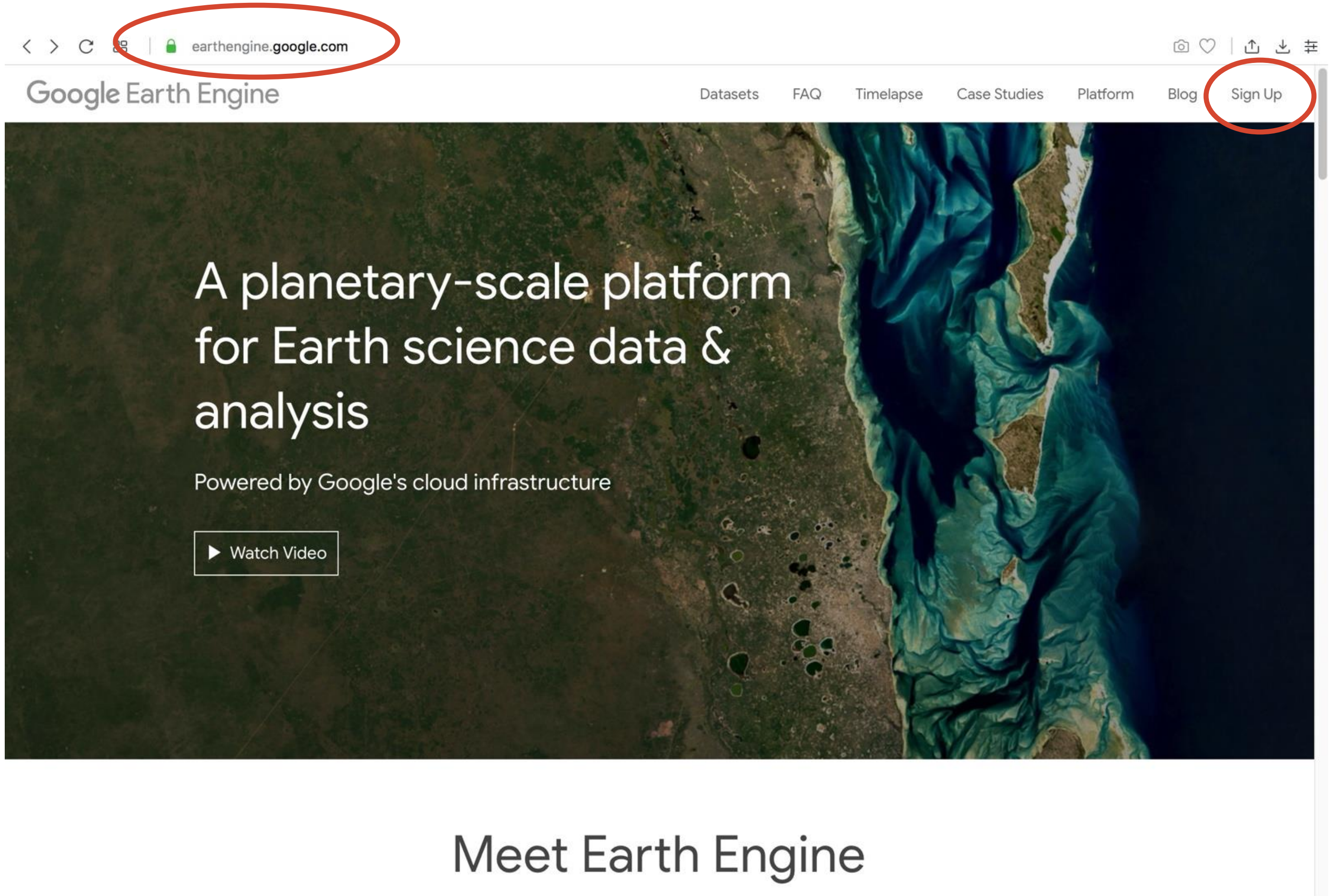
IMERG – Extreme Precipitation and Flood Demonstration Using Google Earth Engine

Google Earth Engine

- https://earthengine.google.com
- Cloud based geospatial processing platform
- Available to scientists, researchers, and developers for analysis of the Earth's surface
- Contains a catalog of satellite imagery and geospatial datasets (including Sentinel-1):
- https://developers.google.com/earth-engine/datasets/catalog/
- Uses JavaScript code editor
- Sign up for a (free) account



Google Earth Engine Code Editor

https://code.earthengine.google.com

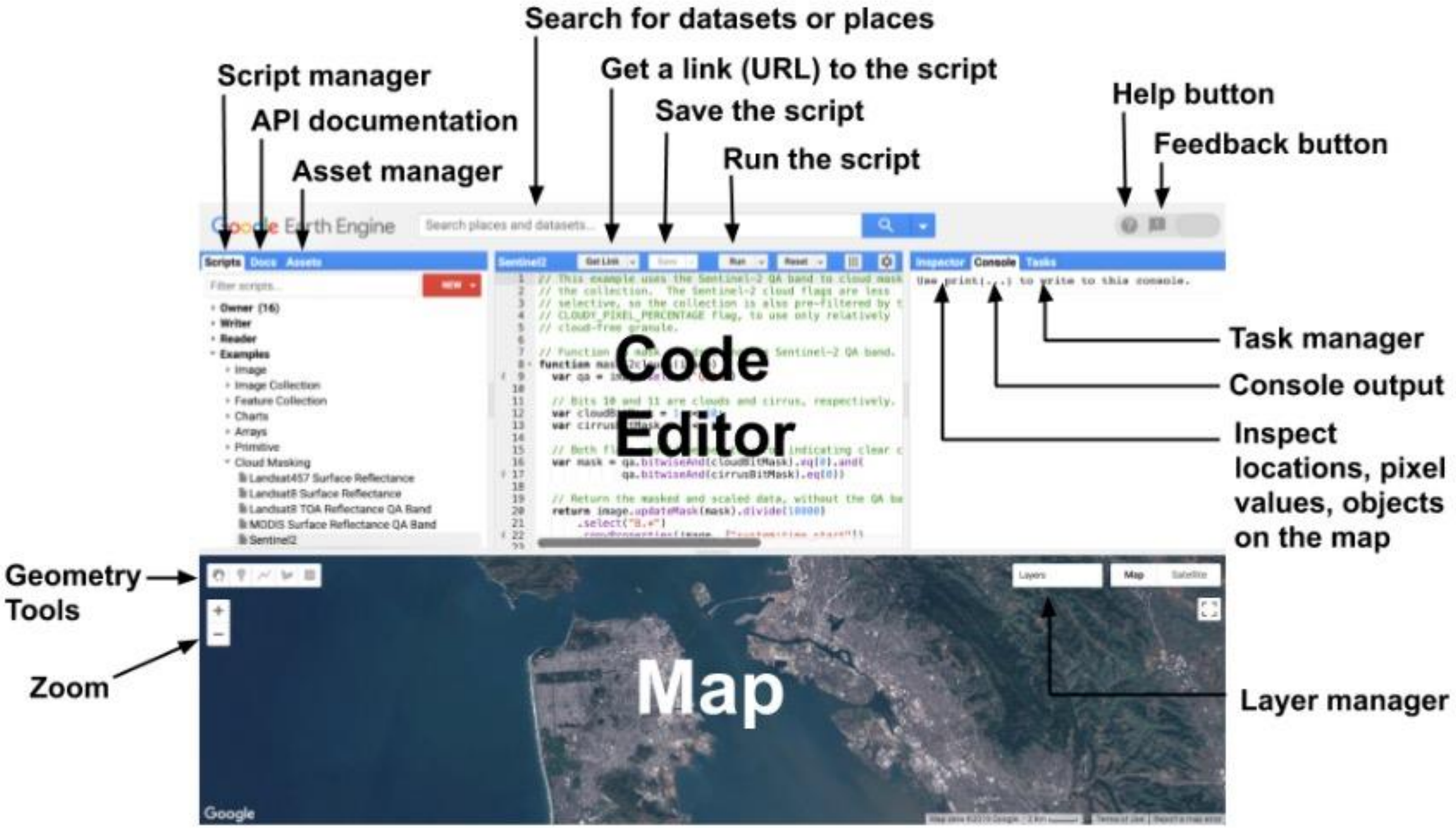
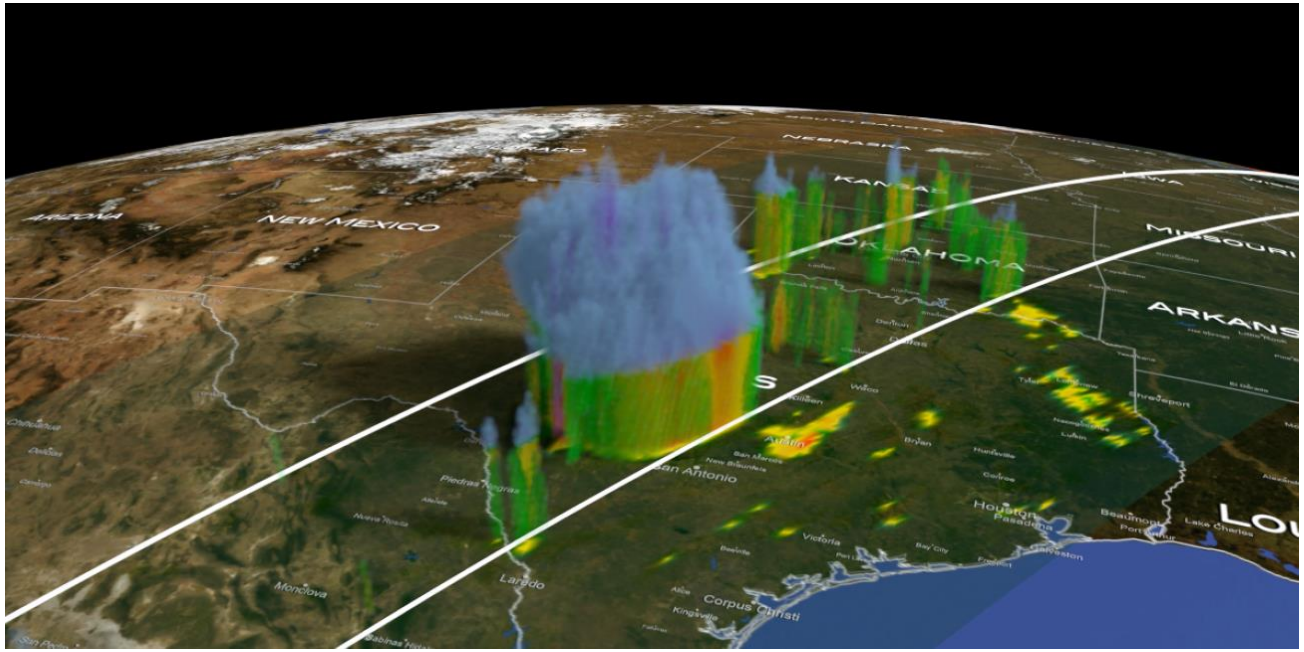


Image Credit: Google

Hill Country Texas Flooding

- Over the fourth of July weekend, the Texas Hill Country was devastated by a powerful flash flood event.
- River levels rose rapidly, on the order of 20 feet or more in 1 to 2 hours or less, all along the upper part of the Guadalupe River.
- Mesoscale Convective System resulting from the remnants of Tropical Storm Barry caused heavy rains.



Texas Hill Country Hit by Powerful Floods
Credit: NASA

GEE Demonstration

Analysis using Java Script:

- Access IMERG half hourly precipitation data and calculate daily rainfall to make a timeseries.
- Generate long-term, monthly mean and standard deviation maps of precipitation.
- Calculate 90th percentile rain values.
- Identify days/areas with extreme precipitation compared to the 90th percentile rain values.
- Calculate daily precipitation anomalies compared to the long-term mean precipitation.
- Identify and mark areas likely to be flooded based on the extreme, anomalous precipitation values.
- Overlay the population and terrain/slope maps to see where flood impact may be higher.

GEE Flood Exercise: Select Area of your Interest

- GEE Code (demo): https://code.earthengine.google.com/53b81be33b0164c8bd0f2de24514af65

- Select the area of your interest for a flood case by changing country, state, county in the code (lines 61–63 & lines 71–74) in the script.

```
60 // Define a variable "AOI" that holds the GAUL Level 1 dataset (countries and states)
61  var AOI = ee.FeatureCollection('FAO/GAUL_SIMPLIFIED_500m/2015/level1');
62 // Define a variable "AOI2" that holds the GAUL Level 2 dataset (counties)
63  var AOI2 = ee.FeatureCollection('FAO/GAUL_SIMPLIFIED_500m/2015/level2');
64 //
65 // Define a variable "myaoi" to select the area of interest (i.e., Texas, USA)
66  var myaoi = AOI
67   .filter(ee.Filter.eq('ADM0_NAME', 'United States of America'))
68   .filter(ee.Filter.eq('ADM1_NAME', 'Texas'));
69 //
70 // Define a variable "myaoi" to select the area of interest (i.e., Texas, USA, county Gillespie)
71  var myaoi2 = AOI2
72   .filter(ee.Filter.eq('ADM0_NAME', 'United States of America'))
73   .filter(ee.Filter.eq('ADM1_NAME', 'Texas'))
74   .filter(ee.Filter.eq('ADM2_NAME', 'Gillespie')); // Gillespie County
75 //
```

GEE Flood Exercise: Select Time of the Flood Event

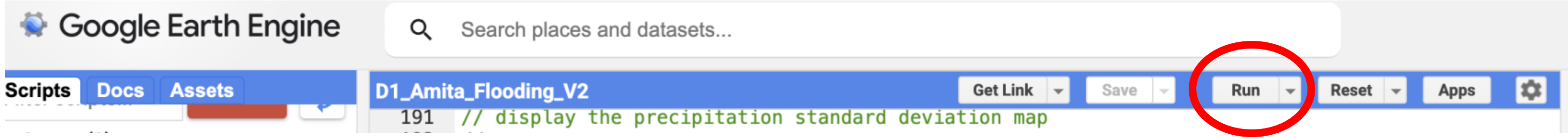
- Select the month when flooding occurred by changing the month in line 138.
- For example, for October change (7, 7,’Month’) to (10,10,’Month’).

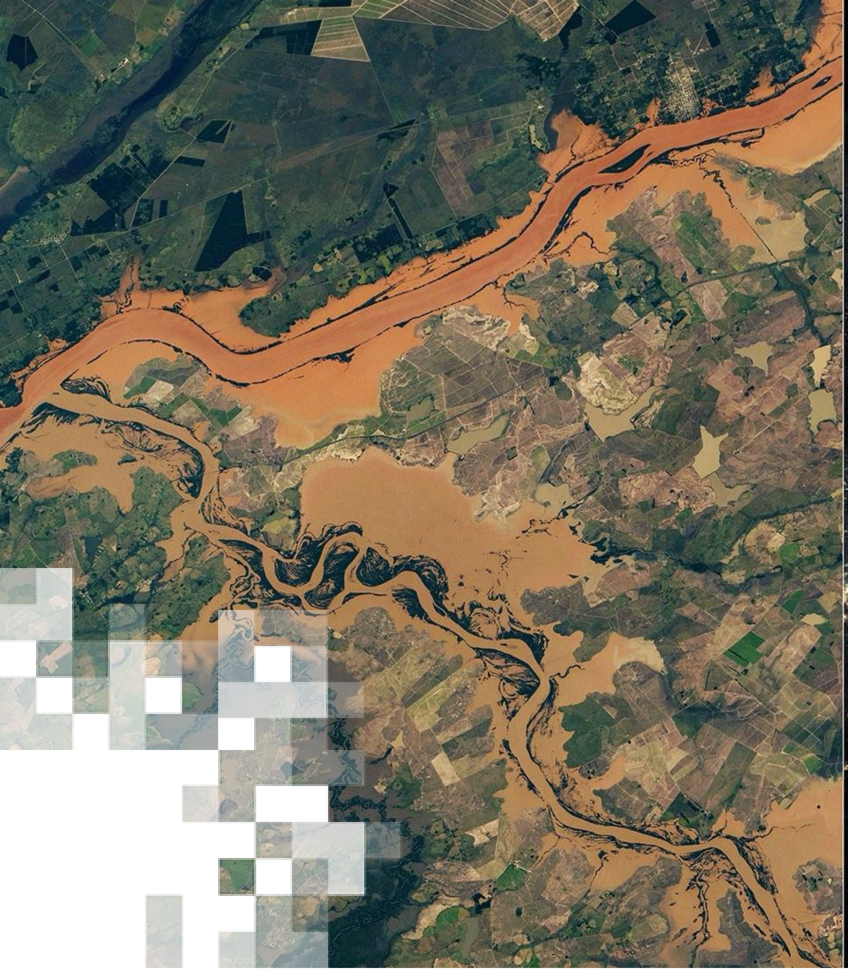
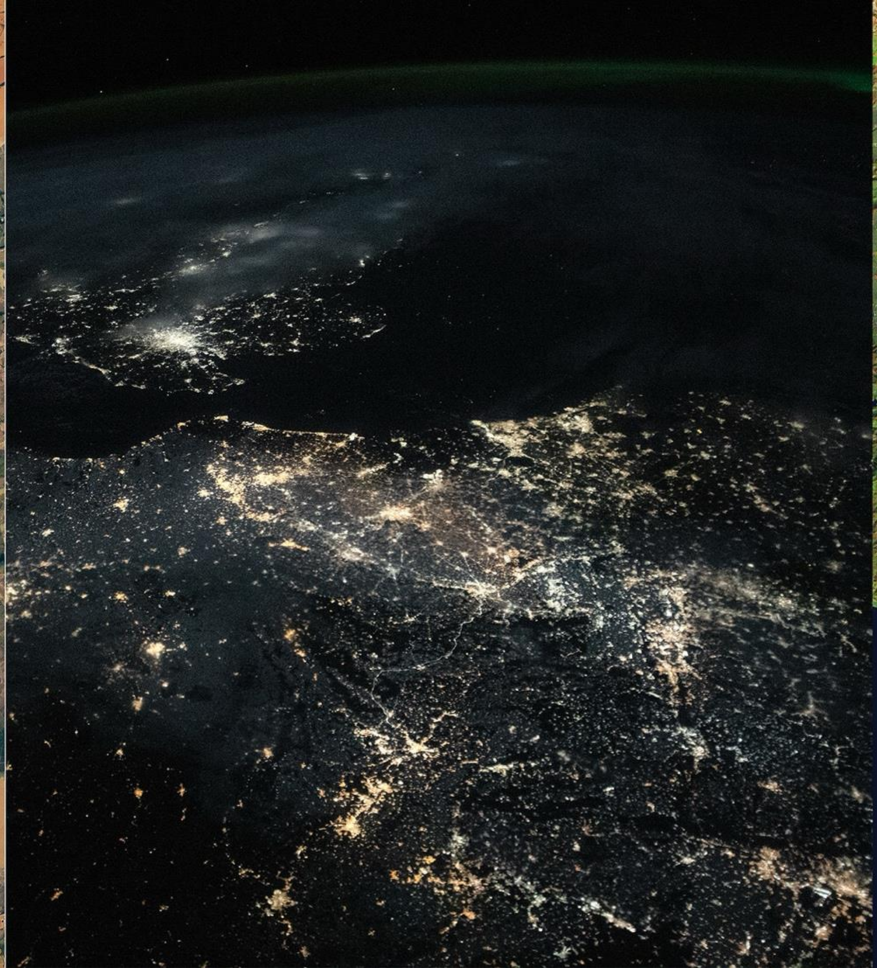
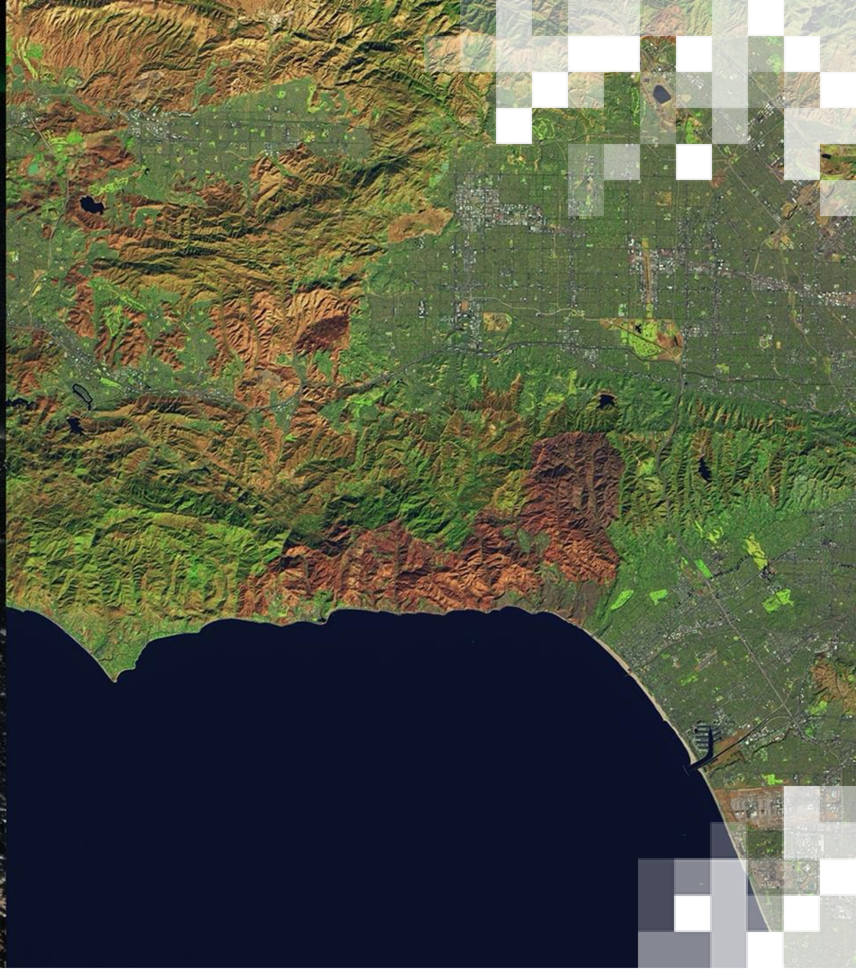
```
138   var prJul= rain.filterDate(startdate,enddate).filter(ee.Filter.calendarRange(7,7,'month'));
```

- Select the days when flooding occurred by changing start date and end date in lines 210 and 211

```
210   var sday = '2025-07-03';    // Start Date
211   var eday = '2025-07-05';    // End Date
```

- Run the script by Clicking ‘Run’



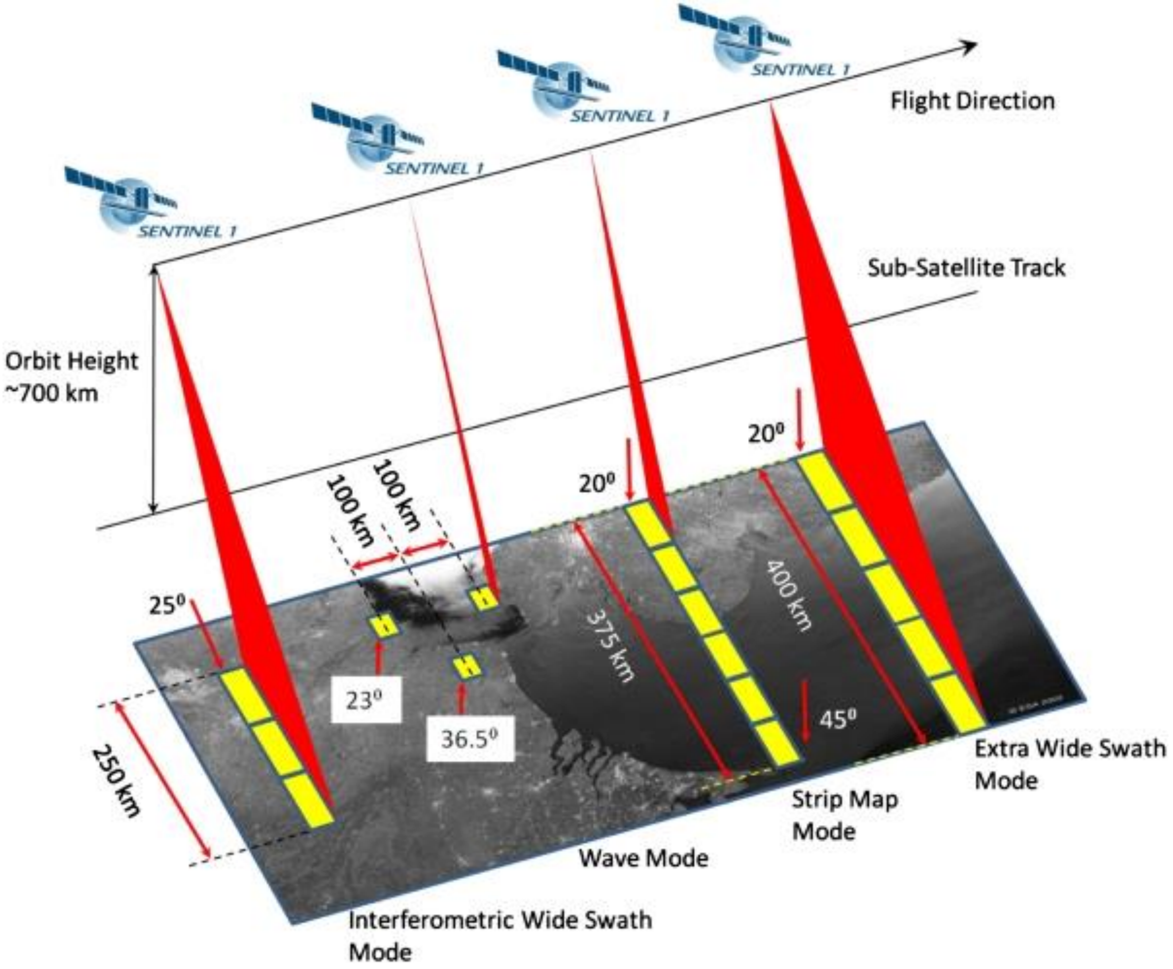
SAR Flood Demonstration Using Google Earth Engine

Sentinel-1 Data

Four Sentinel satellites: A, B, C, & D*

- C-band data
- Each satellite has global coverage every 12 days
- Global coverage of 3–6 days over the equator when using data from all satellites

- *Sentinel 1B experienced a power failure December 23, 2021, led to mission termination August 3, 2022.



Sentinel-1 Data

Different Modes:

- Extra Wide Swath – for monitoring oceans and coasts
- Strip Mode – by special order only and intended for special needs
- Wave Mode – routine collection for the ocean
- *Interferometric Wide Swath – routine collection for land* **(this is the one you want to use for flood mapping)**

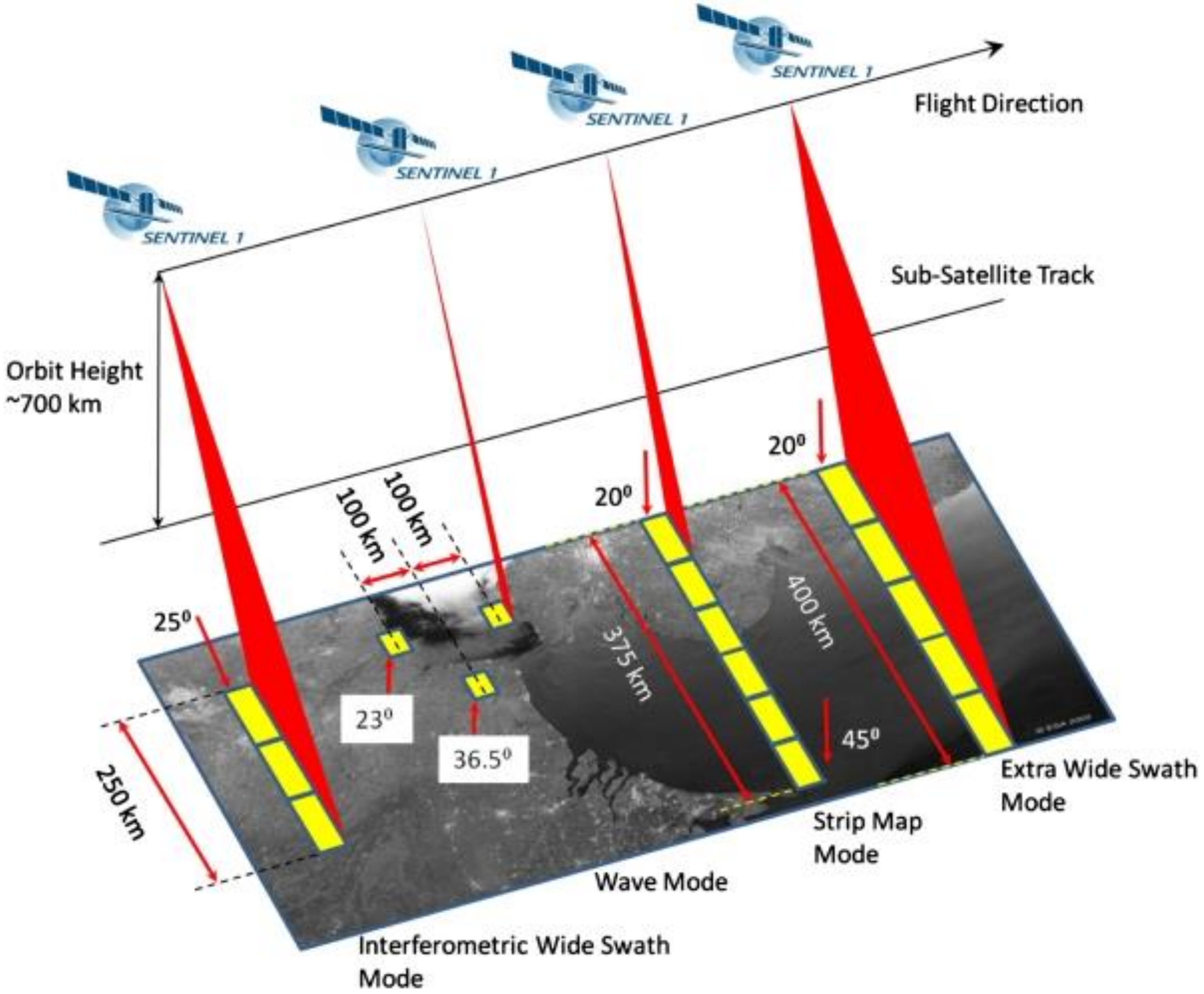


Image Credit: ESA

Sentinel-1 Catalog

- https://developers.google.com/earth-engine/datasets/catalog/COPERNICUS_S1_GRD

The Sentinel-1 mission provides data from a dual-polarization C-band Synthetic Aperture Radar (SAR) instrument. This collection includes the S1 Ground Range Detected (GRD) scenes, processed using the Sentinel-1 Toolbox to generate a calibrated, ortho-corrected product. The collection is updated weekly.

This collection contains all of the GRD scenes. Each scene has one of 3 resolutions (10, 25 or 40 meters), 4 band combinations (corresponding to scene polarization) and 3 instrument modes. Use of the collection in a mosaic context will likely require filtering down to a homogenous set of bands and parameters. See this article for details of collection use and preprocessing. Each scene contains either 1 or 2 out of 4 possible polarization bands, depending on the instrument's polarization settings. The possible combinations are single band VV or HH, and dual band VV+VH and HH+HV:

1. VV: single co-polarization, vertical transmit/vertical receive
2. HH: single co-polarization, horizontal transmit/horizontal receive
3. VV + VH: dual-band cross-polarization, vertical transmit/horizontal receive
4. HH + HV: dual-band cross-polarization, horizontal transmit/vertical receive

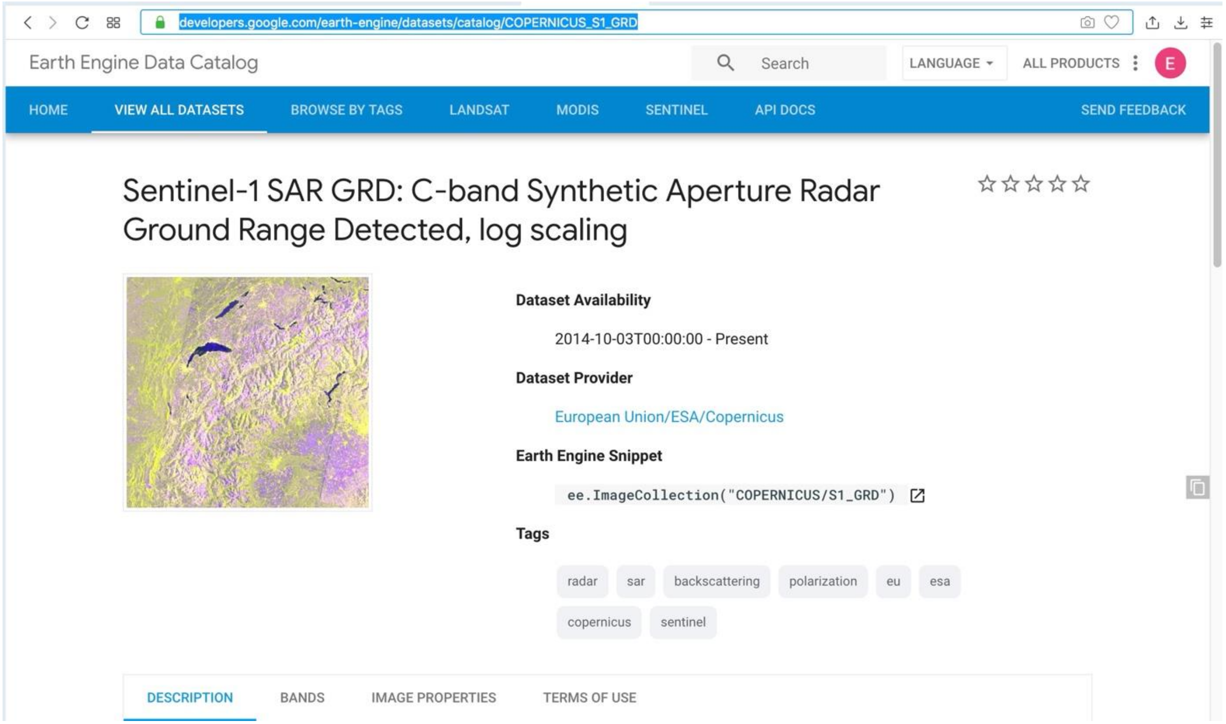
Each scene also includes an additional 'angle' band that contains the approximate viewing incidence angle in degrees at every point. This band is generated by interpolating the 'incidenceAngle' property of the 'geolocationGridPoint' gridded field provided with each asset.

Each scene was pre-processed with Sentinel-1 Toolbox using the following steps:

1. Thermal noise removal
2. Radiometric calibration
3. Terrain correction using SRTM 30 or ASTER DEM for areas greater than 60 degrees latitude, where SRTM is not available. The final terrain-corrected values are converted to decibels via log scaling (10*log10(x).

For more information about these pre-processing steps, please refer to the Sentinel-1 Pre-processing article.

This collection is computed on-the-fly. If you want to use the underlying collection with raw power values (which is updated faster), see COPERNICUS/S1_GRD_FLOAT.



Focus Area

Our demo is focused on floods that occurred on Oct. 28, 2025, in Jamaica due to Hurricane Melissa

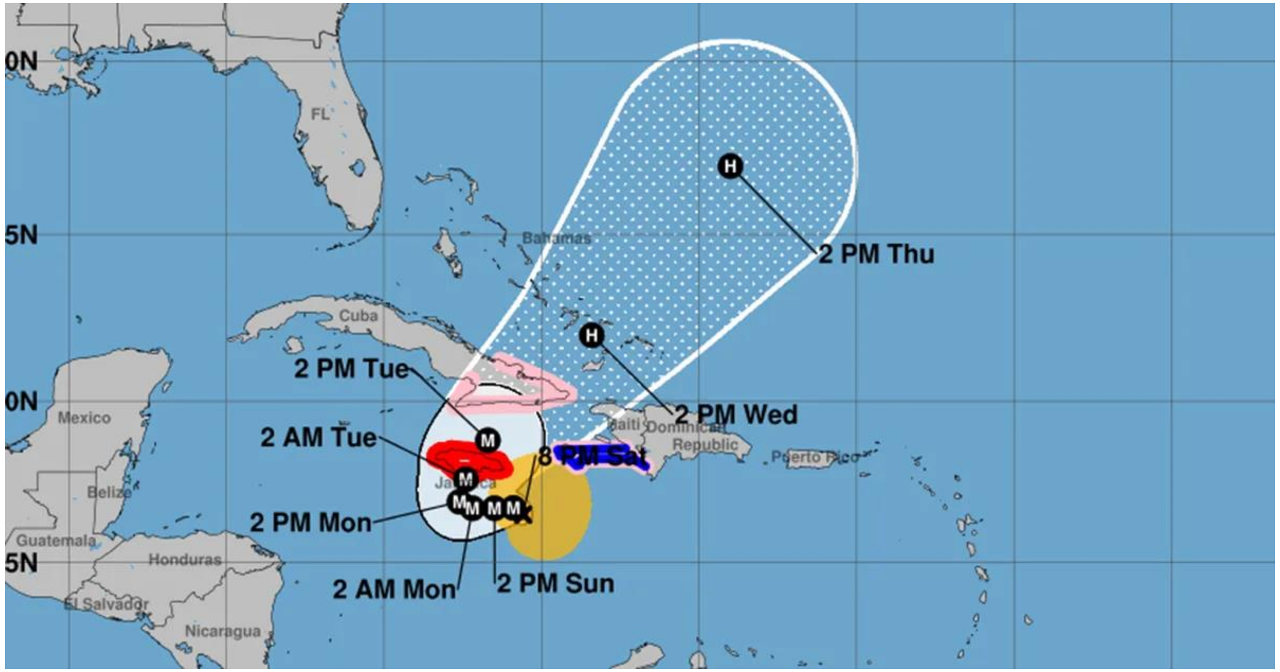


Image Credit: Global Disaster Alert and Coordination System
Credit: Reuters/Siphiwe Sibeko/File Photo

Image Credit: Flooded homes in the Buzi district outside Beira, Mozambique.
Credit: Reuters/Siphiwe Sibeko/File Photo

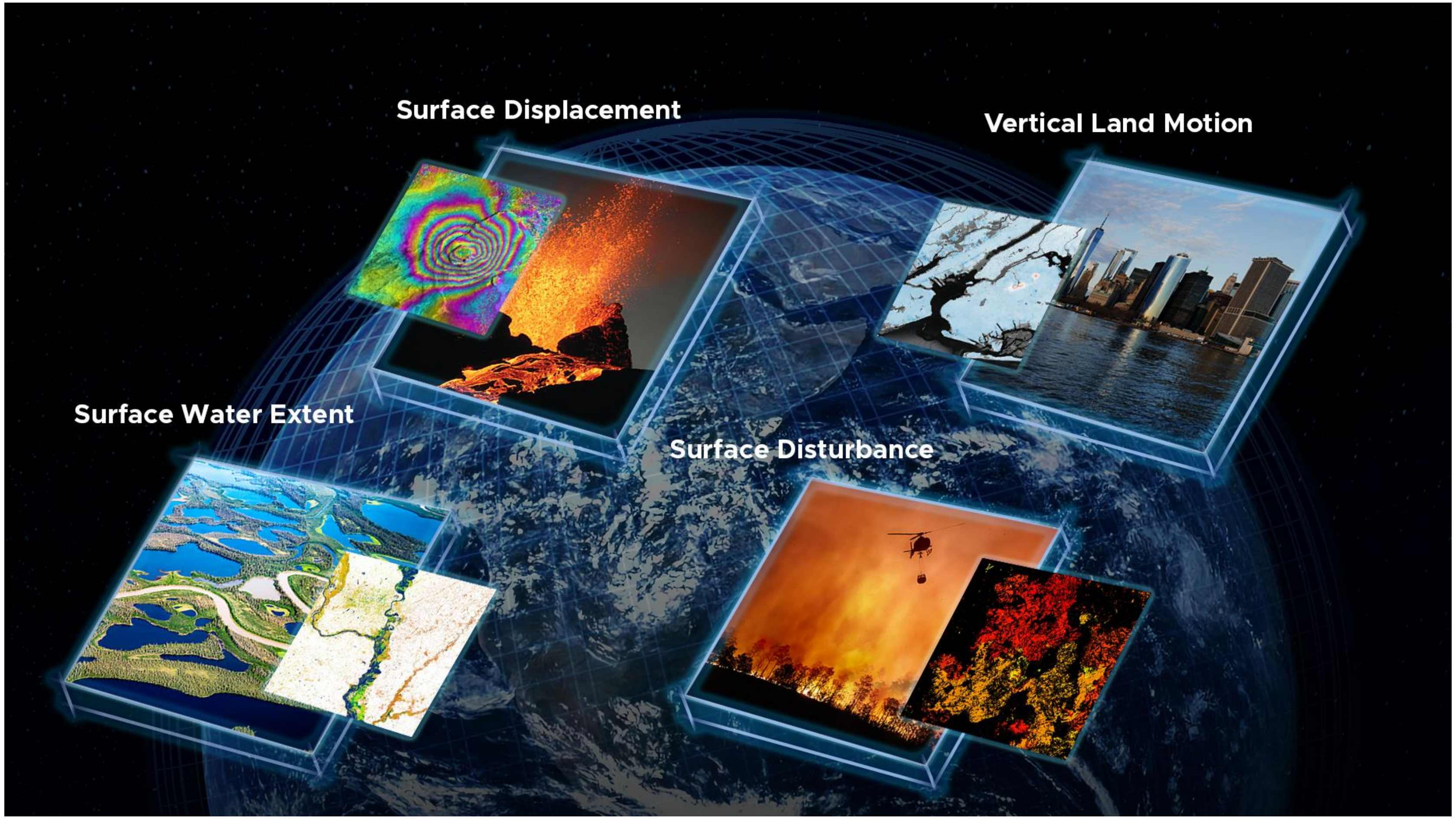
GEE Demo Workflow

- Use Sentinel-1 SAR images of Jamaica from before and after hurricane Melissa to determine flood extent by applying a threshold
- Determine affected crop area
- Determine exposed population
- GEE Code (demo): https://code.earthengine.google.com/bf33abbc4f9e4fffd3a89e83612f222d

OPERA

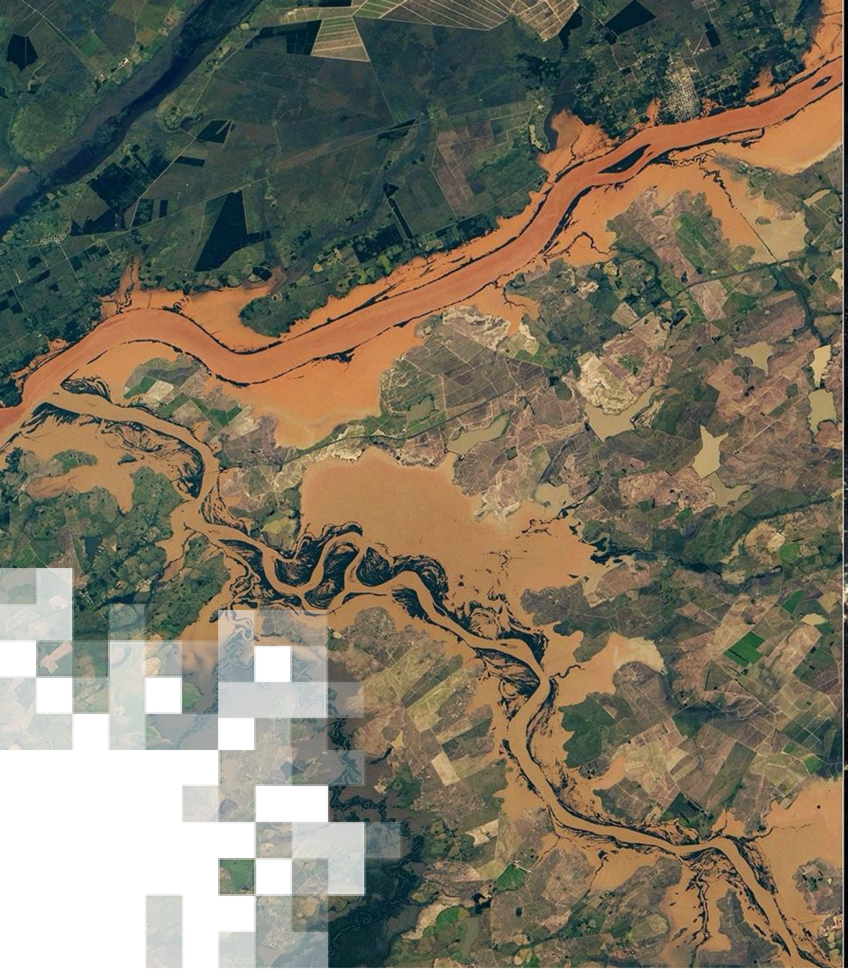
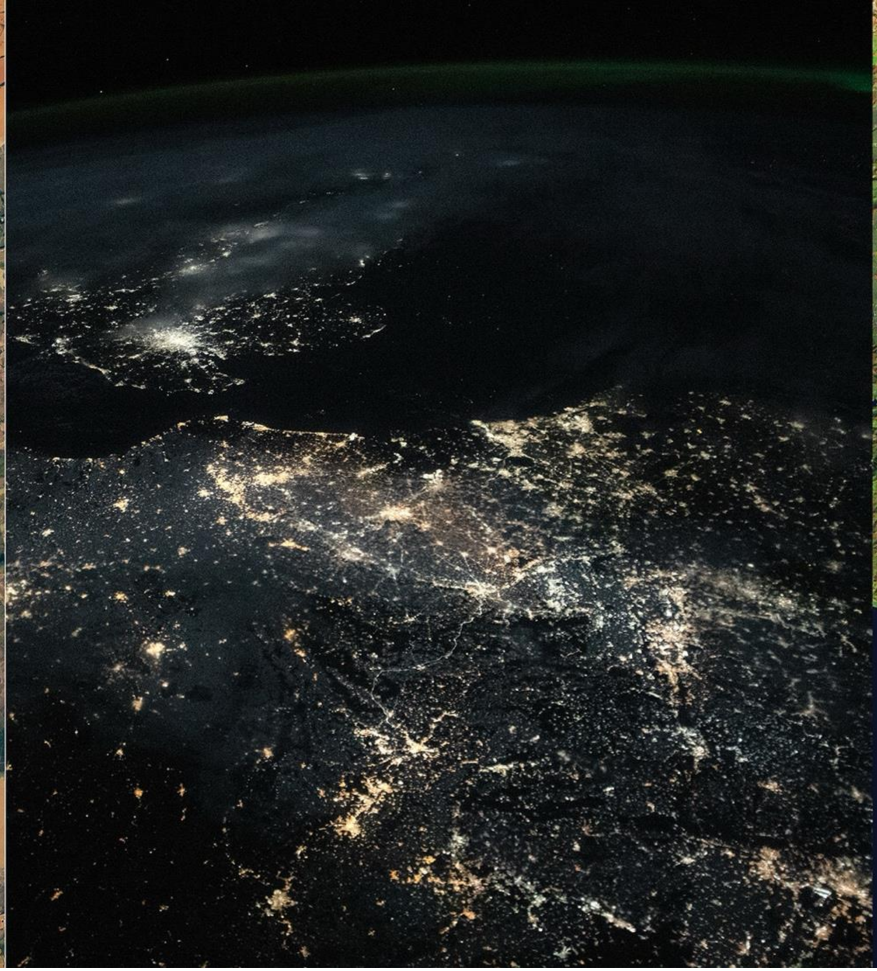
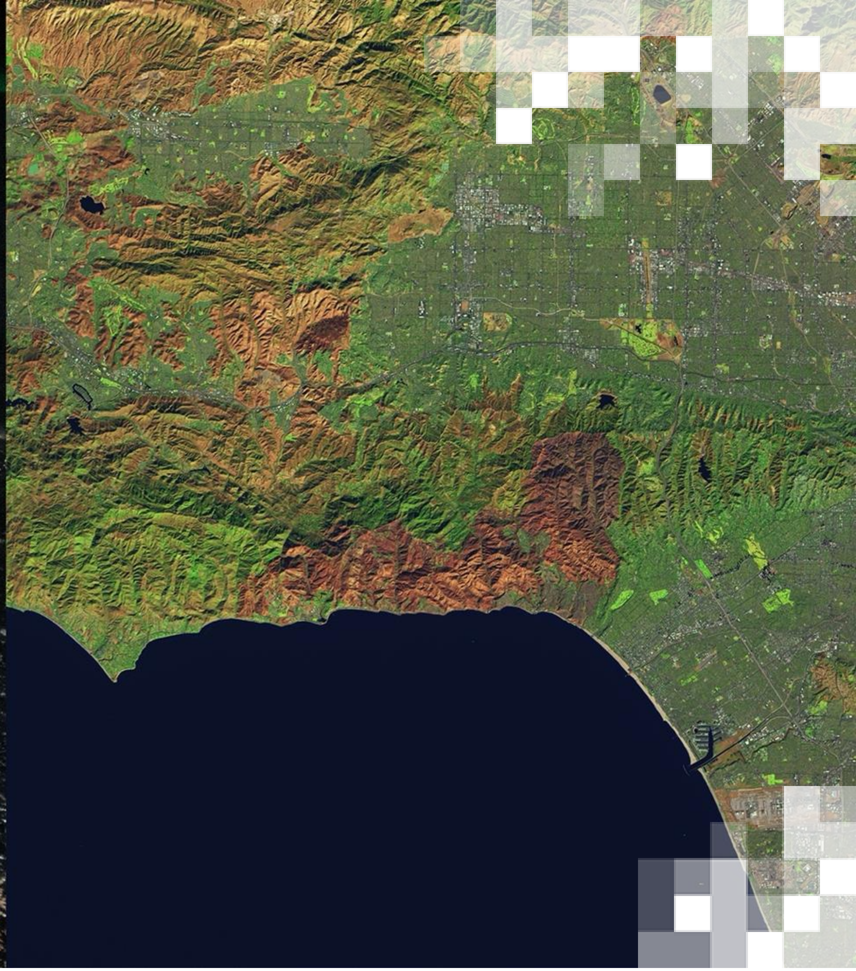
Observational Products for End-Users from Remote Sensing Analysis (OPERA)

The OPERA Dynamic Surface Water Extent (DSWx) product uses Harmonized Landsat-8 Sentinel-2A/B/C (HLS) as the primary image-based inputs. Accordingly, this data product is referred to by the short name DSWx-HLS. It has a spatial resolution of 30 meters.



OPERA data access:

NASA Earthdata

Exercise

Typhoon Fung-wong

- Category 4-equivalent typhoon
- Made landfall in Luzon (Philippines) on November 9, 2025
- Caused extensive flooding and severe wind damage along its track.
- Exercise:
  - Explore Worldview & LANCE Flood Viewer
  - Adapt GEE code from optical (Texas) and/or radar (Jamaica) case studies
  - Develop your own case study in a domain that aligns with your work experience or personal interests.

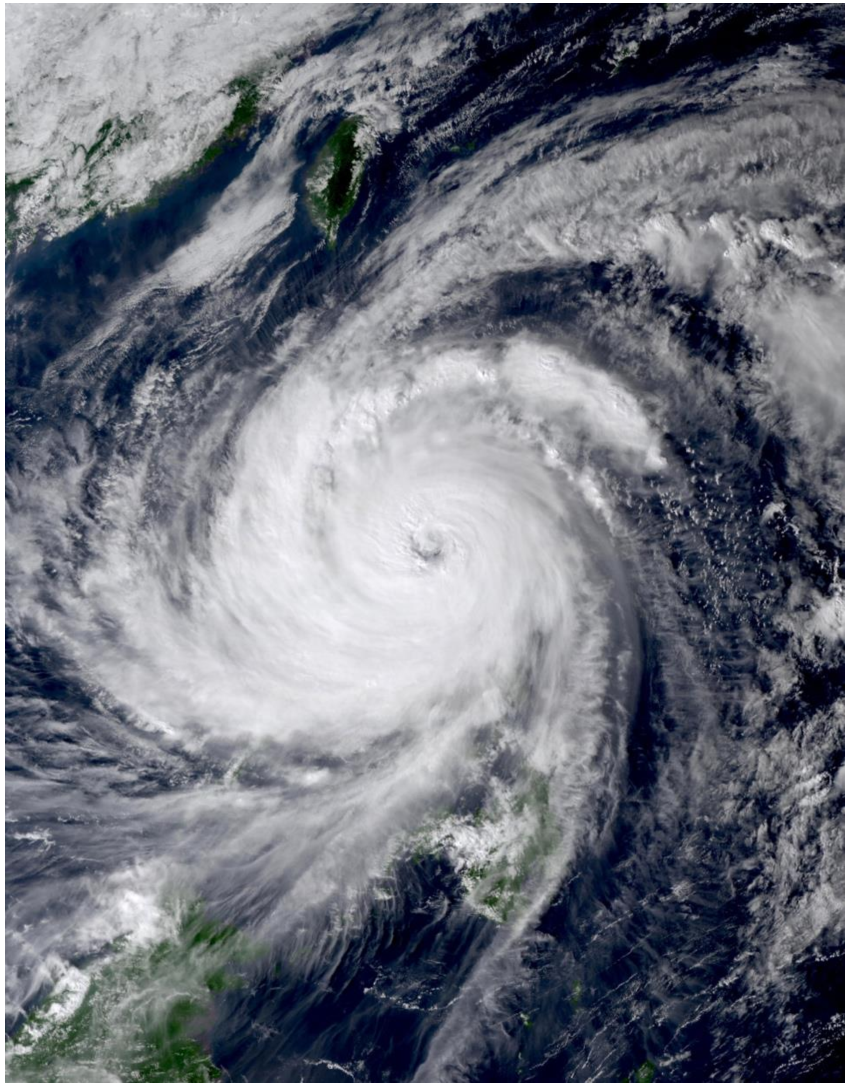


Image credit: JAXA P-Tree system