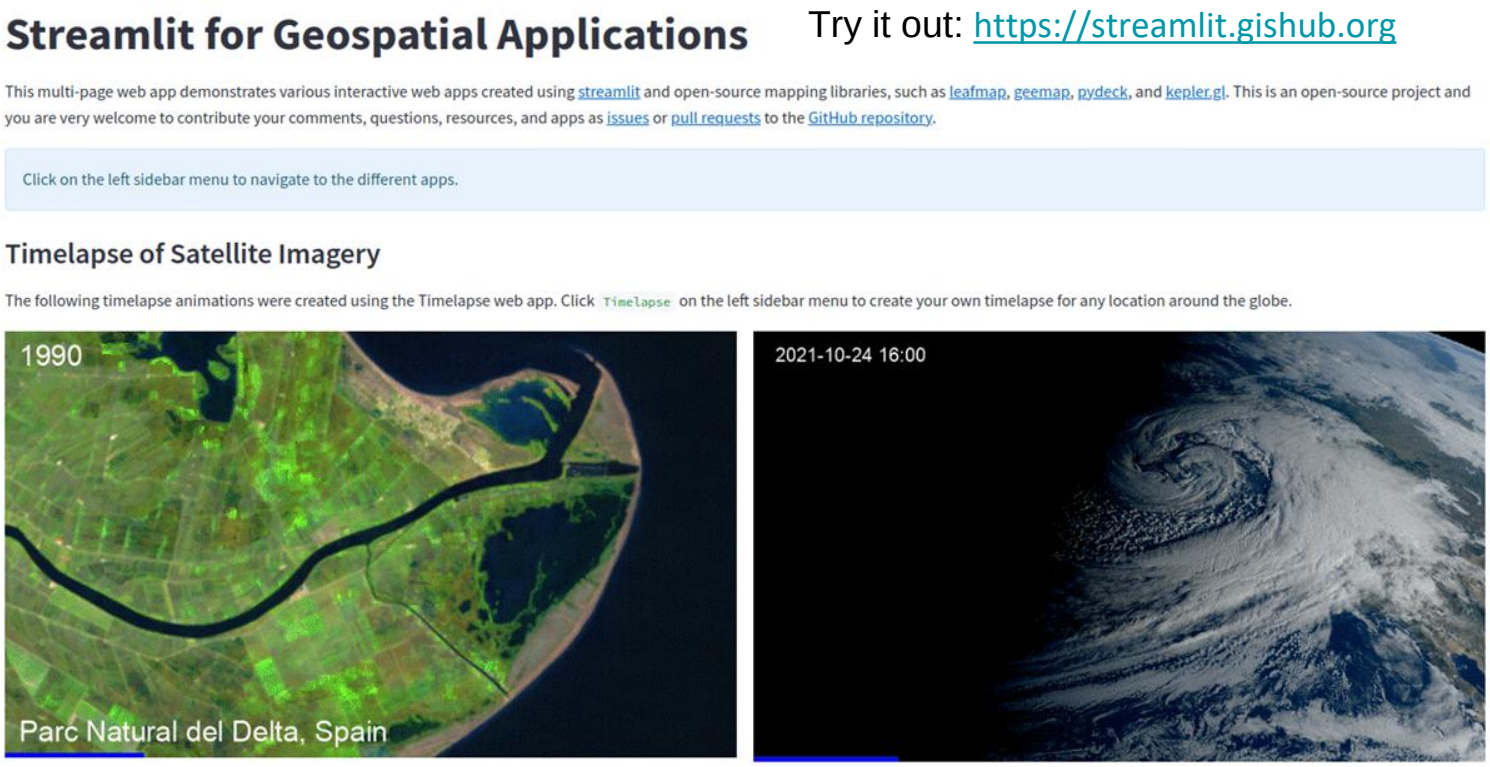
(video | gif | notebook)

- Use Earth Engine with ArcGIS Pro



Timelapse Web App





Try it out: https://streamlit.gishub.org

Create Landsat Timelapse

An interactive web app for creating timelapse of annual Landsat imagery (1984-2021) for any location around the globe. The app was built using streamlit, geemap, and Google Earth Engine.

Draw a small ROI on the map, click the Export button to save it, and then upload it here. Customize timelapse parameters and then click the Submit button.

Drag and drop file here

Limit 200MB per file • GEOJSON

Browse files

data.geojson

Select a collection:

Landsat TM-ETM-OLI Surface Reflectance

Title

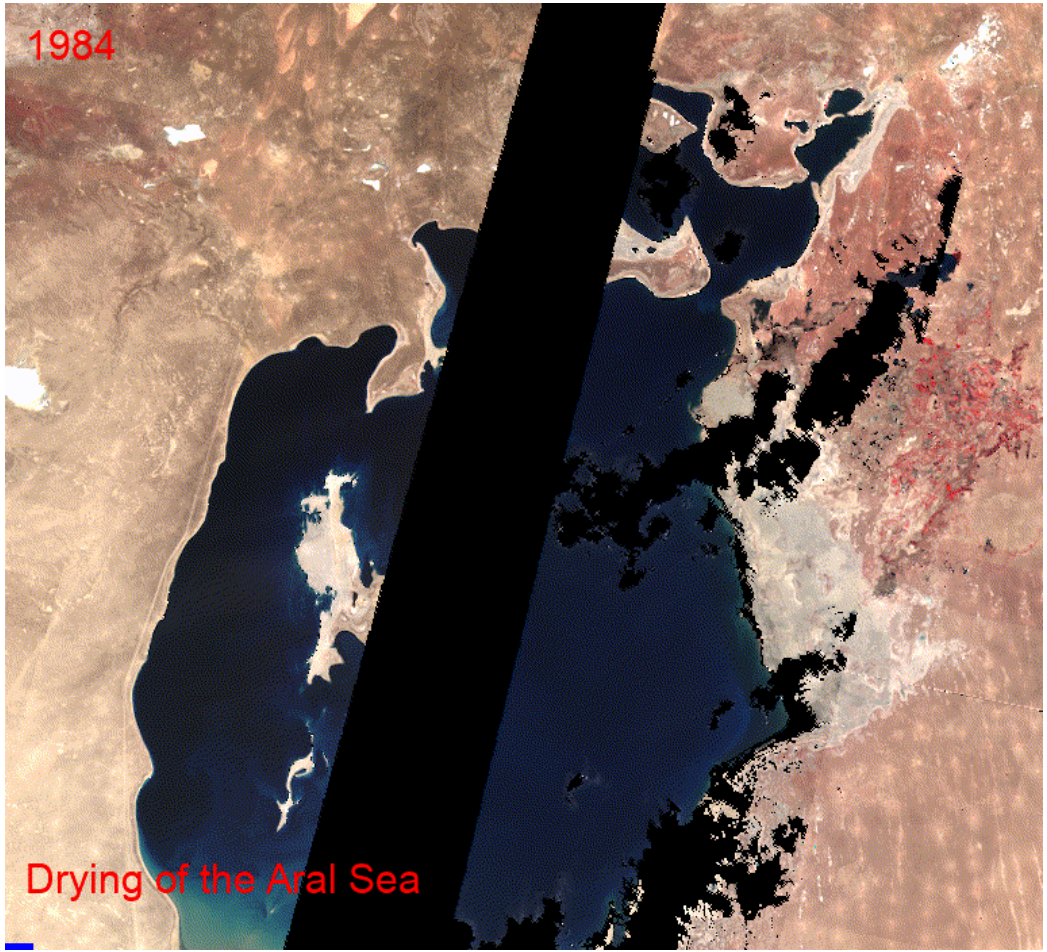
Landsat Timelapse

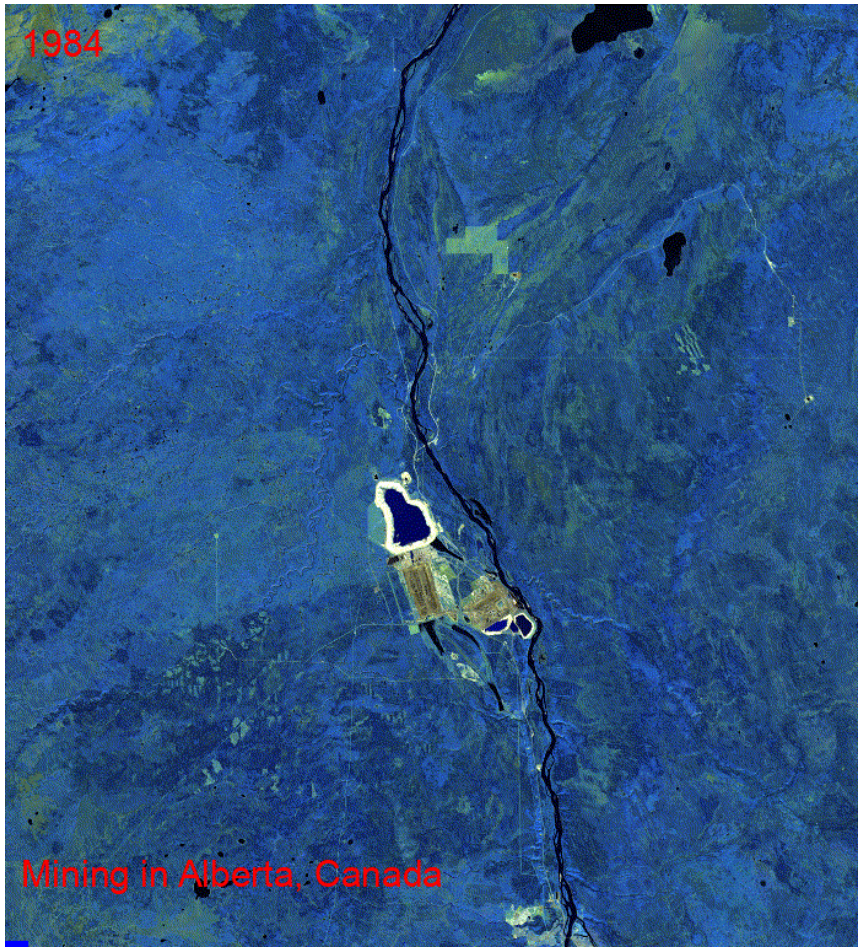
RGB band combination

SWIR1,NIR,Red

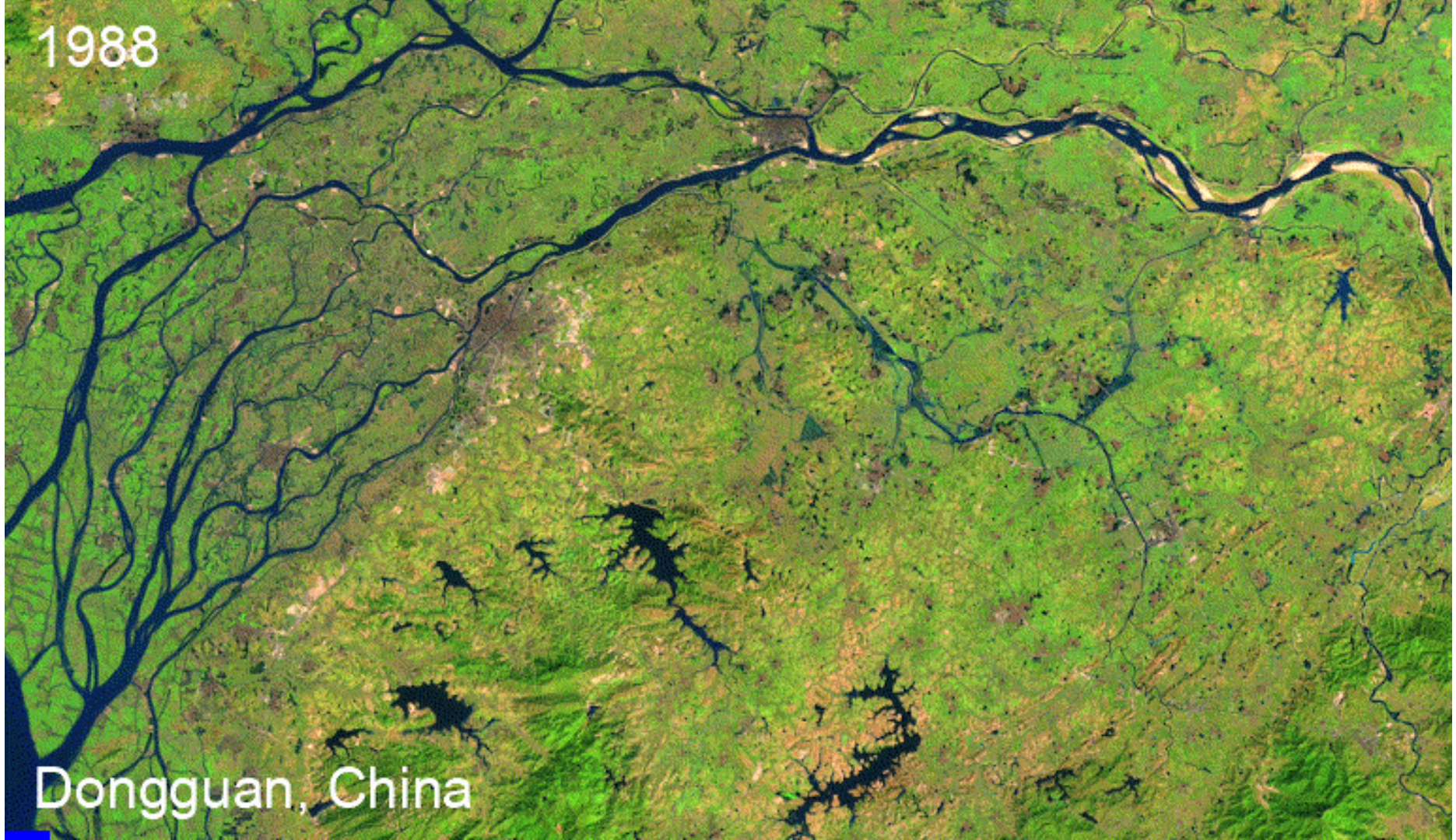
Customize timelapse

Right click the image to save it to your computer.

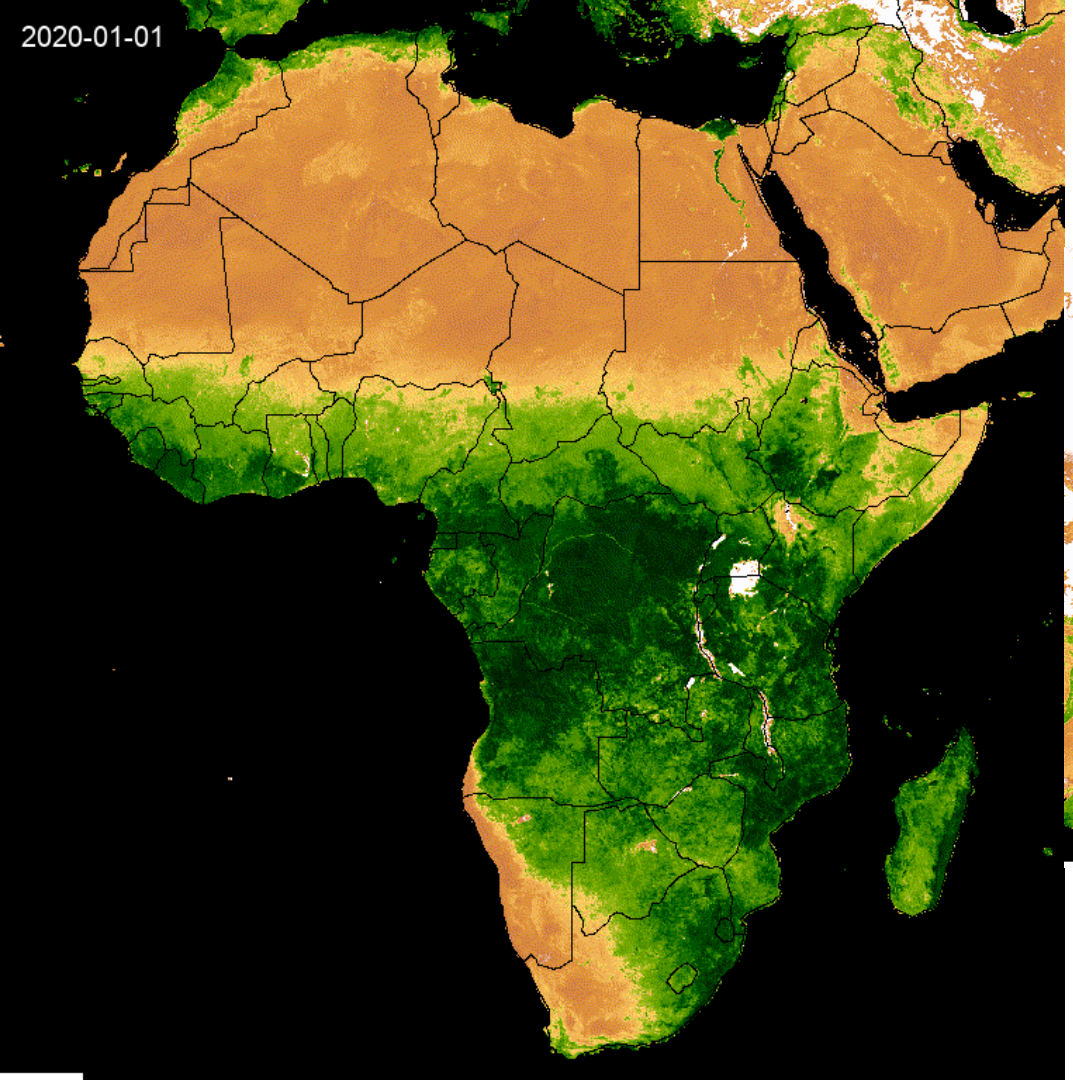

1984
Drying of the Aral Sea

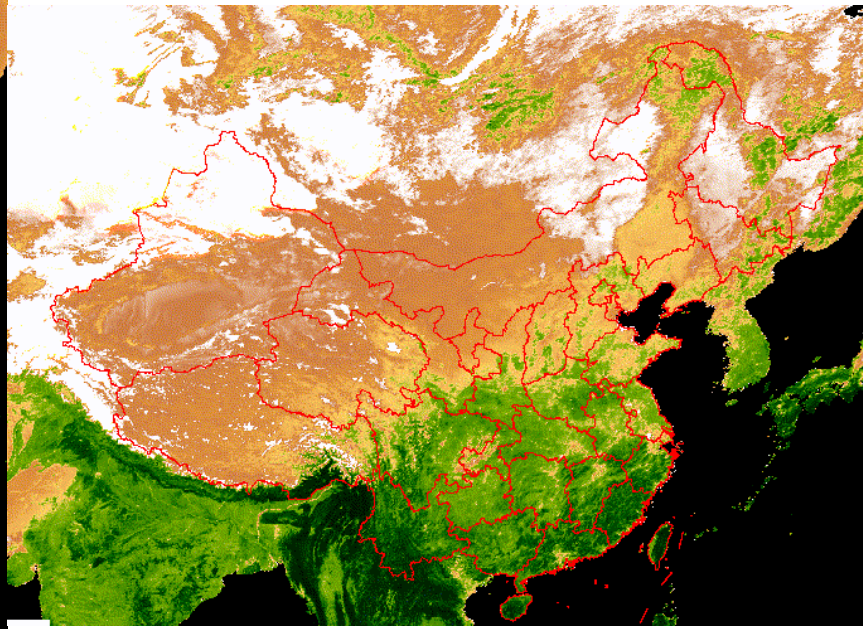

1984
Mining in Alberta, Canada


1984
Urban Growth in Las Vegas, NV


1988
Dongguan, China

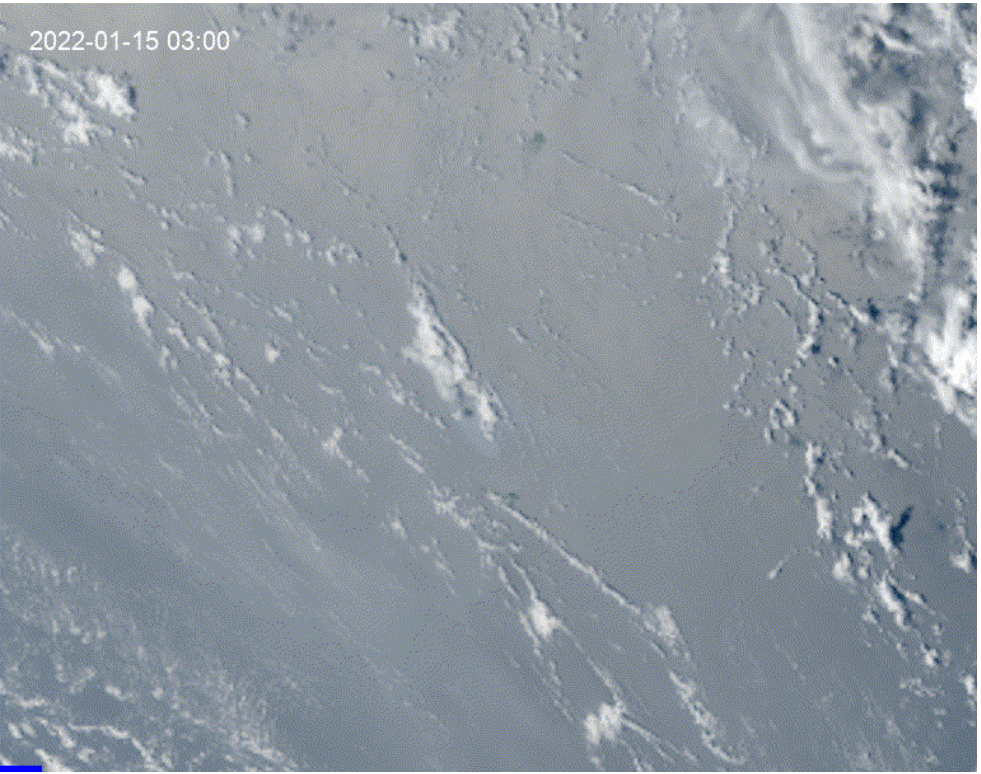

1984
Parc Natural del Delta, Spain


2020-01-01

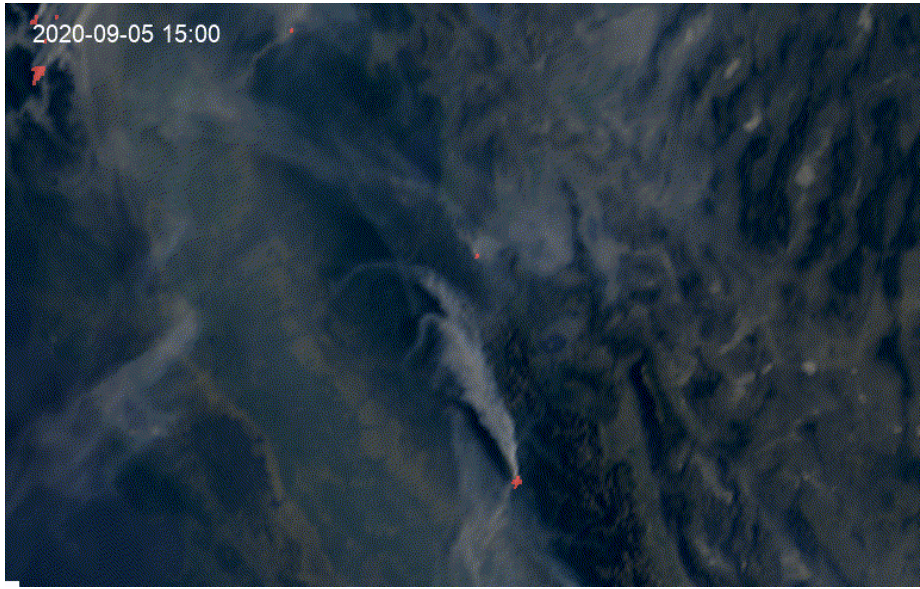


GOES Timelapse

Tonga Volcanic Eruption



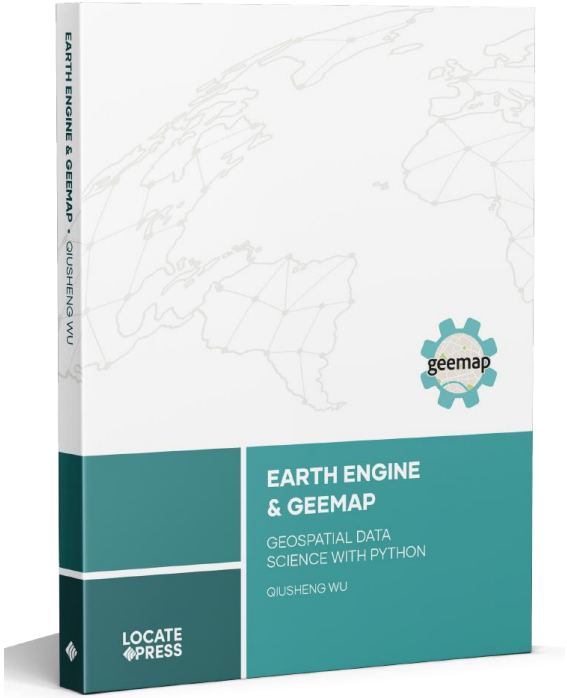
Creak Fire, California



Geemap book

https://locatepress.com/book/gee

408 pages



https://book.geemap.org

geemap

Introduction & Overview

About the Author

Preface

Table of Contents

Chapters

1. Introducing GEE and Geemap
2. Creating Interactive Maps
3. Using Earth Engine Data
4. Using Local Geospatial Data
5. Visualizing Geospatial Data
6. Analyzing Geospatial Data
7. Exporting Earth Engine Data
8. Making Maps with Cartoee
9. Creating Timelapse Animations
10. Building Interactive Web Apps
11. Earth Engine Applications

Appendices

Bibliography

Known Issues

1.4. What is geemap

GEE provides users with both JavaScript and Python APIs for making computational requests to the Earth Engine servers. While the GEE JavaScript API has robust documentation and an interactive IDE (i.e., GEE JavaScript Code Editor), the GEE Python API has relatively limited functionality for visualizing results interactively, and there is a lack of documentation. The **geemap** Python package was created to fill this gap [Wu, 2020]. It is built upon a number of open-source Python libraries, such as the earthengine-api, folium, ipyleaflet, and ipywidgets packages. Geemap enables users to analyze and visualize Earth Engine datasets interactively within a Jupyter environment with minimal coding (see Fig. 1.4).

Geemap is intended for students and researchers who would like to utilize the Python ecosystem of diverse libraries and tools to explore Google Earth Engine. It is also designed for existing GEE users who would like to transition from the GEE JavaScript API to the Python API. Geemap provides an interactive graphical user interface for converting GEE JavaScript projects to Python scripts without coding. It can save users a lot of time and effort by providing a simple interface for exploring and visualizing Earth Engine datasets.

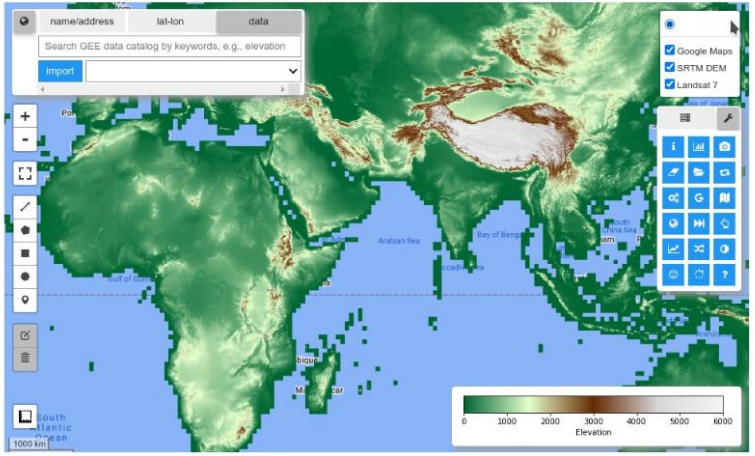


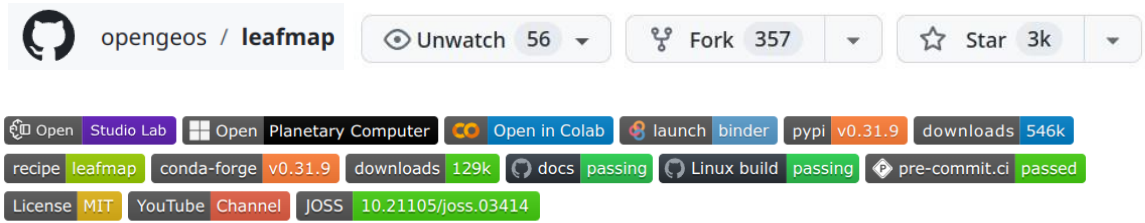
Fig. 1.4 The geemap graphical user interface built upon ipyleaflet and ipywidgets.

https://leafmap.org

Leafmap

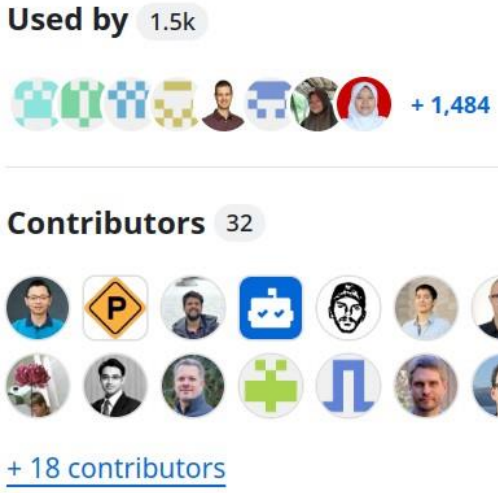
Leafmap

- GitHub: https://github.com/opengeos/leafmap



A Python package for geospatial analysis and interactive mapping in a Jupyter environment.

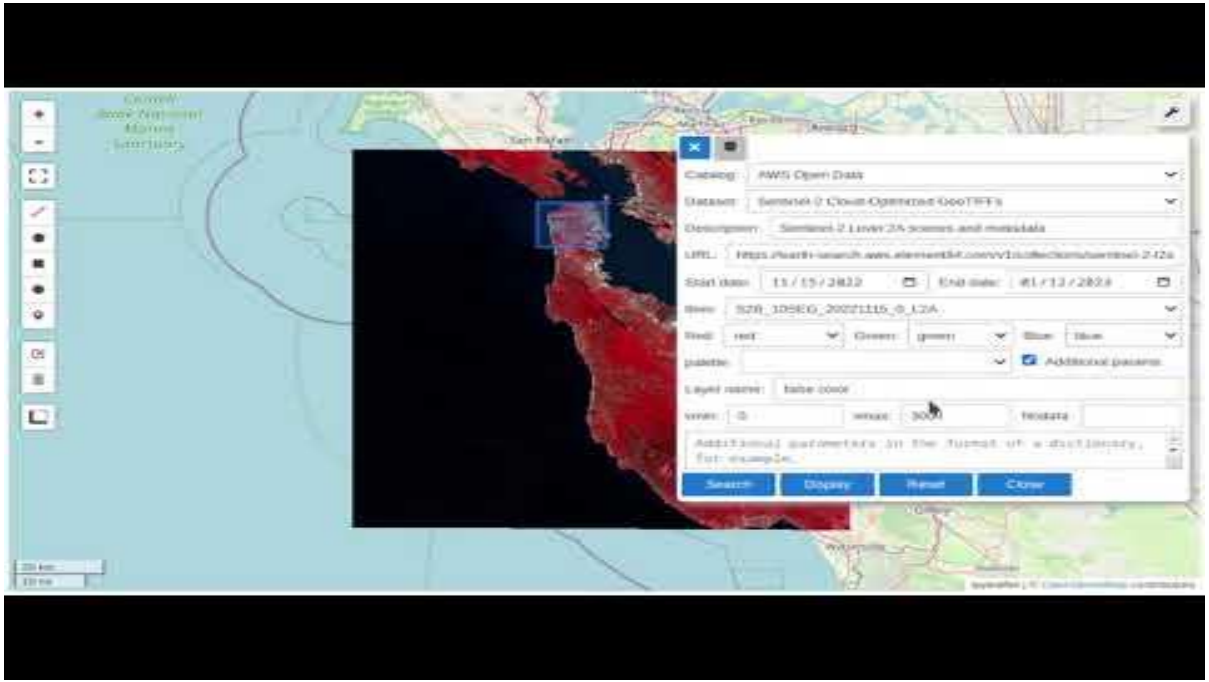
- GitHub repo: https://github.com/opengeos/leafmap
- Documentation: https://leafmap.org
- PyPI: https://pypi.org/project/leafmap
- Conda-forge: https://anaconda.org/conda-forge/leafmap
- Leafmap tutorials on YouTube: https://youtube.com/@giswqs
- Free software: MIT license



Leafmap Key Features

- Search and visualize open geospatial datasets interactively

(gif | notebook)

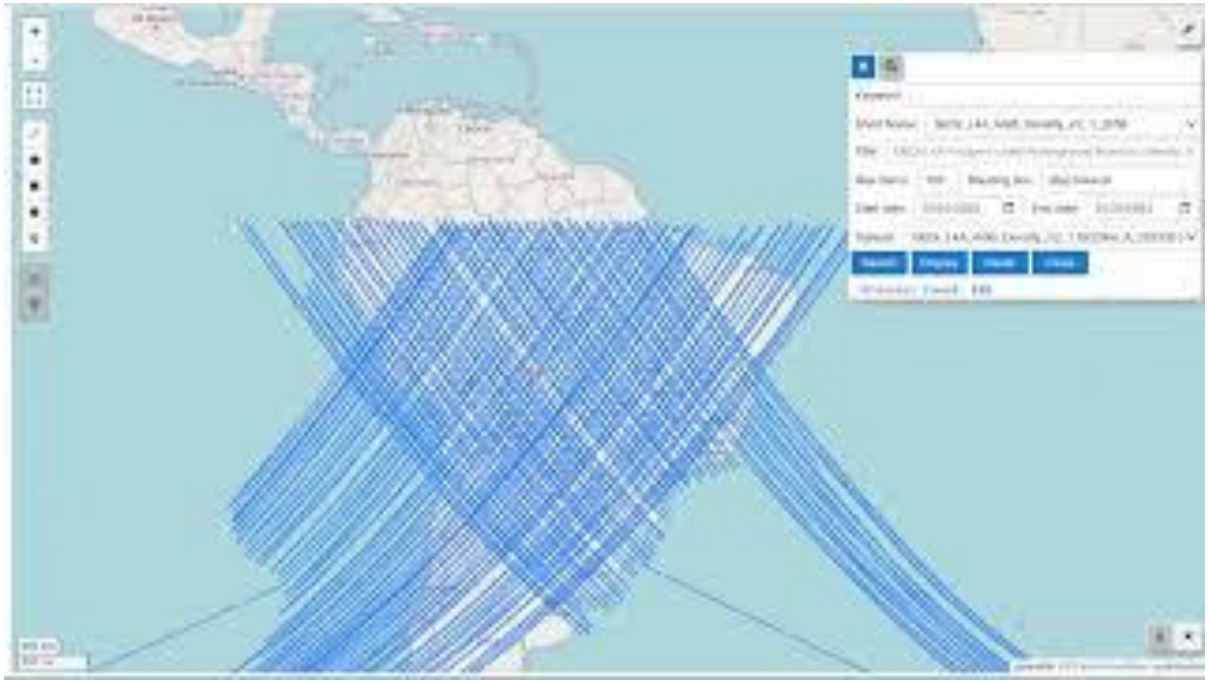


Leafmap is used by AWS, Microsoft, and NASA

Leafmap Key Features

(gif | notebook)

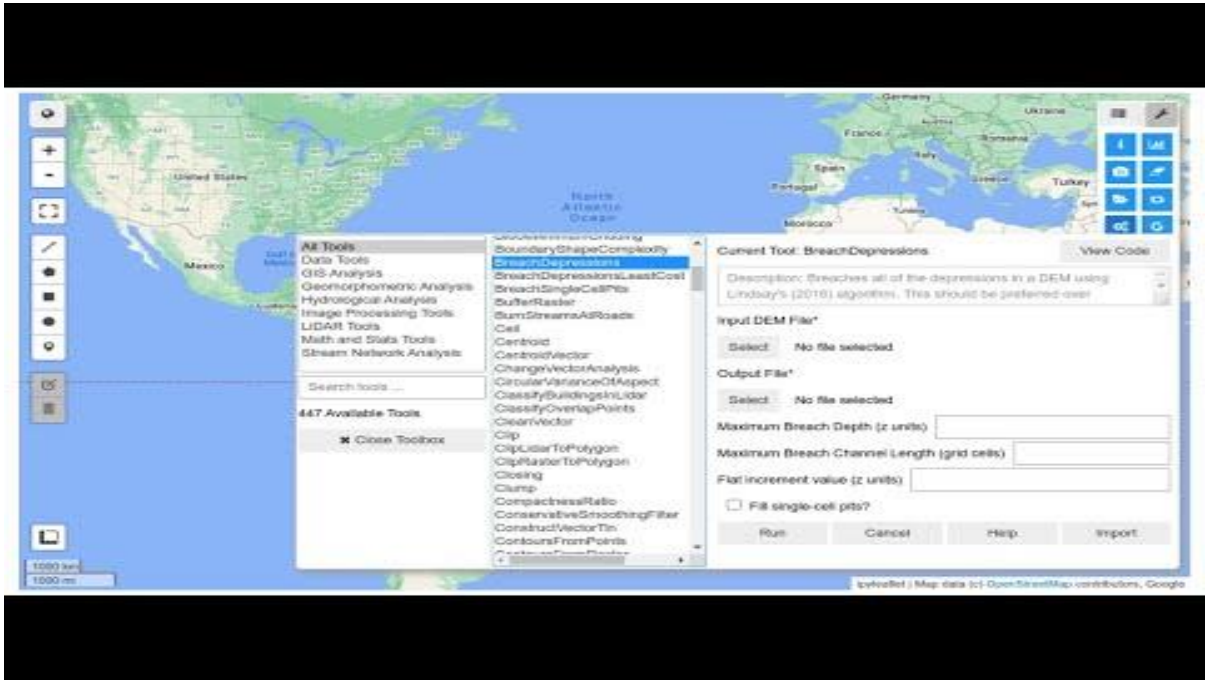
- Search NASA Earth Data



Leafmap Key Features

(gif | notebook)

- Use whiteboxgui with 470+ tools for geospatial analysis



Leafmap Key Features

(gif | notebook)

- Visualize buildings in 3D with MapLibre

Leafmap Key Features

(gif | notebook)

- Visualize buildings in 3D with MapLibre

Leafmap Key Features

(gif | notebook)

- Visualize terrain in 3D with MapLibre

Leafmap Key Features

(gif | notebook)

- Visualize realtime movement data in 3D with MapLibre

Leafmap Key Features

(gif | notebook)

- Display videos on a map

Leafmap Key Features

(gif | notebook)

- Animate a point along a route with MapLibre

Leafmap Key Features

(gif | notebook)

- Draw features interactively on 2D and 3D maps with MapLibre

Leafmap Key Features

(gif | notebook)

- Create marker clusters and heatmaps with MapLibre

Leafmap Key Features

(gif | notebook)

- Visualize remote sensing imagery

Leafmap Key Features

(gif | notebook)

- Visualize Earth Engine data in 3D

https://samgeo.gishub.org

Segment-Geospatial

Segment-Geospatial (SAMGeo)

- GitHub: https://github.com/opengeos/segment-geospatial

Unwatch 53 Fork 274 Star 2.7k

Open Studio Lab | Open Planetary Computer | Open in Colab | pypi v0.10.6 | conda-forge v0.10.6 | pulls 496
downloads 94k | downloads 10k total | JOSS 10.21105/joss.05663

A Python package for segmenting geospatial data with the Segment Anything Model (SAM)

Introduction

The **segment-geospatial** package draws its inspiration from segment-anything-eo repository authored by Aliaksandr Hancharenka. To facilitate the use of the Segment Anything Model (SAM) for geospatial data, I have developed the segment-anything-py and segment-geospatial Python packages, which are now available on PyPI and conda-forge. My primary objective is to simplify the process of leveraging SAM for geospatial data analysis by enabling users to achieve this with minimal coding effort. I have adapted the source code of segment-geospatial from the segment-anything-eo repository, and credit for its original version goes to Aliaksandr Hancharenka.

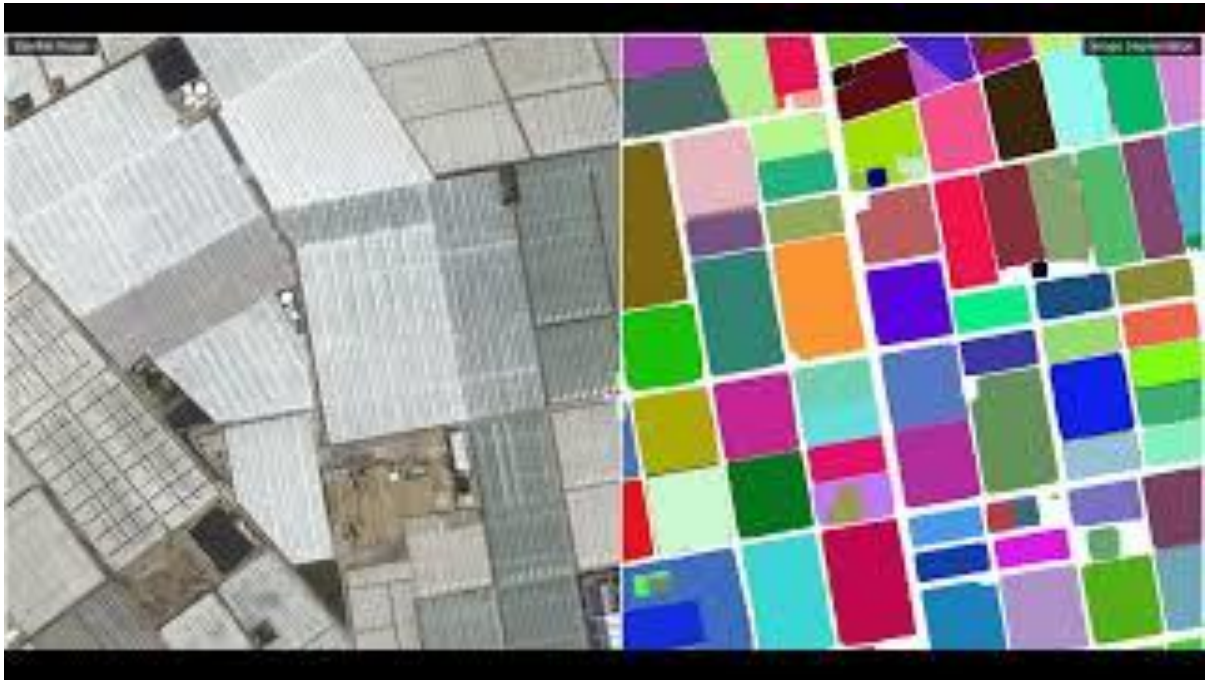
- Free software: MIT license
- Documentation: https://samgeo.gishub.org

Segment Anything (SAM)

SAMGeo Key Features

(notebook)

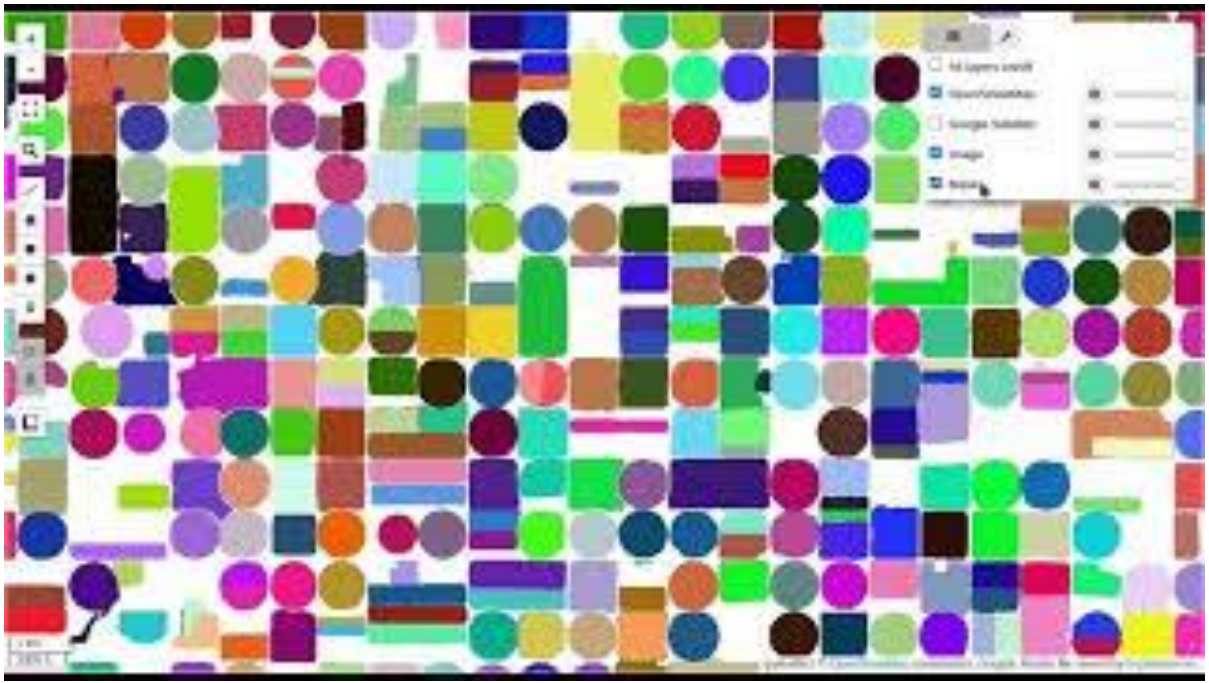
- Automatic mask generator



SAMGeo Key Features

(notebook)

- Automatic mask generator



SAMGeo Key Features

(notebook)

- Use points as input prompts

SAMGeo Key Features

(notebook)

- Use bounding boxes as input prompts

SAMGeo Key Features

(notebook)

- Use text as input prompts

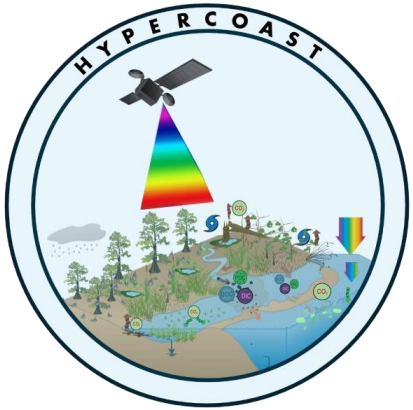
SAMGeo Key Features

(notebook)

- Use text as input prompts

https://hypercoast.org

HyperCoast



HyperCoast

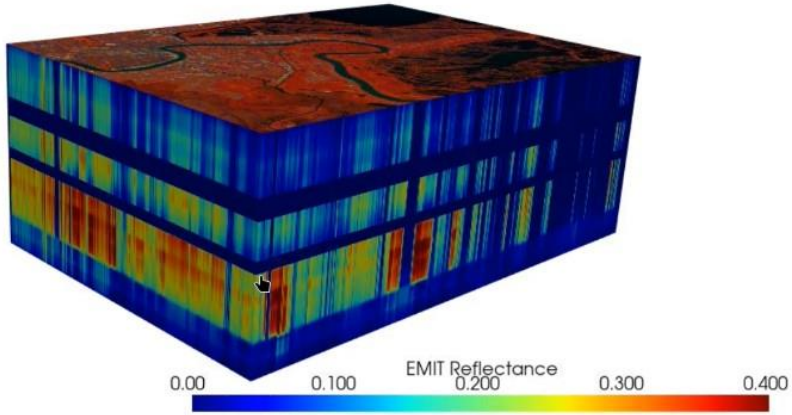
- GitHub: https://github.com/opengeos/HyperCoast

A Python package for visualizing and analyzing hyperspectral data in coastal regions

- Free software: MIT License
- Documentation: https://hypercoast.org

Features

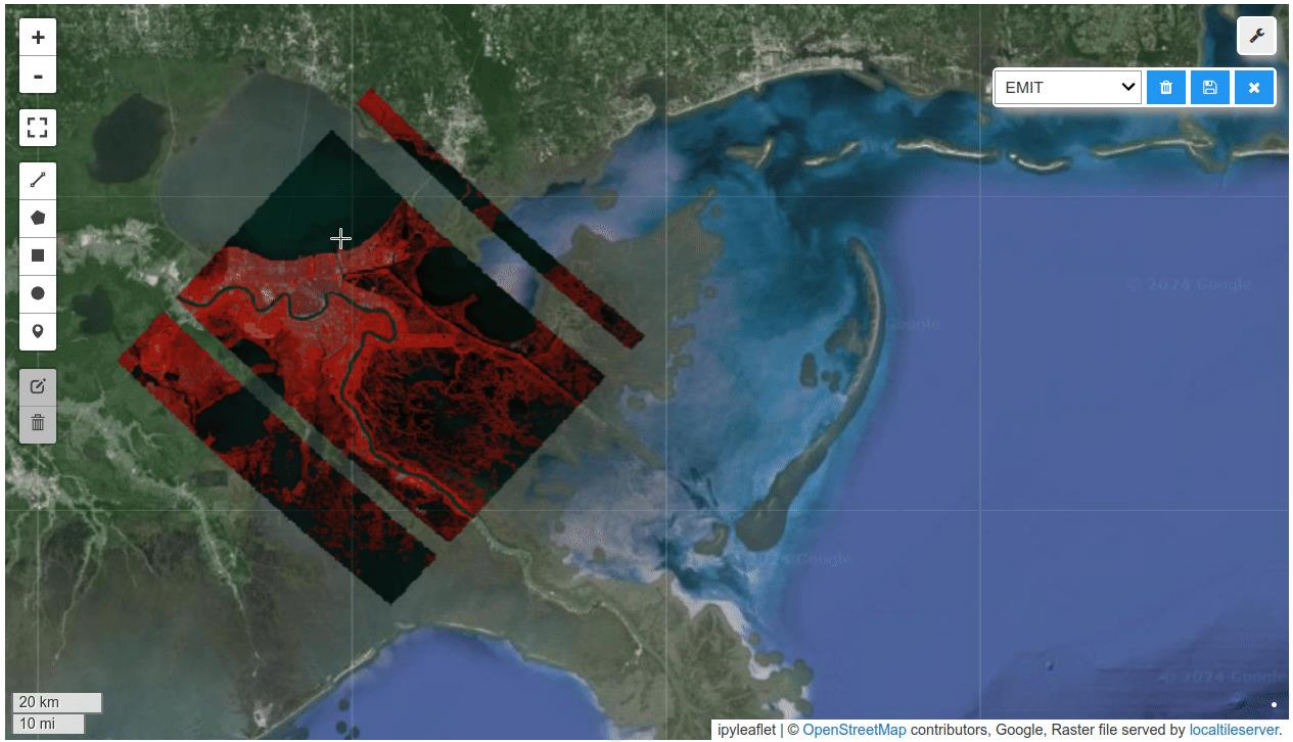
- Searching for NASA hyperspectral data interactively
- Interactive visualization and analysis of hyperspectral data, such as AVIRIS, DESIS, EMIT, PACE, NEON AOP
- Interactive visualization of NASA ECOSTRESS data
- Interactive visualization of PACE chlorophyll-a data
- Interactive extraction and visualization of spectral signatures
- Changing band combinations and colormaps interactively
- Visualizing hyperspectral data in 3D
- Visualizing ERA5 temperature data in 3D
- Interactive slicing and thresholding of hyperspectral data in 3D
- Saving spectral signatures as CSV files



HyperCoast Key Features

(notebook)

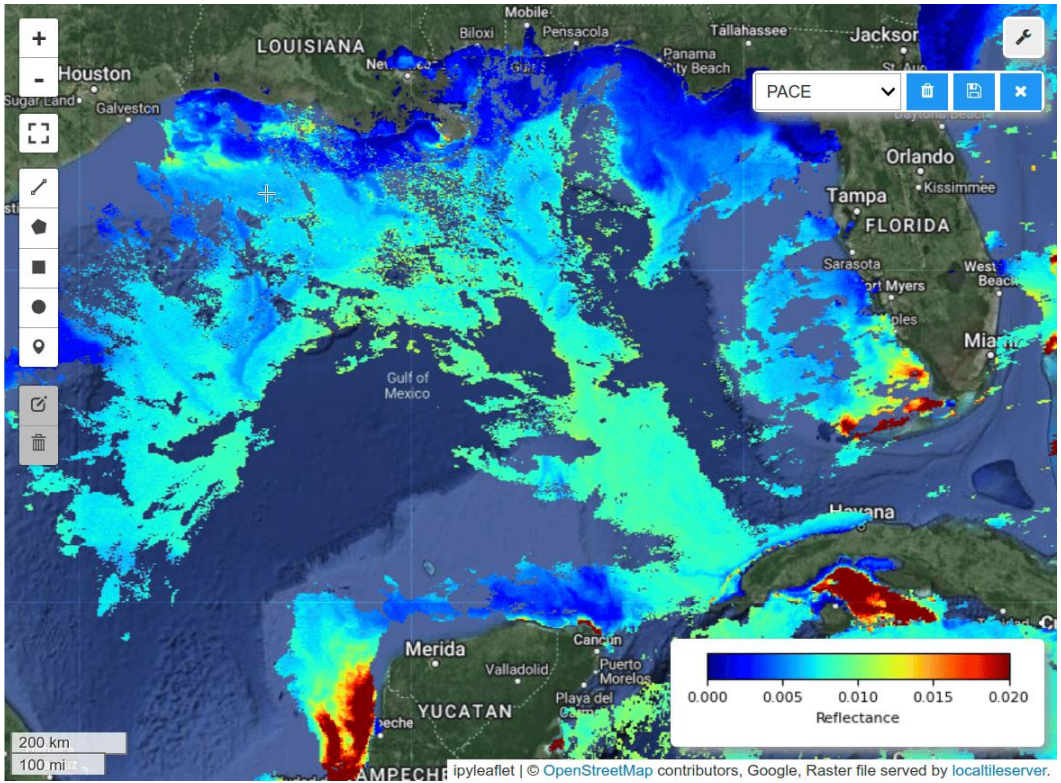
- Visualize NASA Earth Surface Mineral Dust Source Investigation (EMIT) hyperspectral data



HyperCoast Key Features

- Visualize NASA Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) hyperspectral data

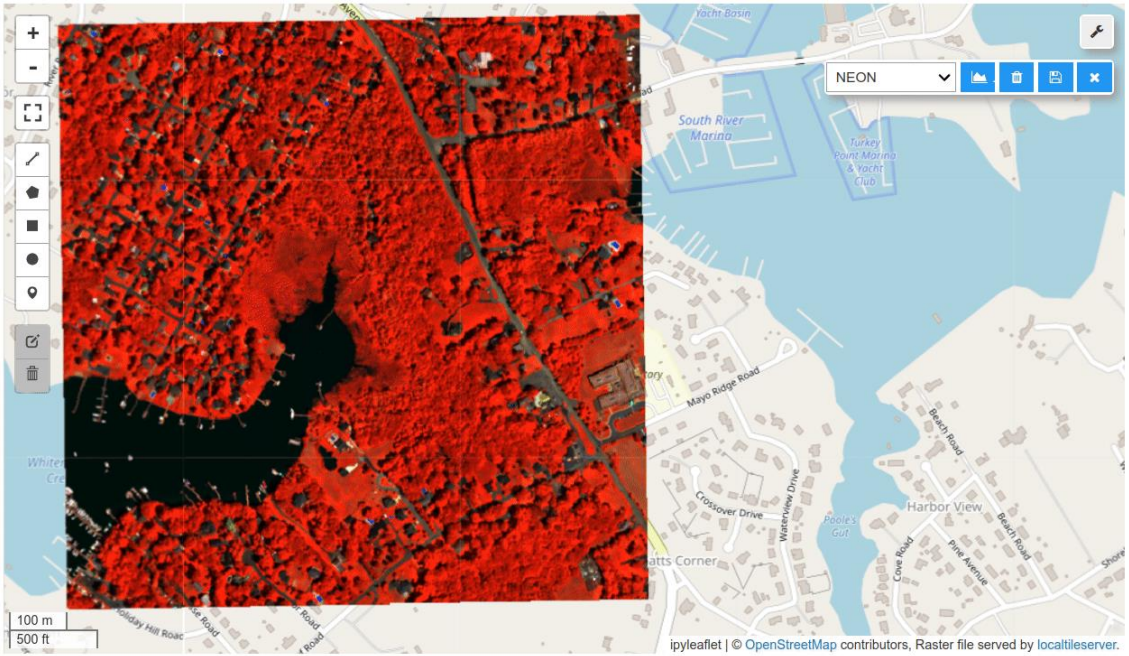
(notebook)



HyperCoast Key Features

(notebook)

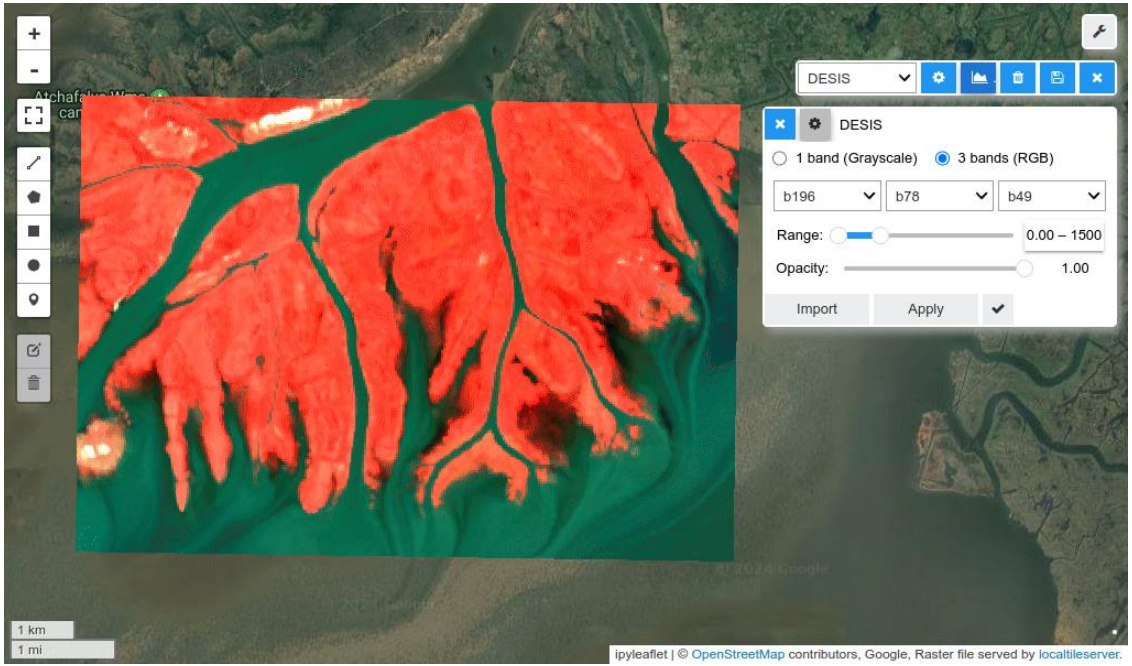
- Visualize NEON AOP hyperspectral data



HyperCoast Key Features

(notebook)

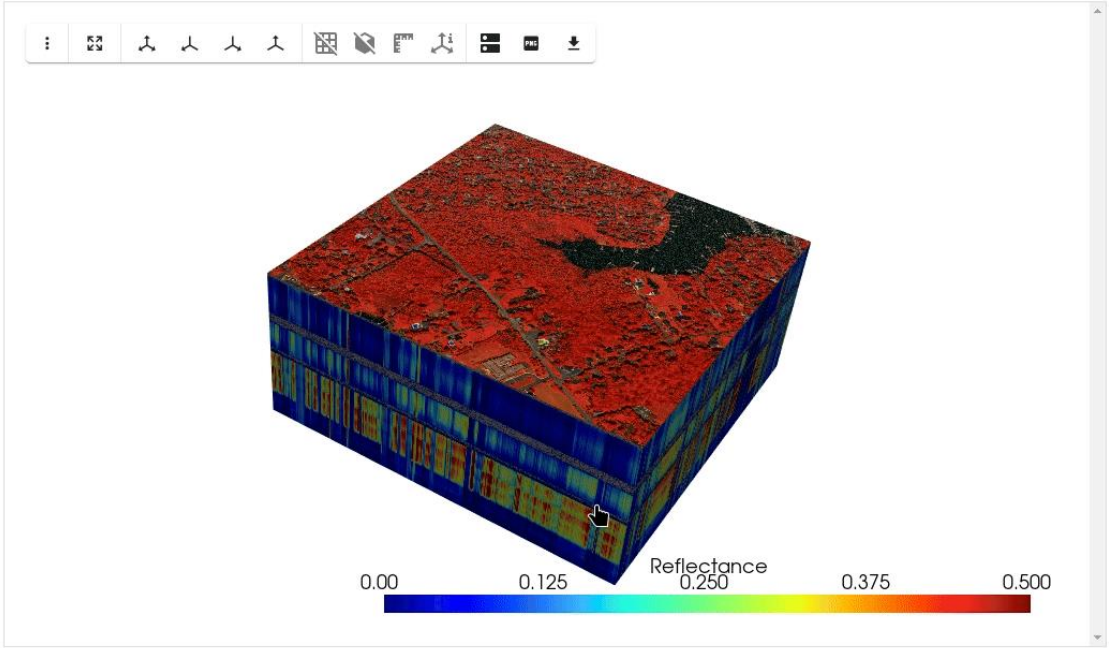
- Change band combinations and colormaps interactively



HyperCoast Key Features

(notebook)

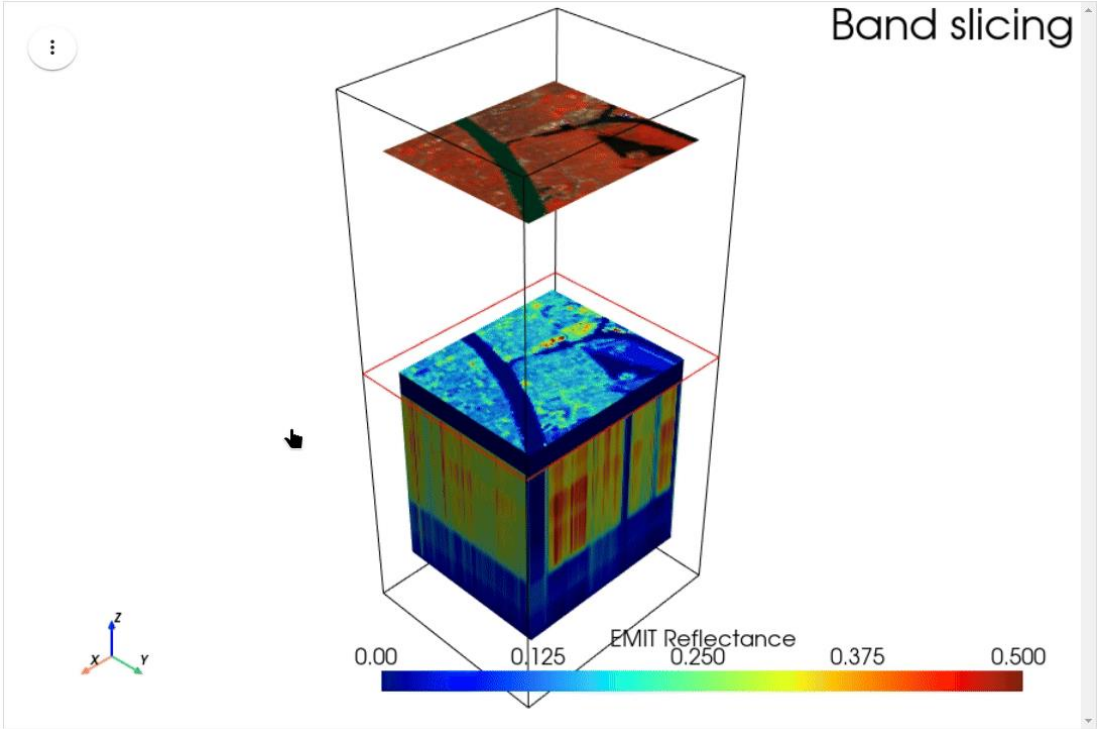
- Visualizing hyperspectral data in 3D



HyperCoast Key Features

(notebook)

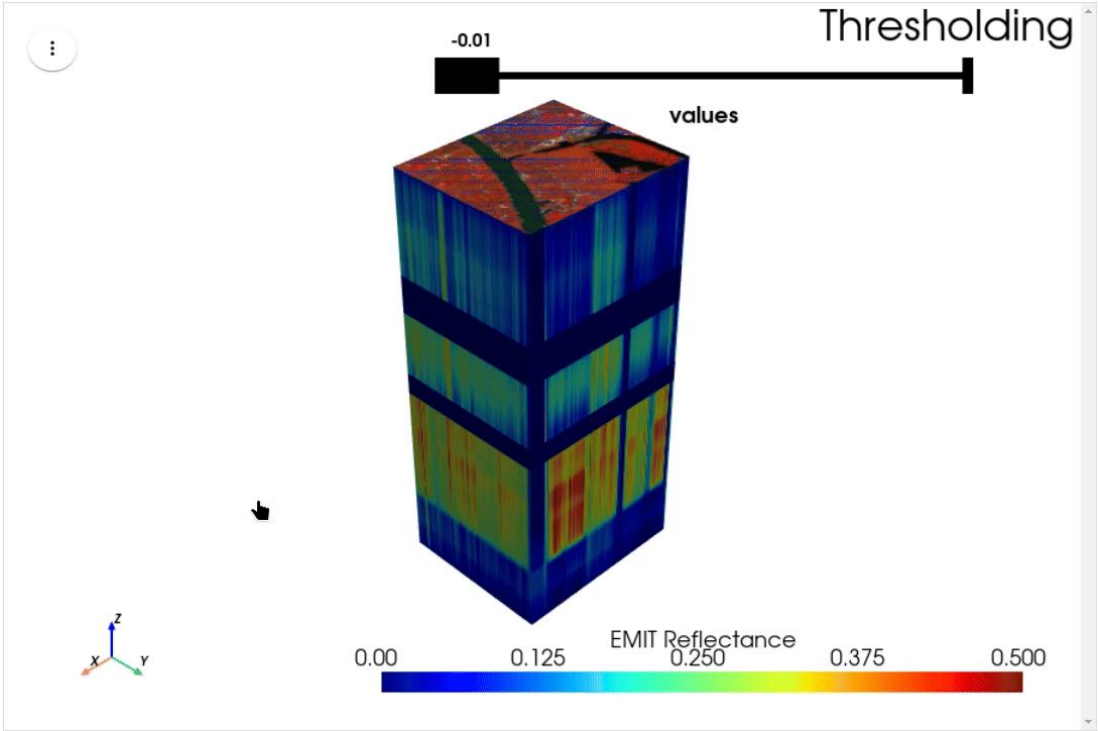
- Interactive slicing of hyperspectral data in 3D



HyperCoast Key Features

(notebook)

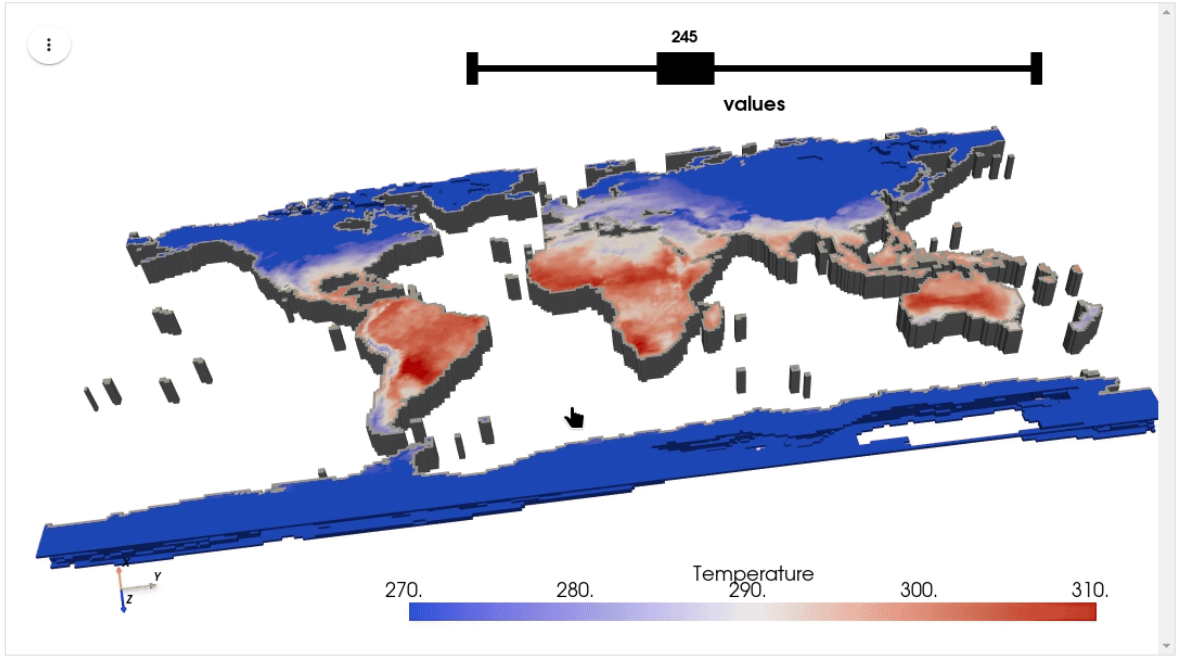
- Interactive thresholding of hyperspectral data in 3D



HyperCoast Key Features

(notebook)

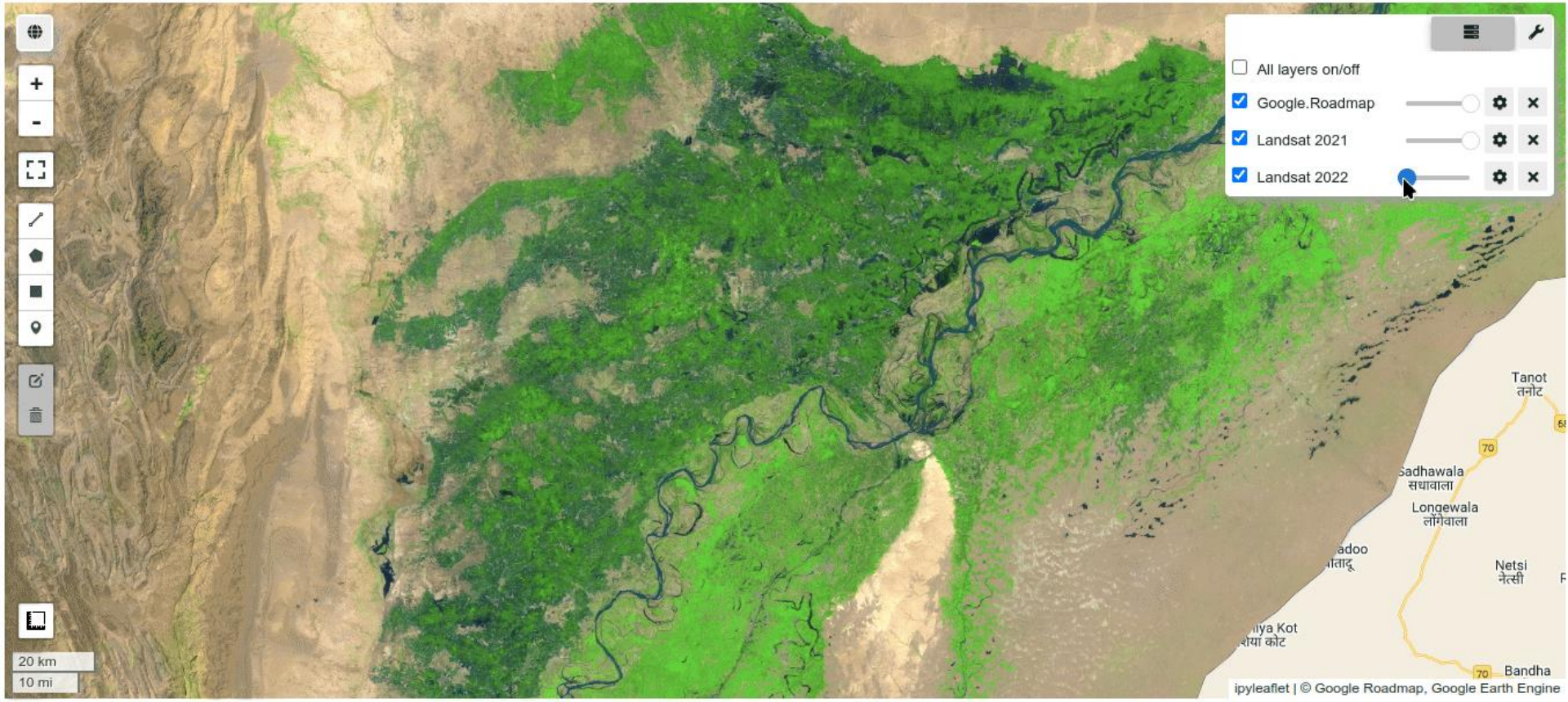
- Visualizing ERA5 temperature data in 3D



Interactive Web Apps

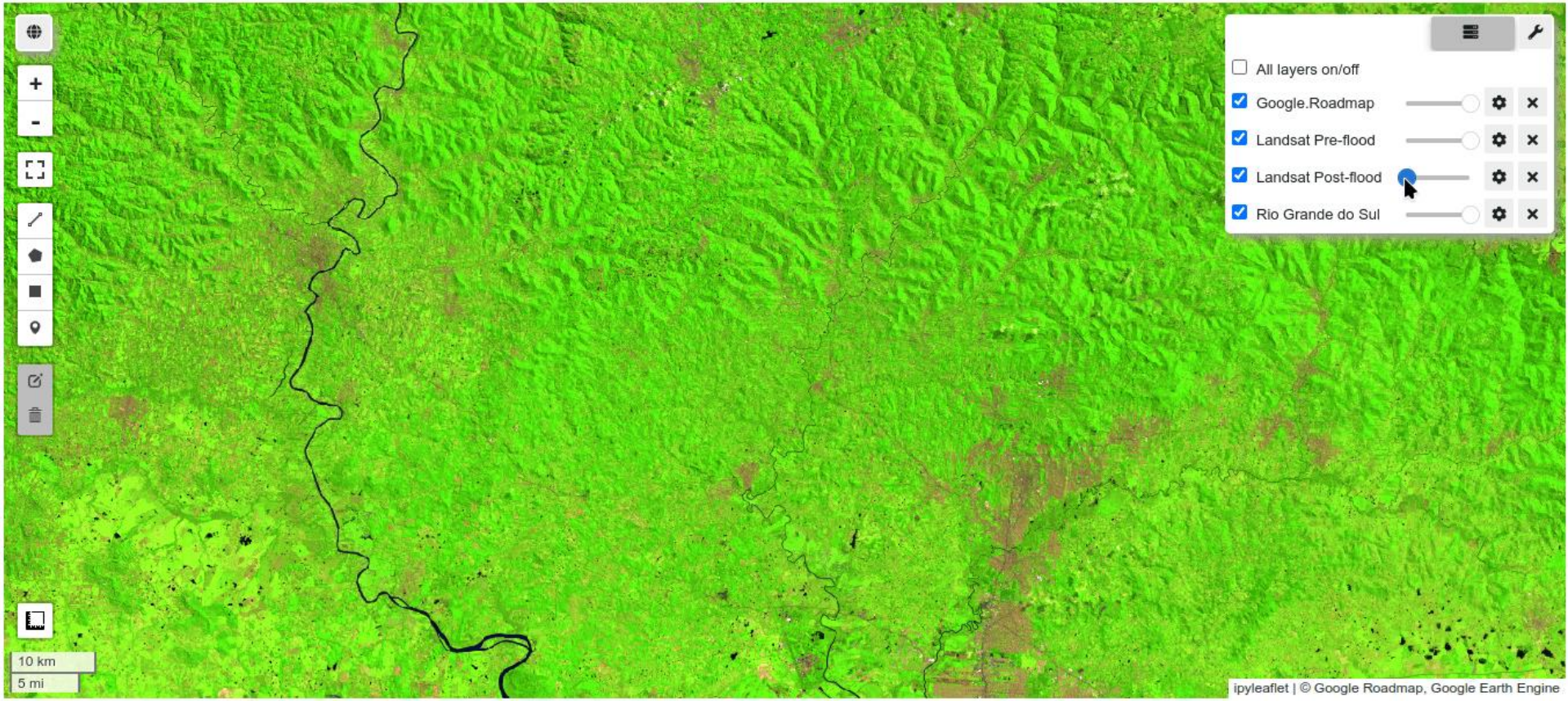
Pakistan Floods 2022

https://share.gishub.org/pakistan_floods



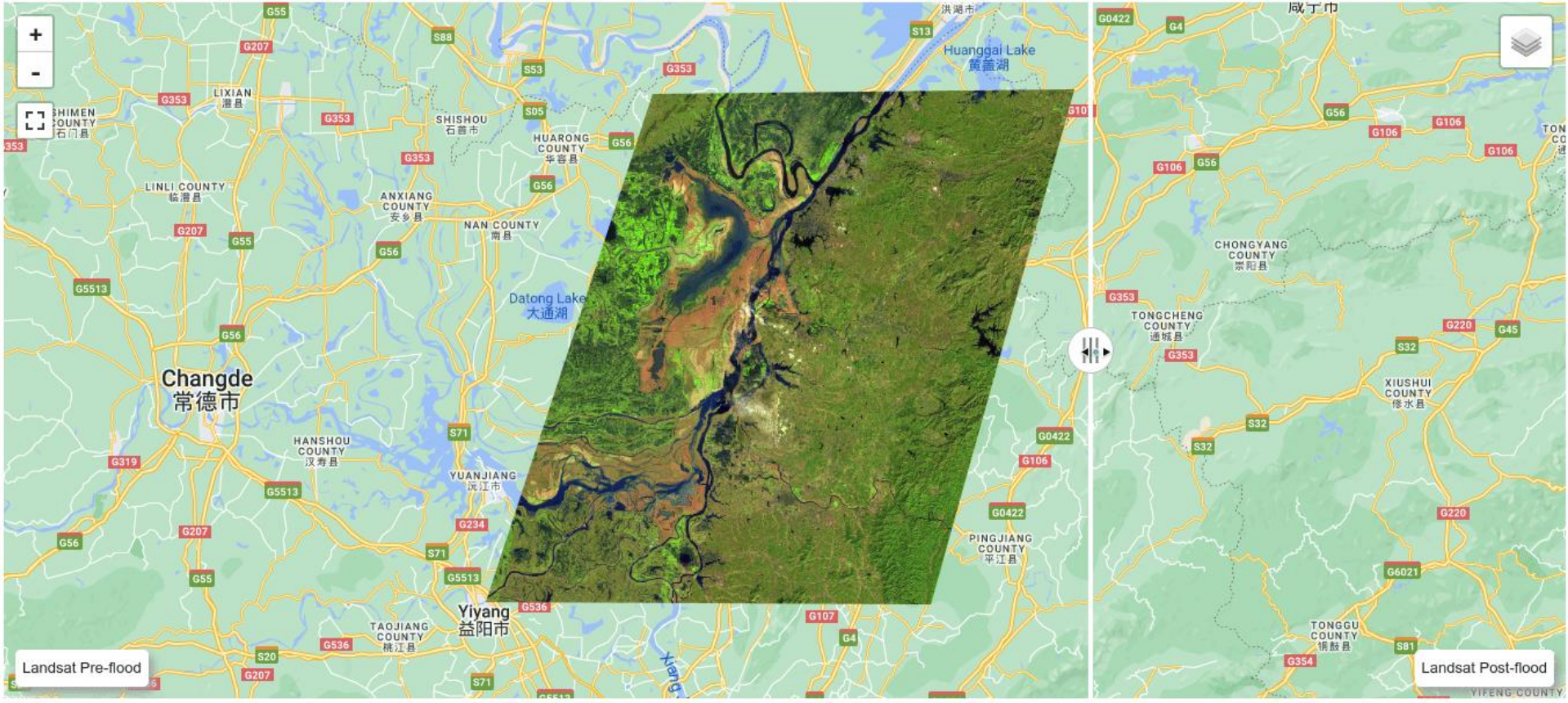
Brazil Floods 2024

https://share.gishub.org/brazil_floods



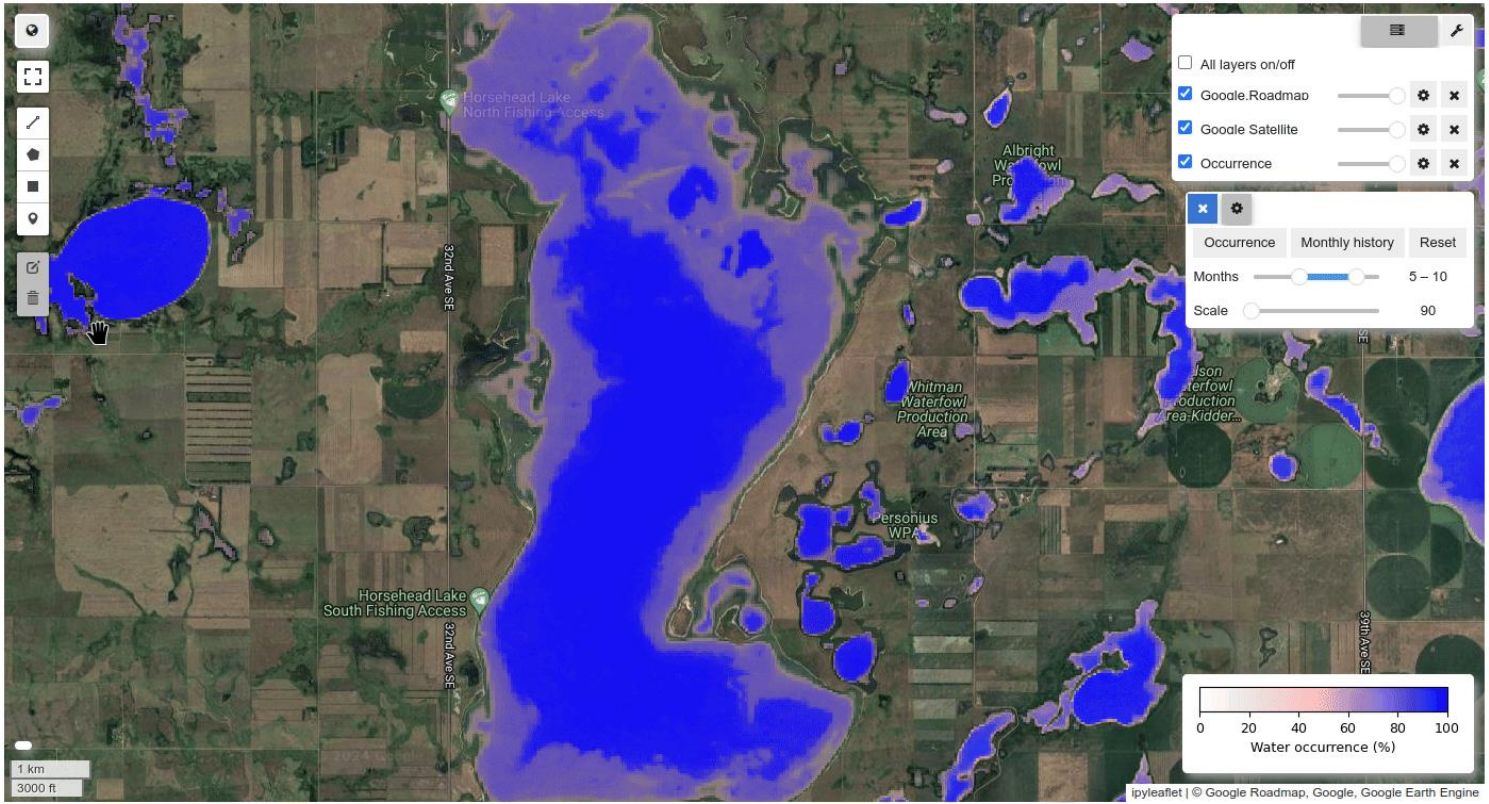
Dongting Lake Floods 2024

https://share.gishub.org/dongting_lake_floods



Global Surface Water Explorer

- Web App
- GitHub



Thank you!

Any questions

Qiusheng Wu

https://gishub.org