
AWS
re:Invent
NOV. 28 – DEC. 2, 2022 | LAS VEGAS, NV

AES303-R

# Simplify downloading, archiving & processing petabytes of satellite data


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Sinergise

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Aerospace & Satellite, AWS



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# Agenda

New realities of geospatial data

Processing your satellite data on AWS

Sentinel Hub – An EO layer on top of cloud infrastructure

Use case #1 - Large scale ML feature preparation for EO

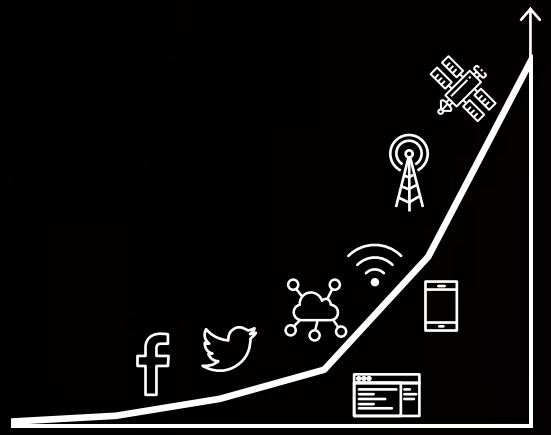
Use case #2 – Monitoring of agriculture activities on field level

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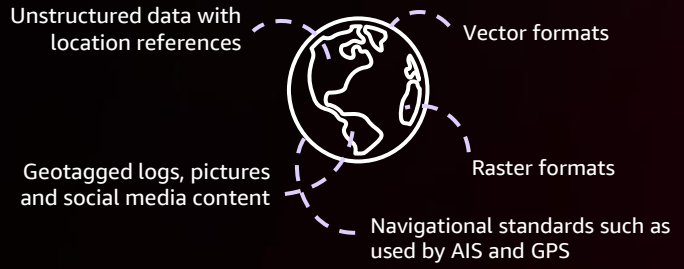
# New realities of geospatial data

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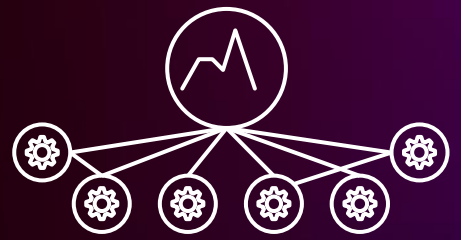
# The new realities of geospatial data



**Explosion of data**




**Explosion of GIS data standards**

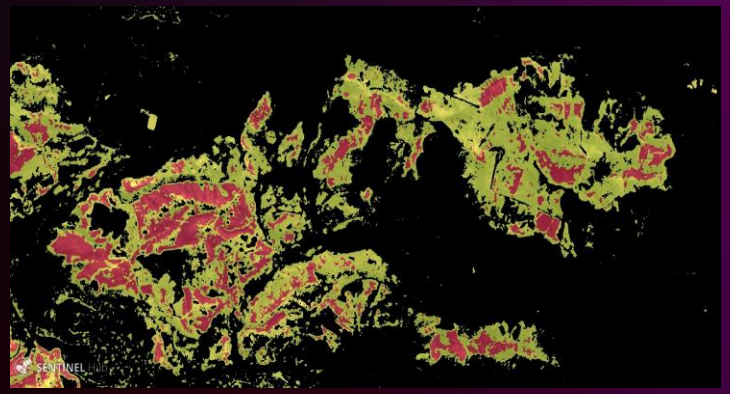


**Demand for faster decision-making**

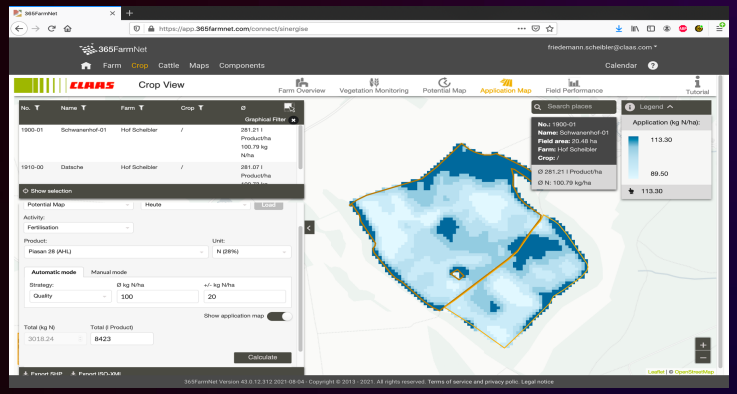
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# Spatial data applications across industries

- Utilities
- Environmental Services
- Local Government
- Agriculture
- Transportation
- Mining
- Surveying
- Advertising
- Retail
- Insurance
- Financial Services

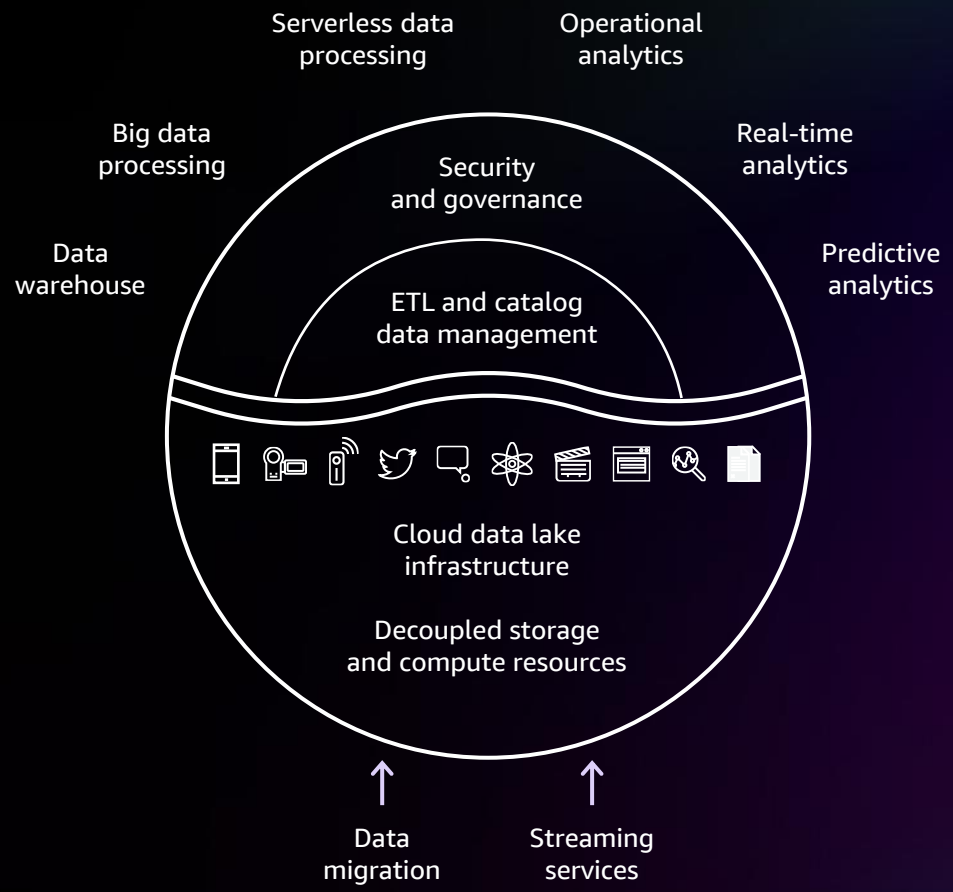





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# Where AWS can help?




**Customers want:**

A single data store that is scalable and cost-effective

To use the standards-based data format of their choice

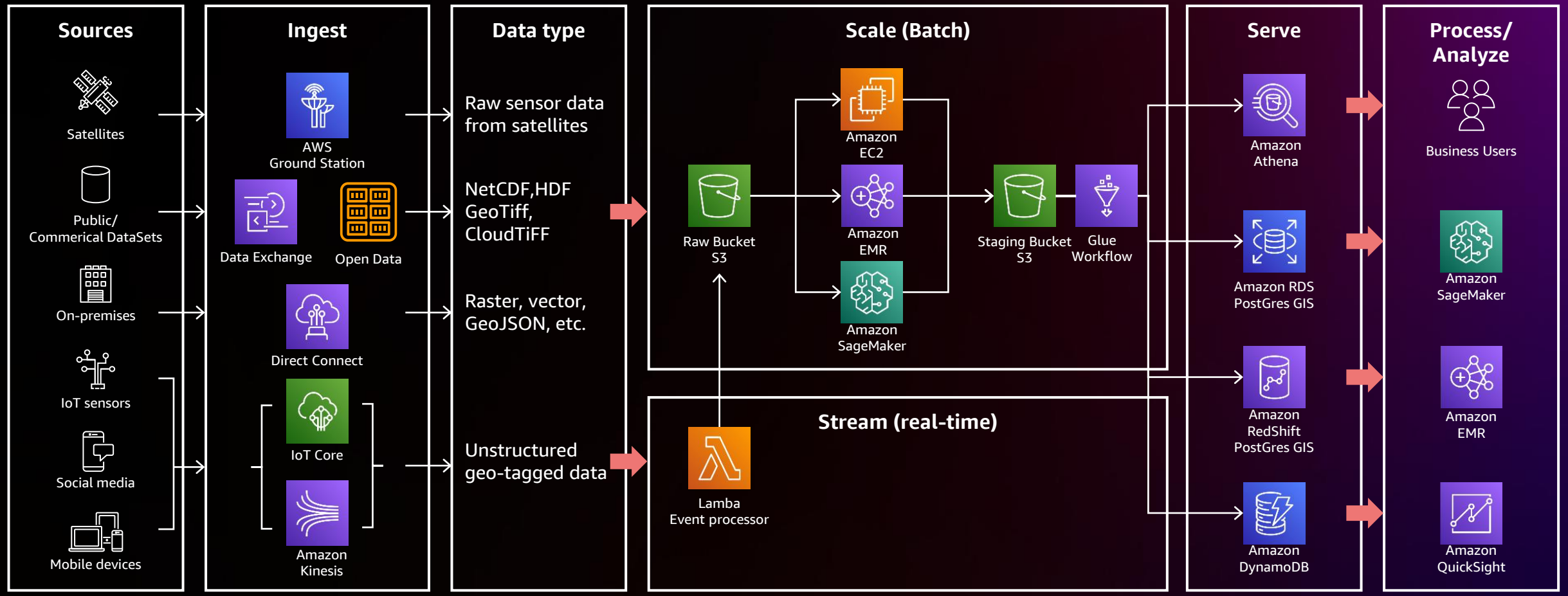
To analyze their data in a variety of ways

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# Processing your satellite data on AWS

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# Data life cycle continuum




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MODIS NOAA GHE USGS 3DEP LiDAR NWM GEFS

TCGA OpenStreetMap GEOS-Chem ECMWF ERA5 NEXRAD

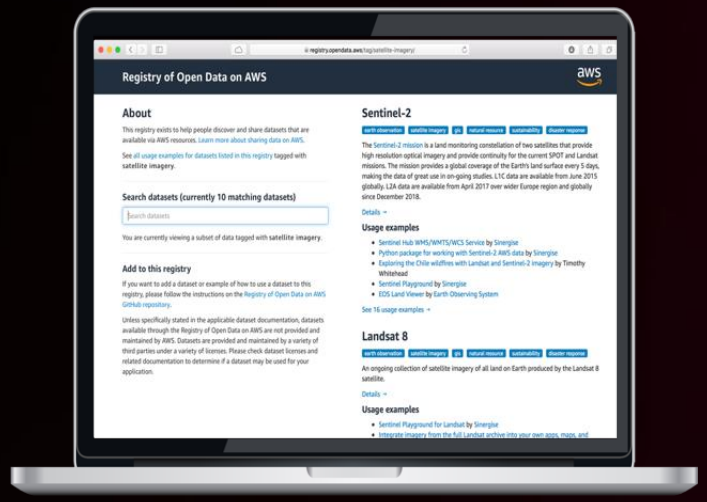
Sentinel-1 HRRR Sentinel-2 OFS eBird Terrain Tiles

GOES-16 NAIP CBERS NOAA ERI

# Registry of Open Data on AWS

HIRLAM ISD gnomAD

GHCN Kids First Landsat GFS




SILAM Air Quality NREL Solar Radiation

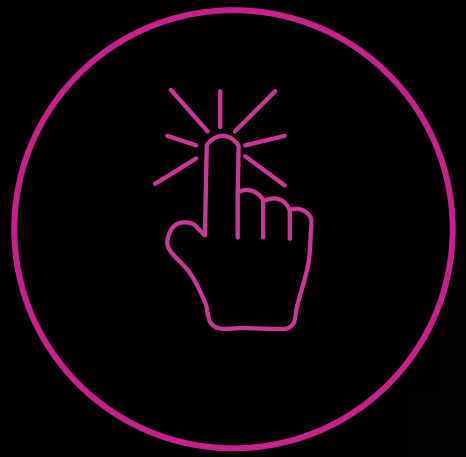
CESM LENS TARGET GOES-17 OpenAQ

NREL Wind Integration Common Crawl

registry.opendata.aws

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# Customers have asked us to make exchanging data simpler



Easy to use



Secure and compliant



Self-service options



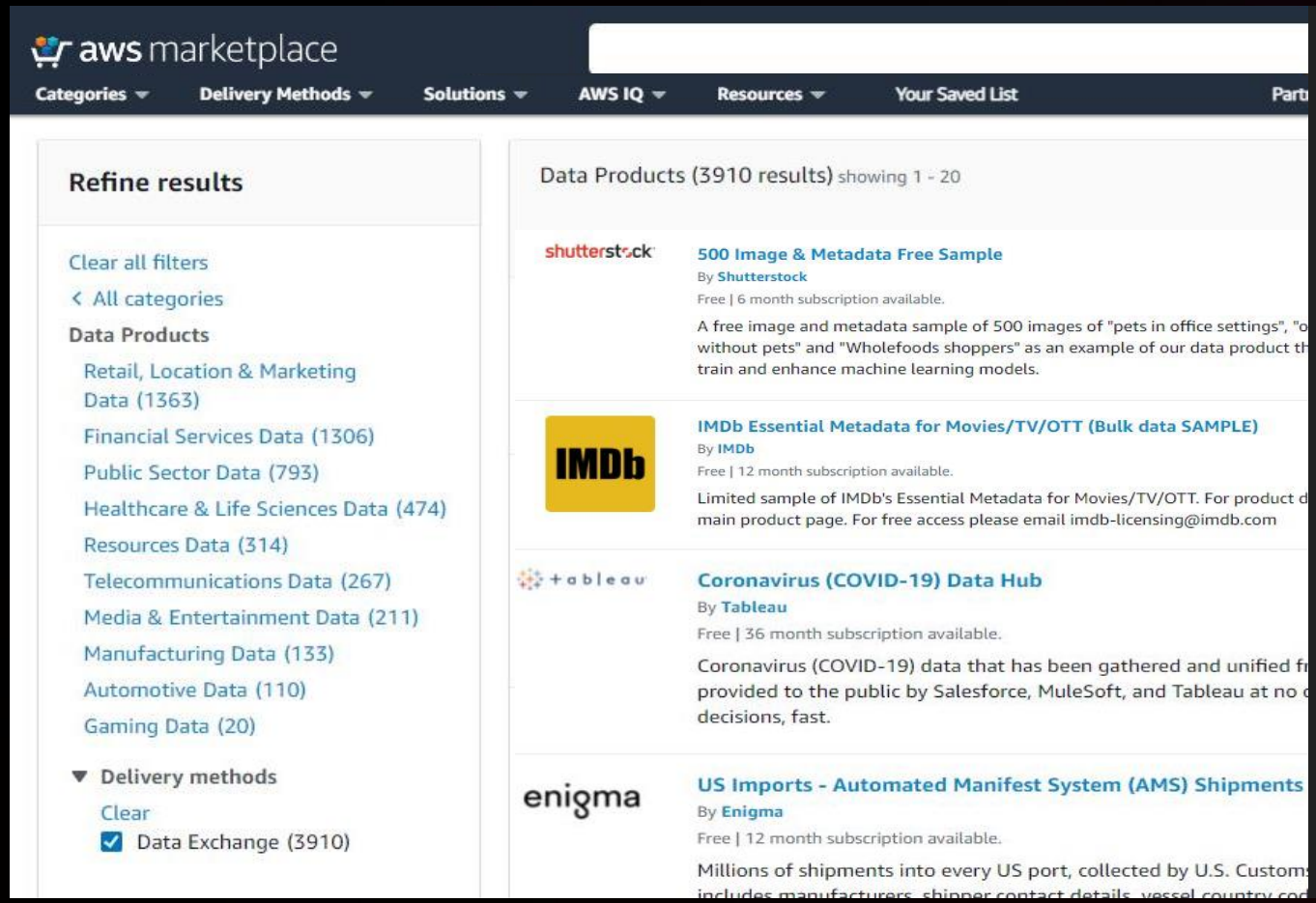
Cloud native



Seamless experience from start to finish

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# AWS Data Exchange enables customers to easily find, subscribe to, and use third-party data in the cloud




- 250+ data providers and 3,000+ public data products
- Over 1,000 free public data products to easily evaluate the data you need
- Support for private products and private data trials
- Data delivery via files, tables, and APIs

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## SUBSCRIBER BENEFITS

**Quickly find** diverse data **in one place**



**Easily analyze** data as it's published



**Spend less time and effort** to use data in production



# AWS Data Exchange



## PROVIDER BENEFITS



**Co-sell with AWS** Partner Network (APN) to reach **millions of potential customers**



**Reduce data engineering time** and duplication

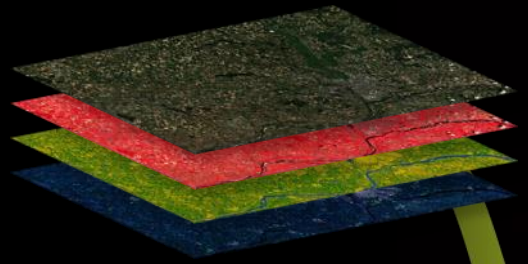


**Automatic entitlement**, billing, and **payment management**

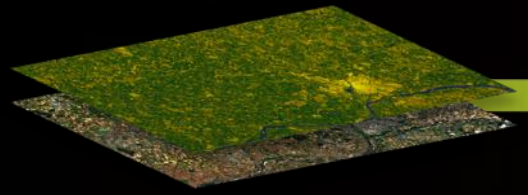
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# Sentinel Hub
# an EO layer on top of cloud infrastructure

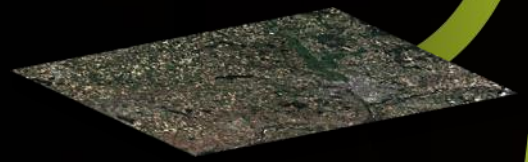
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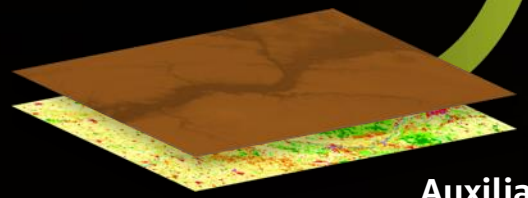
Open imagery



Commercial imagery



Bring-your-own data



**Auxiliary data**:
CORINE Land Cover, DEM

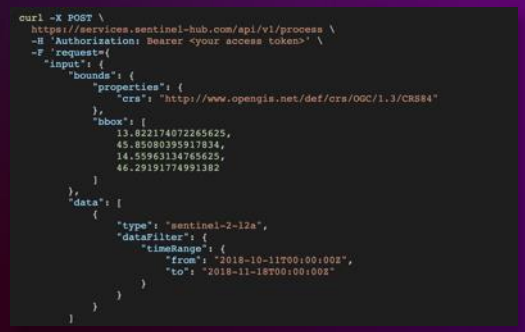
sentinelhub






**Machine learning**

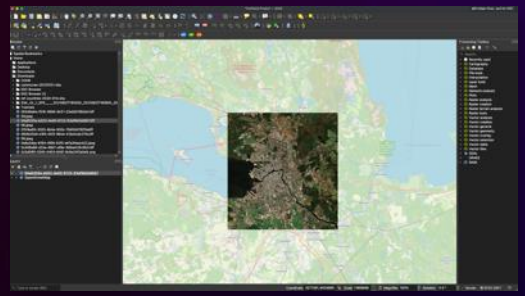
**Cloud API**




Programming:
**JavaScript, Python, R, etc.**



Web/mobile apps



GIS

aws

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# Statistics – March 2022

sentinelhub

## Cloud API

**230 k**
registered users

**12 BN**
km² processed

**50+ PB**
of satellite imagery

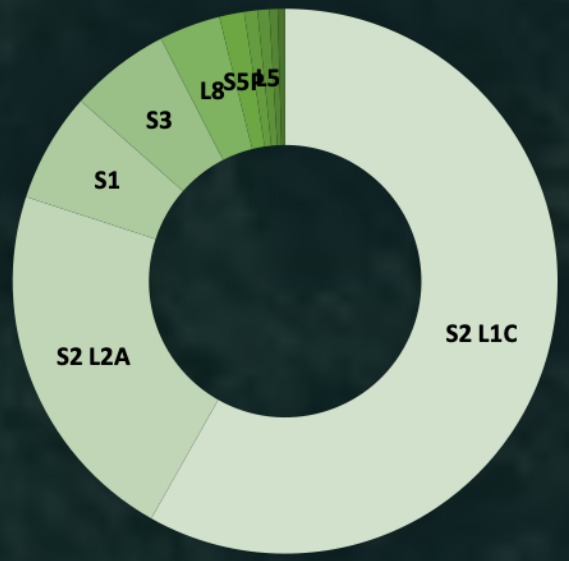
**500 TB**
added every month

**4 Sentinel missions**

**8 Landsat missions**

**MODIS**

**Commercial data**




## EO Browser

**180 k**
monthly visitors

**70 M**
processed requests




**Open-source and free to use**




**Visitors from 159 countries**

EO Browser

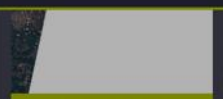
ENGLISH

Login

Discover | Visualize | Compare | Pins

← Back to search

Showing 28 results



0.5 %

20LMR

Visualize



Sentinel-2 L2A

2021-07-14

14:35:20 UTC

0.0 %

20LLR

Visualize



Sentinel-2 L2A

2021-07-14

14:35:15 UTC

3.0 %

20LMR

Visualize



Sentinel-2 L2A

2021-07-14

14:35:12 UTC

Free sign up for all features

Powered by Sentinel Hub with contributions by ESA

v3.4.7




Leaflet | © MapTiler © OpenStreetMap contributors

Results

Showing 6 results.



Sentinel-2 L2A

2021-07-14

14:35:15 UTC

3.0 %

20LMR

Visualize



Sentinel-2 L2A

2021-07-09

14:35:14 UTC

9.6 %

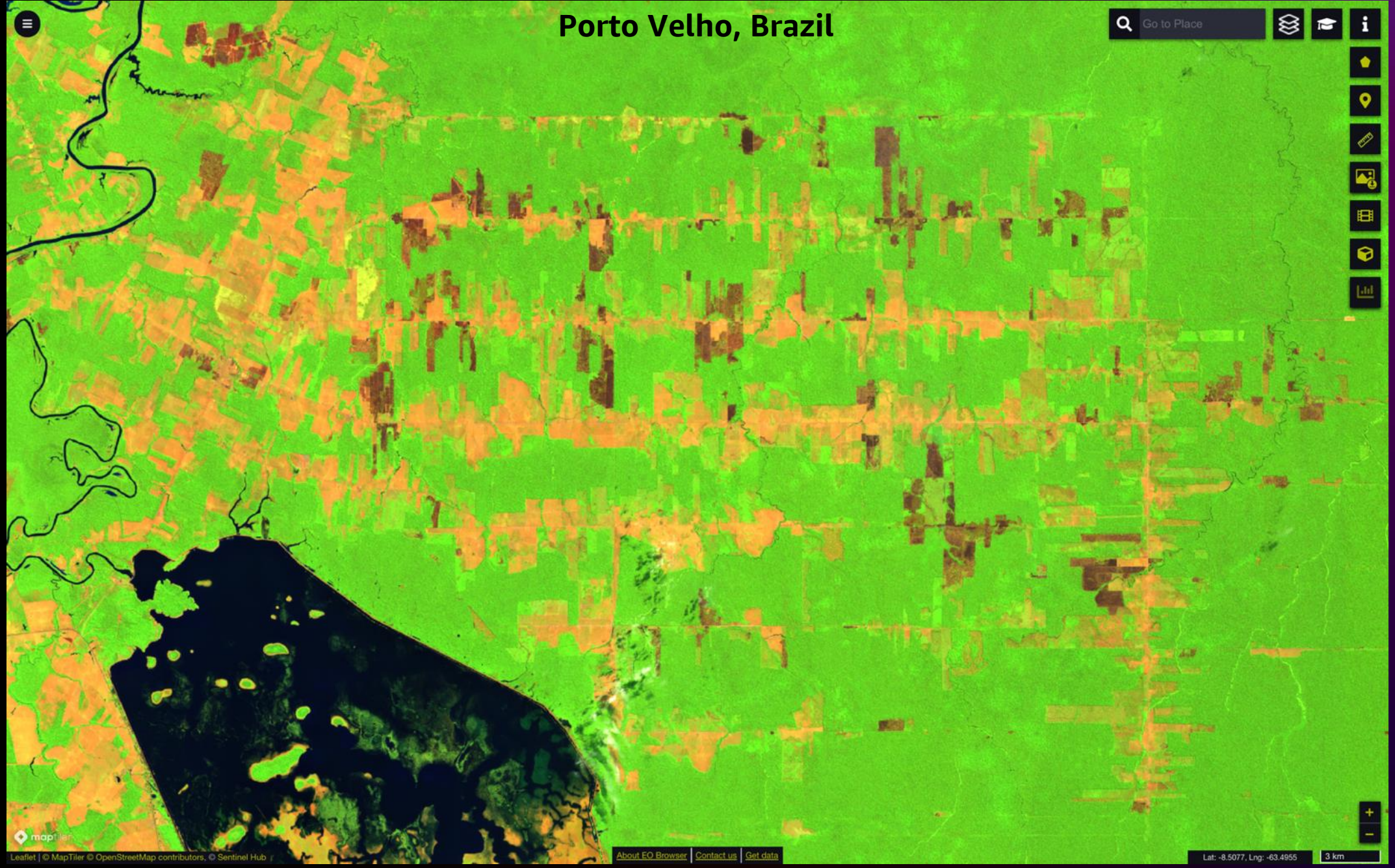
20LMR

Go to Place

About EO Browser | Contact us | Get data

Lat: -8.6340, Lng: -63.3279

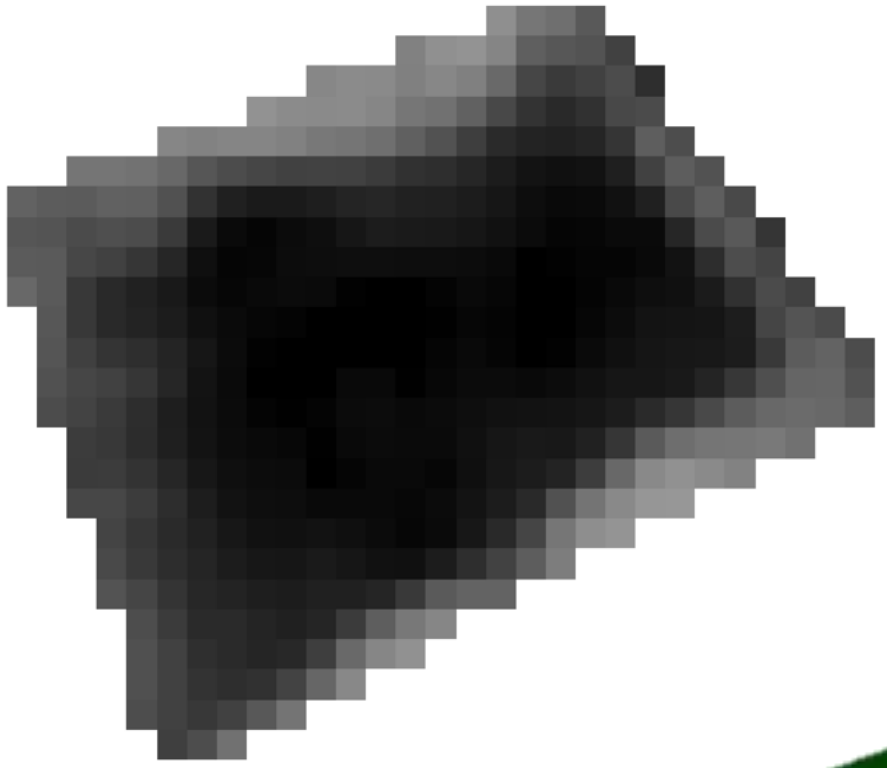
5 km



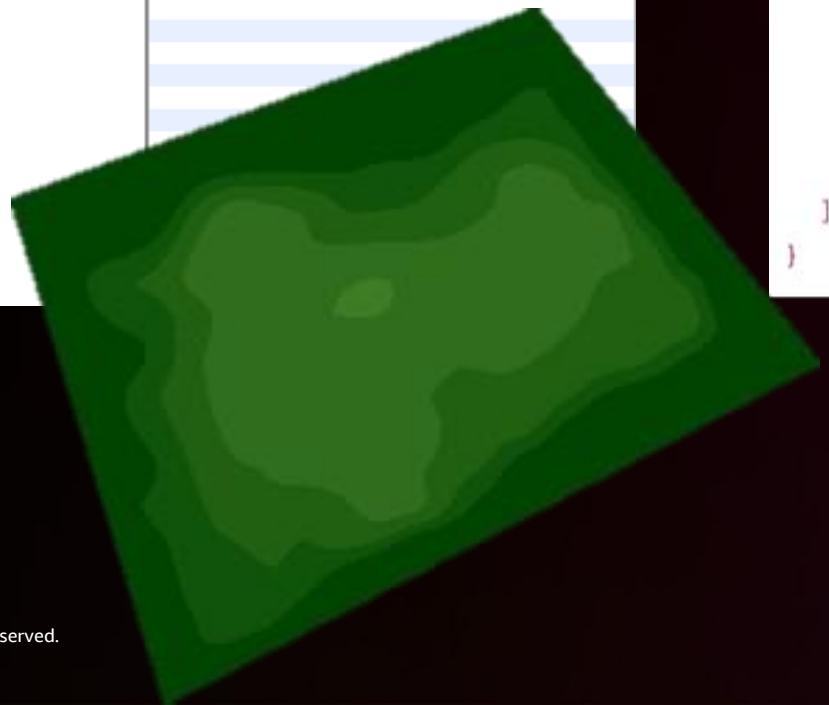

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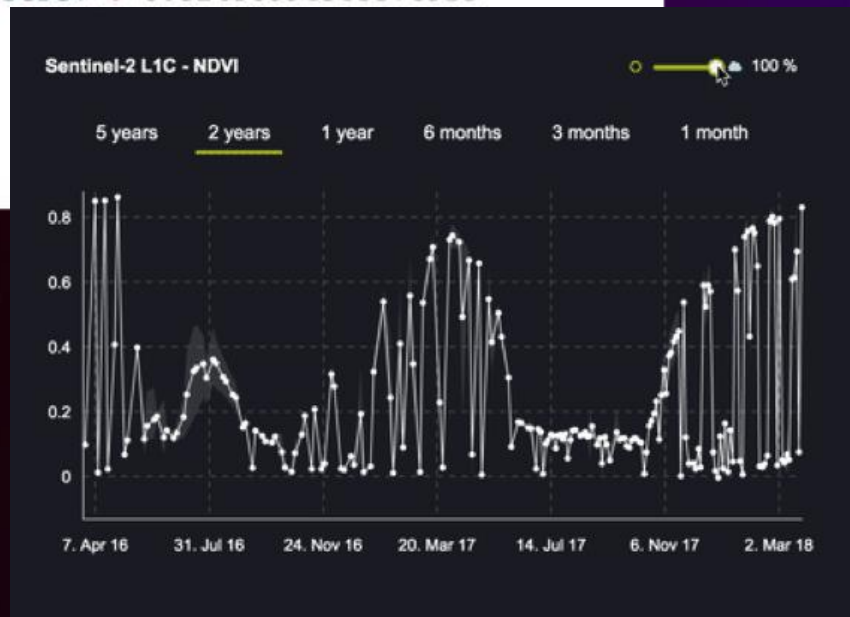

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```
{
  "NDVI": [
    {
      "date": "2015-08-30",
      "basicStats": {
        "min": -0.5478424429893494,
        "max": 0.7815912365913391,
        "mean": 0.147320137875888,
        "stDev": 0.35443419609590726
      }
    },
    {
      "date": "2015-07-11",
      "basicStats": {
        "min": -0.5127978920936584,
        "max": 0.8115044236183167,
        "mean": 0.20168528533031557,
        "stDev": 0.31436594348376923
      }
    }
  ]
}
```


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# A set of tools for various use-cases

## Synchronous APIs

- Catalog
- Process
- Statistical

- OGC
- OpenEO

## Asynchronous APIs

- Async Process
- Batch Processing
- Batch Statistical

- Bring your own COG/ZARR
- Third Party Data Import

- OpenEO

aws

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# Supported datasets

## Open data (global and full archives)

- Sentinel-1 GRD
- Sentinel-2 L1C and L2A
- Sentinel-3 OLCI and SLSTR
- Sentinel-5P
- Landsat Collection 2
- MODIS
- DEM (Copernicus, Mapzen)
- (Copernicus Services)

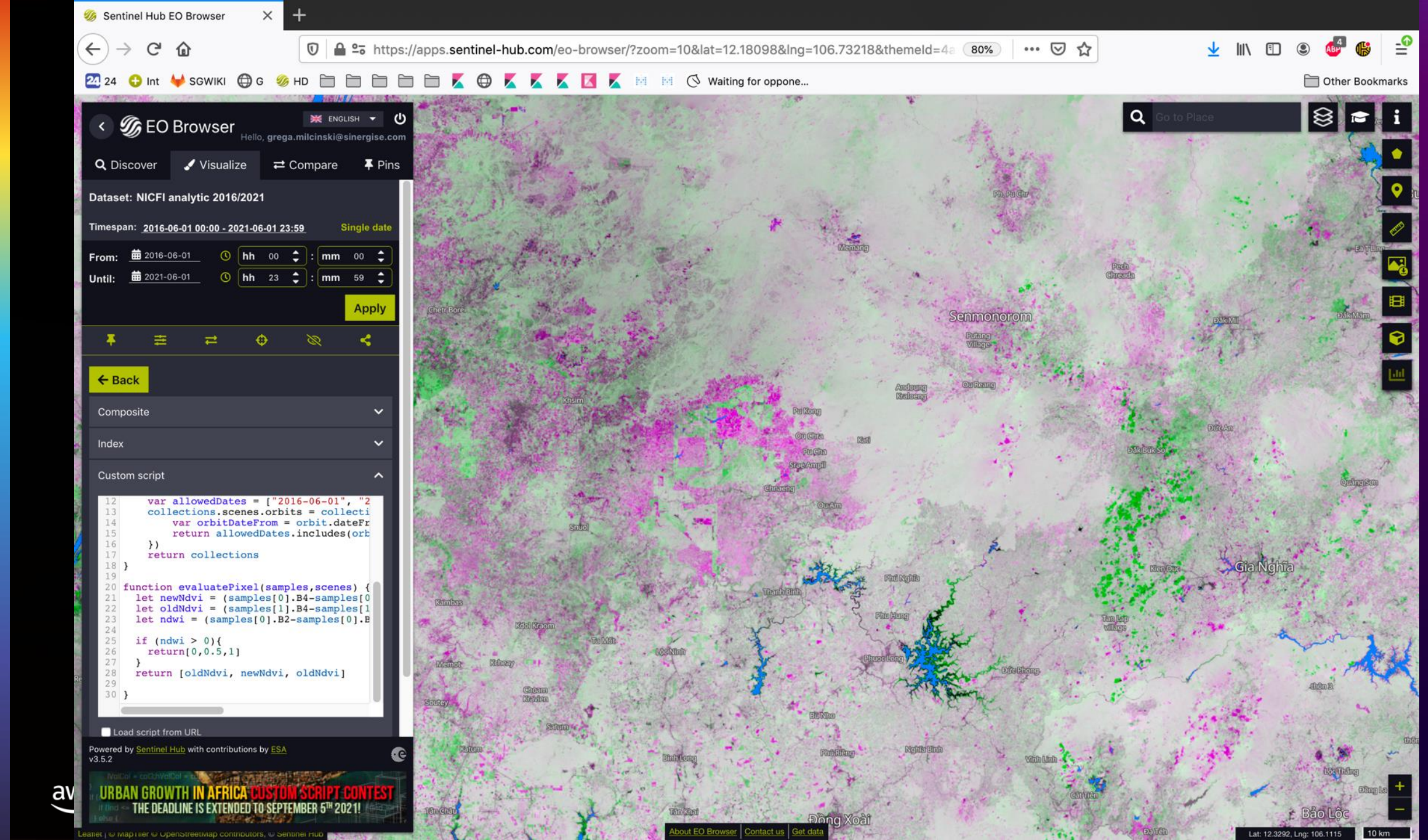
## Commercial data (on-demand, payable)

- PlanetScope
- Planet SkySat
- Airbus Pleiades
- Airbus SPOT
- Maxar

**50+ PB**

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Sentinel Hub EO Browser
https://apps.sentinel-hub.com/eo-browser/?zoom=10&lat=12.18098&lng=106.73218&themeId=4a
80%
Waiting for oppone...
Other Bookmarks
EO Browser
ENGLISH
Hello, grega.milcinski@sinergise.com
Discover
Visualize
Compare
Pins
Dataset: NICFI analytic 2016/2021
Timespan: 2016-06-01 00:00 - 2021-06-01 23:59
Single date
From: 2016-06-01 hh 00 : mm 00
Until: 2021-06-01 hh 23 : mm 59
Apply
Back
Composite
Index
Custom script
var allowedDates = ["2016-06-01", "2
collections.scenes.orbits = collecti
var orbitDateFrom = orbit.dateFr
return allowedDates.includes(orb
})
return collections
}
function evaluatePixel(samples,scenes) {
let newNdvi = (samples[0].B4-samples[0
let oldNdvi = (samples[0].B4-samples[1
let ndwi = (samples[0].B2-samples[0].B
if (ndwi > 0){
return[0,0.5,1]
}
return [oldNdvi, newNdvi, oldNdvi]
}
Load script from URL
Powered by Sentinel Hub with contributions by ESA
v3.5.2
URBAN GROWTH IN AFRICA CUSTOM SCRIPT CONTEST
THE DEADLINE IS EXTENDED TO SEPTEMBER 5TH 2021!
Go to Place
Senmonorom
Gia Nghia
Đồng Xoài
Bảo Lộc
About EO Browser
Contact us
Get data
Lat: 12.3292, Lng: 106.1115
10 km

# ML models embedded in custom script

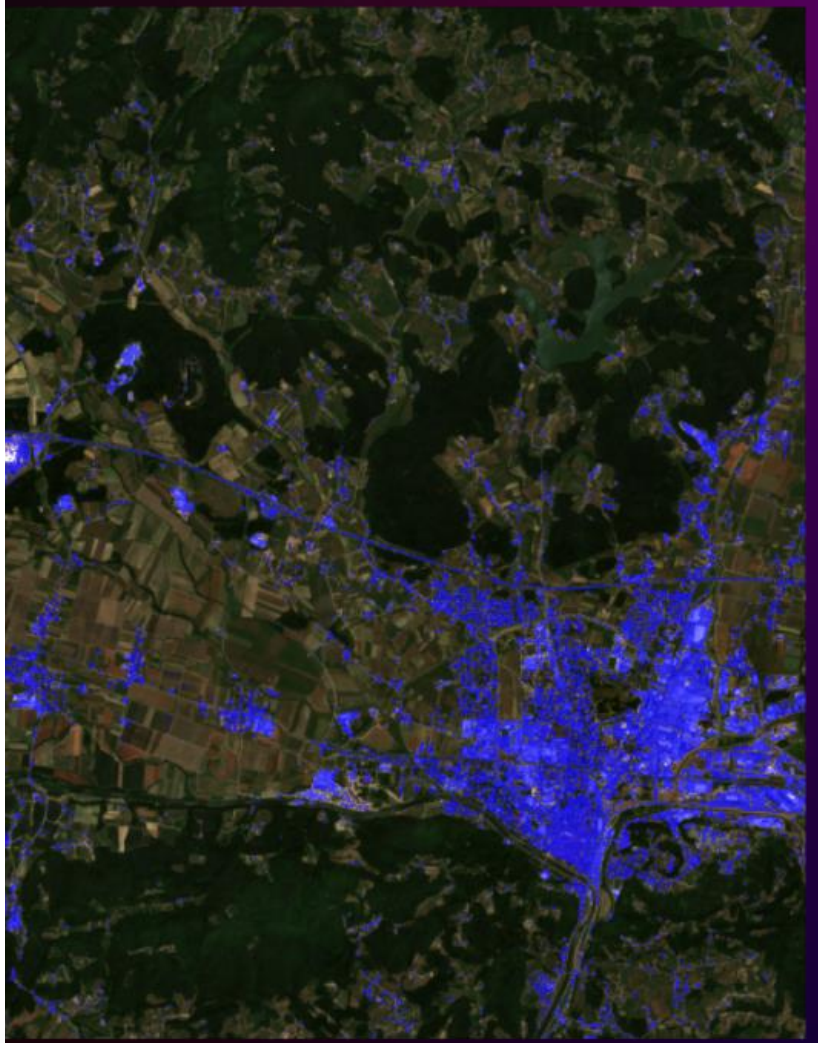
```
function evaluatePixelOrig(samples) {
  var sample = samples[0];
  var b03_norm = normalize(sample.B03, 0, 0.253061520471542);
  var b04_norm = normalize(sample.B04, 0, 0.290393577911328);
  var b05_norm = normalize(sample.B05, 0, 0.305398915248555);
  var b06_norm = normalize(sample.B06, 0.006637972542253, 0.608900395797889);
  var b07_norm = normalize(sample.B07, 0.013972727018939, 0.753827384322927);
  var b8a_norm = normalize(sample.B8A, 0.026690138082061, 0.782011770669178);
  var b11_norm = normalize(sample.B11, 0.016388074192258, 0.493761397883092);
  var b12_norm = normalize(sample.B12, 0, 0.493025984460231);
  var viewZen_norm = normalize(Math.cos(sample.viewZenithMean * degToRad), 0.918595400582046, 1);
  var sunZen_norm  = normalize(Math.cos(sample.sunZenithAngles * degToRad), 0.342022871159208, 0.936206429175402);
  var relAzim_norm = Math.cos((sample.sunAzimuthAngles - sample.viewAzimuthMean) * degToRad)

  var n1 = neuron1(b03_norm,b04_norm,b05_norm,b06_norm,b07_norm,b8a_norm,b11_norm,b12_norm, viewZen_norm,sunZen_norm,relAzim_norm);
  var n2 = neuron2(b03_norm,b04_norm,b05_norm,b06_norm,b07_norm,b8a_norm,b11_norm,b12_norm, viewZen_norm,sunZen_norm,relAzim_norm);
  var n3 = neuron3(b03_norm,b04_norm,b05_norm,b06_norm,b07_norm,b8a_norm,b11_norm,b12_norm, viewZen_norm,sunZen_norm,relAzim_norm);
  var n4 = neuron4(b03_norm,b04_norm,b05_norm,b06_norm,b07_norm,b8a_norm,b11_norm,b12_norm, viewZen_norm,sunZen_norm,relAzim_norm);
  var n5 = neuron5(b03_norm,b04_norm,b05_norm,b06_norm,b07_norm,b8a_norm,b11_norm,b12_norm, viewZen_norm,sunZen_norm,relAzim_norm);

  var l2 = layer2(n1, n2, n3, n4, n5);

  var lai = denormalize(l2, 0.000319182538301, 14.4675094548151);
  return {
    default: [lai / 3]
  }
}

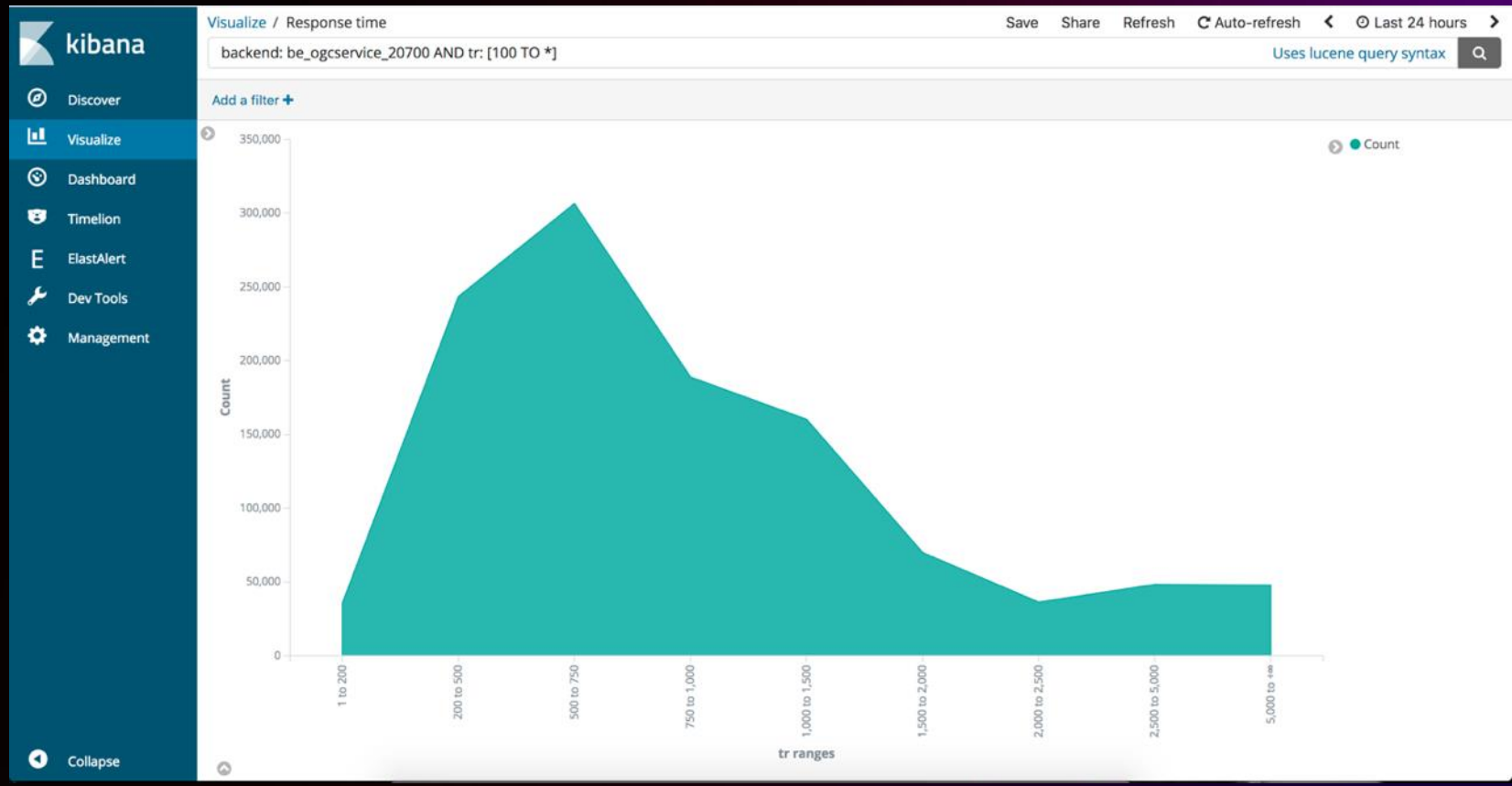
function neuron1(b03_norm,b04_norm,b05_norm,b06_norm,b07_norm,b8a_norm,b11_norm,b12_norm, viewZen_norm,sunZen_norm,relAzim_norm) {
  var sum =
        + 4.96238030555279
        - 0.023406878966470 * b03_norm
        + 0.921655164636366 * b04_norm
        + 0.135576544080099 * b05_norm
        - 1.938331472397950 * b06_norm
        - 3.342495816122680 * b07_norm
        + 0.902277648009576 * b8a_norm
        + 0.205363538258614 * b11_norm
        - 0.040607844721716 * b12_norm
```



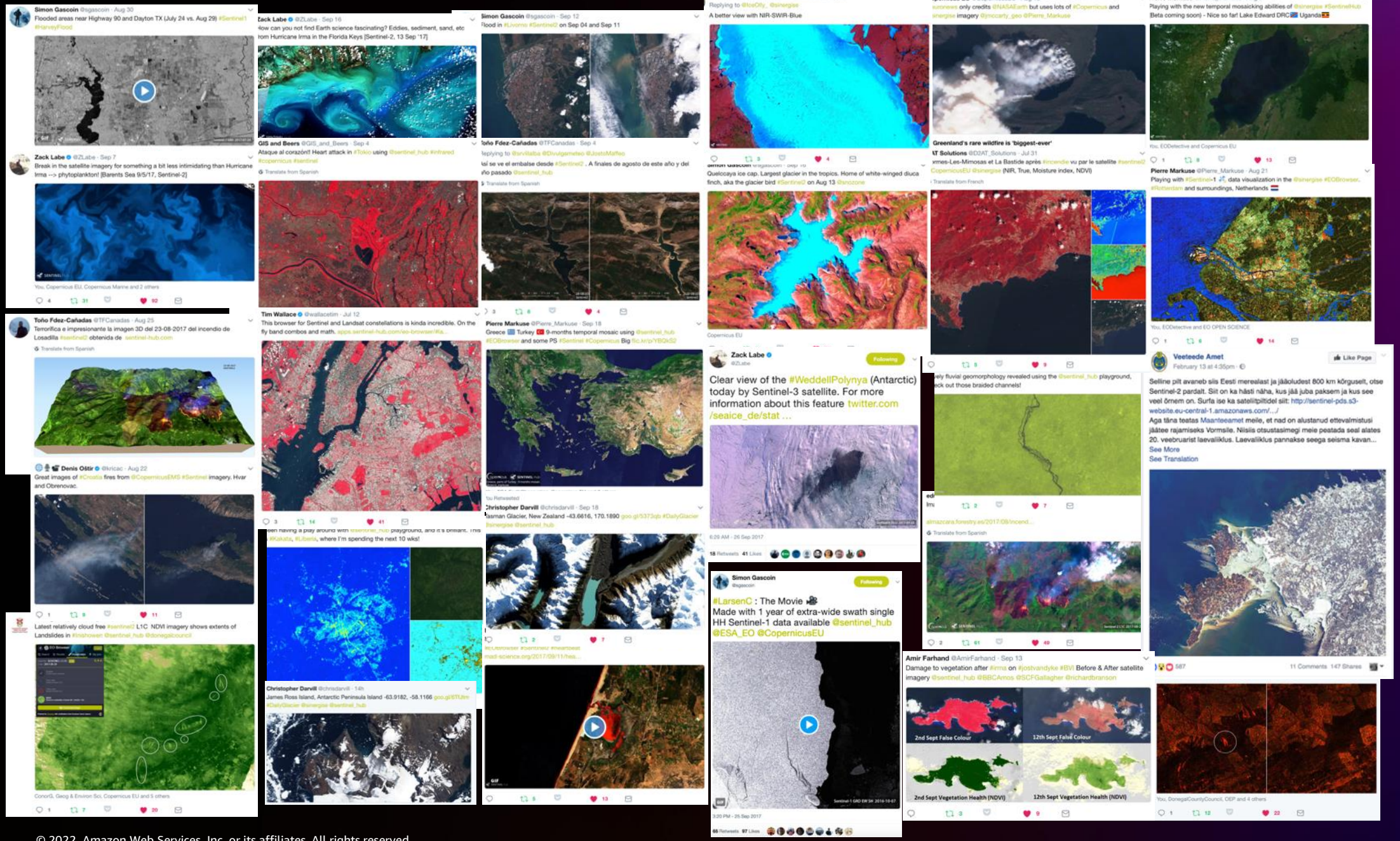
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# Synchronous APIs – (almost) immediate response

- Identify relevant scenes (sensor, time, AOI)
- Fetch data from S3
- Decode, reproject
- Interpolate
- Stitch, resolve overlaps
- (orthorectify, RTC)
- Execute processing script
- Encode and output




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# Climate change: Satellites find new colonies of Emperor penguins

By Jonathan Amos
BBC Science Correspondent

5 August 2020

Share

Climate change

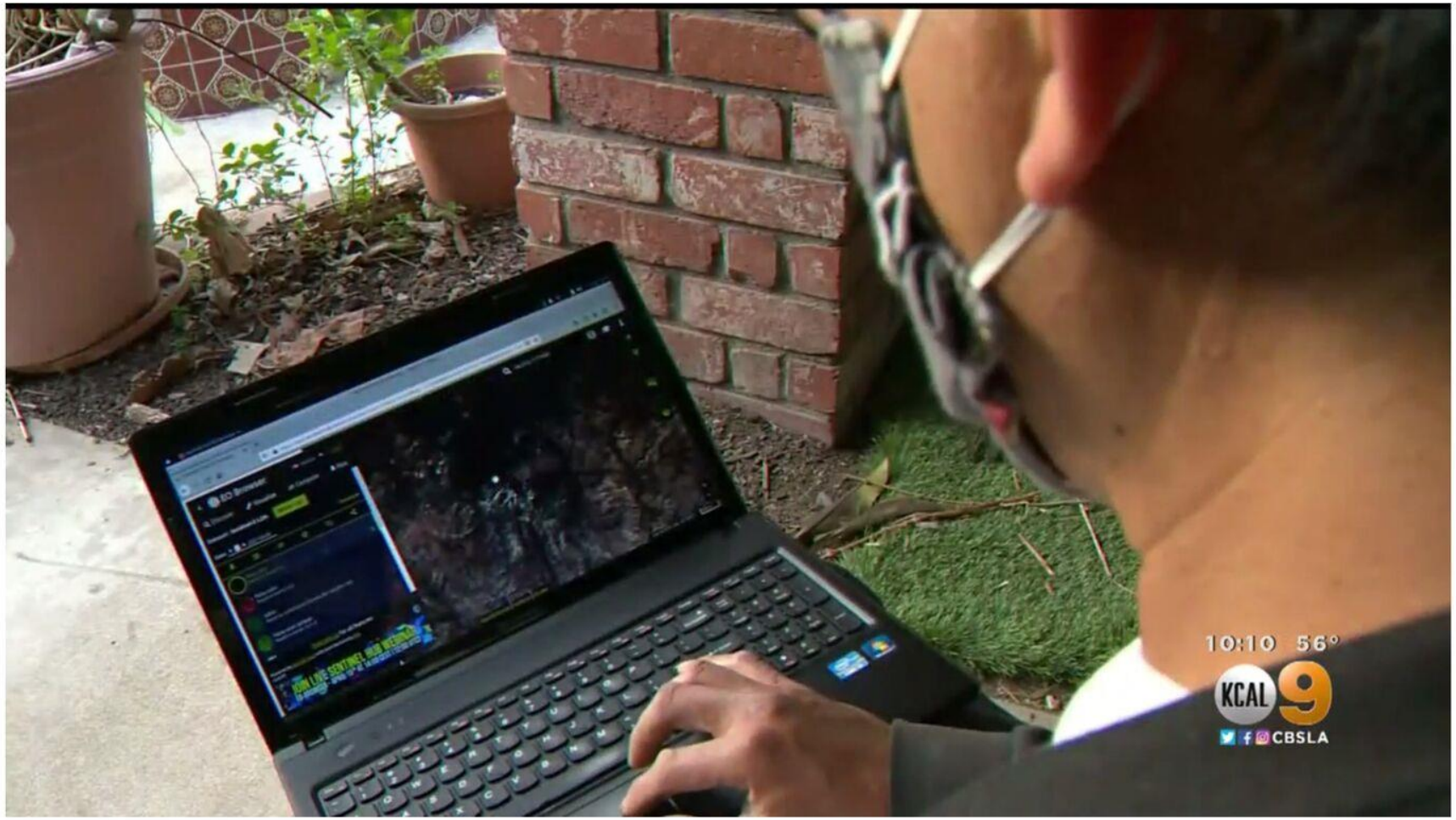



Guano stains: A new colony on fast ice that has formed around grounded icebergs

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# Missing Angeles National Forest Hiker Found Of Map Enthusiast

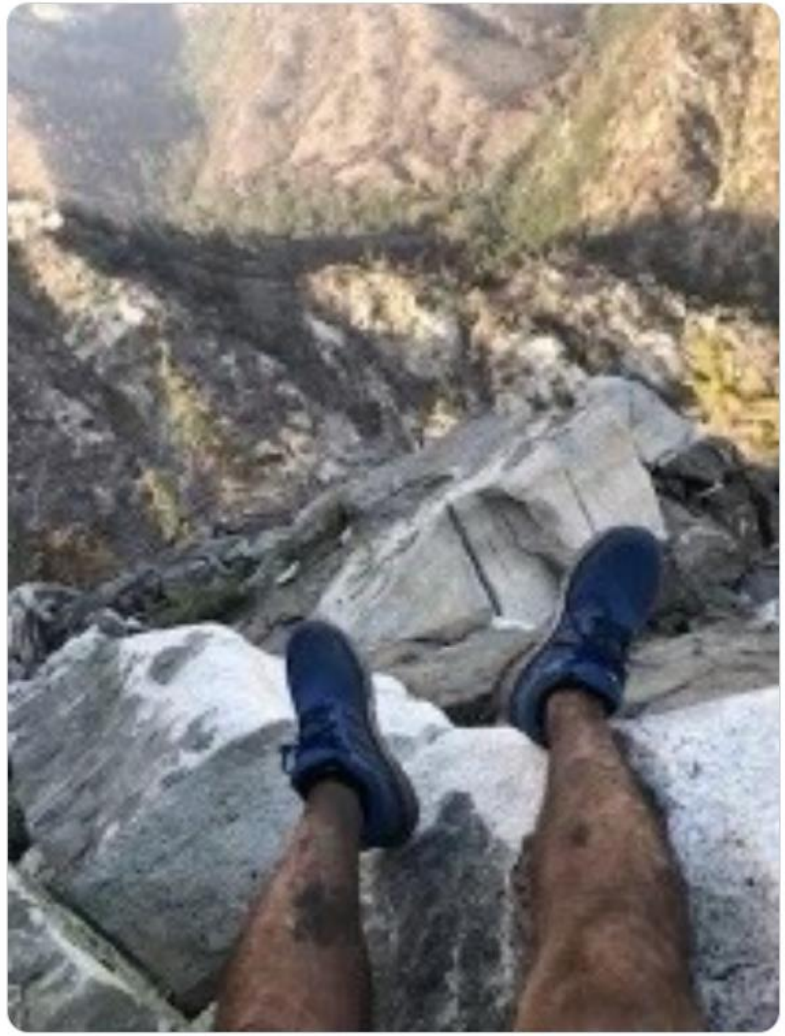
By CBSLA Staff April 13, 2021 at 11:08 pm **Filed Under:** Angeles National Forest, Missing Hiker



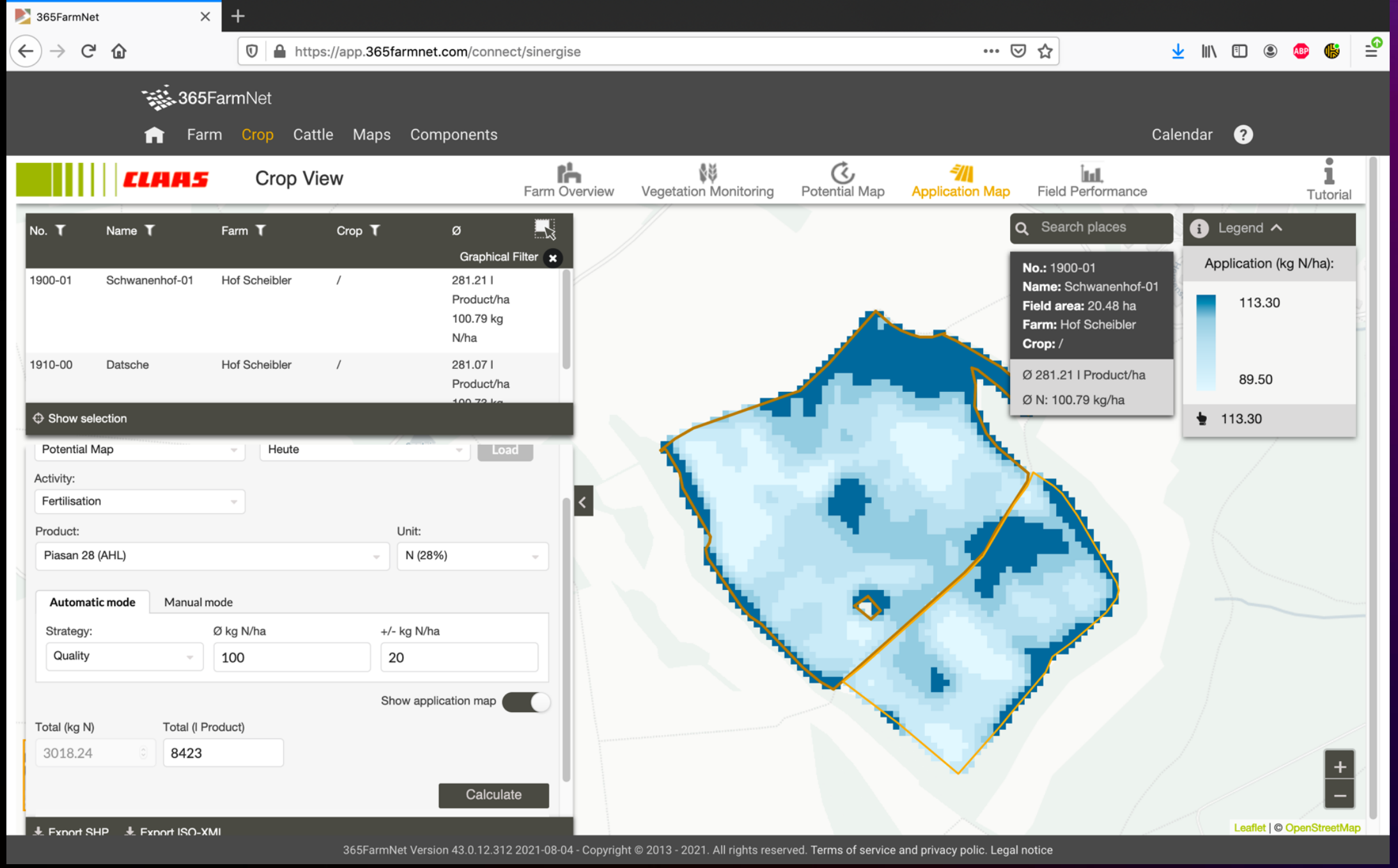

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**LA County Sheriffs** ✓
@LASDHQ

Are You an Avid Hiker in the Mt. Waterman Area? #LASD SAR Teams need help locating a #missing hiker. He sent this picture to a friend. His car was found near Buckhorn Campground/Trailhead. Call us if you recognize the area pictured below 818-248-3464. facebook.com/LosAngelesCoun...



7:10 PM · Apr 13, 2021 · Twitter Web App



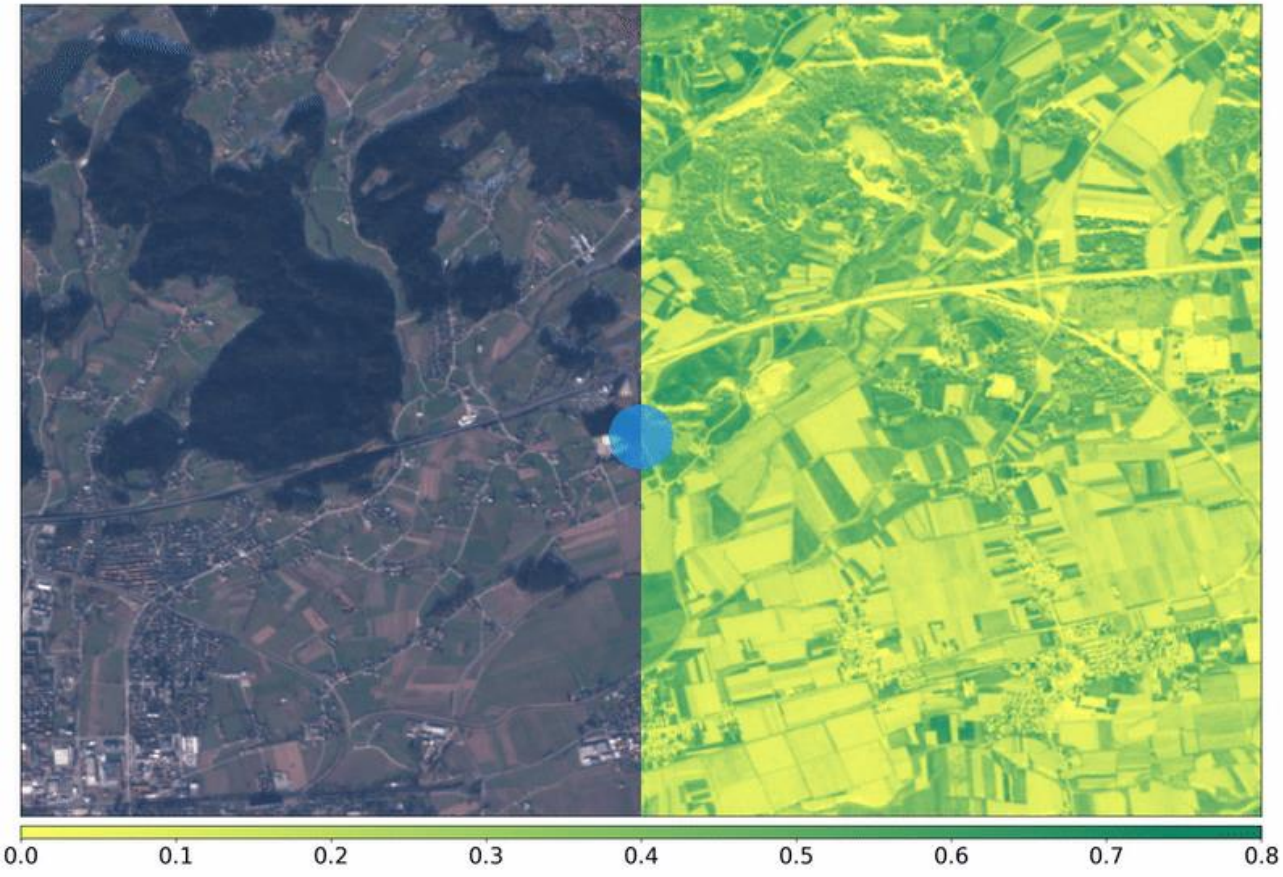

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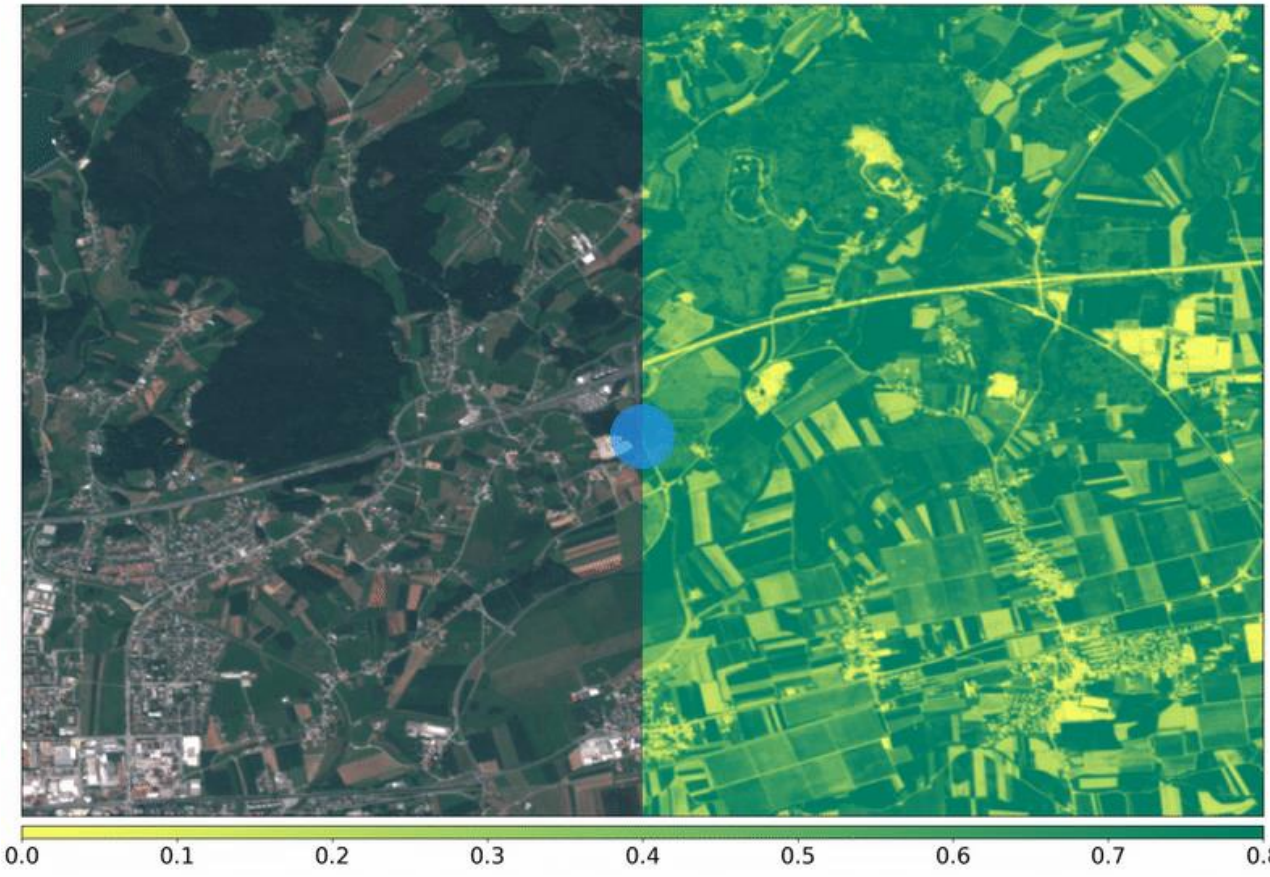
# Use case #1
# Large scale ML feature preparation for EO

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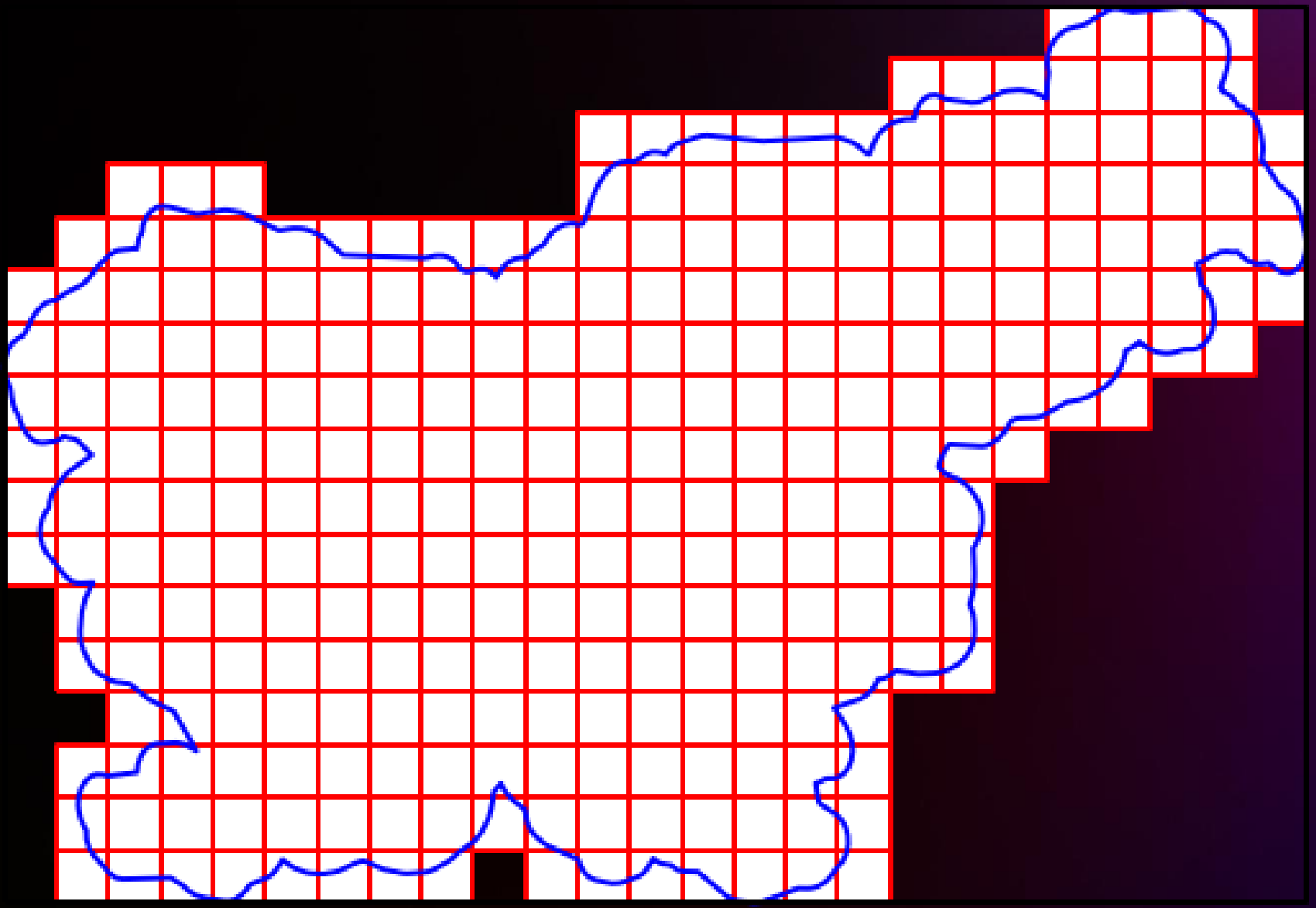



**Winter season**

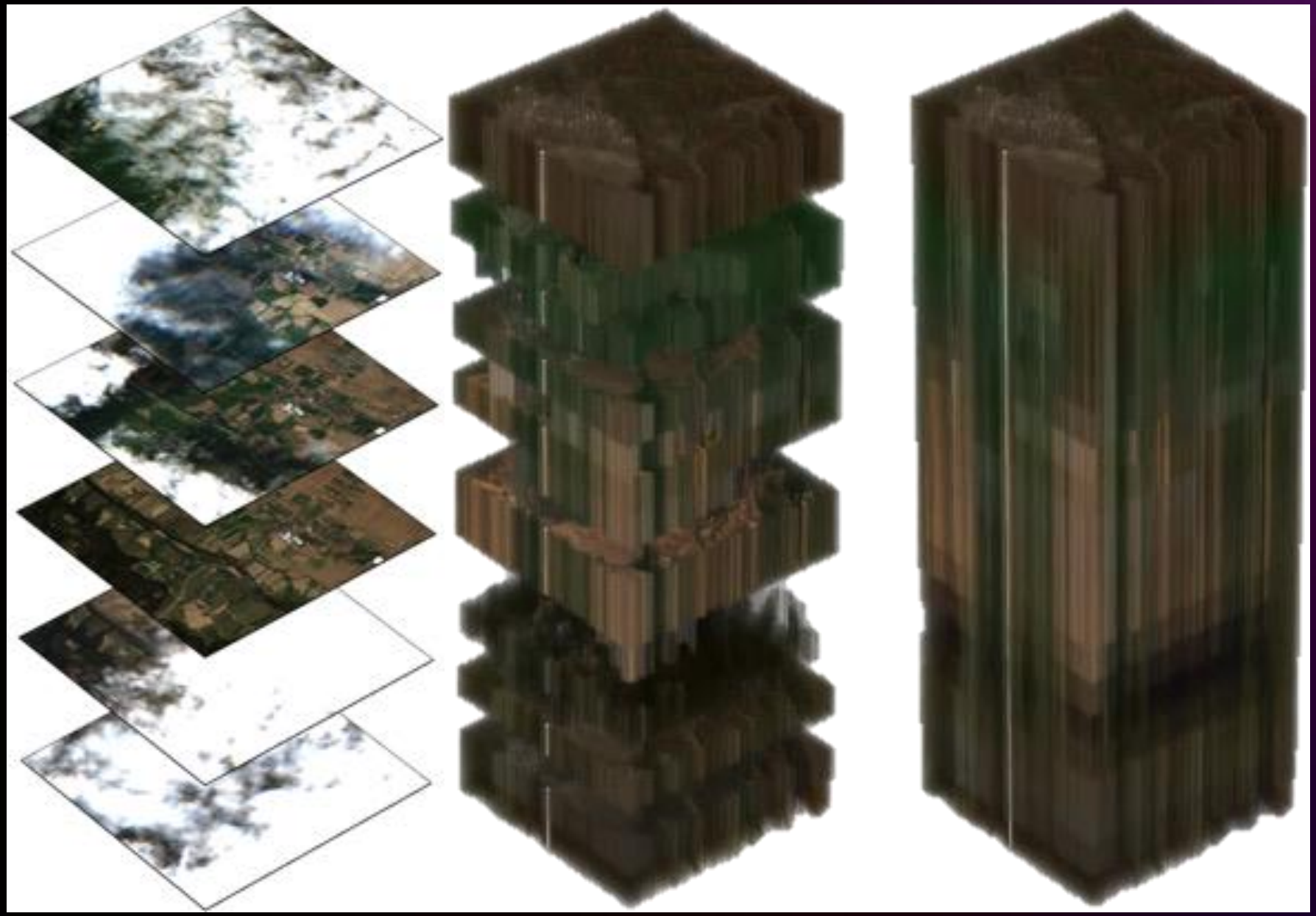
**Summer season**

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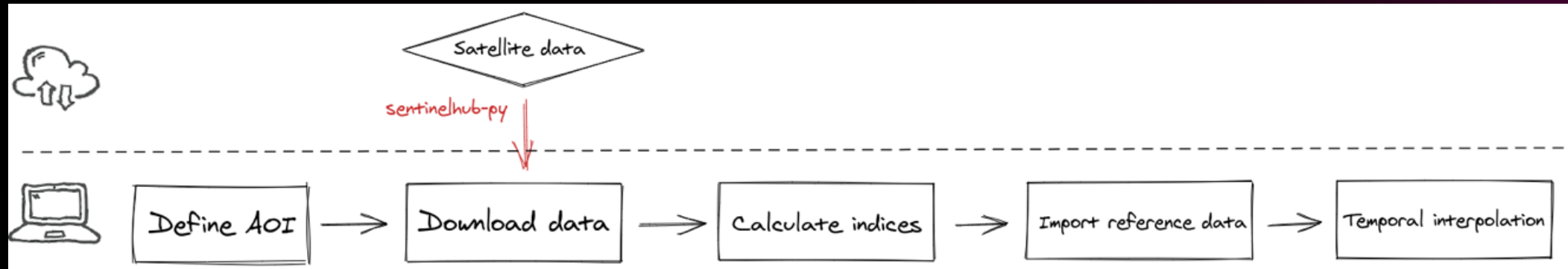




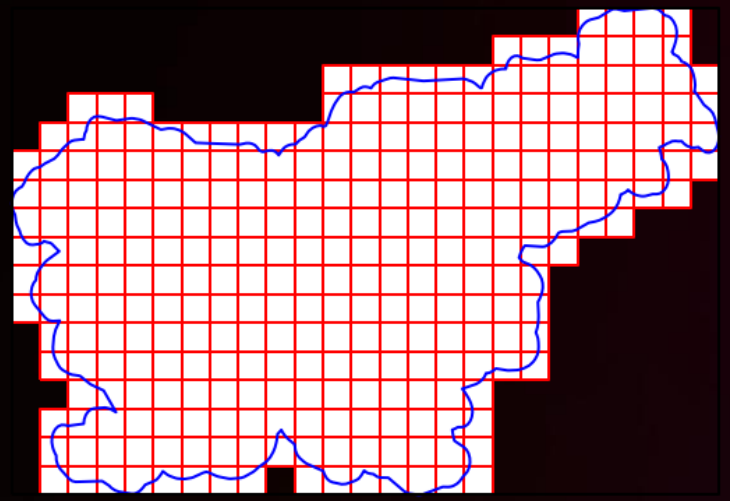
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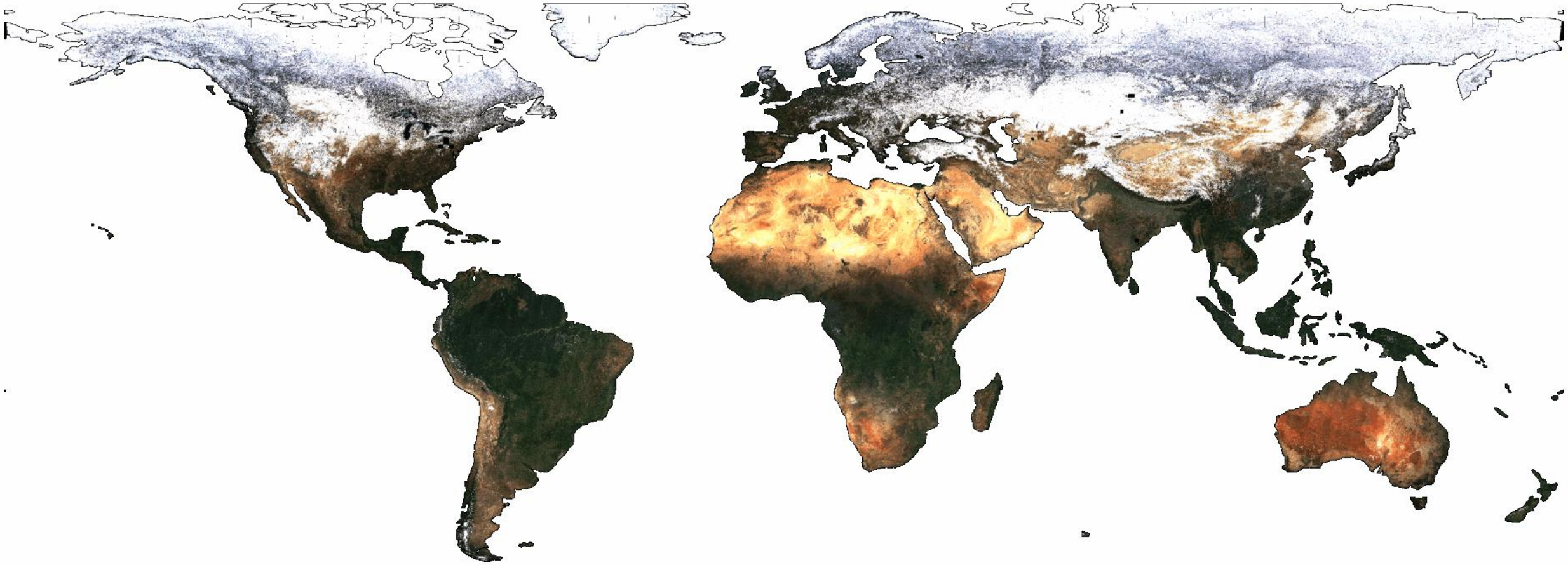
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TensorFlow



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# Sentinel Hub Batch Processing

```
url = "https://services.sentinel-hub.com/api/v1/batch/process"

evalscript = """
    //VERSION=3
    function setup() {
        return {
            input: [{
                bands: ["B04", "B08"]
            }],
            output: [{
                id: "default",
                bands: 3
            }],
            mosaicking: Mosaicking.ORBIT
        }
    }

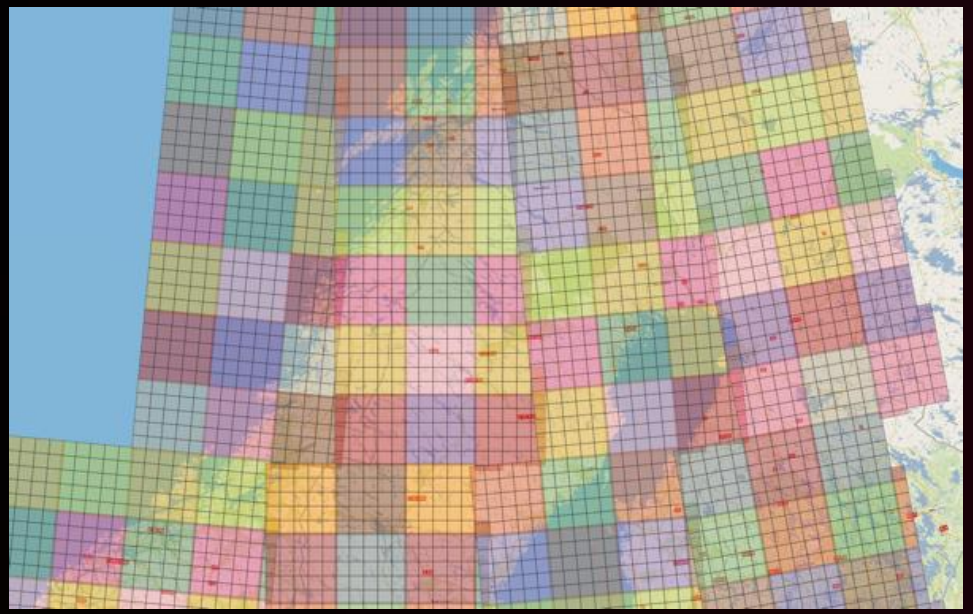
    function calcNDVI(sample) {
        var denom = sample.B04 + sample.B08
        return ((denom != 0) ? (sample.B08 - sample.B04) / denom : 0.0)
    }

    const maxNDVIcolors = [
        [-0.2, 0xbfbfbf],
        [0, 0xebebeb],
        [0.1, 0xc8c682],
        [0.2, 0x91bf52],
        [0.4, 0x4f8a2e],
        [0.6, 0x0f540c]
    ]

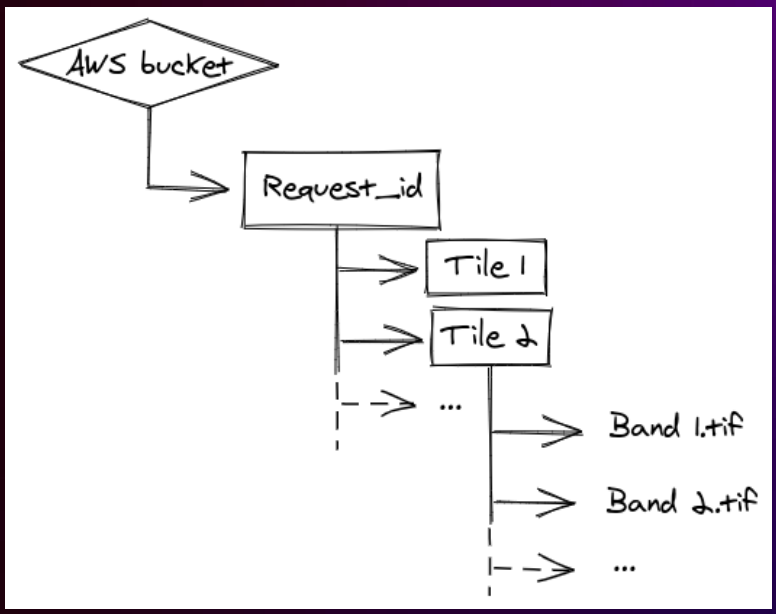
    const visualizer = new ColorRampVisualizer(maxNDVIcolors);

    function evaluatePixel(samples) {
        var max = 0
        for (var i = 0; i < samples.length; i++) {
            var ndvi = calcNDVI(samples[i])
            max = ndvi > max ? ndvi : max
        }
        ndvi = max
        return visualizer.process(ndvi)
    }
"""
```

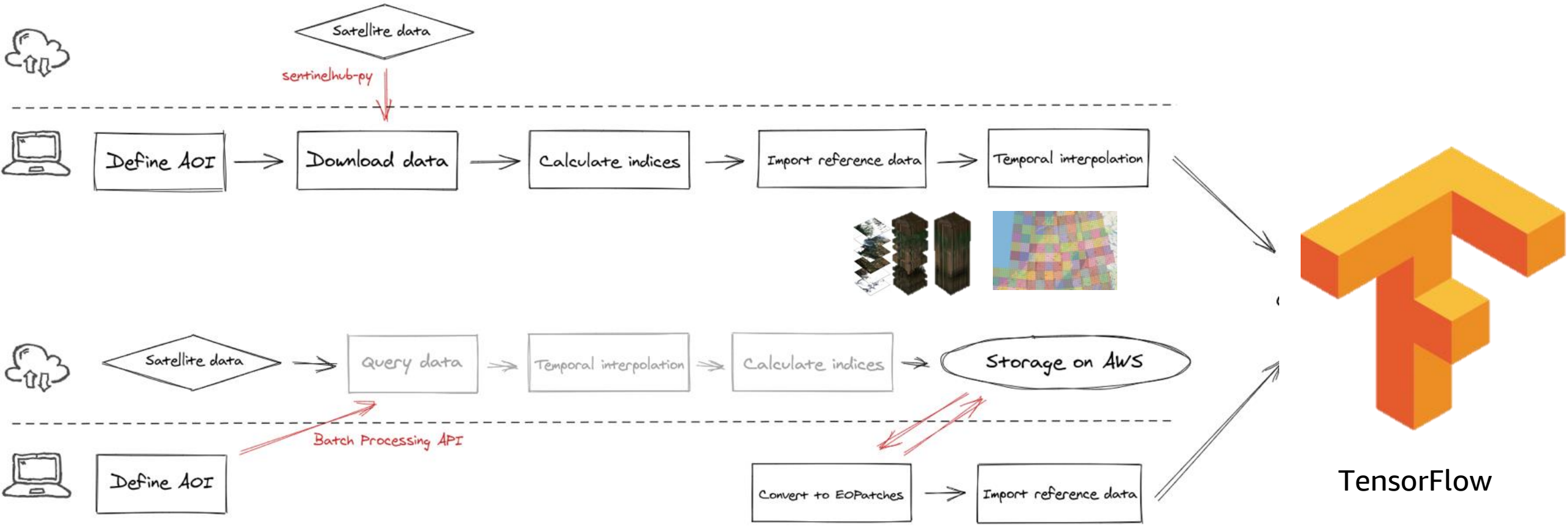
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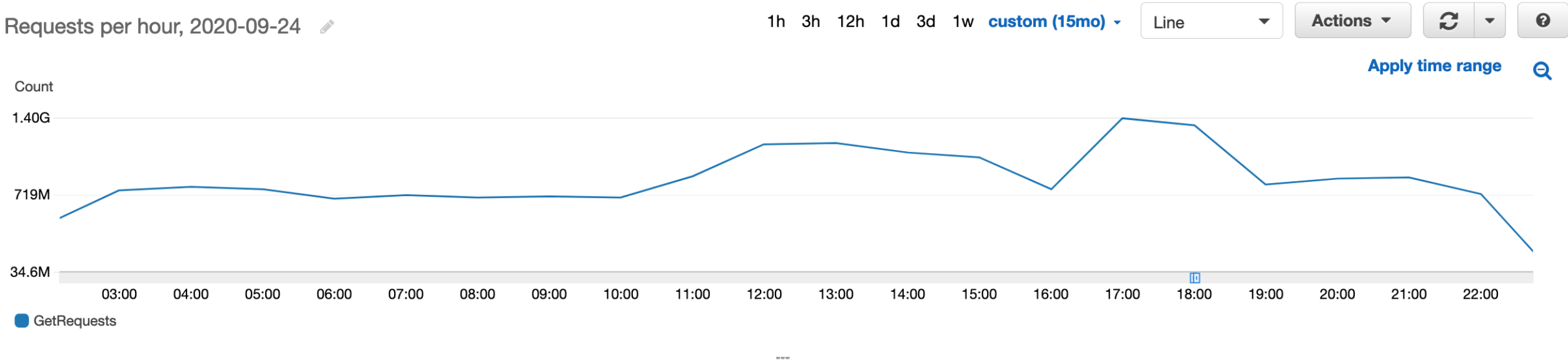



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# 400.000 requests per second



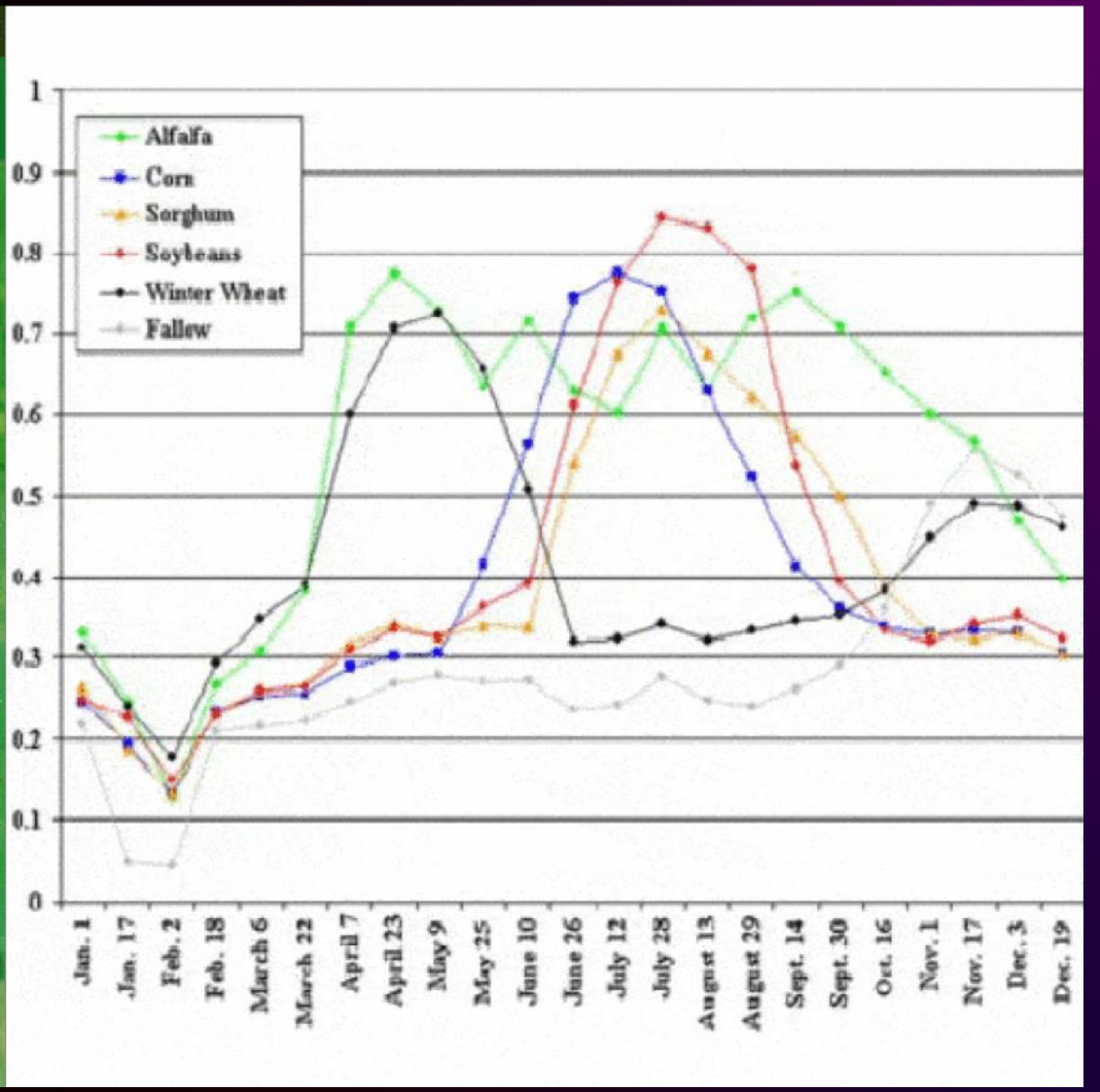

**When I make requests to my Amazon S3 bucket, I get a 503 Slow Down response. How can I avoid this request throttling from Amazon S3?**

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# Use case #2
# Monitoring of agriculture activities on field level

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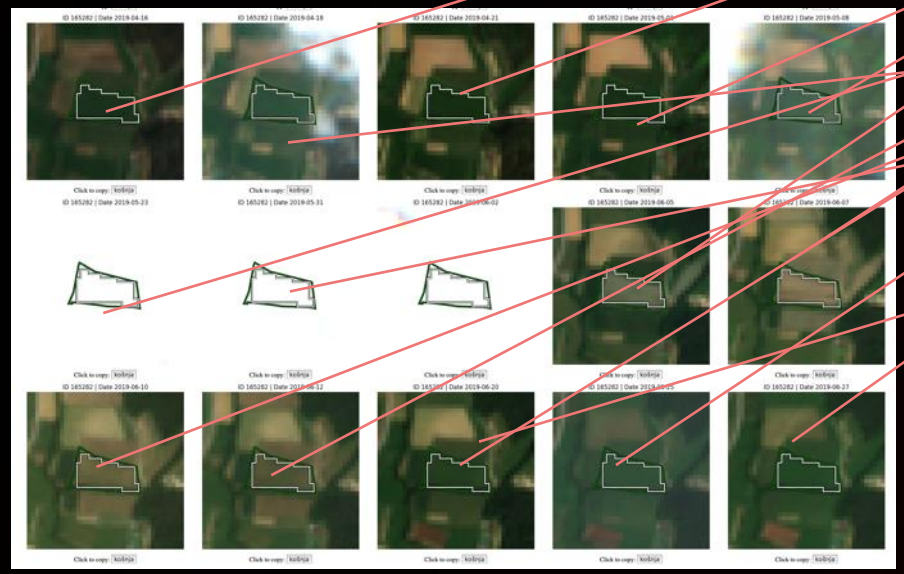

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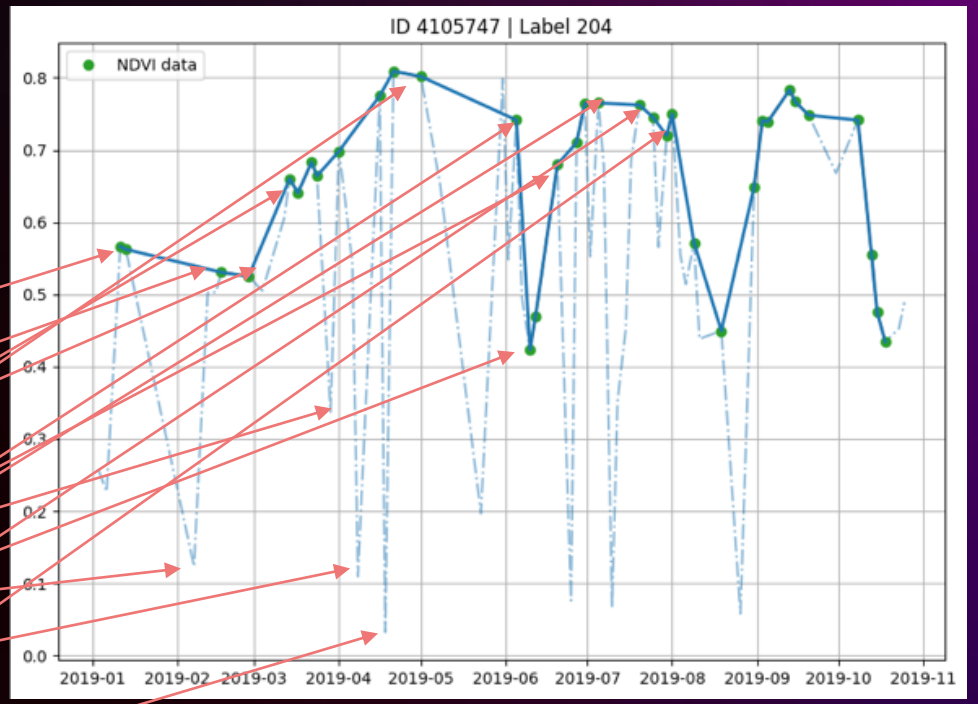



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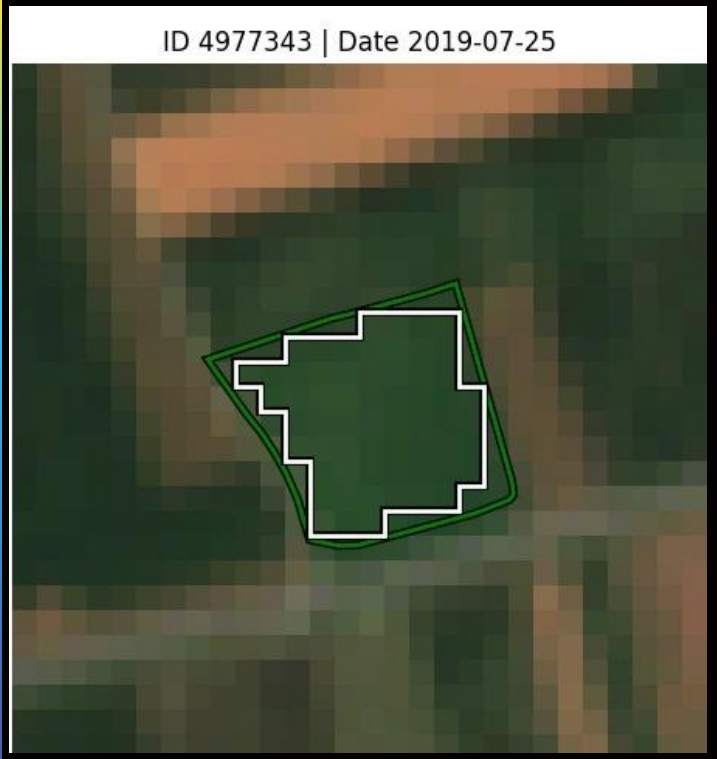
# Parcel’s time-series





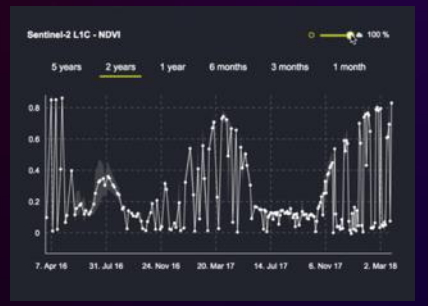

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# Parcel statistics instead of pixel values





```
{'data': [{'interval': {'from': '2020-07-04T00:00:00Z',
    'to': '2020-07-05T00:00:00Z'},
   'outputs': {'output_B04': {'bands': {'B0': {'stats': {'min': 0.07970000058412552,
        'max': 0.309599995613098l4,
        'mean': 0.114711419867788l4,
        'stDev': 0.034298170449733226,
        'sampleCount': 3240,
        'noDataCount': 0,
        'percentiles': {'33.0': 0.09709999710321426,
         '50.0': 0.10360000282526016,
         '75.0': 0.11940000206232071,
         '90.0': 0.16040000319480896}},
       'histogram': {'bins': [{'lowEdge': 0.0, 'highEdge': 0.06, 'count': 0},
         {'lowEdge': 0.06, 'highEdge': 0.12, 'count': 2458},
         {'lowEdge': 0.12, 'highEdge': 0.18, 'count': 558},
         {'lowEdge': 0.18, 'highEdge': 0.24, 'count': 177},
         {'lowEdge': 0.24, 'highEdge': 0.3, 'count': 44}],
        'overflowCount': 0,
        'underflowCount': 3}}}}}],
 'status': 'OK'}
```

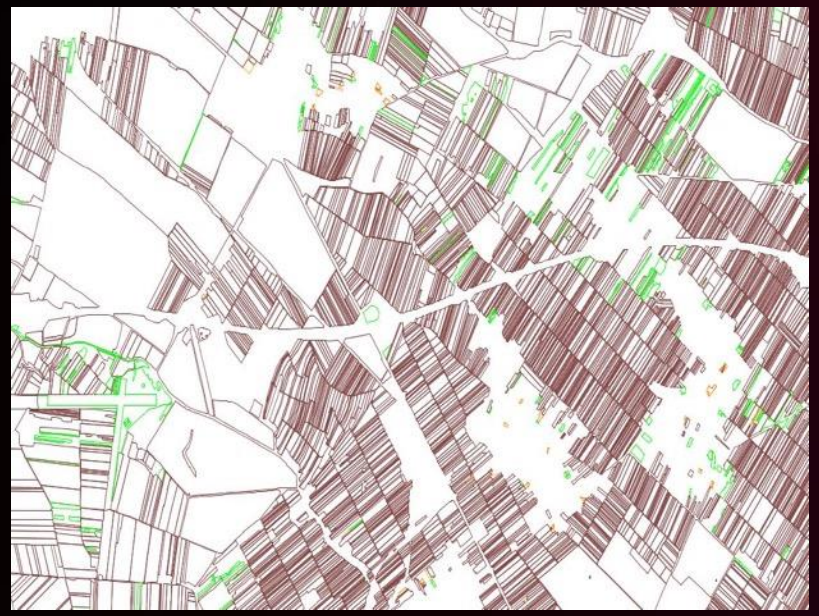




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# Millions of parcels

```
evalscript = """
//VERSION=3
function setup() {
  return {
    input: [{bands: ["B04", "B08", "SCL", "dataMask"]}],
    output: [
      {id: "data", bands: 1},
      {id: "dataMask", bands: 1}]
  }
}
function evaluatePixel(samples) {
    let ndvi = (samples.B08 - samples.B04)/(samples.B08 + samples.B04)
    var validNDVIMask = 1
    if (samples.B08 + samples.B04 == 0 ){
        validNDVIMask = 0
    }
    var noWaterMask = 1
    if (samples.SCL == 6 ){
        noWaterMask = 0
    }
    return {
        data: [ndvi],
        dataMask: [samples.dataMask * validNDVIMask * noWaterMask]
    }
}
"""
```

+

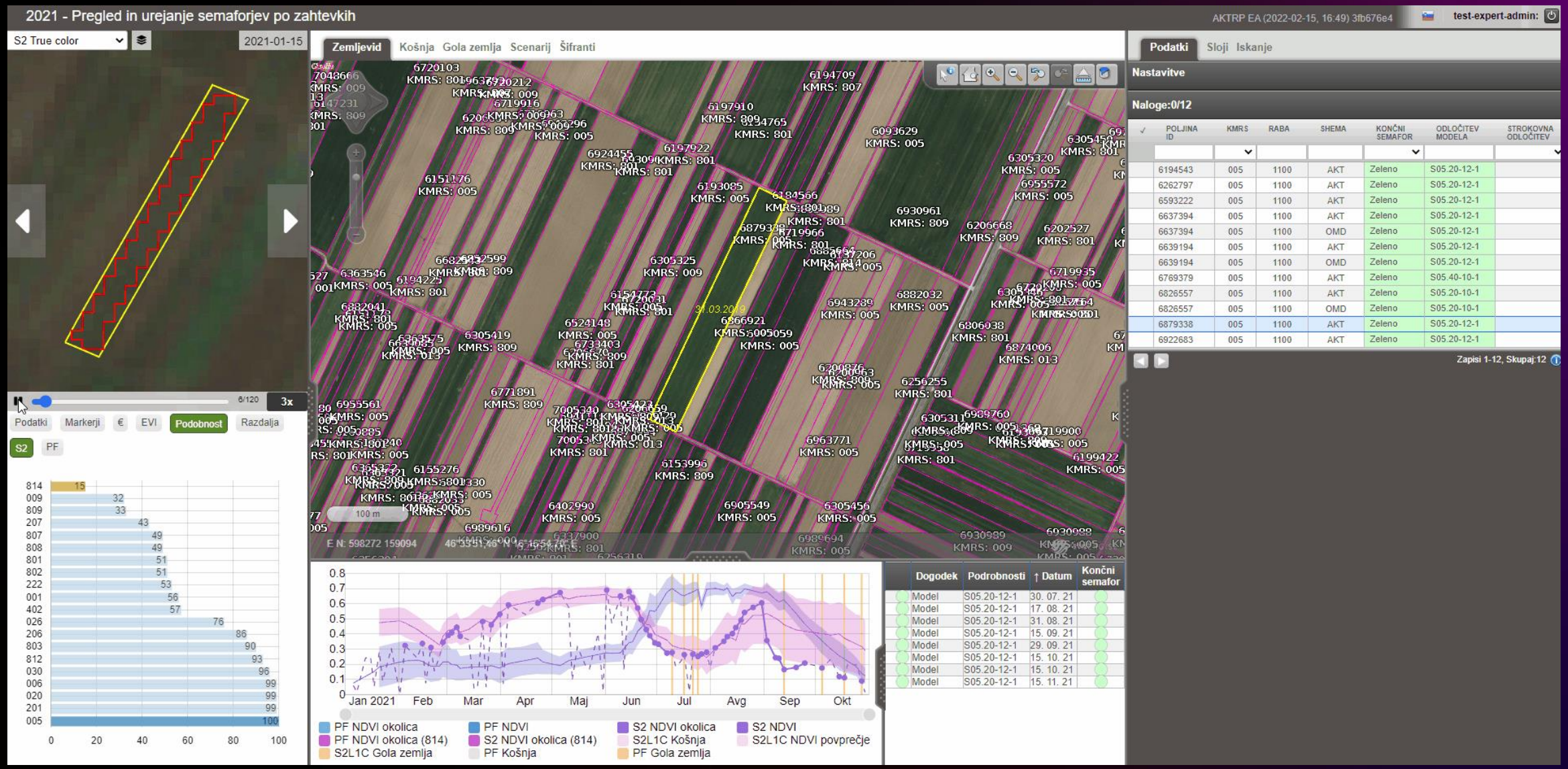


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```
{'data': [
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  'outputs': {'data': {'bands': {'B0': {'stats': {
       'min': 0.24306687712669373,
       'max': 0.6244725584983826,
       'mean': 0.4123224201824293,
       'stDev': 0.055874589607421886,
       'sampleCount': 3036,
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  'outputs': {'data': {'bands': {'B0': {'stats': {
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       'max': 0.4233206510543823,
       'mean': 0.3160828609431641,
       'stDev': 0.02807725936362711,
       'sampleCount': 3036,
       'noDataCount': 1192}}}}},
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  'outputs': {'data': {'bands': {'B0': {'stats': {
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       'max': 0.8021259307861328,
       'mean': 0.5844831434836089,
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       'sampleCount': 3036,
       'noDataCount': 1192}}}}},
 {'interval': {'from': '2020-03-31', 'to': '2020-04-30'},
  'outputs': {'data': {'bands': {'B0': {'stats': {
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       'max': 0.8266128897666931,
       'mean': 0.6615912824901472,
       'stDev': 0.05539347152437238,
       'sampleCount': 3036,
       'noDataCount': 1192}}}}}],
 'status': 'OK'}
```

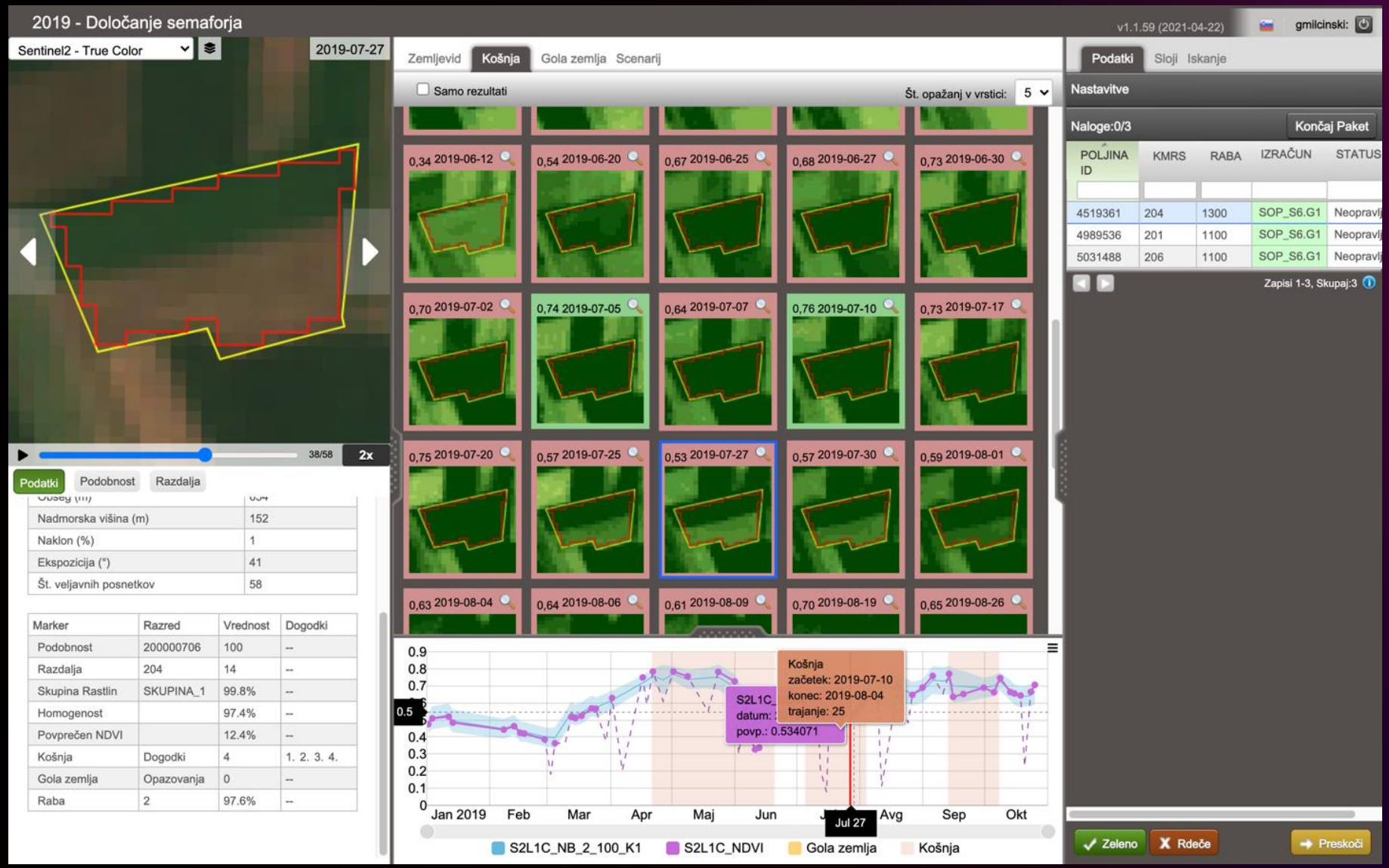

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# Anomaly detection



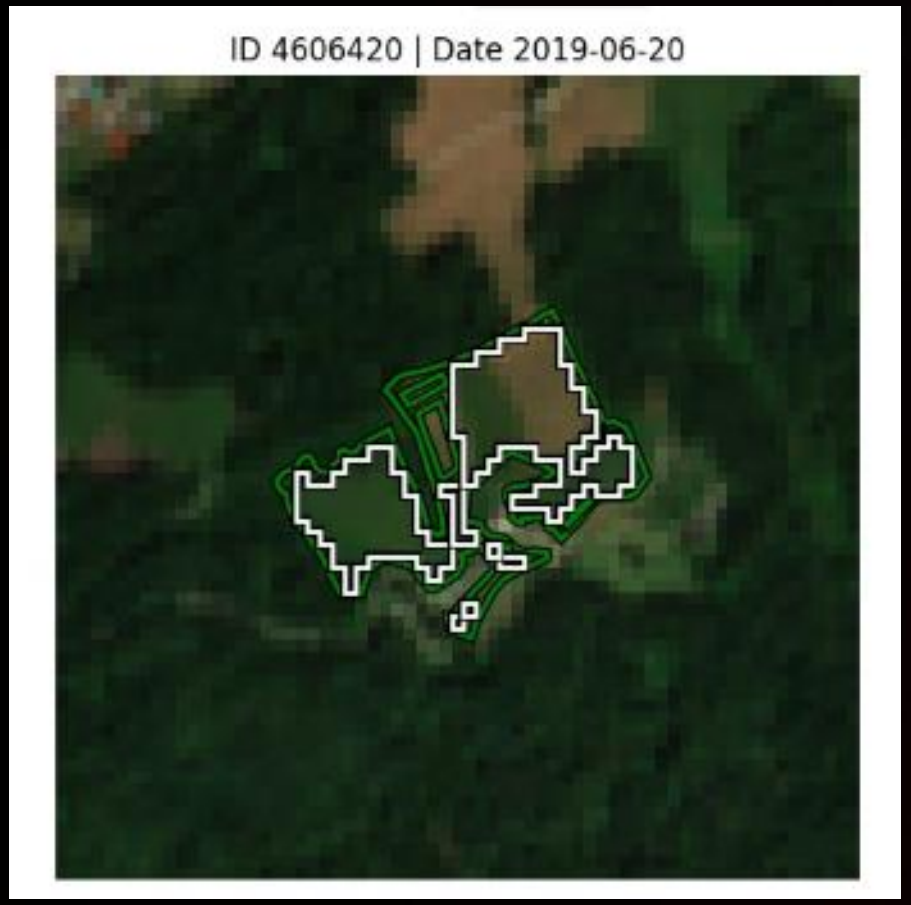

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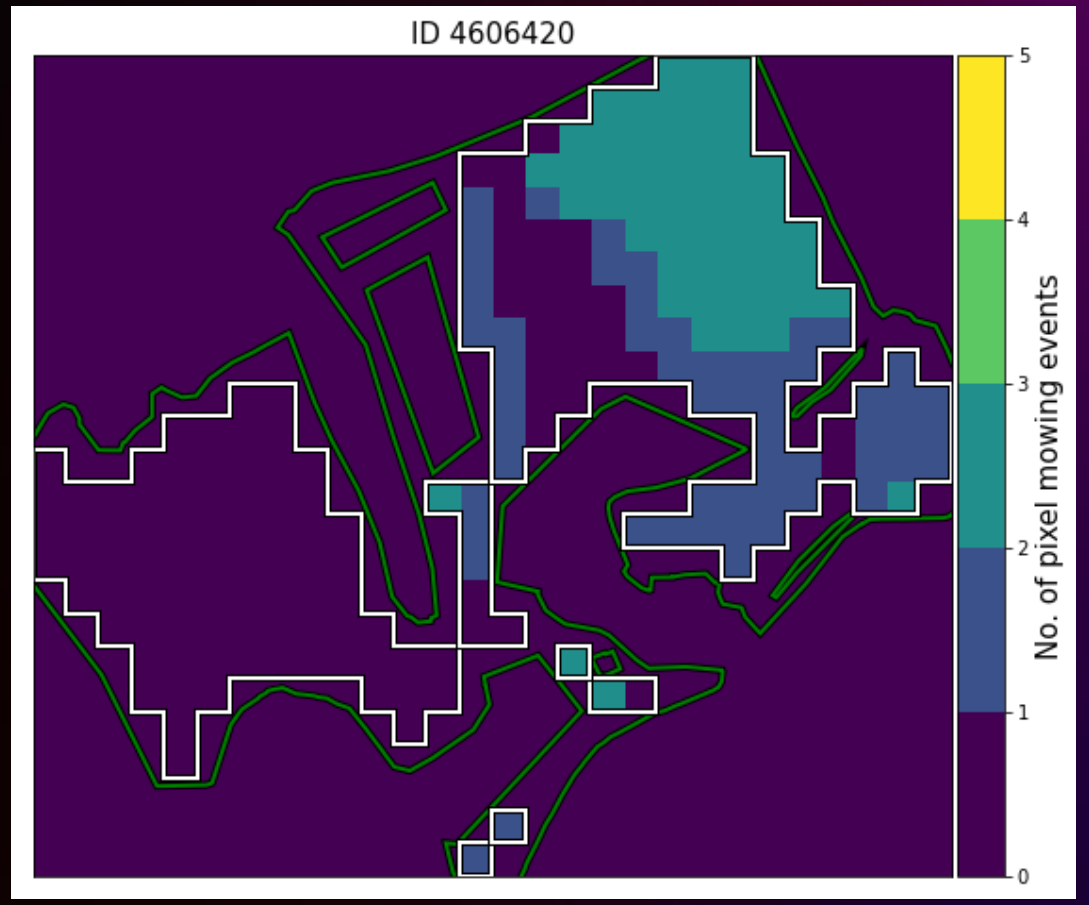
# ML models on parcel level




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# ML models on pixel level




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# Additional resources

- https://sentinel-hub.com
- https://apps.sentinel-hub.com/eo-browser
- https://github.com/sentinel-hub/eo-learn
- https://medium.com/sentinel-hub

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# Do you have some interesting challenge related to EO data that would be worth dissecting in this forum?

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# Thank you!

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@sentinel_hub

Ajit Rajdeosingh
ajitsr@amazon.com



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