# Google Earth Engine and machine learning for Earth monitoring

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6th International Workshop on Deep Learning in Computational Physics (DLCP-2022)

# The Earth Engine Data Catalog

Earth Engine Data Catalog

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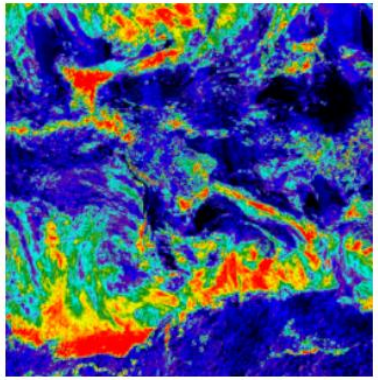
## Datasets tagged climate in Earth Engine

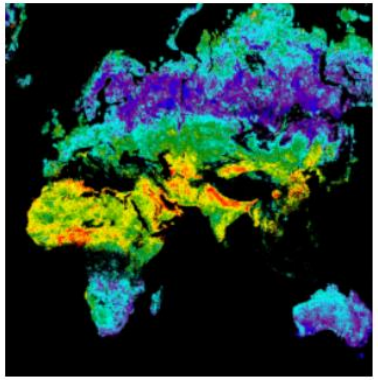
Filter list of datasets

### Sentinel-5P NRTI CLOUD: Near Real-Time Cloud



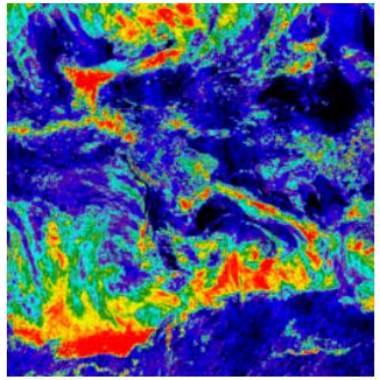
NRTI/L3_CLOUD This dataset provides near real-time high-resolution imagery of cloud parameters. The TROPOMI/S5P cloud properties retrieval is based on the OCRA and ROCINN algorithms currently being used in the operational GOME and GOME-2 products. OCRA retrieves the cloud fraction using measurements in the UV/VIS spectral ...

### Sentinel-5P OFFL CH4: Offline Methane



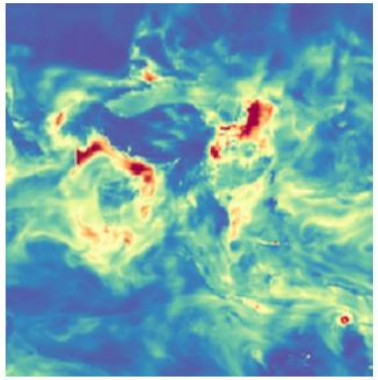
OFFL/L3_CH4 This dataset provides offline high-resolution imagery of methane concentrations. Methane (CH4) is, after carbon dioxide (CO2), the most important contributor to the anthropogenically enhanced greenhouse effect. Roughly three-quarters of methane emissions are anthropogenic and as such it is important to continue

### Sentinel-5P OFFL CLOUD: Near Real-Time Cloud



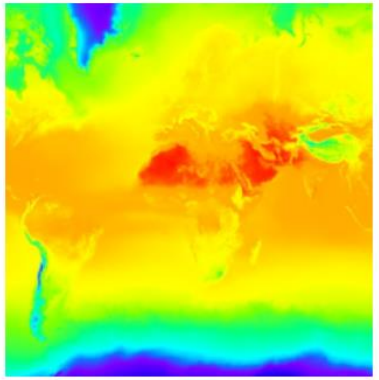
OFFL/L3_CLOUD This dataset provides offline high-resolution imagery of cloud parameters. The TROPOMI/S5P cloud properties retrieval is based on the OCRA and ROCINN algorithms currently being used in the operational GOME and GOME-2 products. OCRA retrieves the cloud fraction using measurements in the UV/VIS spectral regions ...

### Copernicus Atmosphere Monitoring Service (CAMS) Global Near-Real-Time



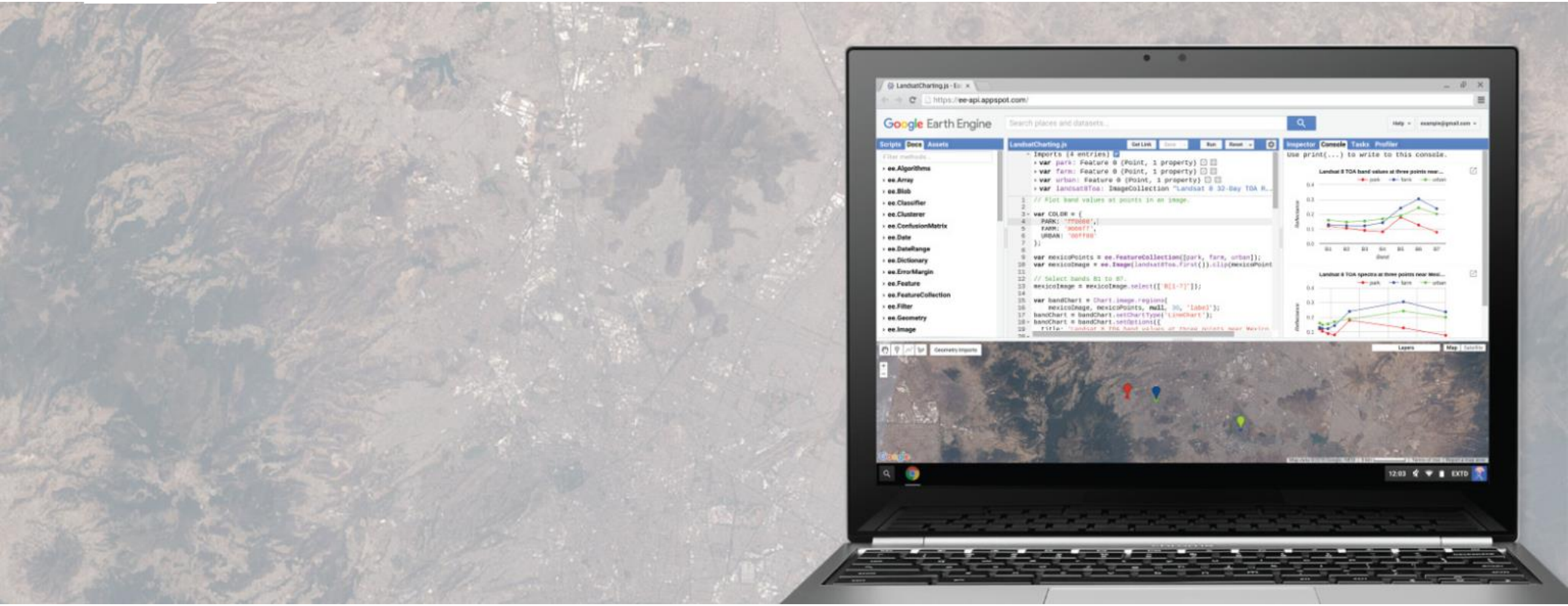
The Copernicus Atmosphere Monitoring Service provides the capacity to continuously monitor the composition of the Earth's atmosphere at global and regional scales. The main global near-real-time production system is a data assimilation and forecasting suite providing two 5-day forecasts per day for aerosols and chemical ...

### ERA5 Daily Aggregates - Latest Climate Reanalysis Produced by ECMWF / Copernicus Climate



ERA5 is the fifth generation ECMWF atmospheric reanalysis of the global climate. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset. ERA5 replaces its predecessor, the ERA-Interim reanalysis. ERA5 DAILY provides aggregated values for each day for ...

# JavaScript code editor https://code.earthengine.google.com/




* python too!

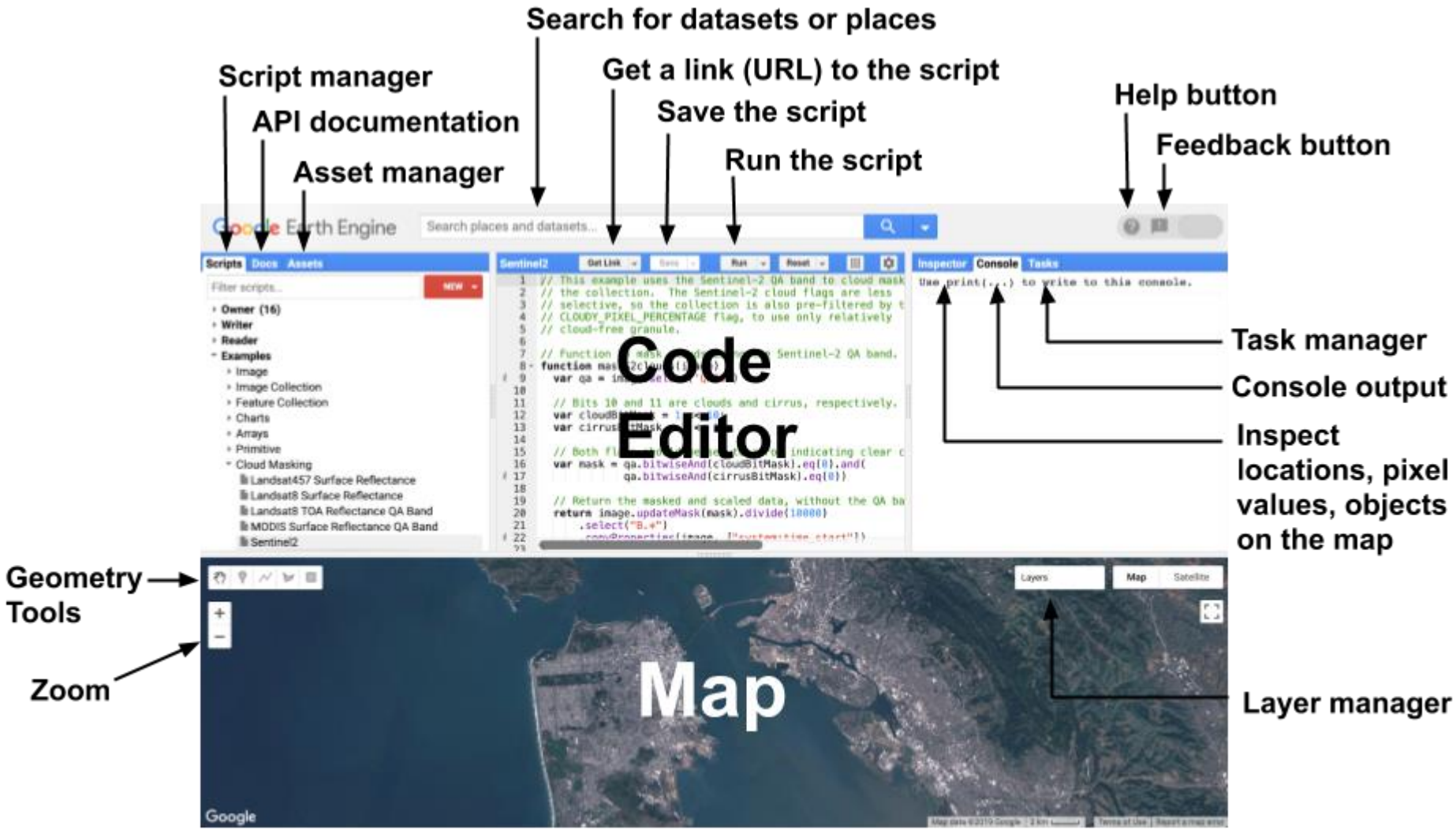
https://developers.google.com/

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

https://code.earthengine.google.com/

https://explorer.earthengine.google.com/

https://developers.google.com/earth-engine/guides/playground#:~:text=The%20Earth%20Engine%20(EE)%20Code,JavaScript%20code%20editor



## Basics

https://code.earthengine.google.com/6b24f55c3c60991a09352ce552fd310a

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New Script * | Get Link | Save | Run | Reset | Apps

```
1  // Use single (or double) quotes to make a string.
2  var greetString = 'Ahoy there!';
3  // Use parentheses to pass arguments to functions.
4  print(greetString);
5
6  // Store a number in a variable.
7  var number = 42;
8  print('The answer is:', number);
9
10 // Use square brackets [] to make a list.
11 var listOfNumbers = [0, 1, 1, 2, 3, 5];
12 print('List of numbers:', listOfNumbers);
13
14
```

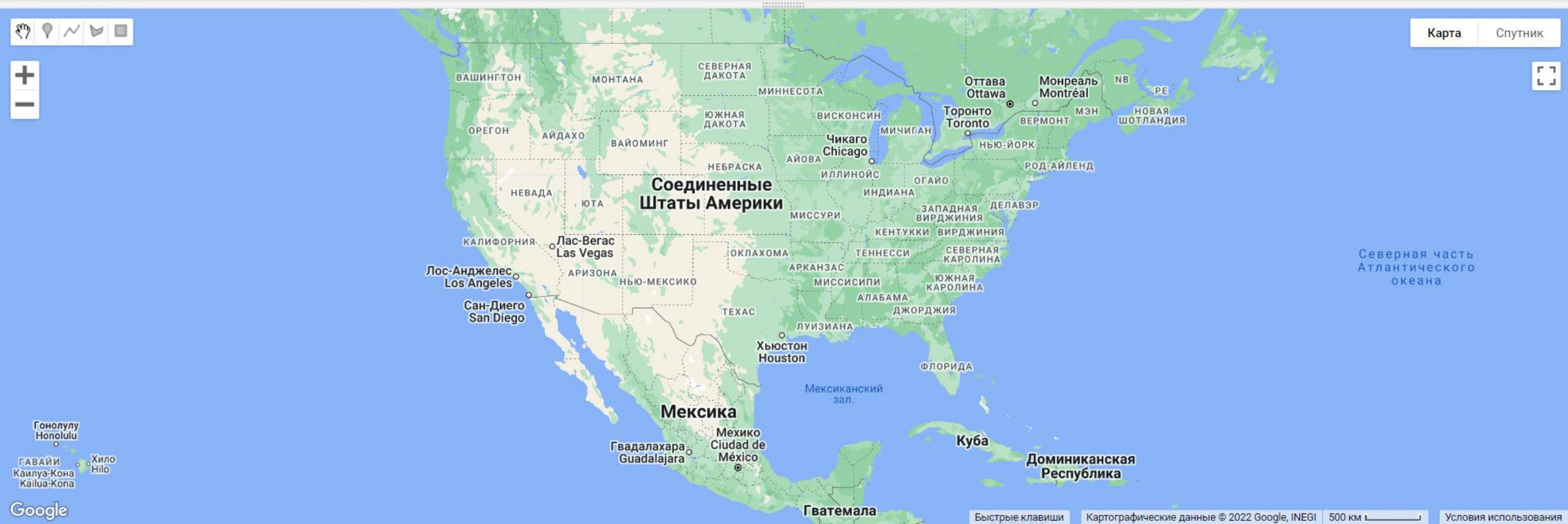
Inspector | Console | Tasks

Use print(...) to write to this console.

Ahoy there! JSON

The answer is: JSON
42

List of numbers: JSON
[0,1,1,2,3,5] JSON



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    - tutorial

New Script * | Get Link | Save | Run | Reset | Apps

```
1  // Use curly brackets {} to make a dictionary of key:value pairs.
2  var object = {
3    foo: 'bar',
4    baz: 13,
5    stuff: ['this', 'that', 'the other thing']
6  };
7  print('Dictionary:', object);
8  // Access dictionary items using square brackets.
9  print('Print foo:', object['foo']);
10 // Access dictionary items using dot notation.
11 print('Print stuff:', object.stuff);
```

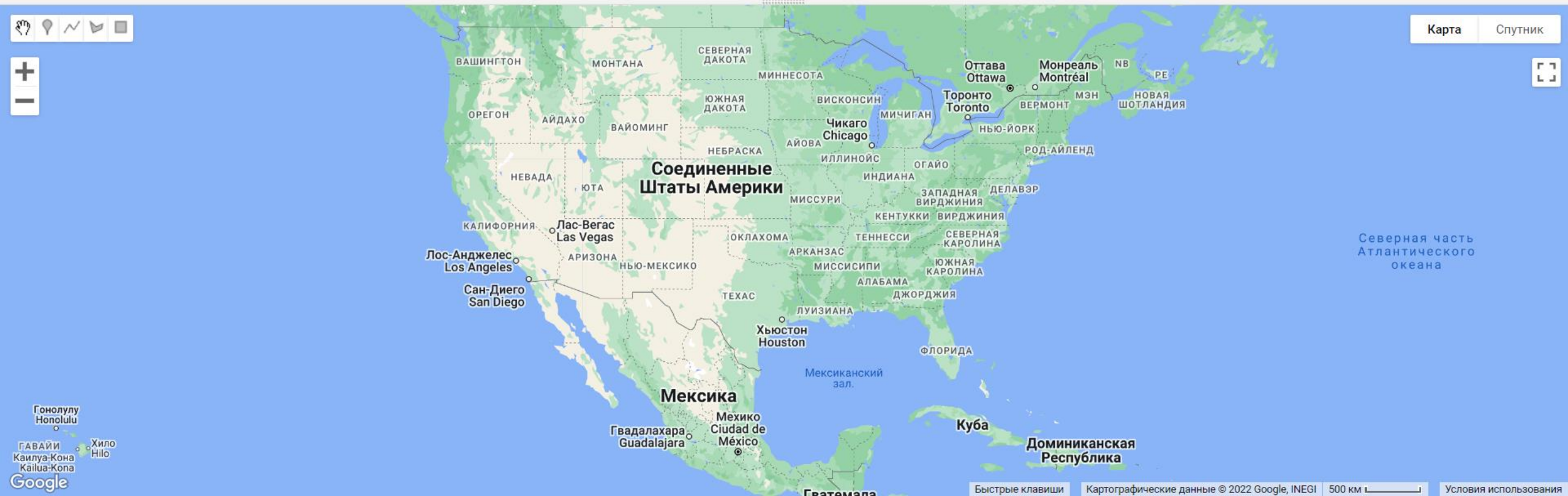
Inspector | Console | Tasks

Use print(...) to write to this console.

Dictionary: JSON
▸ Object (3 properties) JSON

Print foo: JSON
bar JSON

Print stuff: JSON
▸ ["this","that","the other thing"] JSON



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New Script * | Get Link | Save | Run | Reset | Apps

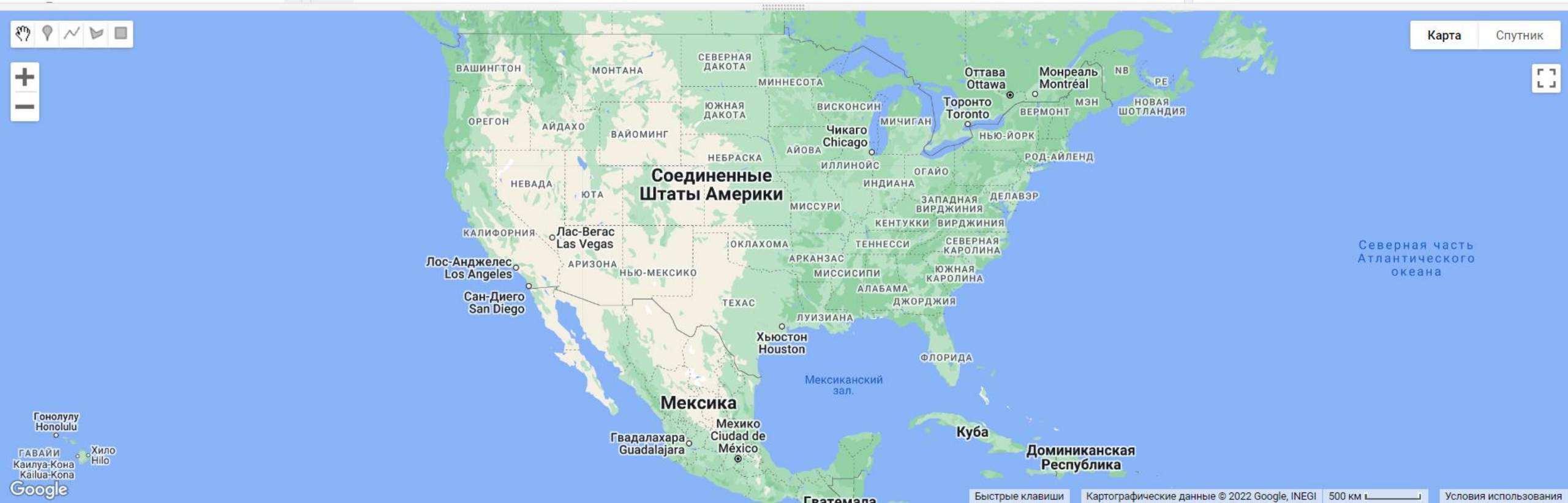
```
1  // The reflect function takes a single parameter: element.
2  var reflect = function(element) {
3    // Return the argument.
4    return element;
5  };
6  print('A good day to you!', reflect('Back at you!'));
```

Inspector | Console | Tasks

Use print(...) to write to this console.

A good day to you! JSON

Back at you! JSON



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New Script * | Get Link | Save | Run | Reset | Apps

```
1  // Define a date in Earth Engine.
2  var date = ee.Date('2015-12-31');
3  print('Date:', date);
4
5  // Get the current time using the JavaScript Date.now() method.
6  var now = Date.now();
7  print('Milliseconds since January 1, 1970', now);
8
9  // Initialize an ee.Date object.
10 var eeNow = ee.Date(now);
11 print('Now:', eeNow);
```

Inspector | Console | Tasks

Use print(...) to write to this console.

Date: JSON

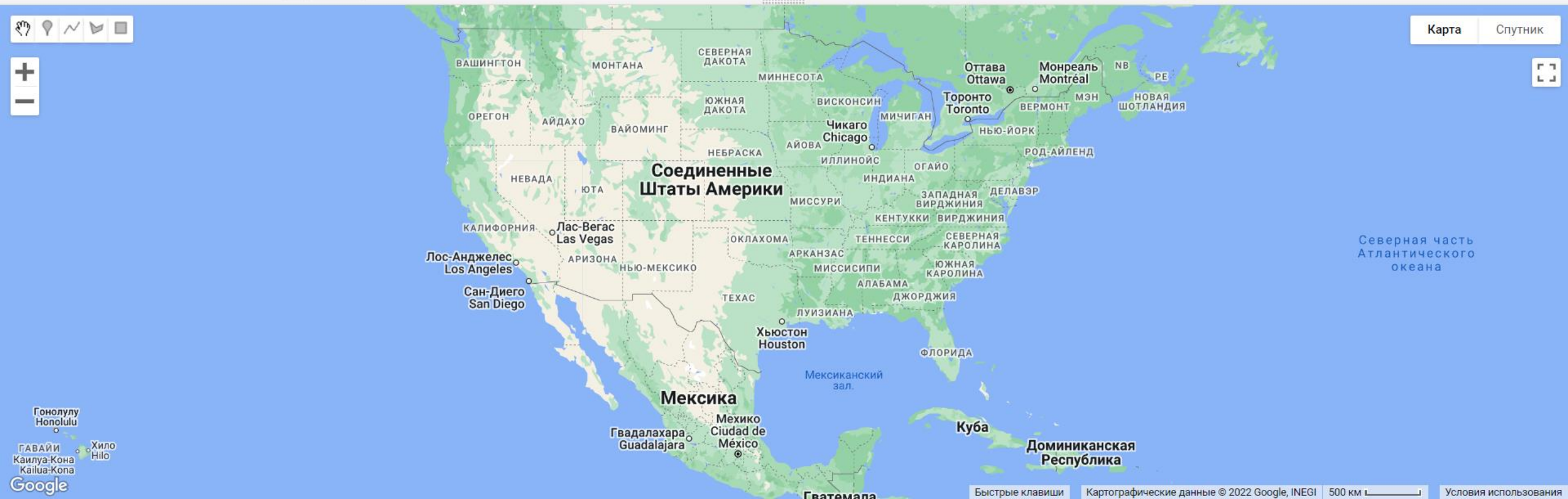
▸ Date (2015-12-31 00:00:00) JSON

Milliseconds since January 1, 1970 JSON

1657653540108

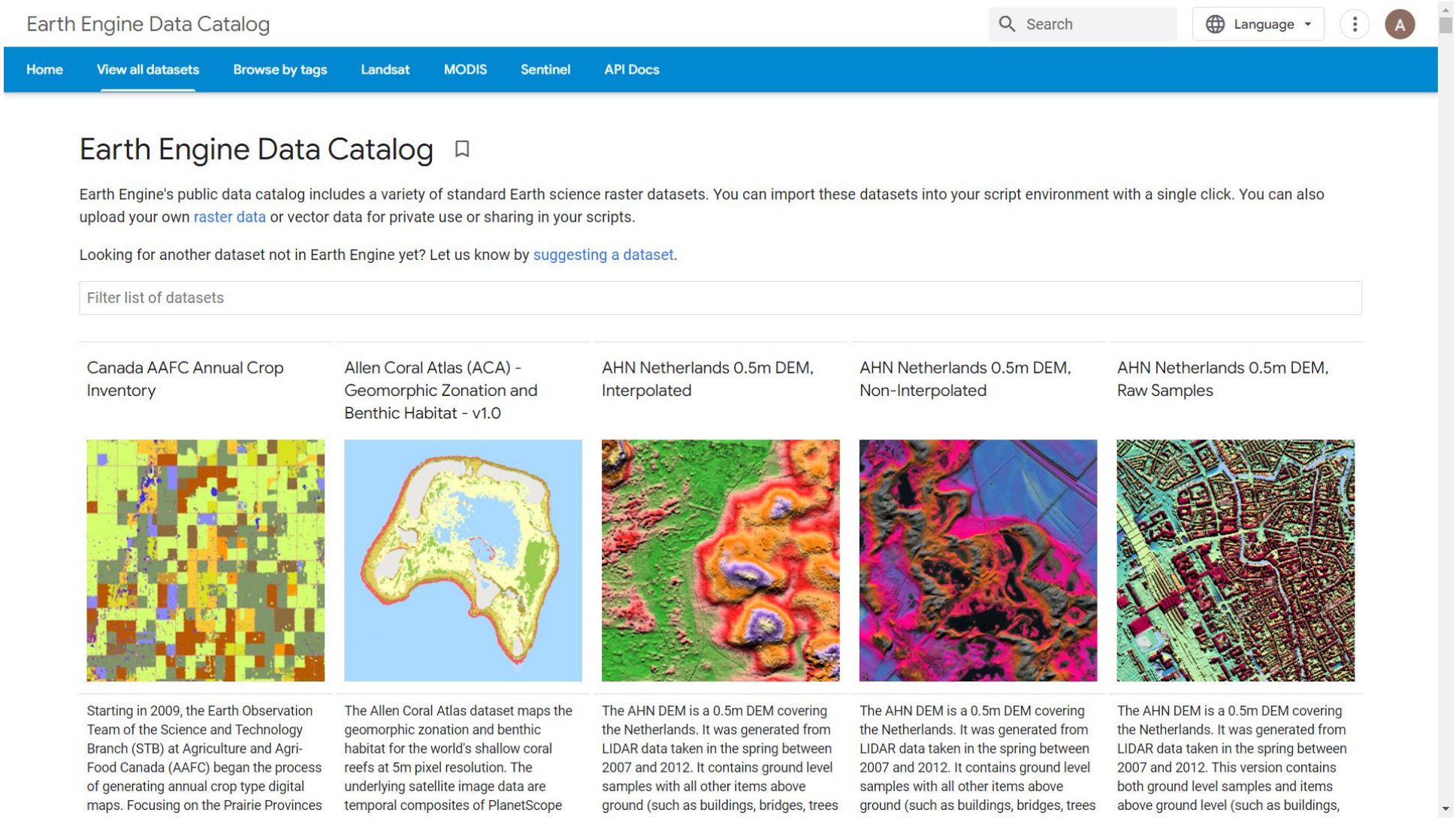
Now: JSON

▸ Date (2022-07-12 19:19:00) JSON



# Data Catalog

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



**Images**

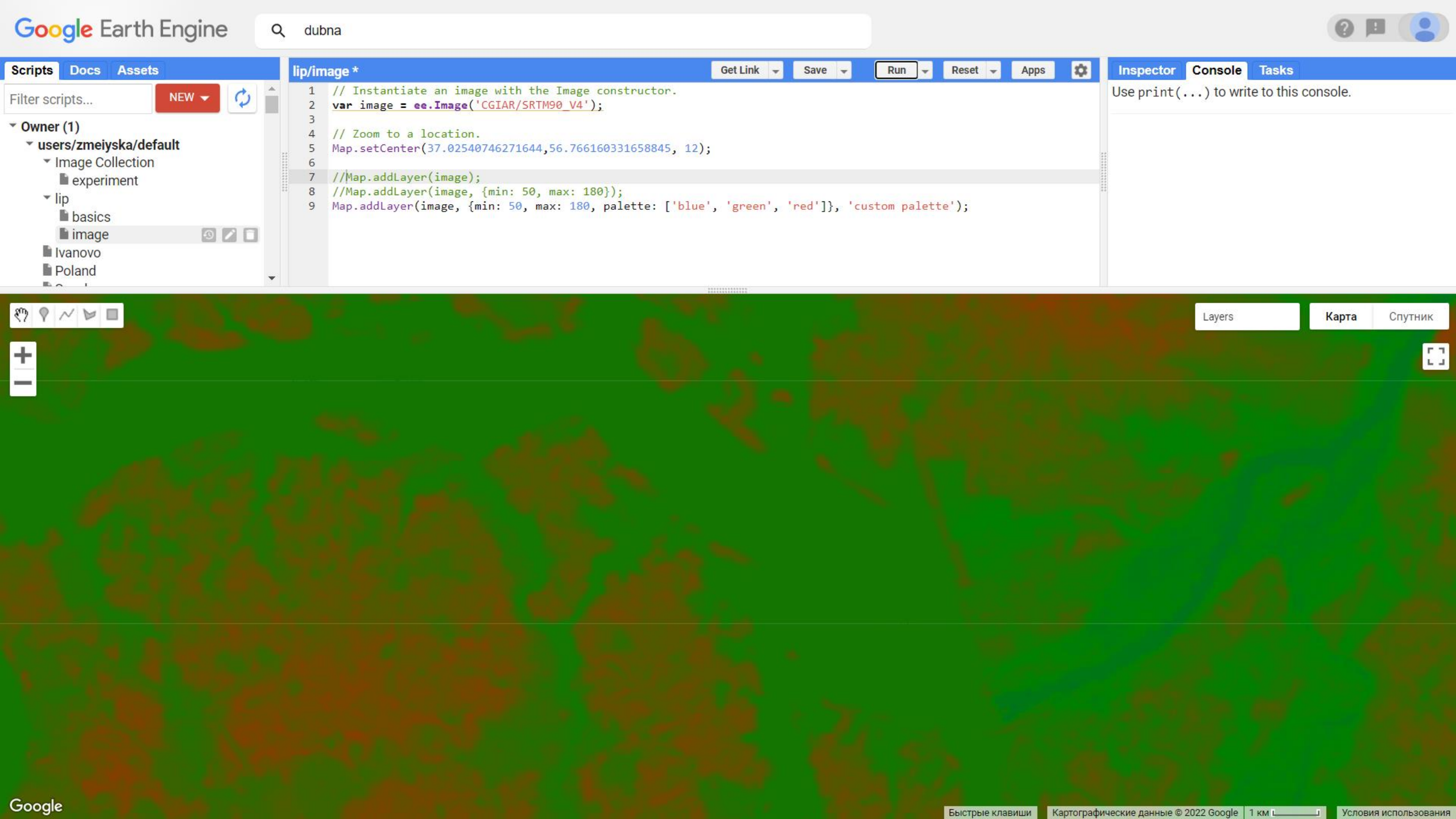
https://developers.google.com/earth-engine/datasets/catalog/CGIAR_SRTM90_V4?hl=en

https://code.earthengine.google.com/31f672aec5b2a3f8bc7d1fbf23450935

```
// Instantiate an image with the Image constructor.
var image = ee.Image('CGIAR/SRTM90_V4');

// Zoom to a location.
Map.setCenter(37.02540746271644,56.766160331658845, 12);

Map.addLayer(image);
//Map.addLayer(image, {min: 50, max: 180});
//Map.addLayer(image, {min: 50, max: 180, palette: ['blue', 'green', 'red']}, 'custom palette');
```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1 // Instantiate an image with the Image constructor.
2 var image = ee.Image('CGIAR/SRTM90_V4');
3
4 // Zoom to a location.
5 Map.setCenter(37.02540746271644,56.766160331658845, 12);
6
7 //Map.addLayer(image);
8 //Map.addLayer(image, {min: 50, max: 180});
9 Map.addLayer(image, {min: 50, max: 180, palette: ['blue', 'green', 'red']}, 'custom palette');
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Use print(...) to write to this console.
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Картографические данные © 2022 Google
1 км
Условия использования

**Images computation**

https://code.earthengine.google.com/a4b27505dfd223c7f5878e97ca42d06b

https://developers.google.com/earth-engine/apidocs/ee-terrain-slope

```
// Instantiate an image with the Image constructor.
var image = ee.Image('CGIAR/SRTM90_V4');

// Apply an algorithm to an image.
var slope = ee.Terrain.slope(image);

// Zoom to a location.
Map.setCenter(37.02540746271644,56.766160331658845, 12);

Map.addLayer(slope, {min: 0, max :5}, 'slope');
```

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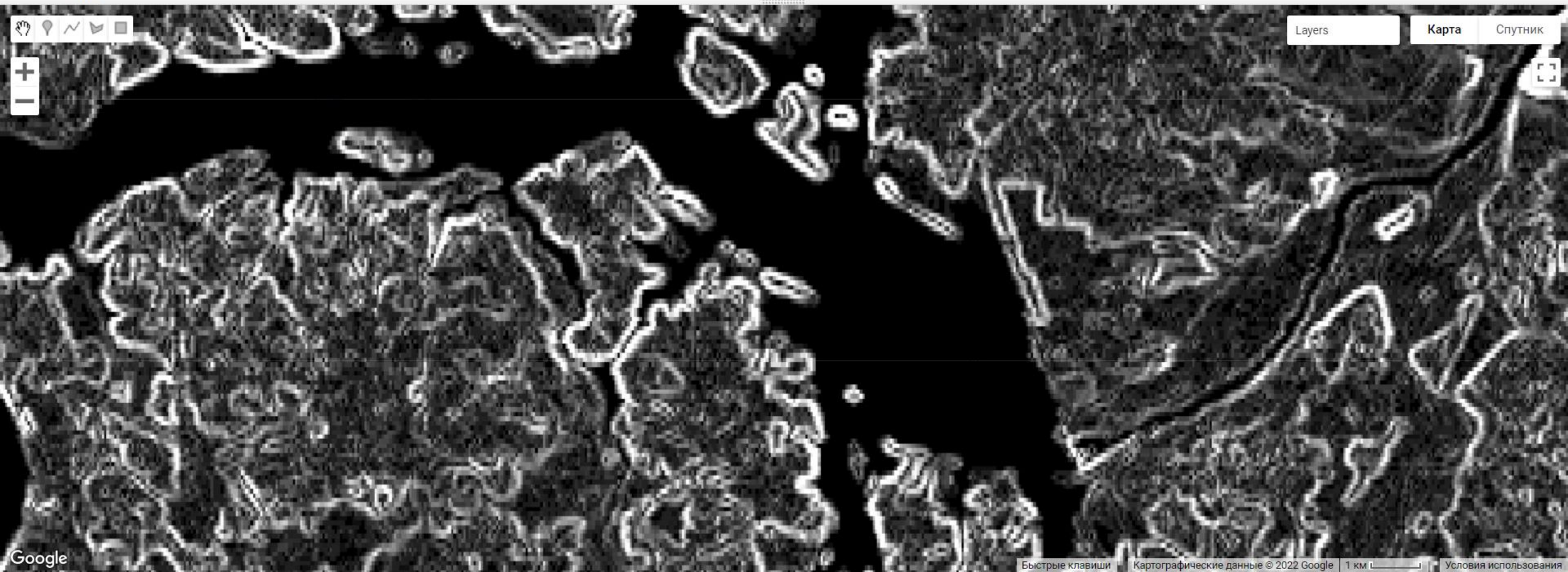
image comp * | Get Link | Save | Run | Reset | Apps

```
1  // Instantiate an image with the Image constructor.
2  var image = ee.Image('CGIAR/SRTM90_V4');
3
4  // Apply an algorithm to an image.
5  var slope = ee.Terrain.slope(image);
6
7  // Zoom to a location.
8  Map.setCenter(37.02540746271644,56.766160331658845, 12);
9
10 Map.addLayer(slope, {min: 0, max :5}, 'slope');
```

Inspector | Console | Tasks

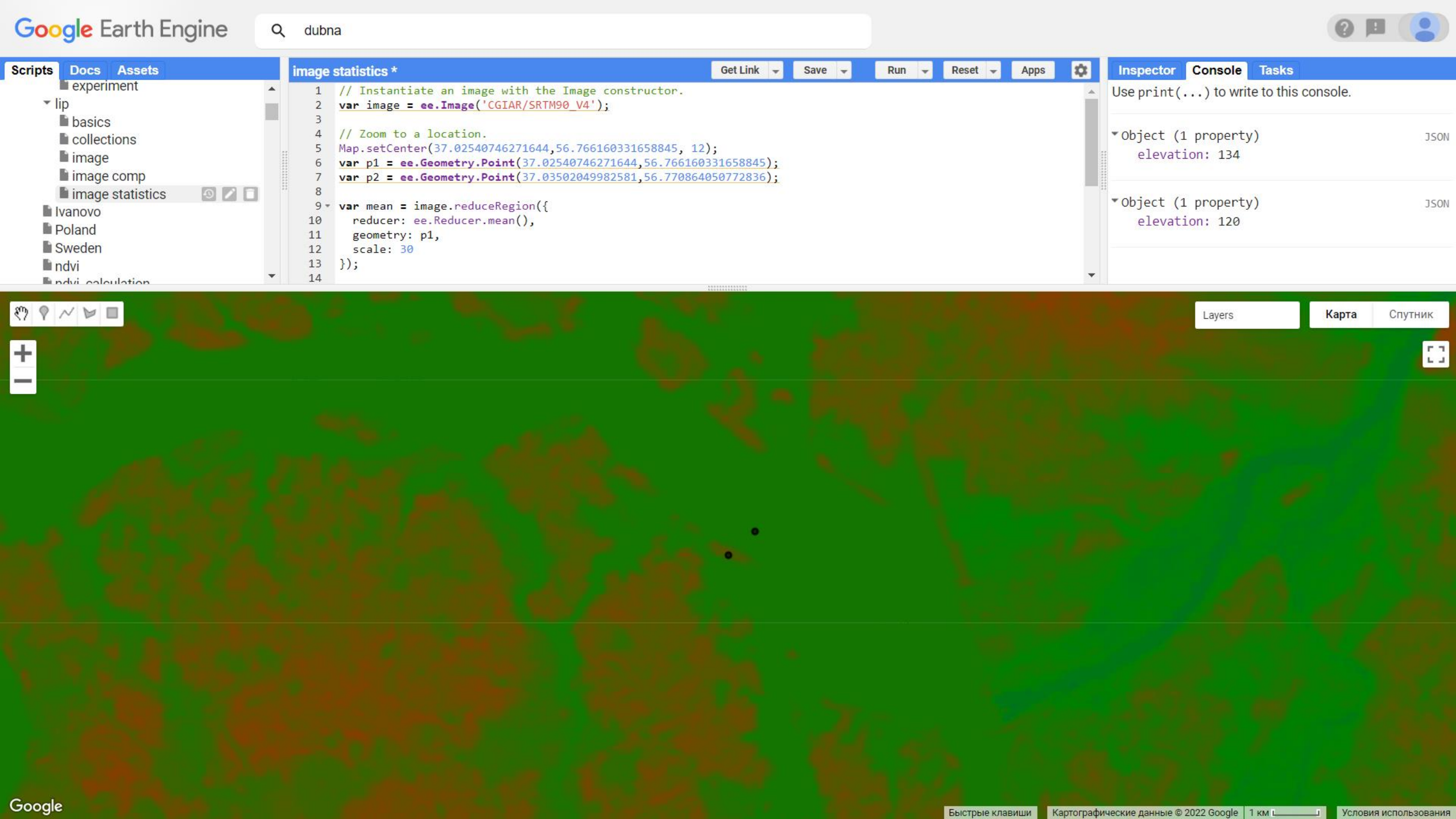
Use `print(...)` to write to this console.



## Image statistics

https://code.earthengine.google.com/37d0c570ad54bf3d0232386d868be168

```
// Instantiate an image with the Image constructor.
var image = ee.Image('CGIAR/SRTM90_V4');

// Zoom to a location.
Map.setCenter(37.02540746271644,56.766160331658845, 12);
var p1 = ee.Geometry.Point(37.02540746271644,56.766160331658845);
var p2 = ee.Geometry.Point(37.03502049982581,56.770864050772836);

var mean = image.reduceRegion({
  reducer: ee.Reducer.mean(),
  geometry: p1,
  scale: 90
});

print(mean);

var mean = image.reduceRegion({
  reducer: ee.Reducer.mean(),
  geometry: p2,
  scale: 90
});

print(mean);

Map.addLayer(image, {min: 50, max: 180, palette: ['blue', 'green', 'red']}, 'custom palette');
Map.addLayer(p1);
Map.addLayer(p2);
```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1 // Instantiate an image with the Image constructor.
2 var image = ee.Image('CGIAR/SRTM90_V4');
3
4 // Zoom to a location.
5 Map.setCenter(37.02540746271644,56.766160331658845, 12);
6 var p1 = ee.Geometry.Point(37.02540746271644,56.766160331658845);
7 var p2 = ee.Geometry.Point(37.03502049982581,56.770864050772836);
8
9 var mean = image.reduceRegion({
10 reducer: ee.Reducer.mean(),
11 geometry: p1,
12 scale: 30
13 });
14
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Use print(...) to write to this console.
Object (1 property)
JSON
elevation: 134
Object (1 property)
JSON
elevation: 120
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Карта
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Быстрые клавиши
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1 км
Условия использования

## Image Collections

https://developers.google.com/earth-engine/datasets/catalog/LANDSAT_LC08_C02_T1_TOA

https://code.earthengine.google.com/92fc966d883b11f9850b36504e6ea5eb

```
var point =  ee.Geometry.Point(37.02540746271644,56.766160331658845);
var l8 = ee.ImageCollection('LANDSAT/LC08/C02/T1_TOA');

var spatialFiltered = l8.filterBounds(point);
print('spatialFiltered', spatialFiltered);

var temporalFiltered = spatialFiltered.filterDate('2022-06-01', '2022-07-17');
print('temporalFiltered', temporalFiltered);

// This will sort from least to most cloudy.
var sorted = temporalFiltered.sort('CLOUD_COVER');

// Get the first (least cloudy) image.
var scene = sorted.first();

Map.setCenter(37.02540746271644,56.766160331658845, 12);
var visParams = {bands: ['B4', 'B3', 'B2'], max: 0.3};
Map.addLayer(scene, visParams, 'true-color composite less clouds');
Map.addLayer(temporalFiltered, visParams, 'true-color composite');
```

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Search places and datasets...

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collections — Get Link | Save | Run | Reset | Apps

```
1  var point =  ee.Geometry.Point(37.02540746271644,56.766160331658845);
2  var l8 = ee.ImageCollection('LANDSAT/LC08/C02/T1_TOA');
3
4  var spatialFiltered = l8.filterBounds(point);
5  print('spatialFiltered', spatialFiltered);
6
7  var temporalFiltered = spatialFiltered.filterDate('2022-06-01', '2022-07-17');
8  print('temporalFiltered', temporalFiltered);
9
10 // This will sort from least to most cloudy.
11 var sorted = temporalFiltered.sort('CLOUD_COVER');
12
13 // Get the first (least cloudy) image.
14 var scene = sorted.first();
15
16 Map.setCenter(37.02540746271644,56.766160331658845, 12);
17 var visParams = {bands: ['B4', 'B3', 'B2'], max: 0.3};
```

Inspector | Console | Tasks

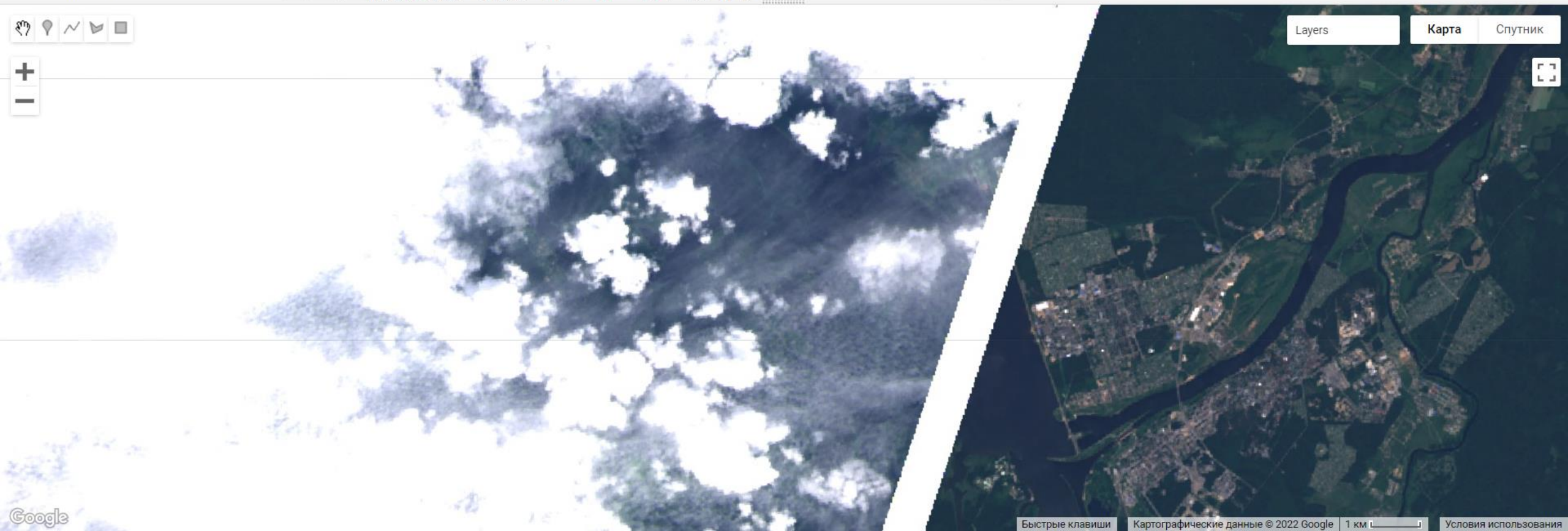
Use print(...) to write to this console.

spatialFiltered JSON

▸ ImageCollection LANDSAT/LC08/C02/T1_TOA (464 elements, 17 band… JSON

temporalFiltered JSON

▸ ImageCollection LANDSAT/LC08/C02/T1_TOA (5 elements, 17 bands) JSON



**Median image**

https://code.earthengine.google.com/e06d18ab4bda8ae5c6500407d8bd97d5

```
var l8 = ee.ImageCollection('LANDSAT/LC08/C02/T1_TOA').filterDate('2022-06-01', '2022-07-17');

Map.addLayer(l8, {bands: ['B4', 'B3', 'B2'], max: 0.3}, 'l8 collection');

// Get the median over time, in each band, in each pixel.
var median = l8.median();
Map.addLayer(median, {bands: ['B4', 'B3', 'B2'], max: 0.3}, 'l8 median');
Map.setCenter(37.025407462716 44,56.766160331658845, 12);
```

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collection composite *

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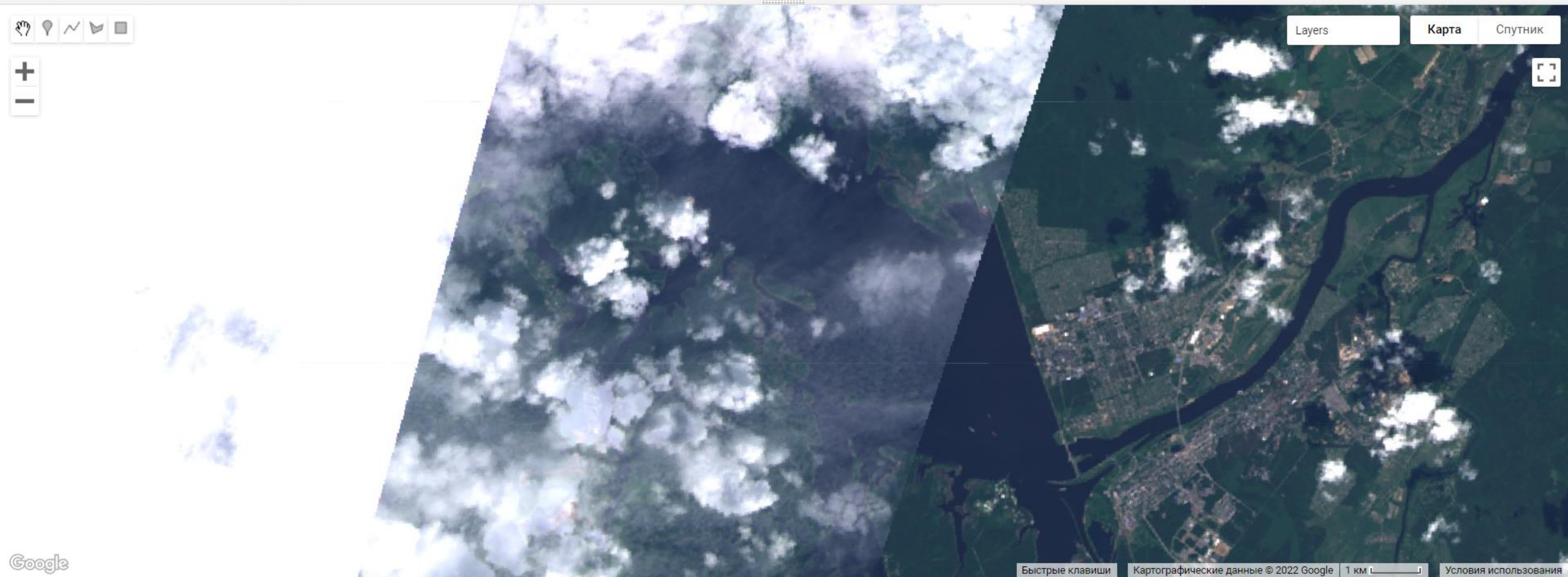
```
1  var l8 = ee.ImageCollection('LANDSAT/LC08/C02/T1_TOA').filterDate('2022-06-01', '2022-07-17');
2
3  Map.addLayer(l8, {bands: ['B4', 'B3', 'B2'], max: 0.3}, 'l8 collection');
4
5  // Get the median over time, in each band, in each pixel.
6  var median = l8.median();
7  Map.addLayer(median, {bands: ['B4', 'B3', 'B2'], max: 0.3}, 'l8 median');
8  Map.setCenter(37.02540746271644,56.766160331658845, 12);
9
```

Inspector | Console | Tasks

Use `print(...)` to write to this console.



# Masking

https://developers.google.com/earth-engine/apidocs/ee-image-updatemask

https://developers.google.com/earth-engine/datasets/catalog/UMD_hansen_global_forest_change_2021_v1_9?hl=en

https://code.earthengine.google.com/976753b4bfb128c1cc8293ac60fe1b3f

```
var l8 = ee.ImageCollection('LANDSAT/LC08/C02/T1_TOA').filterDate('2022-06-01', '2022-07-17');

// Get the median over time, in each band, in each pixel.
var median = l8.median();
Map.addLayer(median, {bands: ['B4', 'B3', 'B2'], max: 0.3}, 'l8 median');
Map.setCenter(37.02540746271644,56.766160331658845, 12);

// Load or import the Hansen et al. forest change dataset.
var hansenImage = ee.Image('UMD/hansen/global_forest_change_2021_v1_9');

// Select the land/water mask.
var datamask = hansenImage.select('datamask');

// Create a binary mask.
var mask = datamask.eq(1);

// Update the composite mask with the water mask.
var maskedComposite = median.updateMask(mask);
Map.addLayer(maskedComposite, {bands: ['B4', 'B3', 'B2'], max: 0.3}, 'masked');
```

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- Ivanovo
- Poland

collection mask *

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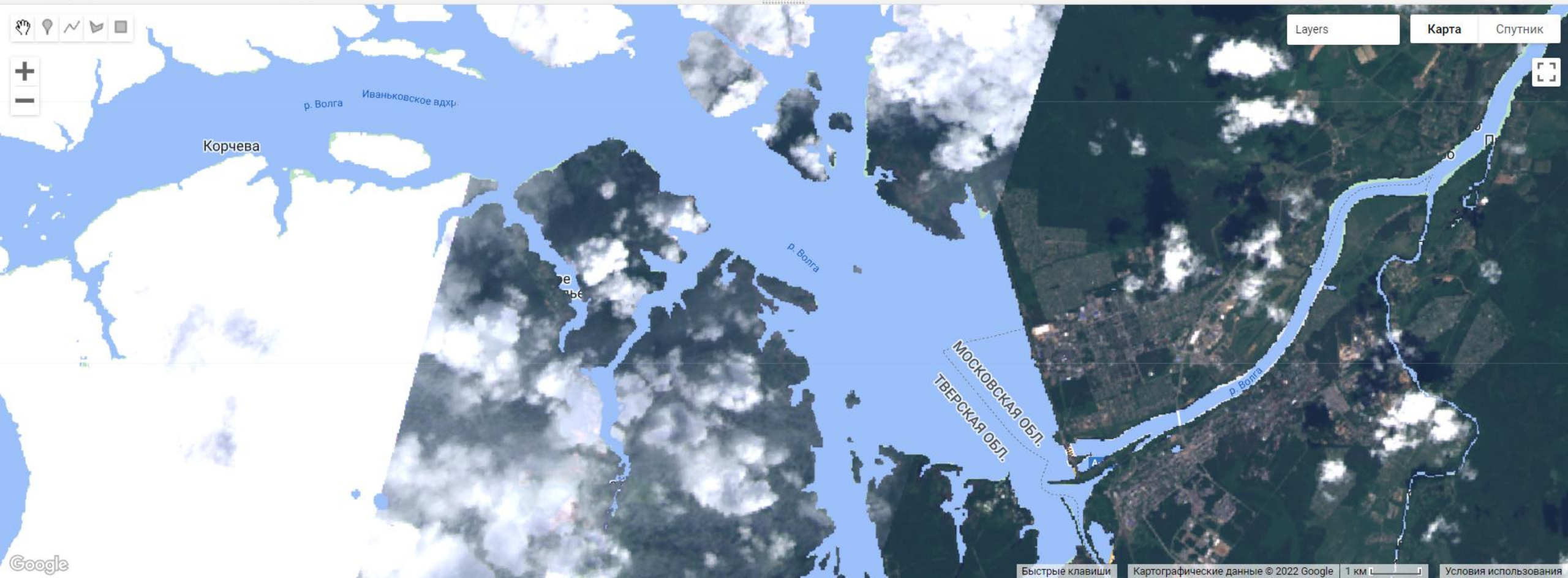
```
6  Map.setCenter(37.02540746271644,56.76616031658845, 12);
7
8  // Load or import the Hansen et al. forest change dataset.
9  var hansenImage = ee.Image('UMD/hansen/global_forest_change_2021_v1_9');
10
11 // Select the land/water mask.
12 var datamask = hansenImage.select('datamask');
13
14 // Create a binary mask.
15 var mask = datamask.eq(1);
16
17 // Update the composite mask with the water mask.
18 var maskedComposite = median.updateMask(mask);
19 Map.addLayer(maskedComposite, {bands: ['B4', 'B3', 'B2'], max: 0.3}, 'masked');
```

Inspector | Console | Tasks

Use `print(...)` to write to this console.



# Clouds

https://code.earthengine.google.com/36ce292efce7e367f53aac53ed970fbf

https://developers.google.com/earth-engine/datasets/catalog/LANDSAT_LC08_C02_T1_L2#description

```
var dataset = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')
    .filterDate('2022-05-01', '2022-07-17');


// Applies scaling factors.
function applyScaleFactors(image) {
  var opticalBands = image.select('SR_B.').multiply(0.0000275).add(-0.2);
  var thermalBands = image.select('ST_B.*').multiply(0.00341802).add(149.0);
  return image.addBands(opticalBands, null, true)
              .addBands(thermalBands, null, true);
}

dataset = dataset.map(applyScaleFactors);

var visualization = {
  bands: ['SR_B4', 'SR_B3', 'SR_B2'],
  min: 0.0,
  max: 0.3,
};

Map.setCenter(37.02540746271644,56.766160331658845, 12);

Map.addLayer(dataset, visualization, 'clouds');
```

```
function maskL8sr(image) {
  // Bit 0 - Fill
  // Bit 1 - Dilated Cloud
  // Bit 2 - Cirrus
  // Bit 3 - Cloud
  // Bit 4 - Cloud Shadow
  var qaMask = image.select('QA_PIXEL').bitwiseAnd(parseInt('11111', 2)).eq(0);
  var saturationMask = image.select('QA_RADSAT').eq(0);

  // Apply the scaling factors to the appropriate bands.
  var opticalBands = image.select('SR_B.').multiply(0.0000275).add(-0.2);

  // Replace the original bands with the scaled ones and apply the masks.
  return image.addBands(opticalBands, null, true)
      .updateMask(qaMask)
      .updateMask(saturationMask);
}

// Map the function over one year of data.
var collection = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')
                  .filterDate('2022-05-01', '2022-07-17')
                  .map(maskL8sr);

var composite = collection.median();

// Display the results.
Map.addLayer(composite, {bands: ['SR_B4', 'SR_B3', 'SR_B2'], min: 0, max: 0.3}, 'no clouds');
```

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  - collections
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collection clouds *

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```
1  var dataset = ee.ImageCollection('LANDSAT/LC08/C02/T1_L2')
2      .filterDate('2022-05-01', '2022-07-17');
3
4
5  // Applies scaling factors.
6  function applyScaleFactors(image) {
7    var opticalBands = image.select('SR_B.').multiply(0.0000275).add(-0.2);
8    var thermalBands = image.select('ST_B.*').multiply(0.00341802).add(149.0);
9    return image.addBands(opticalBands, null, true)
10                .addBands(thermalBands, null, true);
11 }
12
13 dataset = dataset.map(applyScaleFactors);
```

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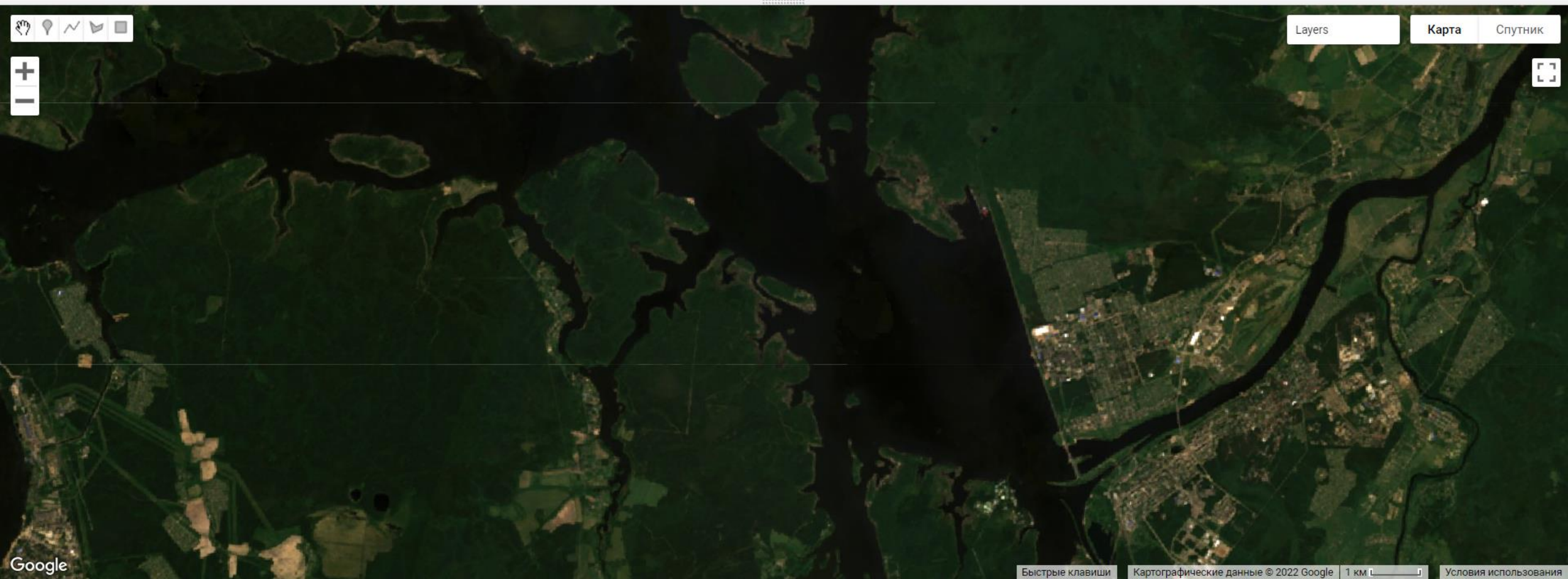
Use `print(...)` to write to this console.



# NDVI

https://code.earthengine.google.com/ec9e2f81b63ad006475b263f5f0cd661

```
var point =  ee.Geometry.Point(37.02540746271644,56.766160331658845);
var l8 = ee.ImageCollection('LANDSAT/LC08/C02/T1_TOA');

// Get the least cloudy image in 2015.
var image = ee.Image(
  l8.filterBounds(point)
    .filterDate('2022-06-01', '2022-07-17')
    .sort('CLOUD_COVER')
    .first()
);

// Compute the Normalized Difference Vegetation Index (NDVI).
var nir = image.select('B5');
var red = image.select('B4');
var ndvi = nir.subtract(red).divide(nir.add(red)).rename('NDVI');

// Display the result.
Map.setCenter(37.02540746271644,56.766160331658845, 12);
var ndviParams = {min: -1, max: 1, palette: ['blue', 'white', 'green']};
Map.addLayer(ndvi, ndviParams, 'NDVI image');
```

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- collections
- fires
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collection ndvi

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```
// Get the least cloudy image in 2015.
var image = ee.Image(
  l8.filterBounds(point)
    .filterDate('2022-06-01', '2022-07-17')
    .sort('CLOUD_COVER')
    .first()
);

// Compute the Normalized Difference Vegetation Index (NDVI).
var nir = image.select('B5');
var red = image.select('B4');
var ndvi = nir.subtract(red).divide(nir.add(red)).rename('NDVI');
```

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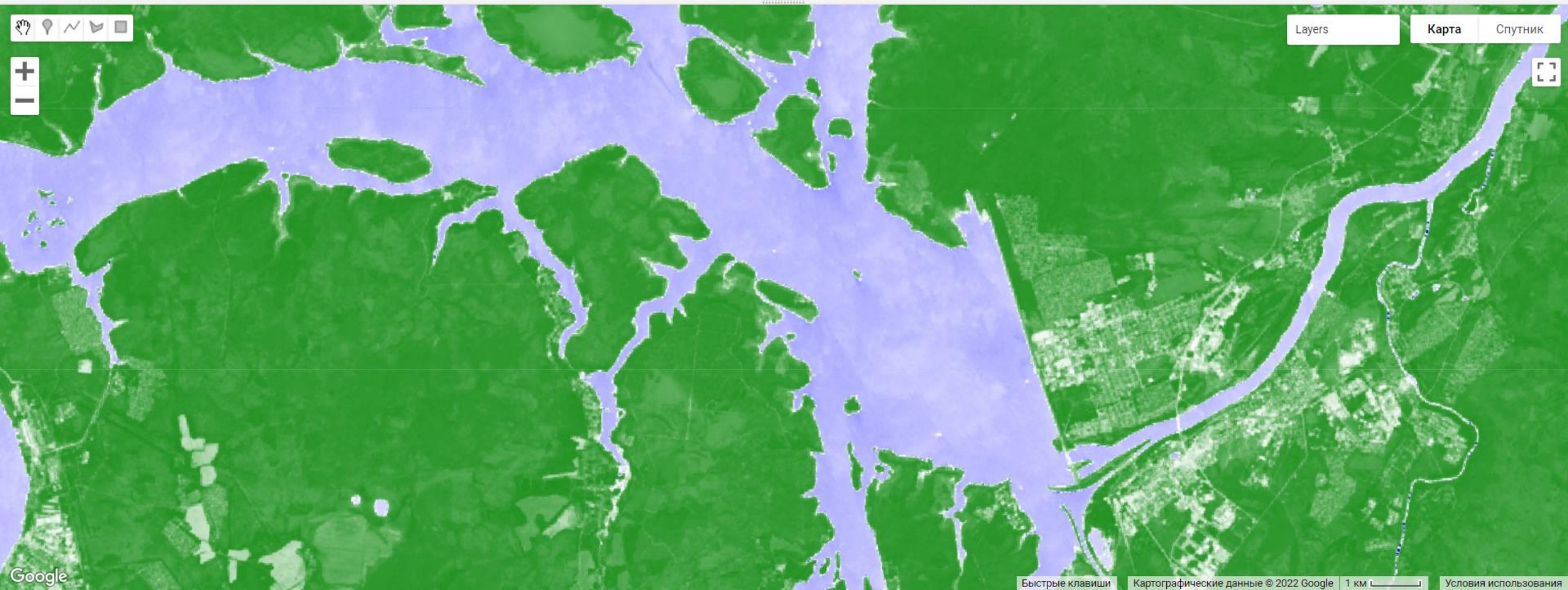
Use `print(...)` to write to this console.



## Charts

https://code.earthengine.google.com/ec976be7da2129036839e1cf2f21cbbb

```
//var cloud_perc = 60;//Max cloud percentile per scene.

// Import the Landsat 8 TOA image collection.
var l8 = ee.ImageCollection('LANDSAT/LC08/C01/T1_TOA')
    .filterDate('2021-03-01', '2021-12-01');
//    .filter(ee.Filter.lt('CLOUD_COVER', cloud_perc));

// Map a function over the Landsat 8 TOA collection to add an NDVI band.
var withNDVI = l8.map(function(image) {
  var ndvi = image.normalizedDifference(['B5', 'B4']).rename('NDVI');
  return image.addBands(ndvi);
});

var roi = ee.Geometry.Rectangle(37.01900746271644,56.76360331658845,37.0340746271644,56.76860331658845);
Map.setCenter(37.02540746271644,56.766160331658845, 12);
Map.addLayer(roi, {color: 'blue'}, 'clouds');


// Create a chart.
var chart = ui.Chart.image.series({
  imageCollection: withNDVI.select('NDVI'),
  region: roi,
  reducer: ee.Reducer.median(),
  scale: 30
}).setOptions({title: 'NDVI over time'});

// Display the chart in the console.
print(chart);
```

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- Two Chart Inspector
- Zoom Box
- Datasets
- Demos

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```
1  //var cloud_perc = 60;//Max cloud percentile per scene.
2
3  // Import the Landsat 8 TOA image collection.
4  var l8 = ee.ImageCollection('LANDSAT/LC08/C01/T1_TOA')
5      .filterDate('2021-03-01', '2021-10-01');
6  //    .filter(ee.Filter.lt('CLOUD_COVER', cloud_perc));
7
8  // Map a function over the Landsat 8 TOA collection to add an NDVI band.
9  var withNDVI = l8.map(function(image) {
10   var ndvi = image.normalizedDifference(['B5', 'B4']).rename('NDVI');
11   return image.addBands(ndvi);
12 });
13
14 var roi = ee.Geometry.Rectangle(37.01900746271644,56.76360331658845,37.0340746271644,56.76860331658845);
```

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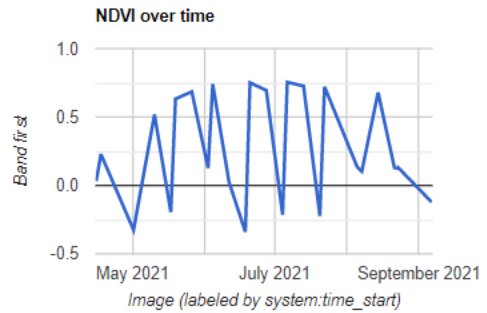


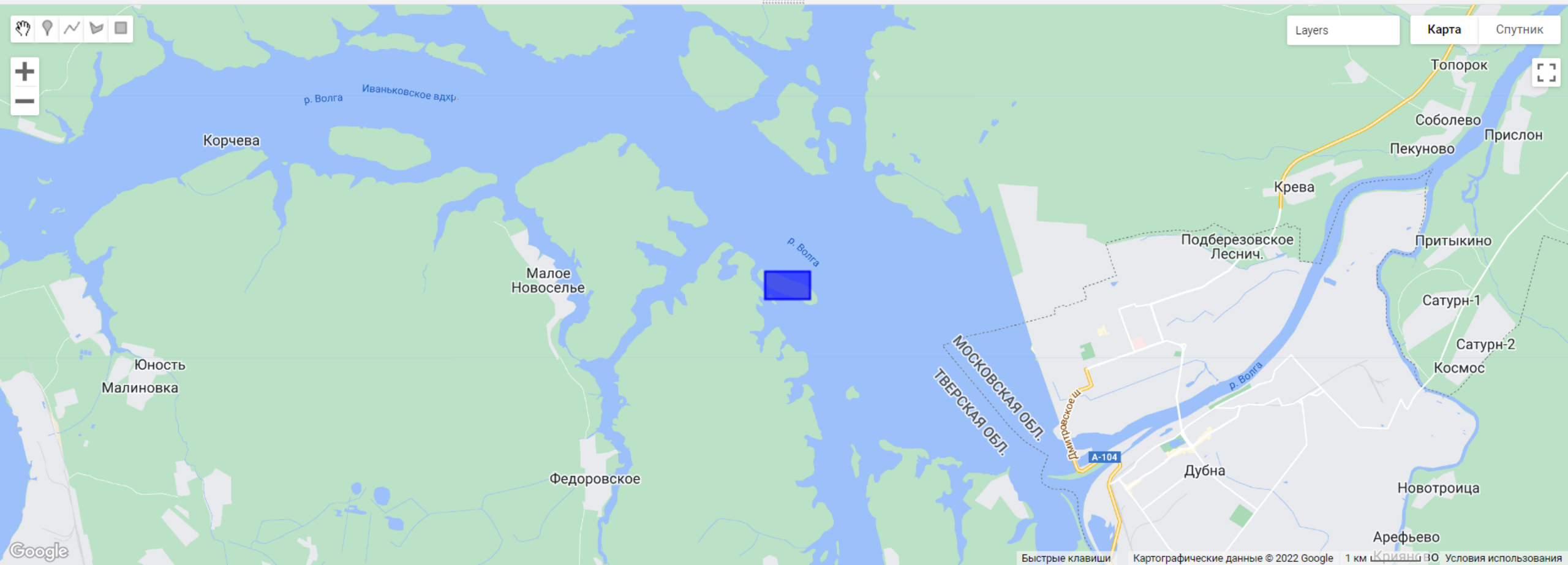

**Burn Areas**

https://developers.google.com/earth-engine/datasets/catalog/FIRMS?hl=en

https://code.earthengine.google.com/e9c2c3dd7cfb47bb55111557da6102d0

```
var dataset = ee.ImageCollection('FIRMS').filter(
    ee.Filter.date('2022-07-01', '2022-07-16'));
var fires = dataset.select('T21');
var firesVis = {
  min: 325.0,
  max: 400.0,
  palette: [
    'ff0000', 'fd4100', 'fb8200', 'f9c400', 'f2ff00', 'b6ff05',
    '7aff0a', '3eff0f', '02ff15', '00ff55', '00ff99', '00ffdd',
    '00ddff', '0098ff', '0052ff', '0210ff', '3a0dfb', '7209f6',
    'a905f1', 'e102ed', 'ff00cc', 'ff0089', 'ff0047', 'ff0004'
  ]
};
Map.setCenter(37.025407462716 44,56.766160331658845, 7);
Map.addLayer(fires, firesVis, 'Fires');
```

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- fires
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- image comp
- image statistics
- Ivanovo
- Poland
- Sweden
- TOA corrections

lip/fires *

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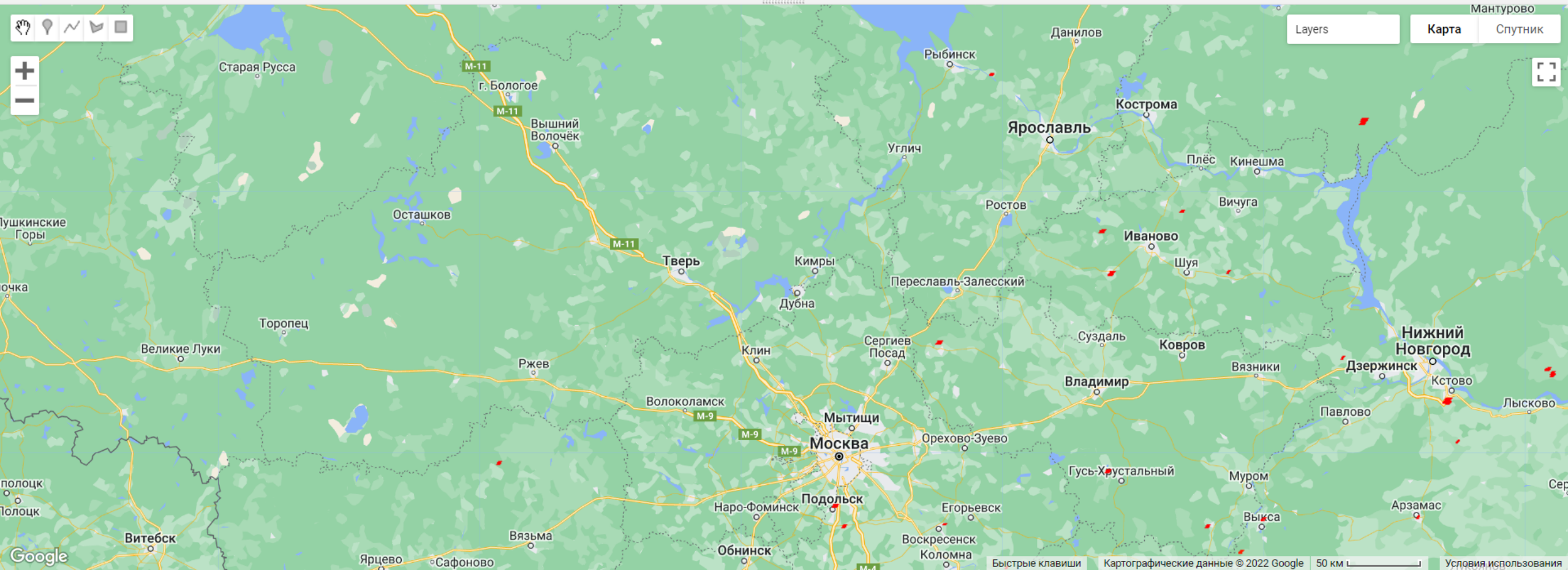
```
3  var fires = dataset.select('T21');
4  var firesVis = {
5    min: 325.0,
6    max: 400.0,
7    palette: [
8      'ff0000', 'fd4100', 'fb8200', 'f9c400', 'f2ff00', 'b6ff05',
9      '7aff0a', '3eff0f', '02ff15', '00ff55', '00ff99', '00ffdd',
10     '00ddff', '0098ff', '0052ff', '0210ff', '3a0dfb', '7209f6',
11     'a905f1', 'e102ed', 'ff00cc', 'ff0089', 'ff0047', 'ff0004'
12   ]
13 };
14 Map.setCenter(37.02540746271644,56.766160331658845, 7);
15 Map.addLayer(fires, firesVis, 'Fires');
16
```

Inspector | Console | Tasks

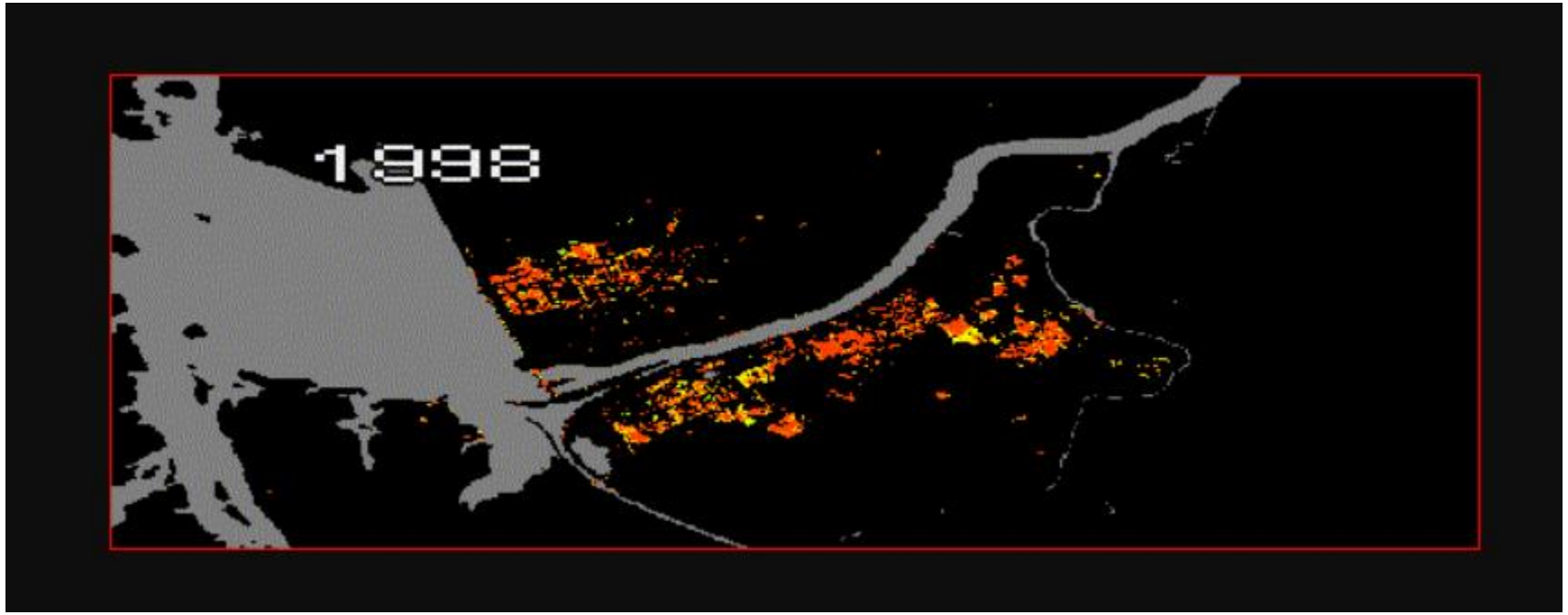
Use `print(...)` to write to this console.



**Timeseries**

https://developers.google.com/earth-engine/datasets/catalog/Tsinghua_FROM-GLC_GAIA_v10?hl=en#description

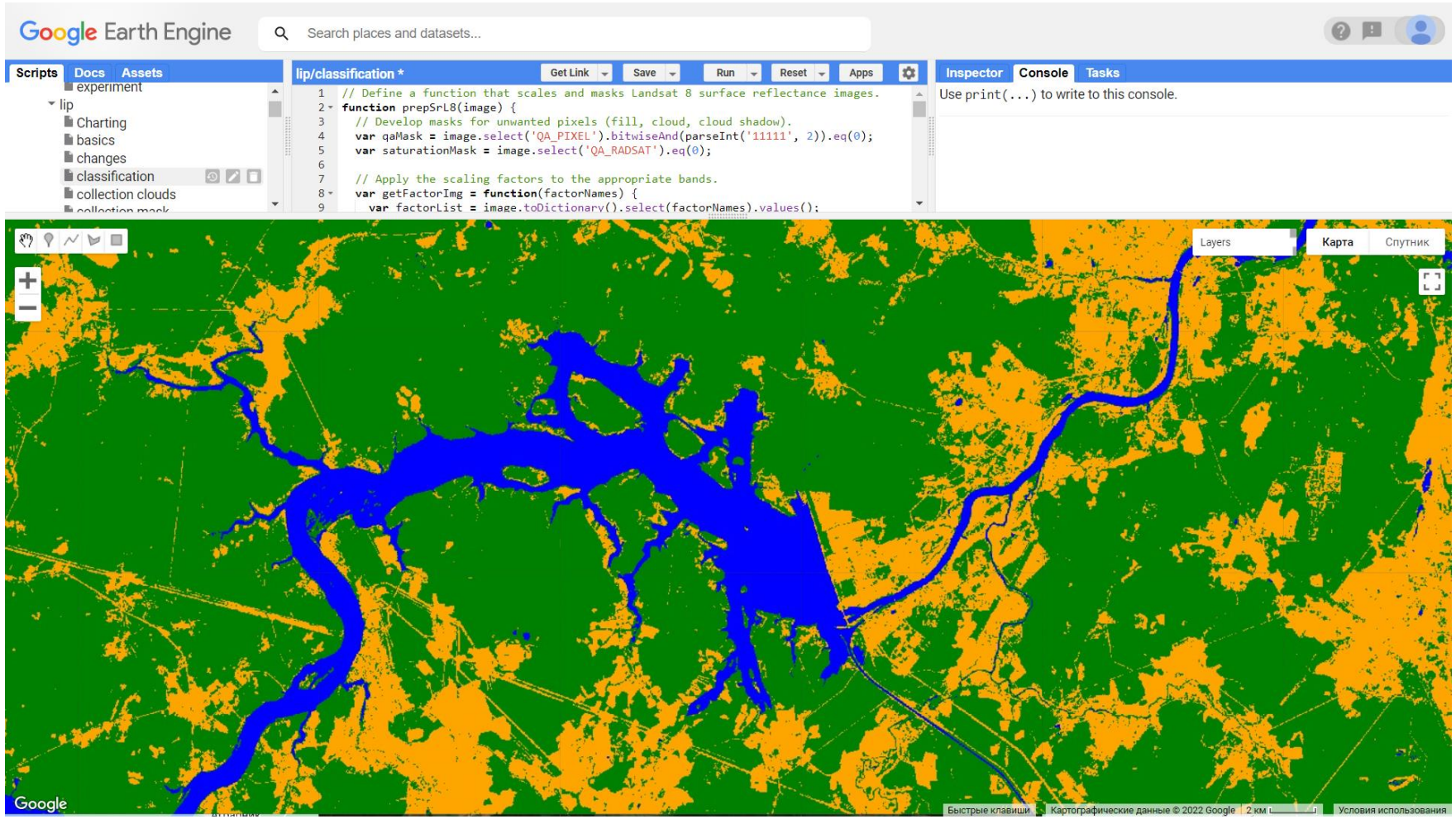
https://code.earthengine.google.com/cdd574d1d7466208b1eb5bff5fb7c02e



## Land use classification

https://developers.google.com/earth-engine/apidocs/ee-classifier-libsvm

https://code.earthengine.google.com/1828d8cf8bd900884f4a9746ee214252




That's all Folks!