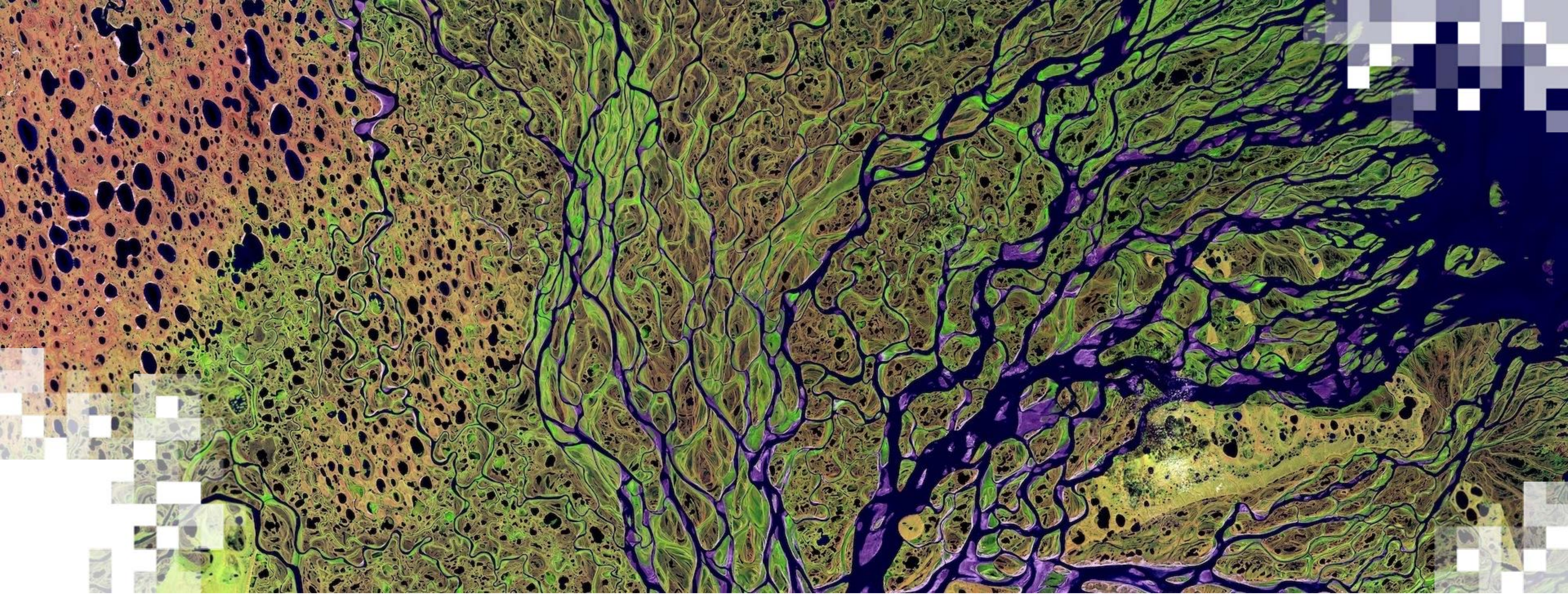


Floods: Google Earth Engine Demo

Google Earth Engine (GEE)

- Cloud-based geospatial processing platform
- Available for free to scientists, researchers, and developers for analysis of the Earth
- Google's computational power
- Application Programming Interface (API)
- JavaScript code editor (Python available)
- Sign up for a free account:
  - https://earthengine.google.com/

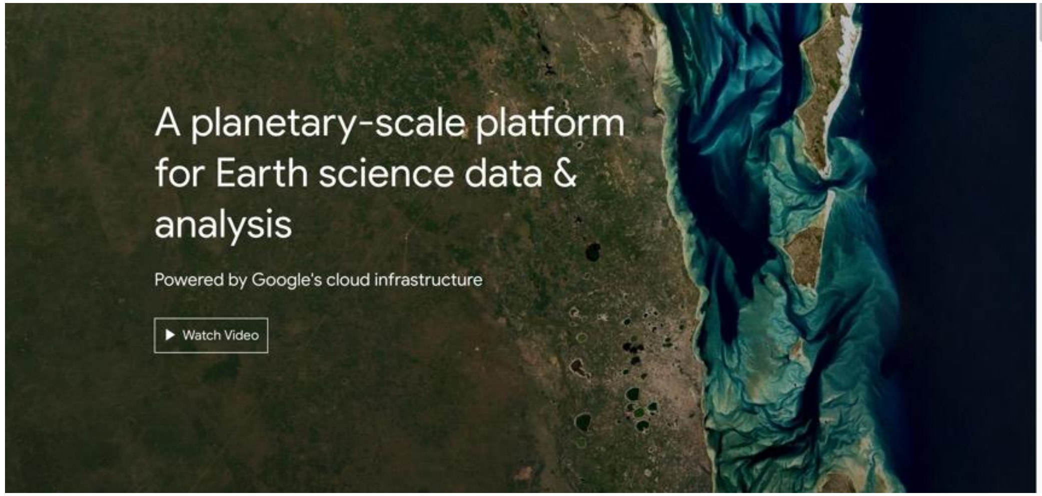
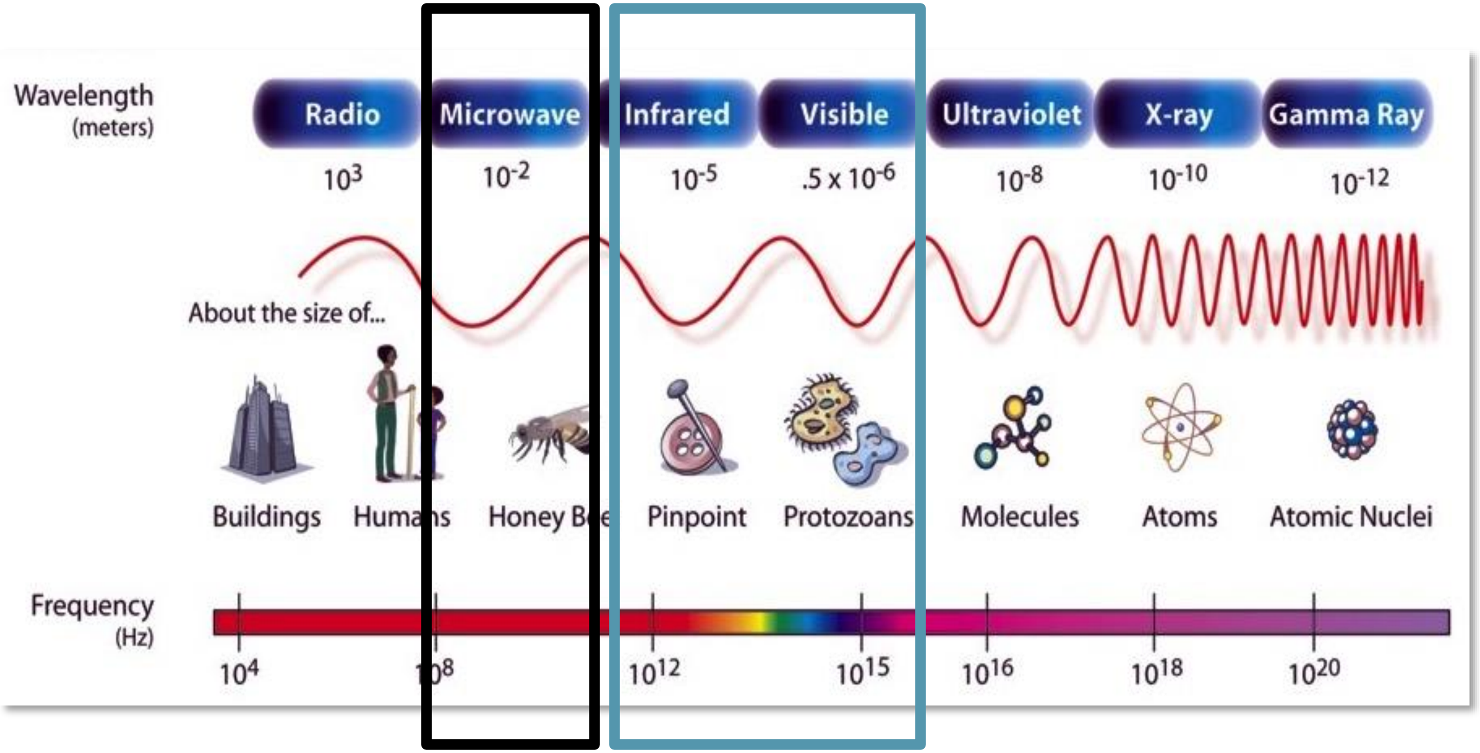


Image Credit: Google

Demo Overview

- Objective: Create flood extent maps and determine cropland affected
- Event: Floods in Kerala, India
- Timeframe: August 2018
- Remote Sensing Data: Sentinel-1 SAR
- Approach: Create a ratio image between a before and after scene and apply a threshold to map flooded areas
- Platform: Google Earth Engine
- Code: Link to code

Electromagnetic Radiation for Remote Sensing



Optical Sensors use infrared–visible regions.

- Optical sensors measure reflected solar light and only function in the daytime.
- The surface of the Earth cannot be imaged with visible or infrared sensors when there are clouds.
- Microwaves can penetrate through clouds and vegetation, and can operate in day or night conditions.

Active and Passive Remote Sensing

Passive: Sensors detect only what is emitted from the landscape or is reflected from another source (e.g., light reflected from the sun).

Active: Instruments emit their own signal and the sensor measures what is reflected back. Sonar and radar are examples of active sensors.

Passive Sensors:

- The source of radiant energy arises from natural sources
- e.g., the Sun, Earth, other “hot” bodies

Active Sensors

- Provide their own artificial radiant energy source for illumination
- e.g., Radar, Synthetic Aperture Radar (SAR), LiDAR

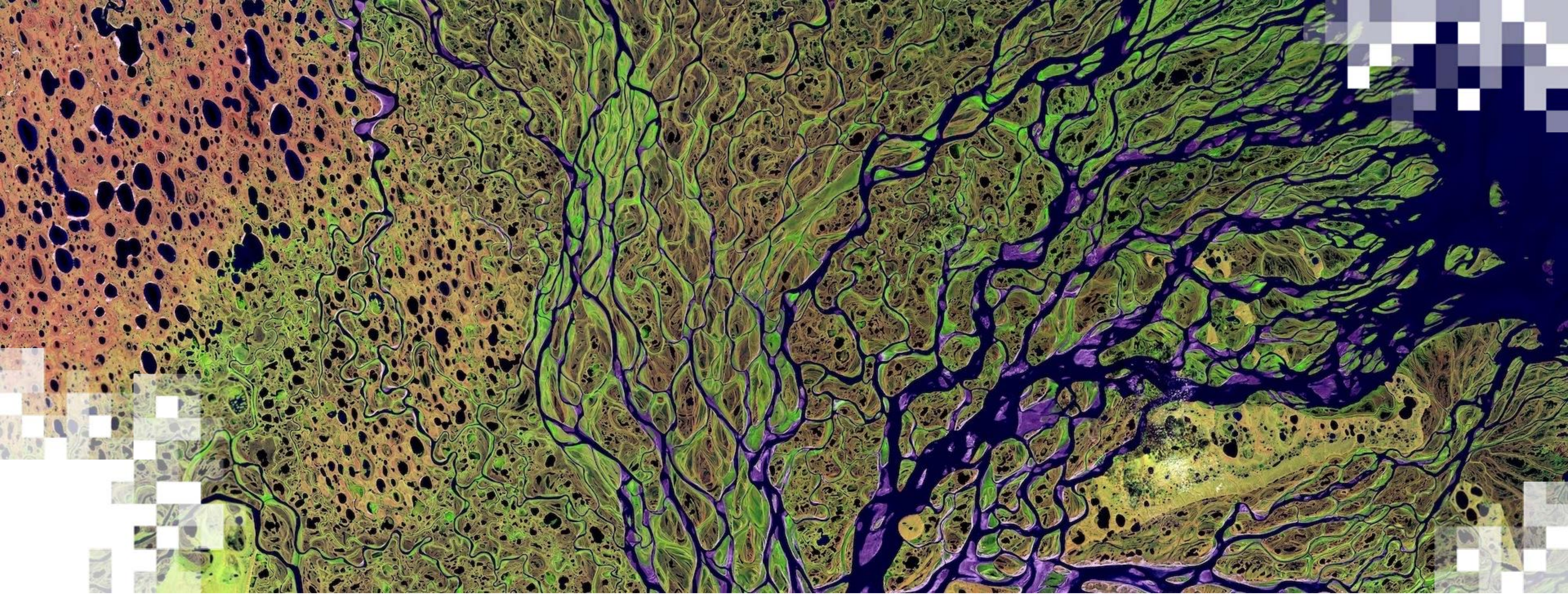
Advantages and Disadvantages of Radar Over Optical Remote Sensing

Advantages

- Nearly all weather capability
- Day or night capability
- Penetration through the vegetation canopy
- Penetration through the soil
- Minimal atmospheric effects
- Sensitivity to dielectric properties (liquid vs. frozen water)
- Sensitivity to structure

Disadvantages

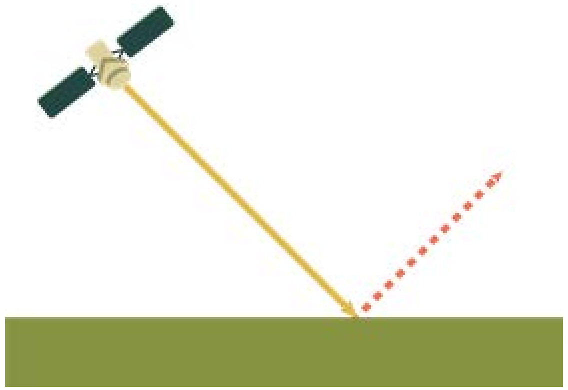
- Information content is different than optical and sometimes difficult to interpret
- Speckle effects (graininess in the image)
- Effects of topography



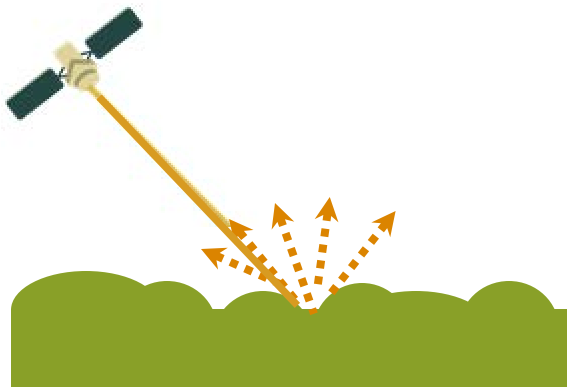
Radar Backscatter Mechanisms

Radar Signal Interaction

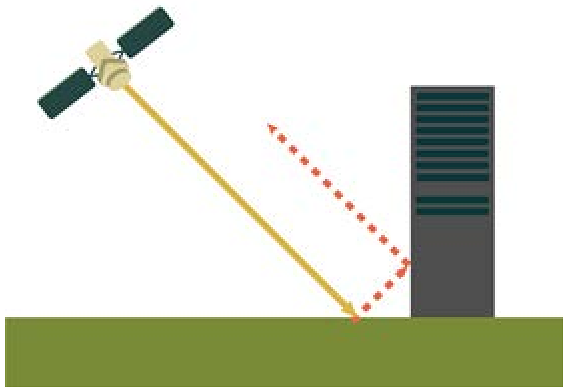
- The scale of the surface relative to the wavelength determines how rough or smooth it appears, as well as how bright or dark it will be in the image.
- Backscattering Mechanisms:



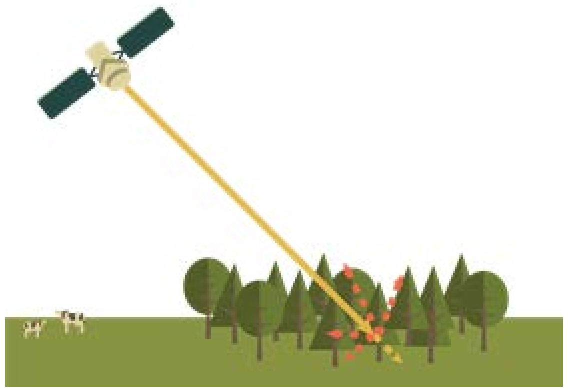
Smooth Surface



Rough Surface

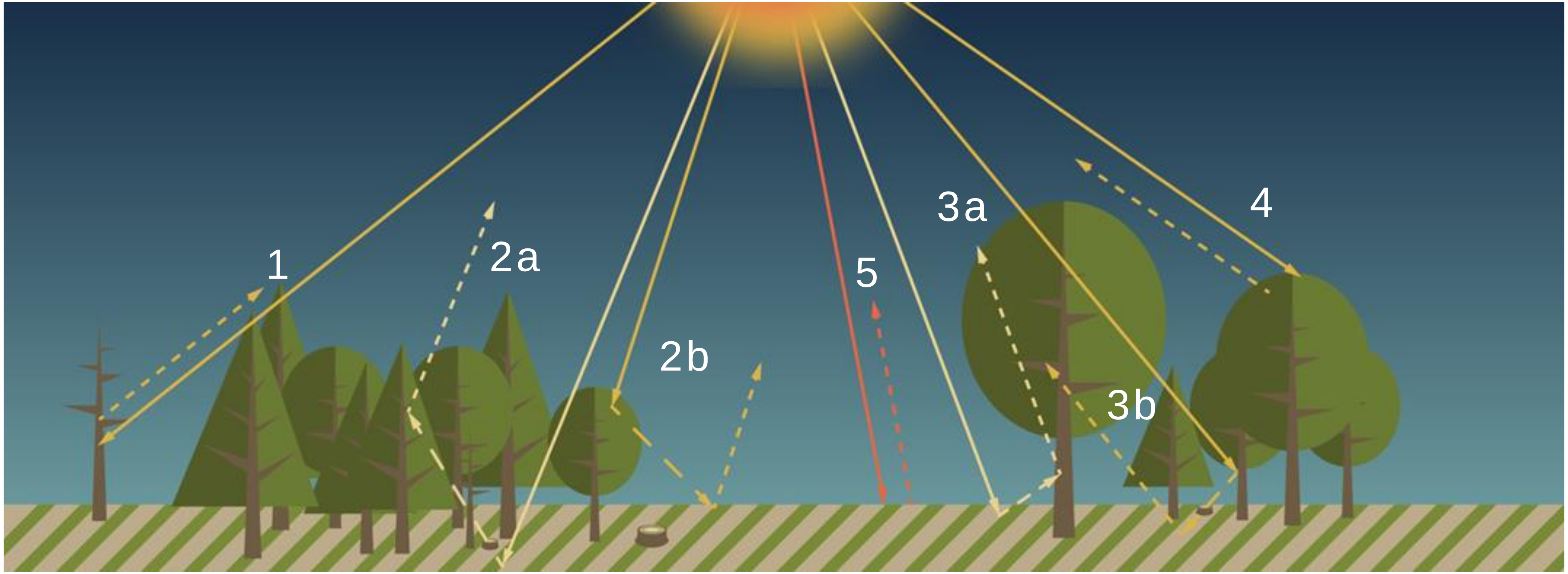


Double Bounce



Vegetation

Radar Backscatter in Forests

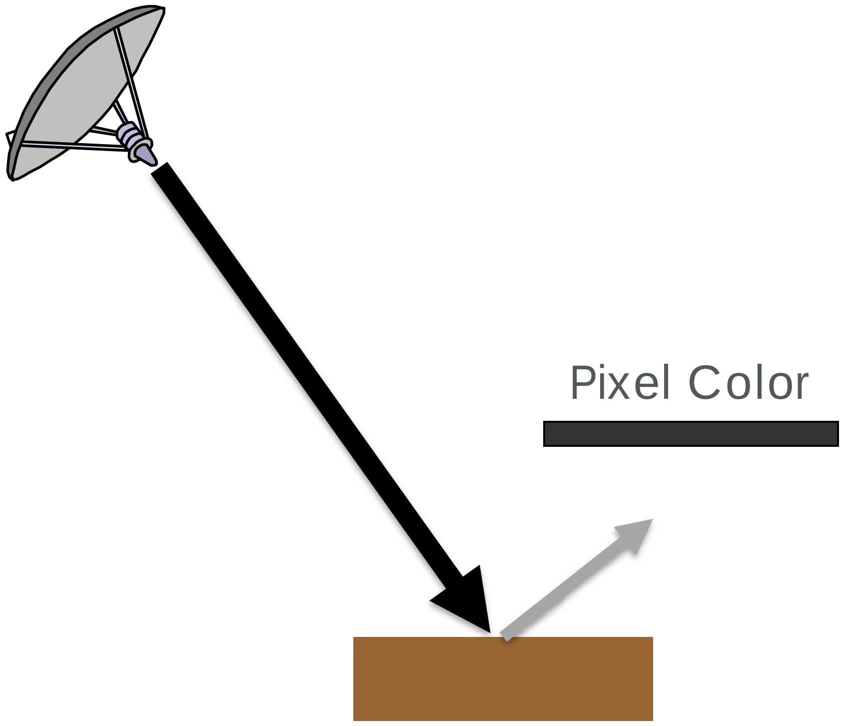


Dominant Backscattering Sources in Forests:

(1) Direct Scattering from the Tree Trunks
(2a) Ground-Crown Scattering
(2b) Crown-Ground Scattering
(3a) Ground-Trunk Scattering
(3b) Trunk-Ground Scattering
(4) Crown Volume Scattering
(5) Direct Scattering from the Soil Surface

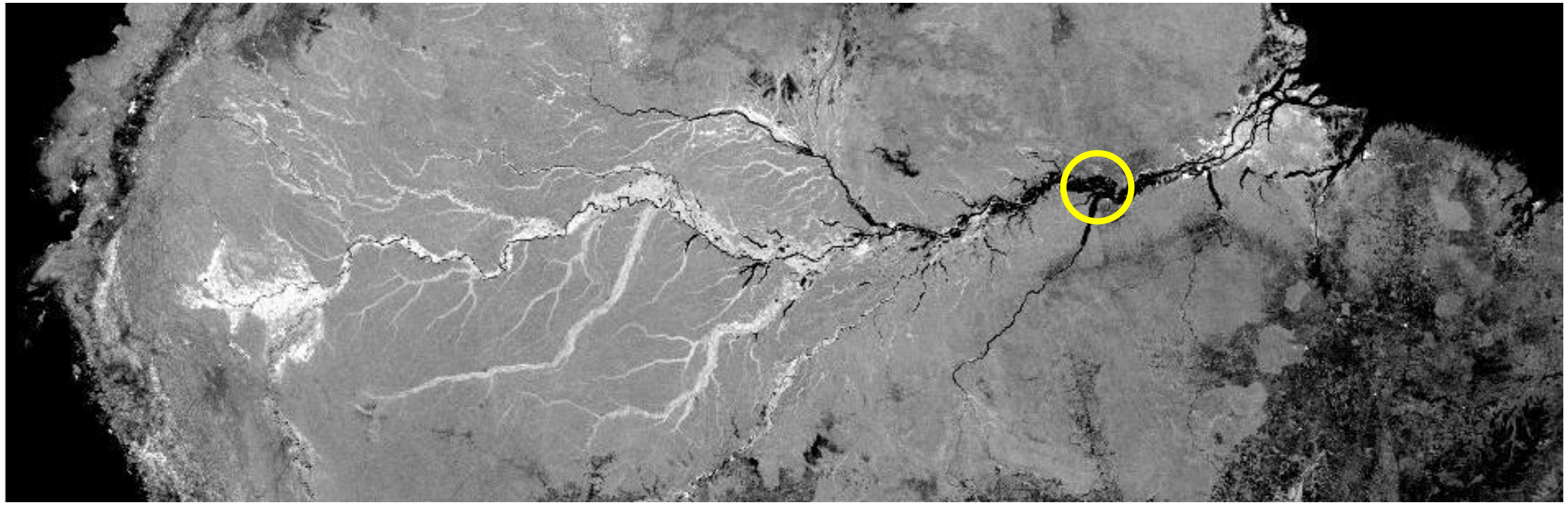
Smooth Surface Reflection

Smooth Surface Reflection (Specular Reflection)

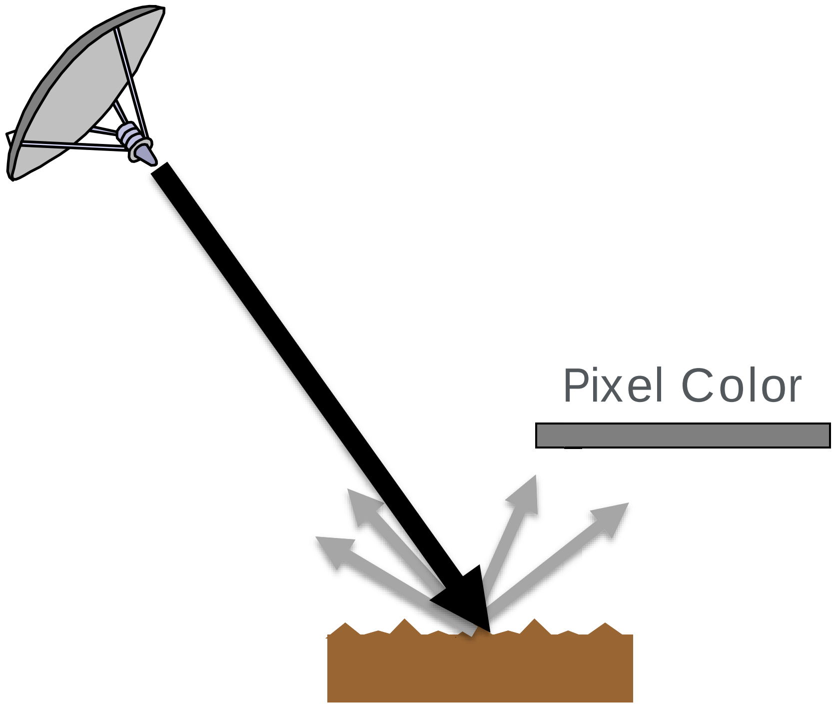


Smooth, Level Surface
(Open Water, Road)

SMAP Radar Mosaic of the Amazon Basin
April 2015 (L-band, HH, 3 km)

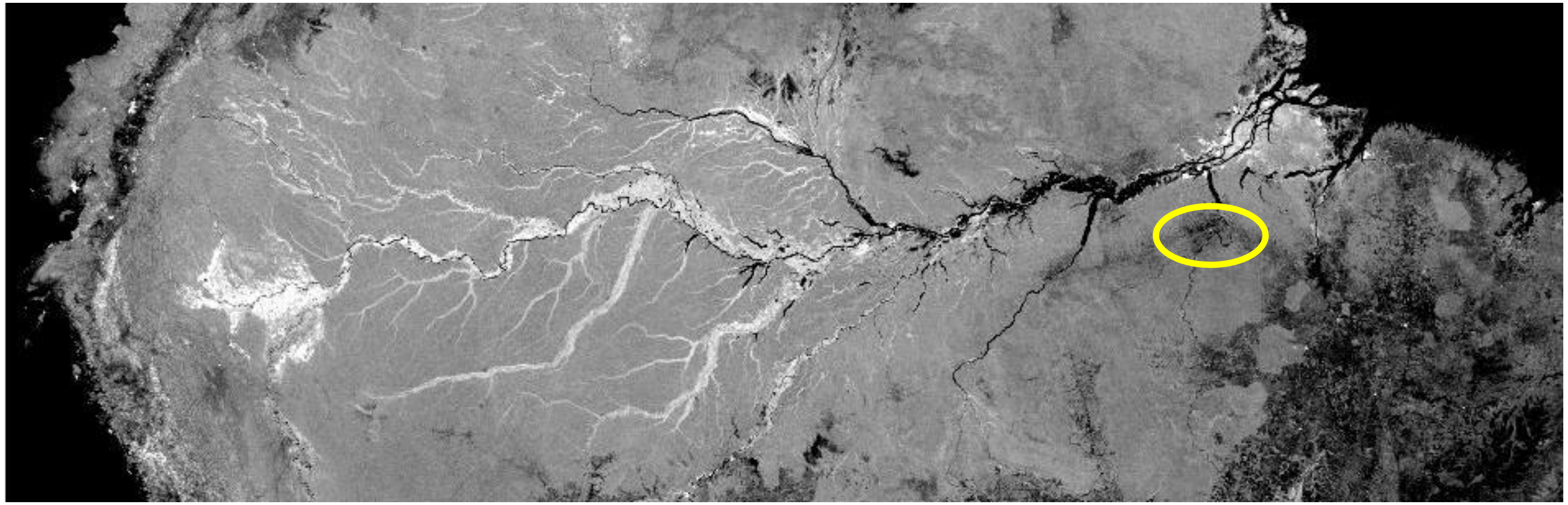


Rough Surface Reflection

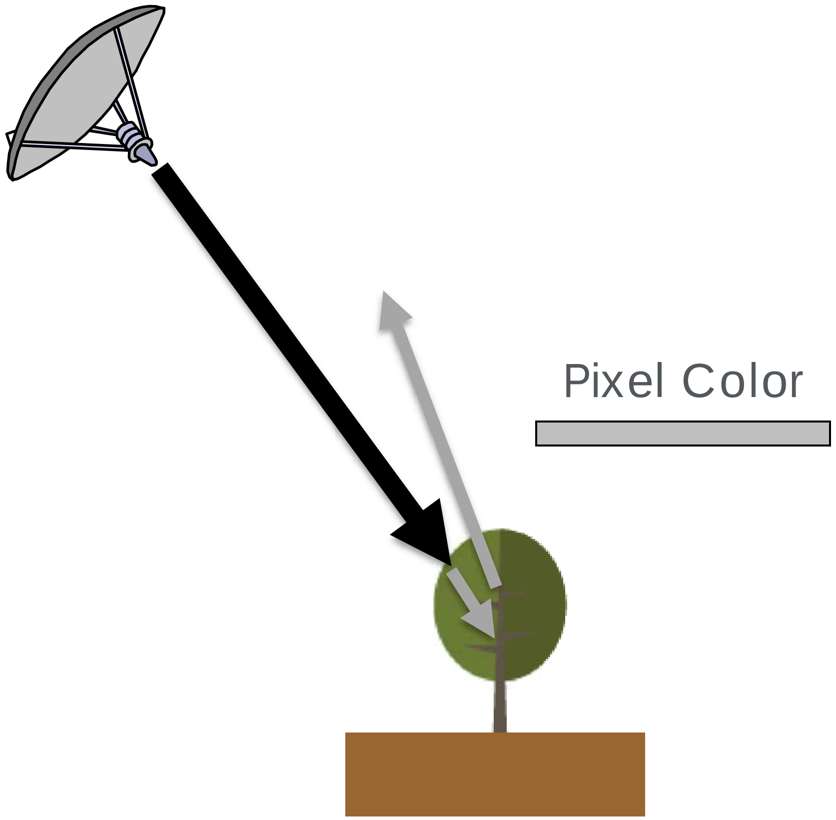


Rough, Bare Surface
(Deforested Areas, Tilled Agricultural Fields)

SMAP Radar Mosaic of the Amazon Basin
April 2015 (L-band, HH, 3 km)

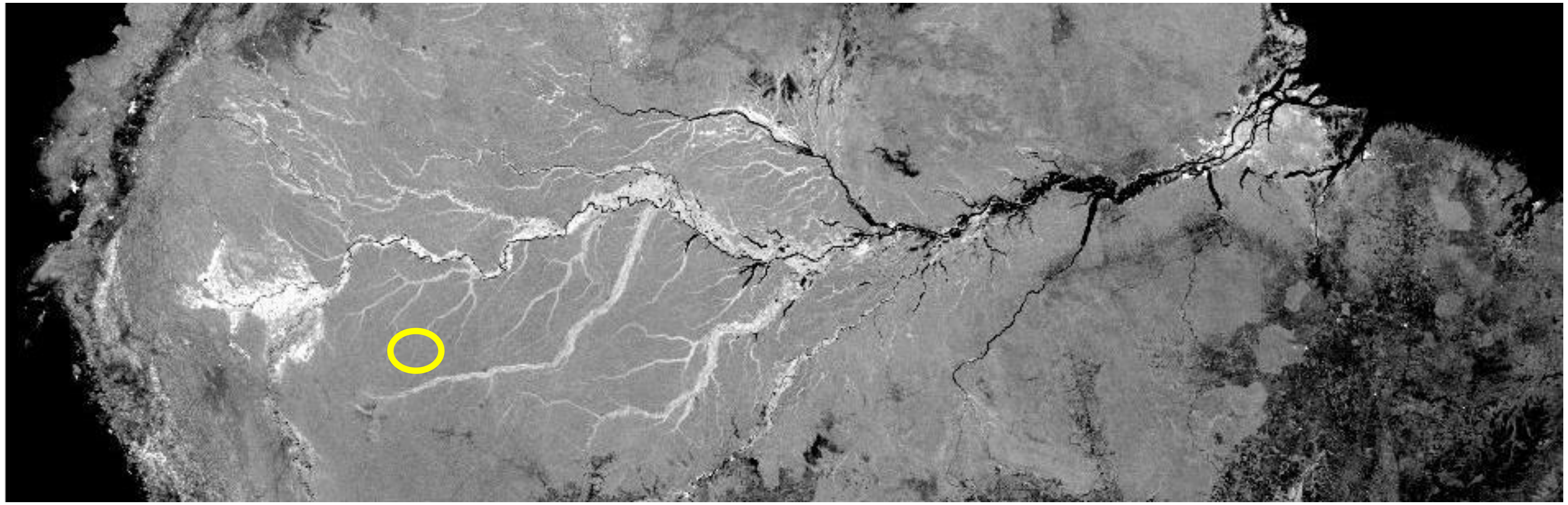


Volume Scattering by Vegetation

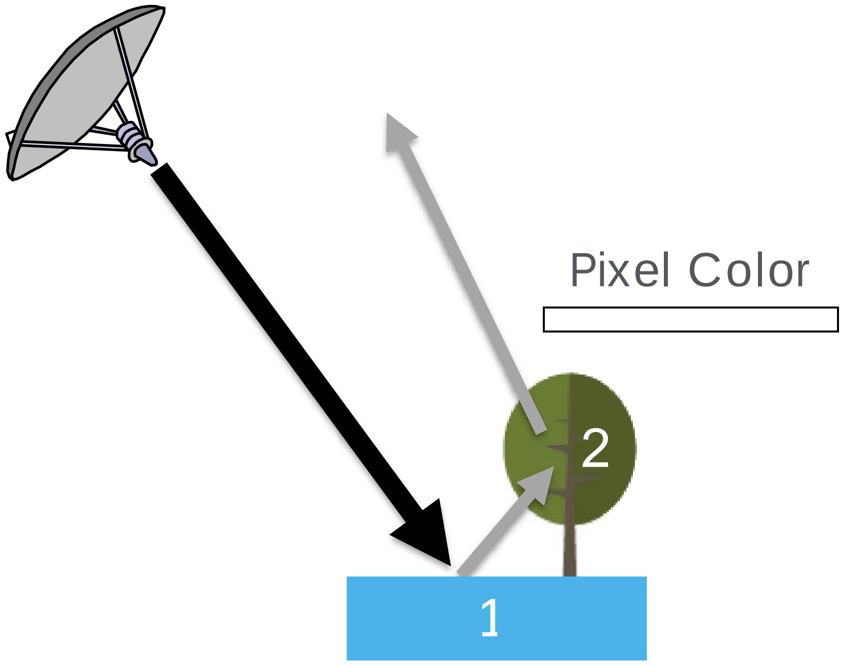


Vegetation

SMAP Radar Mosaic of the Amazon Basin
April 2015 (L-band, HH, 3 km)

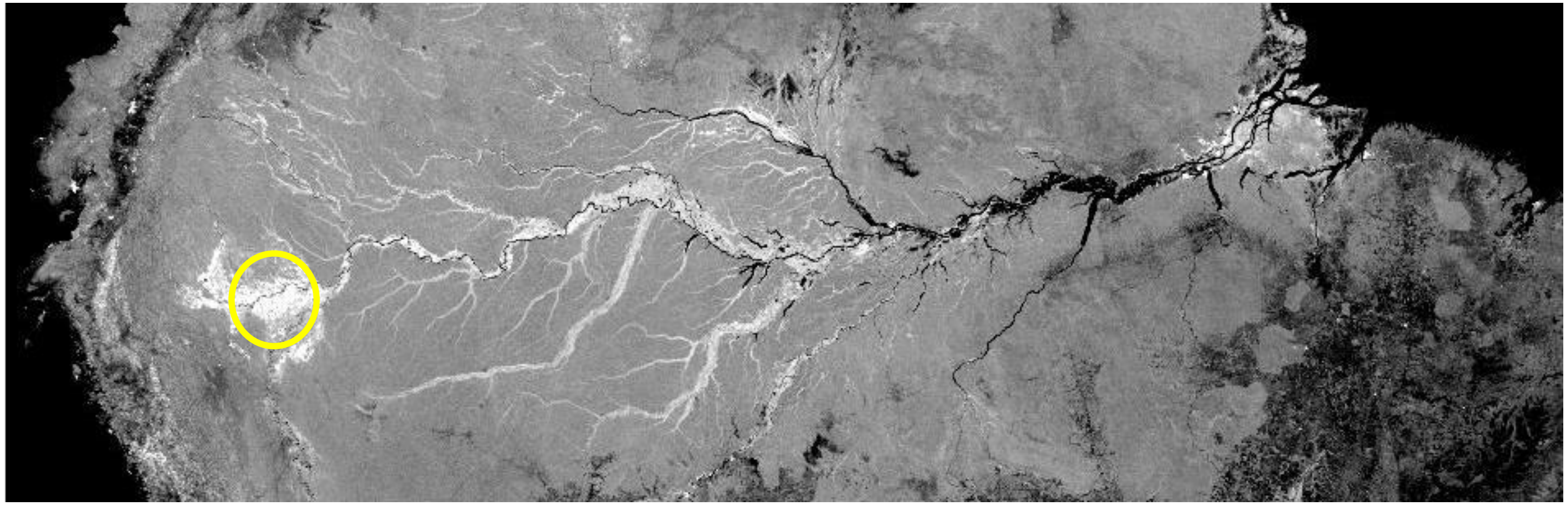


Double Bounce



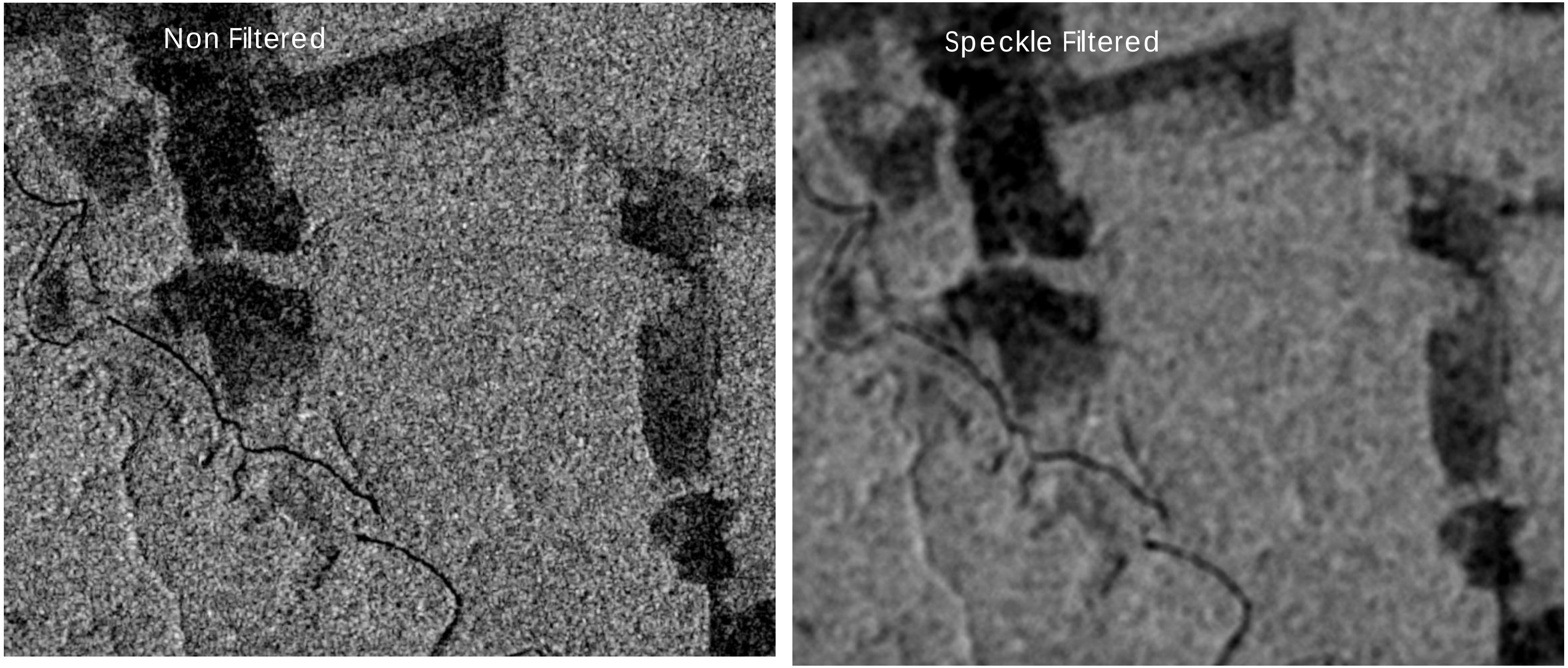
Inundated Vegetation

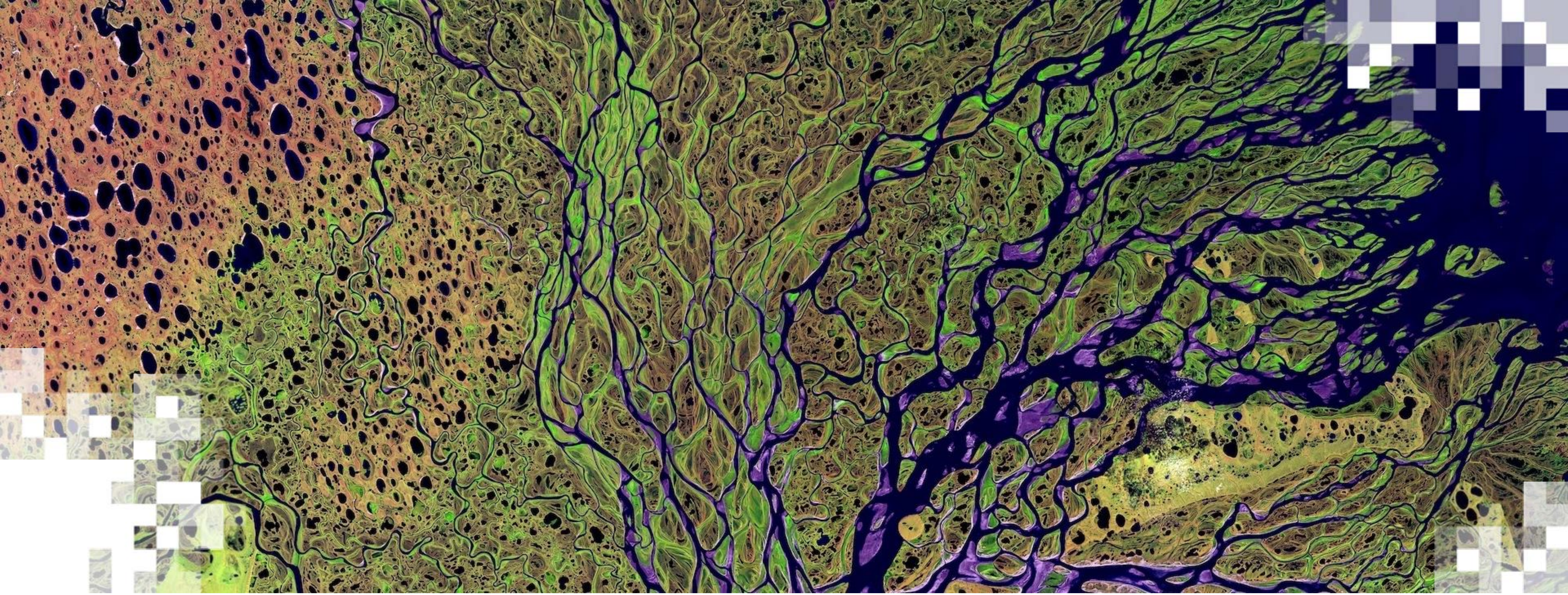
SMAP Radar Mosaic of the Amazon Basin
April 2015 (L-band, HH, 3 km)



Speckle

- Speckle is a granular 'noise' that inherently exists in and degrades the quality of SAR images.





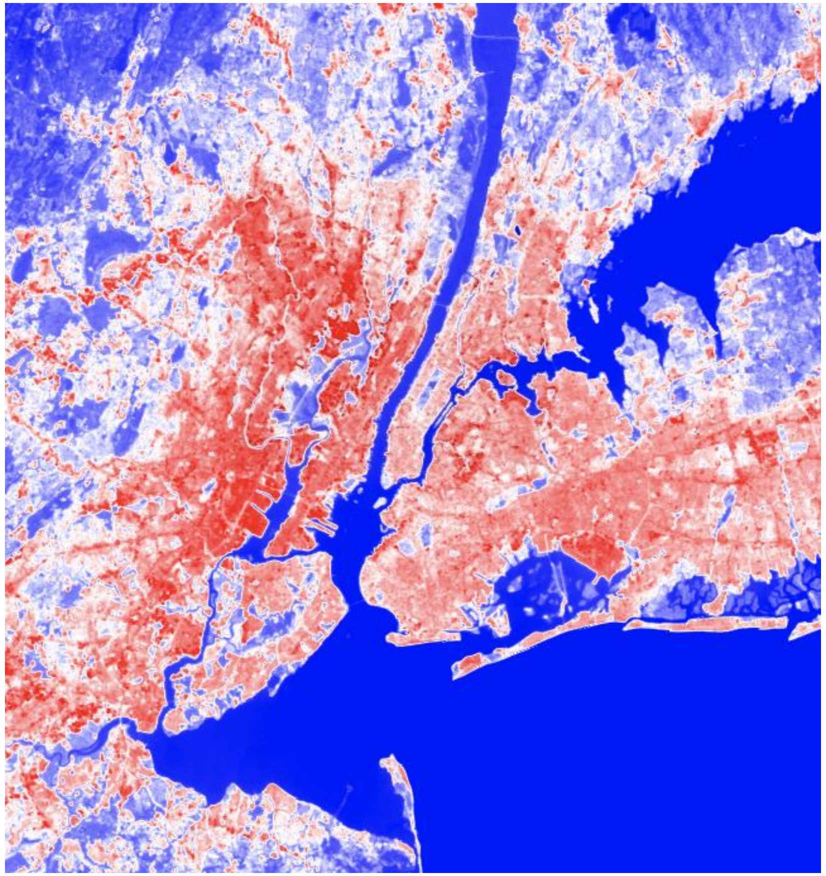
Heat: Google Earth Engine Demo

Using Remote Sensing to Monitor Urban Heat Islands

Link to script

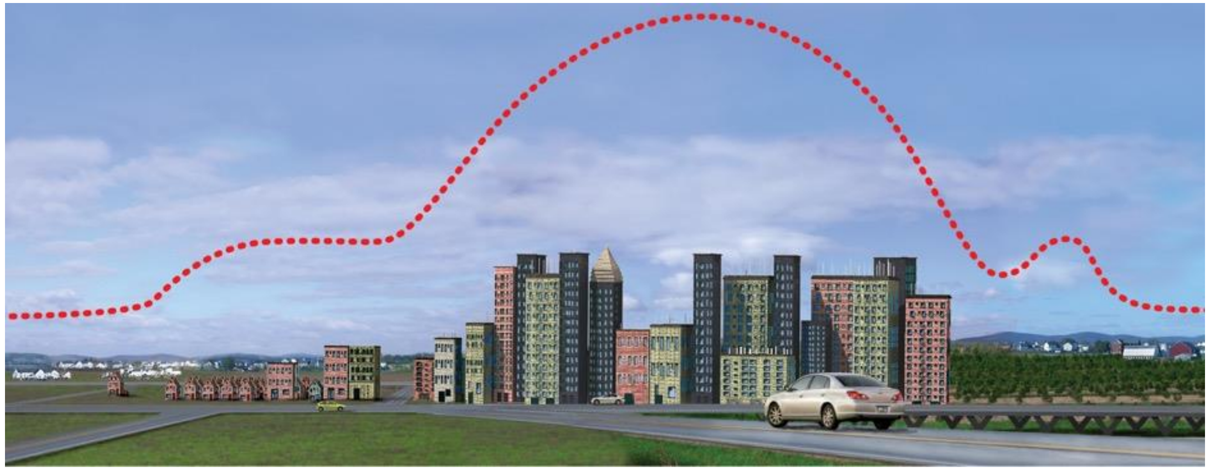
Demo Overview

- Objective: Create land surface temperature map from time series (mean)
- Event: Urban heat island – New York, NY
- Timeframe: Summer 2013–2024
- Remote Sensing Data: Landsat 8 TIRS
- Approach: Analyze and visualize mean surface temperature (ST) time series from Landsat 8 TIRS over New York, NY (USA) from a defined area of interest.
- Platform: Google Earth Engine
- Code: [Link to code]



Urban Heat Islands

- Urban areas experience higher temperatures than outlying areas. This difference in temperature is what constitutes an urban heat island (UHI).
- Difference in temperature has to do with changes in radiative and thermal properties of impervious surfaces i.e., heat-absorbing buildings and pavement.
- Temperatures vary within cities due to the spatial distribution of water, soil, vegetation, and impervious surfaces.



Land surface temperatures in cities, particularly densely-developed cities, tend to be elevated in comparison to surrounding areas. Credit: NASA

Why are Urban Heat Islands a Problem?

- Increased risk of heat-related mortality and morbidity
  - Children, older adults, and those with existing health conditions are particularly at risk.
  - UHIs contribute to respiratory difficulties, heat cramps and exhaustion, non-fatal heat stroke, and heat-related mortality.
- Increased energy consumption
  - Heat islands increase both overall electricity demand as well as peak energy demand.
  - During extreme heat events, demand for cooling can overload systems and require a utility to institute controlled, rolling brownouts or blackouts to avoid power outages.

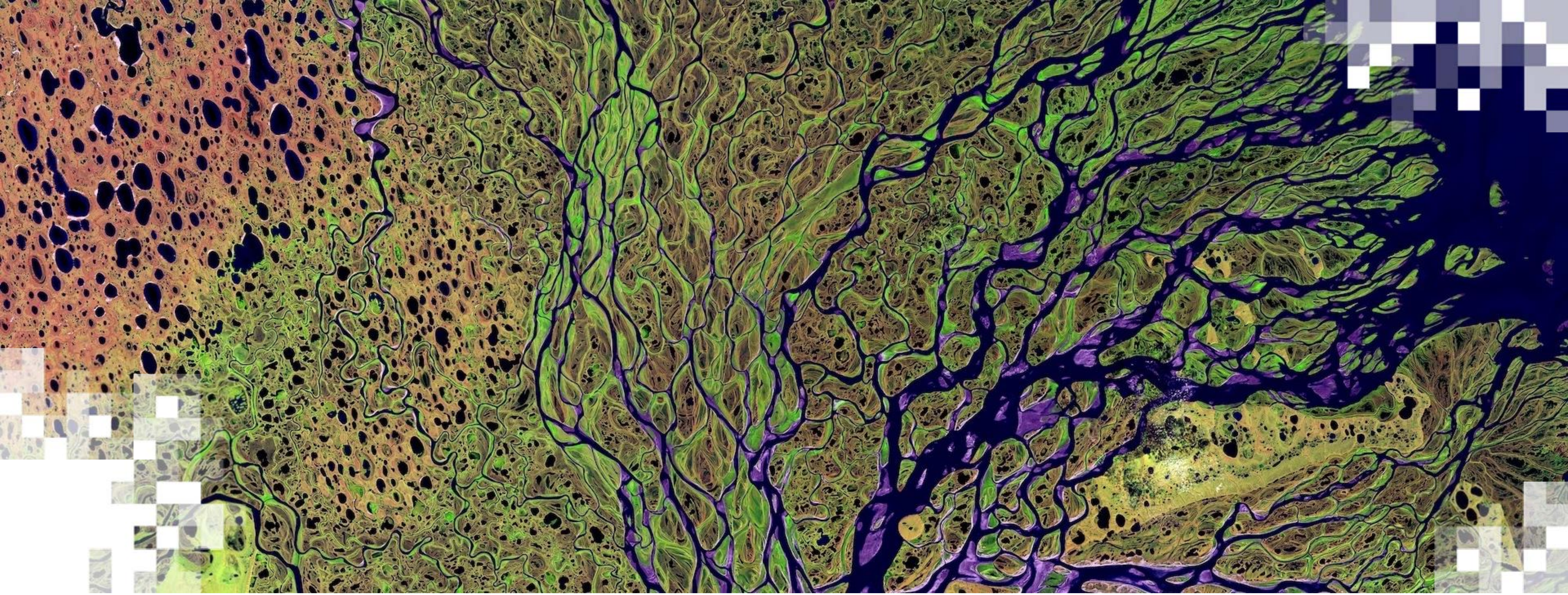
Credit: NIEHS

Computing Land Surface Temperature in GEE

- To modify the different scripts for your study area, users will need to change the following parameters:
  - DATE_RANGE
  - YEAR_RANGE
  - STUDYBOUNDS
  - DISPLAY
  - point: longitude/latitude for area of interest
  - aoi: delineated rectangle for area of interest
  - Rural: delineated polygon(s) for rural areas
  - Urban: delineated polygon(s) for urban areas

```
ssign a variable to filter the day of year from July 1 to August
djust the DATE_RANGE for your own UHI study.
DATE_RANGE = ee.Filter.dayOfYear(182, 243);
ssign a variable to filter years from 2013 – 2024.
djust the YEAR_RANGE for your own UHI study.
YEAR_RANGE = ee.Filter.calendarRange(2013, 2024,'year');
ssign a variable to delineate your area of interest
reate your own aoi using the Geometry tools in the map window. Re
STUDYBOUNDS = aoi;
ssign a variable to display images in the map window
DISPLAY = true;
```

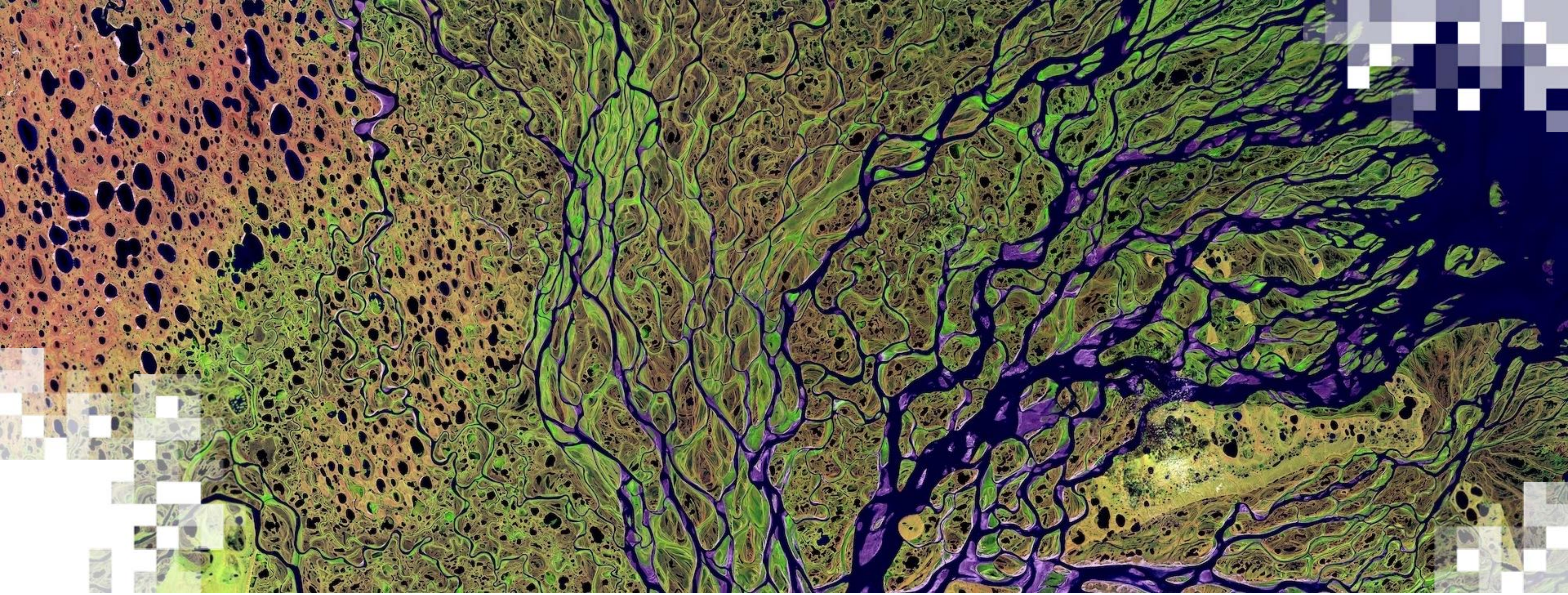
- [Link to script used in demonstration]



Hands On: Climate Engine

Hands On Overview

- Objective: Create precipitation and soil moisture maps and graphs related to the floods in Kerala, India
- Event: Floods in Kerala, India
- Timeframe: August 2018
- Model/Remote Sensing Data: CHIRPS
- Approach: Create precipitation and soil moisture anomaly maps of Kerala
- Platform: Climate Engine https://www.climateengine.org/



Monitoring Night Light for Humanitarian Applications

Objectives

- Monitor night light from NASA's Black Marble data product using Worldview

Outline

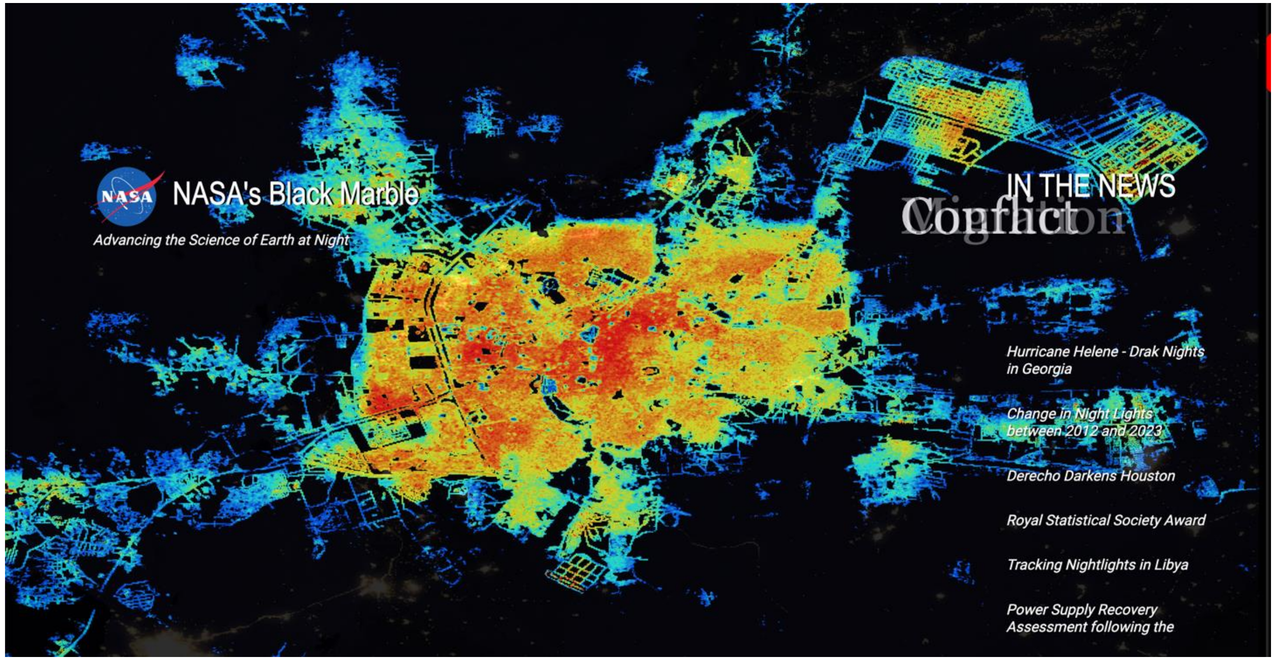
- A brief overview of Black Marble Product
- Demonstrations and Exercise

Black Marble Product

- [Data Creation]

- Uses Visible Infrared Imaging Radiometer Suite (VIIRS) bands

Band	Band Center µm	Band Width µm
M10	1.61	0.06
M11	2.25	0.05
I4	3.74	0.38
M12	3.7	0.18
M13	4.05	0.155
M14	8.55	0.3
M15	10.763	1
I5	11.45	1.9
M16	12.013	0.95



Resources and References

- [NASA Black Marble Night Light Product]
- NASA [Worldview]

Enenkel, M., Shrestha, R.M., Stokes, E.C., Román, M.O., Wang, Z., Espinosa, T.M., Hajzmanova, I., Ginnetti, J., Vinck, P. 2019. Emergencies do not stop at night: Advanced analysis of displacement based on satellite-derived nighttime light observations. IBM Journal of Research and Development, DOI:10.1147/JRD.2019.2954404

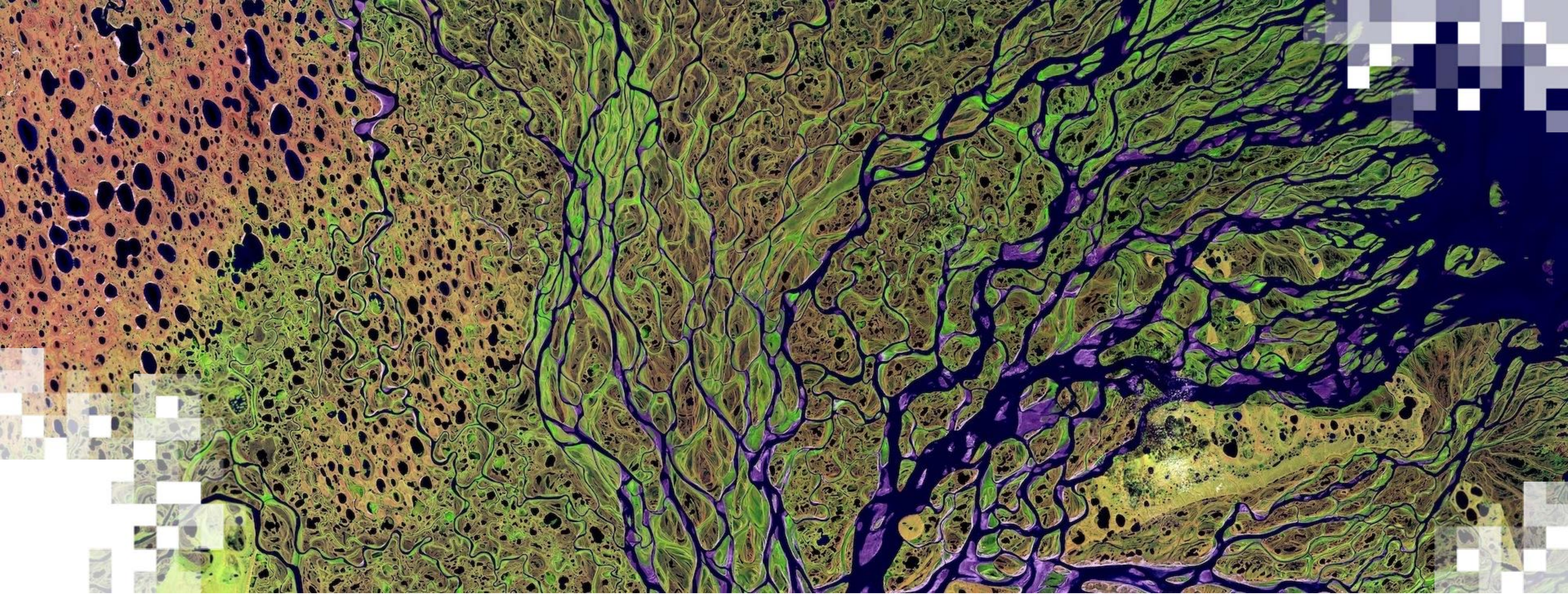
Román, M.O., and Stokes, E.C. 2015. Holidays in lights: Tracking cultural patterns in demand for energy services. Earth's Future 3 (6), pp. 182-205, DOI:10.1002/2014ef000285

Román, M.O., Wang, Z., Sun, Q., Kalb, V., Miller, S.D., Molthan, A., Schultz, L., Bell, J., Stokes, E.C., Pandey, B. and Seto, K.C., et al. 2018. NASA's Black Marble nighttime lights product suite. Remote Sensing of Environment, 210, pp.113-143, DOI:10.1016/j.rse.2018.03.017.

Román, M.O., Stokes, E.C., Shrestha, R.M., Wang, Z., Schultz, L., Sepúlveda Carlo, E.A., Sun, Q., Bell, J., Molthan, A., Kalb, V., Ji, C.,Seto, K.C., McClain, S.N., and Enenkel, M. 2019. Satellite-based assessment of electricity restoration efforts in Puerto Rico after Hurricane Maria. PLoS ONE, 14, DOI:10.1371/journal.pone.0218883.

Wang, Z., Román, M.O., Sun, Q., Molthan, A.L., Schultz, L.A., and Kalb, V. 2018. Monitoring Disaster-Related Power Outages Using NASA Black Marble Nighttime Light Product. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences XLII-3, pp.1853-1856, DOI:10.5194/isprs-archives-xlii-3-1853-2018.

Wang, Z., Román, M.O., Kalb,V., Miller, S.D., Zhang, J., and Shrestha, R.M. 2021. Quantifying uncertainties in nighttime light retrievals from Suomi-NPP and NOAA-20 VIIRS Day/Night Band data. Remote Sensing of Environment, 263 (112557), DOI:10.1016/j.rse.2021.112557.



Disaster Alert Demo:

Link to website

Disaster Alert

- Integrated platform providing situational awareness, decision support, and information exchange capabilities to disaster management decision makers.
- Available in free-access (public) and limited-access (password-protected) versions to support early warning and humanitarian assistance activities in the realm of disaster management and risk reduction.
- Built on Pacific Disaster Center's (PDC) DisasterAWARE platform.

Image Credit: Disaster Alert

Thank You!