Weather & Climate Data Analysis with Google Earth Engine
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 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.
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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

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

Web Application

Earth Engine Code Editor
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

```javascript
var dataset = ee.ImageCollection('ECMWF/ERA5_LAND/HOURLY')
    .filterDate('2020-07-01', '2020-07-02');

var visualization = {
  bands: ['temperature_2m'],
  min: 258.0,
  max: 308.0,
  palette: [
    '000000', '008877', '00FFCC', 'FFFF00', 'FF0000', '6699FF', 'FFFF77', 'FFFFCC', '00FF00',
    'FFFF99', '87FF00', '99CCFF', 'FF00FF', '77FF00', '00CCFF', '990099', 'FF77FF', 'FFFF00',
    'FFFFCC', '99FFFF', 'FF99FF', 'FF9999', '7700FF', 'CCFFFF', 'FF00FF', 'FFFF00', '00FF00',
    'FFFF99', '87FF00', '99CCFF', 'FF0000', '008877', '000000'
  ];
};

Map.setCenter(22.2, 21.2, 0);
Map.addLayer(dataset, visualization, 'Air temperature [K] at 2m height');
```
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
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- 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/14fa4ecc4f2ca39621cc54aa1f9b2ed
Demo
Exploring ERA5-Land.ipynb

https://colab.research.google.com/drive/1suLcNvGzg4derqbf7zN1l9i0Upytbnko
JupyterLab!

- Docker configuration example [github.com/gee-community/ee-jupyter-contrib](https://github.com/gee-community/ee-jupyter-contrib)
- geemap package [https://github.com/giswqs/geemap](https://github.com/giswqs/geemap)

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**Import Python modules**

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

**Initialize Earth Engine**

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

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

```bash
earthengine authenticate
```
at a command line prompt.

**Display a Static Map**

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

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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.

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**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