



Weather & Climate Data Analysis with Google Earth Engine

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Slides: g.co/earth/ecmwf2021

Agenda

01 What is Earth Engine?

A very brief overview.

02 Earth Engine Data Catalog

What datasets are available?

03 APIs & Client Libraries

How to request outputs...

04 Demo

Time to run with scissors....

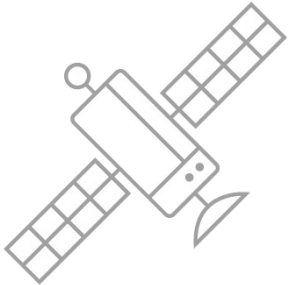
05 Questions

??? and more ???

Earth Engine in Three Sentences

Earth Engine is Google's platform for doing scientific analysis of large-scale Earth data, including satellite imagery, census data, etc. It's composed of two big components: a **collection of scientific data**, and the **computational power** to effectively work with data at that scale.

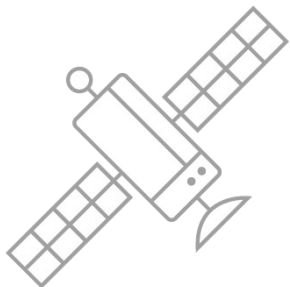
The **Earth Engine API** is the interface through which scientists and researchers express the operations they'd like Earth Engine to perform.



Earth Engine in Three Sentences

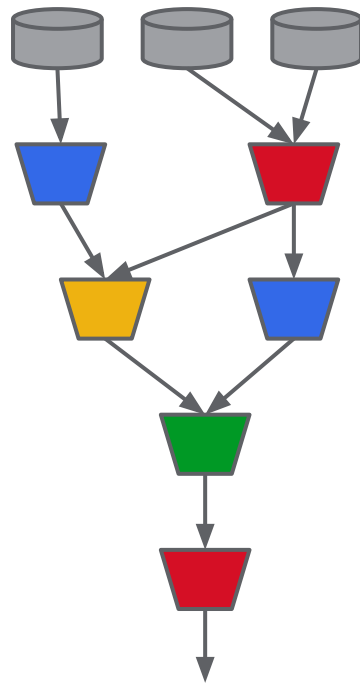
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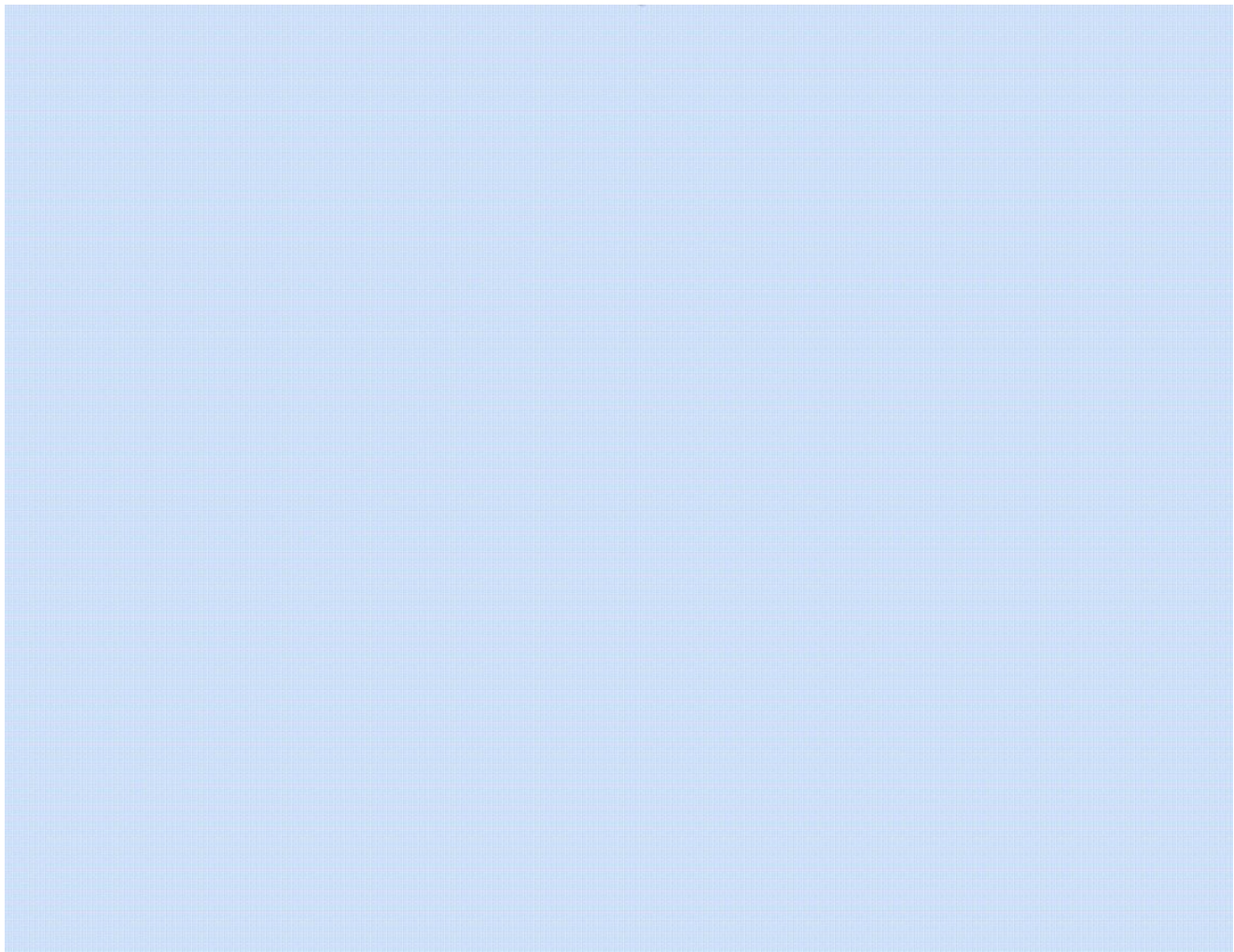
The **Earth Engine API** is the interface through which scientists and researchers express the operations they'd like Earth Engine to perform.



Expressions and Lazy Evaluation

- Earth Engine expressions define new objects in terms of existing objects, as a **directed acyclic graph**.
- Users can define **custom functions** in terms of other functions.
- The core Image and Collection types are **lazy** and **inherently parallel**.
- Computations are specified by an expression + a selector (i.e. which part of the result is needed — for a raster, which pixels at what resolution)





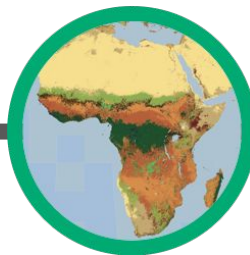
Public Data Catalog



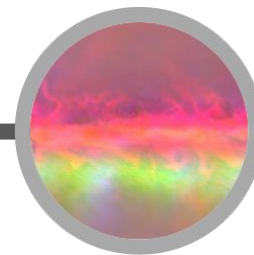
**Optical
Imagery**



**Boundary
Data**



**Terrain &
Land Cover**



**Weather &
Climate**

600+ public datasets

100+ datasets added yearly

30+ petabytes of data

1+ PB of new data every month

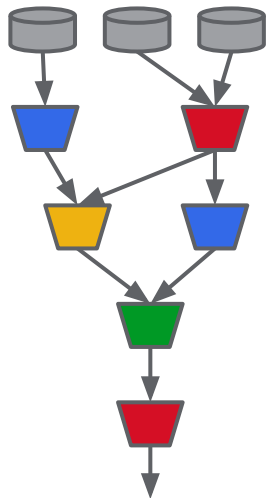
... and upload your own vectors and rasters

Selected Weather & Climate Datasets

- Reanalysis
 - **ECMWF ERA5** daily / monthly
 - **ECMWF ERA5-Land** hourly / monthly
 - **NOAA CFSR**
 - **NCEP/NCAR Reanalysis Data**
- Weather Forecast
 - **NOAA GFS**
 - **NOAA RTMA**
 - **ECMWF CAMS** Global Near-Real-Time (optical depth & particulate matter)
- Climate Projections
 - **CMIP5 NEX-GDDP**

Available Functions

Over 1000 functions/methods that work on Earth Engine objects:



- Images, Image Collections
- Features, Feature Collections
- Reducers
- Joins
- Filters
- Kernels
- Numbers, Lists, Arrays
- Machine Learning Classifiers
- etc...

ee.Date.advance | Google Earth Engine

Google Earth Engine

Home Guides Reference Support Community Data Catalog

API Reference

Overview

Client Libraries

JavaScript/Python

- ee.Algorithms
- ee.Array
- ee.Blob
- ee.Classifier
- ee.Clusterer
- ee.ConfusionMatrix
- ee.Date
 - ee.Date.advance**
 - ee.Date.aside
 - ee.Date.difference
 - ee.Date.evaluate
 - ee.Date.format
 - ee.Date.fromYMD
 - ee.Date.get
 - ee.Date.getFraction
 - ee.Date.getInfo
 - ee.Date.getRange
 - ee.Date.getRelative
 - ee.Date.millis
 - ee.Date.parse
 - ee.Date.serialize
 - ee.Date.unitRatio
 - ee.Date.update
- ee.DateRange
- ee.Dictionary
- ee.ErrorMargin
- ee.Feature
- ee.FeatureCollection
- ee.Filter
- ee.Geometry
- ee.Image
- ee.ImageCollection
- ee.Join
- ee.Kernel
- ee.List

Home > Products > Google Earth Engine > Reference

Rate and review

Send feedback

ee.Date.advance

Table of contents

Examples

Create a new Date by adding the specified units to the given Date.

Usage	Returns
Date.advance(delta, unit, timeZone)	Date

Argument	Type	Details
this: date	Date	
delta	Float	
unit	String	One of 'year', 'month', 'week', 'day', 'hour', 'minute', or 'second'.
timeZone	String, default: null	The time zone (e.g. 'America/Los_Angeles'); defaults to UTC.

Examples

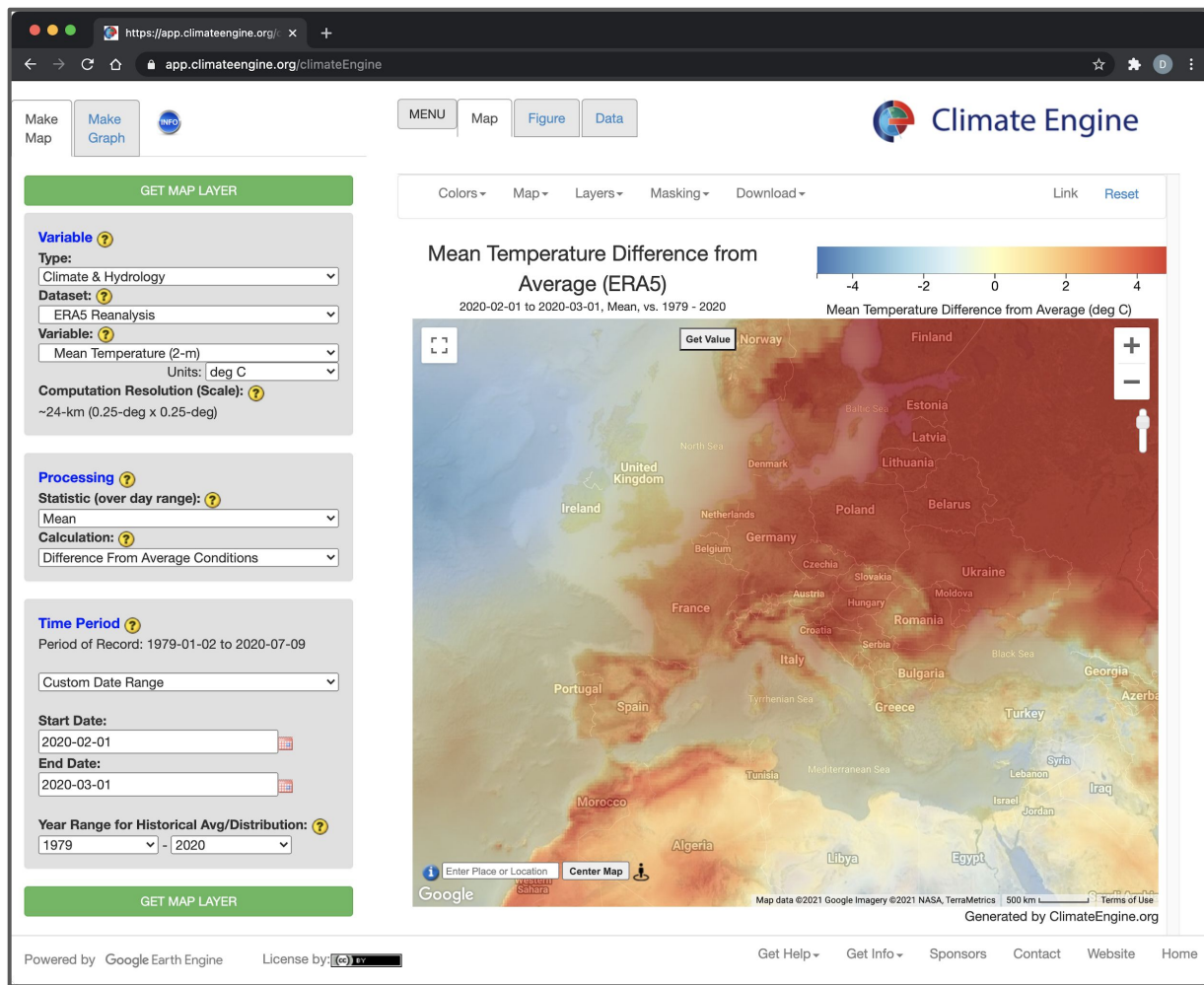
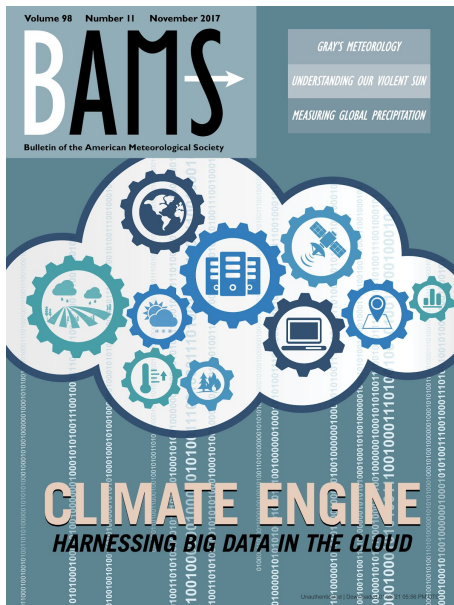
JavaScript Python

```
// Defines a base date/time for the following examples.
var BASE_DATE = ee.Date('2020-7-1T13:00', 'UTC');
print(BASE_DATE, 'The base date/time');

// Demonstrates basic usage.
print(BASE_DATE.advance(1, 'week'), '+1 week');
print(BASE_DATE.advance(2, 'years'), '+2 years');

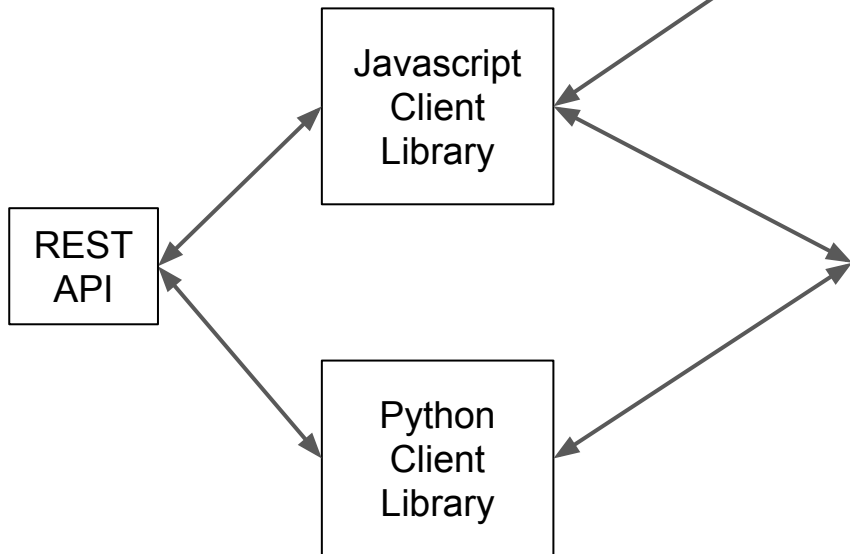
// Demonstrates that negative delta moves back in time.
```

Example Web Application: Climate Engine

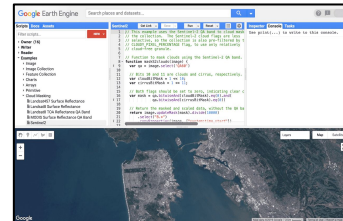




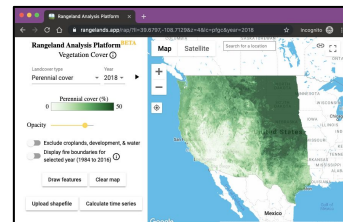
Earth Engine
Backend
Servers



Earth Engine
Code Editor

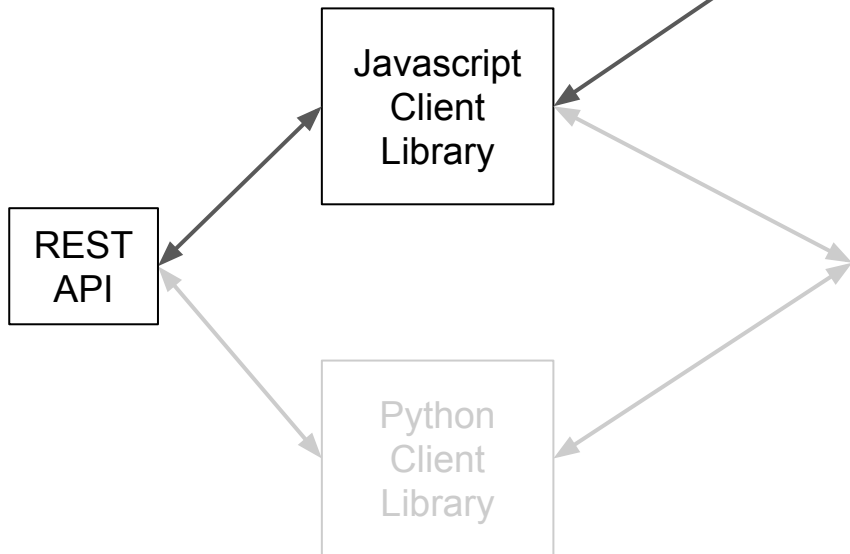


Web
Application

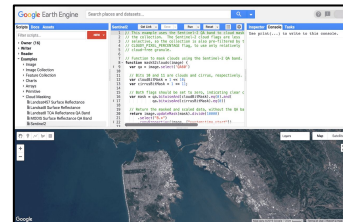




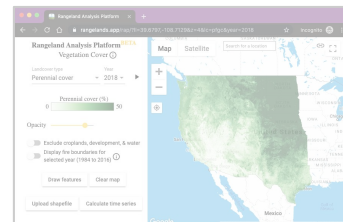
Earth Engine
Backend
Servers



Earth Engine
Code Editor

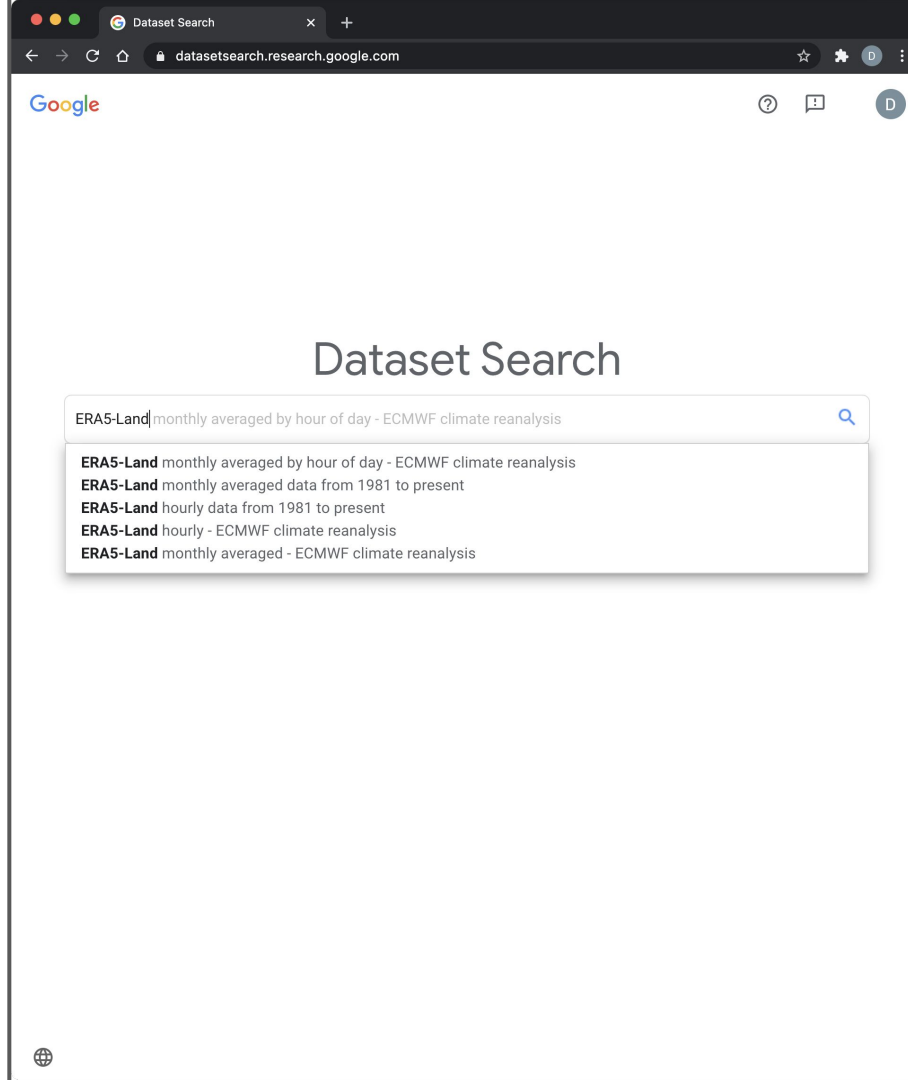


Web
Application



Example: ERA5-Land

- Search for “ERA5-Land hourly” on Google Dataset Search



Example: ERA5-Land

- Search for “ERA5-Land hourly” on Google Dataset Search
- Select a dataset on Earth Engine

The screenshot shows a web browser displaying search results for "ERA5-Land hourly" on Google Dataset Search. The search results list four datasets, all from ECMWF, with details on their sources, formats, and update dates. A highlighted result for "ERA5-Land hourly - ECMWF climate reanalysis" is shown in a light blue box. To the right, the Google Earth Engine interface displays the selected dataset, including a description of the reanalysis data, its time period (1981-2020), and a link to explore it on Earth Engine.

Dataset Search

datasetsearch.research.google.com/search?query=ERA5-Land%20hourly&docid=tdhZnXZDnQ...

Google

ERA5-Land hourly

Last updated Download format Usage rights Topic Free Saved datasets

24 datasets found

ECMWF ERA5-Land hourly data from 1981 to present
cds.climate.copernicus.eu
grib
Updated Jul 12, 2019

Google Earth Engine ERA5-Land hourly - ECMWF climate reanalysis
developers.google.com

ECMWF ECMWF Reanalysis v5 - Land
www.ecmwf.int
grib, grib; netcdf
Updated Sep 4, 2020

ECMWF ERA5-Land monthly averaged data from 1981 to present
cds.climate.copernicus.eu
grib
Updated Jul 12, 2019

ECMWF ERA5 hourly data on single levels from 1979 to present
cds.climate.copernicus.eu
grib
Updated Jun 14, 2018

Google Earth Engine

ERA5-Land hourly - ECMWF climate reanalysis

Related Article

Explore at Google Earth Engine

Dataset provided by
Climate Data Store

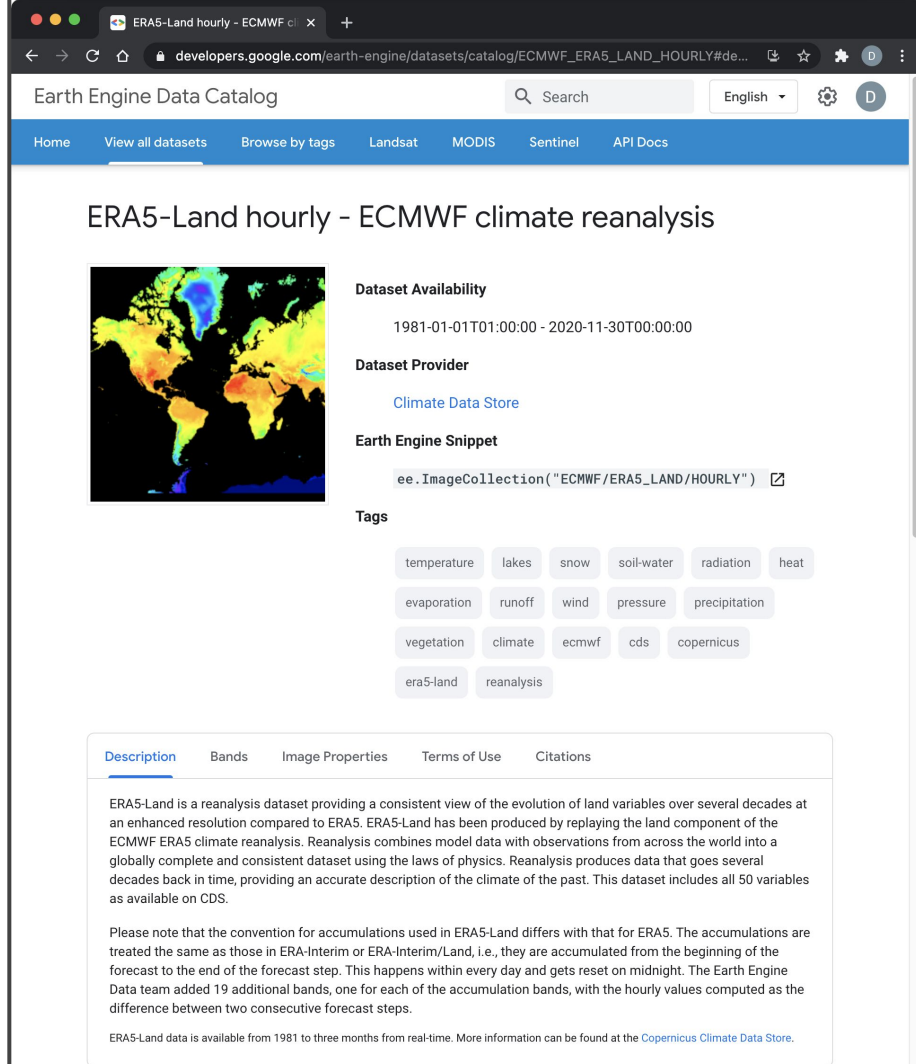
Time period covered
Jan 1, 1981 - Nov 30, 2020

Description

ERA5-Land is a reanalysis dataset providing a consistent view of the evolution of land variables over several decades at an enhanced resolution compared to ERA5. ERA5-Land has been produced by replaying the land component of the ECMWF ERA5 climate reanalysis. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset using the laws of physics. Reanalysis produces data that goes several decades back in time, providing an accurate description of the climate of the past. This dataset includes all 50 variables as available on CDS. Please note that the convention for accumulations used in ERA5-Land differs with that for ERA5. The accumulations are treated the same as those in ERA-Interim or ERA-Interim/Land, i.e., they are accumulated from the beginning of the forecast to the end of the forecast step. This happens within every day and gets reset on midnight. The Earth Engine Data team added 19 additional bands, one for each of the accumulation bands, with the hourly values computed as the difference between two consecutive forecast steps. ERA5-Land data is available from 1981 to three months from real-time. More information can be found at the Copernicus Climate Data Store.

Example: ERA5-Land

- Search for “ERA5-Land hourly” on Google Dataset Search
- Select a dataset on Earth Engine
- Open the dataset description page



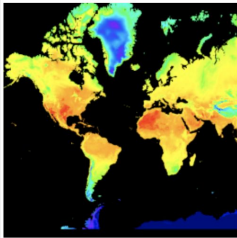
The screenshot shows the Earth Engine Data Catalog interface. The browser address bar displays the URL: `developers.google.com/earth-engine/datasets/catalog/ECMWF_ERA5_LAND_HOURLY#de...`. The page title is "Earth Engine Data Catalog". The navigation bar includes links for Home, View all datasets, Browse by tags, Landsat, MODIS, Sentinel, and API Docs. The main heading is "ERA5-Land hourly - ECMWF climate reanalysis". To the left of the text is a world map showing land cover data. The "Dataset Availability" section shows the time range "1981-01-01T01:00:00 - 2020-11-30T00:00:00". The "Dataset Provider" section links to the "Climate Data Store". The "Earth Engine Snippet" section contains the code `ee.ImageCollection("ECMWF/ERA5_LAND/HOURLY")`. The "Tags" section lists various variables: temperature, lakes, snow, soil-water, radiation, heat, evaporation, runoff, wind, pressure, precipitation, vegetation, climate, ecmwf, cds, copernicus, era5-land, and reanalysis. The "Description" tab is active, showing a detailed text description of the dataset and its history.

Earth Engine Data Catalog

Search English

Home View all datasets Browse by tags Landsat MODIS Sentinel API Docs

ERA5-Land hourly - ECMWF climate reanalysis



Dataset Availability

1981-01-01T01:00:00 - 2020-11-30T00:00:00

Dataset Provider

[Climate Data Store](#)

Earth Engine Snippet

```
ee.ImageCollection("ECMWF/ERA5_LAND/HOURLY")
```

Tags

temperature lakes snow soil-water radiation heat

evaporation runoff wind pressure precipitation

vegetation climate ecmwf cds copernicus

era5-land reanalysis

Description Bands Image Properties Terms of Use Citations

ERA5-Land is a reanalysis dataset providing a consistent view of the evolution of land variables over several decades at an enhanced resolution compared to ERA5. ERA5-Land has been produced by replaying the land component of the ECMWF ERA5 climate reanalysis. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset using the laws of physics. Reanalysis produces data that goes several decades back in time, providing an accurate description of the climate of the past. This dataset includes all 50 variables as available on CDS.

Please note that the convention for accumulations used in ERA5-Land differs with that for ERA5. The accumulations are treated the same as those in ERA-Interim or ERA-Interim/Land, i.e., they are accumulated from the beginning of the forecast to the end of the forecast step. This happens within every day and gets reset on midnight. The Earth Engine Data team added 19 additional bands, one for each of the accumulation bands, with the hourly values computed as the difference between two consecutive forecast steps.

ERA5-Land data is available from 1981 to three months from real-time. More information can be found at the [Copernicus Climate Data Store](#).

Example: ERA5-Land

- Search for “ERA5-Land hourly” on Google Dataset Search
- Select a dataset on Earth Engine
- Open the dataset description page
- Scroll down to find the sample script

The screenshot shows the Earth Engine Data Catalog interface. The browser address bar displays the URL: `developers.google.com/earth-engine/datasets/catalog/ECMWF_ERA5_LAND_HOURLY#de...`. The page title is "Earth Engine Data Catalog". A search bar is located at the top right. Below the navigation bar, the "Description" tab is selected. The description text reads: "ERA5-Land is a reanalysis dataset providing a consistent view of the evolution of land variables over several decades at an enhanced resolution compared to ERA5. ERA5-Land has been produced by replaying the land component of the ECMWF ERA5 climate reanalysis. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset using the laws of physics. Reanalysis produces data that goes several decades back in time, providing an accurate description of the climate of the past. This dataset includes all 50 variables as available on CDS." Below this, a note states: "Please note that the convention for accumulations used in ERA5-Land differs with that for ERA5. The accumulations are treated the same as those in ERA-Interim or ERA-Interim/Land, i.e., they are accumulated from the beginning of the forecast to the end of the forecast step. This happens within every day and gets reset on midnight. The Earth Engine Data team added 19 additional bands, one for each of the accumulation bands, with the hourly values computed as the difference between two consecutive forecast steps." At the bottom of the description, it says: "ERA5-Land data is available from 1981 to three months from real-time. More information can be found at the [Copernicus Climate Data Store](#)." Below the description, there is a section titled "Explore in Earth Engine" which contains a sample script. The script is as follows:

```
var dataset = ee.ImageCollection("ECMWF/ERA5_LAND/HOURLY")
    .filter(ee.Filter.date('2020-07-01', '2020-07-02'));

var visualization = {
  bands: ['temperature_2m'],
  min: 250.0,
  max: 320.0,
  palette: [
    "#000080", "#0000D9", "#4000FF", "#8000FF", "#0080FF", "#00FFFF",
    "#00FF80", "#80FF00", "#DAFF00", "#FFFF00", "#FFF500", "#FFDA00",
    "#FFB000", "#FFA400", "#FF4F00", "#FF2500", "#FF0A00", "#FF00FF",
  ]
};

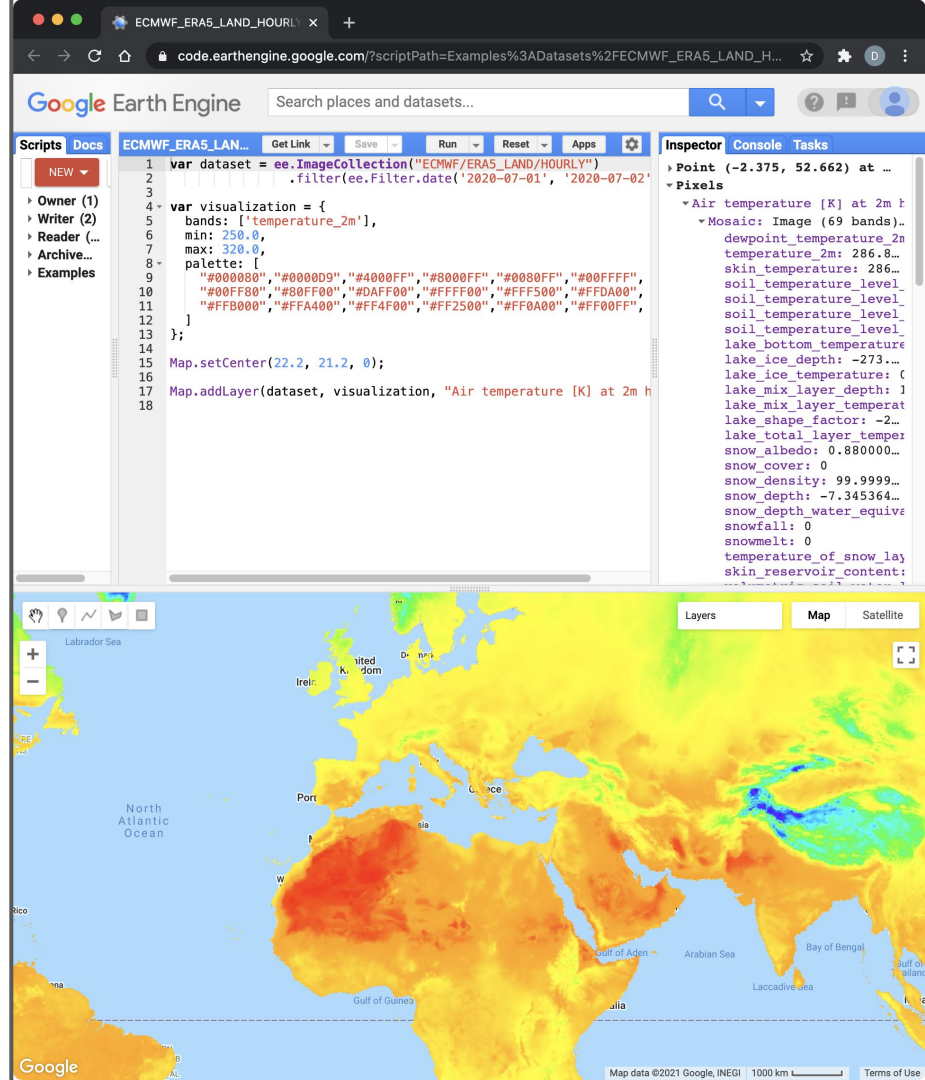
Map.setCenter(22.2, 21.2, 0);

Map.addLayer(dataset, visualization, "Air temperature [K] at 2m height");
```

 At the bottom of the page, there is a button labeled "Open in Code Editor".

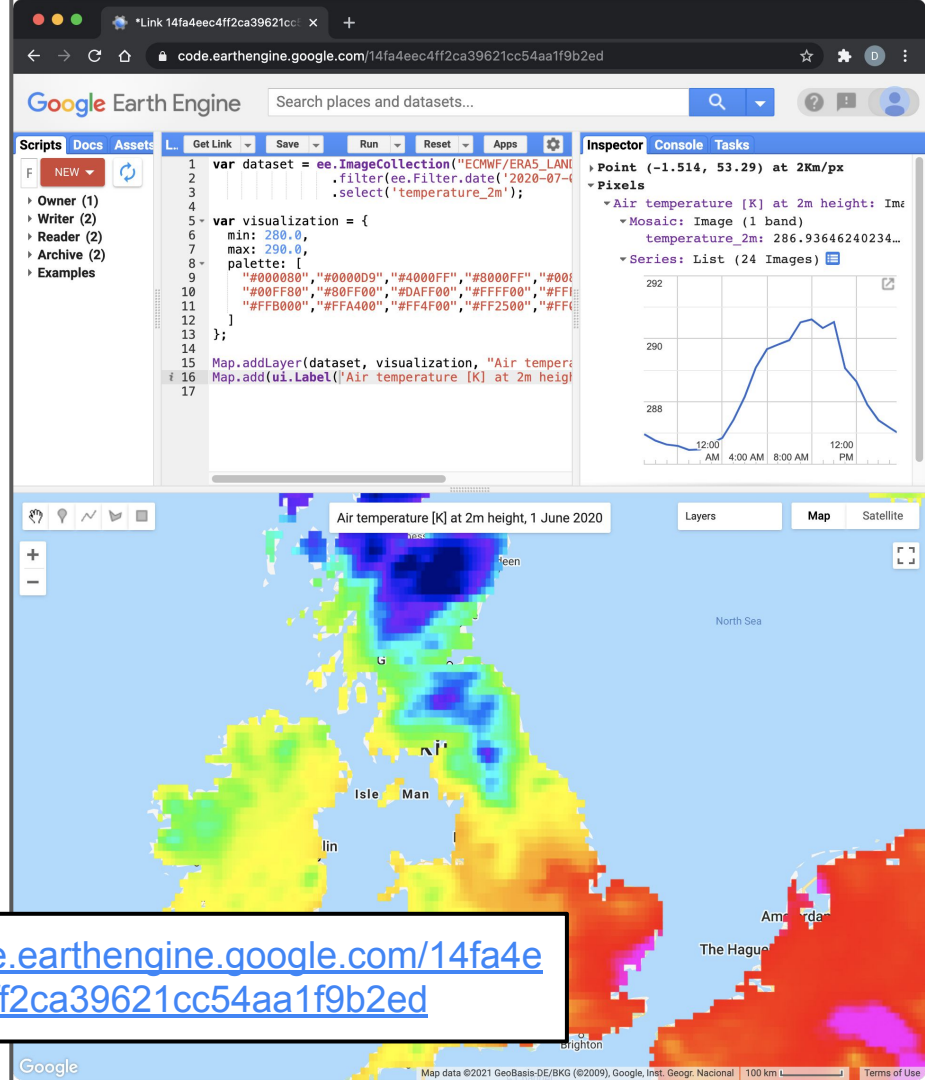
Example: ERA5-Land

- Search for “ERA5-Land hourly” on Google Dataset Search
- Select a dataset on Earth Engine
- Open the dataset description page
- Scroll down to find the sample script
- Open the sample script in the Code Editor GUI

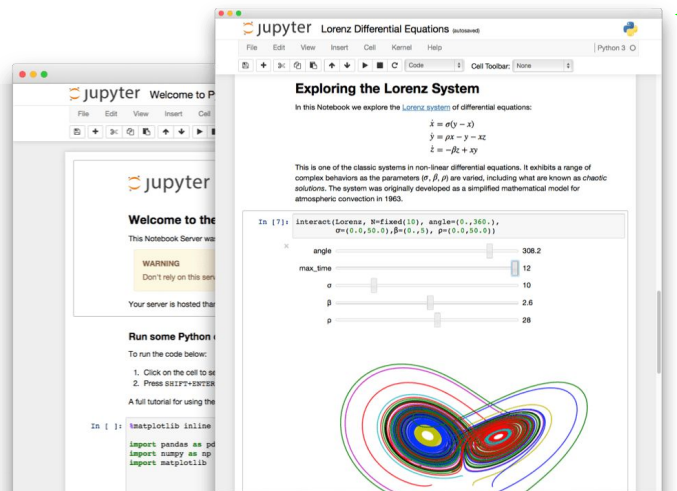


Example: ERA5-Land

- Search for “ERA5-Land hourly” on Google Dataset Search
- Select a dataset on Earth Engine
- Open the dataset description page
- Scroll down to find the sample script
- Open the sample script in the Code Editor GUI
- Modify and click “Get Link” to share with others



<https://code.earthengine.google.com/14fa4ec4ff2ca39621cc54aa1f9b2ed>





Earth Engine
Backend
Servers

REST
API

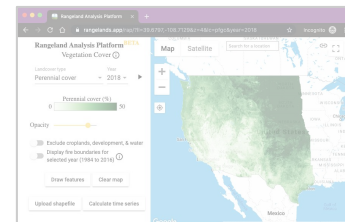
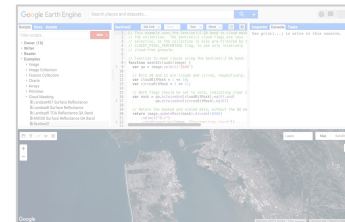
Javascript
Client
Library

Python
Client
Library

Earth Engine
Code Editor

Web
Application

Jupyter-based
Development
Environment



Demo

Exploring ERA5-Land.ipynb

<https://colab.research.google.com/drive/1suLcNvGzg4derqbf7zN1l9i0Upytbnko>

JupyterLab!

- Docker configuration example
github.com/gee-community/ee-jupyter-contrib
- geemap package
<https://github.com/giswqs/geemap>

JupyterLab Alpha Preview

localhost:8888/lab

File Edit Run Kernel View Editor Help

Files

+

+

+

+

...

examples > Getting Started

Name	Last Modified
Display Static Map.ipynb	3 minutes ago

Running

Commands

Cell Tools

Tabs

Launcher

Display Static Map

Python 3

Import Python modules

```
In [1]: import ee
        from IPython.display import Image
```

Initialize Earth Engine

```
In [2]: ee.Initialize()
```

If the preceding command fails, you likely need to authenticate your server to access Earth Engine by running the command

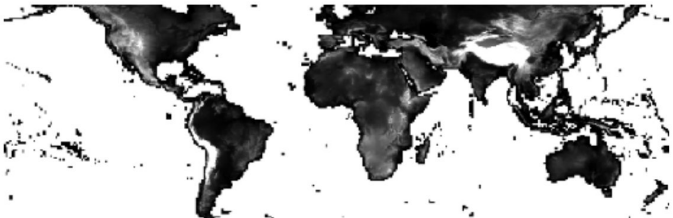
```
earthengine authenticate
```

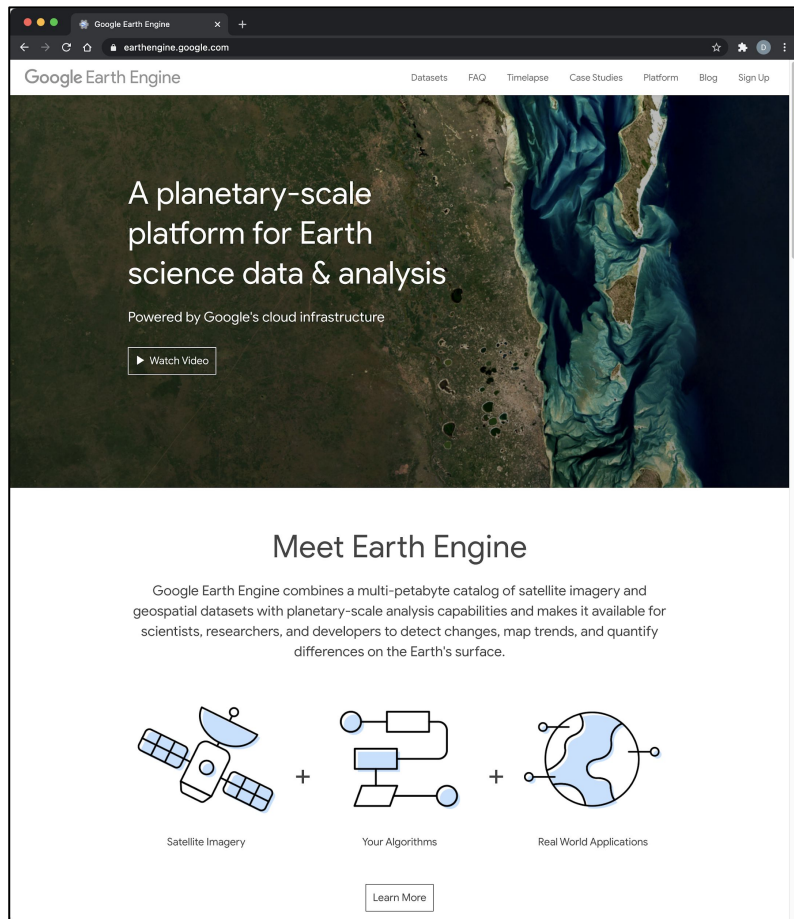
at a command line prompt.

Display a Static Map

```
In [3]: # Generate a URL that displays a global DEM
        url = ee.Image("USGS/SRTMGL1_003").getThumbUrl({'min':0, 'max':3000})
        # Display the image in the notebook.
        Image(url=url)
```

Out[3]:





How to get access

1. Goto: <https://earthengine.google.com/>
2. Click on “Sign Up”
3. Fill out and submit the simple form.
Hint: Use your organizational email
4. Wait for approval email.

Google Earth Engine Terms of Service



Development, research, or educational purposes are allowed



Services can be **evaluated** in a production environment



Services may not be used for **sustained commercial purposes** unless otherwise approved by Google

Thank you!

Tyler Erickson, PhD
Developer Advocate
Google Earth Engine
github.com/tylere
[@tylerickson](https://twitter.com/tylerickson)

More information at:

- Slides for this talk
g.co/earth/ecmwf2021
- Earth Engine Documentation
<https://developers.google.com/earth-engine>
- Geo for Good Summit Videos
<https://earthoutreachonair.withgoogle.com/events/geoforgood20>
- More code examples
<https://github.com/google/earthengine-api>
<https://github.com/google/earthengine-community>
<https://github.com/gee-community/ee-jupyter-contrib>
<https://github.com/giswqs/geemap>