Wildfire Monitoring with Next-Generation Satellites

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EUMETSAT Wildfire Short Course, 11.07.2023

1. FANGS JupyterBook
2. Gironde Fires Case Study
3. Demo: Canada Fires Data Viz

Jupyter Book (website) and Notebooks

FANGS - Fire Applications with Next-Generation Satellites

Search this book...

FANGS - Fire Applications with Next-Generation Satellites

CALIFORNIA, USA 2020

Monitoring fires with next-generation satellites from MTG and Metop-SG

Monitoring smoke transport with next-generation satellites from Metop-SG

MEDITERRANEAN 2021

Forecasting pre-fire risk with next-generation satellites

Monitoring active fires with next-

FANGS - Fire Applications with Next-Generation Satellites

FANGS - Fire Applications with Next-Generation Satellites features Python-based training support material and application cases on fire detection and monitoring of the fire life-cycle. The developed training support material makes use of proxy and simulated data, including data from precursor instruments of the `Meteosat Third Generation (MTG)` and `EUMETSAT Polar System - Second Generation (EPS-SG)` satellite missions. The EPS-SG satellite mission comprises the upcoming `Metop Second Generation (Metop-SG)` satellites, Metop-S and Metop-I.

The course is based on Jupyter notebooks, which allow for a high-level of interactive learning, as it makes code, instructions and visualisations available in the same location.

Executable notebooks are available on a dedicated **Jupyterhub-based course platform**:

- Register
- Access the course notebooks on the Jupyterhub-based course platform

Each case study introduces upcoming instruments, proxy datasets

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CALIFORNIA, USA 2020

Monitoring fires with next-generation satellites from MTG and Metop-SG

- GOES-17 ABI - Level 1B Calibrated Radiances - True Colour Composite Animation - 500m
- GOES-17 ABI - Level 2 Fire Radiative Power and Level 1B Calibrated Radiances
- MODIS Level 3 - Burned Area Monthly - 500m
- Sentinel-2 MSI Level 2A - Composite Imagery, Normalized Burn Ratio and Burn Severity

Monitoring smoke transport with next-generation satellites from Metop-SG

MEDITERRANEAN 2021

Forecasting pre-fire risk with next-generation satellites

Monitoring active fires with next-generation satellites

Assessing post-fire impacts with next-generation satellites

REFERENCES

Functions

Fire Radiative Power

In addition, the FCI will also allow for detection and monitoring of characteristics of active fires such as the area that is burning, the temperature of the fires and the rate of the radiative power emitted (also known as the fire radiative power). Fire radiative power is measured in units of power such as watts or megawatts. Figure 3 shows the fire radiative power from the GOES-17 ABI Fire and Hotspot Characterisation product at 22:01 UTC on 20 August 2020. A few high-intensity fires shown in red are producing dense smoke plumes. In the lower-right corner of the image, a cluster of lower intensity fires colored in blue can be seen. This cluster of fires produced a burn scar, shown in Figure 4, which we will investigate further in the next section of this case study.

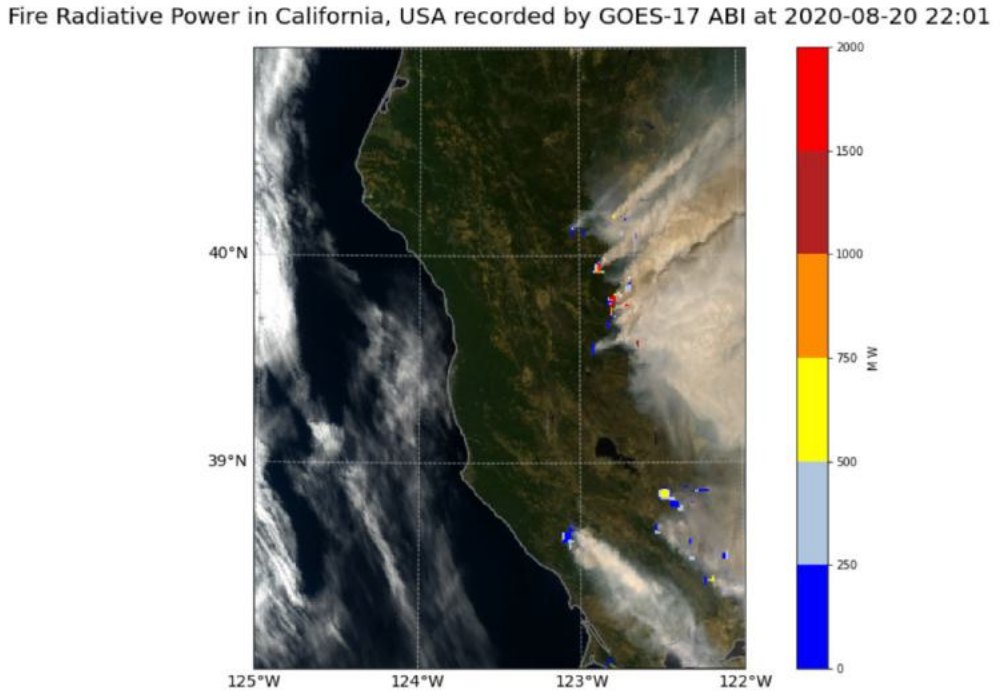

Figure 3. Fire Radiative Power in California, USA overlaid on a true colour composite, recorded by GOES-17 ABI on 20 August 2020.

Learn how this plot of fire radiative power was made.

Contents

The Case Event

Meteosat Third Generation (MTG)

EUMETSAT Polar System - Second Generation (EPS-SG)

MTG Flexible Combined Imager

- Fire risk mapping
- True colour composite imagery
- Fire Radiative Power

EPS-SG METimage

Sentinel-2

Proxy data
GOES-17 ABI Fire and Hotspot Characterisation

Instrument
MTG Flexible Combined Imager (FCI)

As well as introducing complementary datasets

Applications with Next-Generation Satellites

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Monitoring smoke transport with next-generation satellites from Metop-SG

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Forecasting pre-fire risk with

Burn Severity Map

As shown in Figure 8, dNBR can be classified according to burn severity ranges proposed by the USGS. The water bodies are also masked using the water mask from the Sentinel-2 data's scene classification layer. The burn scar around Lake Berryessa has been classified as having areas with both high and moderate-high severity burns. Note that the rectangular-shaped fields on the right side of the image are likely to have been harvested, leading to a false classification as having a high severity burn.

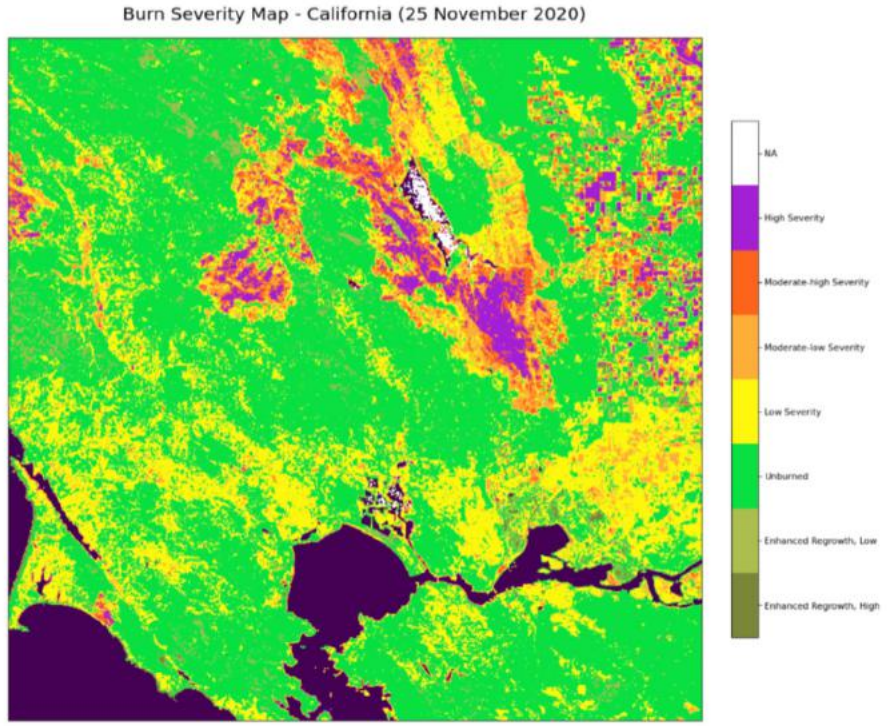

Figure 8. Burn severity is classified using the dNBR image shown in Figure 7. The coastal water bodies are masked using the water mask from the Sentinel-2 data's scene classification layer.

Learn how this Burn severity map was made.

The Case Event
Meteosat Third Generation (MTG)
EUMETSAT Polar System - Second Generation (EPS-SG)
Sentinel-2
Sentinel-2 MultiSpectral Instrument
Natural colour composites
False colour composites
Normalised Burn Ratio (NBR)
Burn Severity Map
References

Instrument
Sentinel-2 MSI

How each figure is made is shown in a Jupyter Notebook workflow

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Sentinel-2 MSI Level 2A - Composite Imagery, Normalized Burn Ratio and Burn Severity

Monitoring smoke transport with

Burn severity map

The dNBR image you calculated can be used for assessing burn severity after a fire. According to UN SPIDER, "areas with higher dNBR values indicate more severe damage whereas areas with negative dNBR values might show increased vegetation productivity. dNBR can be classified according to burn severity ranges proposed by the United States Geological Survey (USGS)."

You can begin by first preparing a water mask using the Scene Classification Layer which is also included in the `IMG_DATA` provided to you. You can use the 20m resolution image to match the dNBR's resolution.

Create water mask using Scene Classification Layer (20m resolution)

First, use the `.open()` function from the rasterio library to open the image. You can reuse the `nov_r20` variable that holds the file path to the image data from 25 November 2020.

```
scl_image=rasterio.open(nov_r20 + "T10SEH_20201125T185719_SCL_20m.jp2")
```

Then, you can read them in as arrays with the `.read()` function. When printing the resulting array, you will see that it contains integers. Each integer represents a different classification. For example:

- 2 indicates dark area pixels
- 4 indicates vegetation
- 5 indicates non-vegetated pixels
- 6 indicates water pixels

```
scl = scl_image.read()
scl = np.array(scl)
scl
```

```
array([[[4, 4, 4, ..., 2, 2, 2],
        [4, 4, 4, ..., 2, 2, 2],
        [4, 4, 5, ..., 5, 2, 5],
        ...,
        [6, 6, 6, ..., 5, 2, 2],
```

Natural colour composites

False colour composites

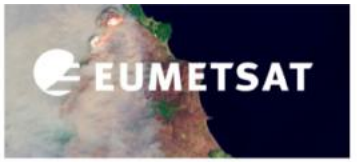
Normalized Burn Ratio (NBR) and Differenced NBR images

Burn severity map

Code cell

Result

The workflows can also be executed by users…



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- **Sentinel-2 MSI Level 2A - Composite Imagery, Normalized Burn Ratio and Burn Severity**

Monitoring smoke transport with

Sentinel-2 MSI Level 2A - Composite Imagery, Normalized Burn Ratio and Burn Severity

Hint

Execute the notebook on the training platform >>

This notebook provides you an introduction to data from the Sentinel-2 MultiSpectral Instrument (MSI), which has has 13 spectral bands which provide data for land cover/change classification, atmospheric correction and cloud/snow separation. This notebook demonstrates several ways that Level 2A data from Sentinel-2 can be used, including the creation of composite imagery, calculation of a burn index and burn severity mapping.

The event featured is the August Complex fire in California, USA in 2020. This was the largest wildfire in CA history, spreading over 1,000,000 acres (over 4,000 sq km). The image shown in this notebook is taken from 7 October 2020.

Basic Facts

Spatial resolution: `10 m, 20m and 60m`
Spatial coverage: `Near global`
Revisit time: `5 days at the equator`
Data availability: `since 2015`

How to access the data

Sentinel-2 Level 2A data can be obtained via the Copernicus Open Access Hub and are disseminated as `.zip archives` when downloaded. You need to register for an account before downloading data.

The data when unzipped, are in "SENTINEL-SAFE format, including image data in JPEG2000 format, quality indicators (e.g. defective pixels mask), auxiliary data and metadata." Learn more about the data format here.

MSI data

- [Optional] Unzip the downloaded Sentinel-2 zipped archives

Natural colour composites

False colour composites

Normalized Burn Ratio (NBR) and Differenced NBR images

Burn severity map

… on a Jupyterhub based platform which has preloaded data

File Edit View Run Kernel Tabs Settings Help

Filter files by name

/ med_part3_workflows /

Name	Last Modified
rasterio	3 months ago
figure1_MODIS_BurnedArea_Monthly.ipynb	2 months ago
figure2345_Sentinel-2.ipynb	2 months ago

figure2345_Sentinel-2.ipyn

Markdown

Python 3 (ipykernel)

Sentinel-2 MSI Level 2A - Composite Imagery, Normalized Burn Ratio and Burn Severity

About

This notebook provides you an introduction to data from the Sentinel-2 MultiSpectral Instrument (MSI), which has has 13 spectral bands which provide data for land cover/change classification, atmospheric correction and cloud/snow separation. This notebook demonstrates several ways that Level 2A data from Sentinel-2 can be used, including the creation of composite imagery, calculation of a burn index and burn severity mapping.

The events featured in this notebook are the wildfires in Italy and Greece in summer 2021. The image below shows the active burning on the Evia island of Greece on 8 August 2021, recorded by the Sentinel 2 MSI.

https://bit.ly/girondefires

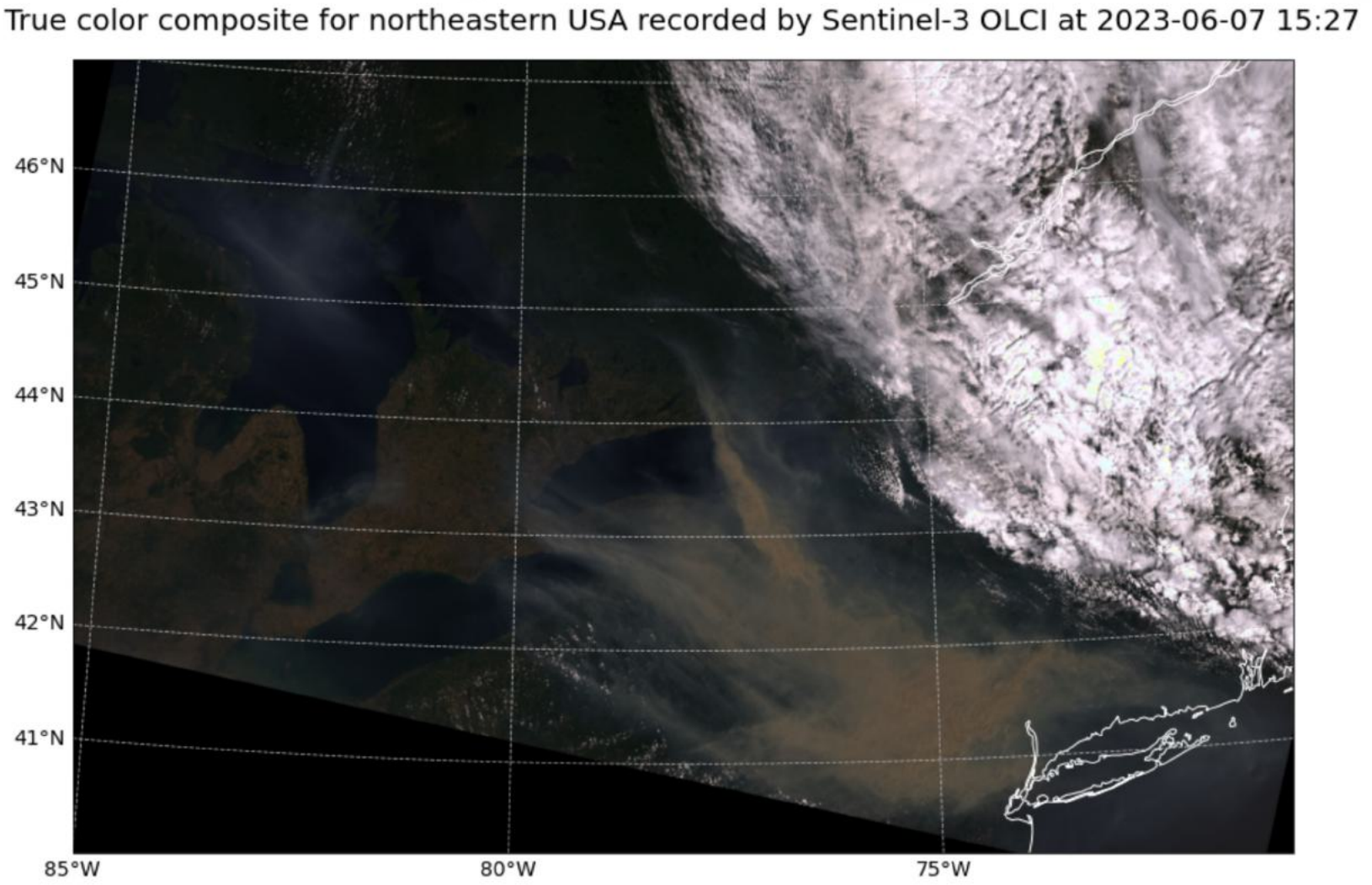
Monitoring fires with next-generation satellites from MTG and Metop-SG: Gironde, France Wildfires Case Study

In the near future, new satellites such as Meteosat Third Generation (MTG) and Metop - Second Generation (Metop-SG) will provide advanced capabilities and valuable data for monitoring fires and their impacts. This case study will introduce upcoming data products from MTG and Metop-SG in the context of the wildfires in Gironde, France in July and August 2022 and show how these upcoming products, alongside complementary existing data products, can be used to monitor the full fire life cycle.

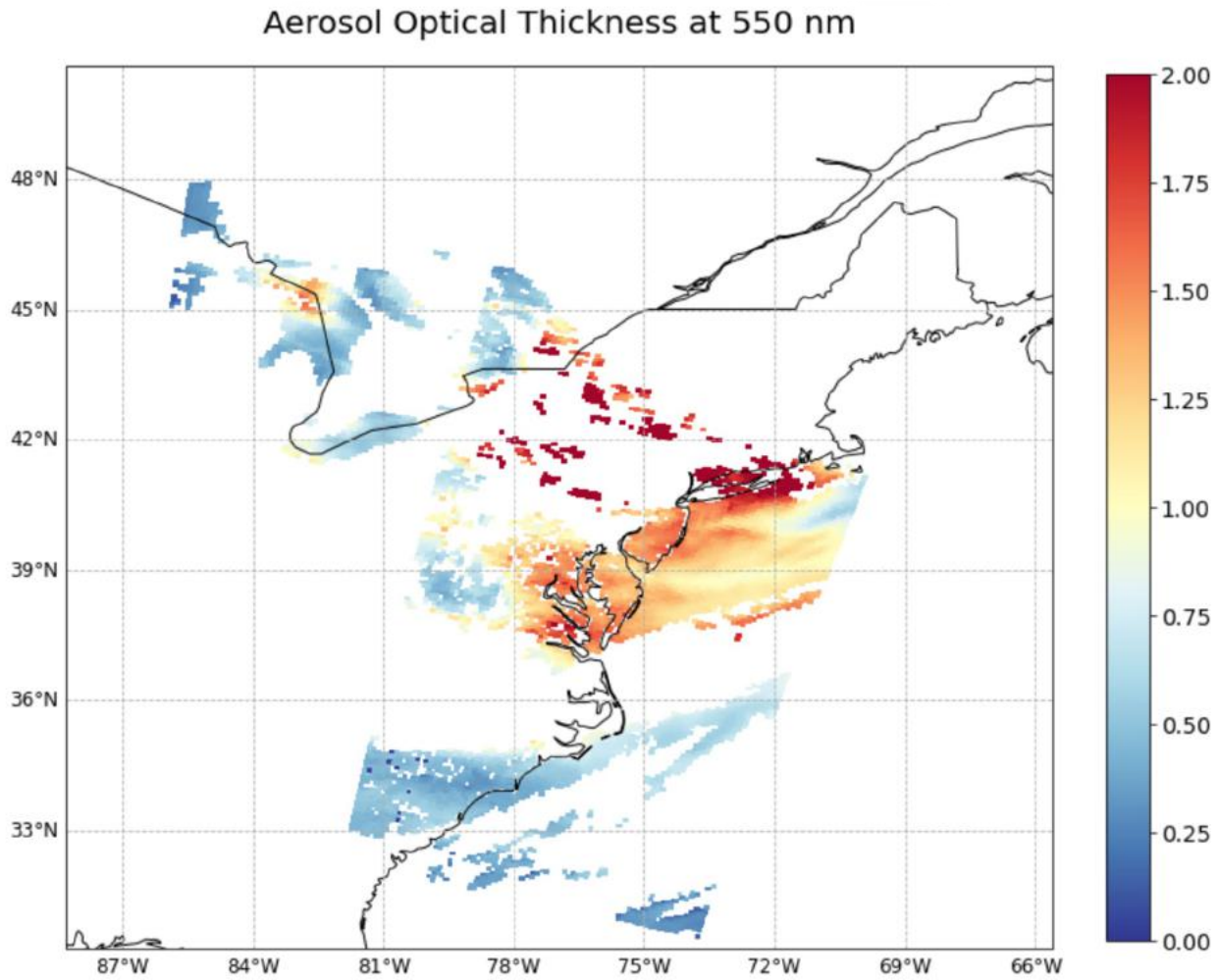
The Case Event

According to Al Jazeera, "The Gironde was hit by major wildfires in July which destroyed more than 20,000 hectares (49,421 acres) of forest and temporarily forced nearly 40,000 people from their homes." These fires continued to burn in August, leading to the deployment of over 1,000 firefighters to try and control the spread.

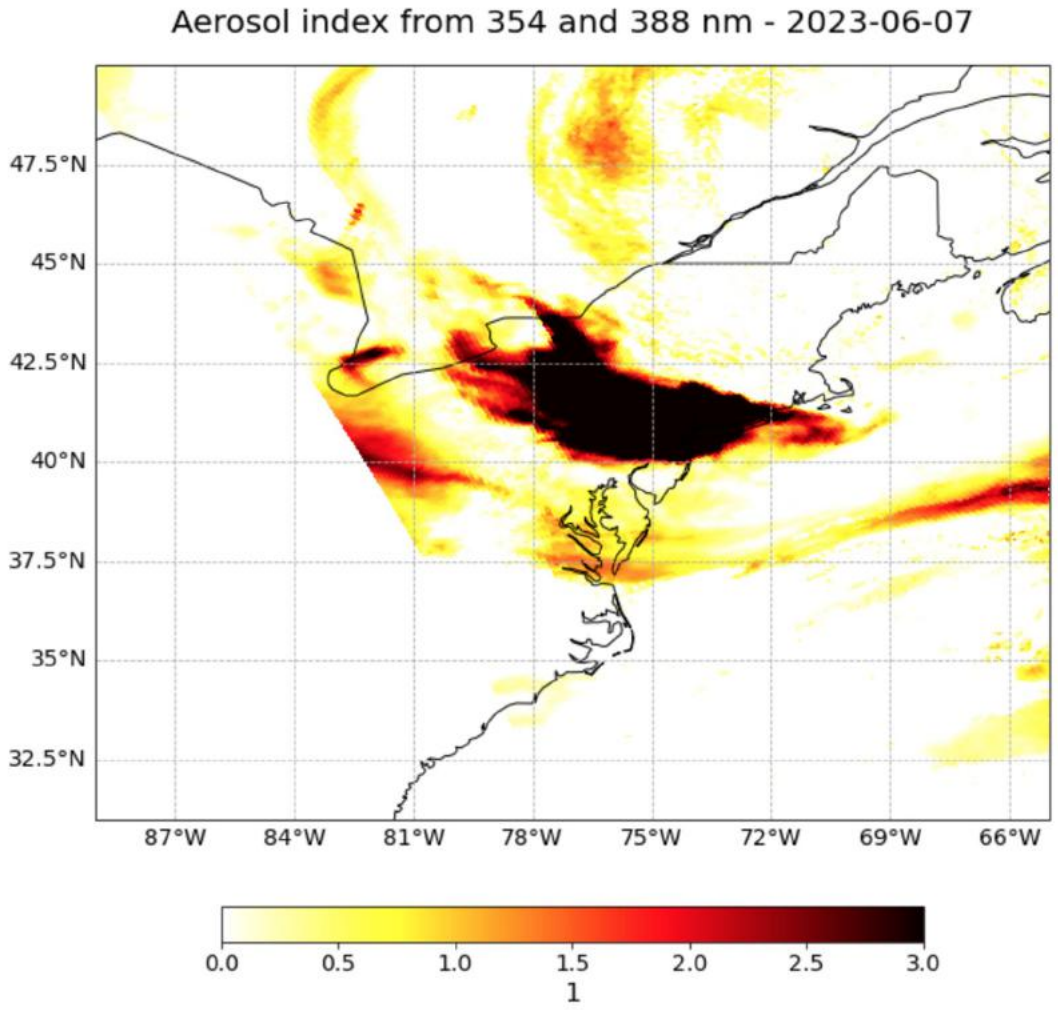
Sentinel-3 OLCI L1B True Color RGB Composite



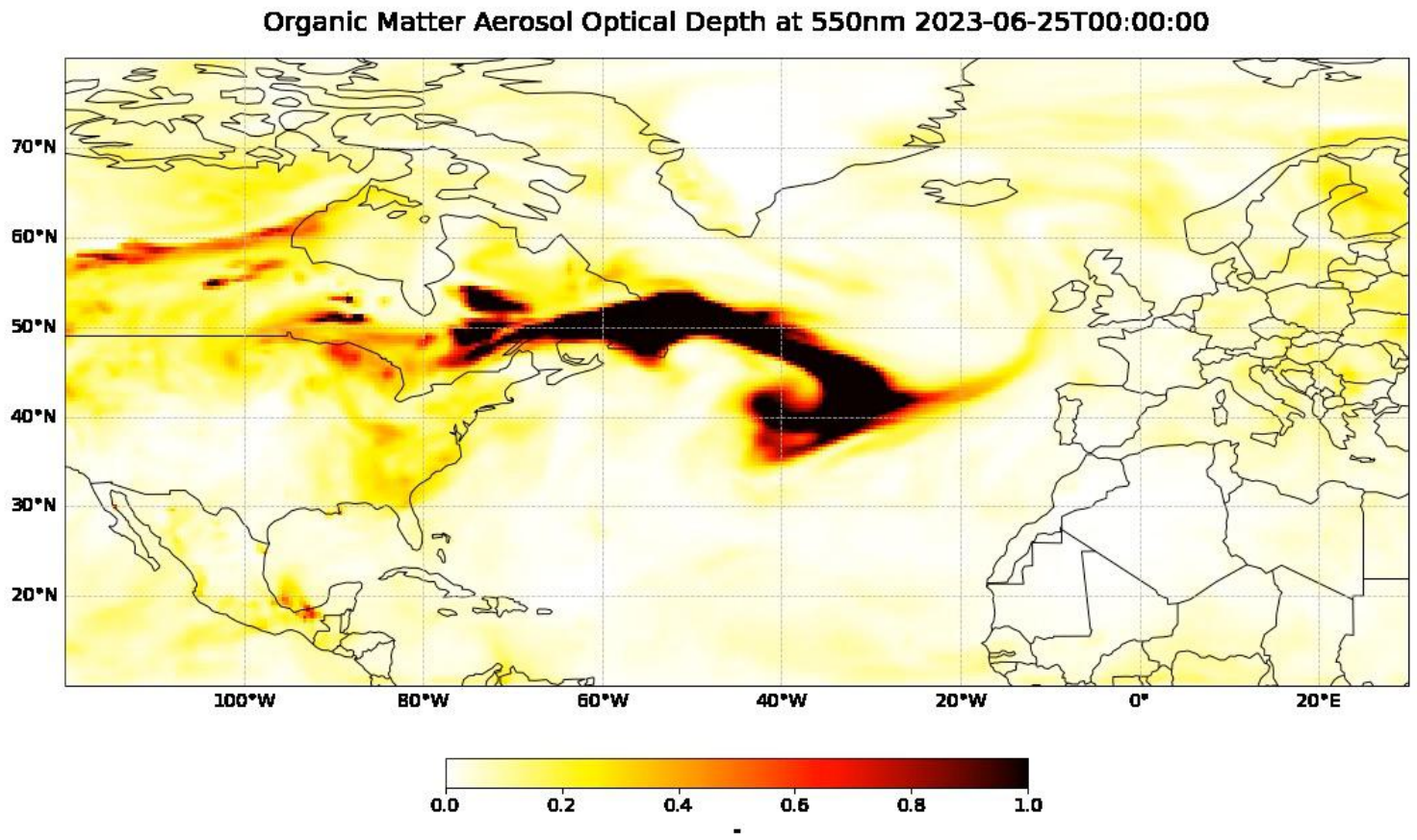
Sentinel-3 SLSTR NRT L2 Aerosol Product



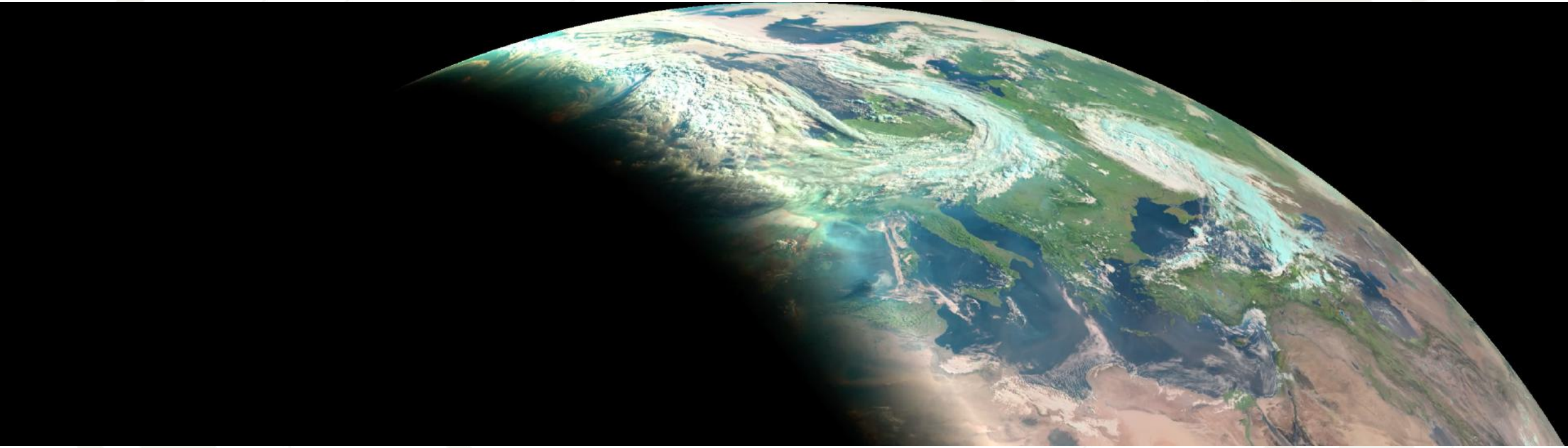
Sentinel-5P TROPOMI UV Aerosol Index



CAMS Global Forecast OMAOD Animation



MSG SEVIRI True Colour RGB Animation



Useful Links

- JupyterBook
  - https://fire.trainhub.eumetsat.int/
- Gironde Case Study
  - https://gitlab.eumetsat.int/eumetlab/atmosphere/atmosphere/-/tree/master/90_workshops/202210_EUM_wildfire_workshop
- Canada Fires Data Visualisations
  - https://gitlab.eumetsat.int/eumetlab/atmosphere/atmosphere/-/tree/master/90_workshops/202307_EUM_wildfire_short_course
- Register for an account on the training platform at
  - https://login.ltpy.adamplatform.eu/

Thank you!

Questions are welcome.

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