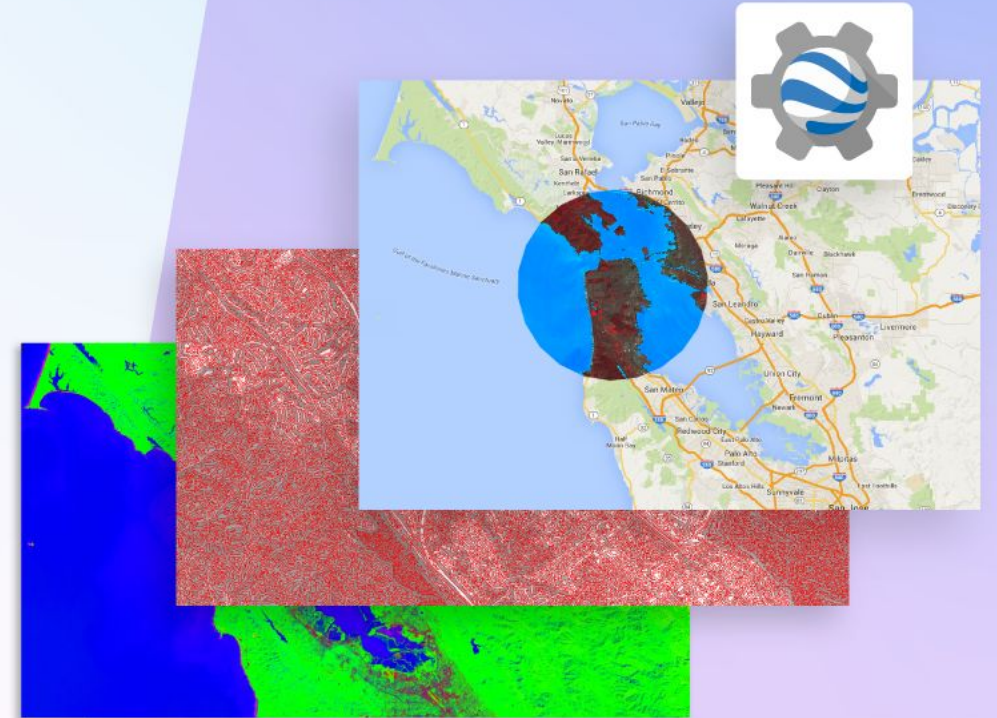


PROCESAMIENTO Y VISUALIZACIÓN DE DATOS GEOESPACIALES CON GOOGLE EARTH ENGINE

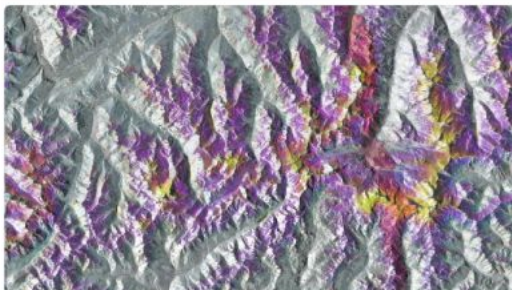


David Montero Loaiza 🇨🇴
Ing. Topográfico





Google Earth Engine



Sentinel-1 SAR GRD: C-band Synthetic Aperture Radar

Data availability: 2014 – Present

The Sentinel-1 mission provides data from a dual-polarization C-band Synthetic Aperture Radar (SAR) instrument. SAR instruments are capable of acquiring meaningful data in all weather conditions (even clouds) during daytime and nighttime. Sentinel-1 data is used across many domains, including maritime activity, sea-ice mapping, humanitarian aid, crisis response, and forest management.



Sentinel-2 MSI: Multispectral Instrument

Data availability: 2015 – Present

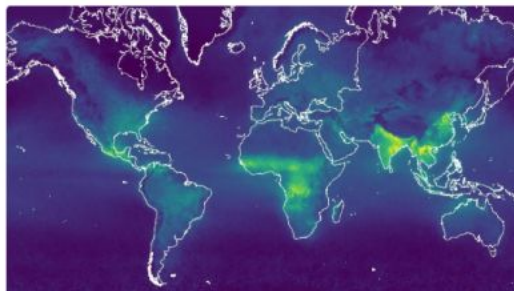
The Sentinel-2 mission collects high-resolution multispectral imagery useful for a broad range of applications, including monitoring of vegetation, soil and water cover, land cover change, as well as humanitarian and disaster risk.



Sentinel-3 OLCI EFR: Ocean and Land Color Instrument

Data availability: 2016 – Present

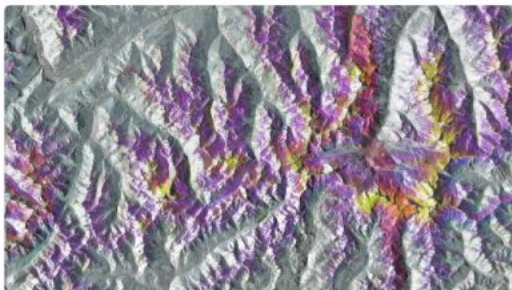
The Sentinel-3 instrument provides systematic measurements of the planet's oceans, land, ice, and atmosphere, including the temperature, color and height of the sea surface as well as the thickness of sea ice.



Sentinel-5P TROPOMI: TROPospheric Monitoring Instrument

Data availability: 2018 – Present

The Sentinel-5 Precursor mission collects data useful for assessing air quality, including concentrations of: ozone, methane, formaldehyde, aerosol, carbon monoxide, nitrogen oxide, and sulphur dioxide.



Sentinel-1 SAR GRD: C-band Synthetic Aperture Radar

Data availability: 2014 – Present

The Sentinel-1 mission provides data from a dual-polarization C-band Synthetic Aperture Radar (SAR) instrument. SAR instruments are capable of acquiring meaningful data in all weather conditions (even clouds) during daytime and nighttime. Sentinel-1 data is used across many domains, including maritime activity, sea-ice mapping, humanitarian aid, crisis response, and forest management.



Sentinel-2 MSI: Multispectral Instrument

Data availability: 2015 – Present

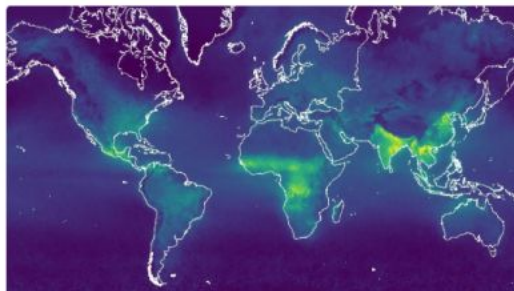
The Sentinel-2 mission collects high-resolution multispectral imagery useful for a broad range of applications, including monitoring of vegetation, soil and water cover, land cover change, as well as humanitarian and disaster risk.



Sentinel-3 OLCI EFR: Ocean and Land Color Instrument

Data availability: 2016 – Present

The Sentinel-3 instrument provides systematic measurements of the planet's oceans, land, ice, and atmosphere, including the temperature, color and height of the sea surface as well as the thickness of sea ice.



Sentinel-5P TROPOMI: TROPospheric Monitoring Instrument

Data availability: 2018 – Present

The Sentinel-5 Precursor mission collects data useful for assessing air quality, including concentrations of: ozone, methane, formaldehyde, aerosol, carbon monoxide, nitrogen oxide, and sulphur dioxide.



Landsat 8 Surface Reflectance

2013 - Present



Landsat 7 Surface Reflectance

1999 - Present



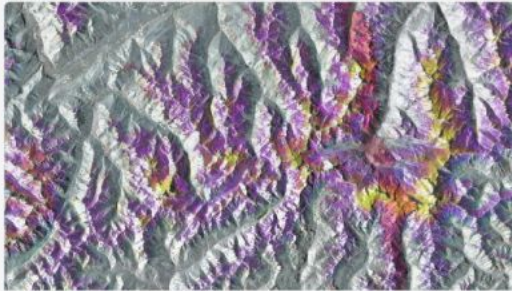
Landsat 5 Surface Reflectance

1984 – 2012



Landsat 4 Surface Reflectance

1982 - 1993



Sentinel-1 SAR GRD: C-band Synthetic Aperture Radar

Data availability: 2014 – Present

The Sentinel-1 mission provides data from a dual-polarization C-band Synthetic Aperture Radar (SAR) instrument. SAR instruments are capable of acquiring meaningful data in all weather conditions (even clouds) during daytime and nighttime. Sentinel-1 data is used across many domains, including maritime activity, sea-ice mapping, humanitarian aid, crisis response, and forest management.



Sentinel-2 MSI: Multispectral Instrument

Data availability: 2015 – Present

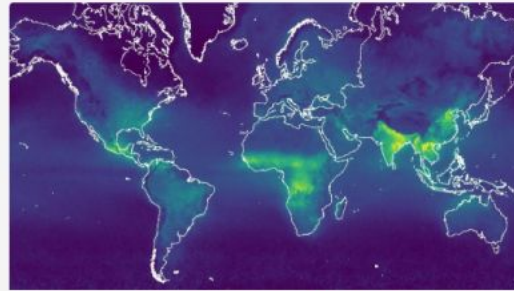
The Sentinel-2 mission collects high-resolution multispectral imagery useful for a broad range of applications, including monitoring of vegetation, soil and water cover, land cover change, as well as humanitarian and disaster risk.



Sentinel-3 OLCI EFR: Ocean and Land Color Instrument

Data availability: 2016 – Present

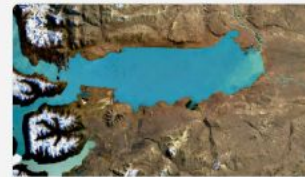
The Sentinel-3 instrument provides systematic measurements of the planet's oceans, land, ice, and atmosphere, including the temperature, color and height of the sea surface as well as the thickness of sea ice.



Sentinel-5P TROPOMI: TROPospheric Monitoring Instrument

Data availability: 2018 – Present

The Sentinel-5 Precursor mission collects data useful for assessing air quality, including concentrations of: ozone, methane, formaldehyde, aerosol, carbon monoxide, nitrogen oxide, and sulphur dioxide.



Landsat 8 Surface Reflectance

2013 - Present



Landsat 7 Surface Reflectance

1999 - Present



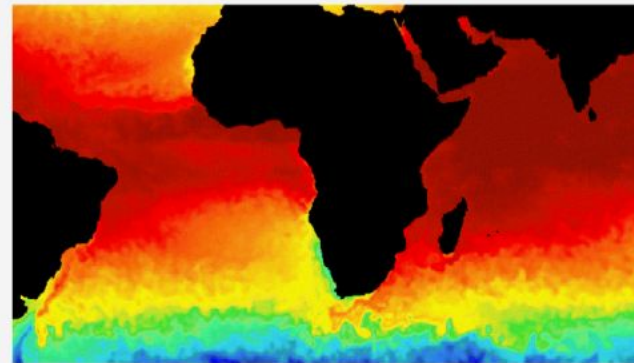
Landsat 5 Surface Reflectance

1984 – 2012



Landsat 4 Surface Reflectance

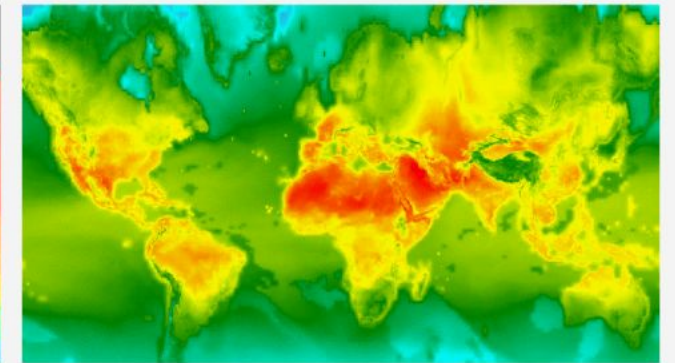
1982 - 1993



Surface Temperature

Thermal satellite sensors can provide surface temperature and emissivity information. The Earth Engine data catalog includes both land and sea surface temperature products derived from several spacecraft sensors, including MODIS, ASTER, and AVHRR, in addition to raw Landsat thermal data.

[Explore temperature data](#)

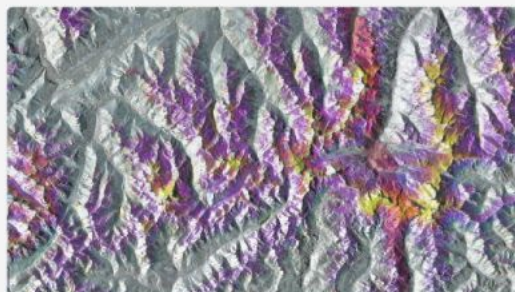


Climate

Climate models generate both long-term climate predictions and historical interpolations of surface variables. The Earth Engine catalog includes historical reanalysis data from NCEP/NCAR, gridded meteorological datasets like NLDAS-2, and GridMET, and climate model outputs like the University of Idaho MACAv2-METDATA and the NASA Earth Exchange's Downscaled Climate Projections.

[Explore climate data](#)

► Catálogo de Google Earth Engine



Sentinel-1 SAR GRD: C-band Synthetic Aperture Radar

Data availability: 2014 – Present

The Sentinel-1 mission provides data from a dual-polarization C-band Synthetic Aperture Radar (SAR) instrument. SAR instruments are capable of acquiring meaningful data in all weather conditions (even clouds) during daytime and nighttime. Sentinel-1 data is used across many domains, including maritime activity, sea-ice mapping, humanitarian aid, crisis response, and forest management.



Sentinel-2 MSI: Multispectral Instrument

Data availability: 2015 – Present

The Sentinel-2 mission collects high-resolution multispectral imagery useful for a broad range of applications, including monitoring of vegetation, soil and water cover, land cover change, as well as humanitarian and disaster risk.



Landsat 8 Surface Reflectance

2013 - Present



Landsat 7 Surface Reflectance

1999 - Present



Landsat 5 Surface Reflectance

1984 – 2012



Landsat 4 Surface Reflectance

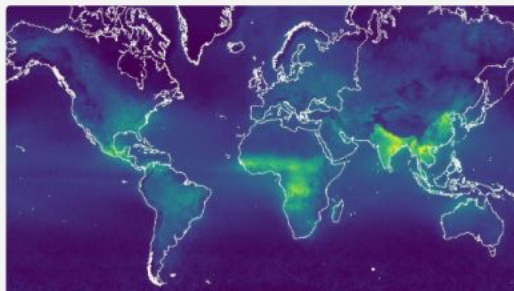
1982 - 1993



Sentinel-3 OLCI EFR: Ocean and Land Color Instrument

Data availability: 2016 – Present

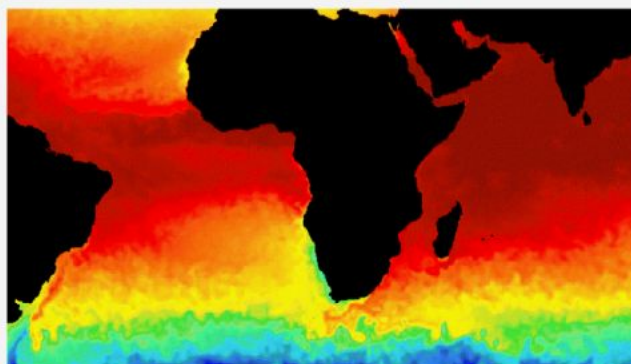
The Sentinel-3 instrument provides systematic measurements of the planet's oceans, land, ice, and atmosphere, including the temperature, color and height of the sea surface as well as the thickness of sea ice.



Sentinel-5P TROPOMI: TROPospheric Monitoring Instrument

Data availability: 2018 – Present

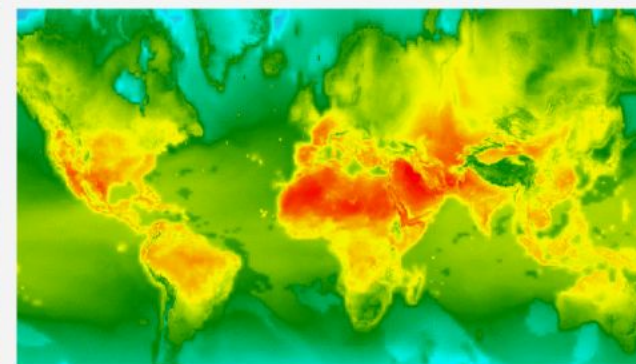
The Sentinel-5 Precursor mission collects data useful for assessing air quality, including concentrations of: ozone, methane, formaldehyde, aerosol, carbon monoxide, nitrogen oxide, and sulphur dioxide.



Surface Temperature

Thermal satellite sensors can provide surface temperature and emissivity information. The Earth Engine data catalog includes both land and sea surface temperature products derived from several spacecraft sensors, including MODIS, ASTER, and AVHRR, in addition to raw Landsat thermal data.

[Explore temperature data](#)



Climate

Climate models generate both long-term climate predictions and historical interpolations of surface variables. The Earth Engine catalog includes historical reanalysis data from NCEP/NCAR, gridded meteorological datasets like NLDAS-2, and GridMET, and climate model outputs like the University of Idaho MACAv2-METDATA and the NASA Earth Exchange's Downscaled Climate Projections.

[Explore climate data](#)

► Catálogo



Landsat 8 Surface
Reflectance

2013 - Present



Landsat 7 Surface
Reflectance

1999 - Present



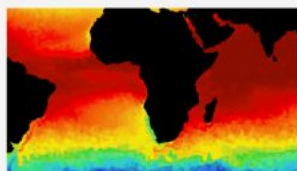
Landsat 5 Surface
Reflectance

1984 - 2012



Landsat 4 Surface
Reflectance

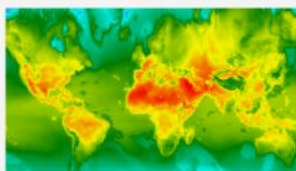
1982 - 1993



Surface Temperature

Thermal satellite sensors can provide surface temperature and emissivity information. The Earth Datacube catalog includes both land and sea surface temperature products derived from several spacecraft sensors, including MODIS, ASTER, and AVHRR, in addition to sea-land thermal data.

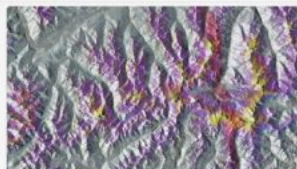
[Explore thermal sea data](#)



Climate

Climate models generate both long-term climate predictions and historical interpolations of surface weather. The Earth Datacube catalog includes historical reanalysis data from NCEP-NCAR, global meteorological datasets like MLDAS-3, and GCMNET, and climate model outputs like the University of Idaho MAGAZ METDATA and the NASA Earth Exchange's Downloaded Climate Projections.

[Explore climate data](#)



Sentinel-1 SAR GRD: C-band Synthetic Aperture Radar

Data availability: 2014 - Present

The Sentinel-1 mission provides data from a dual-polarization C-band Synthetic Aperture Radar (SAR) instrument. SAR instruments are capable of acquiring meaningful data in all weather conditions (even inclement) during daytime and nighttime. Sentinel-1 data is used across many domains, including maritime activity, sea ice mapping, humanitarian aid, crisis response, and forest management.



Sentinel-2 MSI: Multispectral Instrument

Data availability: 2015 - Present

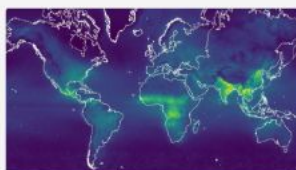
The Sentinel-2 mission collects high-resolution multispectral imagery useful for a broad range of applications, including monitoring of vegetation, soil and water cover, land cover change, as well as humanitarian and disaster risk.



Sentinel-3 OLCI EFR: Ocean and Land Color Instrument

Data availability: 2016 - Present

The Sentinel-3 instrument provides systematic measurements of the planet's oceans, land, ice, and atmosphere, including the temperature, color and height of the sea surface as well as the thickness of sea ice.



Sentinel-5P TROPOMI: TROPospheric Monitoring Instrument

Data availability: 2018 - Present

The Sentinel-5P Precursor mission collects data useful for assessing air quality, including concentrations of ozone, methane, formaldehyde, aerosol, carbon monoxide, nitrogen dioxide, and sulphur dioxide.

► Catálogo



Landset 8 Surface Reflectance
2013 - Present



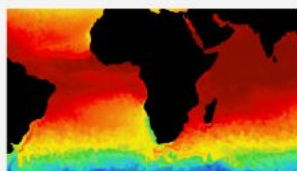
Landset 7 Surface Reflectance
1999 - Present



Landset 5 Surface Reflectance
1984 - 2012



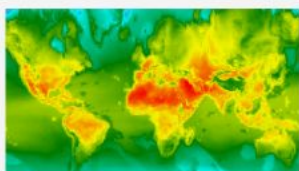
Landset 4 Surface Reflectance
1982 - 1993



Surface Temperature

Thermal satellite sensors can provide surface temperature and emissivity information. The Earth Engine data catalog includes both land and sea surface temperature products derived from several spaceborne sensors, including MODIS, AVHRR, and JAMS. In addition to raw Landset thermal data, the catalog includes derived products such as sea surface temperature and land surface temperature.

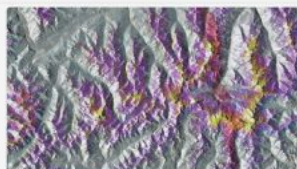
[Explore temperature data](#)



Climate

Climate models generate both long-term climate predictions and historical simulations of surface variables. The Earth Engine catalog includes historical reanalysis data from NCEP/NCAR, global meteorological datasets like M2000, and climate model outputs like the University of Miami M2000 METDATA and the NASA Earth Exchange Global Climate Prediction.

[Explore climate data](#)



Sentinel-1 SAR GRD: C-band Synthetic Aperture Radar

Data availability: 2014 - Present

The Sentinel-1 mission provides data from a dual-polarization C-band Synthetic Aperture Radar (SAR) instrument. SAR instruments are capable of acquiring meaningful data in all weather conditions (even clouds) during daytime and nighttime. Sentinel-1 data is used across many domains, including maritime activity, sea ice mapping, humanitarian aid, crisis response, and forest management.



Sentinel-2 MSI: Multispectral Instrument

Data availability: 2015 - Present

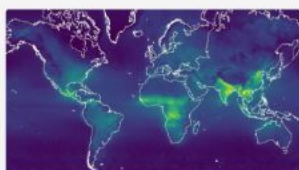
The Sentinel-2 mission collects high-resolution multispectral imagery useful for a broad range of applications, including monitoring of vegetation, soil and water cover, land cover change, as well as humanitarian and disaster risk.



Sentinel-3 OLCI EFR: Ocean and Land Color Instrument

Data availability: 2016 - Present

The Sentinel-3 instrument provides systematic measurements of the planet's oceans, land, ice, and atmosphere, including the temperature, color and height of the sea surface as well as the thickness of sea ice.



Sentinel-5P TROPOMI: TROPospheric Monitoring Instrument

Data availability: 2018 - Present

The Sentinel-5P Precursor mission collects data useful for assessing air quality including concentrations of ozone, methane, formaldehyde, aerosol, carbon monoxide, nitrogen dioxide, and nitrogen dioxide.

► API: Objetos y Métodos



Image

The fundamental raster data type in Earth Engine.



ImageCollection

A set of images.



Geometry

The fundamental vector data type in Earth Engine.



Feature

A geometry with attributes.



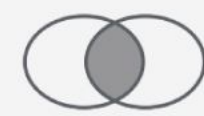
FeatureCollection

A set of features.



Reducer

An object used to compute statistics or perform aggregations.



Join

Combine datasets (Image or Feature collections) based on time, location, or an attribute property.



Array

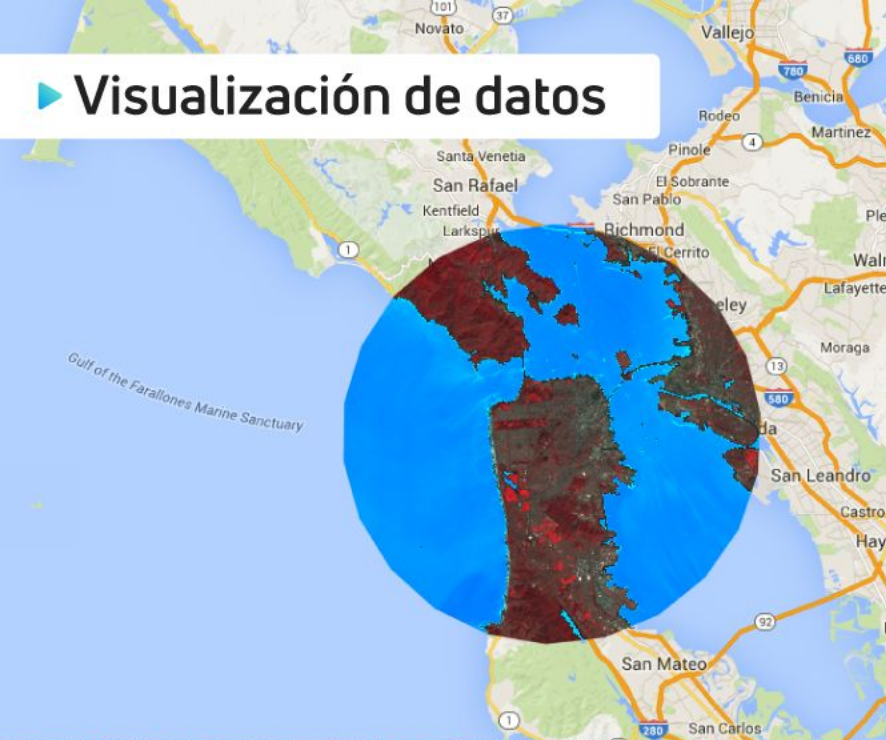
An object for multi-dimensional analyses.



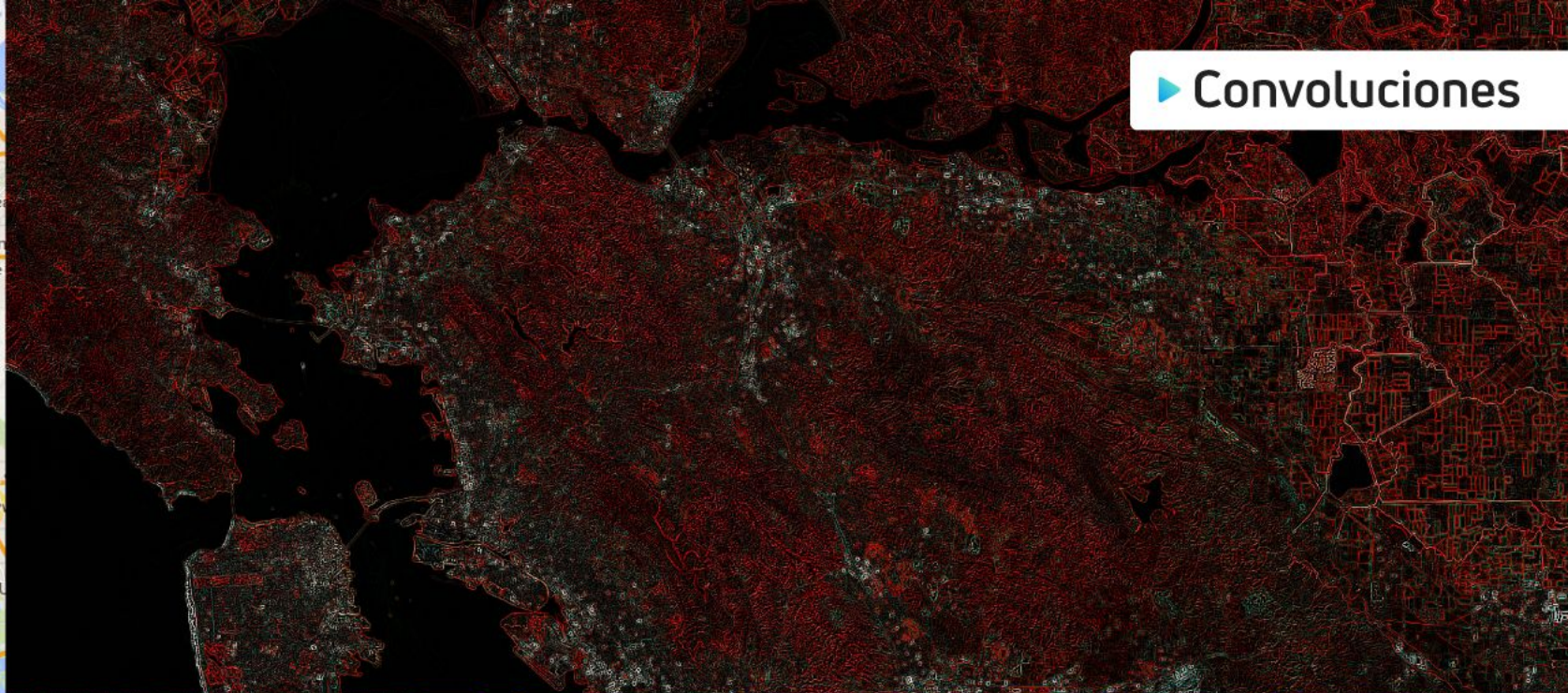
Chart

An object for charting properties and spatiotemporal reductions.

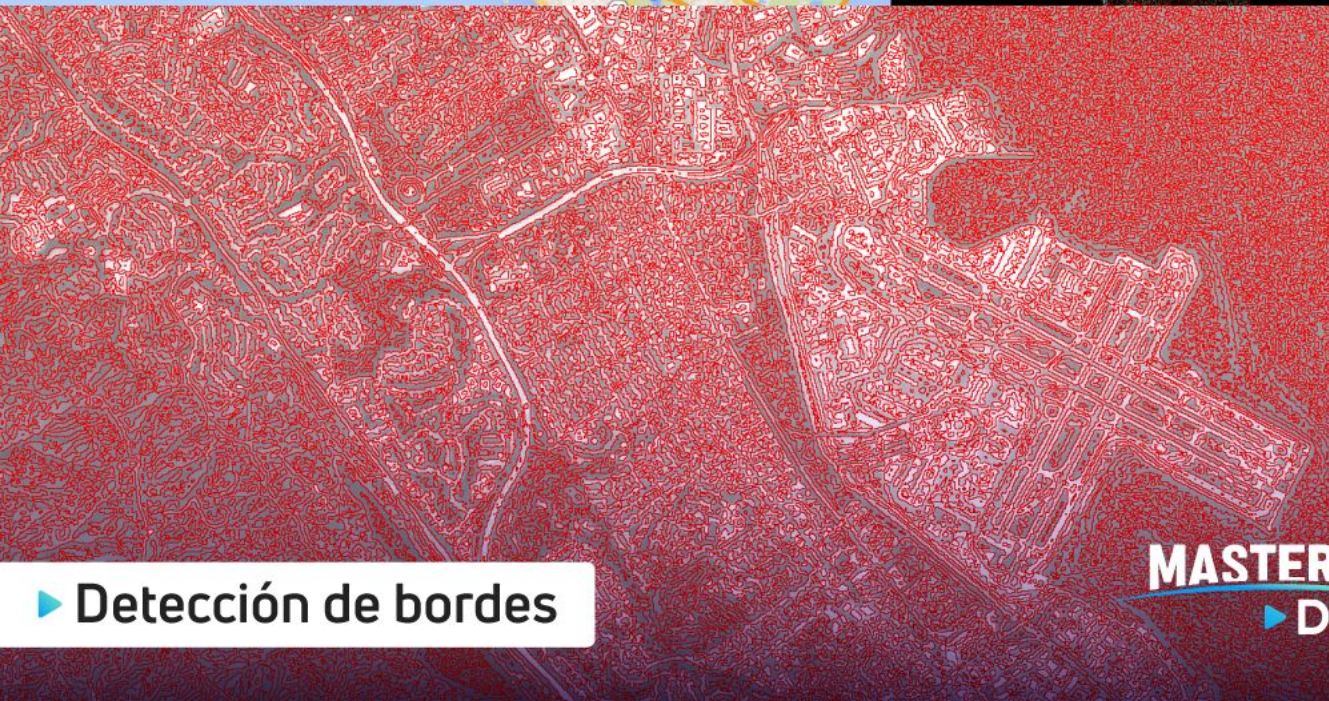
► Visualización de datos



► Convoluciones



► Detección de bordes

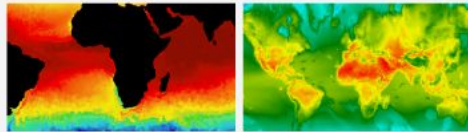


MASTERGIS
► Days

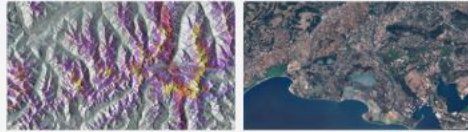
► Transformaciones espectrales



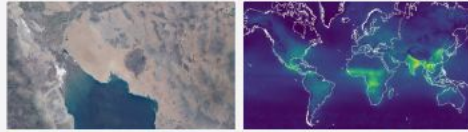
► Catálogo



Surface temperature
Climate



Sentinel-1A SAR C-band Synthetic Aperture Radar
Sentinel-2 MSI Multispectral Instrument



Sentinel-3 OLCI B10 Ocean and Land Color Instrument
Sentinel-3P TRISOPOL TRISOPOL Monitoring Instrument

► API: JavaScript y Python



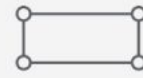
Image

The fundamental raster data type in Earth Engine.



ImageCollection

A set of images.



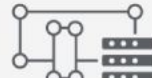
Geometry

The fundamental vector data type in Earth Engine.



Feature

A geometry with attributes.



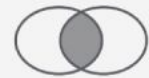
FeatureCollection

A set of features.



Reducer

An object used to compute statistics or perform aggregations.



Join

Combine datasets (Image or Feature collections) based on time, location, or an attribute property.



Array

An object for multi-dimensional analyses.



Chart

An object for charting properties and spatiotemporal reductions.



Search for datasets or places

Script manager
API documentation
Asset manager

Get a link (URL) to the script
Save the script
Run the script

Help button
Feedback button

Code Editor

Task manager
Console output
Inspect locations, pixel values, objects on the map

Geometry Tools
Zoom

Map

Layer manager



Get, filter and mask clouds and shadows in the MOD09Q1 MODIS Product. Also, compute the median composite.

```
[4] 1 MOD09Q1 = ee.ImageCollection('MODIS/006/MOD09Q1')
    2     .filterDate('2020-01-01', '2021-01-01')
    3     .maskClouds()
    4     .scale()
    5     .median()]
```

Visualization

► API: JavaScript y Python



<p>Image The fundamental raster data type in Earth Engine.</p>	<p>ImageCollection A set of images.</p>	<p>Geometry The fundamental vector data type in Earth Engine.</p>
<p>Feature A geometry with attributes.</p>	<p>FeatureCollection A set of features.</p>	<p>Reducer An object used to compute statistics or perform aggregations.</p>
<p>Join Combine datasets (Image or Feature collections) based on time, location, or an attribute property.</p>	<p>Array An object for multi-dimensional analyses.</p>	<p>Chart An object for charting properties and spatiotemporal reductions.</p>



Search for datasets or places

Script manager
API documentation
Asset manager

Get a link (URL) to the script
Save the script
Run the script

Help button
Feedback button

Code Editor

Task manager
Console output
Inspect locations, pixel values, objects on the map

Geometry Tools
Zoom

Map

Layer manager

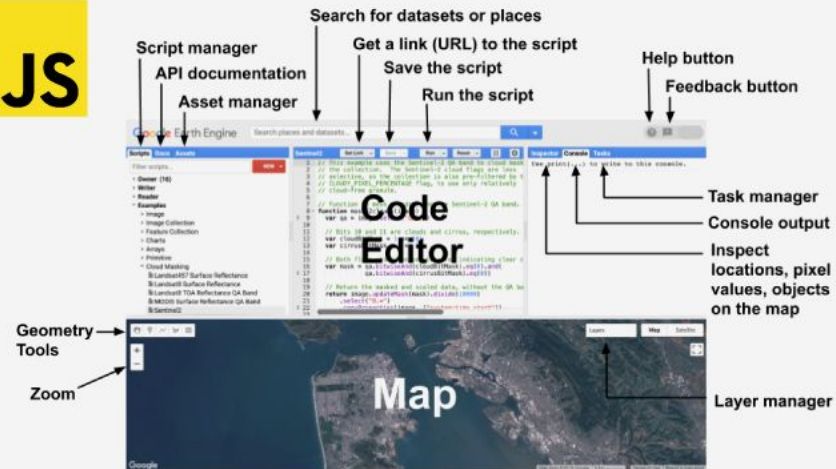
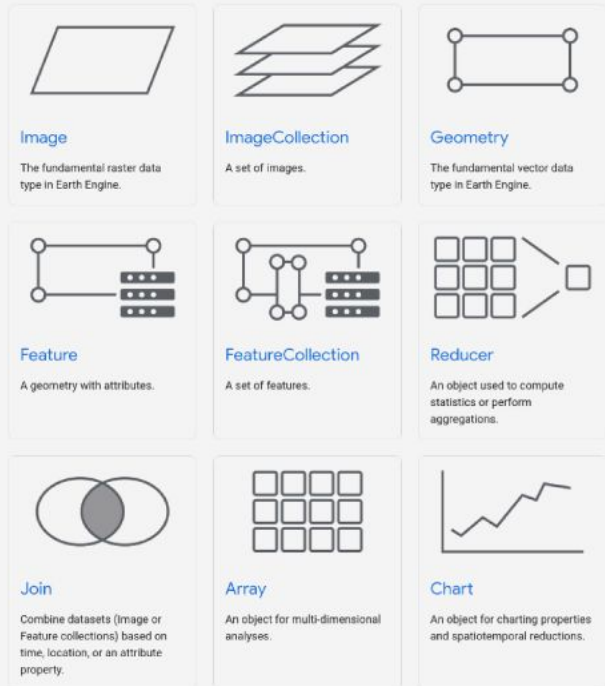
```

Get, filter and mask clouds and shadows in the MOD09Q1 MODIS Product. Also, compute the median composite.

[4] 1 MOD09Q1 = (ee.ImageCollection('MODIS/09A01/MOD09Q1')
2   .filterDate('2020-01-01', '2021-01-01')
3   .maskClouds()
4   .scale()
5   .median())
  
```

Visualization

► API: JavaScript y Python



MASTERGIS
► Days

► Extensions: R, Julia, QGIS



(Aybar et al., 2020)

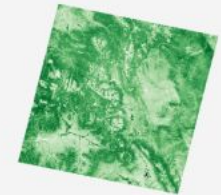
```
RegionCenter(0.00001, 47.00001, 3)
RegionLayer(
  region = col.indicator,
  colorname = "land",
  mode = "raster", "raster",
  size = 5,
  min = c(0.10, 20, -0.10),
  max = c(0.10, 20, -0.10)
)
```



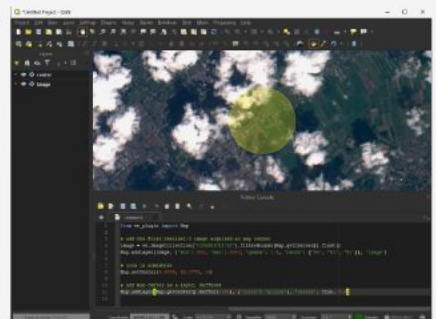
(Markert, 2021)

```
thunderbolt = getThunderbolt(
  id = "thunderbolt",
  url = "https://api.thunderbolt.com/v1/thunderbolt",
  headers = {
    "Content-Type": "application/json",
    "Authorization": "Bearer token"
  }
)
localpath = download(thunderbolt)
png = plot(png, ticks = nothing, border = :none)
```

The results should look like the following image:



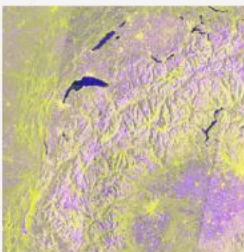
(Donchyts et al., 2021)



Taller JS

► Colecciones: ráster y vector

Sentinel-1 SAR GRD: C-band
Synthetic Aperture Radar
Ground Range Detected, log



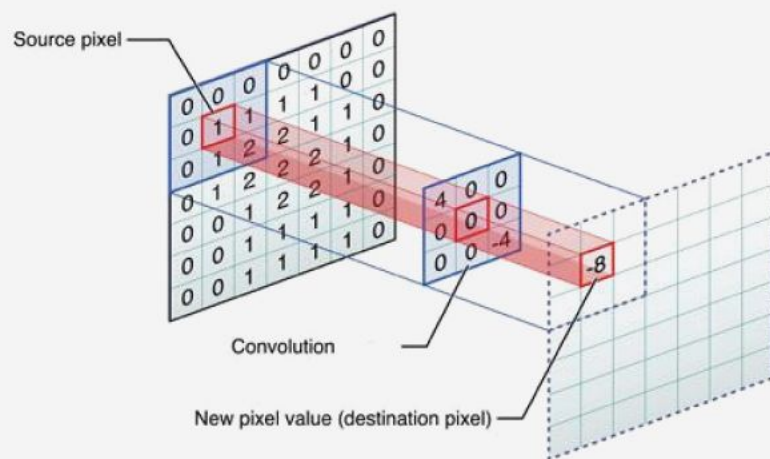
Sentinel-2 MSI: MultiSpectral
Instrument, Level-1C



FAO GAUL: Global
Administrative Unit Layers 2015,
Second-Level Administrative

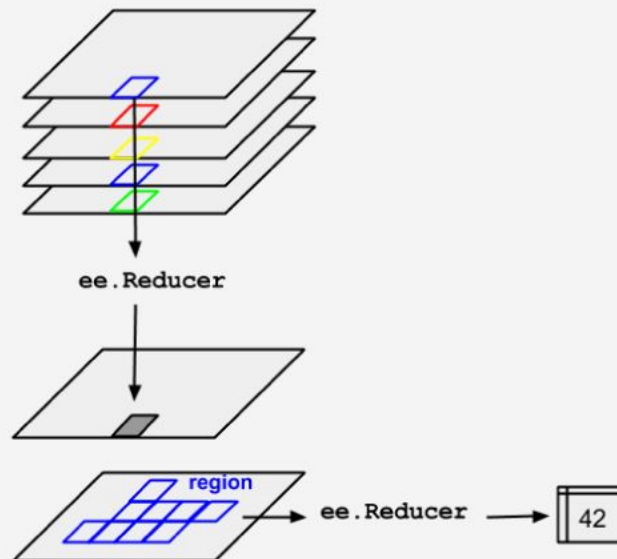


► Convoluciones



(Basavarajaiah, 2019)

► Reducers



► Matemática de bandas

$$\text{NDVI} = (N - R) / (N + R)$$

► Módulos de terceros



(Montero, 2021)



(Braaten and
Donchyts, 2020)

► Funciones personalizadas



GRACIAS



David Montero Loaiza 🇨🇴
Ing. Topográfico

