Google “Air View”

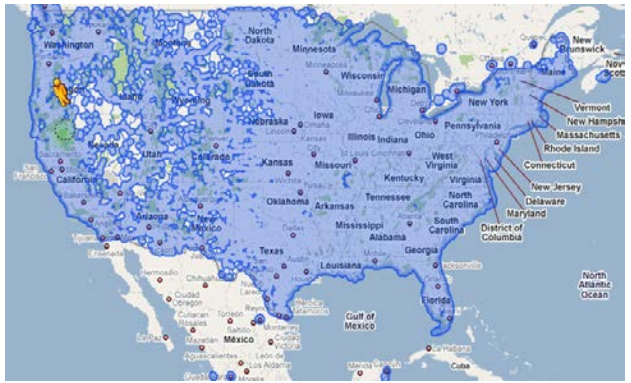
Helping to make air quality information more useable and accessible

Karin Tuxen-Bettman, PhD
Google Earth Outreach

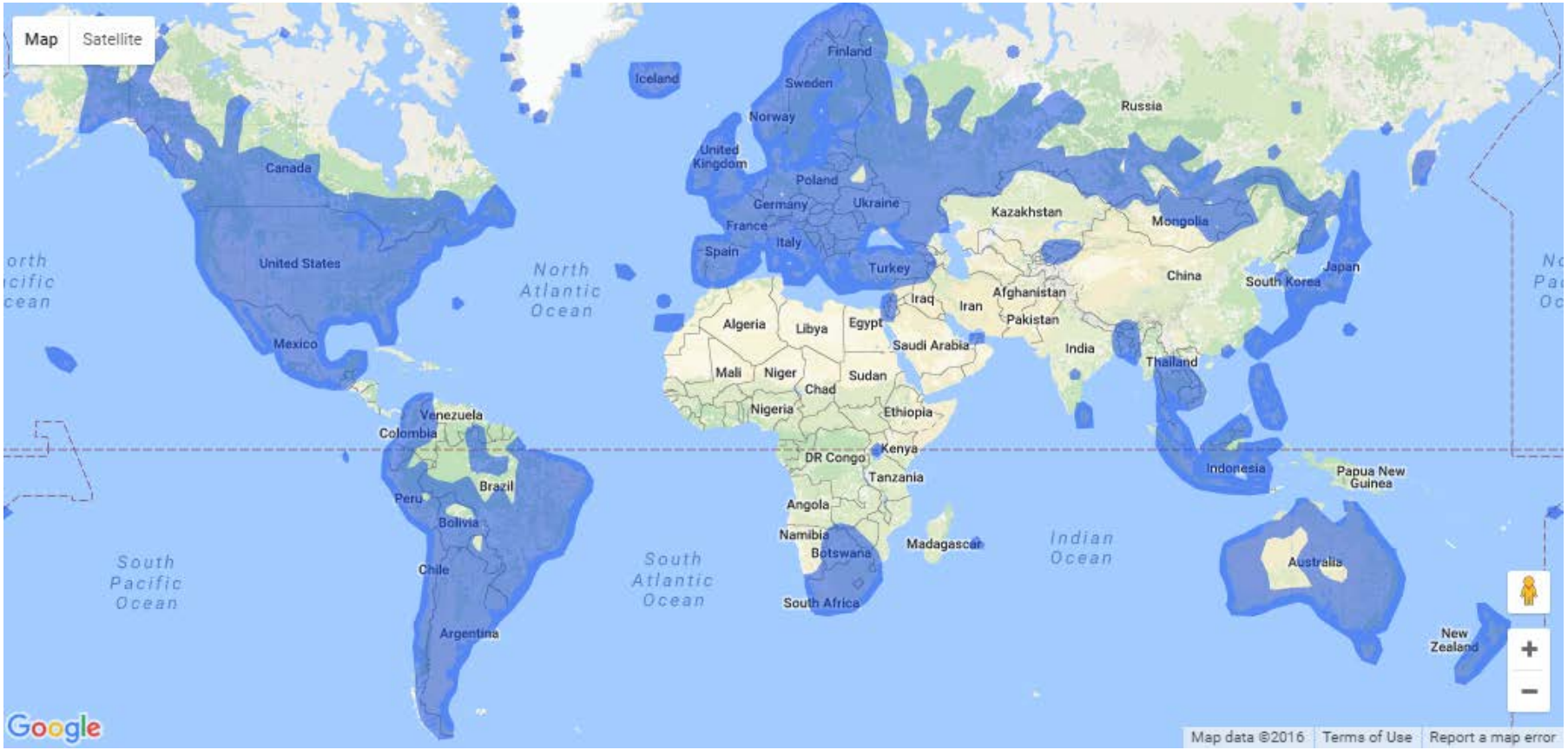

Google maps
Street View
google.com/streetview

Street View launch, May 2007

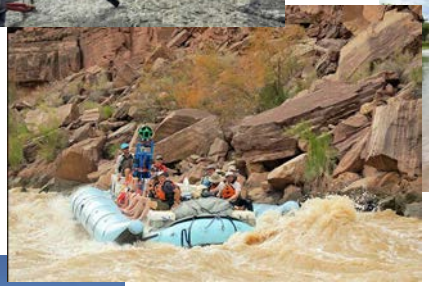
Scaling! (2007-2009)

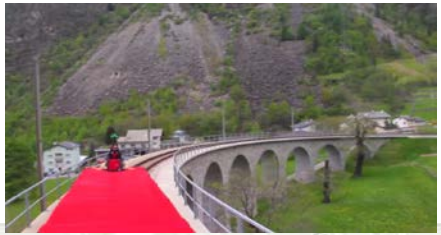


Coverage today: 77 countries across 7 continents



Oh, the places you'll go...

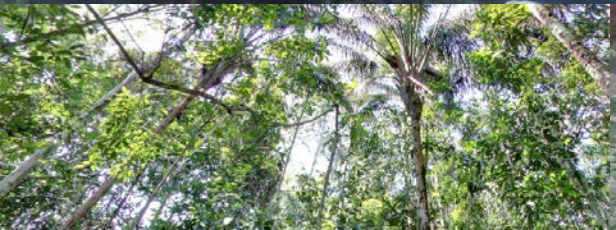





Glen Merry
PHOTO SPHERE - Jul 2014



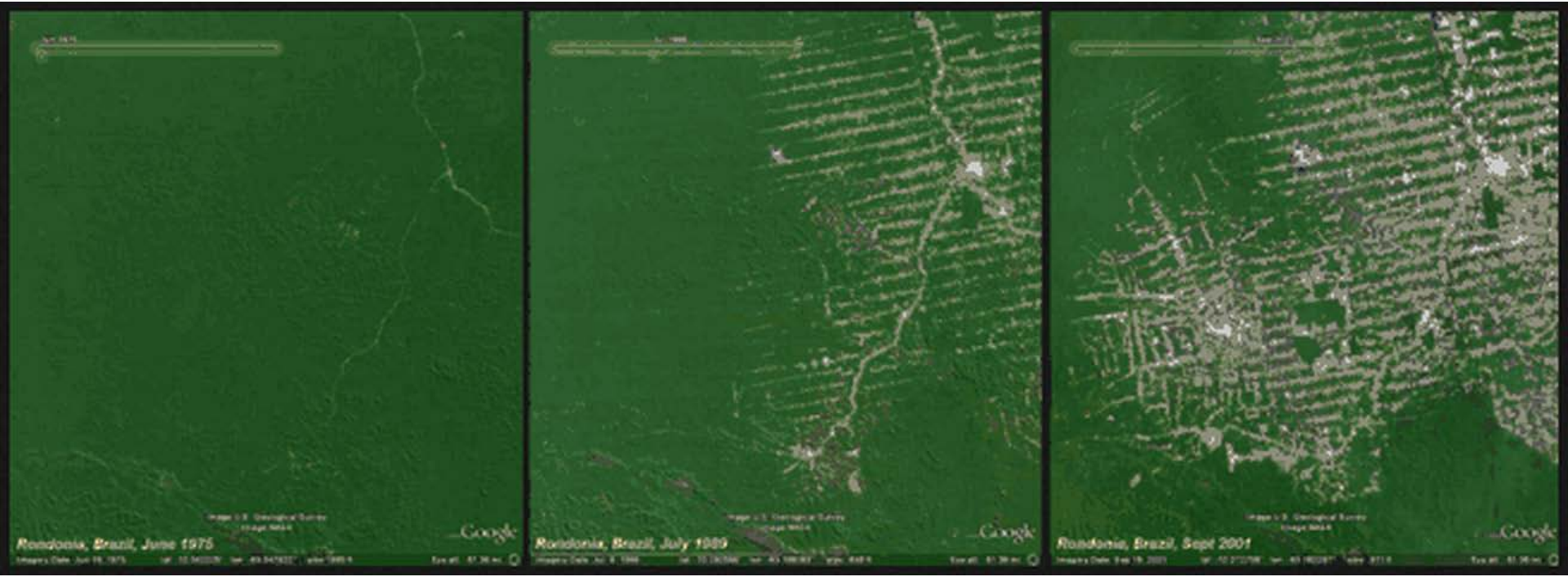




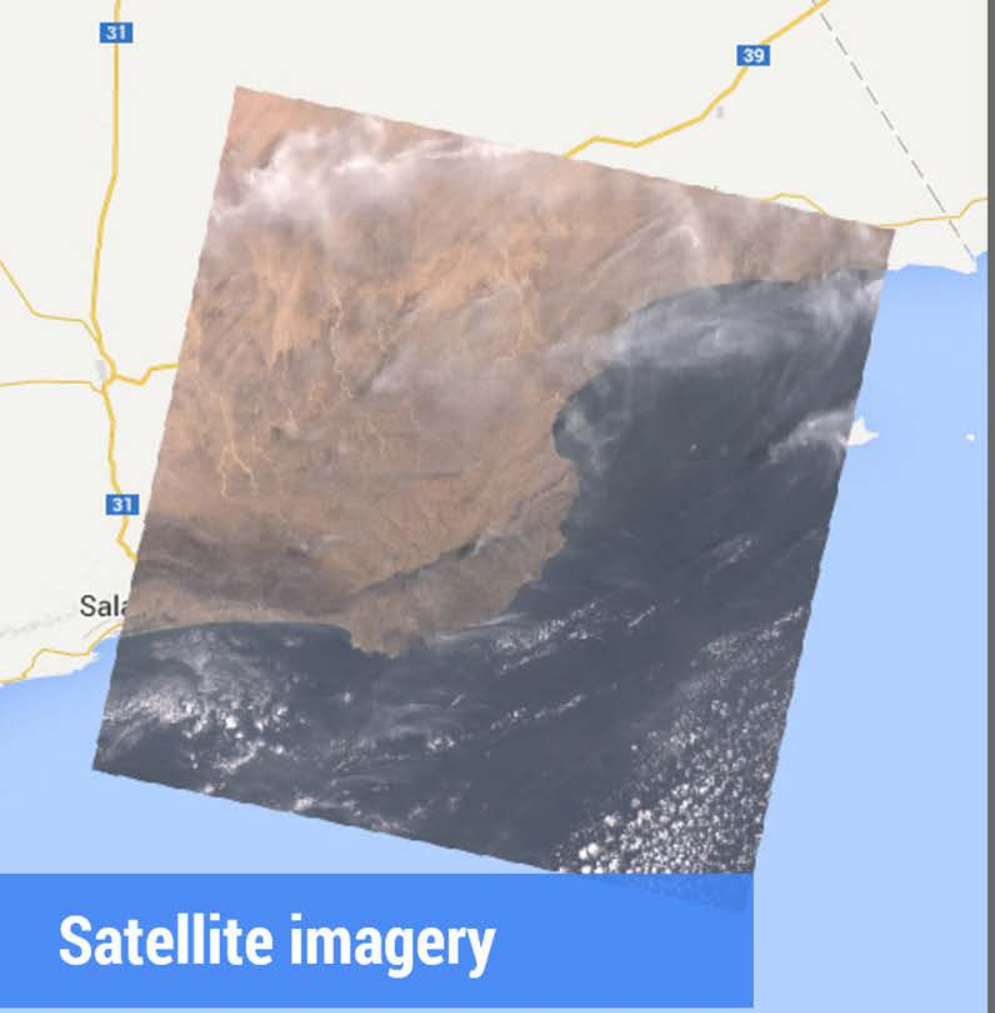
N 4th St
St. Louis, Missouri
Street View - Jun 2015
HYATT
292
Market St
Gateway Arch &
Old Courthouse
Back to Map
Google
Image capture: Jun 2015
© 2016 Google
Terms
Report a problem

Origins (2009): The Problem



Source: UNEP Atlas of Our Changing Environment


Operating NASA Earth Science Missions
QuikSCAT
OSTM/Jason 2
Aquarius/SAC-D
Aqua
Terra
TRMM
EO-1
Suomi NPP
Aura
ACRIMSAT
Landsat 7
Landsat 8
SORCE
GRACE (2)
GPM Core
CALIPSO
CloudSat



Satellite imagery

One Landsat 8 image:

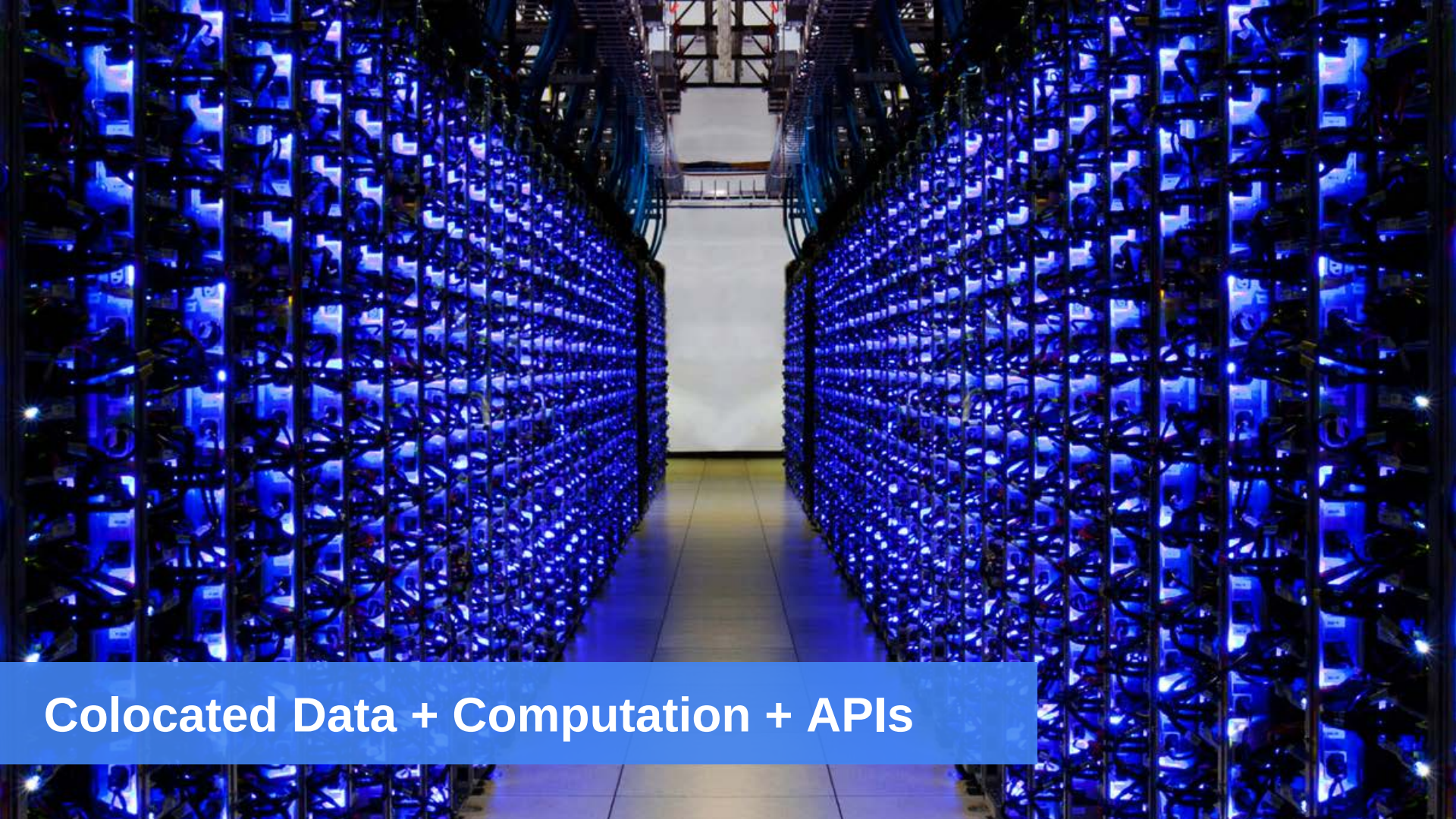
- 64M pixels (30m resolution)
- 10 spectral bands
- 12 bits/band
- 600 images/day

MORE THAN 4M IMAGES FROM 42 YEARS OF LANDSAT.

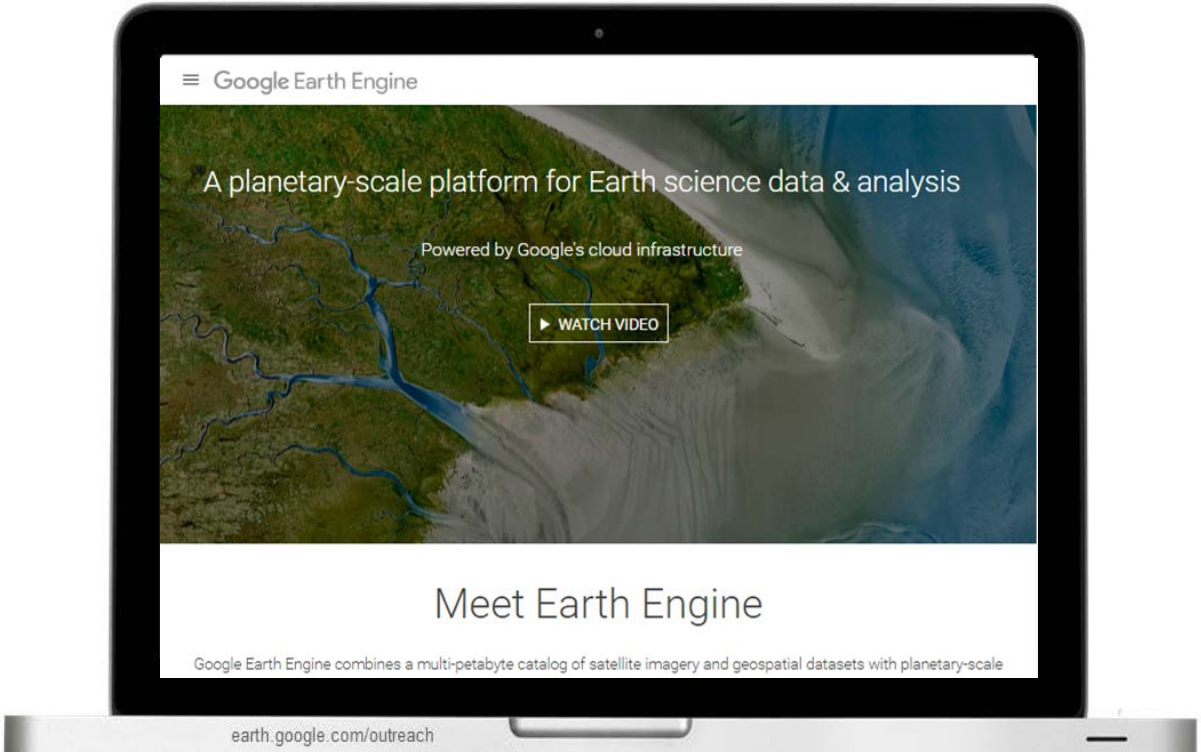
Many other satellites with different combinations of spatial resolution, spectral bands, collection frequency.

4 Million Landsat images *(1972-2016)*
More than a petabyte stored on tapes at USGS and growing daily

Earth Observation Data Archives


Colocated Data + Computation + APIs

Google Earth Engine



earthengine.google.com

The Earth Engine Data Catalog

Landsat & Sentinel
10-30m, 14-day

MODIS
250m daily

Your own data can be added

Terrain & Land Cover

Weather & Climate
NOAA NCEP, OMI, ...

... and many more, updating daily!

> 200 public datasets

> 5 million images

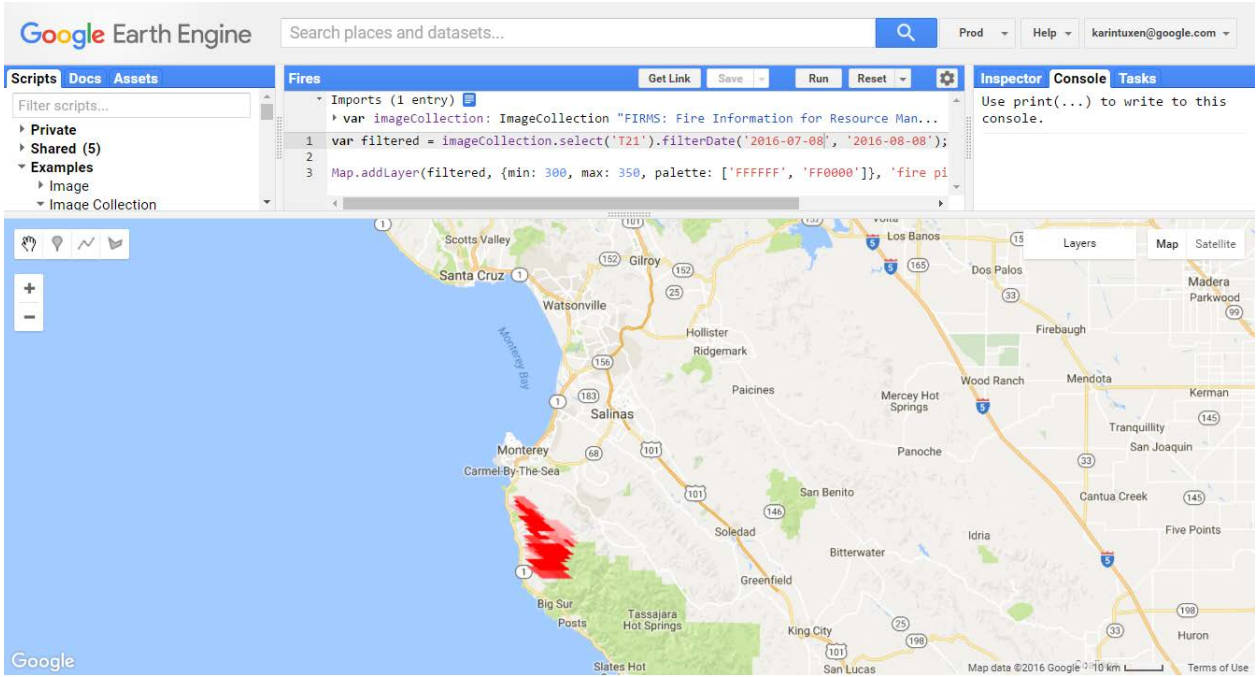
> 4000 new images every day

> 5 petabytes of data

AQ-related datasets in Earth Engine

- MODIS fire data (FIRMS) ingested into EE daily.

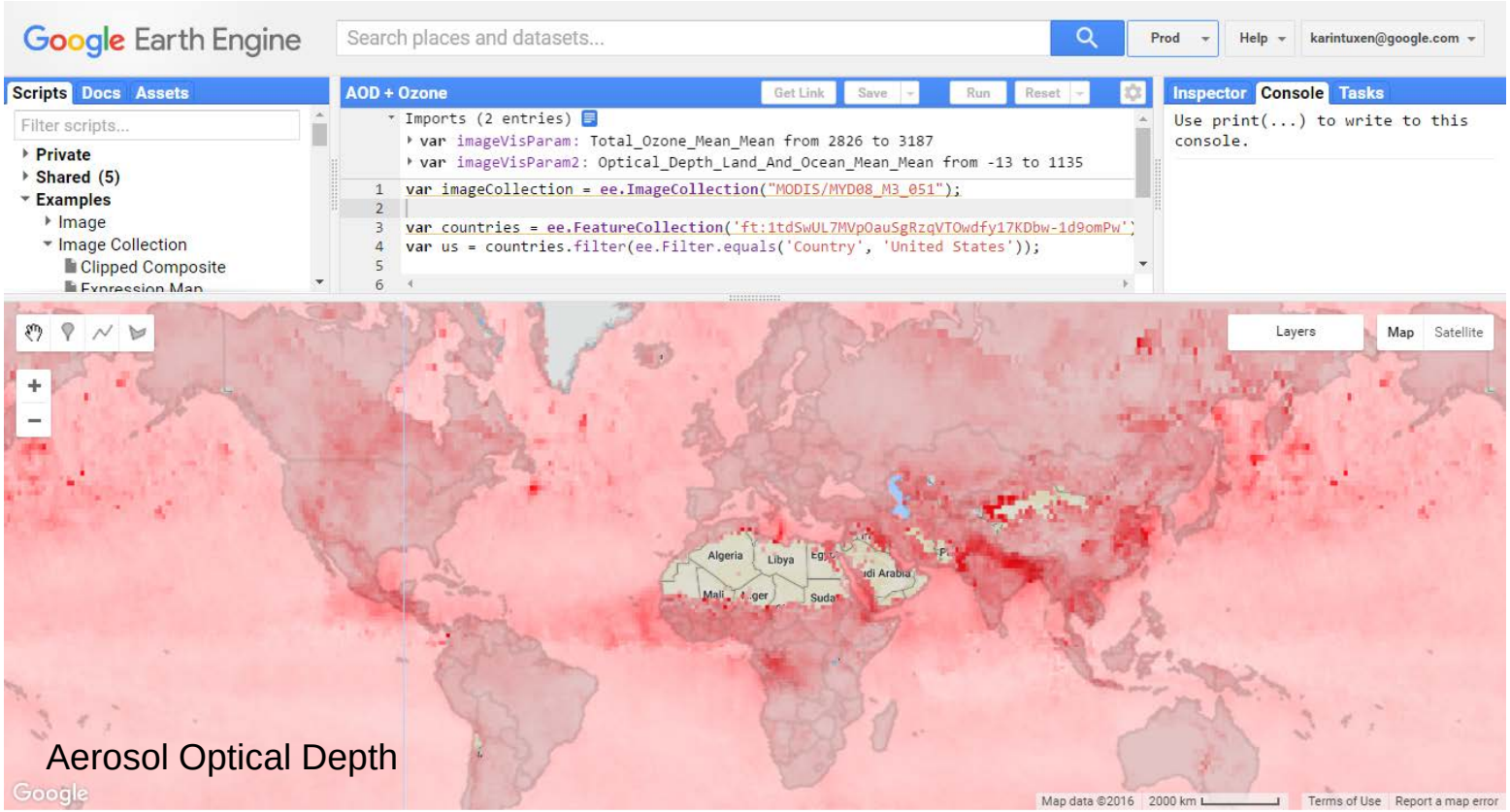
MODIS of Soberanes Fire

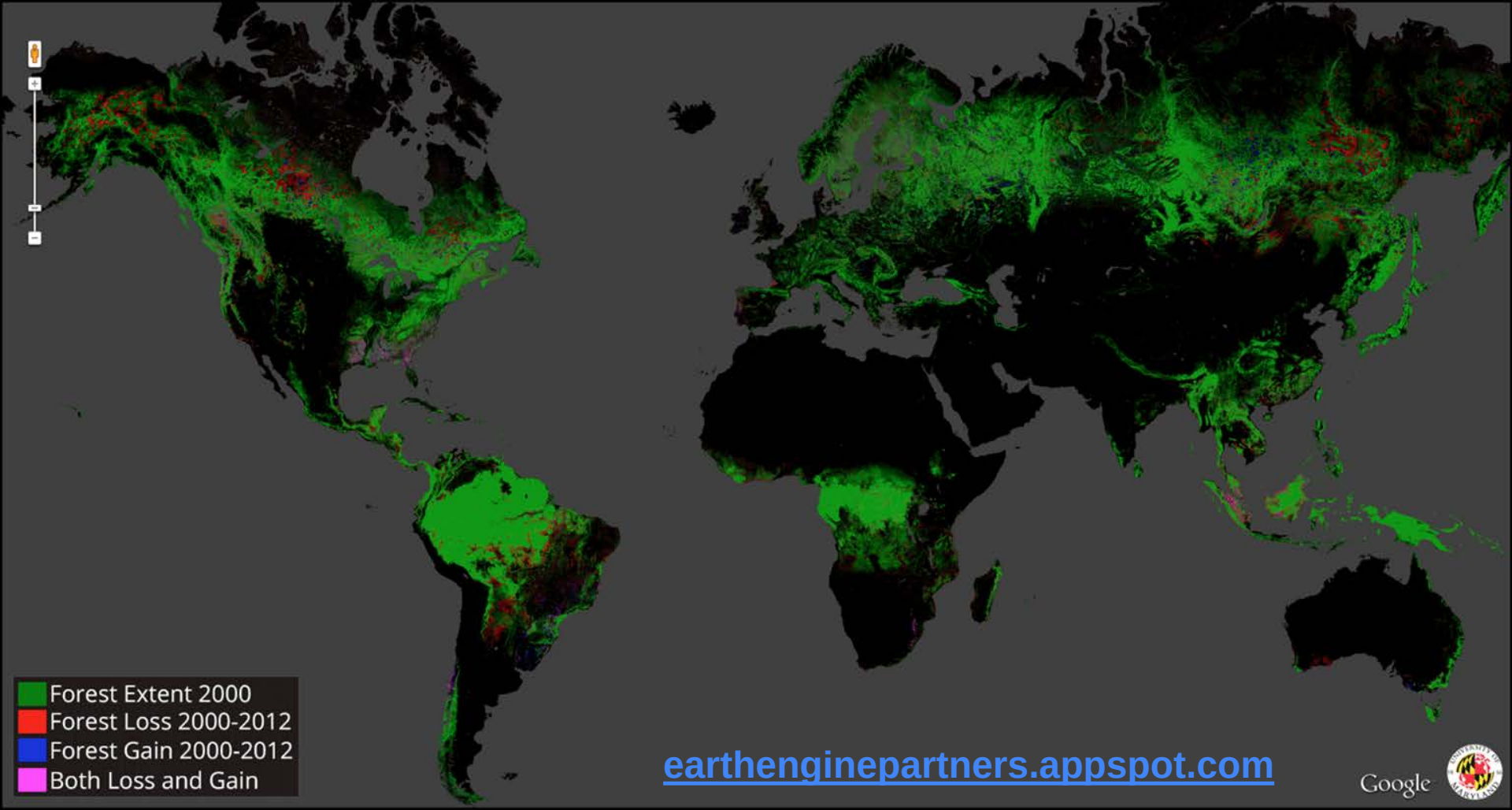


FIRMS data showing Soberanes Fire in Earth Engine

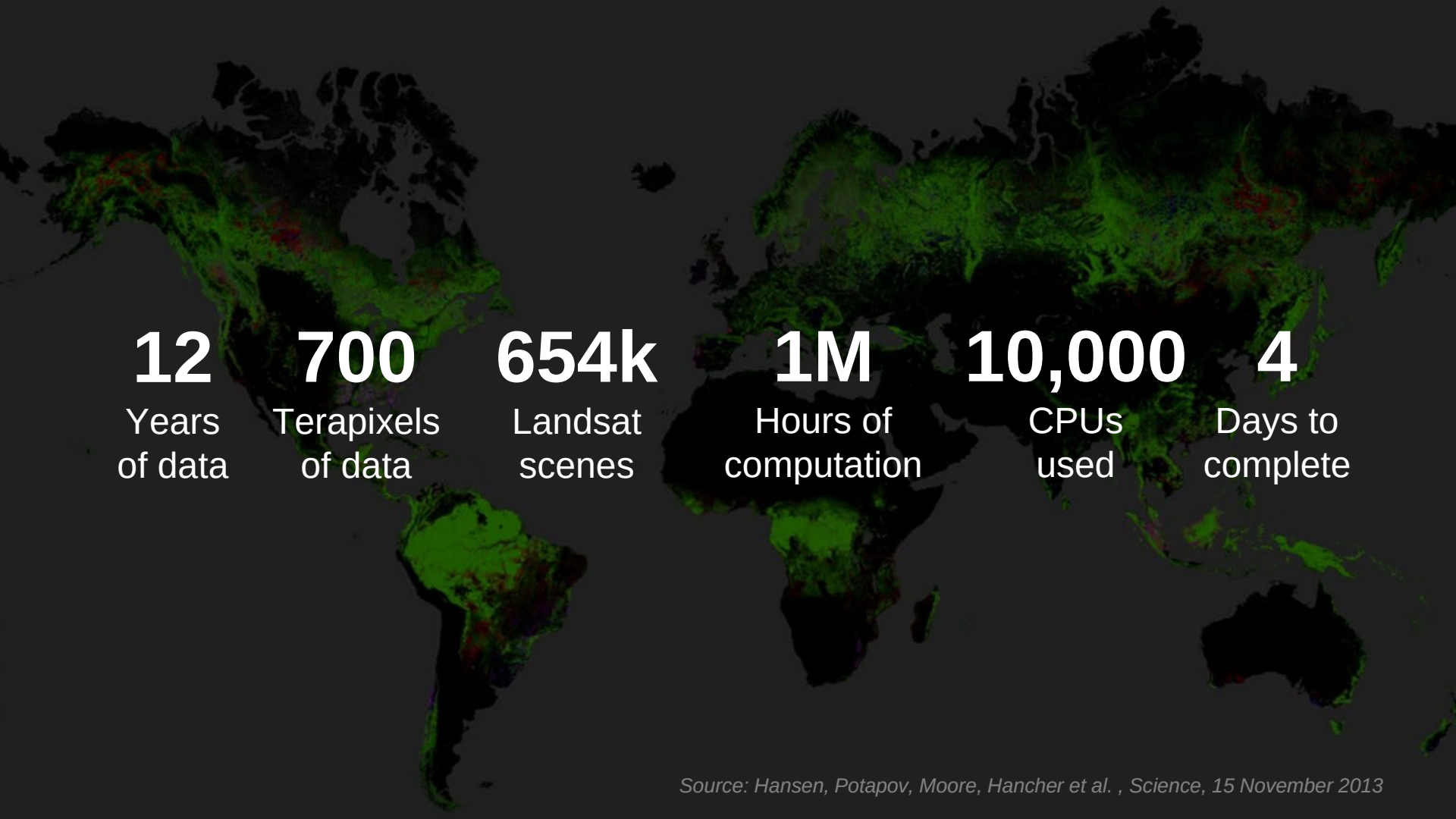
AQ-related datasets in Earth Engine

- MODIS 08 Gridded Atmospheric Product ingested into EE daily.





Global Forest Change, 2000-2012 Source: Hansen, Potapov, Moore, Hancher, et al. (Science, 2013) Powered by Google Earth Engine



Source: Hansen, Potapov, Moore, Hancher et al. , Science, 15 November 2013

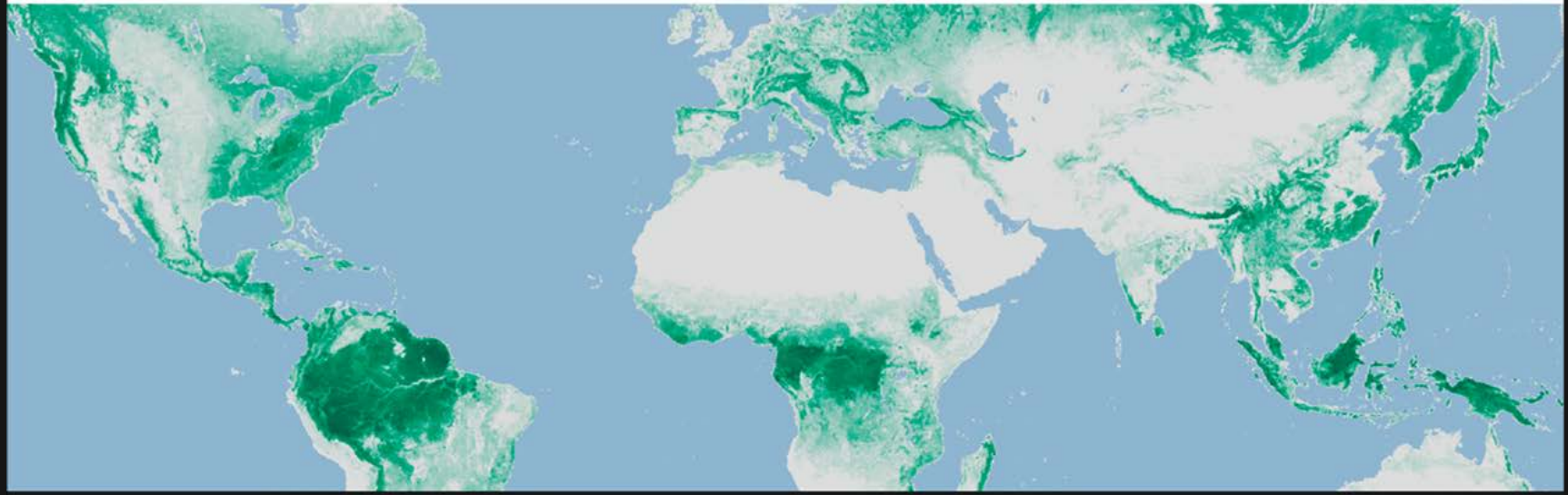
GLOBAL FOREST WATCH 2.0

HOME COUNTRIES STORIES MAP BLOG DATA ABOUT ENGLISH +

Find out what is happening in forests right now

44,479
ALERTS IN THE PAST YEAR

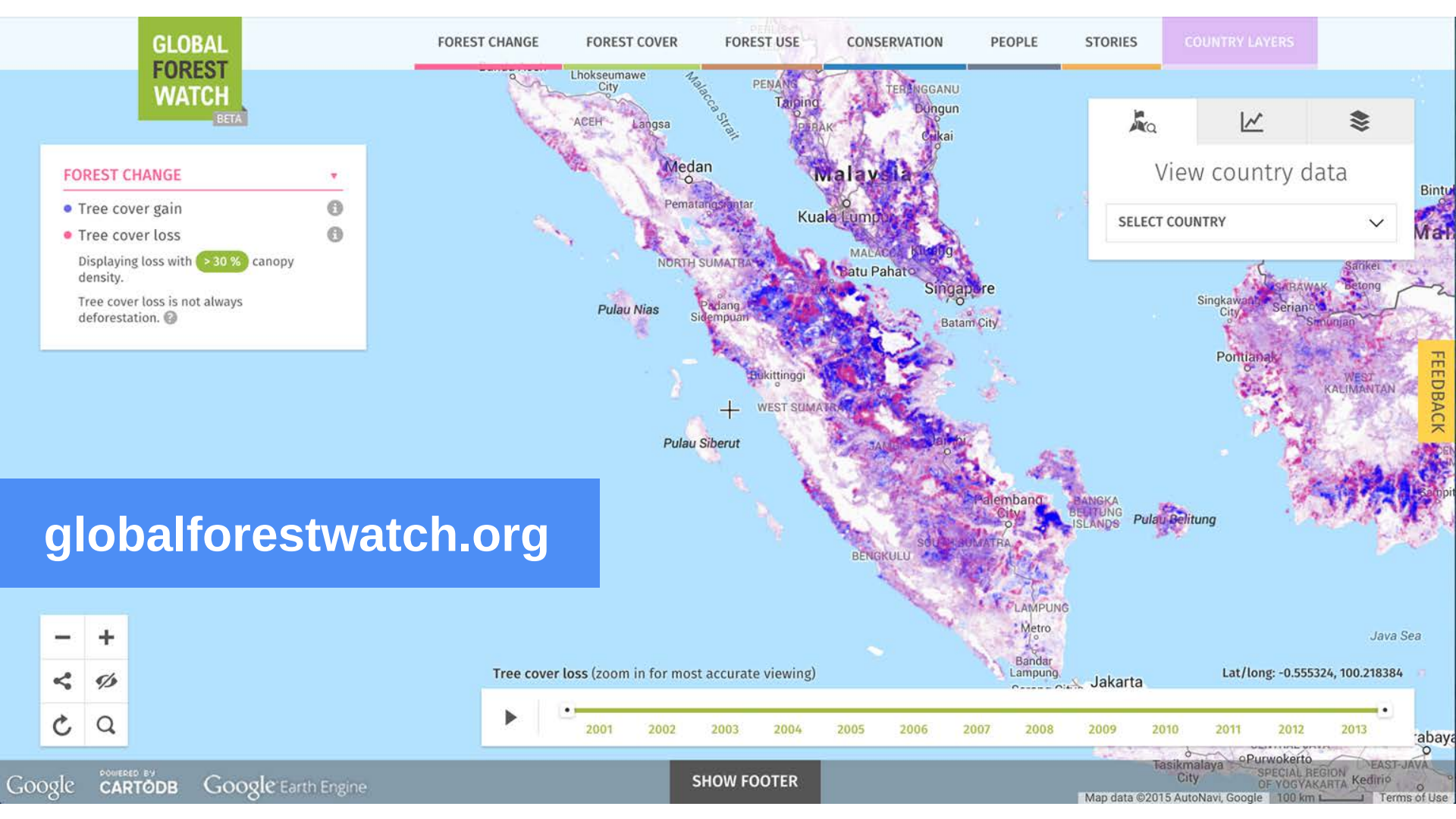
3
NEW FOREST STORIES

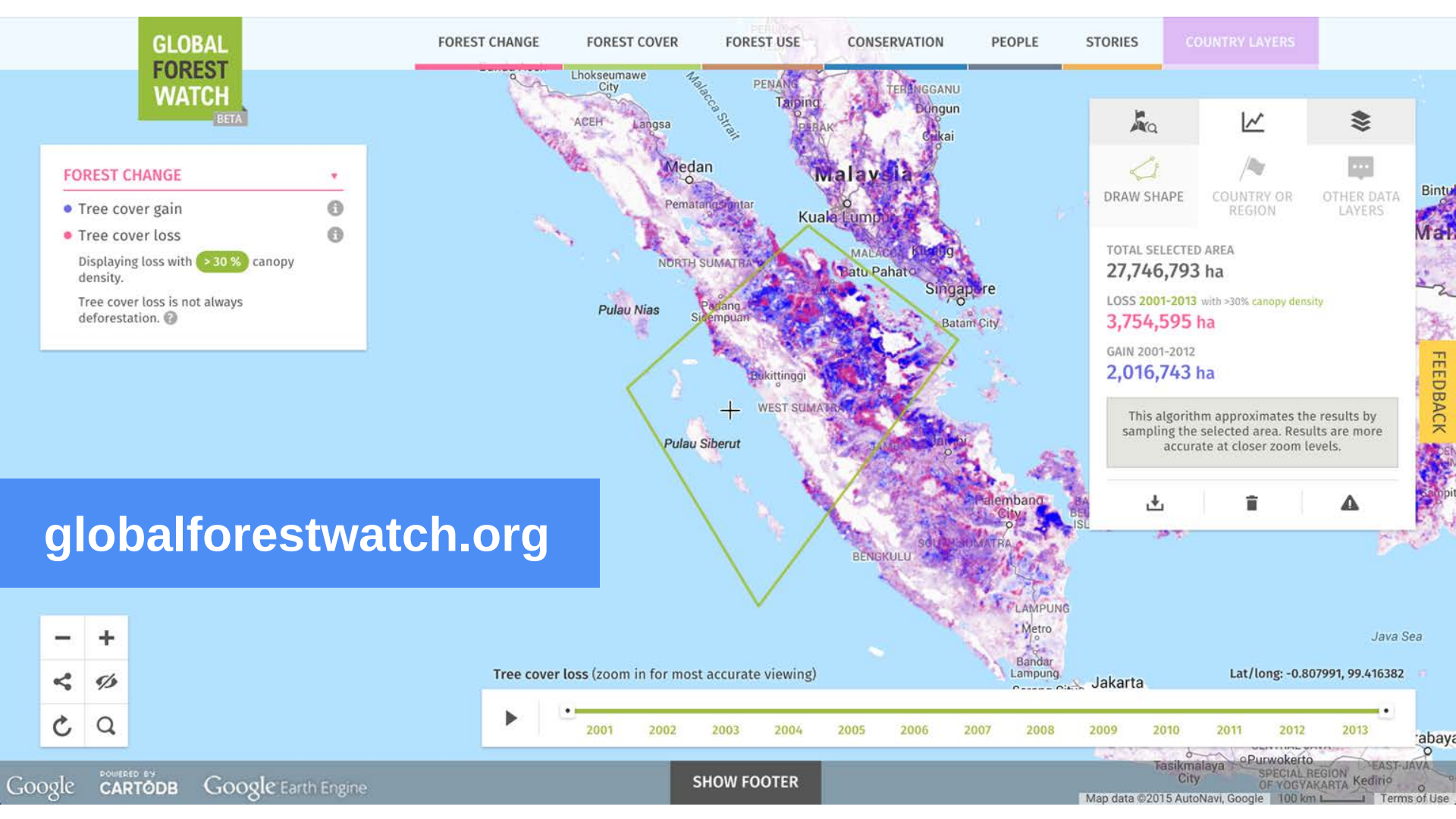


Join the community

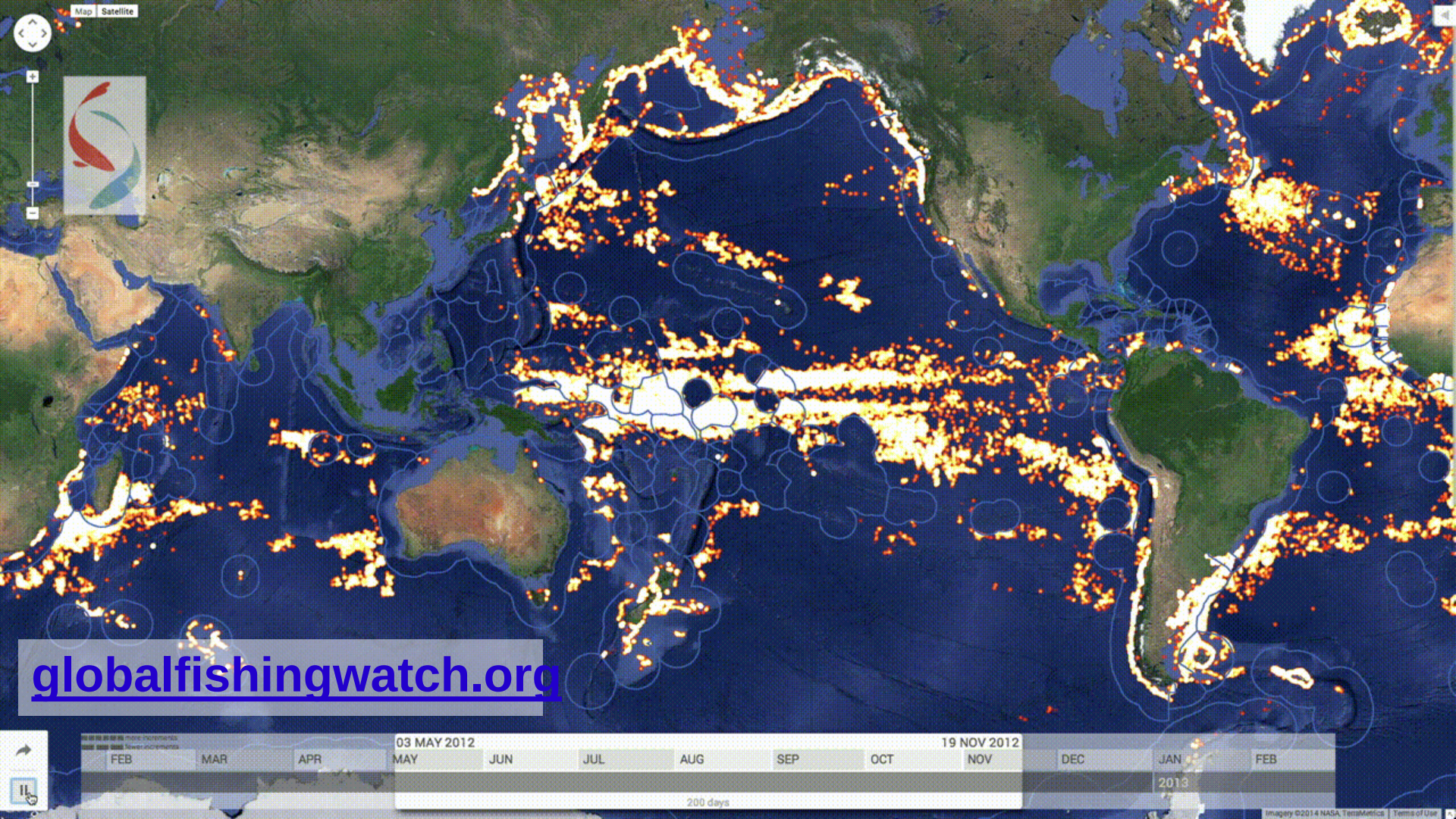
Analysis tool

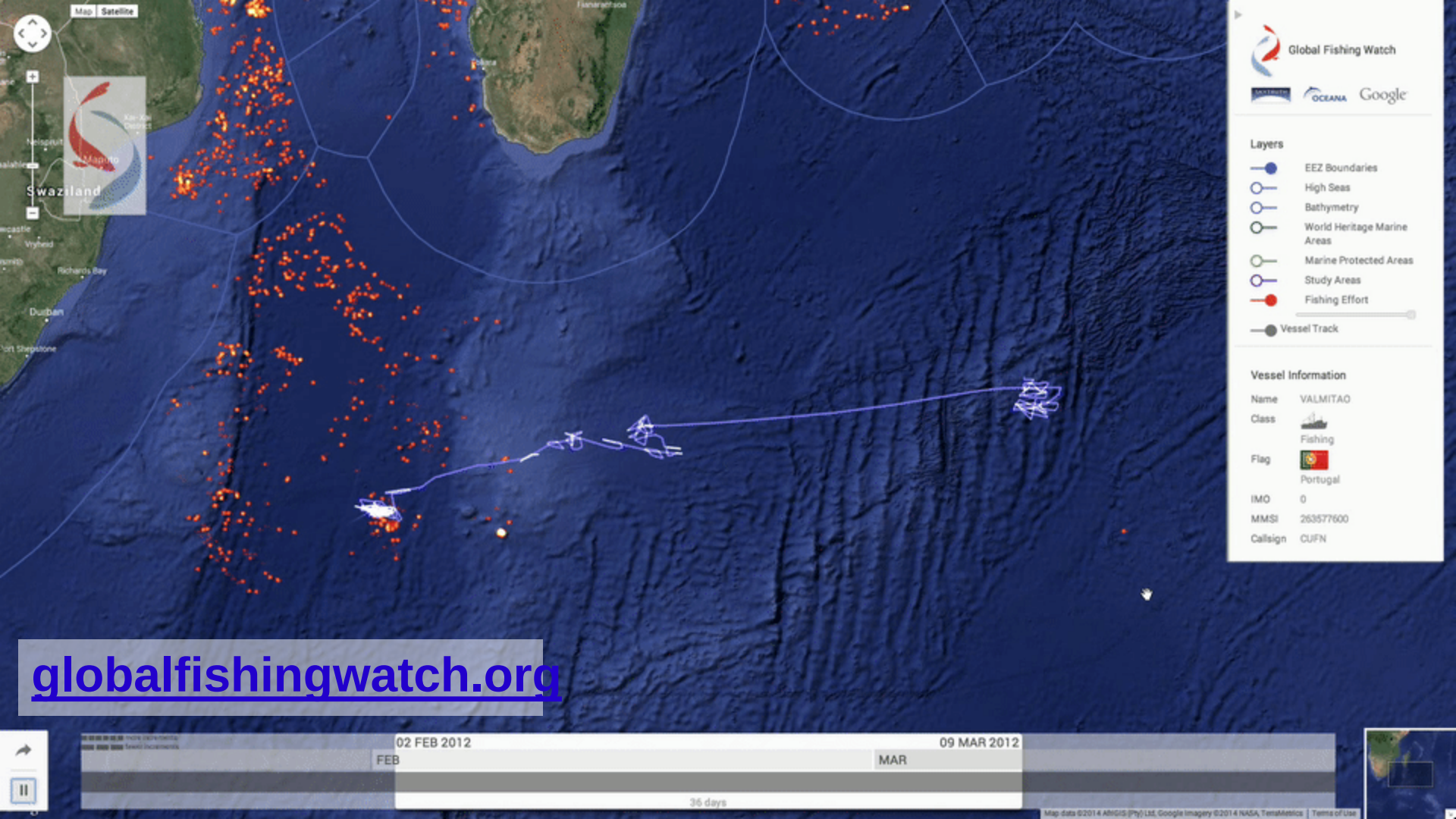
Stay updated

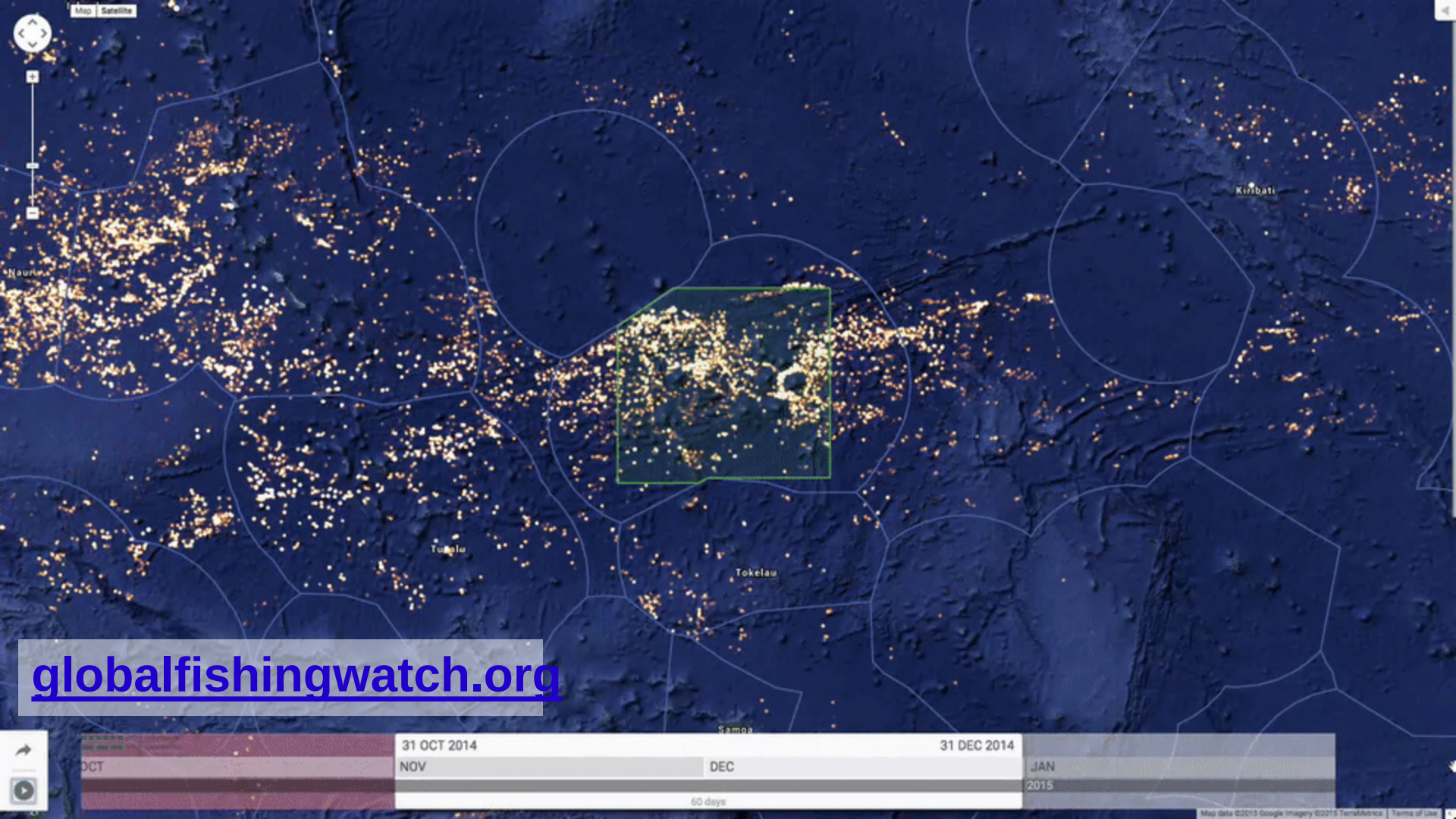

GLOBAL FOREST WATCH
BETA
FOREST CHANGE
FOREST COVER
FOREST USE
CONSERVATION
PEOPLE
STORIES
COUNTRY LAYERS
FOREST CHANGE
Tree cover gain
Tree cover loss
Displaying loss with > 30 % canopy density.
Tree cover loss is not always deforestation.
View country data
SELECT COUNTRY
FEEDBACK
globalforestwatch.org
Tree cover loss (zoom in for most accurate viewing)
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Lat/long: -0.555324, 100.218384
SHOW FOOTER
Google
POWERED BY CARTODB
Google Earth Engine
Map data ©2015 AutoNavi, Google
100 km
Terms of Use
Lhokseumawe City
ACEH
Langsa
Malacca Strait
PENANG
Taiping
PERAK
TERENGGANU
Dungun
Cukai
Medan
Malaysia
Pematangsiantar
Kuala Lumpur
MALACCA
Klang
NORTH SUMATRA
Batu Pahat
Singapore
Pulau Nias
Padang Sidempuan
Batam City
Bukittinggi
WEST SUMATRA
Pulau Siberut
Palembang City
BANGKA BELITUNG ISLANDS
Pulau Belitung
BENGKULU
LAMPUNG
Metro
Bandar Lampung
Jakarta
Java Sea
Singkawang City
SARAWAK
Sanggau
Sekadau
Serian
Simunjan
Pontianak
WEST KALIMANTAN
Tasikmalaya City
Purwokerto
SPECIAL REGION OF YOGYAKARTA
Kediri
EAST JAVA


GLOBAL FOREST WATCH
BETA
FOREST CHANGE
FOREST COVER
FOREST USE
CONSERVATION
PEOPLE
STORIES
COUNTRY LAYERS
FOREST CHANGE
Tree cover gain
Tree cover loss
Displaying loss with > 30 % canopy density.
Tree cover loss is not always deforestation.
DRAW SHAPE
COUNTRY OR REGION
OTHER DATA LAYERS
TOTAL SELECTED AREA
27,746,793 ha
LOSS 2001-2013 with >30% canopy density
3,754,595 ha
GAIN 2001-2012
2,016,743 ha
This algorithm approximates the results by sampling the selected area. Results are more accurate at closer zoom levels.
FEEDBACK
globalforestwatch.org
Tree cover loss (zoom in for most accurate viewing)
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Lat/long: -0.807991, 99.416382
Lhokseumawe City
Malacca Strait
Medan
Malaysia
Kuala Lumpur
Singapore
Pulau Nias
Pulau Siberut
Batam City
Palembang
Jakarta
Java Sea
Purwokerto
Kediri
Google
CARTODB
Google Earth Engine
SHOW FOOTER
Map data ©2015 AutoNavi, Google
100 km
Terms of Use


© HAP/Quirky China News/REX


Map
Satellite
globalfishingwatch.org
03 MAY 2012
19 NOV 2012
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
2013
200 days
Imagery ©2014 NASA, TerraMetrics
Terms of Use


Map
Satellite
Swaziland
Richards Bay
Durban
Global Fishing Watch
OCEANA
Google
Layers
EEZ Boundaries
High Seas
Bathymetry
World Heritage Marine Areas
Marine Protected Areas
Study Areas
Fishing Effort
Vessel Track
Vessel Information
Name VALMITAO
Class Fishing
Flag Portugal
IMO 0
MMSI 263577600
Callsign CUFN
globalfishingwatch.org
02 FEB 2012
09 MAR 2012
FEB
MAR
36 days


Map
Satellite
Kiribati
Nauru
Tuvalu
Tokelau
Samoa
globalfishingwatch.org
31 OCT 2014
31 DEC 2014
OCT
NOV
DEC
JAN
2015
60 days

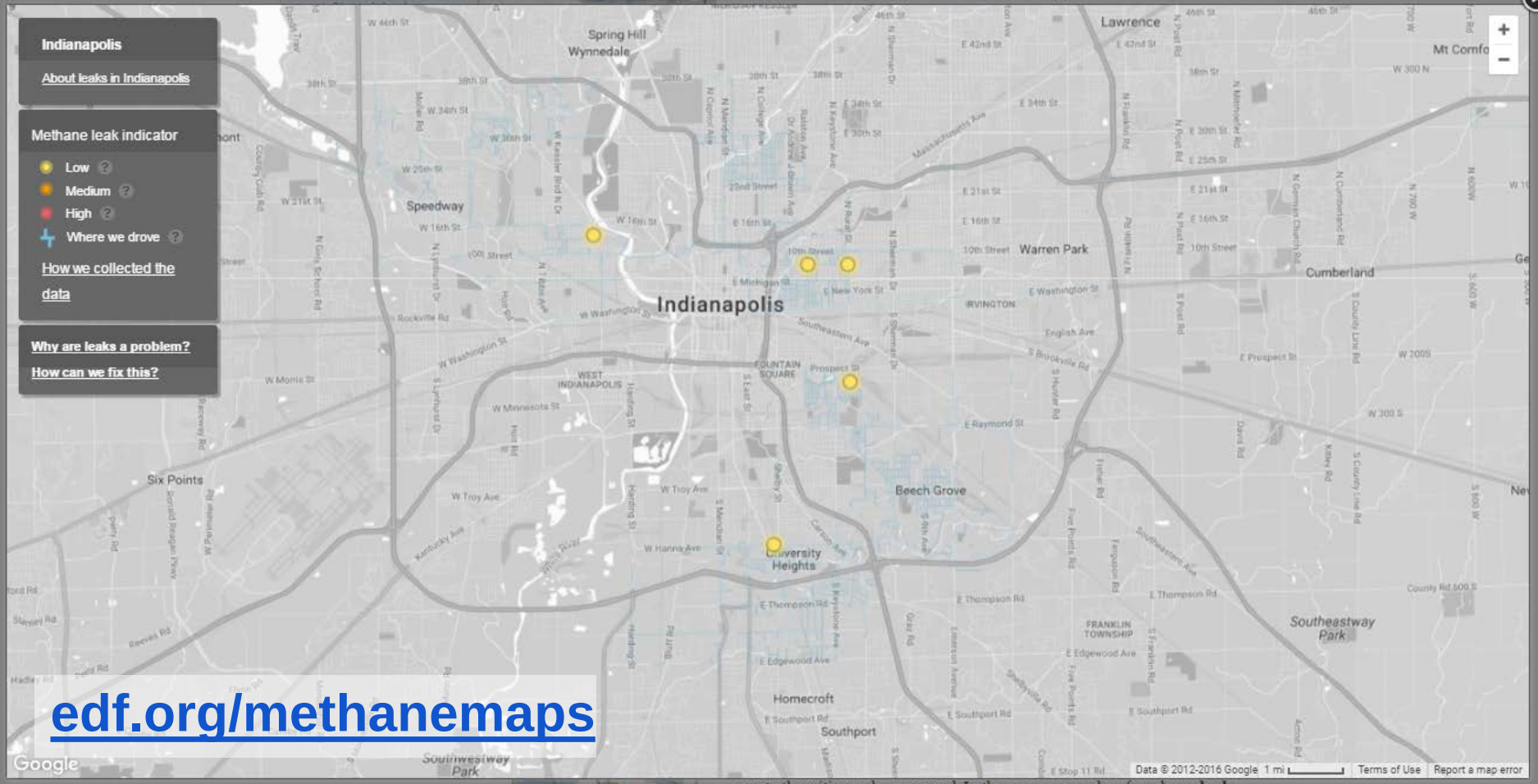
For Climate Change:
Methane
Carbon Dioxide (CO_2)

For Human Health:
Particulate Matter
Black Carbon
Carbon Monoxide (CO)
Nitric Oxide (NO)
Nitrogen Dioxide (NO_2)
Ozone (O_3)

Los Angeles Area

Mesa

Burlington is a smaller system built more recently than others in New



most other cities we have mapped. In the areas surveyed we found **one leak for every nine miles we drove.**

NEWSROOM

Media Contacts
Press Releases
Social Media
Investor Relations
PSEG in the Community
Directions to PSEG Headquarters

Contact /

Brooke Houston

Phone: 973-430-7734

November 16, 2015

PSE&G Receives Approval of $905 Million Program to Accelerate Replacement of Aging Gas Infrastructure

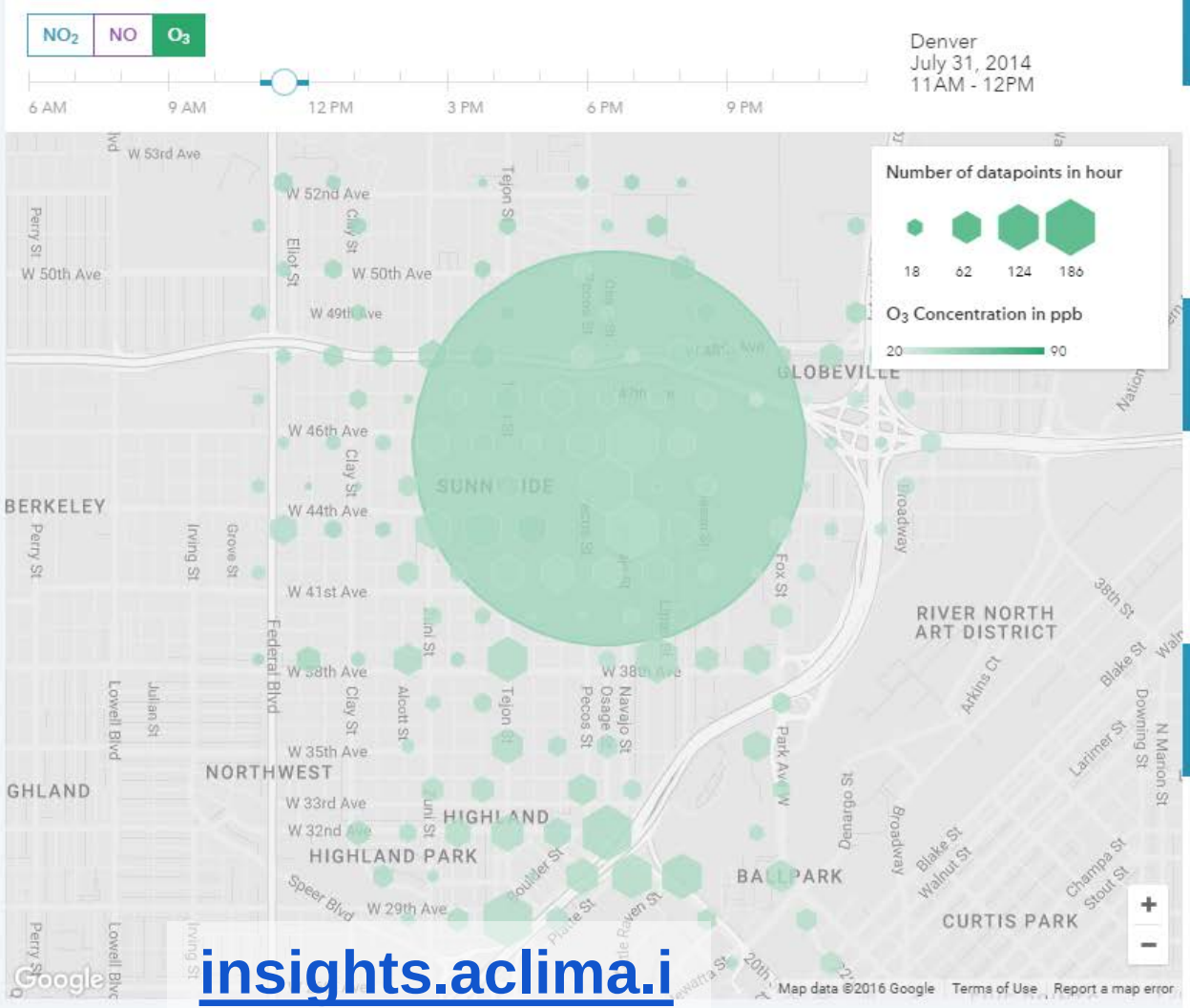
Utility to replace up to 510 miles of cast iron and unprotected steel pipes over three years
Low gas supply prices make this the ideal time to upgrade system

(Nov. 16, 2015 – Newark, N.J.) – Public Service Electric and Gas Company (PSE&G), New Jersey's largest utility, today announced the approval of a three-year, $905 million program to expedite the replacement of aging gas pipes. Approved by the New Jersey Board of Public Utilities, the program will enable PSE&G to accelerate the modernization of its cast iron and unprotected steel gas infrastructure -- replacing up to 510 miles of gas mains and 38,000 service lines over the three-year period.

Work is being prioritized based on the condition and location of the gas mains. In addition, data on methane emissions from the Environmental Defense Fund (EDF) will be used in prioritizing this work.

unprotected steel gas pipes are located. PSE&G is working with municipalities to determine when replacements will be done. Engineering and planning of the construction is underway, with work set to begin in the spring.

Work is being prioritized based on the condition and location of the gas mains. In addition, data on methane emissions from the Environmental Defense Fund (EDF) will



Walking the Dog

There are 40,000 vehicles on the road in this area of town during rush hour, leading to elevated concentrations of NO. Some NO_2 is directly emitted from vehicles, but much of it comes from oxidation of NO emissions. O_3 concentrations are low because the photochemistry is just getting started.

11 AM

Early Lunch Hour

With increased sunlight and temperature, photochemistry speeds up leading to higher O_3 concentrations. NO and NO_2 concentrations decrease from losses due to photochemistry and an increase in the thickness of the atmospheric boundary layer.

4 PM

Soccer Practice

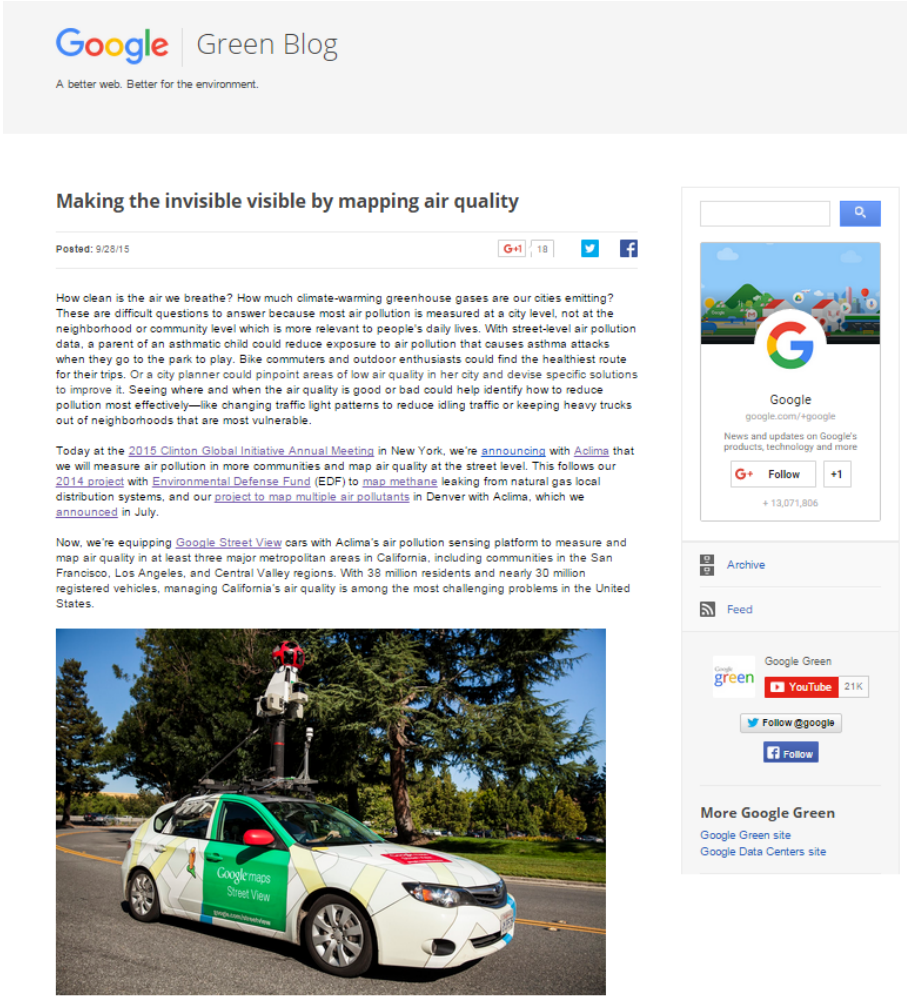
Ozone concentrations are reaching their peak. NO emissions begin to increase as the afternoon rush hour starts. The relative amounts of NO and NO_2 is a balance between the conversion of NO_2 to NO by sunlight and the conversion of NO to NO_2 by ozone. On this day, the NO concentrations decrease to near-zero as the afternoon progresses.

Starting in California...

In September 2015, Google and Aclima announced that we will be driving multiple communities in the San Francisco Bay Area, Los Angeles, and Central Valley Regions of California, through 2016.

We will be making the measurements available online to scientists via Google Cloud and Google Earth Engine.

Read more.



Google Green Blog

A better web. Better for the environment.

Making the invisible visible by mapping air quality

Posted: 9/28/15

How clean is the air we breathe? How much climate-warming greenhouse gases are our cities emitting? These are difficult questions to answer because most air pollution is measured at a city level, not at the neighborhood or community level which is more relevant to people's daily lives. With street-level air pollution data, a parent of an asthmatic child could reduce exposure to air pollution that causes asthma attacks when they go to the park to play. Bike commuters and outdoor enthusiasts could find the healthiest route for their trips. Or a city planner could pinpoint areas of low air quality in her city and devise specific solutions to improve it. Seeing where and when the air quality is good or bad could help identify how to reduce pollution most effectively—like changing traffic light patterns to reduce idling traffic or keeping heavy trucks out of neighborhoods that are most vulnerable.

Today at the 2015 Clinton Global Initiative Annual Meeting in New York, we're announcing with Aclima that we will measure air pollution in more communities and map air quality at the street level. This follows our 2014 project with Environmental Defense Fund (EDF) to map methane leaking from natural gas local distribution systems, and our project to map multiple air pollutants in Denver with Aclima, which we announced in July.

Now, we're equipping Google Street View cars with Aclima's air pollution sensing platform to measure and map air quality in at least three major metropolitan areas in California, including communities in the San Francisco, Los Angeles, and Central Valley regions. With 38 million residents and nearly 30 million registered vehicles, managing California's air quality is among the most challenging problems in the United States.

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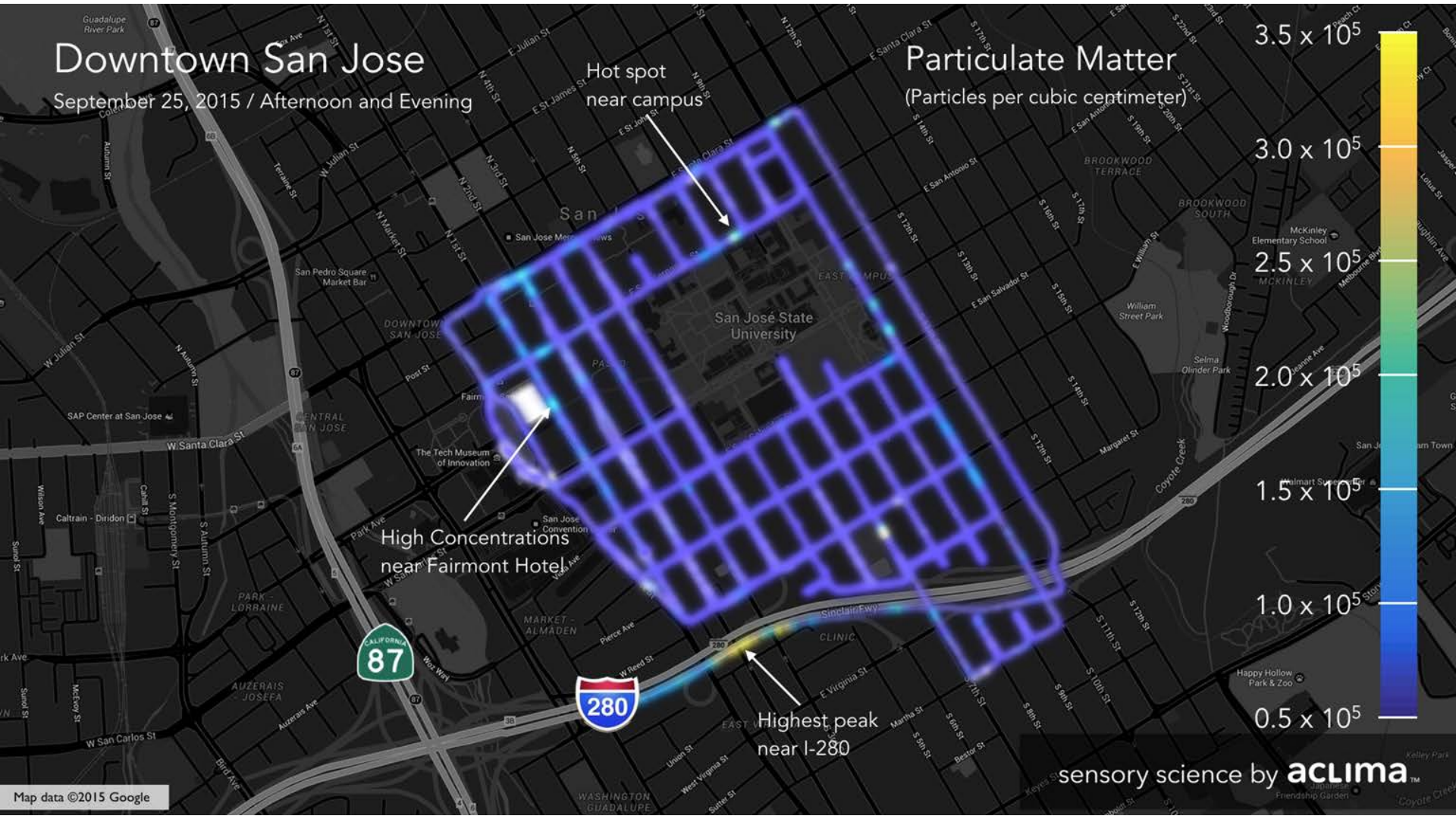
Follow

More Google Green
Google Green site
Google Data Centers site


Downtown San Jose
September 25, 2015 / Afternoon and Evening
Hot spot near campus
Particulate Matter
(Particles per cubic centimeter)
3.5 x 10^5
3.0 x 10^5
2.5 x 10^5
2.0 x 10^5
1.5 x 10^5
1.0 x 10^5
0.5 x 10^5
High Concentrations near Fairmont Hotel
Highest peak near I-280
San José State University
sensory science by aclima
Map data ©2015 Google

Downtown San Jose

September 25, 2015 / Afternoon and Evening

Hot spot near campus

Particulate Matter

(Particles per cubic centimeter)

3.5 x 10^5

3.0 x 10^5

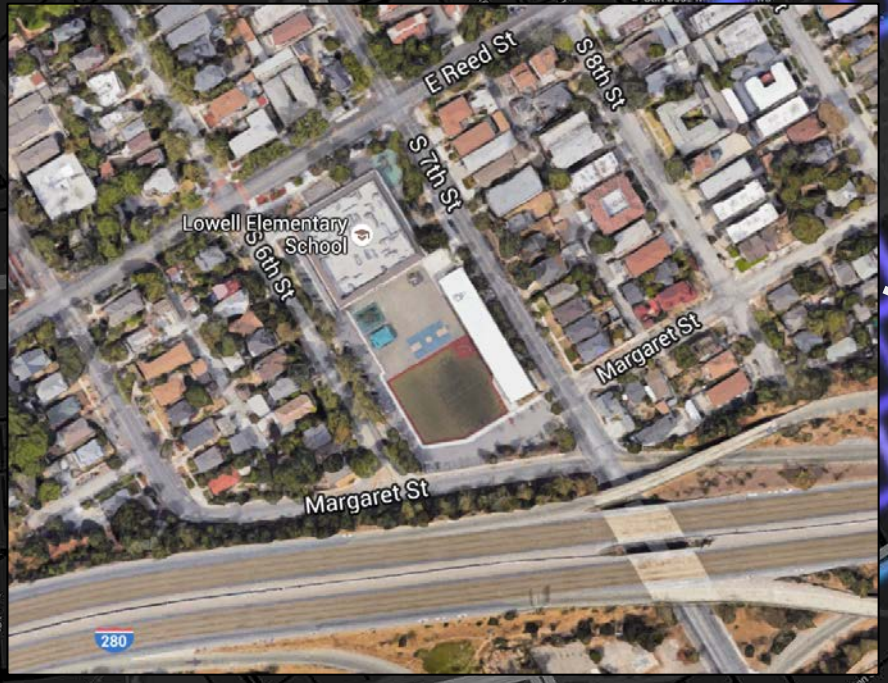
2.5 x 10^5

2.0 x 10^5

1.5 x 10^5

1.0 x 10^5

0.5 x 10^5

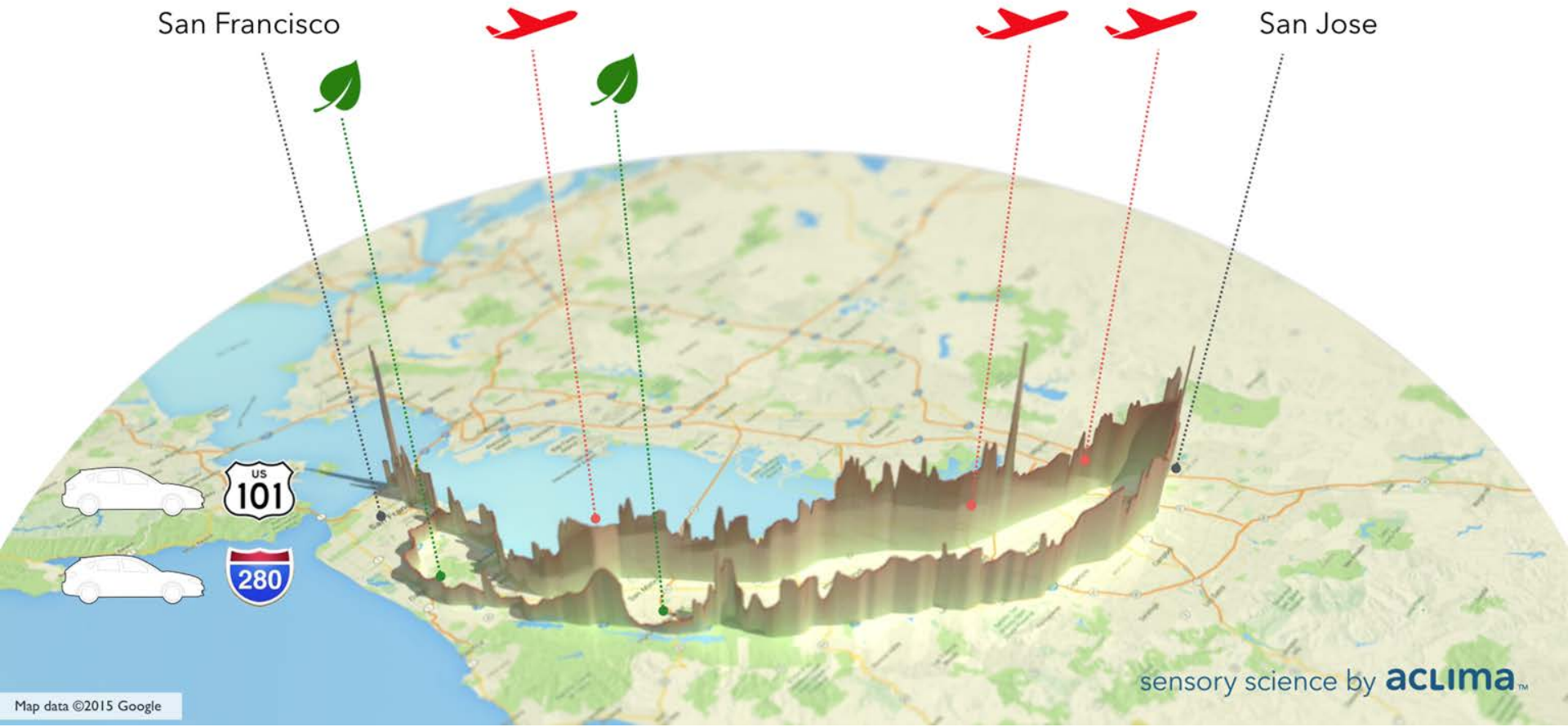


Highest peak near I-280

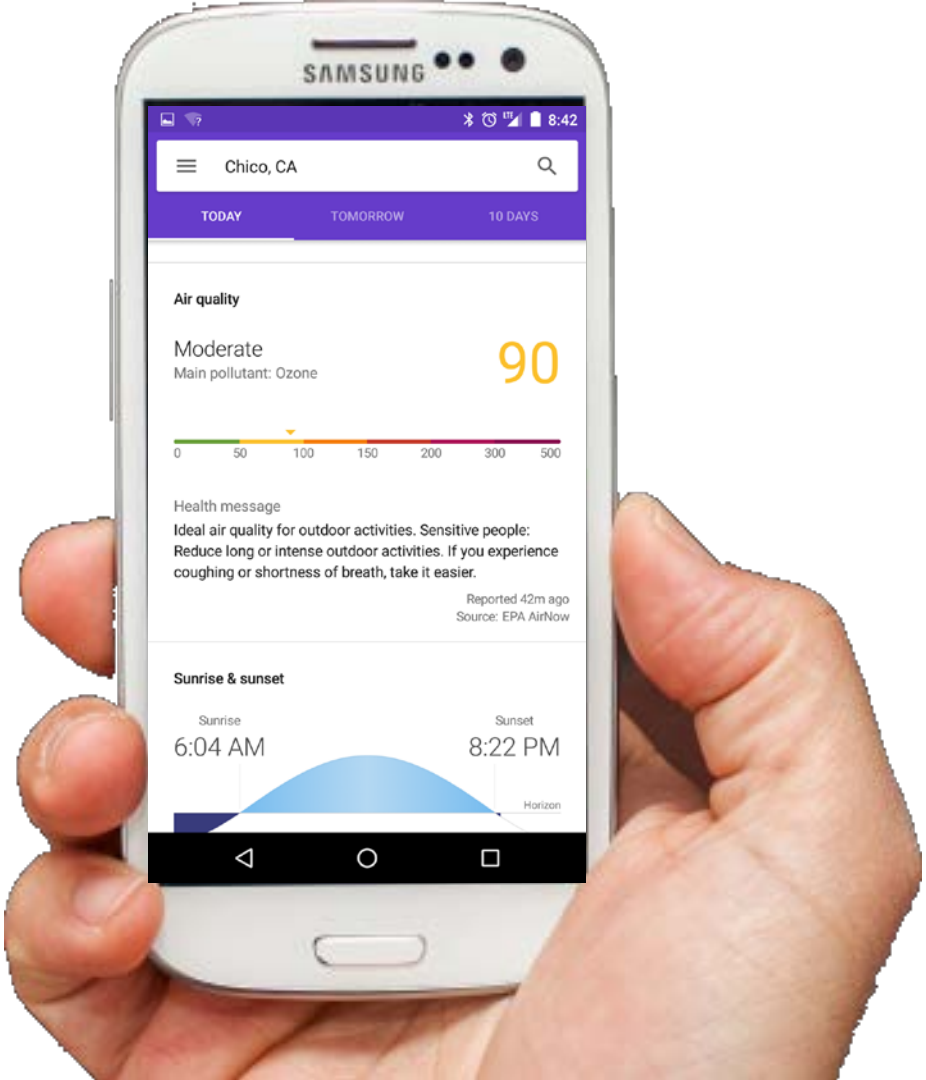
sensory science by aclima™

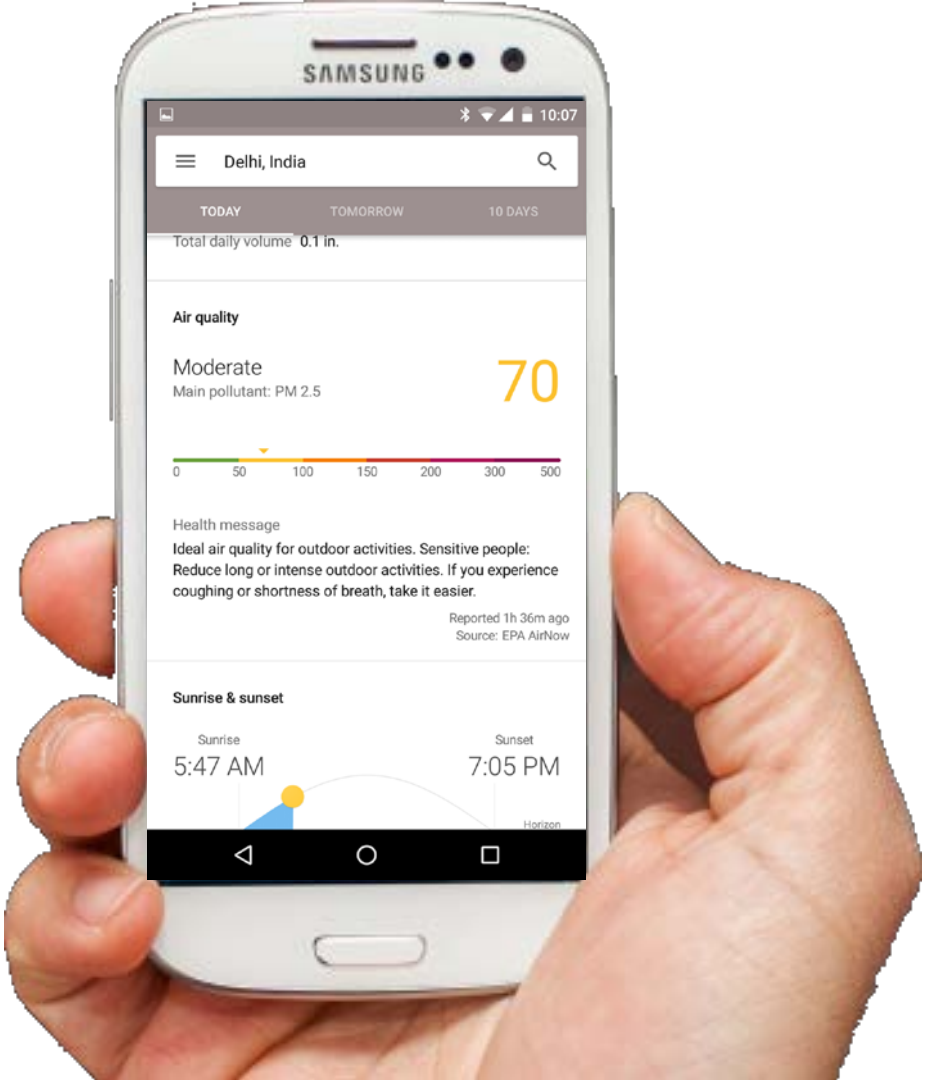
A tale of two commutes

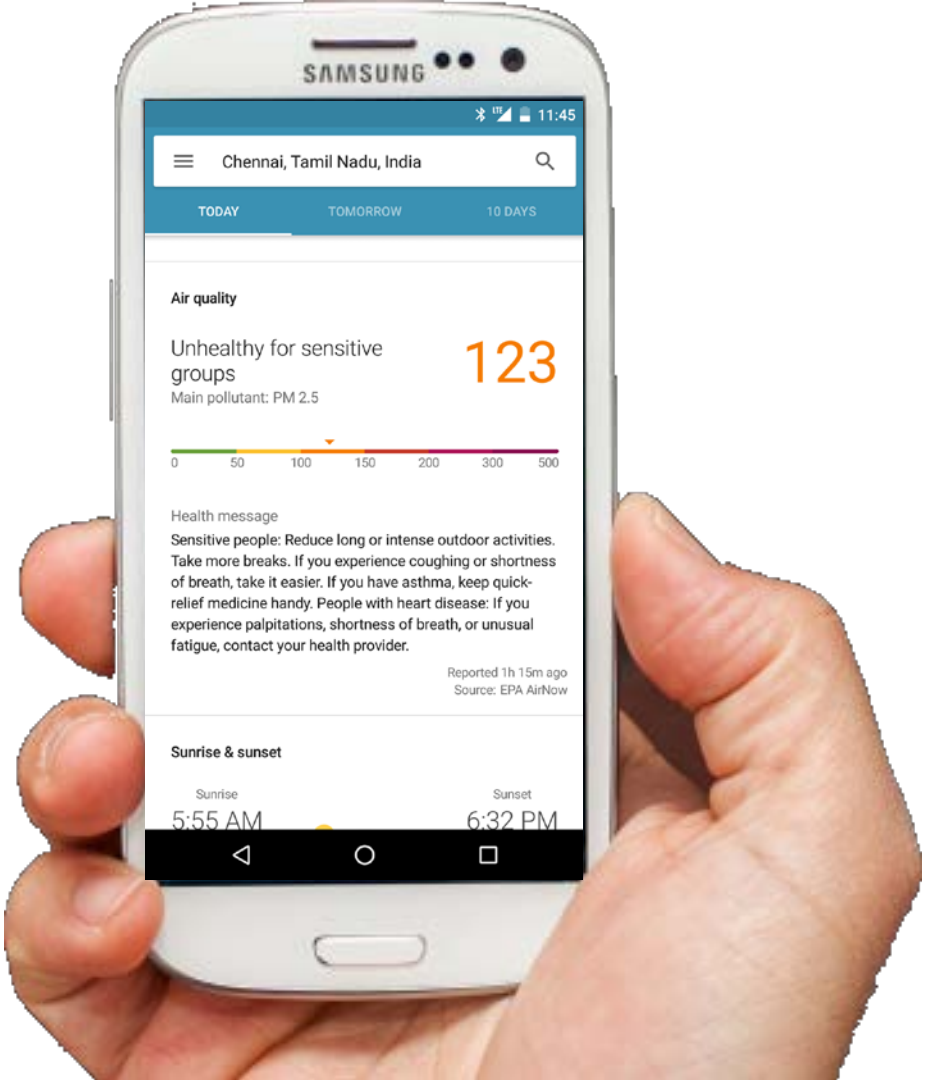
Nitrogen Dioxide / October 14, 2015




SAMSUNG


SAMSUNG
8:42
Chico, CA
TODAY
TOMORROW
10 DAYS
Air quality
Moderate
Main pollutant: Ozone
90
0
50
100
150
200
300
500
Health message
Ideal air quality for outdoor activities. Sensitive people: Reduce long or intense outdoor activities. If you experience coughing or shortness of breath, take it easier.
Reported 42m ago
Source: EPA AirNow
Sunrise & sunset
Sunrise
6:04 AM
Sunset
8:22 PM
Horizon


SAMSUNG
10:07
Delhi, India
TODAY
TOMORROW
10 DAYS
Total daily volume 0.1 in.
Air quality
Moderate
Main pollutant: PM 2.5
70
0
50
100
150
200
300
500
Health message
Ideal air quality for outdoor activities. Sensitive people: Reduce long or intense outdoor activities. If you experience coughing or shortness of breath, take it easier.
Reported 1h 36m ago
Source: EPA AirNow
Sunrise & sunset
Sunrise
5:47 AM
Sunset
7:05 PM
Horizon


SAMSUNG
11:45
Chennai, Tamil Nadu, India
TODAY
TOMORROW
10 DAYS
Air quality
Unhealthy for sensitive groups
Main pollutant: PM 2.5
123
0
50
100
150
200
300
500
Health message
Sensitive people: Reduce long or intense outdoor activities. Take more breaks. If you experience coughing or shortness of breath, take it easier. If you have asthma, keep quick-relief medicine handy. People with heart disease: If you experience palpitations, shortness of breath, or unusual fatigue, contact your health provider.
Reported 1h 15m ago
Source: EPA AirNow
Sunrise & sunset
Sunrise
5:55 AM
Sunset
6:32 PM

In conclusion...

- Google tries to help tackle big issues where we can make a unique contribution, such as:
  - Using our existing Street View fleet as environmental sensing platforms.
  - Analyzing big data, e.g. sensors.
  - Surfacing results and interpretation to millions of people via smart phones.
- Please reach out to me with questions & ideas!


Thank you
karintuxen@google.com