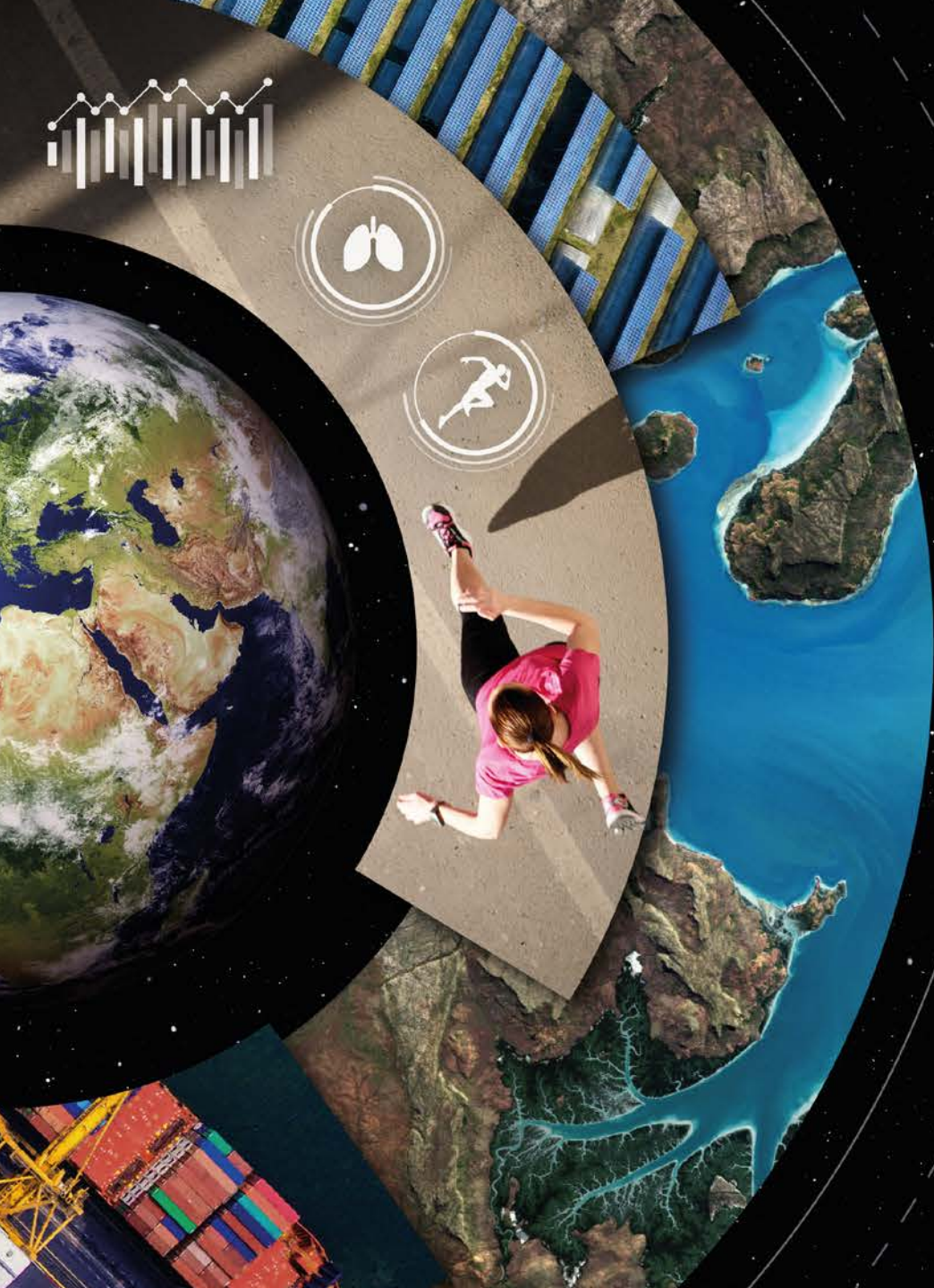




SENTINEL Hub
by SINERGISE

→ Guidelines

- Guidelines how/when to interact during the WebEx session:
 - Due to the number of attendees, please keep always your webcam and microphone switched-off
 - You can use anytime the “chat to all” function to submit your questions that will be then addressed at the end of the Webinar



**→ YOUR BUSINESS
POWERED BY SPACE**

Roberto Cossu

roberto.cossu@esa.int
business.esa.int

European Space Agency

→ THE EUROPEAN SECTOR IS POWERED BY SPACE



Earth Observation

Satellite Navigation

Satellite Communication

Human Space Flights Technologies

Who are we

→ A European funding programme



We have **€195m**
available for funding



€190m
in over



500 European
Businesses

And we have invested...



What we offer

→ Support to propel your business with Space



Zero-Equity
Funding



Technical & Commercial
Guidance



Access to Our Network
& Partners



Use of the ESA
Brand for
Credibility



Earth Observation



Satellite Navigation



Satellite Communication



Human Space Flights
Technologies



European Space Agency

Space for ...

→ YOUR BUSINESS



Satellite Navigation

- Global Positioning
- Navigation
- Timing



Satellite Communication

- Communication on the move
- Deployable connectivity
- Unprecedented speeds



Earth Observation

- Digital Mapping
- Global coverage
- Hi-res imagery
- Weather forecasting



Space for ...

→ YOUR BUSINESS



**Satellite
Navigation**



**Satellite
Communication**



**Earth
Observation**

- Digital Mapping
- Global coverage
- Hi-res imagery
- Weather forecasting



Earth Observation

→ Land monitoring 1/2

Forestry: clear-cut and partial-cut detection, forest type classification, biomass estimation, mapping of forest fire ...

Agriculture and precision farming: Monitoring of crop conditions, soil properties and mapping tillage activities →

- help to assess land use,
- predict harvests,
- monitor seasonal changes and
- assist in implementing policy for sustainable development.



Earth Observation

→ Land monitoring 2/2

Characterisation of Vegetation: extensive range of parameters characterising vegetation like NDVI, FaPAR

Snow and Ice monitoring: snow and ice classification, sea-ice and ice thickness monitoring

River and lakes: river and lake water levels, extensive range of parameters, e.g. chlorophyll



Earth Observation

→ Marine Monitoring

Ship Monitoring: detection and location of ships

Oil Pollution Monitoring

Marine and Coastal Monitoring: built up-areas, coastal erosion, sea surface temperature, geophysical parameters of the water including population by phytoplankton biomass

Marine Winds: direction, wavelength and heights of waves on the open oceans

Ocean Colour: sea surface temperature, geophysical parameters of the water

Sea Ice: tracking of glaciers and icebergs

Earth Observation

→ Emergency Management

Flood monitoring: assessment of the extent of flooded areas and the impact on human, economic and environmental loss

Extreme weather events

Subsidence, landslides and volcano monitoring: monitor surface deformation to provide early warning of potential disasters and monitoring of critical infrastructure

Earthquakes: medium and high-resolution maps of earthquake deformations

Forest fires

Oil Spills



business
applications

Earth Observation

→ Security, Climate Change, Atmospheric monitoring

Security: Maritime Surveillance, border control

Climate Change: Land Monitoring, Marine Environmental Monitoring, Atmospheric Monitoring, Essential Climate Variables

Atmospheric monitoring: including Greenhouse Gases, Ozone and Solar UV Radiation, Aerosols



Earth Observation

→ Example

In the URGED project Rezatec Ltd has developed a suite of services for detecting, monitoring and predicting water infrastructure failures and pipeline leakage signals

- EO data - Terrain Motion

- EO data - Vegetation encroachment

- Other data: use of historic burst, leak event data associated with corresponding pipeline attributes to model individual pipe segment failure probabilities.

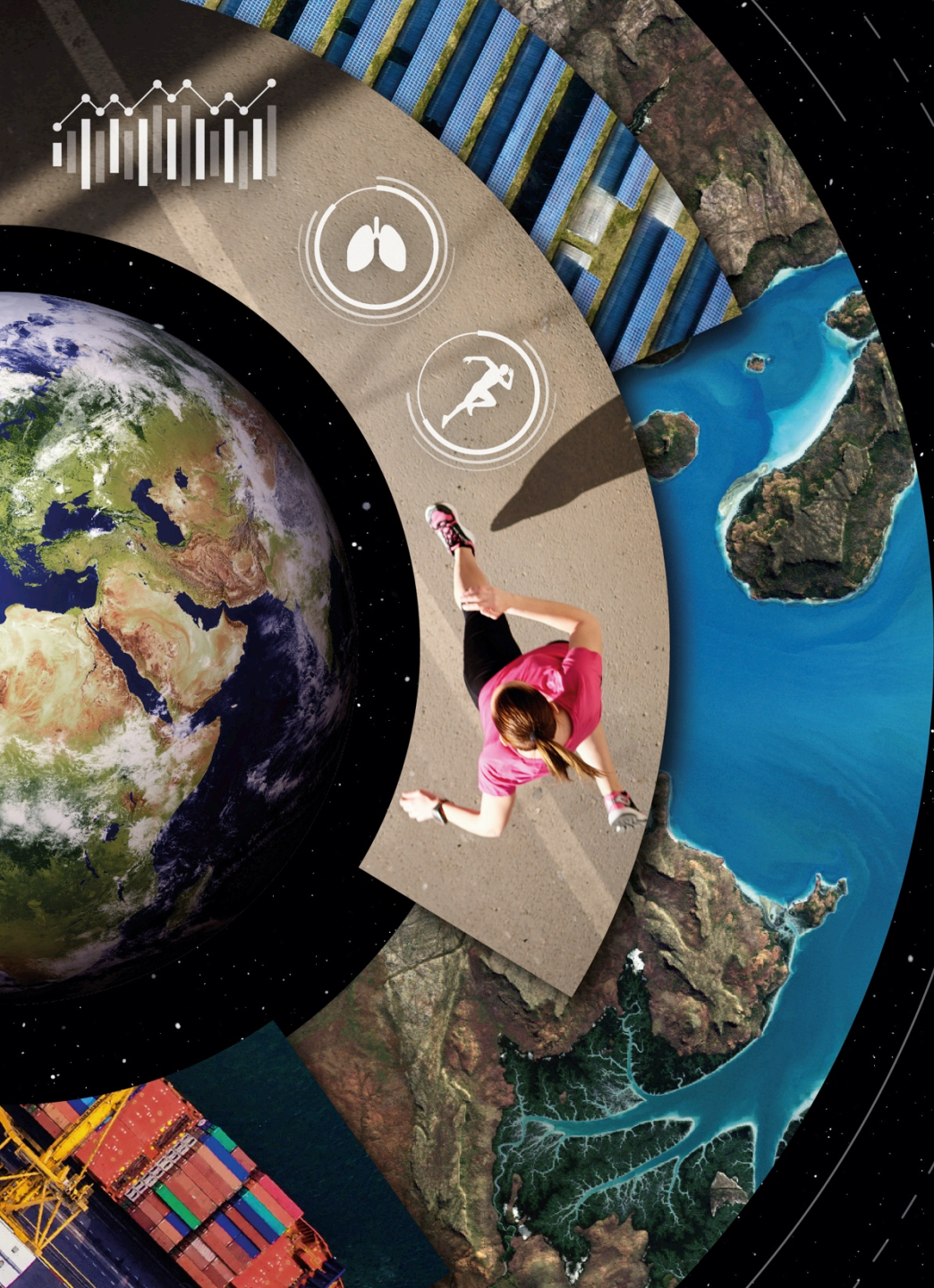
- Pipeline Failure Risk

→ business.esa.int/projects/URGED





→ YOUR BUSINESS POWERED BY SPACE



Sentinel Hub

Grega Milcinski, Sinergise

Enormous data availability

COPERNICUS AND ITS SENTINELS

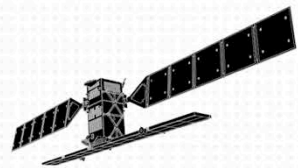
European Earth Observation Programme Copernicus: observing our planet for a safer world

-  Known as **GMES** until 2012 - Global Monitoring for Environment and Security
-  **30** Public and Private missions are also contributing data
-  **16** years of development and testing
-  **Sentinel-Missions** at the heart of the space component
-  **Civil Security.** Allowing early warning and crisis prevention in conflict and disaster areas
-  **Emergency Management.** Accurate and timely data for emergency plans and rescue for disaster management
-  **Land Surface Monitoring.** Geographical information on land cover, related variables and urban development
-  **Marine Environmental Monitoring.** Observations and forecasts on the state of the physical oceans and regional seas
-  **Climate Change Monitoring.** Helps to understand the reason for climate change, rising sea levels and melting ice caps
-  **Earth Atmosphere Monitoring.** Daily information on the global atmospheric composition and when Sentinel-4 is in service this will be hourly

SENTINEL-1



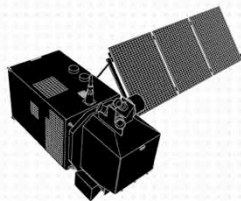
- **All-weather, day-and-night radar imaging satellite for land and ocean services**
- Able to "see" through clouds and rain
- Data delivery within 1 hour of acquisition
- Airbus Defence and Space developed C-band radar instrument



SENTINEL-2



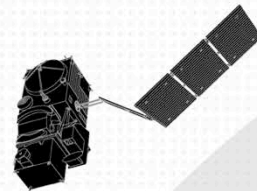
- **Medium Res Multispectral optical satellite for observation of land, vegetation and water**
- 13 spectral bands with 10, 20 or 60 m resolution and 290 km swath width
- Global coverage of the Earth's land surface every 5 days
- Airbus Defence and Space prime contractor for satellites and instruments



SENTINEL-3



- **Measures sea-surface topography with a resolution of 300 m, sea and land surface temperature and colour with a resolution of 1 km**
- Measures water vapour, cloud water content and thermal radiation emitted by the Earth
- Determines global sea surface temperatures with an accuracy greater than 0.3 K
- Airbus Defence and Space supplies Microwave Radiometer



SENTINEL-5P



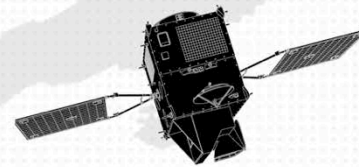
- **Global observation of key atmospheric constituents, including ozone, nitrogen dioxide, sulphur dioxide and other environmental pollutants**
- Improves climate models and weather forecasts
- Provides data continuously during five-year gap between the retirement of Envisat and the launch of Sentinel-5
- Airbus Defence and Space prime contractor for satellite and TROPOMI instrument



SENTINEL-4



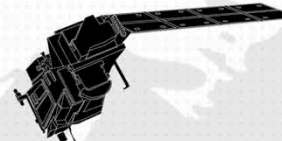
- **Provides hourly updates on air quality with data on atmospheric aerosol and traces gas concentrations**
- Spatial sampling is 8 km and spectral resolution between 0.12 nm and 0.5 nm
- Airbus Defence and Space prime contractor for spectrometer
- Carried aboard EUMETSAT's Meteosat Third Generation (MTG) satellites



SENTINEL-5



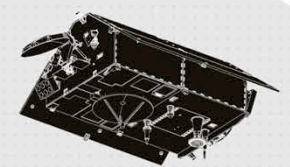
- **Measures air quality and solar radiation, monitors stratospheric ozone and the climate**
- Global coverage of Earth's atmosphere with an unprecedented spatial resolution
- Airbus Defence and Space prime contractor for instrument
- Carried aboard EUMETSAT's MetOp Second Generation satellites



SENTINEL-6



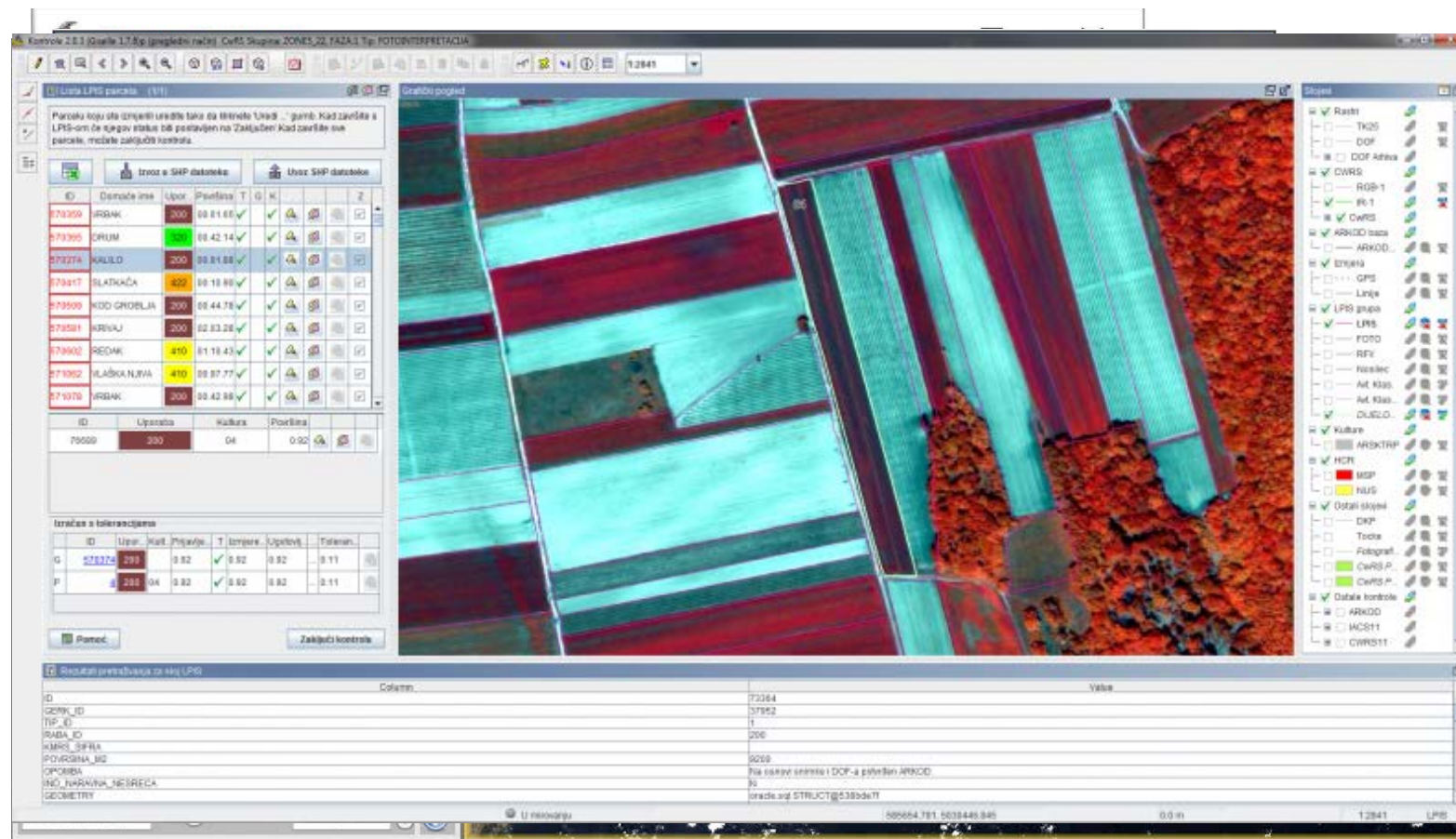
- **Observes changes in sea surface height with an accuracy of a few centimeters**
- Global mapping of the sea surface topography every 10 days
- Enables precise observation of ocean currents and ocean heat storage; vital for predicting rises in sea levels
- Airbus Defence and Space prime contractor for satellite



2014

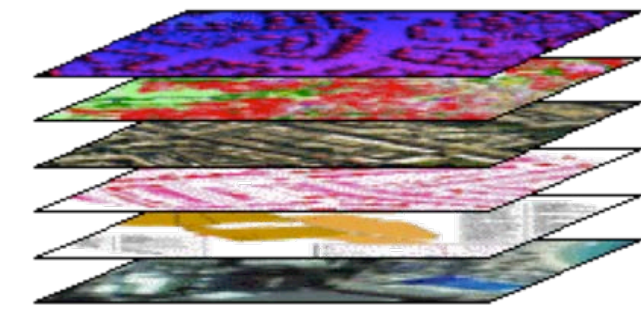
2020

Manual processing no longer feasible

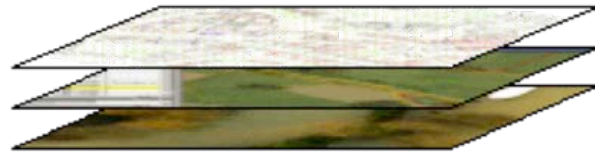


RGB Composite

Open EO data - Sentinel-1, Sentinel-2, Landsat, etc.



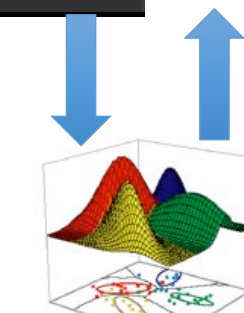
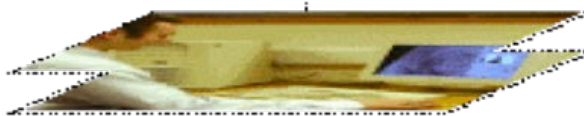
Commercial EO data – WorldWind, GeoEye,...



Aerial imagery (drone, plane)



Other raster data



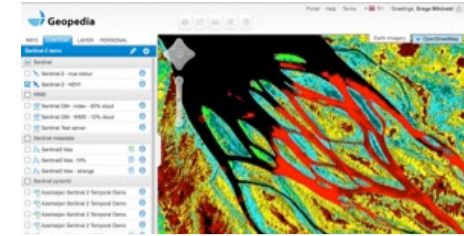
Machine learning

WMTS

WMS

WCS

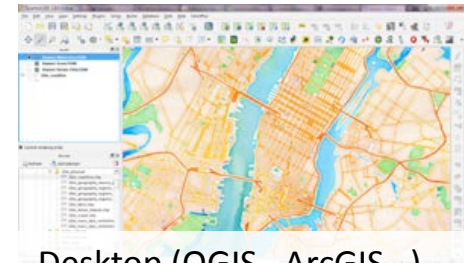
API



Cloud GIS



Web / Mobile apps

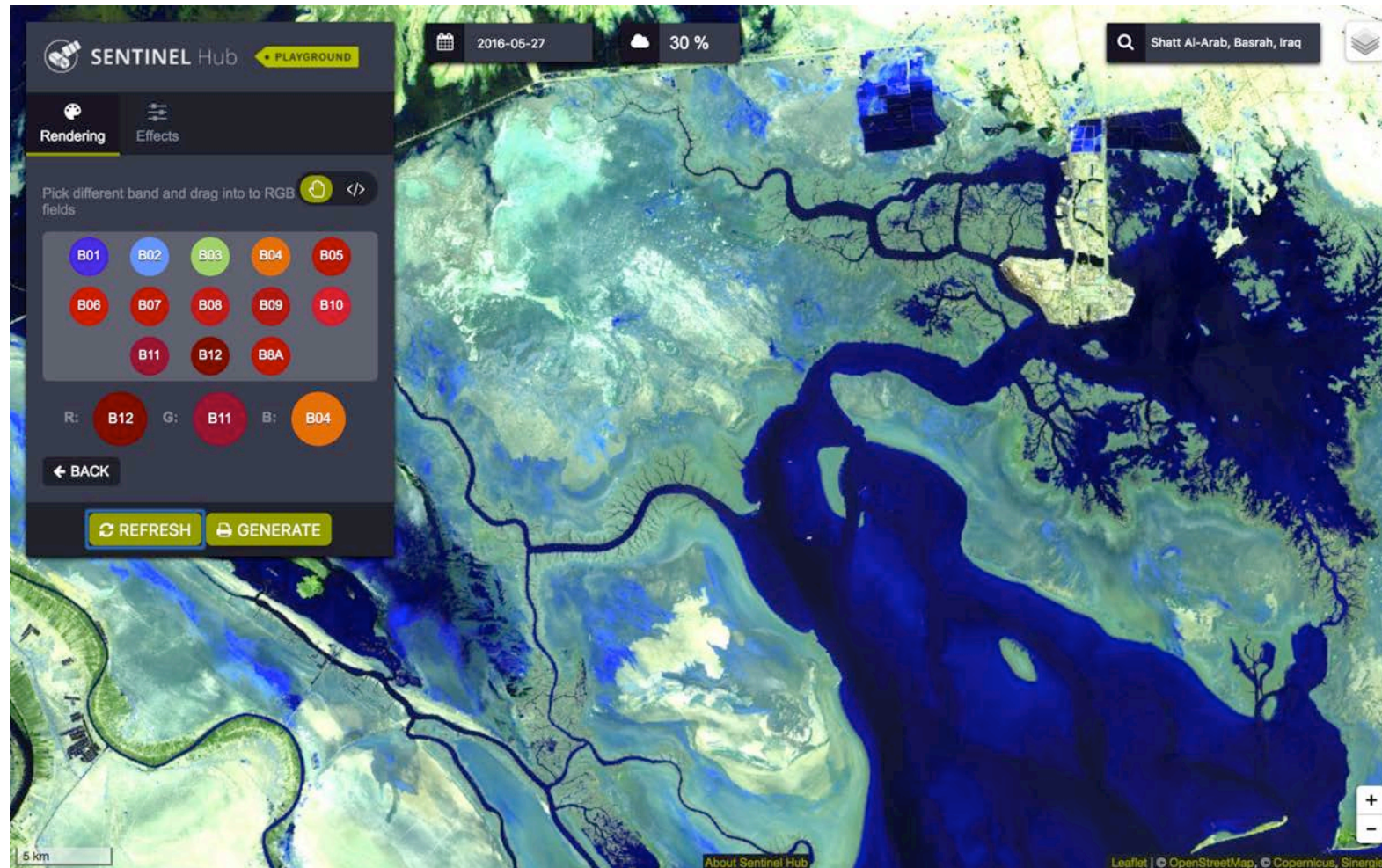


Desktop (QGIS,, ArcGIS...)



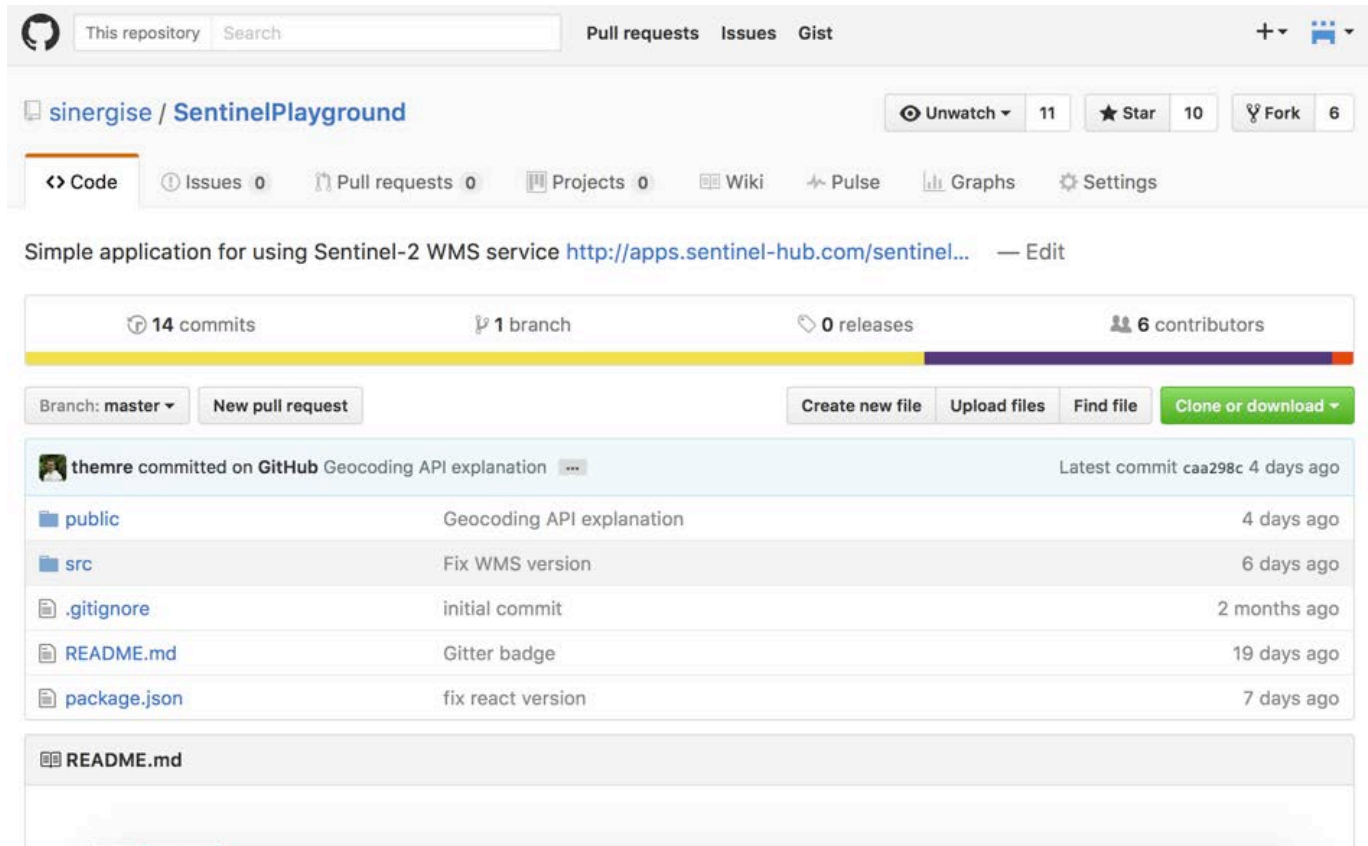
Scripting
(R, Python, ENVI...)

App example – Sentinel Playground



<http://apps.sentinel-hub.com/sentinel-playground/>

Sentinel Playground on GitHub

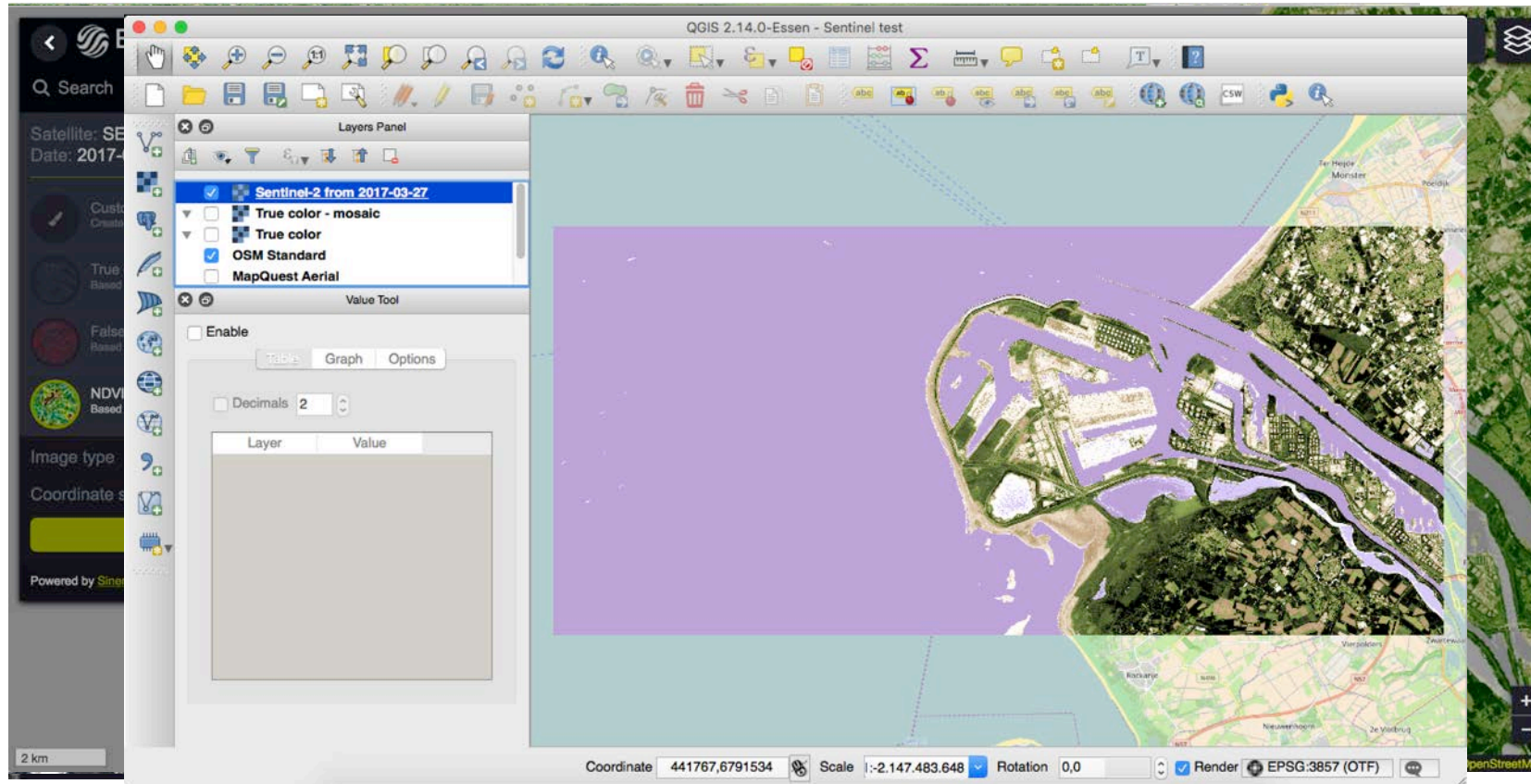


The screenshot shows the GitHub repository page for `sinergise / SentinelPlayground`. The repository has 11 stars, 10 forks, and 6 contributors. It contains 14 commits, 1 branch, and 0 releases. The repository is described as a "Simple application for using Sentinel-2 WMS service" with a link to <http://apps.sentinel-hub.com/sentinel...>. The repository is currently on the `master` branch. The commit history shows the following files and their commit dates:

| File | Commit Message | Commit Date |
|---------------------------|---------------------------|--------------|
| <code>public</code> | Geocoding API explanation | 4 days ago |
| <code>src</code> | Fix WMS version | 6 days ago |
| <code>.gitignore</code> | initial commit | 2 months ago |
| <code>README.md</code> | Gitter badge | 19 days ago |
| <code>package.json</code> | fix react version | 7 days ago |

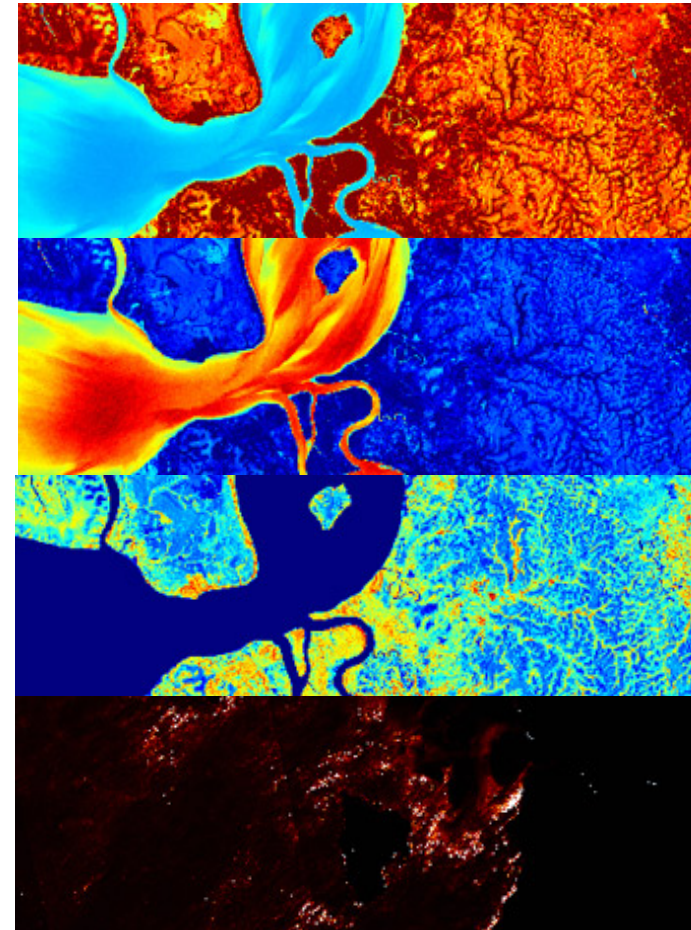
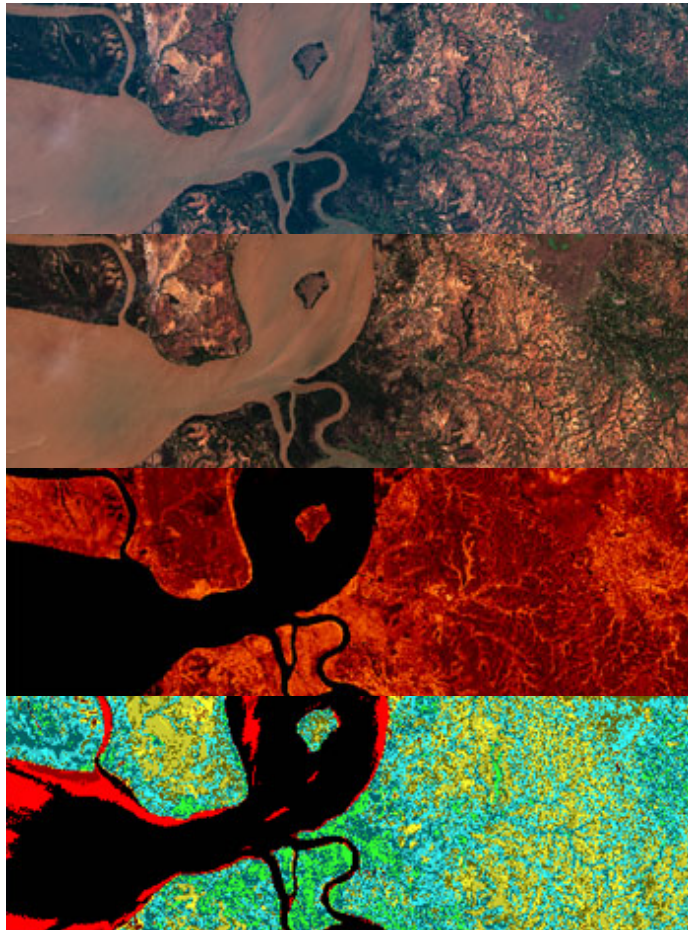
<https://github.com/sinergise/SentinelPlayground>

App example – EO Browser



<http://apps.sentinel-hub.com/eo-browser/>

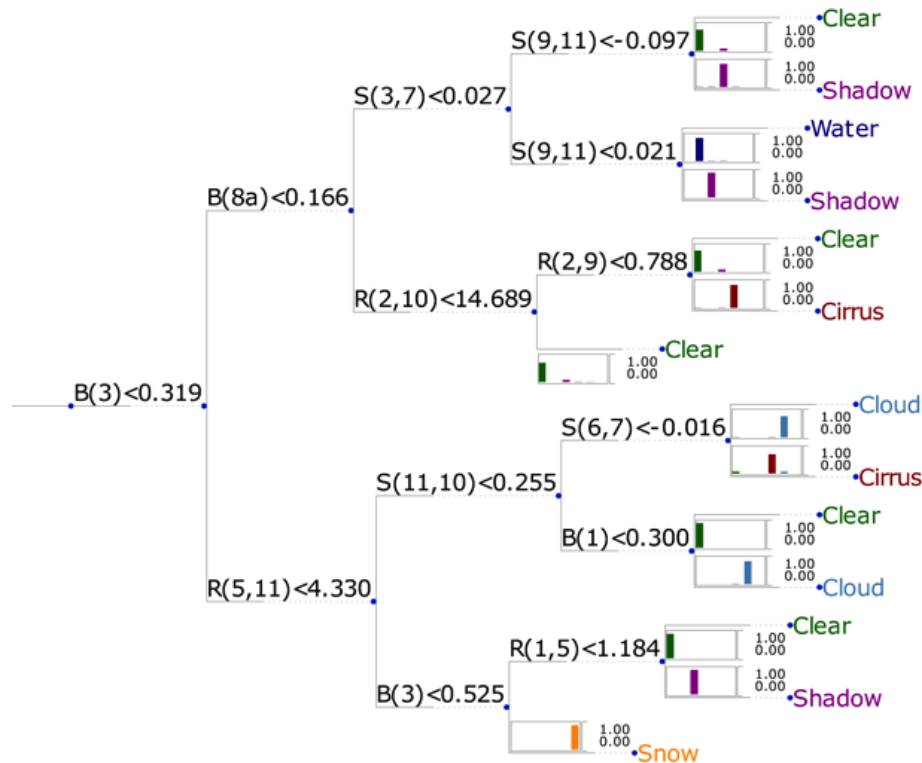
E0 Product Templates



Custom scripting

Hollstein et. al: *Ready-to-Use Methods for the Detection of Clouds, Cirrus, Snow, Shadow, Water and Clear Sky Pixels in Sentinel-2 MSI Images*

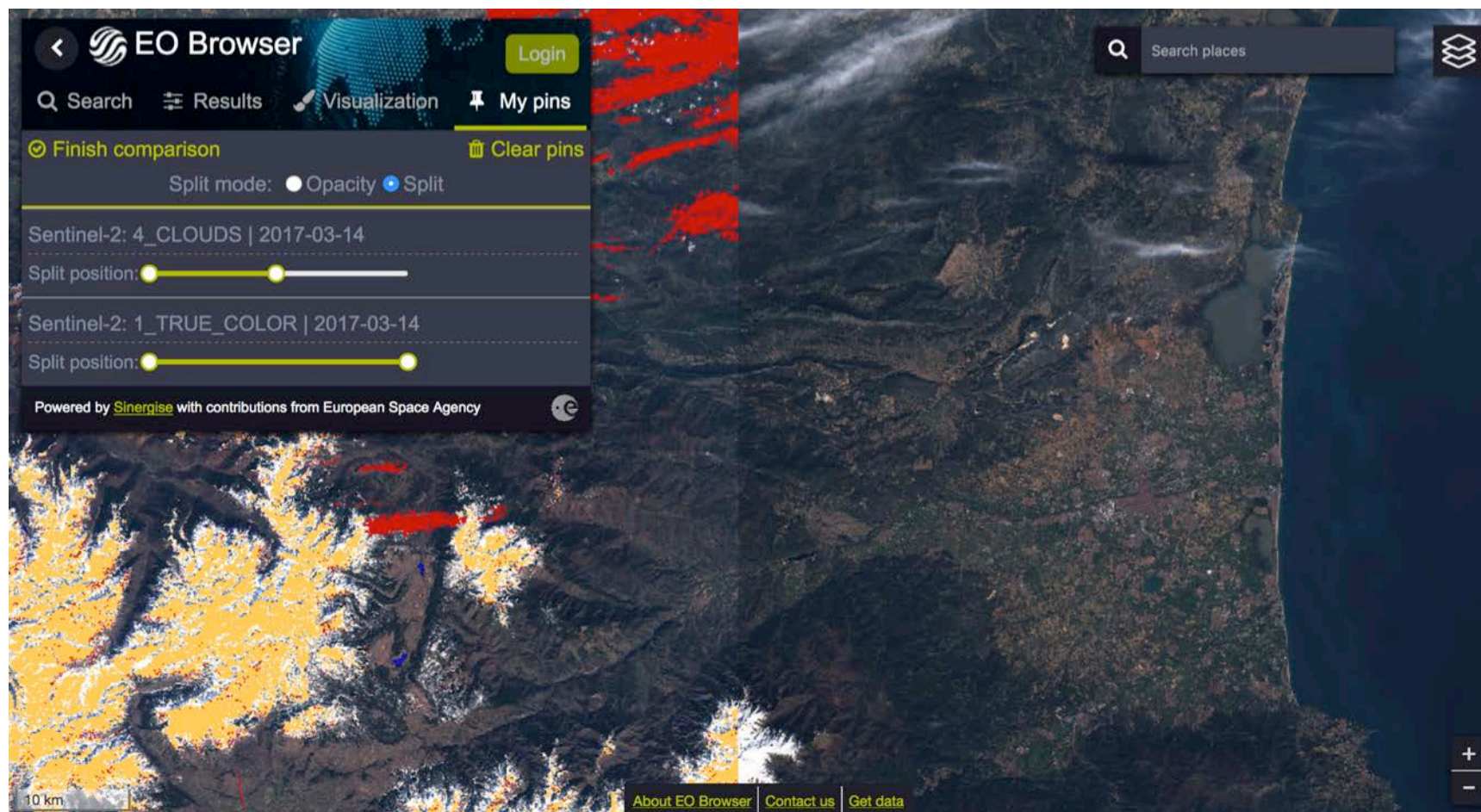
<http://www.mdpi.com/2072-4292/8/8/666>



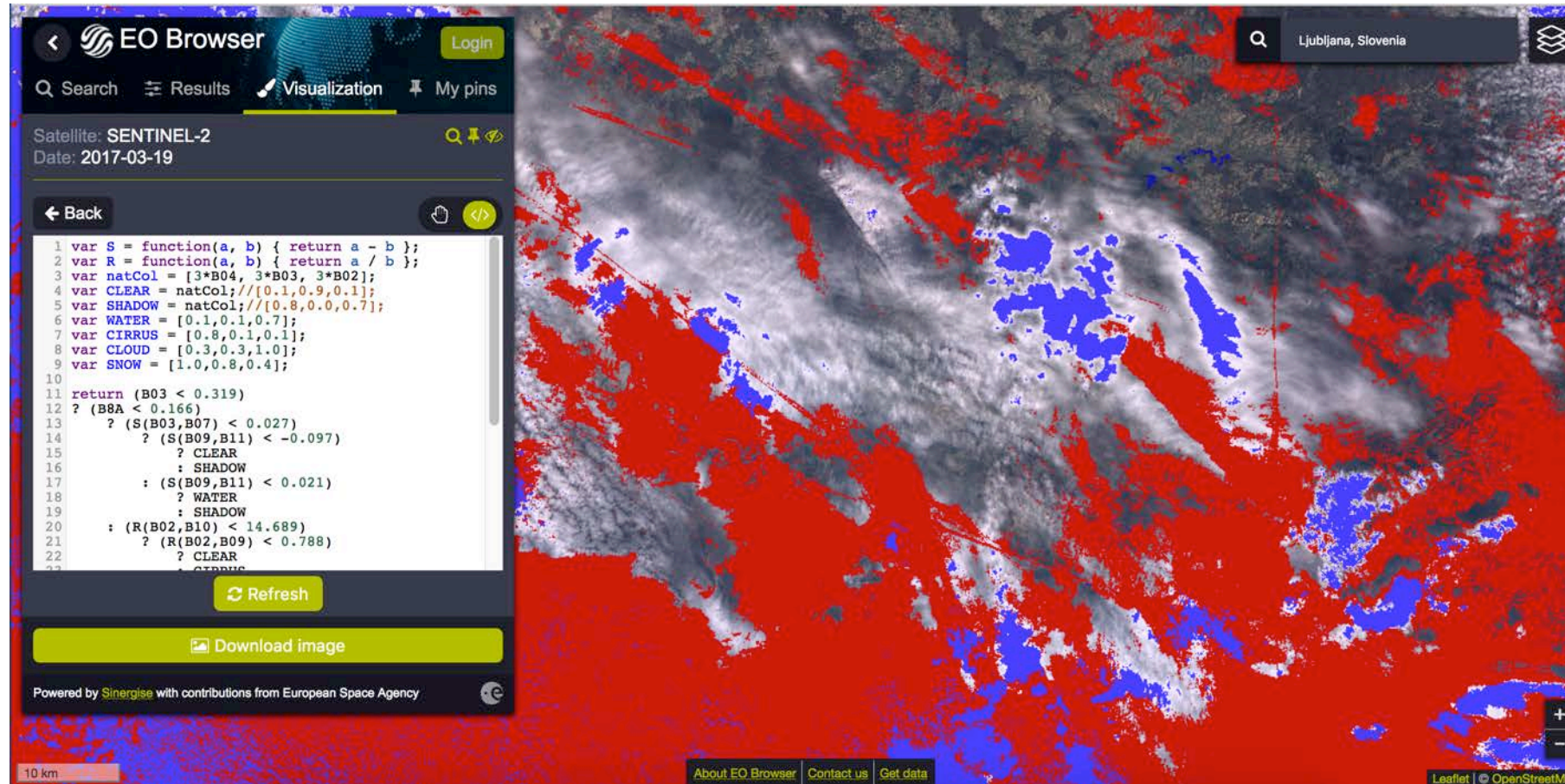
```
JavaScript
var S = function(a, b) { return a - b };
var R = function(a, b) { return a / b };
var natCol = [3*B04, 3*B03, 3*B02];
var CLEAR = natCol/[0.1,0.9,0.1];
var SHADOW = natCol/[0.8,0.0,0.7];
var WATER = [0.1,0.1,0.7];
var CIRRUS = [0.8,0.1,0.1];
var CLOUD = [0.3,0.3,1.0];
var SNOW = [1.0,0.8,0.4];

return (B03 < 0.319)
? (B8A < 0.166)
  ? (S(B03,B07) < 0.027)
    ? (S(B09,B11) < -0.097)
      ? CLEAR
      : SHADOW
    : (S(B09,B11) < 0.021)
      ? WATER
      : SHADOW
    : (R(B02,B10) < 14.689)
      ? (R(B02,B09) < 0.788)
        ? CLEAR
        : CIRRUS
      : CLEAR
  : (R(B05,B11) < 4.33)
    ? (S(B11, B10) < 0.255)
      ? (S(B06, B07) < -0.016)
        ? CLOUD
        : CIRRUS
      : (B01 < 0.3)
        ? CLEAR
        : CLOUD
    : (B03 < 0.525)
      ? (R(B01, B05) < 1.184)
        ? CLEAR
        : SHADOW
      : SNOW;
```

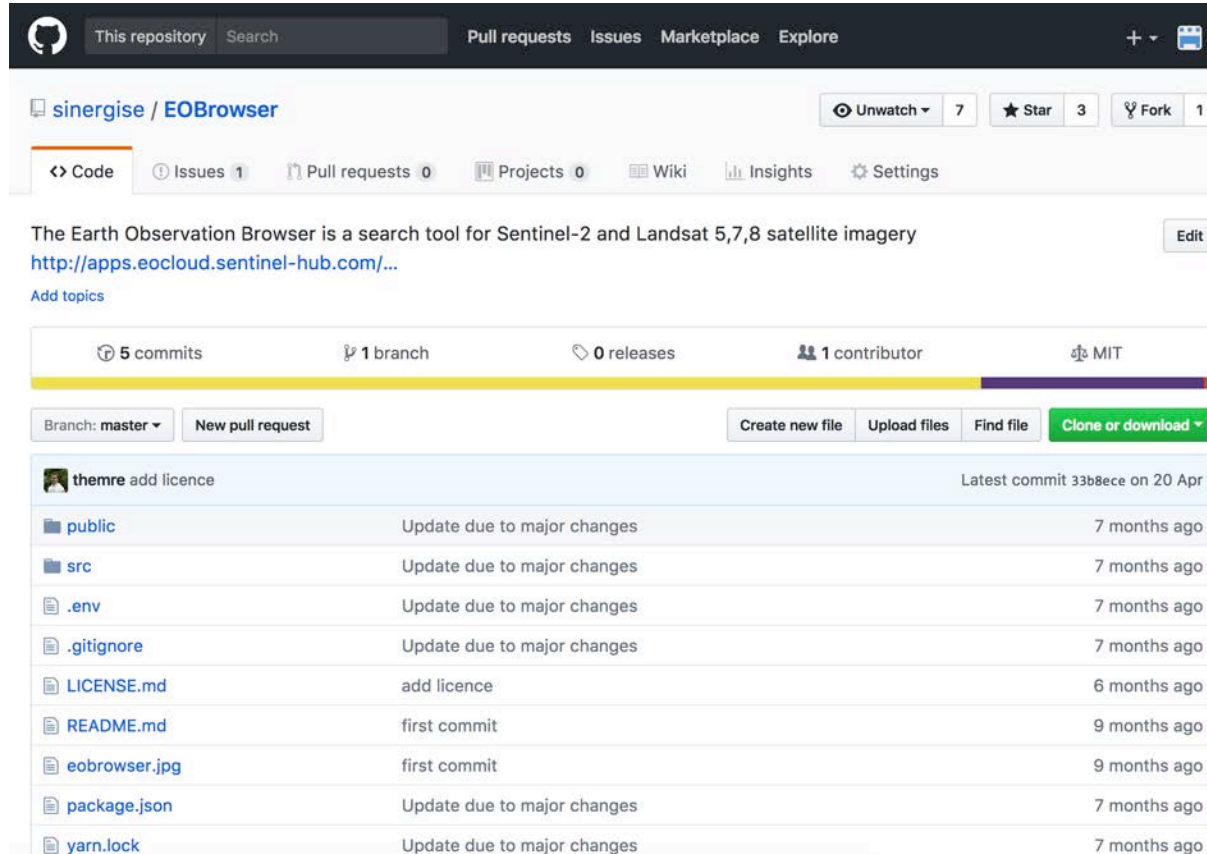

Custom scripting



Algorithm evaluation



EO Browser on GitHub

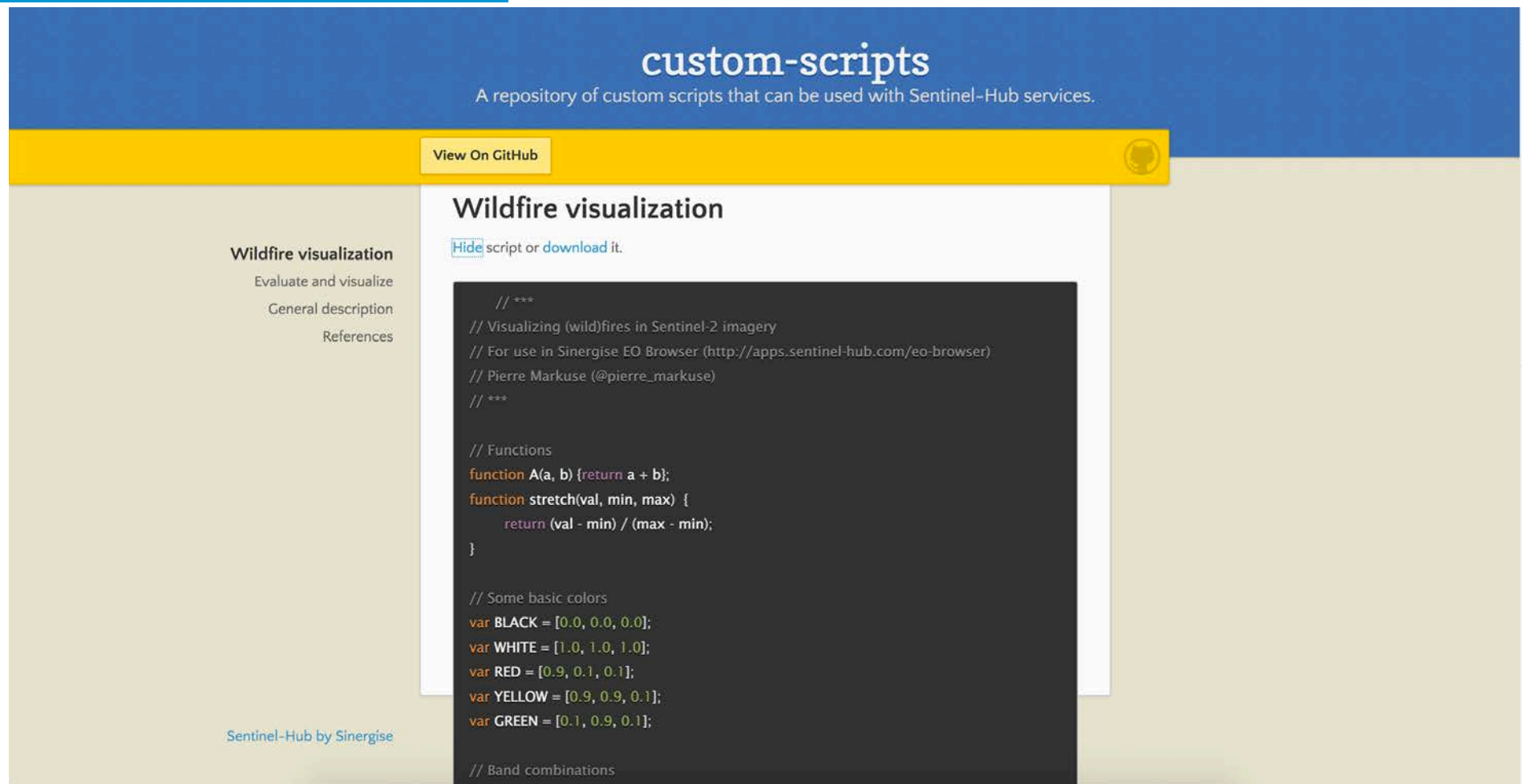


The screenshot shows the GitHub repository page for `sinergise / EOBrowser`. The repository is public and has 7 stars, 3 forks, and 1 pull request. The description states: "The Earth Observation Browser is a search tool for Sentinel-2 and Landsat 5,7,8 satellite imagery" with a link to <http://apps.eocloud.sentinel-hub.com/>. The repository has 5 commits, 1 branch, 0 releases, and 1 contributor. The latest commit is by `themre` with the message "add licence" on 20 Apr. The file list includes `public`, `src`, `.env`, `.gitignore`, `LICENSE.md`, `README.md`, `eobrowser.jpg`, `package.json`, and `yarn.lock`.

| File | Commit Message | Time Ago |
|----------------------------|-----------------------------|--------------|
| <code>public</code> | Update due to major changes | 7 months ago |
| <code>src</code> | Update due to major changes | 7 months ago |
| <code>.env</code> | Update due to major changes | 7 months ago |
| <code>.gitignore</code> | Update due to major changes | 7 months ago |
| <code>LICENSE.md</code> | add licence | 6 months ago |
| <code>README.md</code> | first commit | 9 months ago |
| <code>eobrowser.jpg</code> | first commit | 9 months ago |
| <code>package.json</code> | Update due to major changes | 7 months ago |
| <code>yarn.lock</code> | Update due to major changes | 7 months ago |

<https://github.com/sinergise/EOBrowser>

Custom Scripts on GitHub

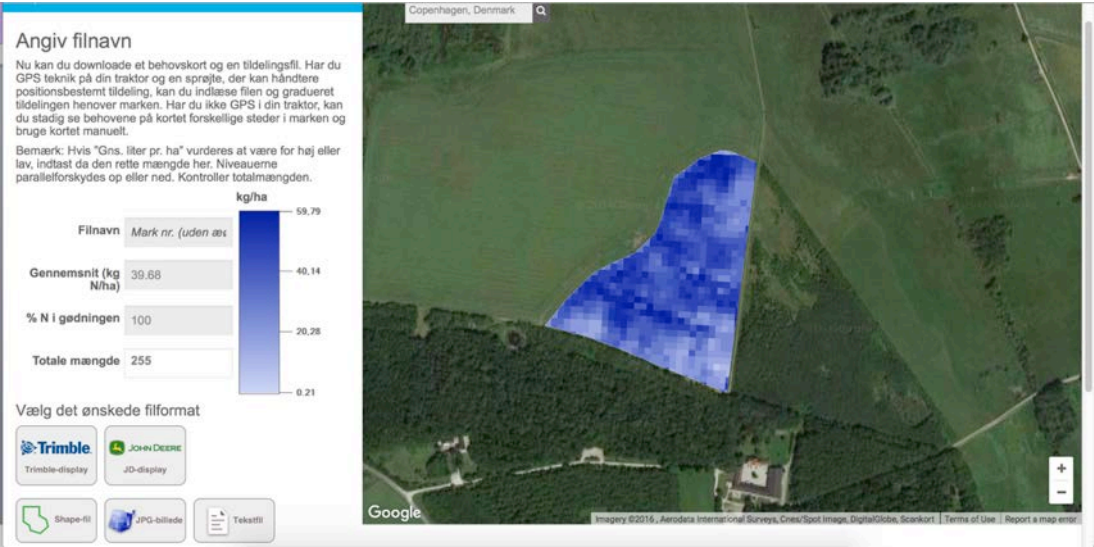


The screenshot shows the 'custom-scripts' repository page on the Sentinel-Hub website. The page has a blue header with the title 'custom-scripts' and a subtitle 'A repository of custom scripts that can be used with Sentinel-Hub services.' Below the header is a yellow bar with a 'View On GitHub' button and a GitHub icon. The main content area is divided into a left sidebar and a main panel. The sidebar contains the title 'Wildfire visualization' and three links: 'Evaluate and visualize', 'General description', and 'References'. The main panel displays the title 'Wildfire visualization' and a link to 'Hide script or download it.' Below this is a dark gray code block containing a JavaScript script for visualizing wildfires in Sentinel-2 imagery. The script includes comments, function definitions for 'A(a, b)' and 'stretch(val, min, max)', and color definitions for BLACK, WHITE, RED, YELLOW, and GREEN. It also includes a comment for 'Band combinations'.

```
// ***  
// Visualizing (wild)fires in Sentinel-2 imagery  
// For use in Sinergise EO Browser (http://apps.sentinel-hub.com/eo-browser)  
// Pierre Markuse (@pierre_markuse)  
// ***  
  
// Functions  
function A(a, b) {return a + b};  
function stretch(val, min, max) {  
  return (val - min) / (max - min);  
}  
  
// Some basic colors  
var BLACK = [0.0, 0.0, 0.0];  
var WHITE = [1.0, 1.0, 1.0];  
var RED = [0.9, 0.1, 0.1];  
var YELLOW = [0.9, 0.9, 0.1];  
var GREEN = [0.1, 0.9, 0.1];  
  
// Band combinations
```

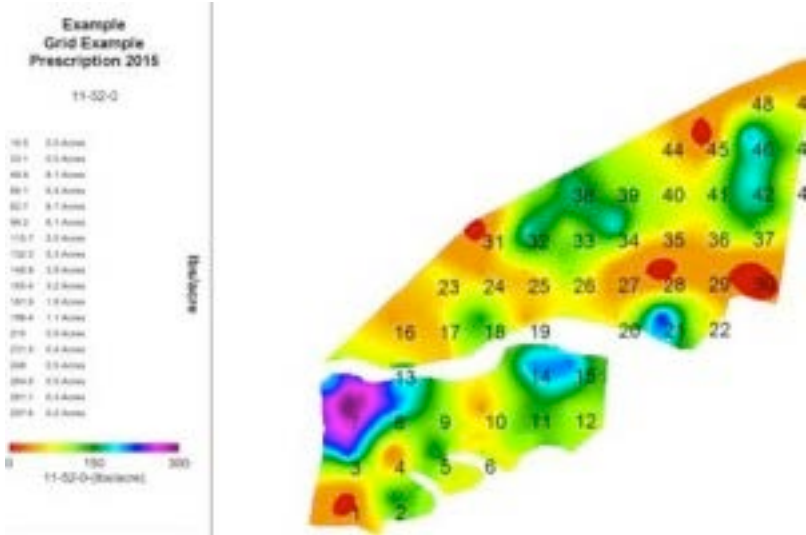
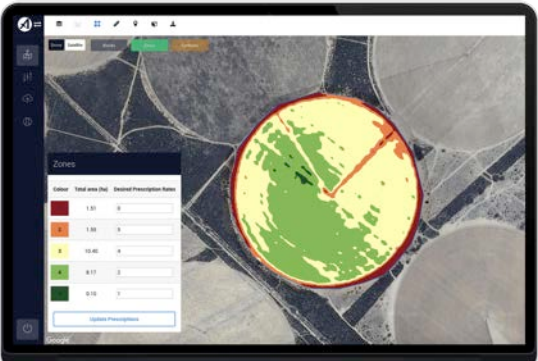
<http://custom-scripts.sentinel-hub.com>

App example – Agriculture



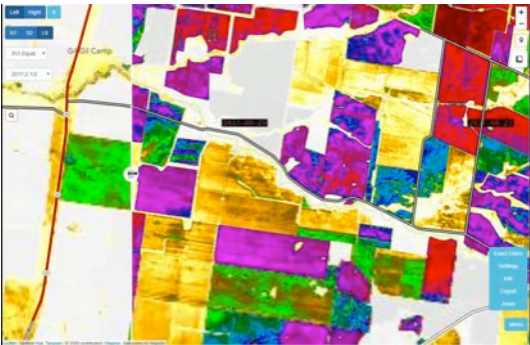
cropsat.dk (.sk, .no)

AeroView, aerobotics.co.za

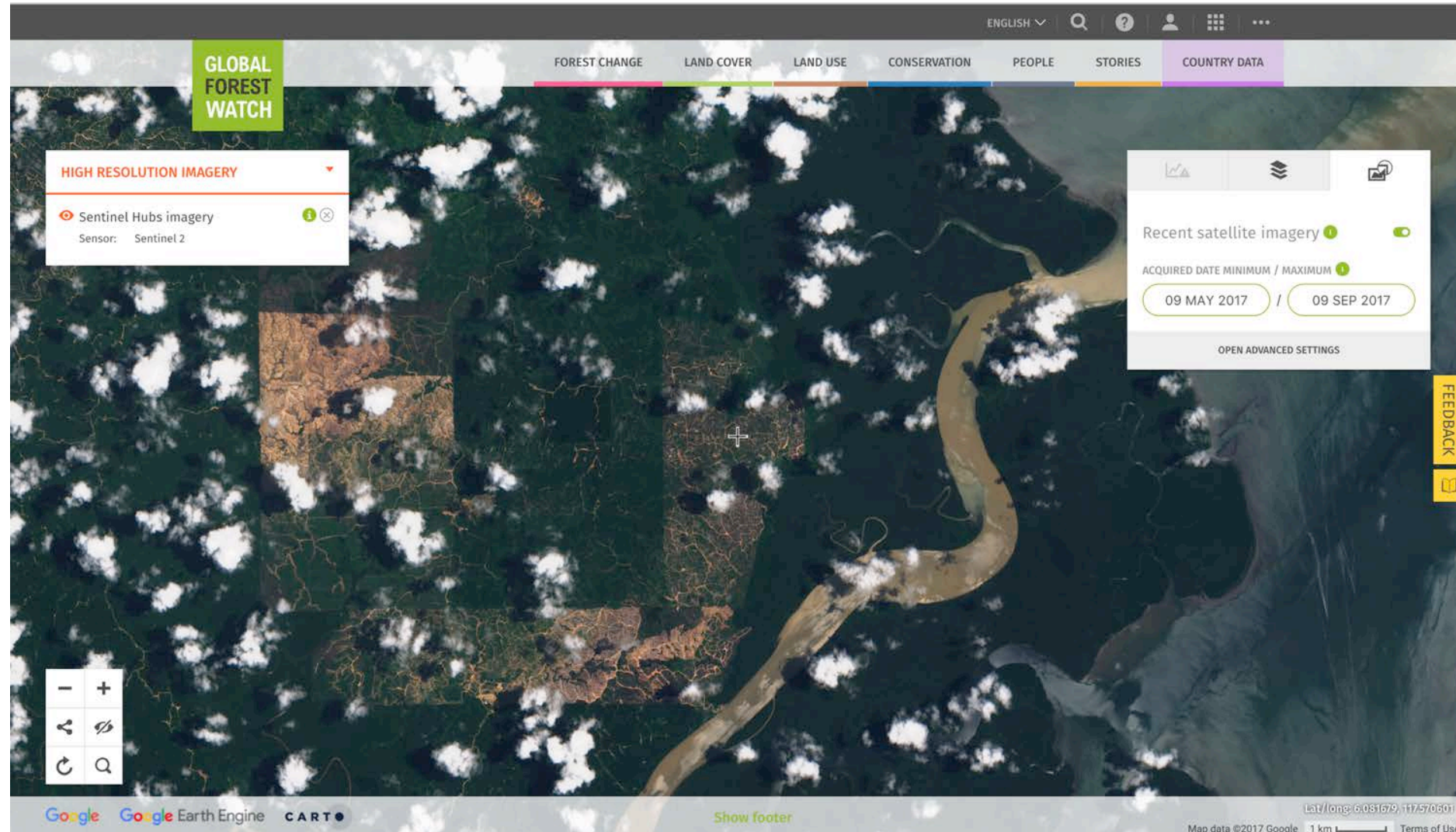


cropwatch.co.za

satamaps.co.au



App example - Forestry



- post-processing of data
- GeoTiff, JP2
- full resolution
- reflectance/composites

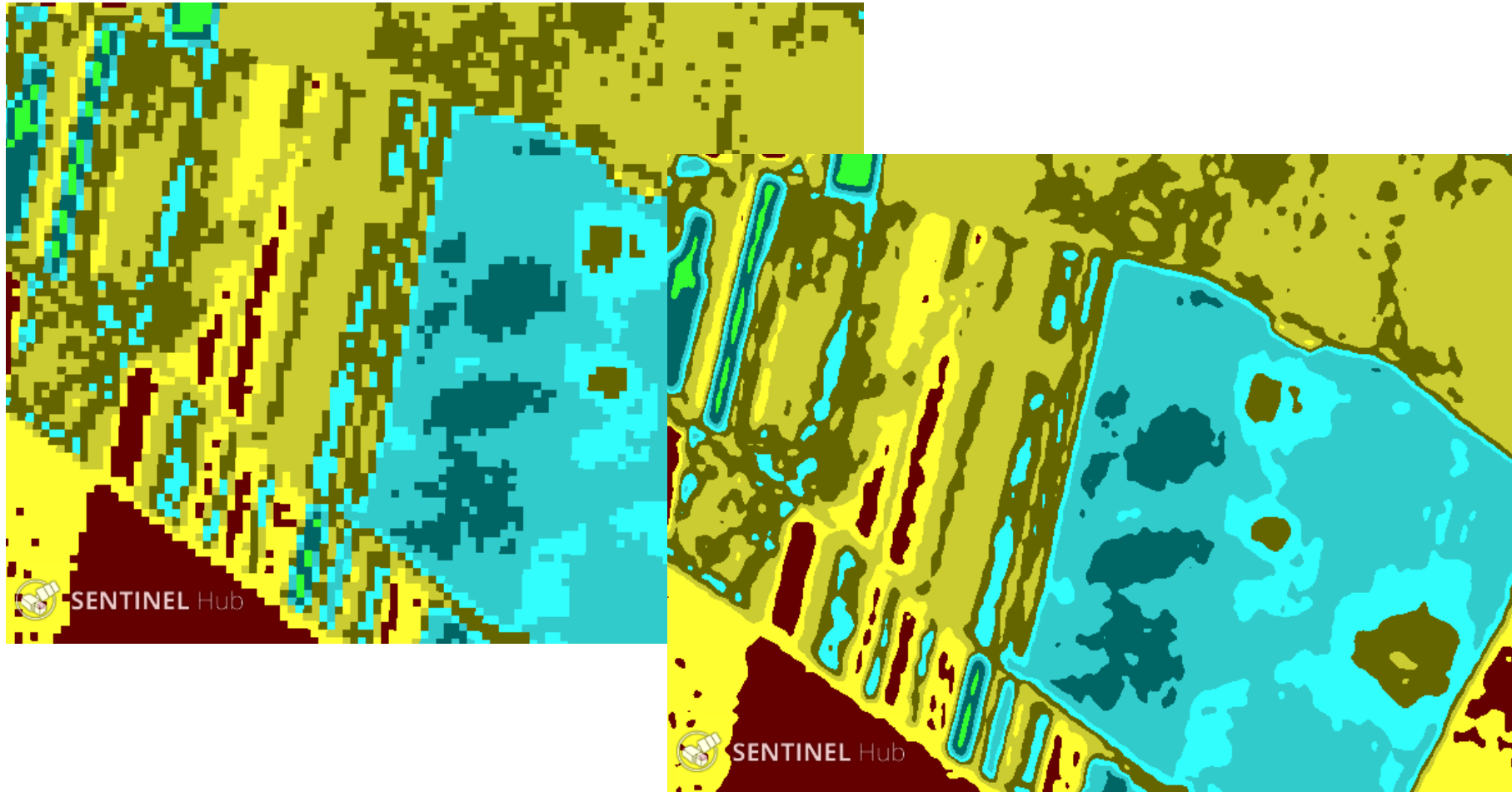


Statistical API – time series

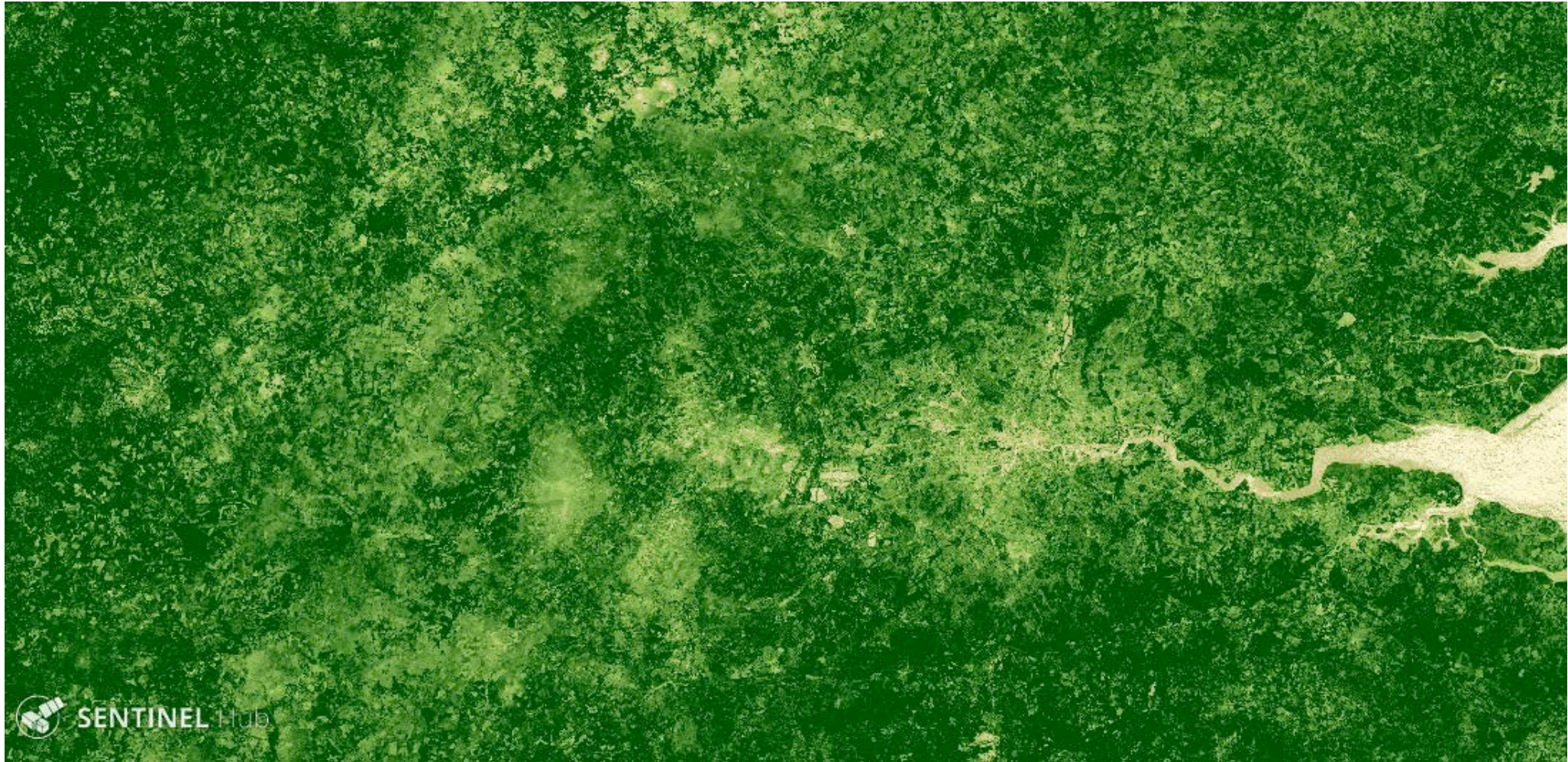
```
{
  "NDVI": [
    {
      "date": "2015-08-30",
      "basicStats": {
        "min": -0.5478424429893494,
        "max": 0.7815912365913391,
        "mean": 0.147320137875888,
        "stDev": 0.35443419609590726
      }
    },
    {
      "date": "2015-07-11",
      "basicStats": {
        "min":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

```
{
  "NDVI": [
    {
      "date": "2015-08-30",
      "basicStats": {
        "min": -0.5478424429893494,
        "max": 0.7815912365913391,
        "mean": 0.147320137875888,
        "stDev": 0.35443419609590726
      },
      "histogram": {
        "bins": [
          {
            "value": -0.23164855383139124,
            "count": 14377.0
          },
          {
            "value": 0.08134964140017291,
            "count": 1844.0
          },
          {
            "value": 0.23792375711536012,
            "count": 4692.0
          },
          {
            "value": 0.37365802377462387,
            "count": 4.0
          }
        ]
      }
    }
  ]
}
```

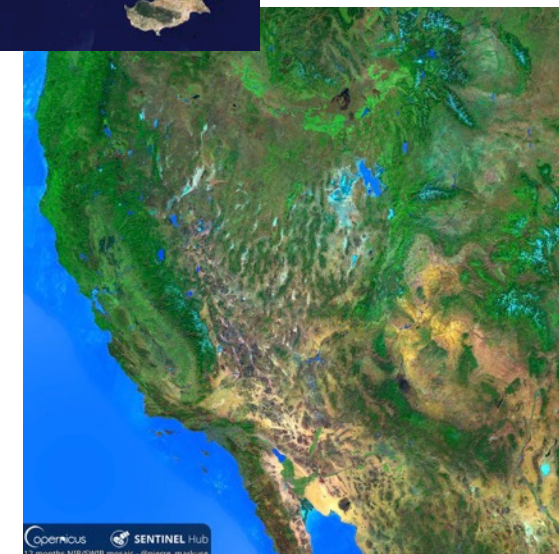
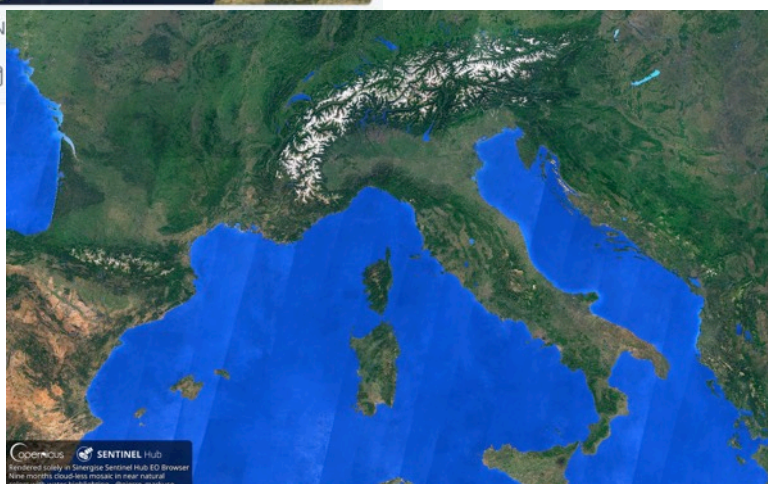
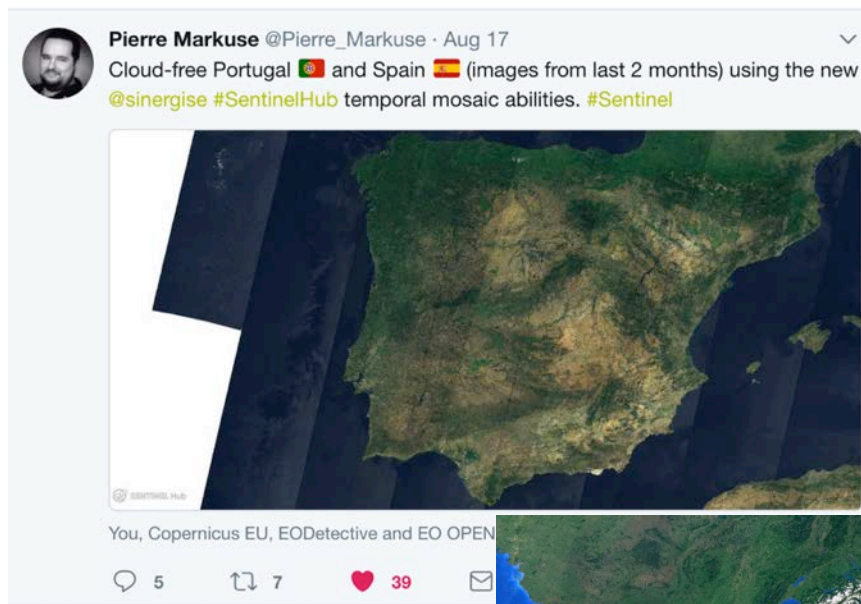

Upsampling/downsampling



Multi-temporal processing

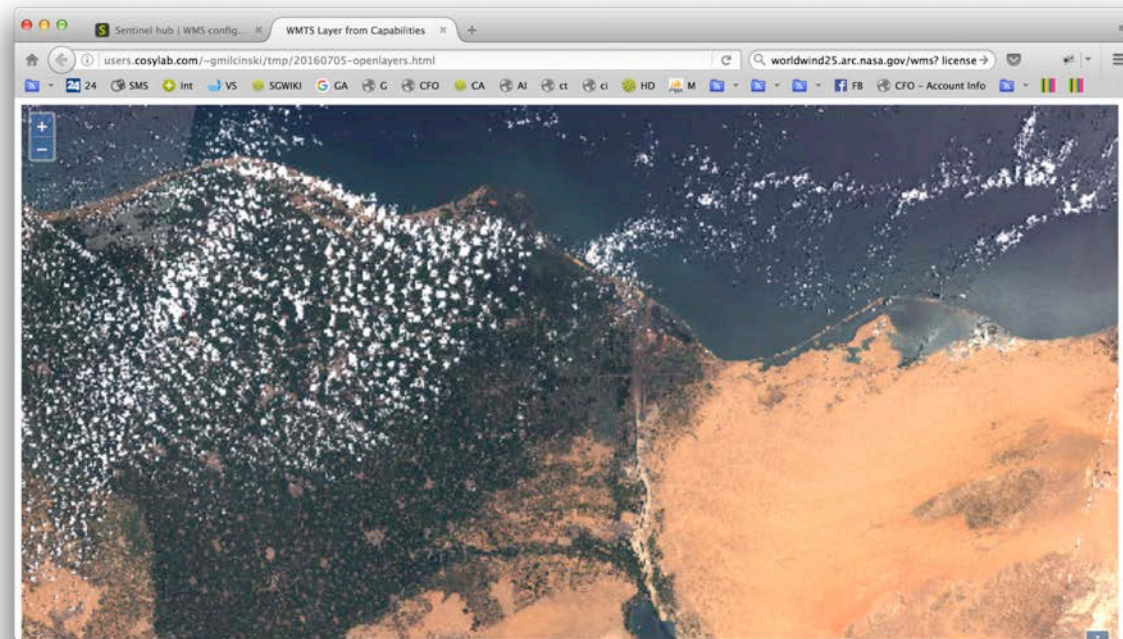


Multi-temporal processing



Why OGC services

```
fetch('http://services.sentinel-hub.com/v1/wmts/INSTANCE_ID?REQUEST=GetCapabilities').then(function(response) {  
  return response.text();  
}).then(function(text) {  
  var result = parser.read(text);  
  var options = ol.source.WMTS.optionsFromCapabilities(result,  
    {layer: 'TRUE_COLOR', matrixSet: 'PopularWebMercator512'});
```



Configuration Utility

The screenshot displays the Sentinel Hub Configuration Utility interface. A modal window titled "Custom script for Custom visualization" is open, showing a custom script for visualization. The script is a JavaScript function that takes a value and returns a color-coded array based on a series of conditional checks. The background interface shows a configuration page for a Sentinel S2 - L1C layer, with options for service end-points, advanced settings, and map bounds.

Custom script for Custom visualization

```
1 //ndvi
2 var val = (B08-B04)/(B08+B04);
3
4 if (val<-1.1) return [0,0,0];
5 else if (val<-0.2) return [0.75,0.75,0.75];
6 else if (val<-0.1) return [0.86,0.86,0.86];
7 else if (val<0) return [1,1,0.88];
8 else if (val<0.025) return [1,0.98,0.8];
9 else if (val<0.05) return [0.93,0.91,0.71];
10 else if (val<0.075) return [0.87,0.85,0.61];
11 else if (val<0.1) return [0.8,0.78,0.51];
12 else if (val<0.125) return [0.74,0.72,0.42];
13 else if (val<0.15) return [0.69,0.76,0.38];
14 else if (val<0.175) return [0.64,0.8,0.35];
15 else if (val<0.2) return [0.57,0.75,0.32];
16 else if (val<0.25) return [0.5,0.7,0.28];
17 else if (val<0.3) return [0.44,0.64,0.25];
18 else if (val<0.35) return [0.38,0.59,0.21];
19 else if (val<0.4) return [0.31,0.54,0.18];
20 else if (val<0.45) return [0.25,0.49,0.14];
```

Cancel Save

Integrate Sentinel Hub in common web apps

Used parameters:

- one of the predefined visualizations - COLOR
- without atmospheric correction
- without showing dates on tiles
- adapted with gain of 1
- adapted with gamma of 1

Select the *maps* library and copy the code generated for the configured visualization.

- Leaflet v1.0.3
- OpenLayers v4.0.1
- GoogleMaps API v3

Enter your Google Maps API key

Apply

i Your Google Maps code example won't work without a valid Google Maps API key. Click [here](#) for more informations.

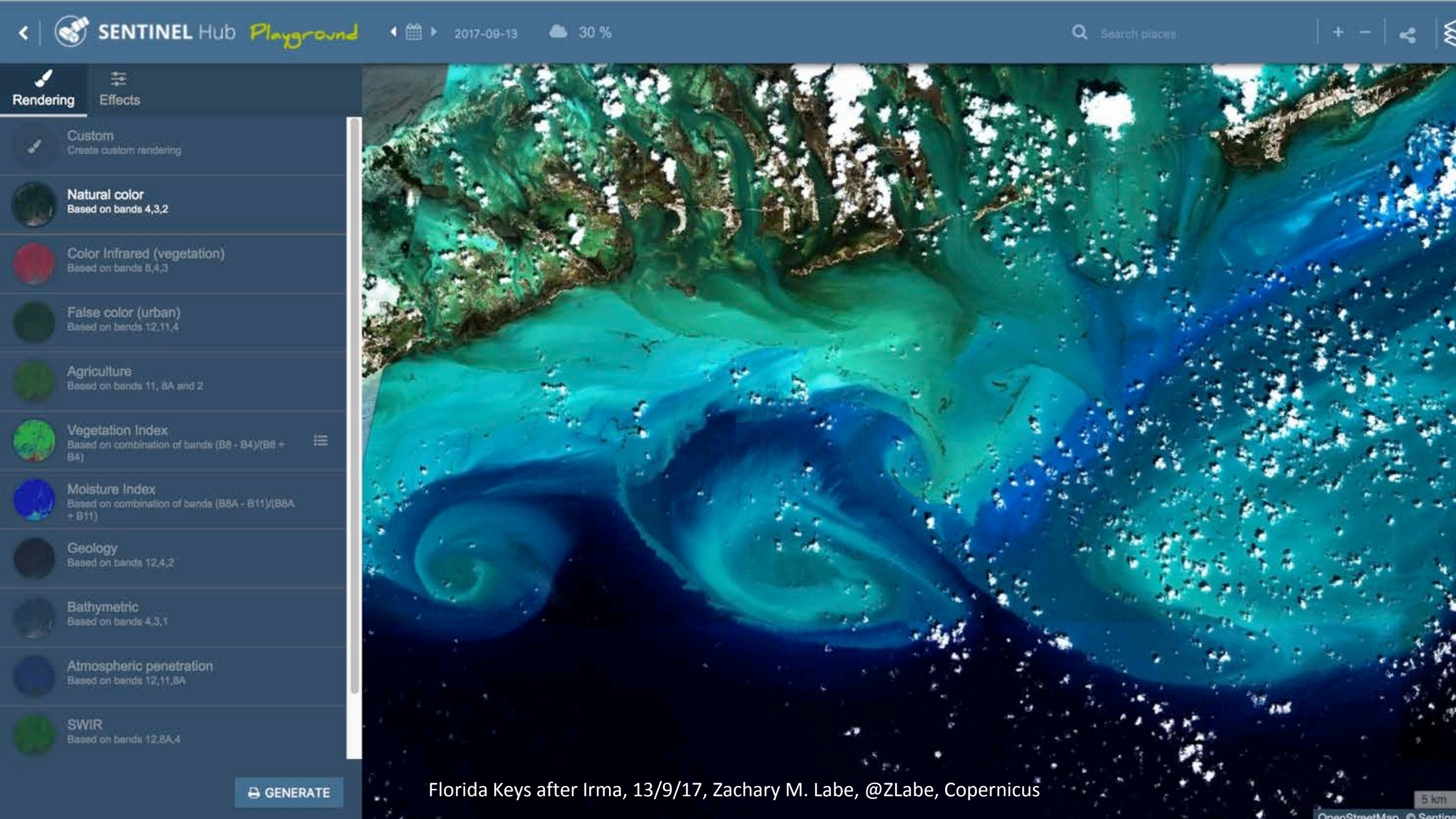
Leaflet and OpenLayers examples are not affected by this.

Your code using GoogleMaps library

[code](#) [preview](#) [download](#) [copy](#)

```
1 <!DOCTYPE html>
2 <html lang="en">
3
4 <head>
5   <meta charset="utf-8" />
6   <meta http-equiv="x-ua-compatible" content="ie=edge, chrome=1" />
7   <title>Sentinel Hub WMS services with Google Maps API v3</title>
8   <style>
9     html,
10    body {
11      margin: 0;
12      padding: 0;
13      height: 100%;
14      width: 100%;
15    }
16
17    #map {
18      height: 100%;
19      width: 100%;
20    }
21  </style>
22 </head>
23
24 <body>
25
26   <div id="map"></div>
27
28   <!-- Load Babel -->
29   <script src="https://unpkg.com/babel-standalone@6/babel.min.js"></script>
30   <script type="text/babel">
31     // settings
32     window.mapCenter = { lat: 40.39990182440178, lng: -3.7298583984375 };
33     window.defaultZoom = 12;
34     window.shMinZoom = 7;
35     window.shMaxZoom = 16;
36
37     window.SH_BASE_WMS_URL = 'services.sentinel-hub.com';
38     window.SH_INSTANCE_ID = 'bc56fb14-2c84-49fc-a826-6f4b5f7791c0';
```


- Currently available
 - Sentinel-1 GRD
 - Sentinel-2 (full global archive)
 - Sentinel-3 (full global archive)
 - Landsat-8 USGS (global archive)
 - Landsat-5, 7, 8 (ESA Archive)
 - Envisat MERIS (full global archive)
 - MODIS Terra and Aqua
 - DEM – SRTM30
- Up to date!



Florida Keys after Irma, 13/9/17, Zachary M. Labe, @ZLabe, Copernicus