

Big Data for Air Quality: Sensors, Satellites, and Spatial Analysis, Oh My!

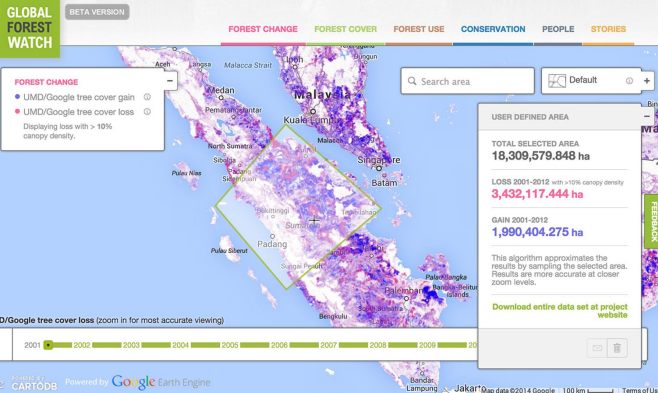


Air quality data from Google / Aclima

Karin Tuxen-Bettman
Program Manager

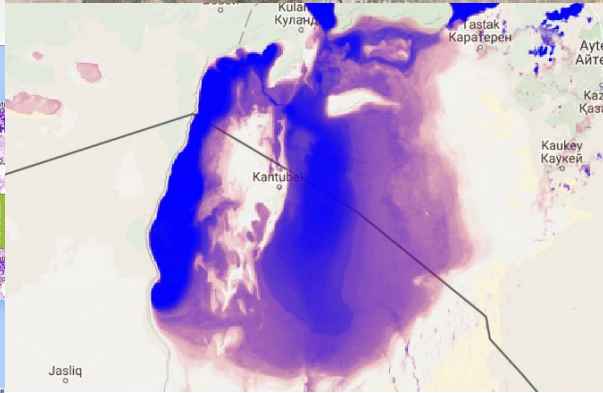
Google Earth

Monitoring deforestation



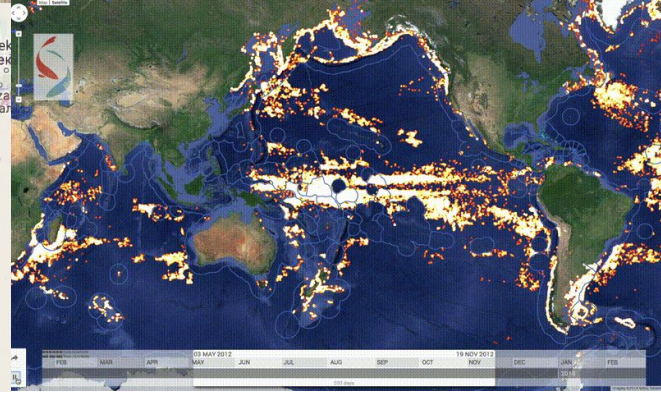
globalforestwatch.org/map

Mapping surface water over time



global-surface-water.appspot.com

Tracking fishing activity



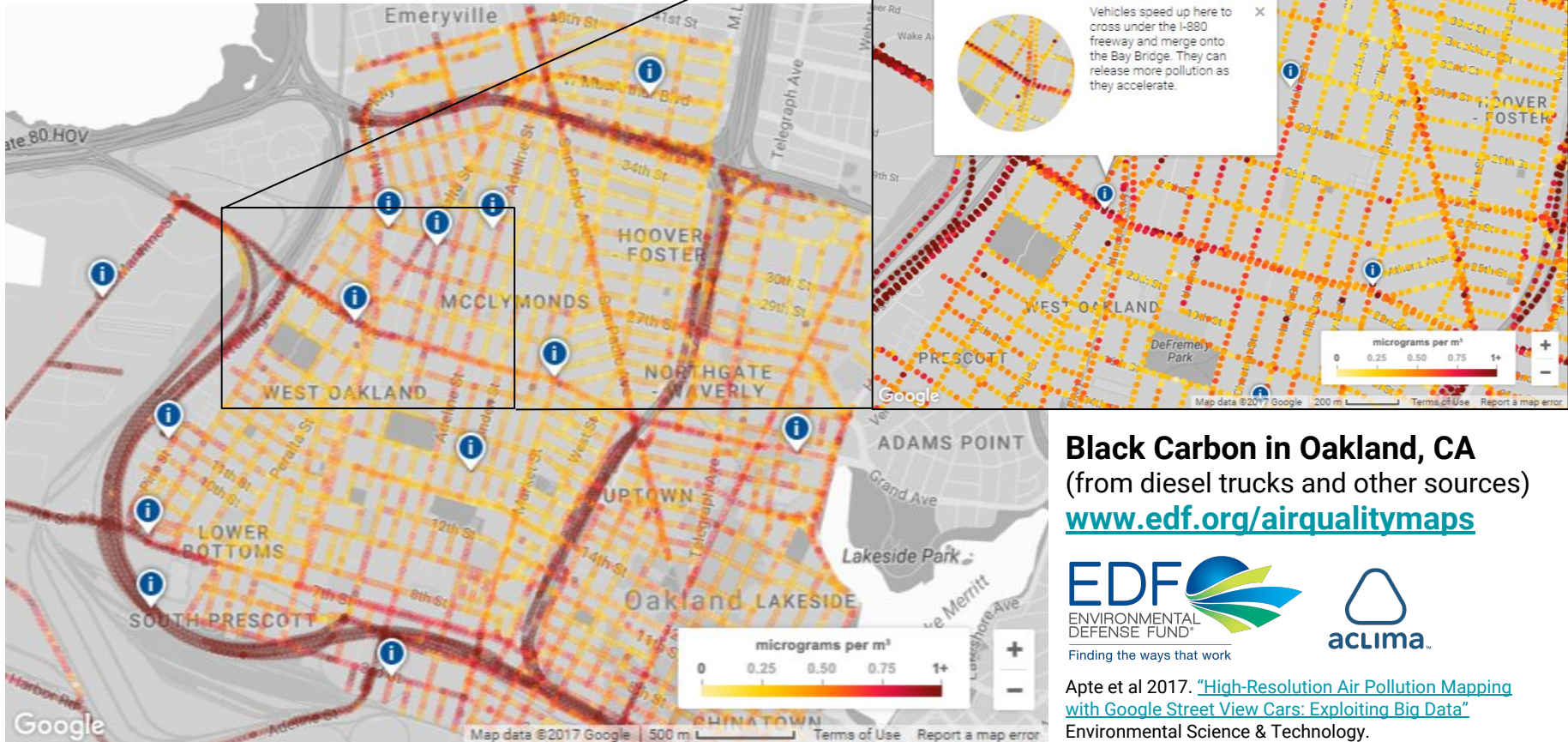
globalfishingwatch.org

Since 2013...



Scientific-grade equipment:
PM 2.5
Ultrafine PM
Black Carbon
Carbon Dioxide (CO₂)
Carbon Monoxide (CO)
Nitric Oxide (NO)
Nitrogen Dioxide (NO₂)
Ozone (O₃)

2017: Oakland study released



Black Carbon in Oakland, CA
(from diesel trucks and other sources)
www.edf.org/airqualitymaps



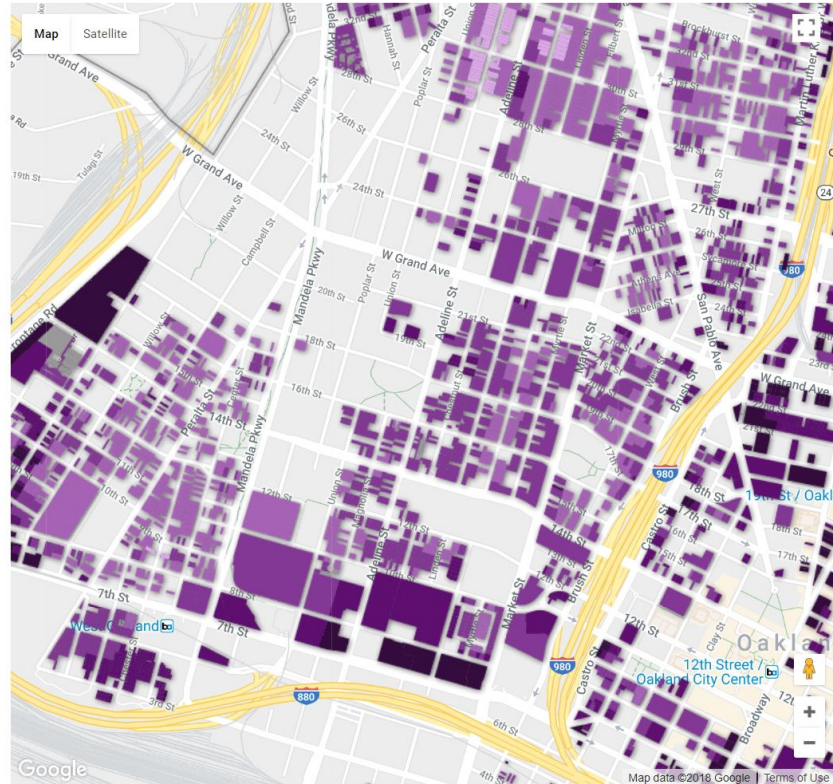
Finding the ways that work



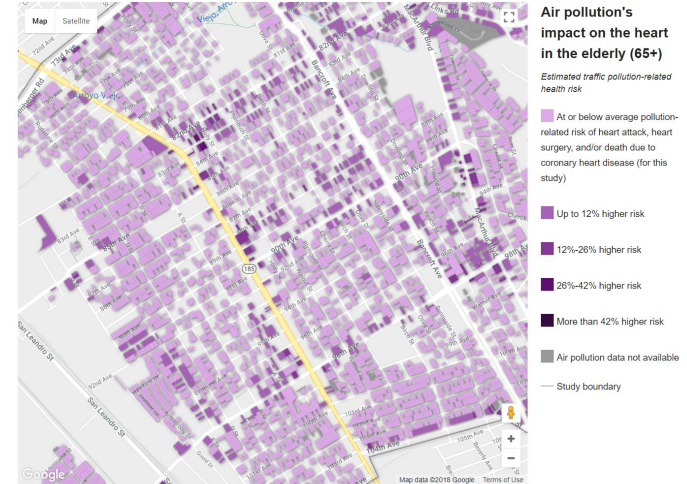
Apte et al 2017. "High-Resolution Air Pollution Mapping with Google Street View Cars: Exploiting Big Data" Environmental Science & Technology.

2018: Health Impact study

West/Downtown Oakland Study Area



East Oakland Study Area



Health Impacts in Oakland, CA

(from diesel trucks and other sources)

www.edf.org/airqualitymaps/how-pollution-impacts-human-health



Finding the ways that work



KAISER PERMANENTE®

Alexeev et al 2017. [“High-resolution mapping of traffic related air pollution with Google street view cars and incidence of cardiovascular events within neighborhoods in Oakland, CA”](#) Environmental Health.

2017: California data released

- 250M+ AQ measurements
- 2+ years
- 50+ scientists



Los Angeles

Air quality data from Google / Aclima



Google Earth

Today



Today



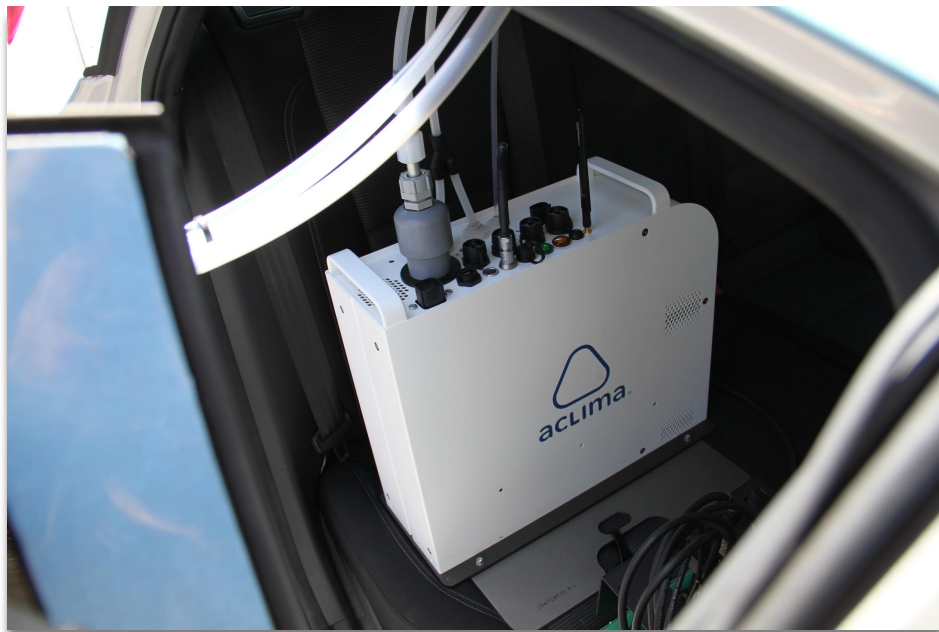
Today: Scaling to 50 Street View cars

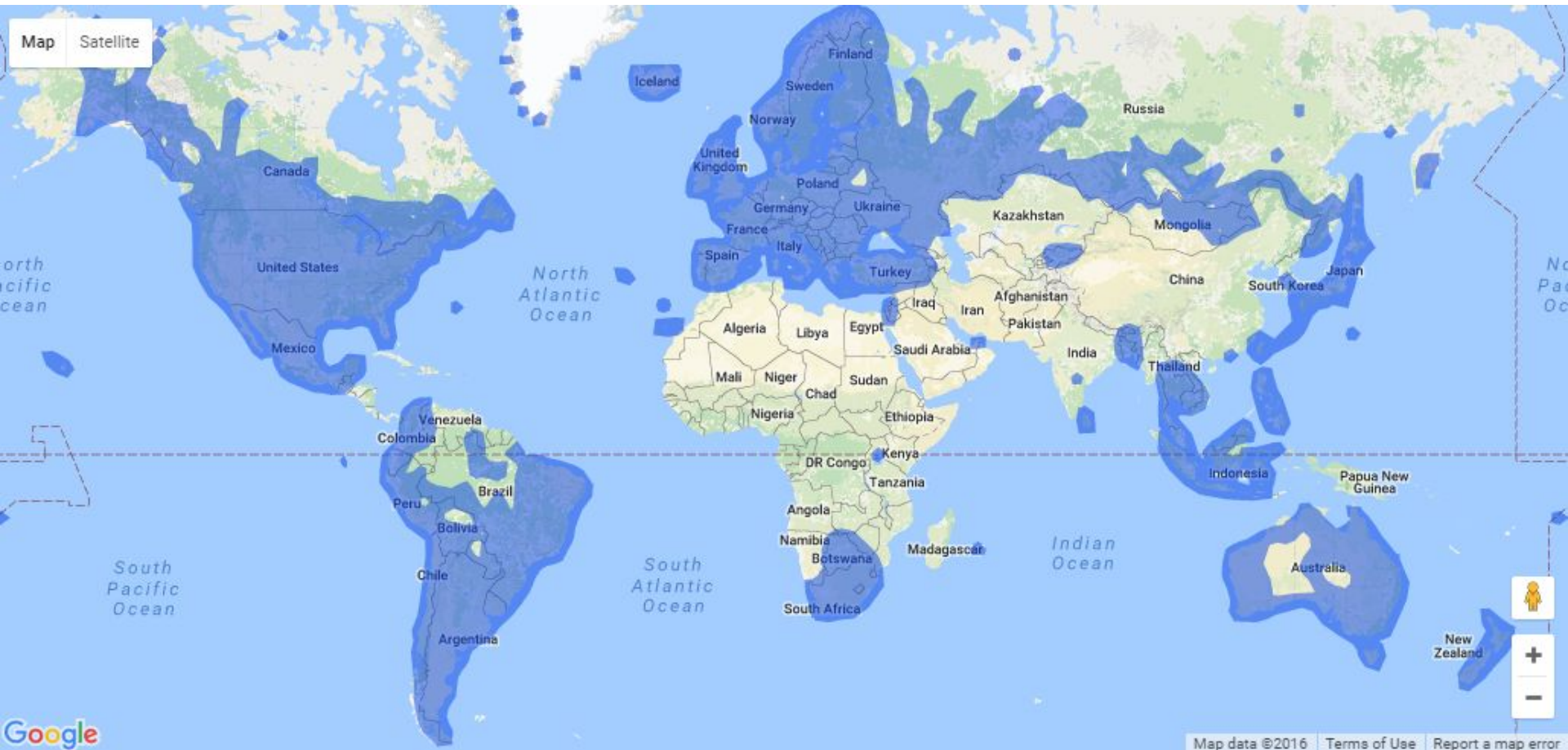


Google



Today





Map Satellite

North Pacific Ocean

North Atlantic Ocean

South Pacific Ocean

South Atlantic Ocean

Indian Ocean

North Pacific Ocean

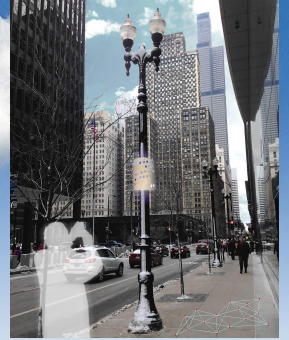
Google

Map data ©2016 Terms of Use Report a map error



Cloud

Devices deployed by cities, universities, and companies



Consumer devices



...and other mobile fleets

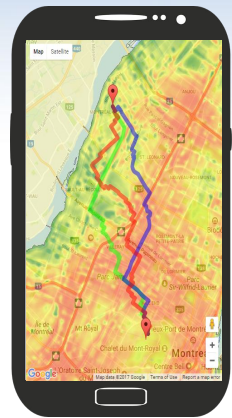
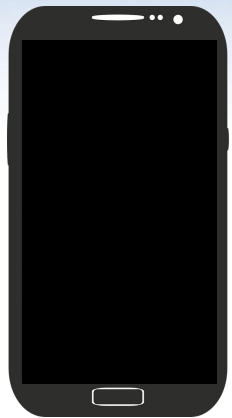
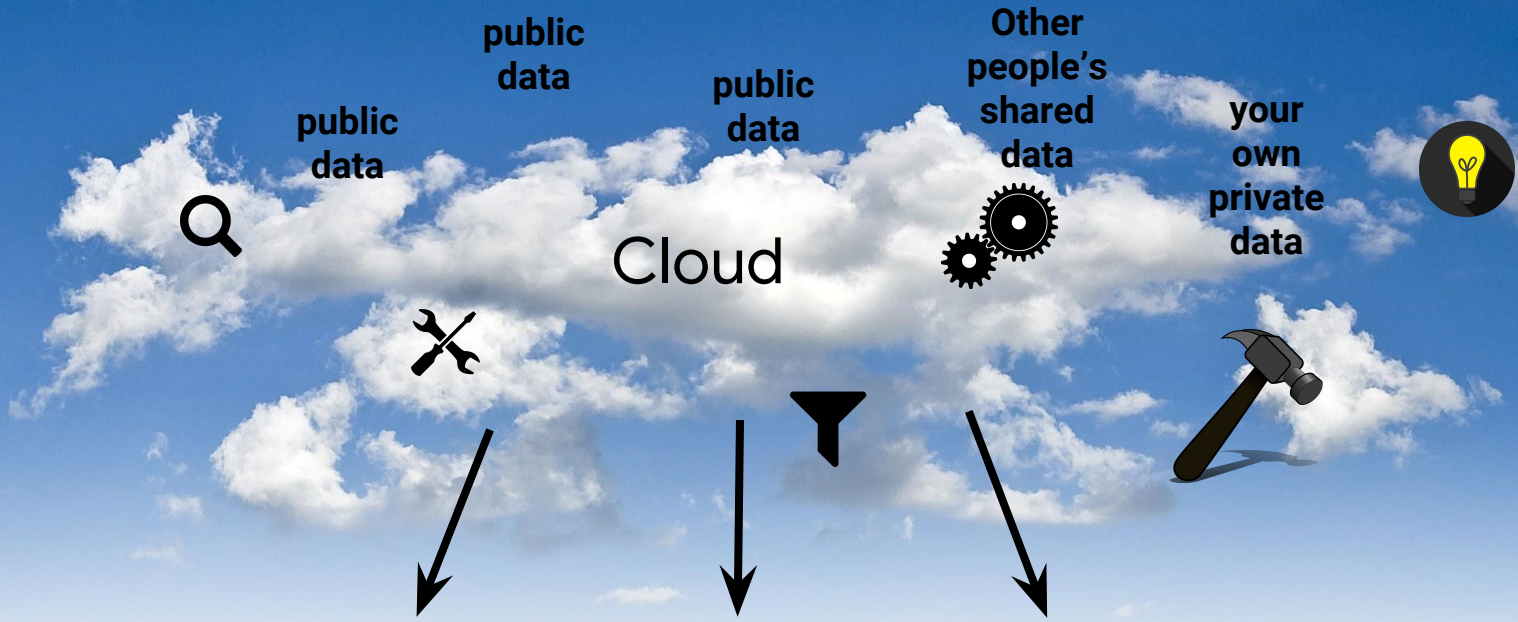


Street View cars

Government & regulatory monitoring stations



Google



GOOGLE CLOUD BIG DATA AND MACHINE LEARNING

Innovation in data processing and machine learning technology



U.S. EPA and OpenAQ air quality data now available

Wednesday, June 7, 2017

By Mike Hamberg, Partner Operations Manager, gTech Feeds

Using these new public datasets in BigQuery is a great way to understand air quality in your community

Take a deep breath: The average person takes between 17,000 and 23,000 breaths a day. But how often can you know if the air in your town is clean?

We're helping answer those questions. We've leveraged decades of data from the [U.S. EPA](#) and real-time air quality datasets to the [Google Cloud Public Datasets](#) program:

- OpenAQ, which includes [real-time air quality](#) from 47 countries around the world
- EPA, which includes the [last 27 years of air quality](#) from around the United States

Kubernetes, Google Cloud Pub/Sub, and BigQuery
 Real-time logs analysis using Fluentd and BigQuery
 Analyzing Financial Time Series using BigQuery

Resources

- All Resources
- Pricing
- Quotas & Limits
- Release Notes
- Support & Troubleshooting
- ▾ Public Datasets
 - Overview
 - 1000 Cannabis Genomes Project
 - Bay Area Bike Share Trips Data
 - Chicago Crime Data
 - Chicago Taxi Trips
 - [EPA Historical Air Quality Data](#)
 - GDELT Books Corpus
 - GitHub Data
 - Hacker News
 - Healthcare Common Procedure Coding System (HCPCS) Level II
 - IRS 990 Data
 - Major League Baseball
 - Medicare
 - NHTSA Traffic Fatality Data
 - NOAA GHCN Weather
 - NOAA GSOD Weather
 - NOAA ICOADS
 - NYC 311 Service Requests
 - NYC Citi Bike Trips
 - NYC TLC Trips
 - NYC Tree Census

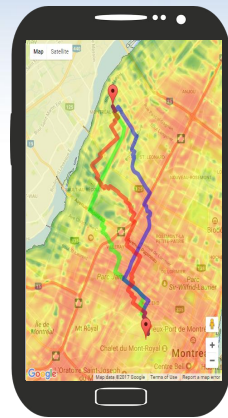
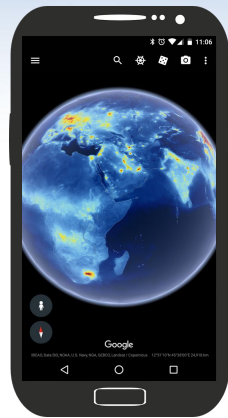
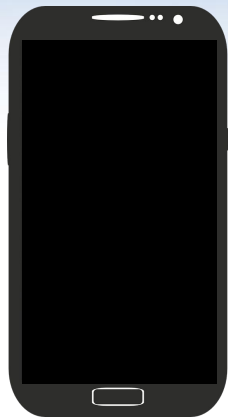
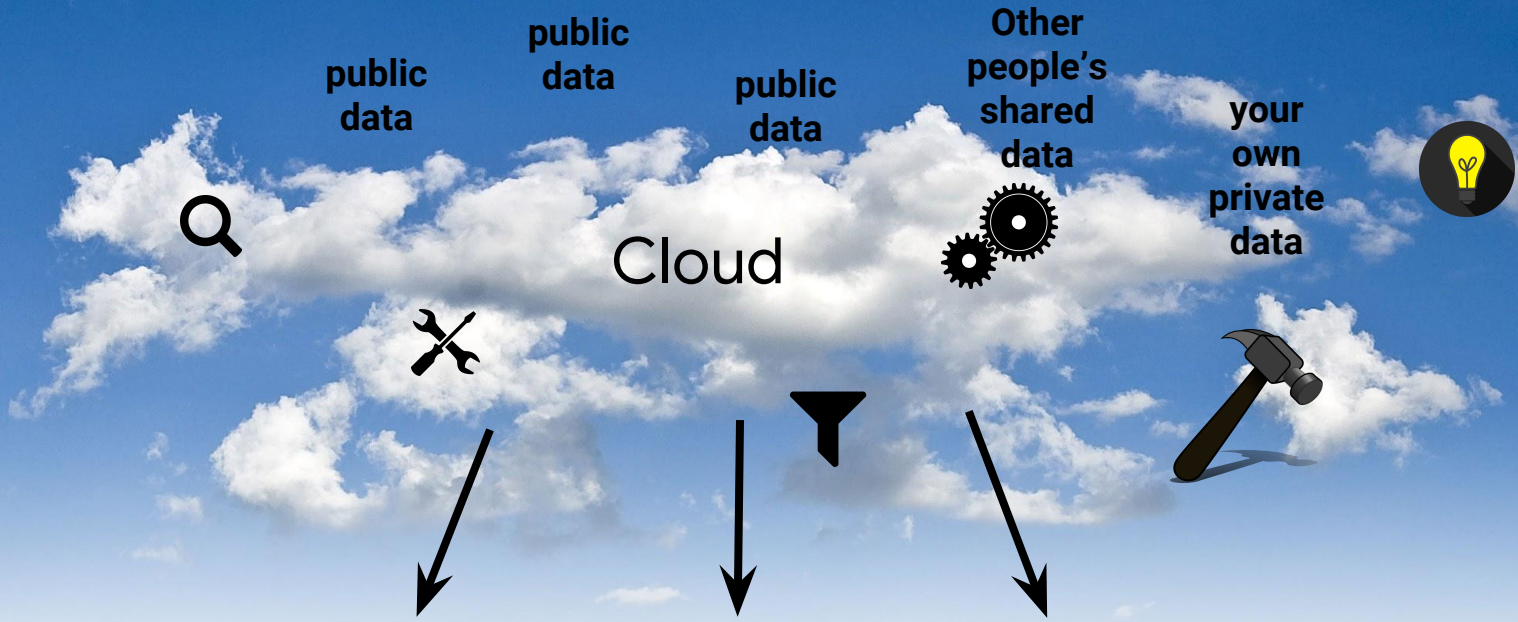
BigQuery > Documentation

EPA Historical Air Quality Data

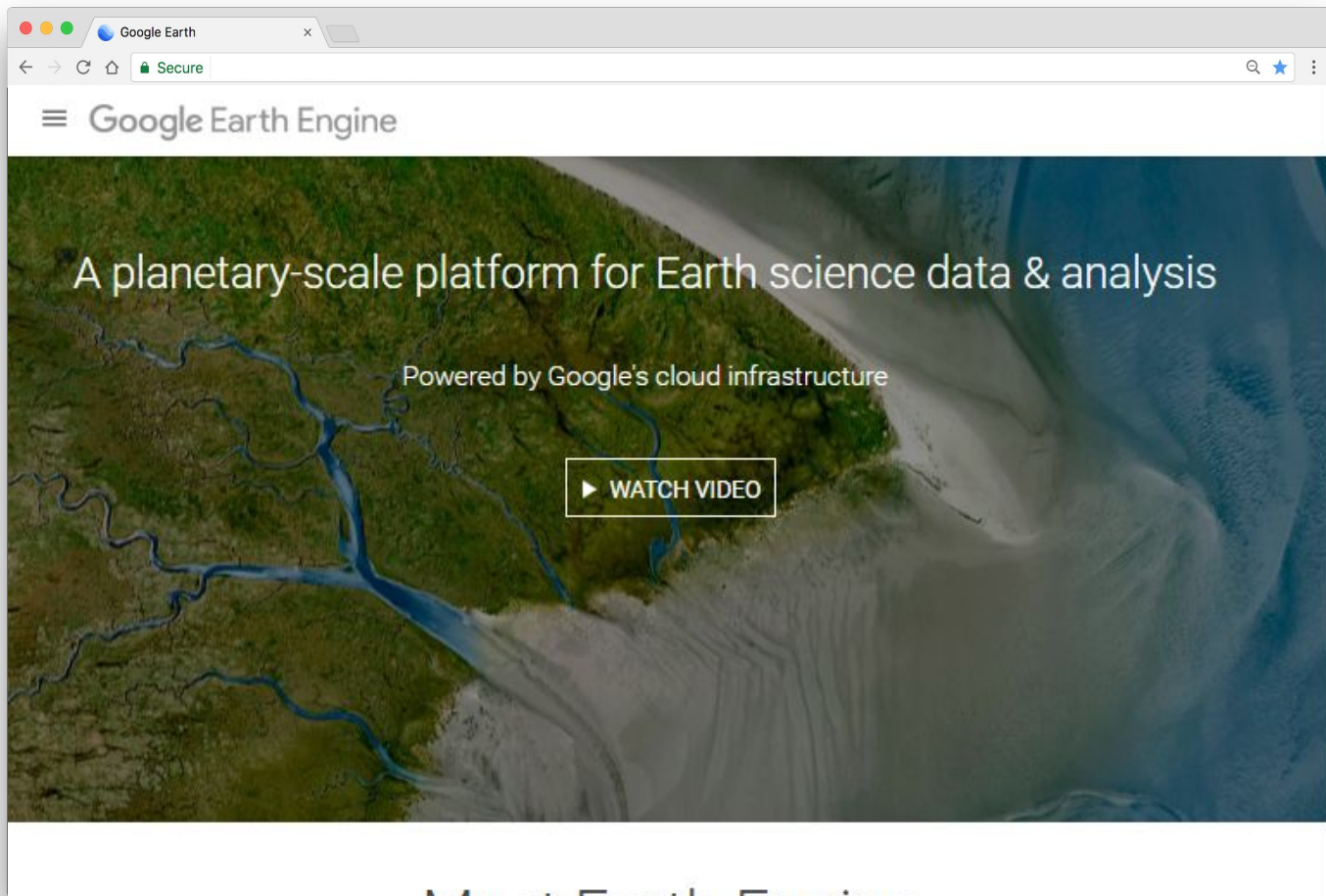
The United States Environmental Protection Agency (EPA) protects both public health and establishing the standards for national air quality. The EPA provides annual summary data across the following categories:

- Criteria Gases
 - Carbon monoxide (CO)
 - Ground-level Ozone (O3)
 - Nitrogen Dioxide (NO2)
 - Sulfur Dioxide (SO2)
- Particulates
 - PM2.5 FRM/FEM Mass
 - PM2.5 non FRM/FEM Mass
 - PM10 Mass
 - PM2.5 Speciation
- Meteorological
 - Barometric Pressure
 - Relative Humidity and Dewpoint
 - Temperature
 - Winds (Resultant)
- Toxics
 - Lead (Pb)
 - Hazardous Air Pollutants (HAPs)
 - Nitrous Oxides (NONxNOy)
 - Volatile Organic Compounds (VOCs)

[Link](#)



earthengine.google.com



The image shows a browser window displaying the Google Earth Engine homepage. The browser's address bar shows "Secure" and the page title is "Google Earth". The main content area features a satellite-style background image of a river delta. The text "A planetary-scale platform for Earth science data & analysis" is centered at the top. Below it, the text "Powered by Google's cloud infrastructure" is displayed. A central button with a play icon and the text "WATCH VIDEO" is visible. At the bottom of the page, the words "More about Earth Engine" are partially visible.

Google Earth

Secure

Google Earth Engine

A planetary-scale platform for Earth science data & analysis

Powered by Google's cloud infrastructure

▶ WATCH VIDEO

More about Earth Engine

The Earth Engine Data Catalog



**Landsat &
Sentinel**

10-30m, 14-day

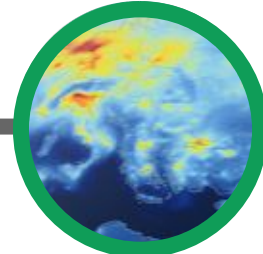


MODIS

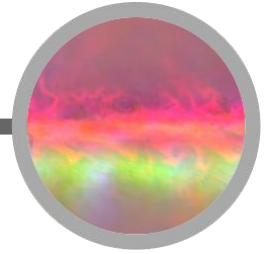
250m daily



**Your own data
can be added**



Air Pollution



Weather & Climate

NOAA NCEP, OMI, ...

... and many more, updating daily!

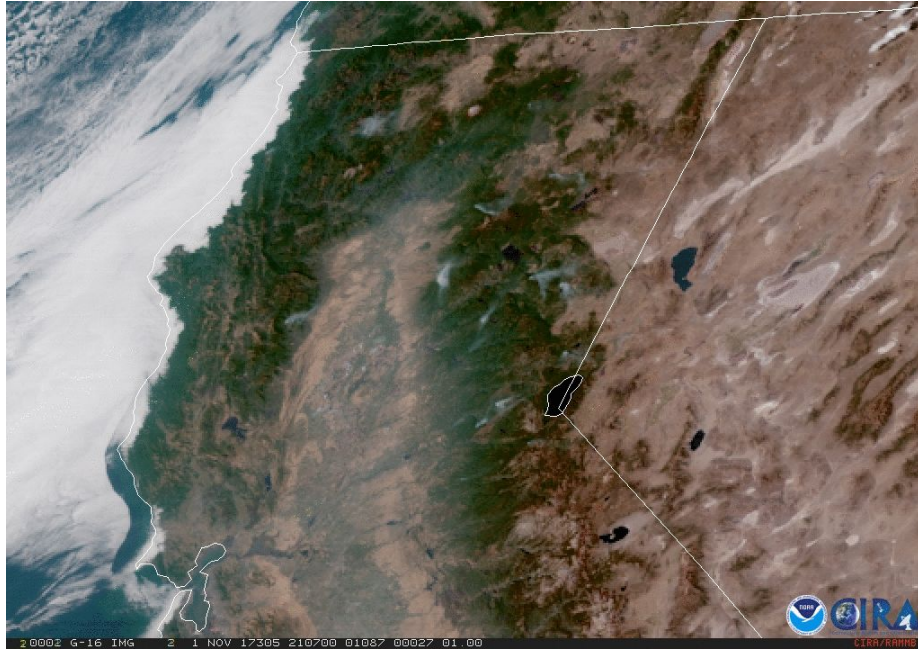
> 200 public datasets

> 5 million images

> 4000 new images every day

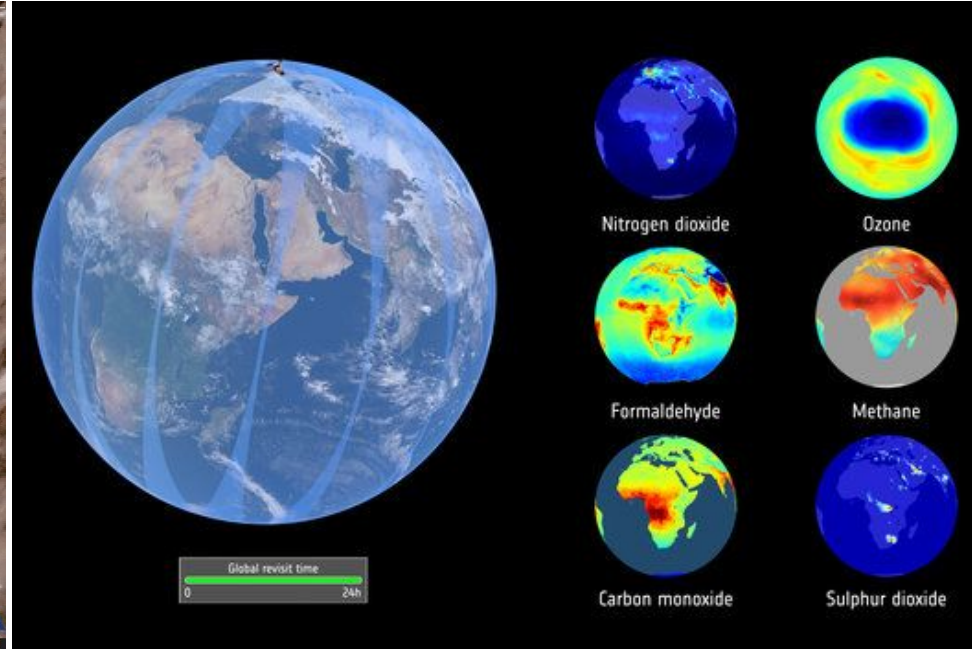
> 5 petabytes of data

New air pollution satellites



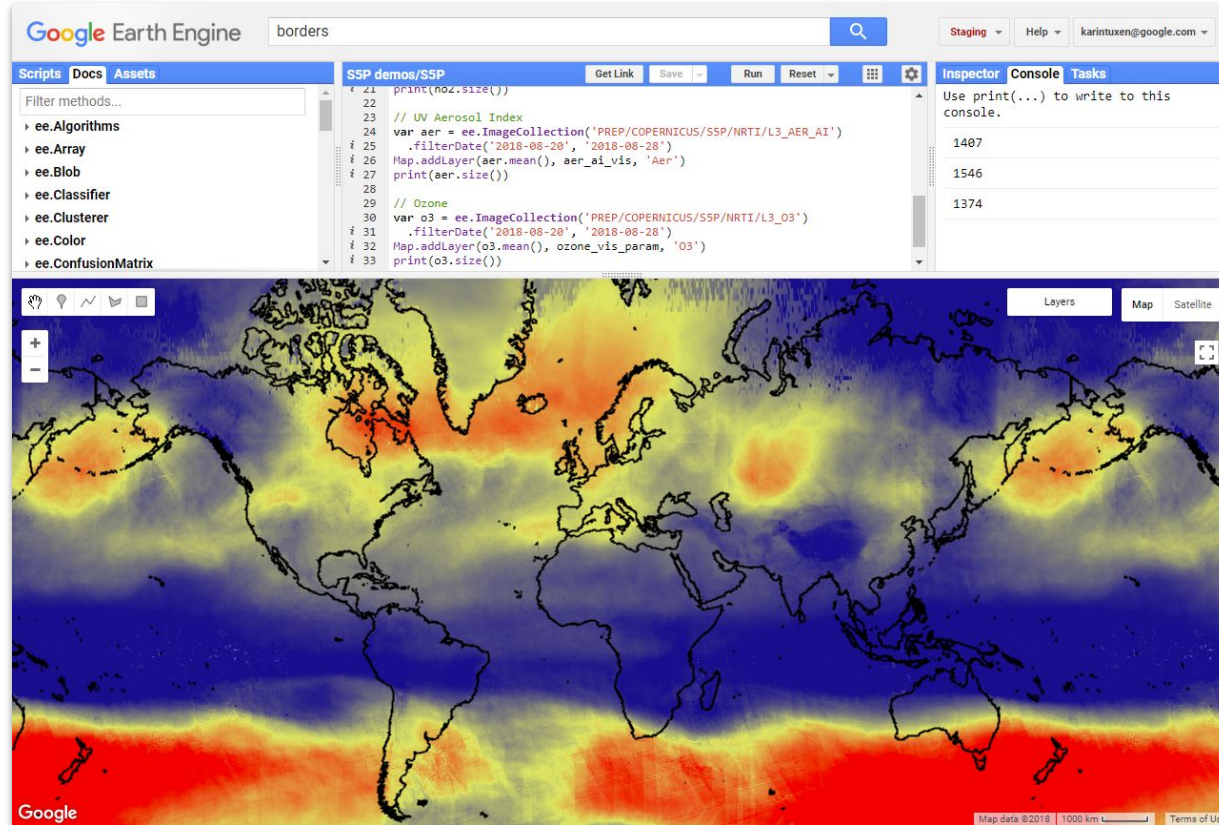
NOAA's GOES-R

Google



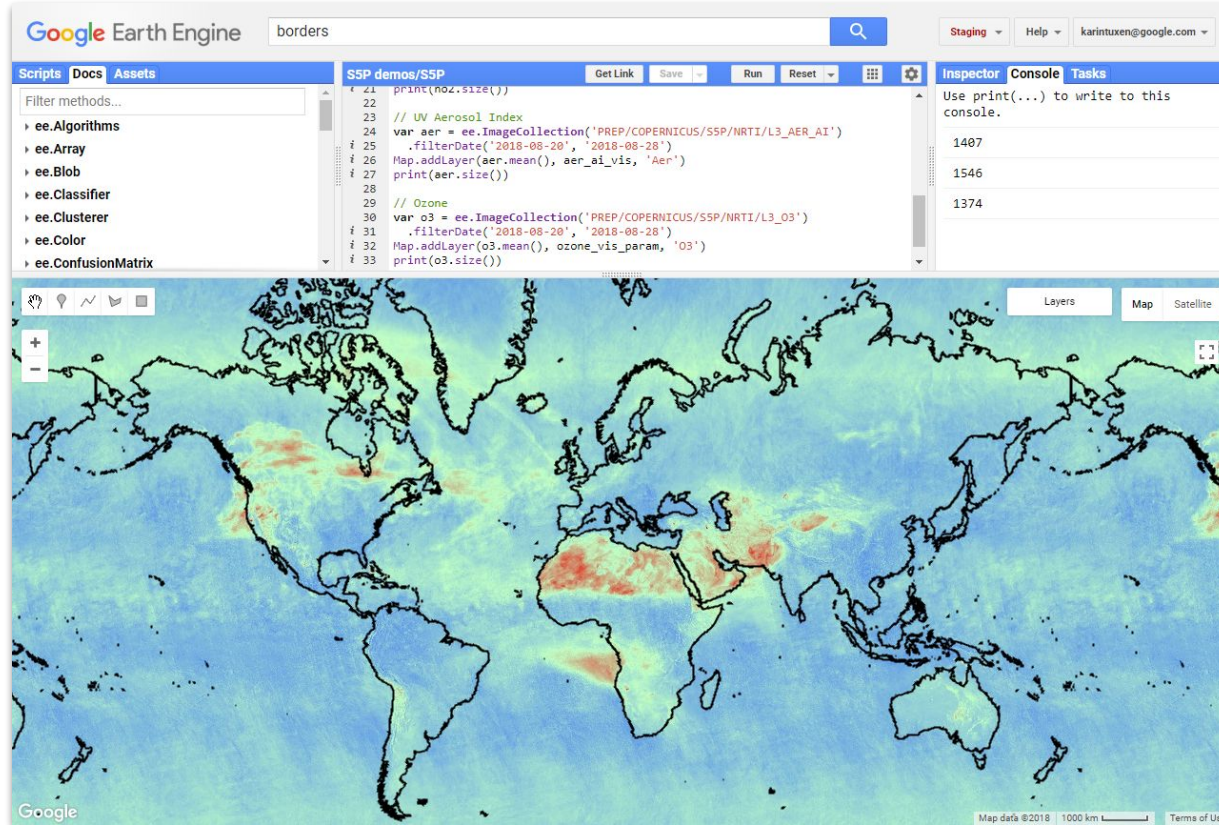
TROPOMI on ESA's Sentinel-5p

Sentinel 5p: Ozone



TROPOMI on ESA's Sentinel-5p

Sentinel 5p: UV Aerosol Index



TROPOMI on ESA's Sentinel-5p

Sentinel 5p: NO₂

The screenshot displays the Google Earth Engine (GEE) interface. At the top, the search bar contains the word "borders". The main interface is divided into several panels:

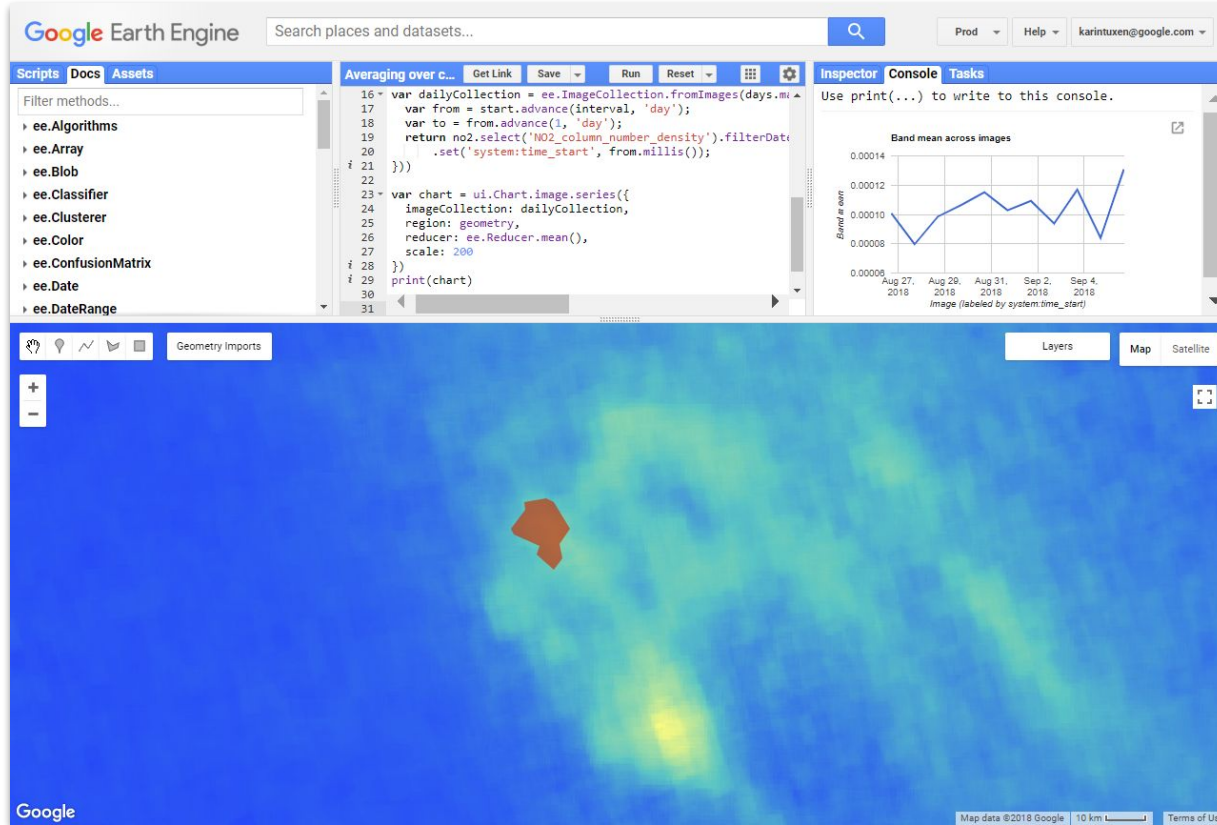
- Scripts Panel:** Shows a script titled "SSP demos/SSP" with the following code:

```
21 print(no2.size())
22
23 // UV Aerosol Index
24 var aer = ee.ImageCollection('PREP/COPERNICUS/SSP/NRTI/L3_AER_AI')
25   .filterDate('2018-08-20', '2018-08-28')
26   .mean()
27   .print('Aer')
28
29 // Ozone
30 var o3 = ee.ImageCollection('PREP/COPERNICUS/SSP/NRTI/L3_O3')
31   .filterDate('2018-08-20', '2018-08-28')
32   .mean()
33   .print('O3')
```
- Inspector Panel:** Shows the output of the script, listing the number of images in the collections:

```
Use print(...) to write to this console.
1407
1546
1374
```
- Map Panel:** Displays a global map with a color scale from blue to red. The map shows high concentrations of NO₂ (red/orange) over East Asia and South Asia, and lower concentrations (blue/green) over the oceans and other regions. The map includes a scale bar (1000 km) and a "Map" button.

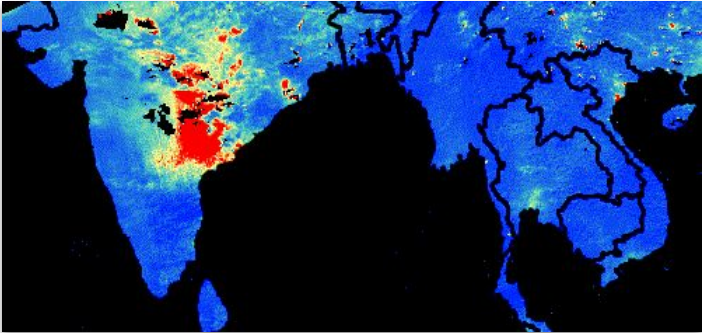
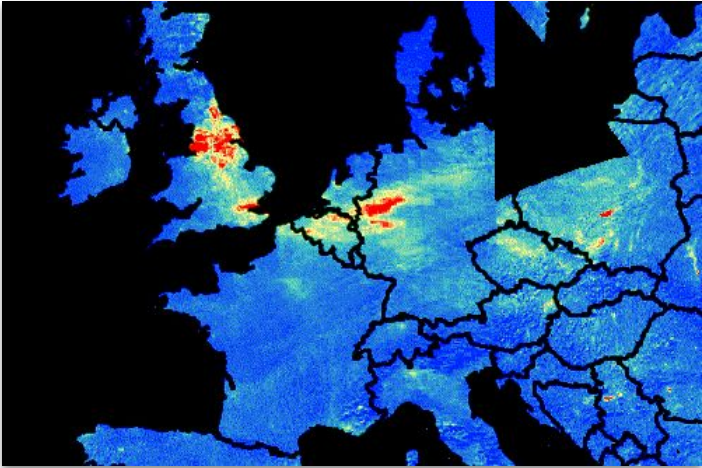
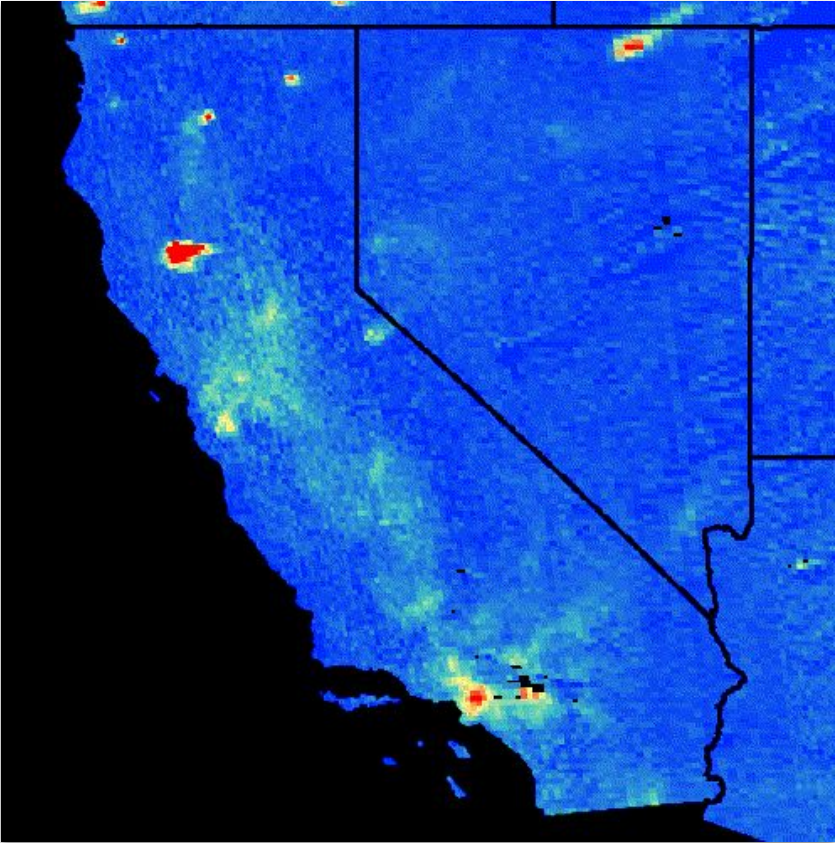
TROPOMI on ESA's Sentinel-5p

Averaging NO₂ for Oakland (Aug. 27 - Sept. 6)

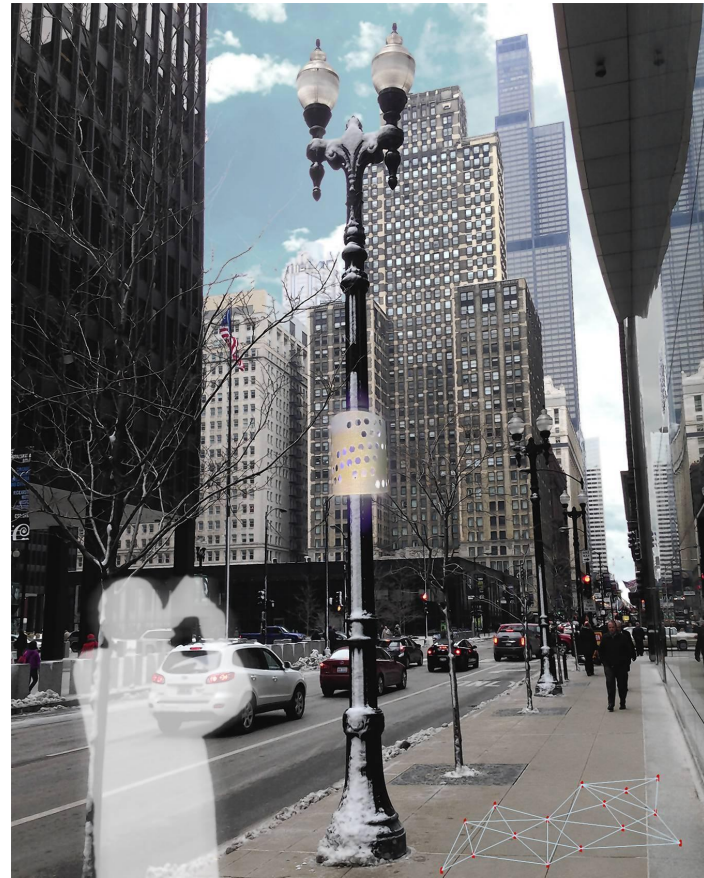


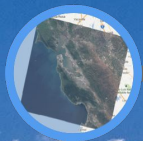
TROPOMI on ESA's Sentinel-5p

Sentinel 5p: NO₂ for Aug. 27 - Sept. 6



TROPOMI on ESA's Sentinel-5p

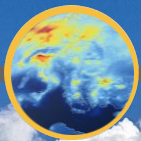




Landsat & Sentinel



MODIS



AQ data



Terrain & Land Cover



Weather & Climate

Devices deployed by cities, universities, and companies



Cloud

Government & regulatory monitoring stations



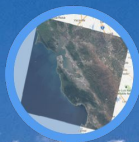
Street View cars



...and other mobile fleets

Consumer devices

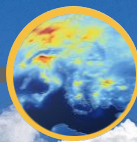




**Landsat &
Sentinel**



MODIS



AQ data

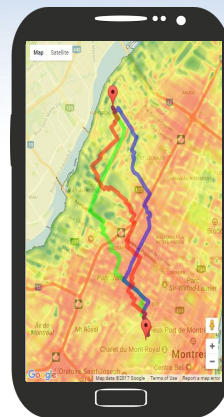
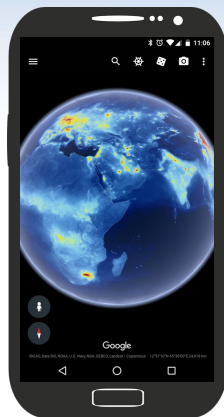
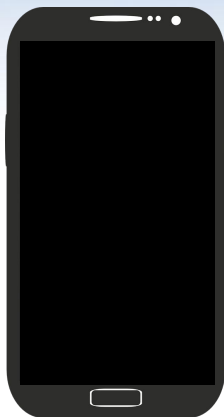


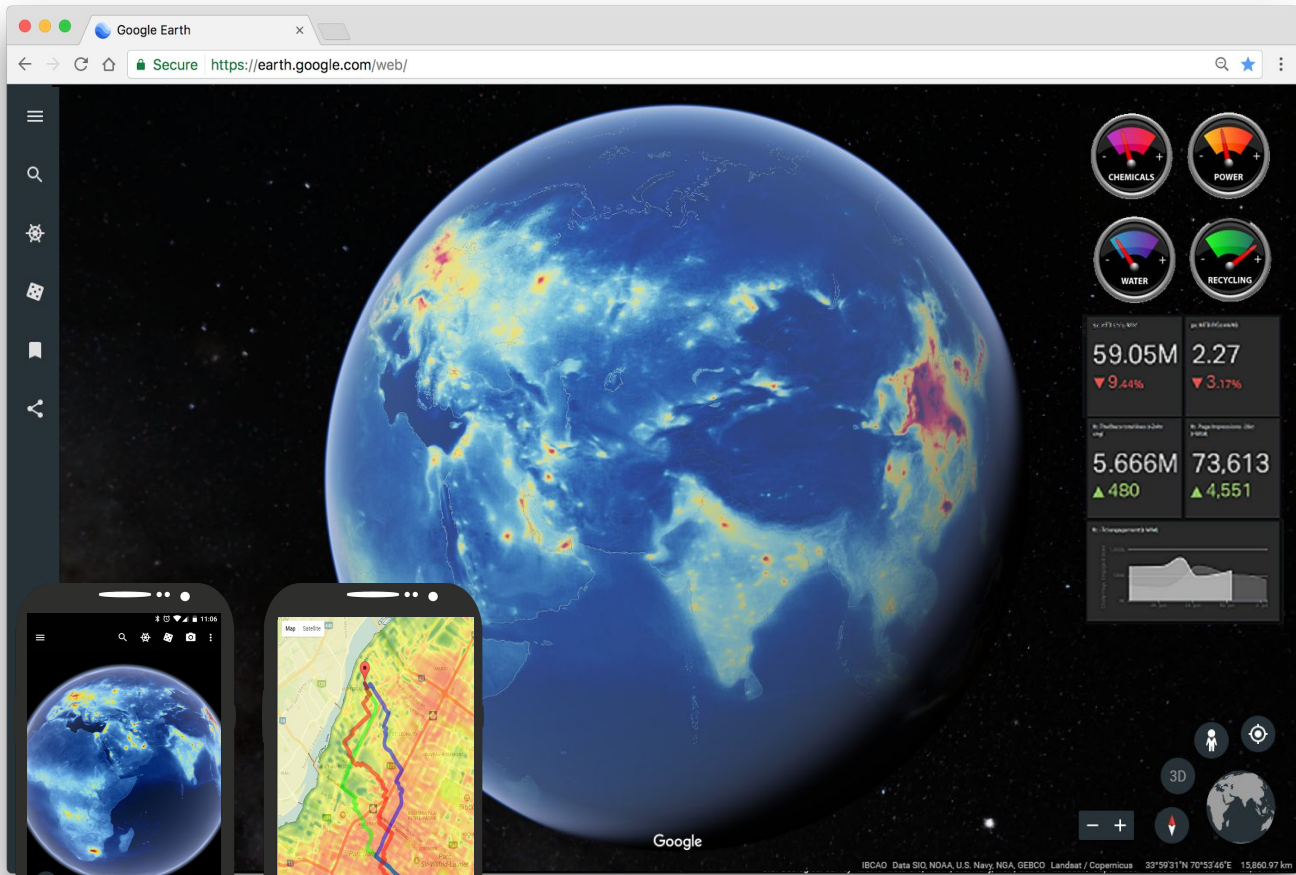
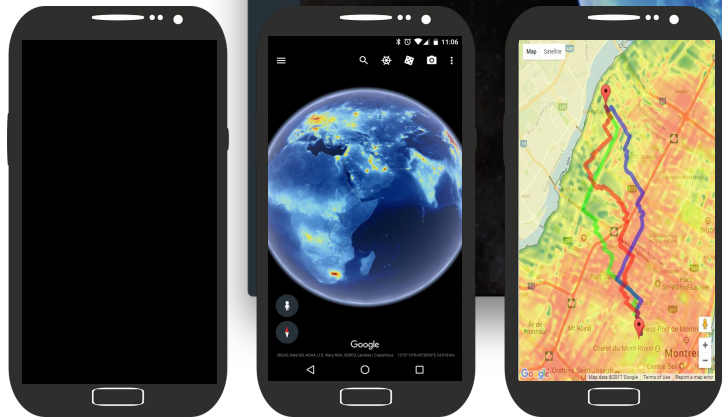
**Terrain &
Land Cover**



**Weather &
Climate**

Cloud





Source: <https://www.nasa.gov/topics/earth/features/health-sapping.html>

Thank you!



Air quality data from Google / Aclima

Karin Tuxen-Bettman
Program Manager

Google Earth