Weather & Climate Data Analysis with Google Earth Engine

Tyler Erickson, PhD

Developer Advocate, Google Earth Engine

10 February 2021

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...

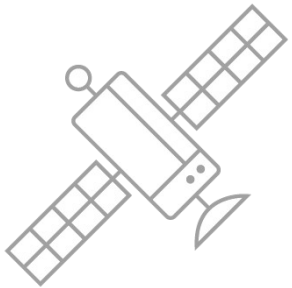
04 **Demo**
Time to run with scissors....

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.

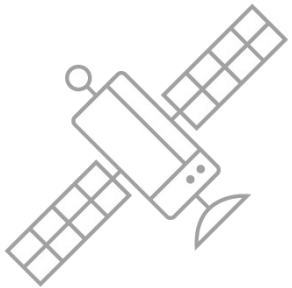
The **Earth Engine API** is the interface through which scientists and researchers express the operations they'd like Earth Engine to perform.



Earth Engine in Three Sentences

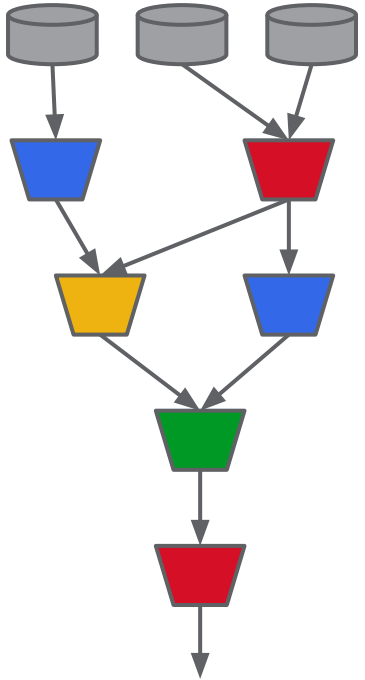
Earth Engine is Google's platform for doing scientific analysis of large-scale Earth data, including satellite imagery, census data, etc. It's composed of two big components: a **collection of scientific data**, and the **computational power** to effectively work with data at that scale.

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

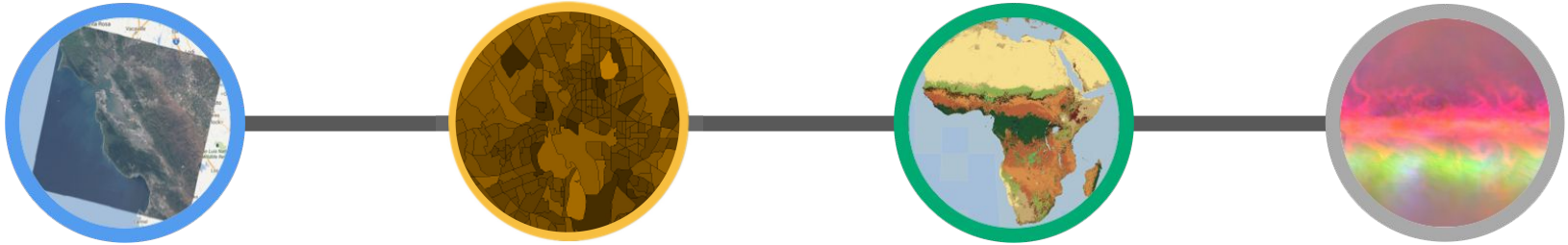


Expressions and Lazy Evaluation

- 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

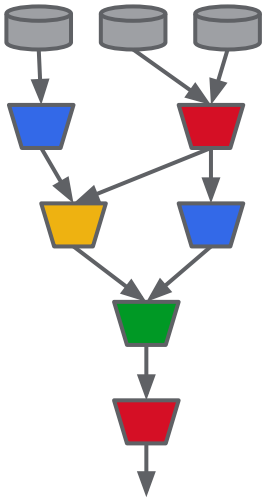
... and upload your own vectors and rasters

Selected Weather & Climate Datasets

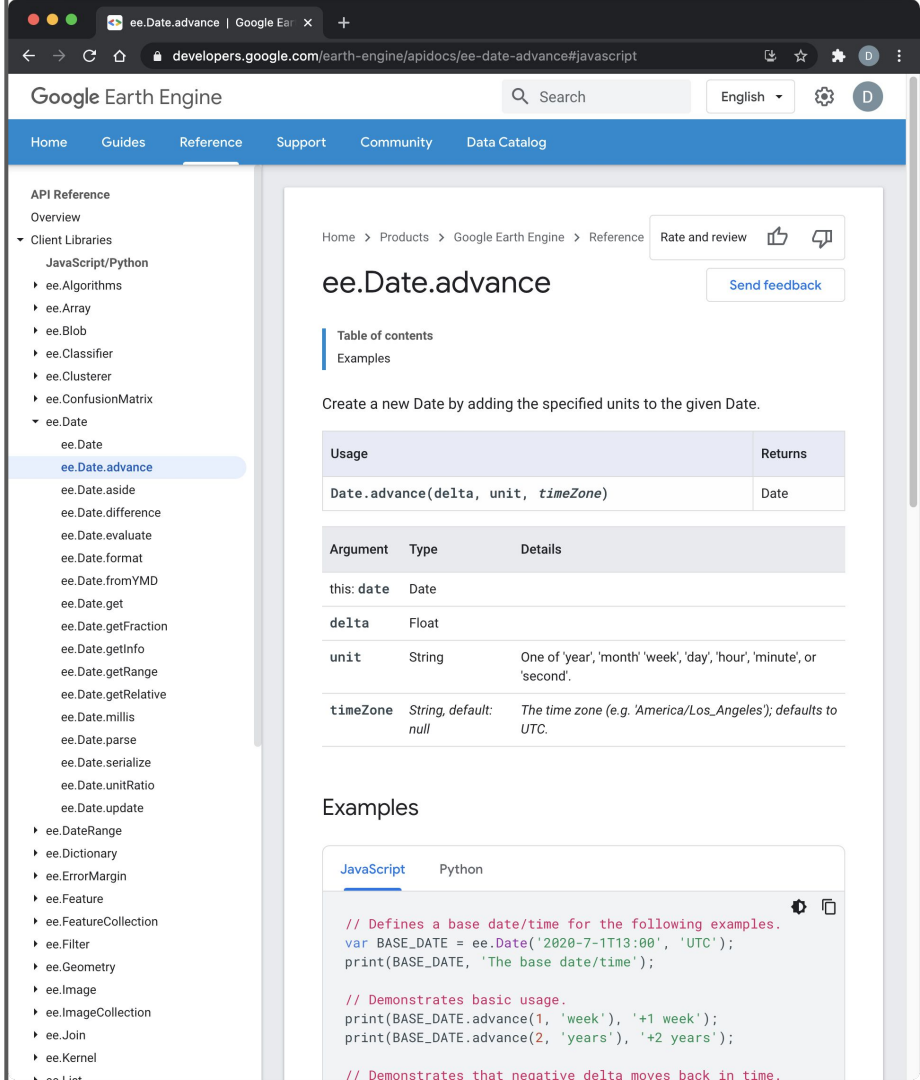
- Reanalysis
  - **ECMWF ERA5** daily / monthly
  - **ECMWF ERA5-Land** hourly / monthly
  - **NOAA CFSR**
  - **NCEP/NCAR Reanalysis Data**
- Weather Forecast
  - **NOAA GFS**
  - **NOAA RTMA**
  - **ECMWF CAMS** Global Near-Real-Time (optical depth & particulate matter)
- Climate Projections
  - **CMIP5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

Available Functions

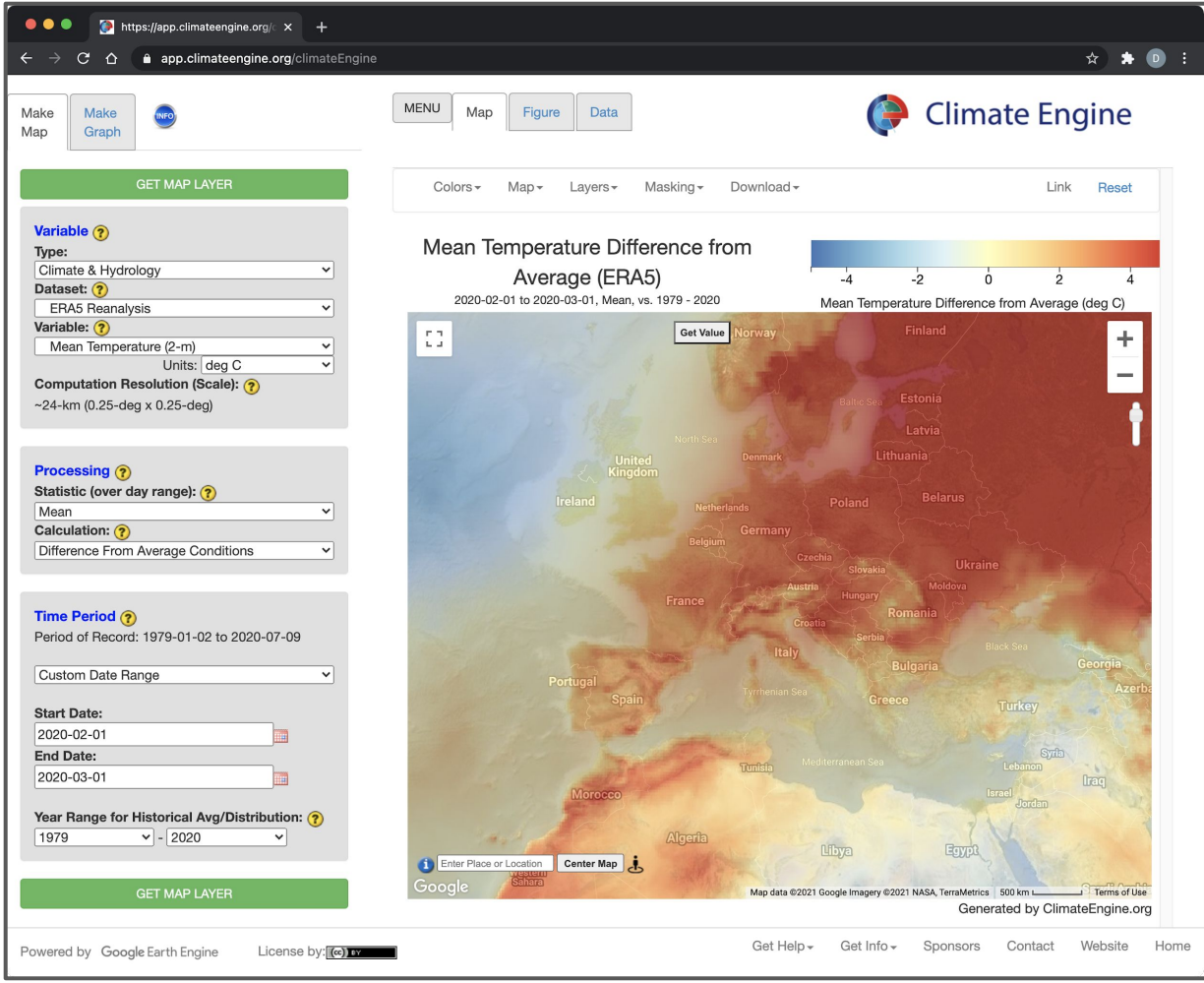
Over 1000 functions/methods that work on Earth Engine objects:



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



Example Web Application: Climate Engine



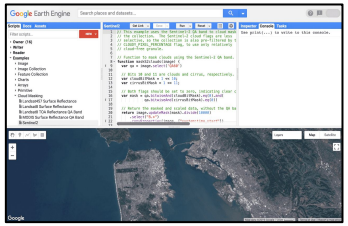
Earth Engine
Backend
Servers

REST
API

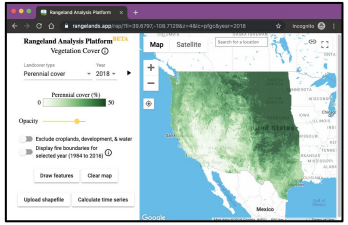
Javascript
Client
Library

Python
Client
Library

Earth Engine
Code Editor



Web
Application



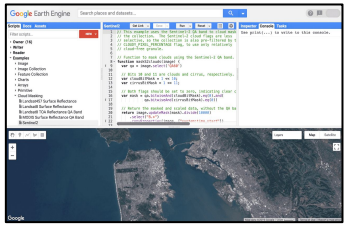
Earth Engine
Backend
Servers

REST
API

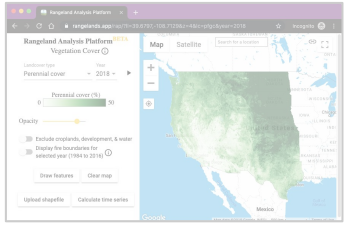
Javascript
Client
Library

Python
Client
Library

Earth Engine
Code Editor

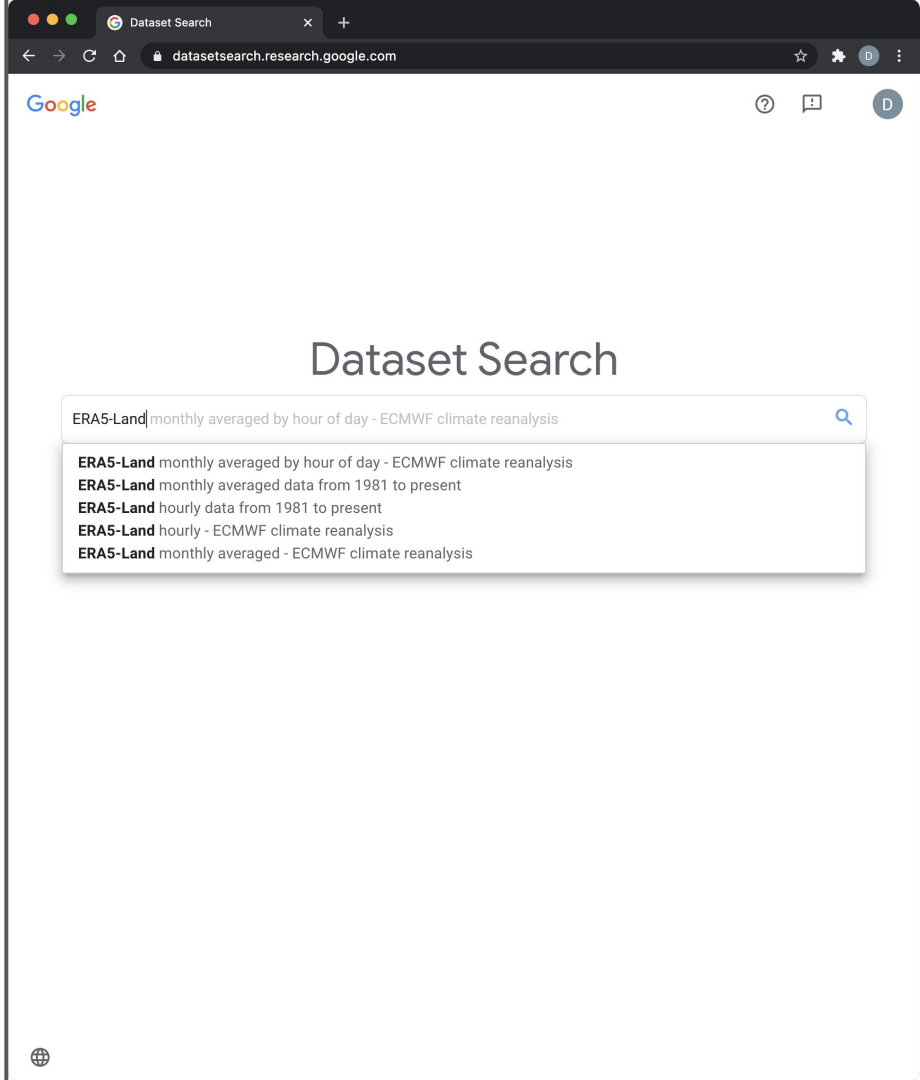


Web
Application



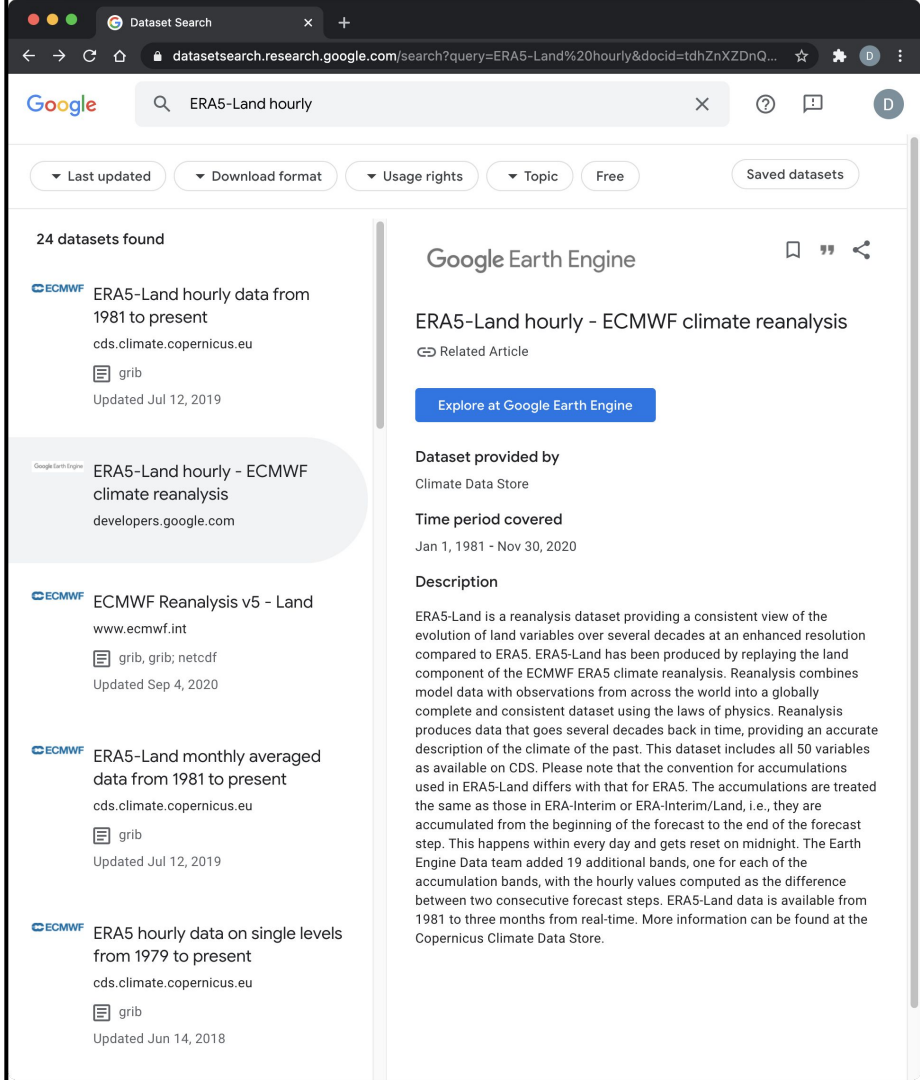
Example: ERA5-Land

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



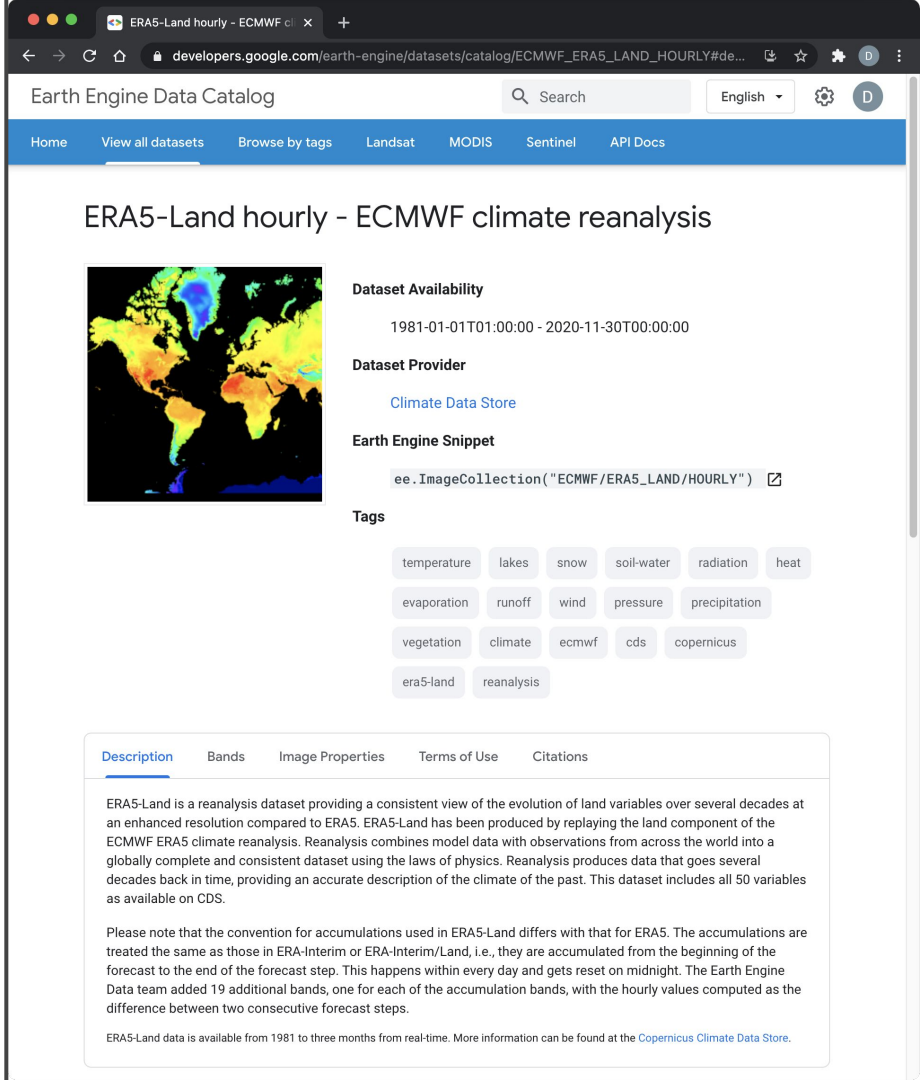
Example: ERA5-Land

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



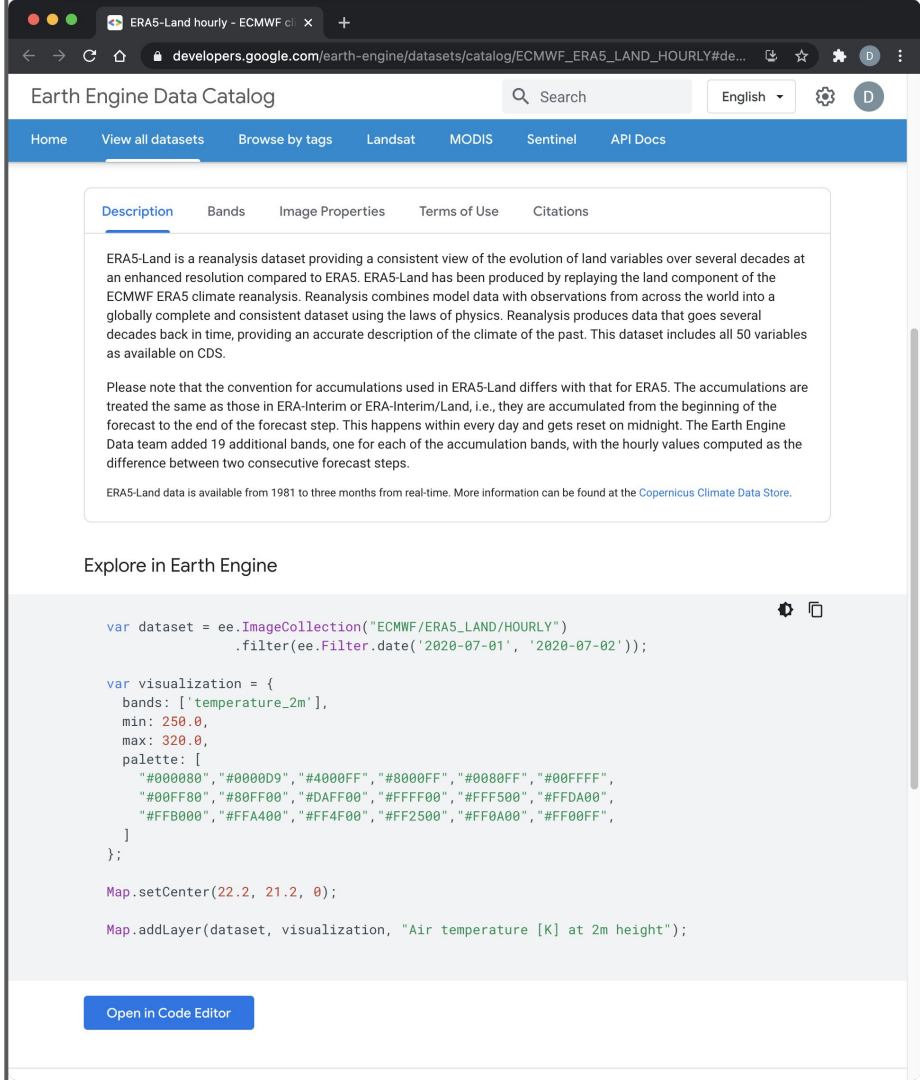
Example: ERA5-Land

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



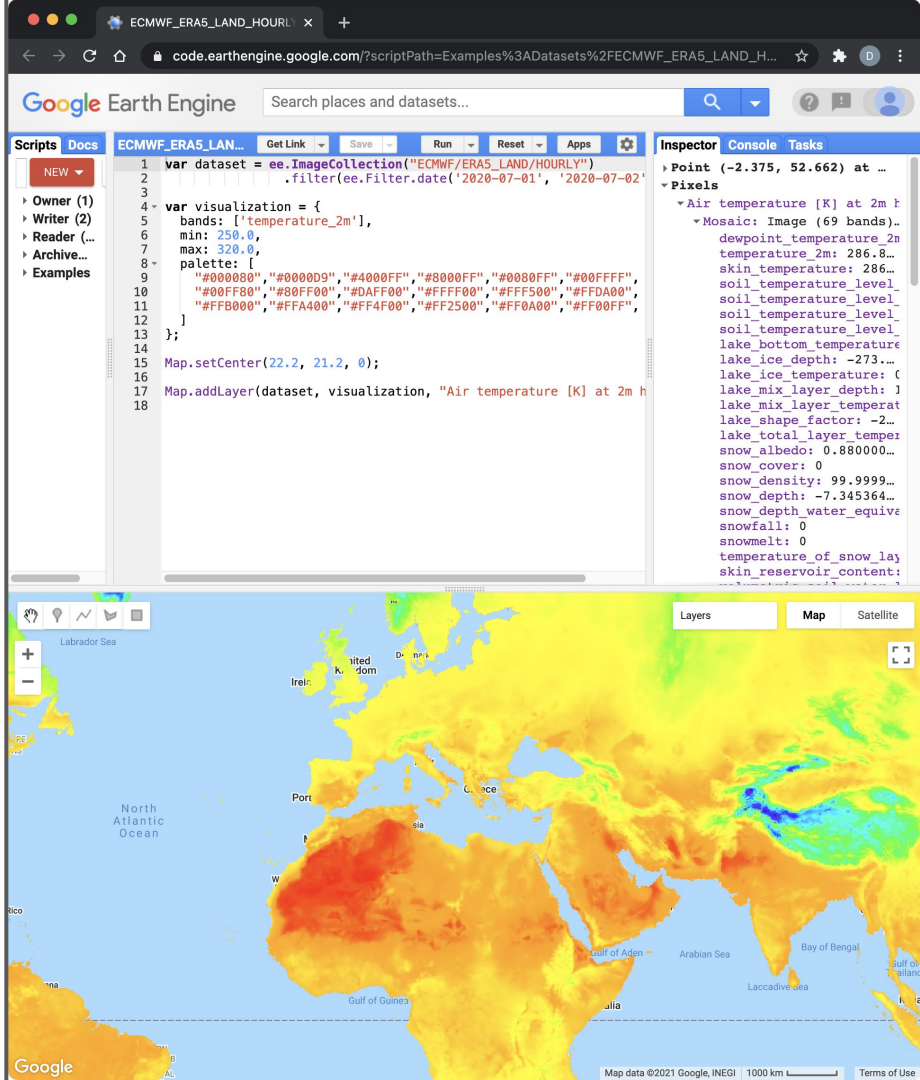
Example: ERA5-Land

- 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



Example: ERA5-Land

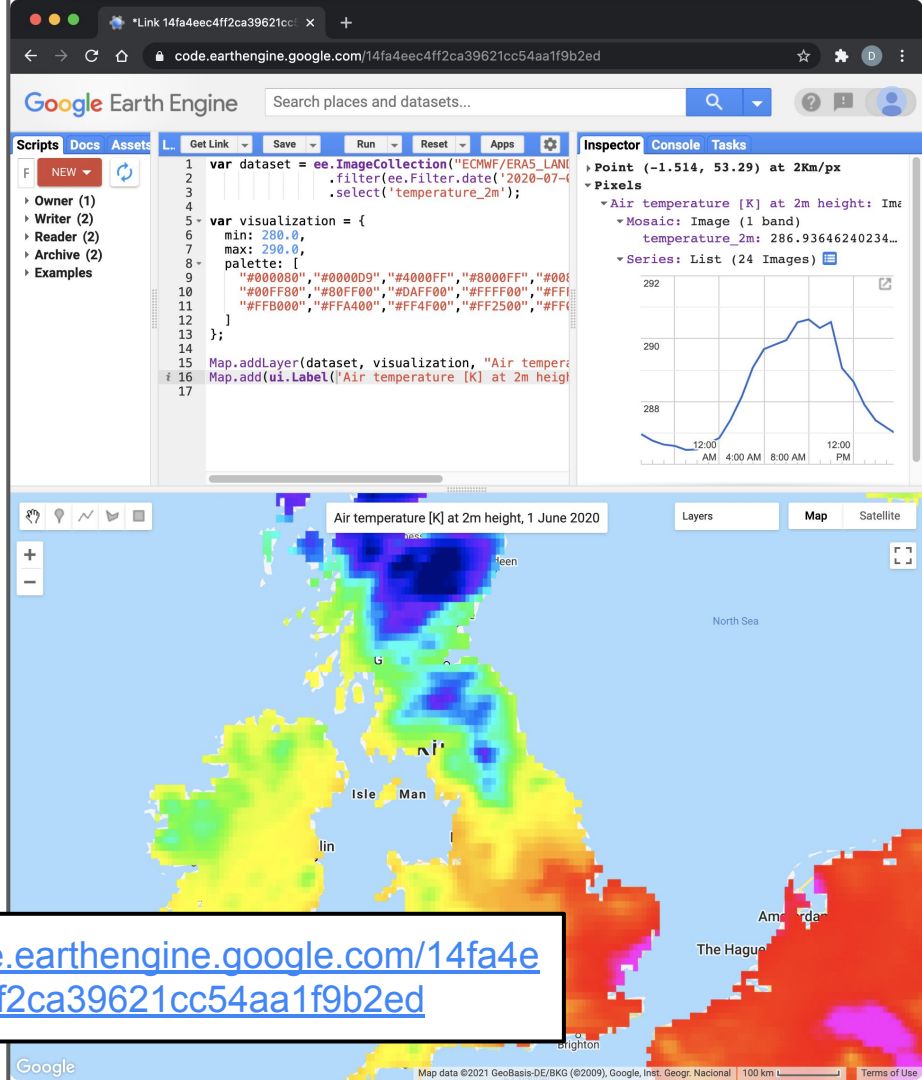
- Search for “ERA5-Land hourly” on Google Dataset Search
- Select a dataset on Earth Engine
- Open the dataset description page
- Scroll down to find the sample script
- Open the sample script in the Code Editor GUI

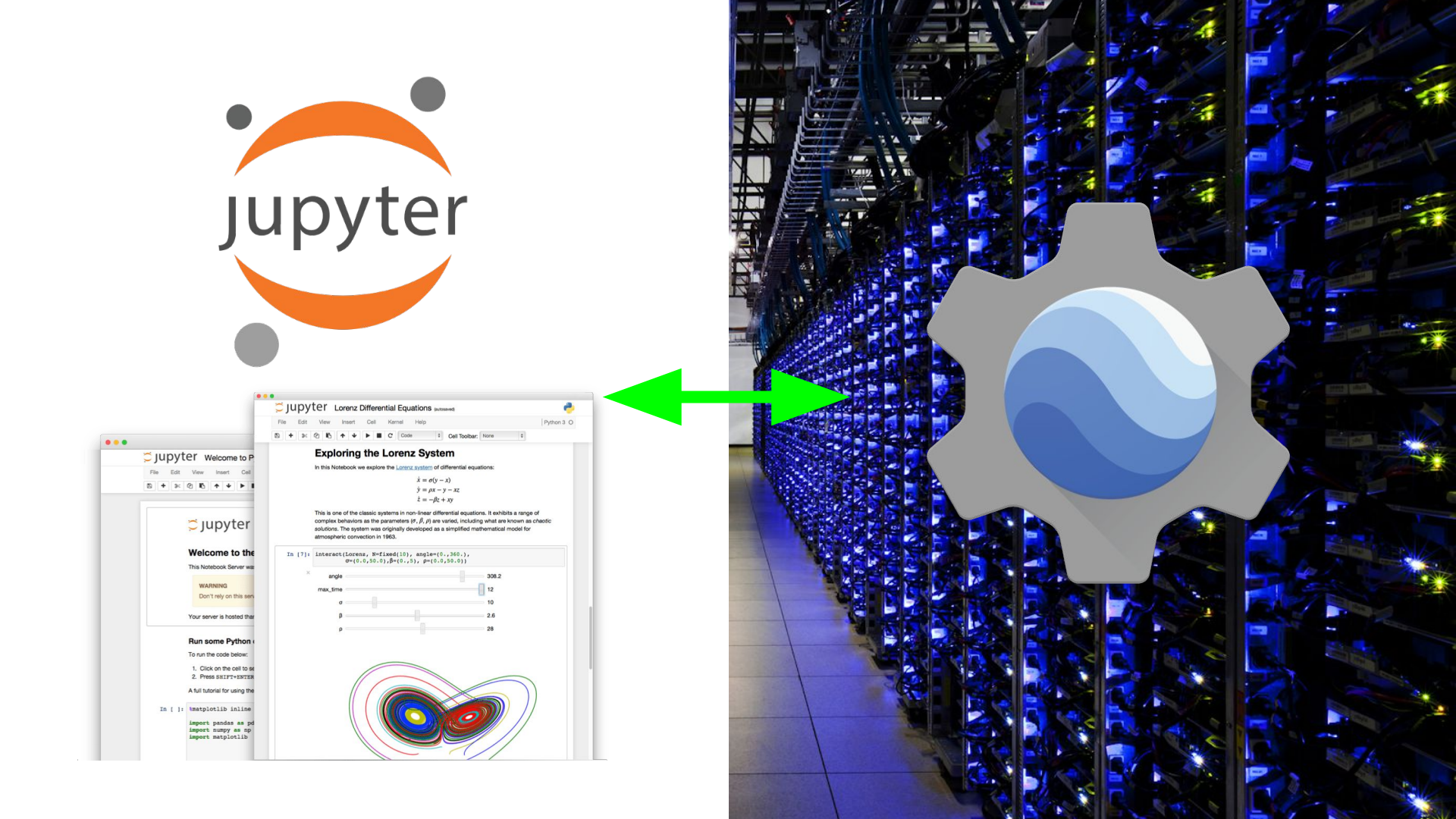


Example: ERA5-Land

- 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/14fa4eec4ff2ca39621cc54aa1f9b2ed




jupyter
jupyter Lorenz Differential Equations
Exploring the Lorenz System
In this Notebook we explore the Lorenz system of differential equations:
$$\dot{x} = \sigma(y - x)$$
$$\dot{y} = \rho x - y - xz$$
$$\dot{z} = -\beta z + xy$$
This is one of the classic systems in non-linear differential equations. It exhibits a range of complex behaviors as the parameters (σ, β, ρ) are varied, including what are known as chaotic solutions. The system was originally developed as a simplified mathematical model for atmospheric convection in 1963.
In [7]: interact(Lorenz, N=fixed(10), angle=(0.,360.),
σ=(0.0,50.0),β=(0.,5), ρ=(0.0,50.0))
angle 308.2
max_time 12
σ 10
β 2.6
ρ 28
jupyter Welcome to P
Welcome to the
Run some Python
To run the code below:
1. Click on the cell to
2. Press SHIFT+ENTER
In [ ]: %matplotlib inline
import pandas as pd
import numpy as np
import matplotlib

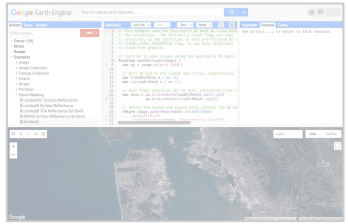
Earth Engine
Backend
Servers

REST
API

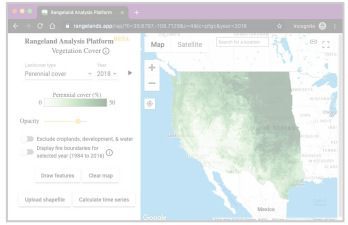
Javascript
Client
Library

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 Running Commands Cell Tools Tabs

examples > Getting Started

Name	Last Modified
Display Static Map.ipynb	3 minutes ago

Launcher | Display Static M

Code 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

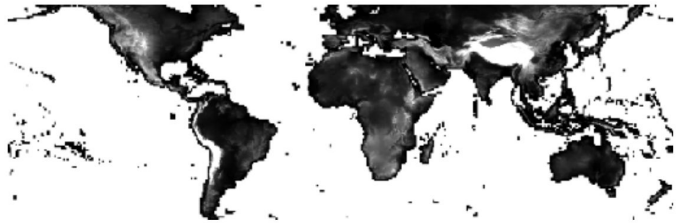
```
earthengine authenticate
```

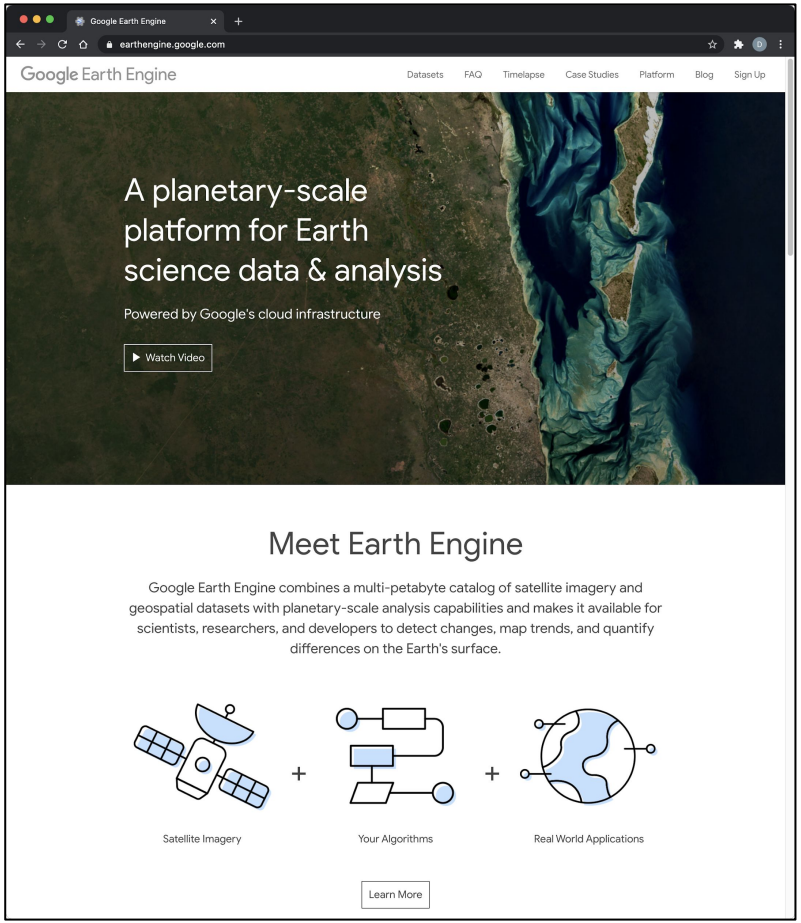
at a command line prompt.

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

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