Assessing the Impacts of Fires on Watershed Health

Part 1: Satellite Observations and Tools for Fire Risk

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July 6, 2023

About ARSET

About ARSET

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- Trainings include a variety of applications of satellite data and are tailored to audiences with a variety of experience levels.

AGRICULTURE

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DISASTERS

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About ARSET Trainings

- Online or in-person
- Live and instructor-led or asynchronous and self-paced
- Cost-free
- Bilingual and multilingual options
- Only use open-source software and data
- Accommodate differing levels of expertise

- Visit the ARSET website to learn more.

Assessing the Impacts of Fires on Watershed Health
Overview

Training Learning Objectives

By the end of this training, participants will be able to:

- Analyze the key fire science criteria to select the appropriate data from satellites/instruments for a given watershed
- Distinguish, compare, and contrast the biophysical conditions pre- and post-fire
- Acquire land use & land cover maps for the region of interest
- Select river basin and sub-basin boundaries for their region of interest
- Recognize how to apply the Soil and Water Assessment Tool (SWAT), a river basin-scale model, to simulate the quality and quantity of surface water and groundwater

Prerequisites

- Fundamentals of Remote Sensing
- Satellite Observations and Tools for Fire Risk, Detection, and Analysis
- Using Google Earth Engine for Land Monitoring Applications
- Texas A&M Instructional Videos for SWAT

Training Outline

Part 1

Satellite Observations and Tools for Fire Risk

July 6, 2023

Part 2

Earth Observations and The Soil & Water Assessment Tool (SWAT) for Assessing Post-Fire Water Quality in Watersheds

July 11, 2023

Part 3

Using Google Earth Engine to Monitor Post-Fire Impacts

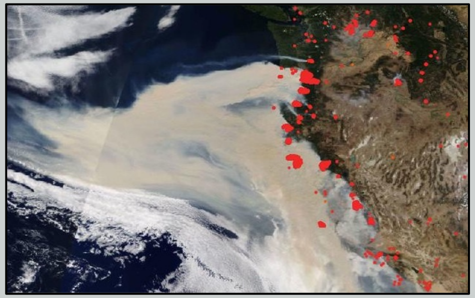
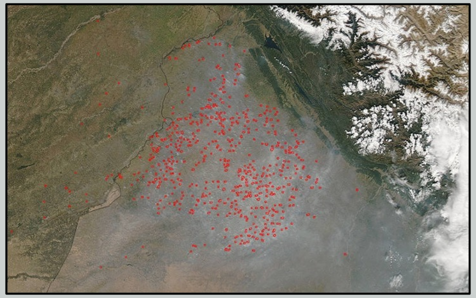
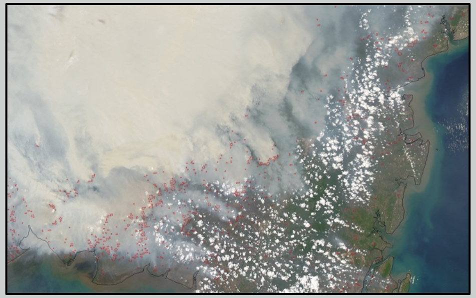
July 13, 2023

Homework

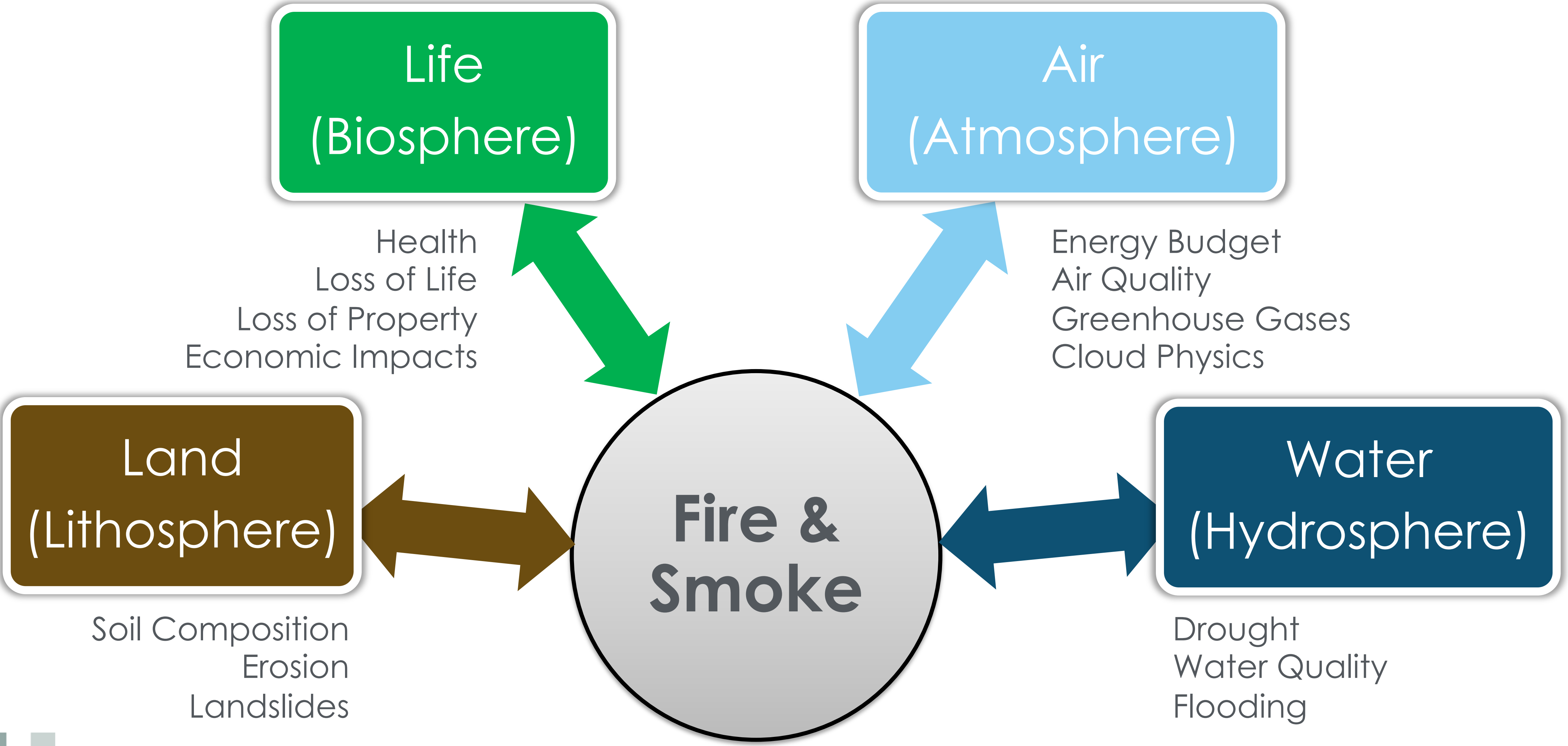
Opens July 13 – Due July 27 – Posted on Training Webpage

A **certificate of completion** will be awarded to those who attend all live sessions and complete the homework assignment(s) before the given due date.

Types of Fire

	Wildfire or Wildland	Deforestation	Agricultural	Peat
				
What does it burn?	Forests, Shrub, Grass	Forests	Crops, Grasses, Shrubs	Peat (soil-like material)
When does it burn?	Dry Seasons, Variable from Year to Year	Seasonal	Seasonal	Seasonal, Variable from Year to Year
Why did it burn?	Natural (lightning), or Humans (prescribed burns, accidental, arson)	Humans (forest clearing for livestock and crops)	Humans (burn prior to or after a growing season to clear fields for crops)	Natural (permafrost thaw), Humans (clear land for crops and animal grazing)
How did it burn?	Higher Intensity (can burn millions of acres if not controlled)	High Intensity	Lower Intensity	Very Low Intensity (burns underground, difficult to put out)

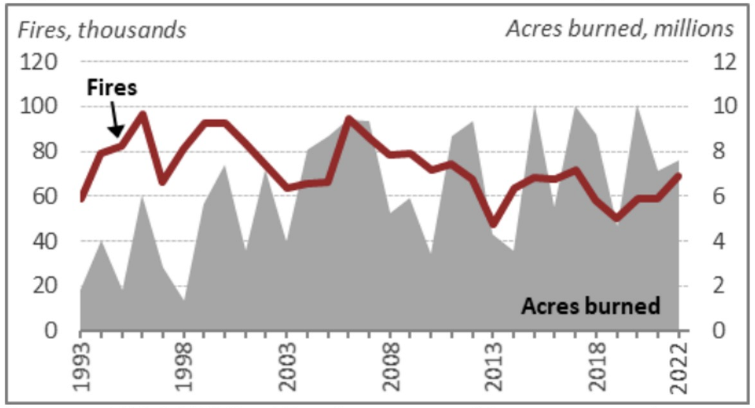
Fire in the Earth System



Wildfires

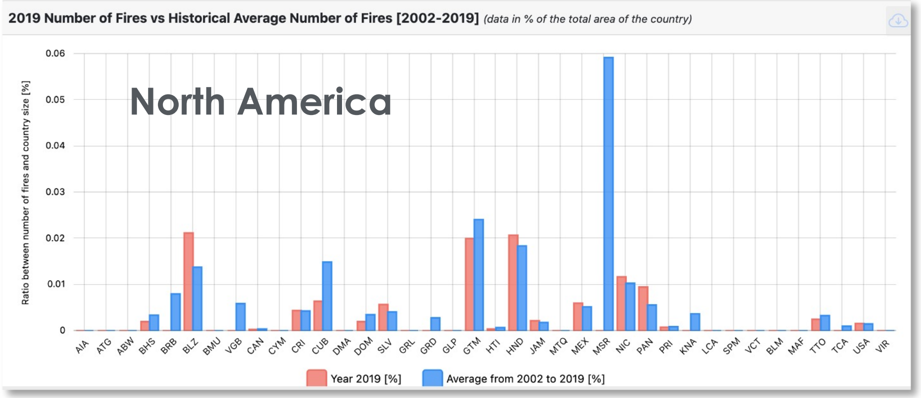
- Highly impact human lives, infrastructure, ecosystems, and wildlife.
- The 10-year average cost of fire suppression in the US is estimated to be **$2,358,603,800** (National Interagency Fire Center).
- While many wildfires are caused by humans, climate change is expected to increase wildfire activities due to warmer and drier conditions (Climate Change Indicators)
- Frequency, intensity, and extent of fires vary inter-annually depending on a complex connection between weather and climate conditions and ecosystem processes.

Figure 1. Annual Wildfires and Acres Burned, 1993-2022



Source: NICC Wildland Fire Summary and Statistics annual reports.
Note: Data reflect wildland fires and acres burned nationwide, including wildland fires on federal and nonfederal lands.

IN FOCUS

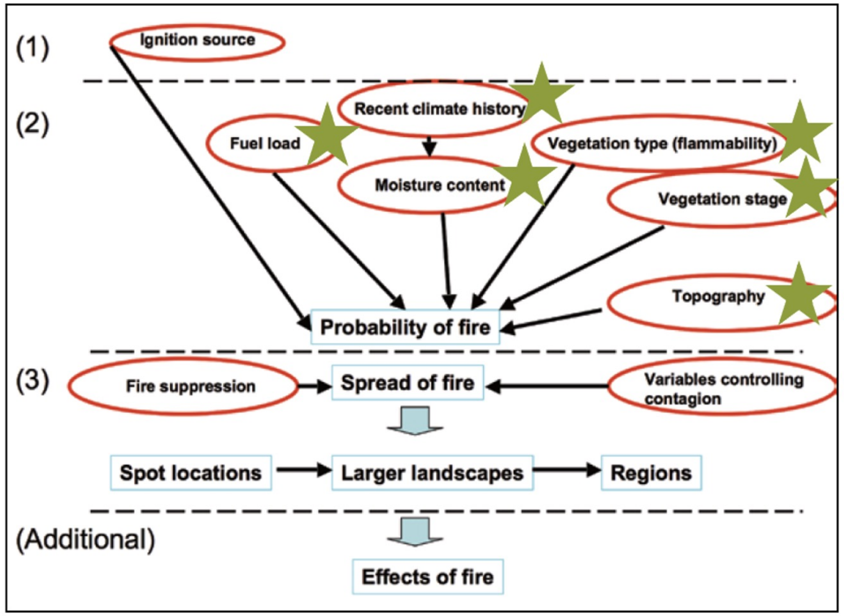


Global Wildfire Information System (GWIS)

Fire Risk Mapping

- The probability that a fire might start in a certain area.
- Risk is determined by compiling relevant factors that influence fire ignition and behavior.

Where remotely sensed data can be used independently or with ground-based observations



Calculation of fire risk: There are three aspects to predicting fire: (1) the probability of ignition; (2) the biophysical influences on fire, such as fuel load, moisture content, flammability of the vegetation, and topography; and (3) the spread of fire once it gets established.

Image Credit: Weinstein and Woodbury, USFS

Comprehensive fire risk maps are challenging to produce due to the many factors that impact the probability of fire.

In this training we focus on fire risk assessment by monitoring fire fuel, temperature, precipitation, and soil moisture in a watershed.

Assessing the Impacts of Fires on Watershed Health

Part 1: Satellite Observations and Tools for Fire Risk

Trainers

Amita Mehta

Instructor, Water & Disasters

Sean McCartney

Instructor, Water & Disasters

Part 1 Objectives

By the end of Part 1, participants will be able to:

- Provide examples of fire science criteria for drought conditions pre-fire to select the appropriate data from satellites/instruments for a watershed of interest
- Demonstrate how to delineate river basins and subbasins for a watershed of interest
- Calculate anomalies in biophysical and meteorological conditions for a watershed of interest

Part 1 Outline

- Overview of Earth observations for fire risk assessment
- Overview of tools for monitoring fire risk
- Remote sensing-based fire risk indicators
- Case studies: Recent Fires in US and Canada
- **Demonstration**

  Pre-fire Risk Assessment: Woolsey Fire and Quebec Fires Case Studies using GEE
  - Delineate a watershed
  - Derive Standardized Precipitation Index (SPI) to assess dry conditions
  - Monitor anomalies[1] of soil moisture and Normalized Difference Vegetation Index (NDVI) within a watershed

[1]Departure from long-term mean values

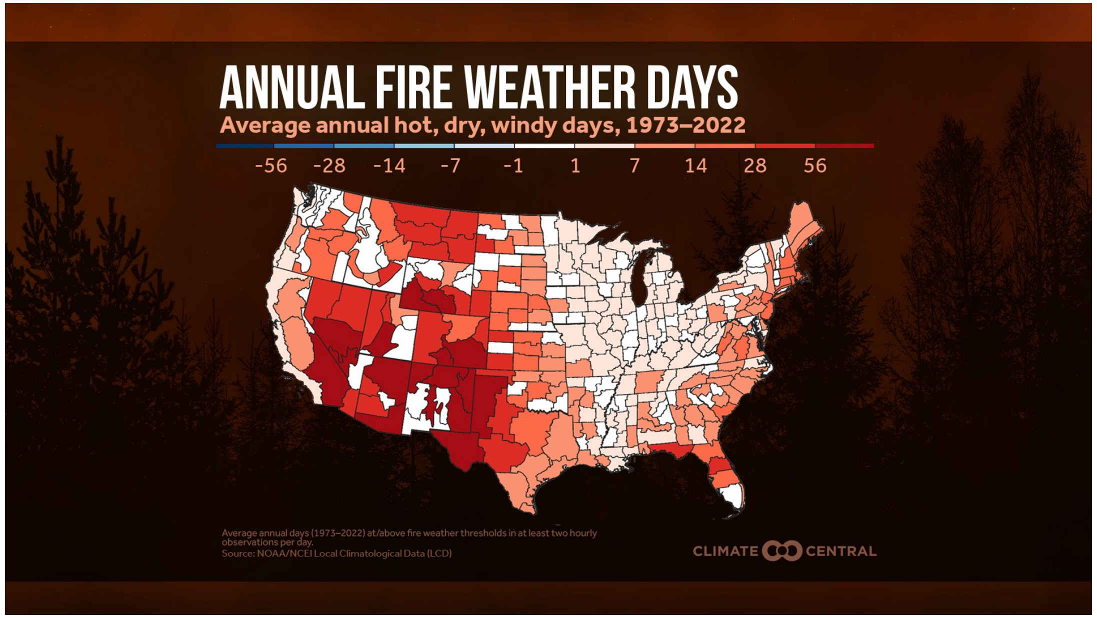
How to Ask Questions

- Please put your questions in the Questions box and we will address them at the end of the webinar.
- Feel free to enter your questions as we go. We will try to get to all of the questions during the Q&A session after the webinar.
- The remainder of the questions will be answered in the Q&A document, which will be posted to the training website about a week after the training.

Earth Observation Satellites & Sensors for Fire Risk Assessment

Quick Review – Fire Facts

- Most fires occur in dry and warm conditions.
- Both weather and climate conditions impact fire risk.
- Vegetation cover, type (trees, shrubs, grasses, dead leaves), density, and height provide fuel for fires.



Climate Central

Watershed Data Relevant for Fire Risk Assessment

- Precipitation
- Surface Temperatures
- Soil Moisture
- Vegetation Fuel
- Topography
- Humidity
- Winds

NASA remote sensing and Earth system models provide these data for pre-fire, during-fire, and post-fire watershed conditions.

For details, see Satellite Observations and Tools for Fire Risk, Detection, and Analysis (Part-2)

Satellites and Sensors for Fire Risk Assessment

Parameter	Satellite	Sensors	Spatial/Temporal Resolutions and Coverage
Precipitation	Combined TRMM & GPM With Multiple Satellite Constellation → **IMERG**	Microwave Radiometer (TMI, GMI) and RADAR (PR, DPR) Microwave Imagers and Sounders Calibrated with GPM Sensor Data	0.1° x 0.1° 30-Minute, Daily, Monthly 6/2000 to Present
Soil Moisture	SMAP	L-Band Microwave Radiometer	9 km x 9 km & 36 km x 36 km Daily 3/2015 to Present
Topography	SRTM	C-Band Radar	30m Static Data: 2001

TRMM: Tropical Rainfall Measurement Mission
SMAP: Soil Moisture Active Passive
IMERG: Integrated Multi-satellitE Retrievals for GPM

GPM: Global Precipitation Measurement
SRTM: Shuttle Radar Topography Mission

Satellites and Sensors for Fire Risk Assessment

Parameter	Satellite	Sensors	Spatial/Temporal Resolutions and Coverage
Landcover Land Surface Temperatures	Landsat Terra, Aqua	TM, ETM+, TIRS MODIS	30m, 16-Day, 1972-Present 1 km, Daily, 8-Day, Monthly, 2000-Present
Landcover & Normalized Difference Vegetation Index (NDVI)	Terra, Aqua Sentinel-2 SNPP, JPSS	MODIS MSI VIIRS	250m, 500m,1 km Daily, 8-Day, Monthly 2000-Present 10m, 20m, 60m 2-5 Day June 2015-Present 375m, 750m Daily 2012-Present

SNPP: Suomi National Polar-orbiting Partnership
JPSS: Joint Polar Satellite System
OLI: Operational Land Imager
MSI: Multi Spectral Imager

MODIS: MODerate-Resolution Imaging Spectroradiometer
VIIRS: Visible Infrared Imaging Radiometer Suite
ETM: Enhance Thematic Mapper

Satellite Observation-Based Models for Fire Risk Assessment

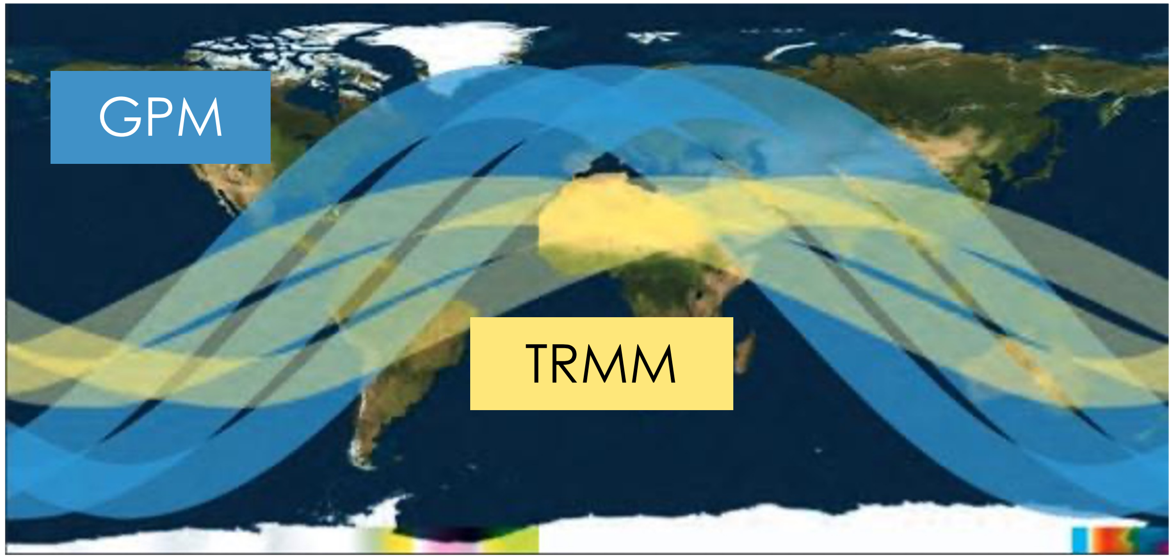
Parameter	Model	Spatial/Temporal Resolutions and Coverage
Fire Weather and Climate Data [Precipitation, Surface Temperature, Relative Humidity, Winds]	MERRA-2	0.5° x 0.667°, Hourly, Monthly 1980 to Present
Soil Moisture Evapotranspiration	NLDAS GLDAS v2.1	0.125° x 0.125°, Hourly, Monthly 1979 to Present 0.25° x 0.25°, 1° x 1°, 3-Hourly, Monthly 2000 to Present

MERRA-2: Modern-Era Retrospective analysis for Research and Applications, Version 2
https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/index.php
NLDAS: North American Land Data Assimilation System https://ldas.gsfc.nasa.gov/nldas
GLDAS: Global Land Data Assimilation System https://ldas.gsfc.nasa.gov/gldas

Global Precipitation Measurement (GPM) Mission

http://pmm.nasa.gov/GPM/

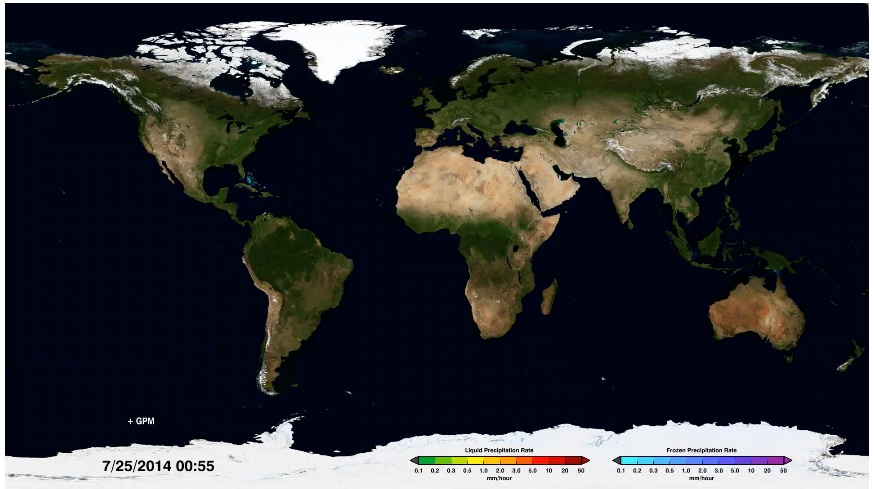
- Core satellite launched Feb 27, 2014
  - Non-polar, low-inclination orbit
    - Altitude: 407 km
- Spatial Coverage:
  - 16 orbits a day, covering global area between 65°S and 65°N
- Along with a constellation of satellites, GPM has a revisit time of 2-4 hrs over land
- Sensors:
  - GMI (GPM Microwave Imager)
  - DPR (Dual Precipitation Radar)



Global Precipitation Measurement (GPM) Mission & Tropical Rainfall Measurement Mission (TRMM)

IMERG Version 06 Data

- IMERG is a single integrated code system for near-real and post-real time.
- Multiple runs for different user requirements for latency and accuracy
  - "Early" – 4 hr (flash flooding)
  - "Late" – 14 hr (crop forecasting)
  - "Final" – 3 months (research)
- Morphing of precipitation based on numerical models poleward of 60° N/S latitude
- Overall calibration is provided by TRMM and GPM Combined Radar-Radiometer Algorithm. TRMM June 2000-May 2014, GPM thereafter.
- IMERG is adjusted to GPCP monthly climatology zonally to achieve a bias profile that is considered reasonable.



A constellation of satellites is used along with GPM observations to get half-hourly precipitation data at 0.1°x0.1° resolution.

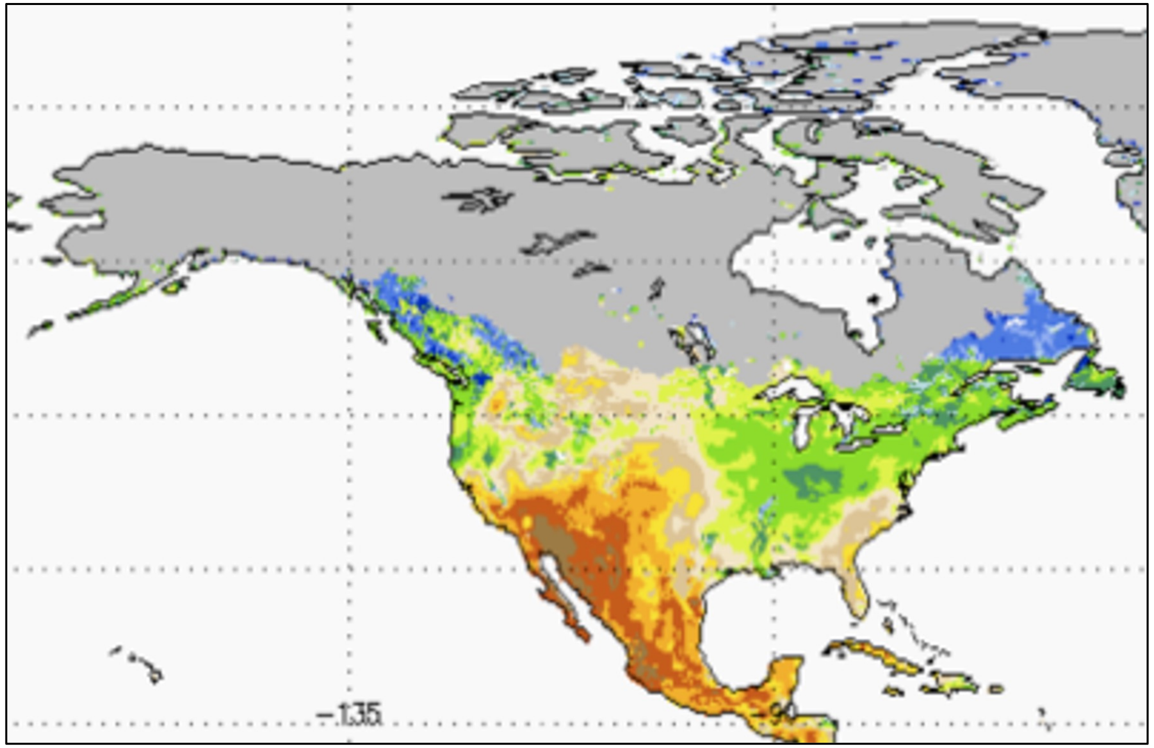
Based On: Huffman (https://www.youtube.com/watch?v=OyPUp7SuEy4&feature=youtu.be)

Soil Moisture Active Passive (SMAP)

http://smap.jpl.nasa.gov

- Polar Orbit
  - Altitude: 685 km
- Spatial Coverage:
  - Global
- Launched Jan 31, 2015
- Temporal Coverage:
  - Daily, March 2015 – Present
- Sensors:
  - Microwave Radiometer 1.41. GHz
  - Microwave Radar (not available)

Measures moisture in the top 5 cm of the soil



Landsat and Sentinel-2

- **Landsat**
  - First Landsat launched in 1972
  - Landsat 9 launched in 2021
  - Multispectral, 30-meter pixels, 15-meter panchromatic band, 16-day revisit
- **Sentinel-2**
  - Launched in June 2015
  - Multispectral, 10, 20, and 60-meter pixel bands, 2–5-day revisit

- **Vegetation-Based Fire Applications:**
  - Vegetation Extent and Type: Land cover classification
  - Vegetation Stage and Health: Variety of vegetation indices, including NDVI, EVI, SAVI
  - Vegetation Moisture: NDWI

Image Credits: USGS, ESA

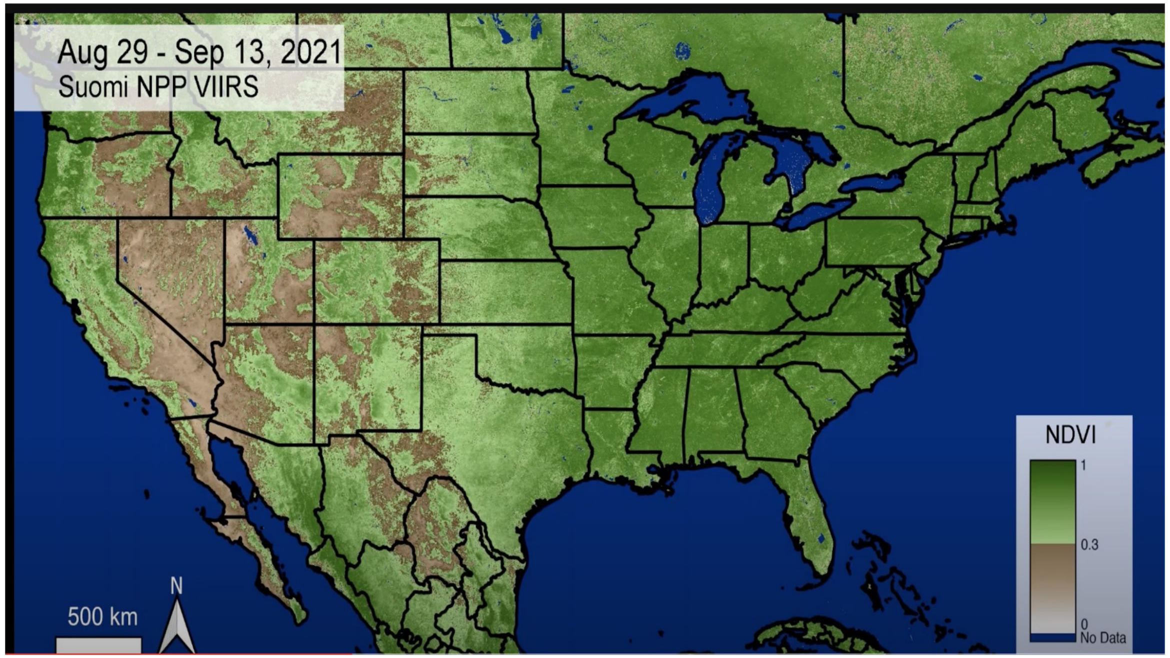
MODIS

- **Vegetation-Based Fire Applications:**
  - Vegetation Extent and Type: Land cover classification
  - Vegetation Stage and Health: NDVI, EVI, High Temporal Resolution Phenology
- Spatial Resolution:
  - 250m, 500m, 1 km
- Temporal Resolution:
  - Daily, 8-Day, 16-Day, Monthly, Quarterly, Yearly
  - 2000 – Present
- Spectral Coverage:
  - 36 Bands

Time lapse of MODIS NDVI in Africa.
Image Credit: Google Earth Engine Developers

Visible Infrared Imaging Radiometer Suite (VIIRS)

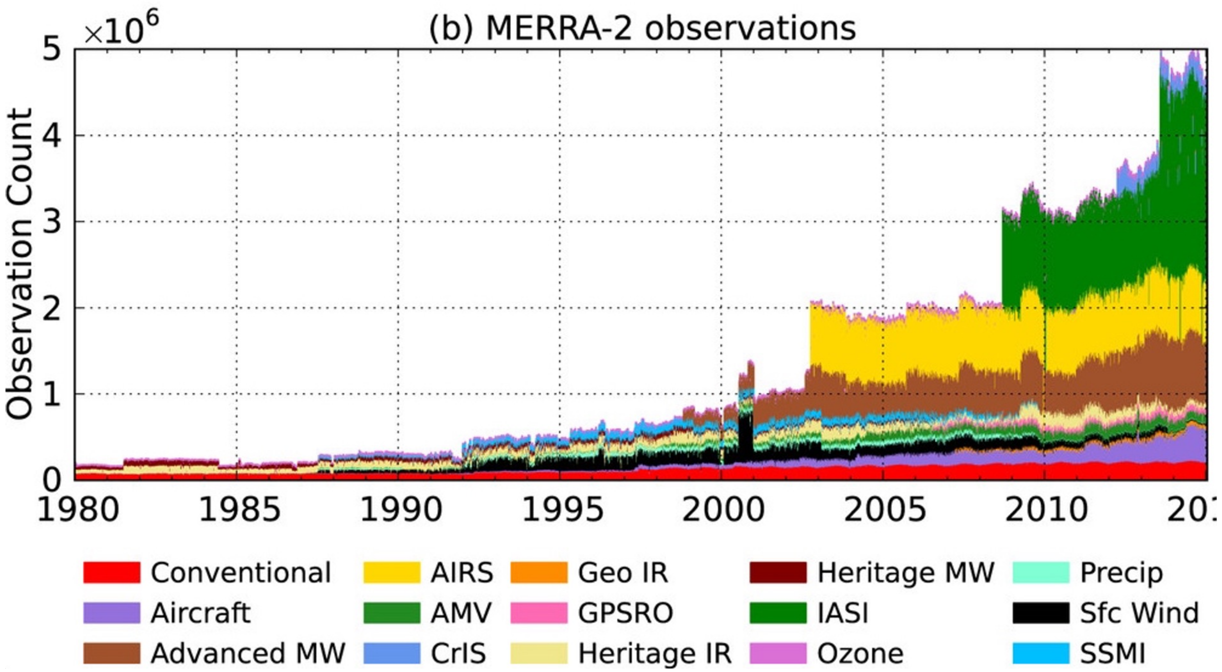
- **Vegetation-Based Fire Applications:**
  - Vegetation Stage: VIIRS Vegetation Index include NDVI and EVI
  - Vegetation Health: VIIRS Vegetation Health product includes Vegetation Condition Index, Temperature Condition Index, and Vegetation Health Index
- Launched in 2012; collects visible and infrared imagery
- Daily temporal resolution and global coverage
- Spatial Resolution:
  - 5 high resolution bands: 375m
  - 16 moderate resolution bands: 750m



MERRA-2

https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/

- Blends the vast quantities of observational data with output data from the Goddard Earth Observing System (GEOS-5) model (1980 – Present)
- Provides state-of-the-art global analyses on weather to climate time scales
- Focuses on improvement in the hydrological cycle



MERRA-2 Overview: The Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2), Ronald Gelaro, et al., 2017, J. Clim., doi: 10.1175/JCLI-D-16-0758.1

Global Land Data Assimilation System (GLDAS)

http://ldas.gsfc.nasa.gov/gldas/

A water and energy balance model with assimilation of remote sensing data.

Inputs:

- Rainfall: TRMM and Multi-Satellite-Based Data
- Meteorological Data: Global Reanalysis and Observations-Based Data from Princeton University
- Vegetation Mask, Land/Water Mask, Leaf Area Index (LAI): MODIS (GLDAS-2)
- Clouds and Snow (for surface radiation): NOAA and DMSP Satellites

Integrated Outputs Include:

- Soil Moisture
- Evapotranspiration
- Surface/Sub-Surface Runoff
- Snow Water Equivalent

Reference: Rodell, M., P. R. Houser, U. Jambor, J. Gottschalck, K. Mitchell, C.-J. Meng, K. Arsenault, B. Cosgrove, J. Radakovich, M. Bosilovich, J. K. Entin, J. P. Walker, D. Lohmann, and D. Toll, 2004. The Global Land Data Assimilation System. Bulletin of the American Meteorological Society, 85(3):381–394.

North American Land Data Assimilation System-2 (NLDAS-2)

http://ldas.gsfc.nasa.gov/nldas/

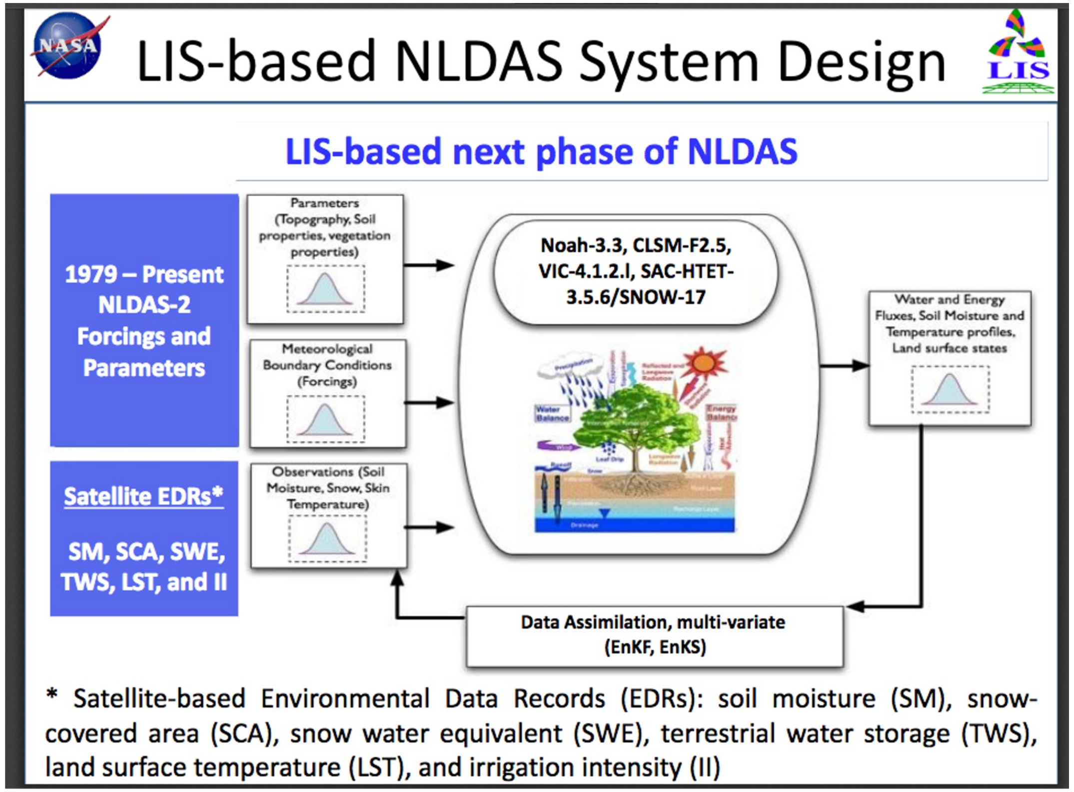
Four Land Surface Model Versions: Noah, CLM2, Mosaic, and VIC

Inputs:

- Precipitation: NOAA-CPC Rain Gauges
- Meteorological Data, Surface Radiation Data: North American Regional Analysis

Integrated Outputs Include:

- Soil Moisture
- Evapotranspiration
- Surface/Sub-Surface Runoff
- Snow Water Equivalent

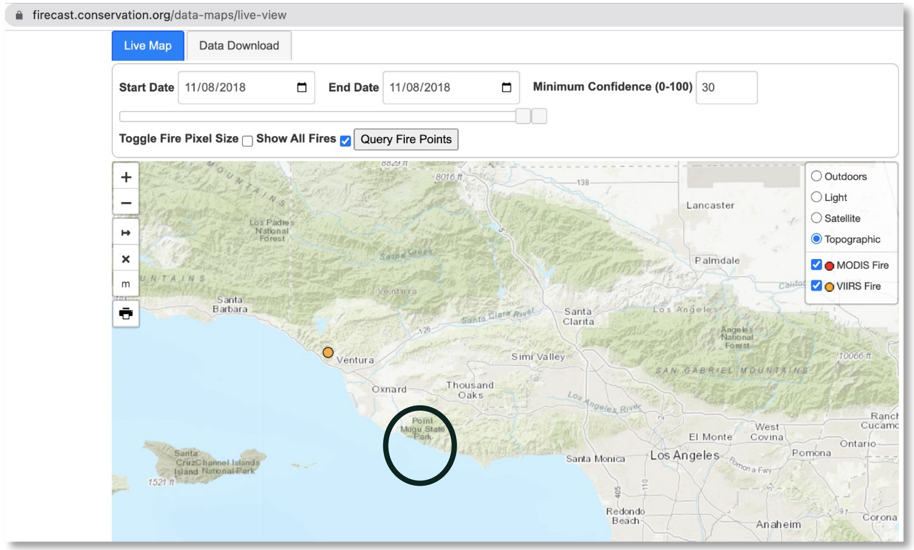


Courtesy: David Mocko (NASA-GSFC), http://ldas.gsfc.nasa.gov/nldas/presentations/NLDAS-LIS-status-future_2015-03-11.pdf

Remote Sensing-Based Tools for Monitoring Fire Risk

Fire Risk Monitoring Tools (Regional)

- LANDFIRE: Existing Vegetation cover and height, topography, fuel, and fire regime (US)
- North American Wildland Fuels Database (NAWFD): Per-hectare fuel load from field data (US)
- The Forest Inventory and Analysis (FIA): US Forest Service portal for field-based and remote sensing-based information about tree species, size, health, and mortality (US)
- Firecast: Remote sensing-based Near Real Time fires and forest disturbance alerts (limited to US, specific countries in South America, Indonesia, Madagascar)



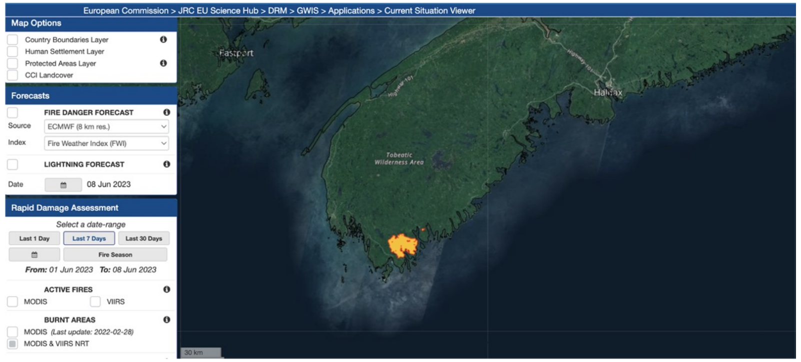
Woolsey Fire Location from FIRECAST

For details, see Satellite Observations and Tools for Fire Risk, Detection, and Analysis (Part-2)

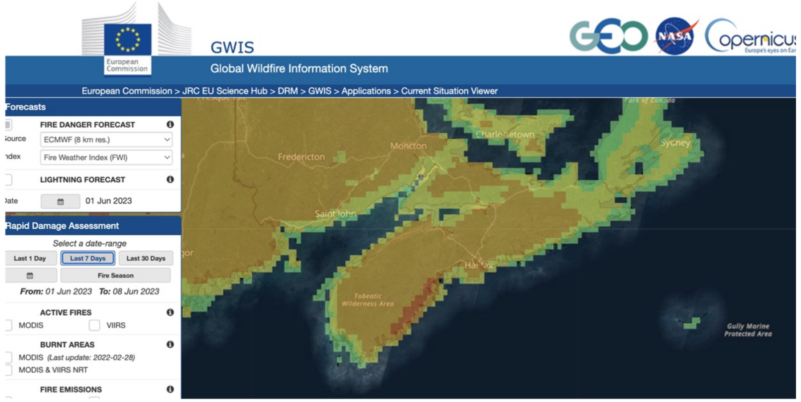
Fire Risk Monitoring Tools (Global)

- [Evaporative Stress Index Mapper](): Provides evapotranspiration anomalies as an indicator of dry conditions
- [Global Wildfire Information System](): Provides a comprehensive view and evaluation of fire regimes, and long-term fire weather forecast and fire effects at the global level

Recent Fire in Nova Scotia from GWIS



Fire Weather Index from GWIS



[For details, see Satellite Observations and Tools for Fire Risk, Detection, and Analysis]() (Part-2)

Data and Modeling Tools

Tools used in this training:

- Google Earth Engine (GEE)
- SWAT
- NASAaccess

Remote Sensing-Based Indicators for Monitoring Fire Risk

Fire Risk Indicators

- Standardized Precipitation Index (SPI)
- Normalized Difference Vegetation Index (NDVI)
- Enhanced Vegetation Index (EVI)
- Soil Adjusted Vegetation Index (SAVI)
- Normalized Difference Water Index (NDWI)
- Normalized Dry Matter Index (NDMI)
- Evaporative Stress Index (ESI)
- Anomalies of precipitation, soil moisture, and vegetation indices

For details, see Satellite Observations and Tools for Fire Risk, Detection, and Analysis (Part-2)

Additional Fire Risk Factors

- Vegetation height and density
- Elevation – Impacts rainfall, temperature, type of vegetation, wind exposure, potential for lightning strikes
- Terrain Aspect and Slope: Impacts amount of solar radiation, potential for fire spread

This perspective view, combining a Landsat image with SRTM topography, shows topography. Image Credit: NASA

For details, see Satellite Observations and Tools for Fire Risk, Detection, and Analysis (Part-2)

Case Study Demonstration: Fire Risk Indicators

We will focus on calculating the following indicators:

- Standardized Precipitation Index (SPI)
- Normalized Difference Vegetation Index (NDVI)
- Enhanced Vegetation Index (EVI)
- Soil Adjusted Vegetation Index (SAVI)
- Normalized Difference Water Index (NDWI)
- Normalized Dry Matter Index (NDMI)
- Evaporative Stress Index (ESI)
- Anomalies of land surface temperature, precipitation, soil moisture, and vegetation indices

For details, see Satellite Observations and Tools for Fire Risk, Detection, and Analysis (Part-2)

Standardized Precipitation Index (SPI)

http://www.cpc.ncep.noaa.gov/products/Drought/Monitoring/spi.shtml

- Primarily defined to characterize meteorological drought
- Mathematically, historical rainfall data at any location fitted with gamma distribution represent cumulative probability function
- If a rainfall event has a low probability on the cumulative probability function, it is indicative of a drought event.
- The SPI values can be interpreted as the number of standard deviations by which the observed rainfall anomaly deviates from the long-term mean.
- $SPI = (P - P^*) / \sigma_p$

where P = Precipitation

p^* = Mean Precipitation

σ_p = Standard Deviation of Precipitation

Reference: Guttman, N. B., 1999: Accepting the Standardized Precipitation Index: A calculation algorit\hm. J. Amer. Water Resour. Assoc.., 35(2), 311-322.

Normalized Difference Vegetation Index (NDVI)

- NDVI is widely used as a metric for vegetation health and phenology.
- A measure of vegetation greenness
- Values range from -1.0 to 1.0
  - Negative values to 0 mean no green leaves.
  - Values close to 1 indicate the highest possible density of green leaves.
- NDVI Formula:

$$\frac{\text{Near-Infrared} - \text{Red}}{\text{Near-Infrared} + \text{Red}}$$

NDVI in CA, showing dry vegetation where Woolsey fire occurred in November 2018

Case Studies

Recent Fires in US and Canada

Woolsey Fire 2018

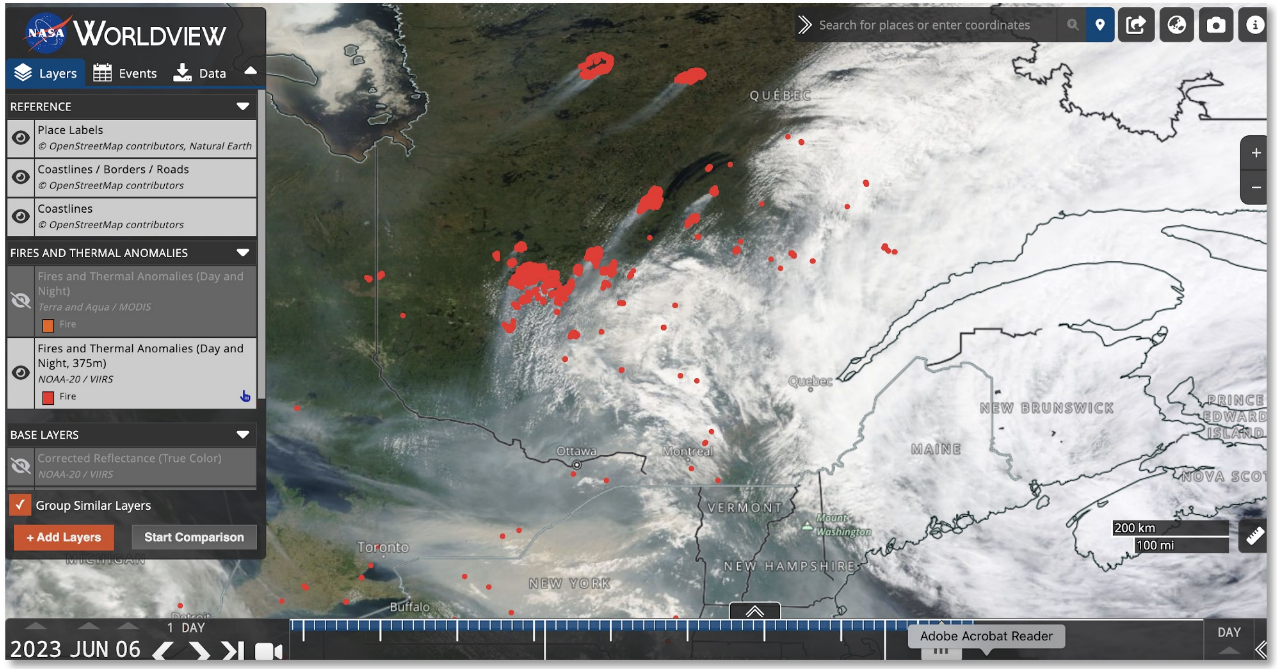
- The Woolsey Fire started on November 8, 2018, in the Woolsey Canyon near Los Angeles and Ventura Counties in southern California.
- The fire burned almost 100,000 acres of land.
- There was an estimated $6 billion in damage to infrastructure.
- The fire started when power lines arced, igniting dry grasses in Woolsey Canyon, and was spread rapidly by strong Santa Ana winds.

Image Credit: The New Yorker

Fires in Quebec 2023

- Overall, 3.3 million hectares (8.2 million acres) burned so far this year in Canada.
- The fires on 5th June were the worst in Quebec, with 160 fires and 10000 people displaced.
- A storm system off the coast of Nova Scotia forced the smoke from these fires south into the United States.

(People)

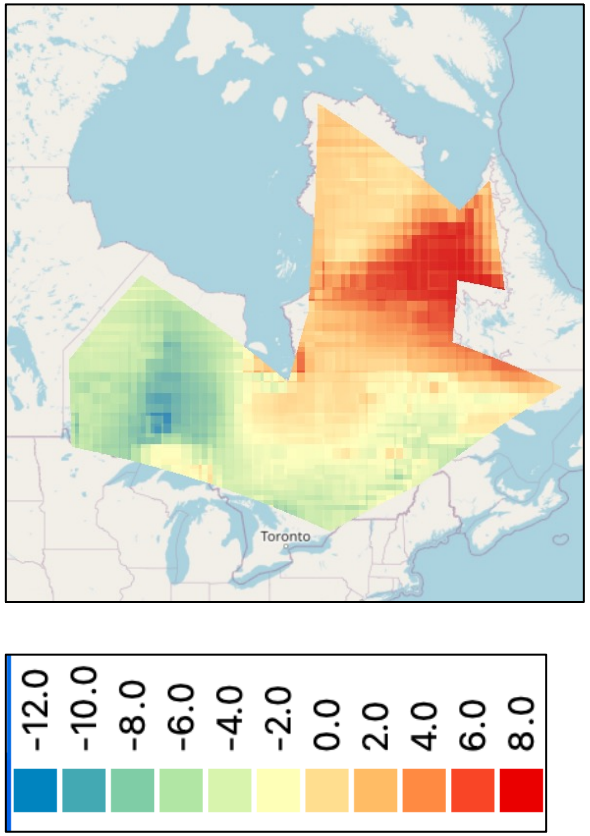


Fires Observed from MODIS and VIIRS on 6 June 2023
NASA Worldview

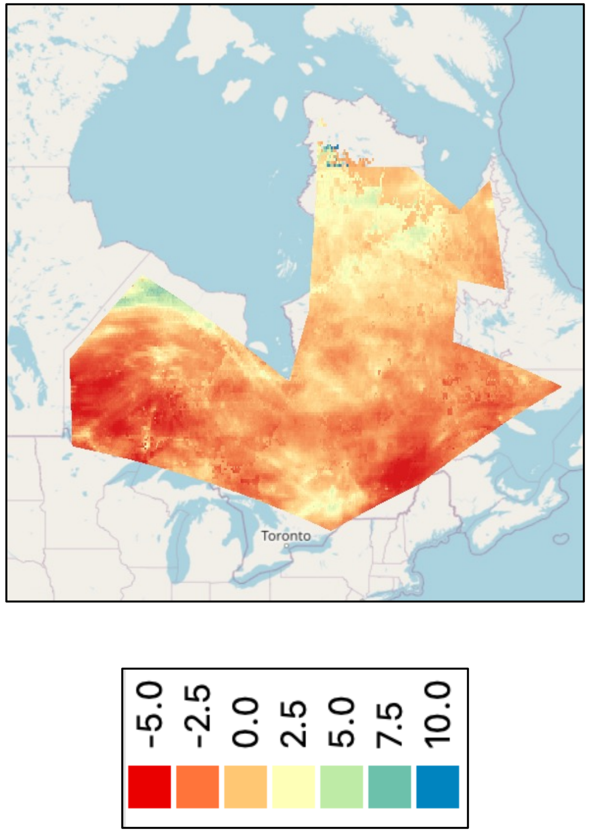
Fires in Quebec: Earth Observations

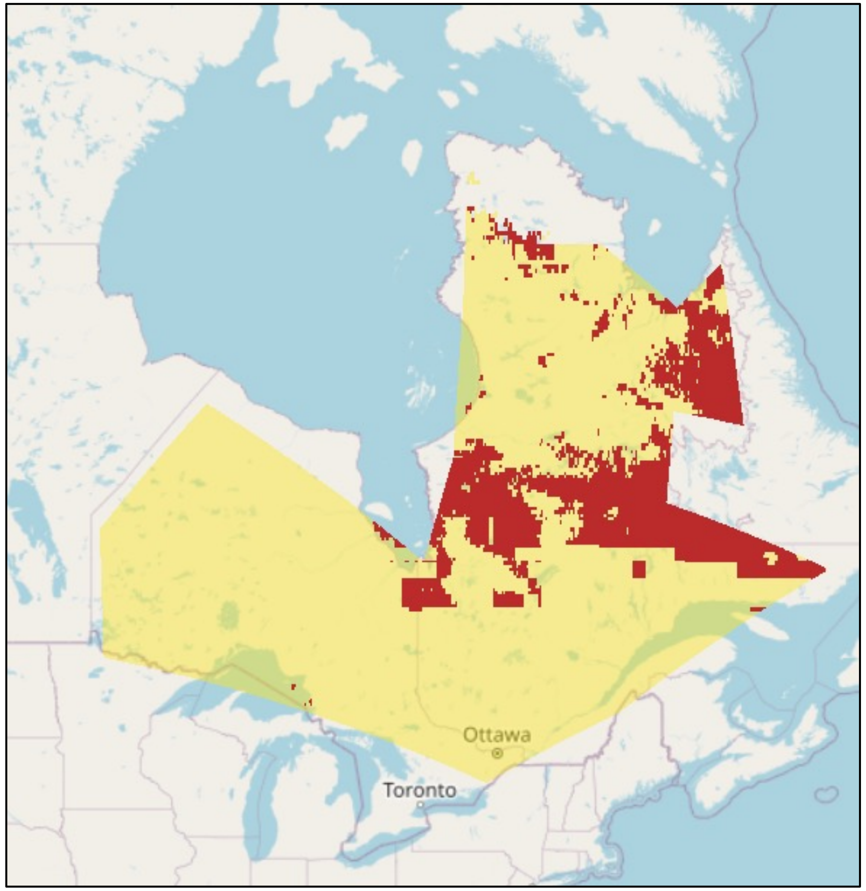
Dry and Warm Anomalies Indicating Fire Risk

MERRA-2: Surface Skin Temperature Anomalies for May 2023



IMERG: Precipitation Anomalies for May 2023





Note: Anomalies are calculated by subtracting 2001-2022 Mean quantities from May 2023.

Google Earth Engine (GEE) Overview

The Google Earth Engine Platform

- Google Earth Engine (GEE) takes advantage of cloud computing capabilities to provide users with a single place for **accessing satellite data, applying remote sensing methodologies, and displaying analysis results**.
- GEE's application programming interface (API) allows users to easily apply land cover monitoring algorithms and classifications with coded commands.

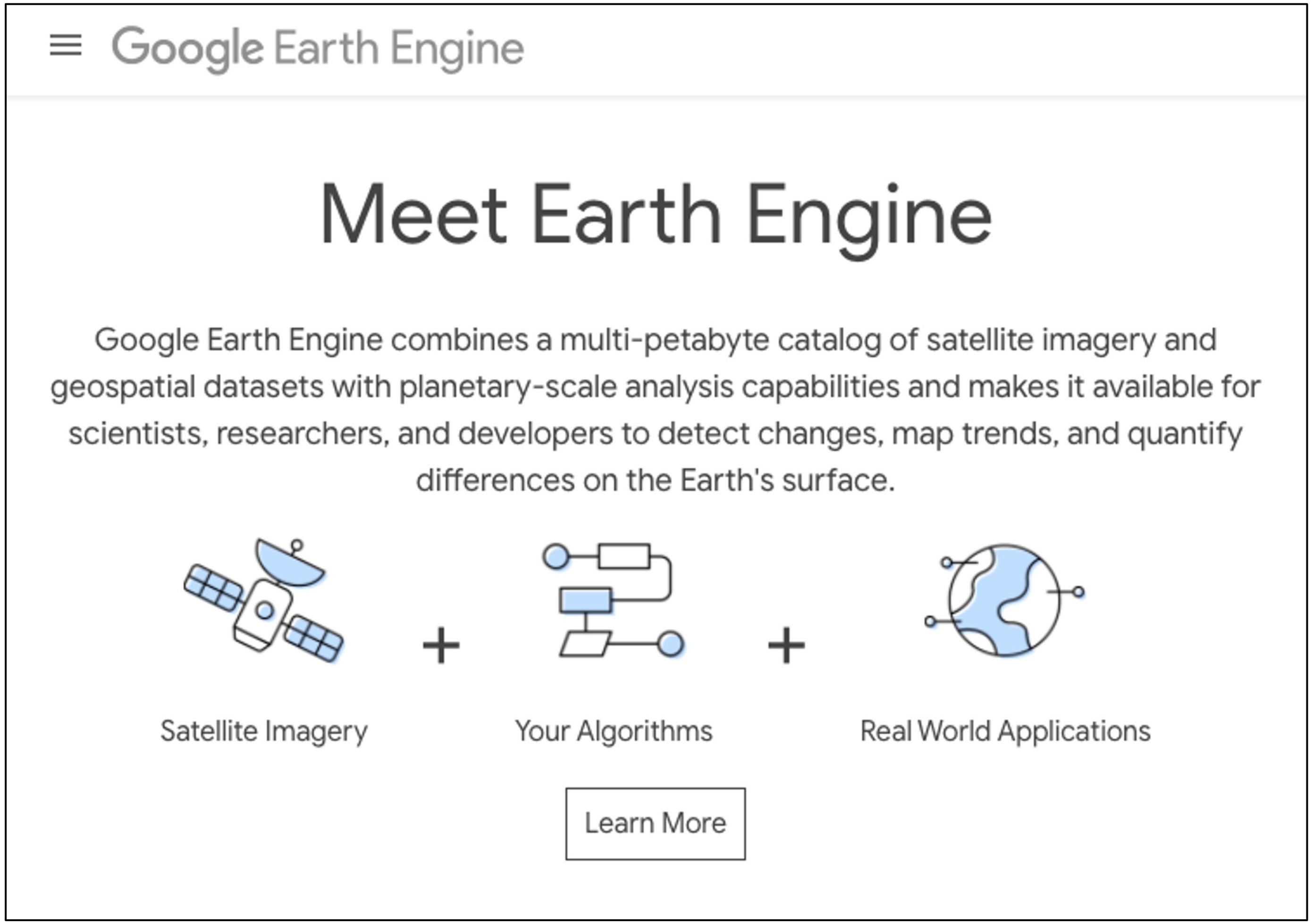
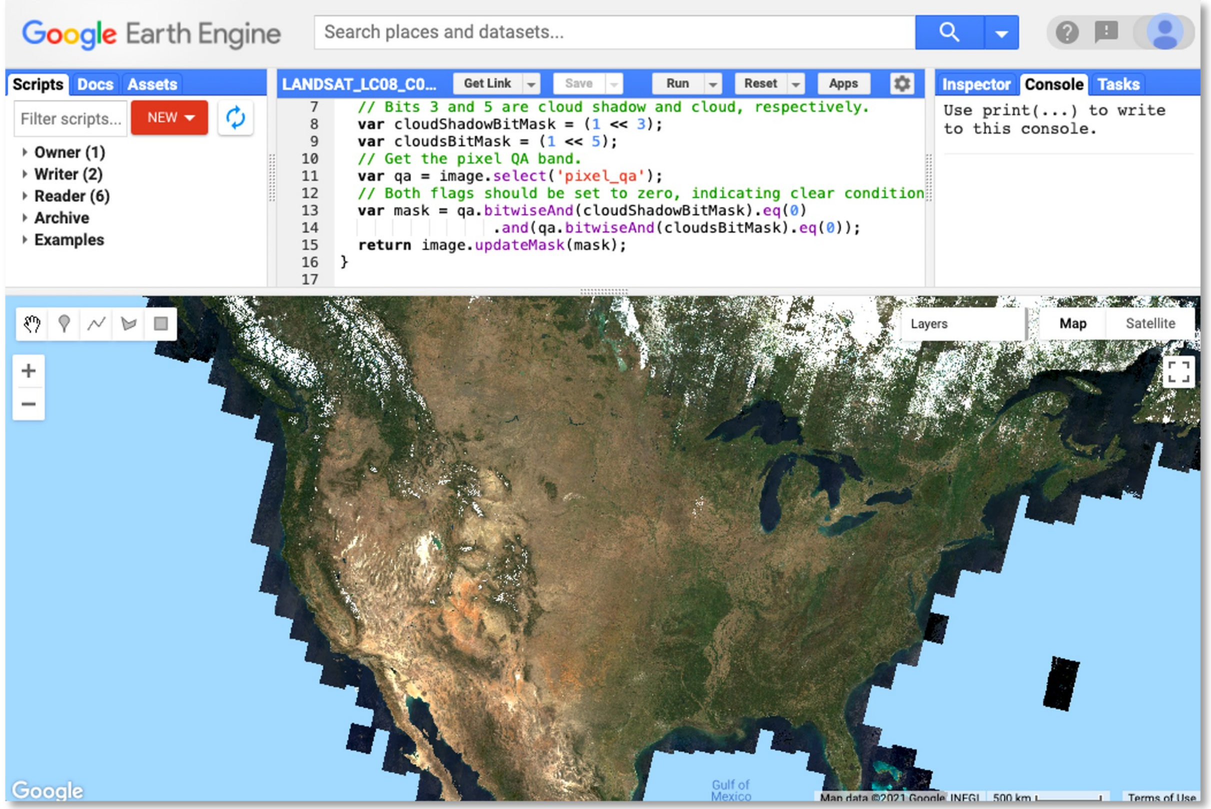


Image Credit: Google Earth Engine

Cloud-Based Raster Computing for Remote Sensing Analysis

- Cloud-based raster computing removes barriers and limitations related to…
  - Data hosting and storage
  - Imagery access and availability
  - Personal computing capabilities
- GEE is also free for scientists, researchers, and developers.

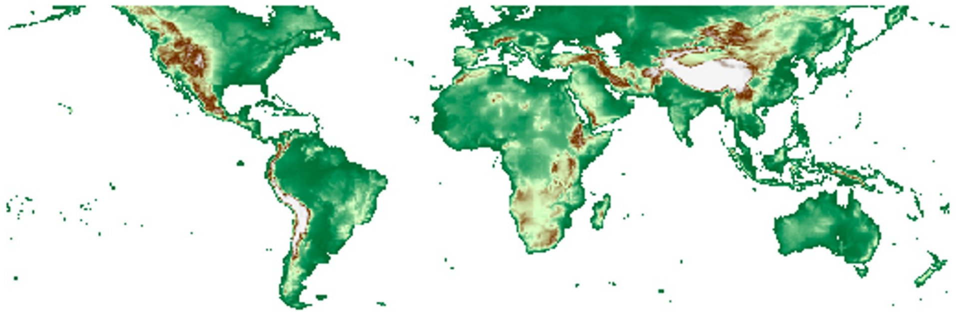


Google Earth Engine code editor interface using the JavaScript API, displaying Landsat 8 surface reflectance true color imagery for the U.S. Credit: [Google Earth Engine Developers](#)

Application Programming Interface (API)

- The Earth Engine JavaScript API is currently the most widely used method of working with GEE.
- A Python API through Google Colaboratory (Colab) is also available for those interested in using Python.
  - This is a bit more complicated than working directly in the GEE code editor with JavaScript.

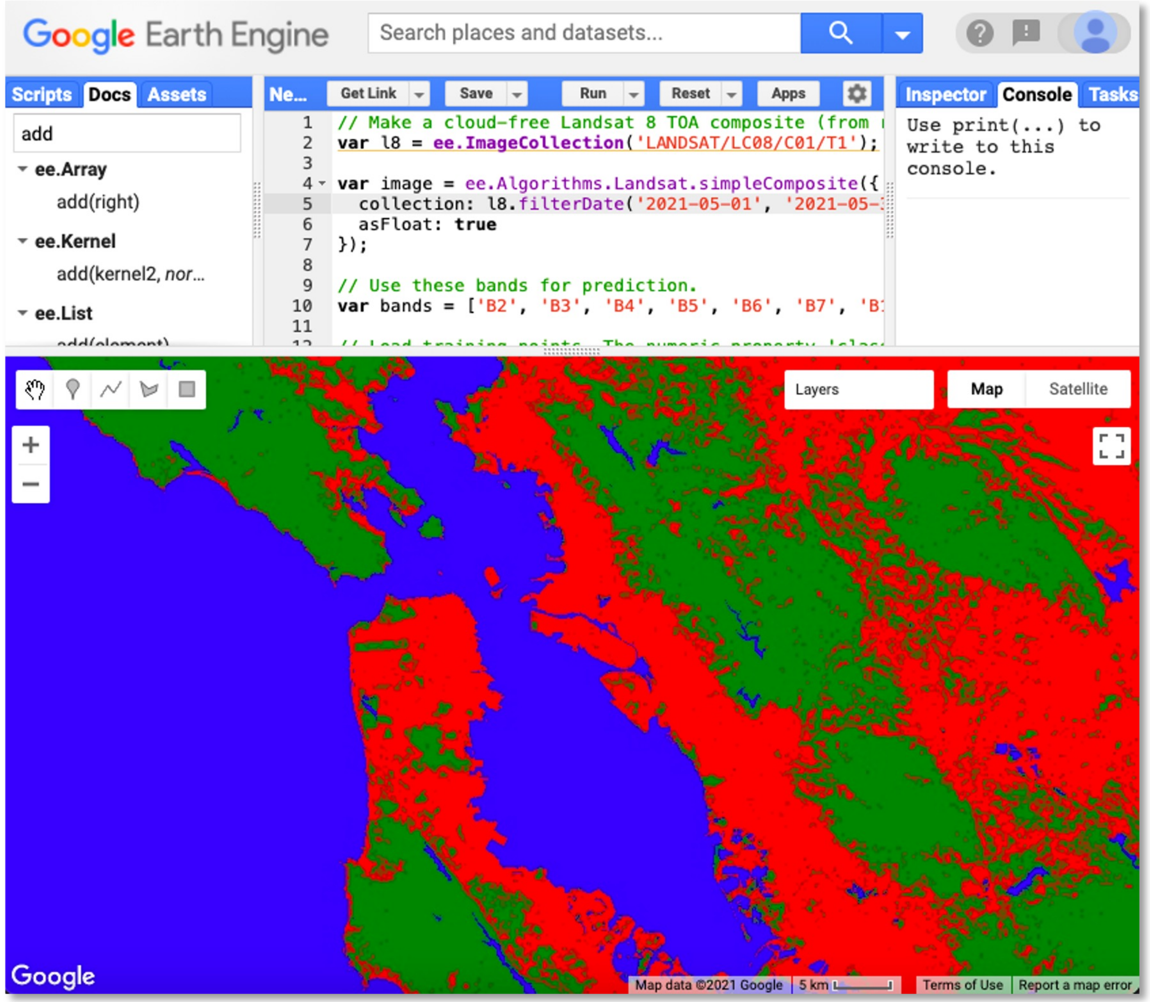
```
# Import the Image function from the IPython.display module.
from IPython.display import Image

# Display a thumbnail of global elevation.
Image(url = dem.updateMask(dem.gt(0))
  .getThumbURL({'min': 0, 'max': 4000, 'dimensions': 512,
                'palette': ['006633', 'E5FFCC', '662A00', 'D8D8D8', 'F5F5F5']}))
```



Google Colab notebook using a coded section to display elevation in an output cell. Credit: Google Colab

Google Earth Engine Functionality

- Uses of GEE for satellite imagery analysis include:
  - Automation of data processing and display
  - Near real-time monitoring (limited by the availability of data in the catalog)
  - Machine learning algorithm application
  - Graphical User Interface implementation



Simple Classification and Regression Trees (CART) classifier implemented in the GEE API to identify three classes urban, forest, and water in the San Francisco Bay Area for May 2021 using Landsat 8 imagery. Credit: Google Earth Engine Developers

Case Study Demonstration Using GEE

Pre-Fire Risk Assessment

Quebec and Woolsey Fires

Case Study Code – Earth Engine

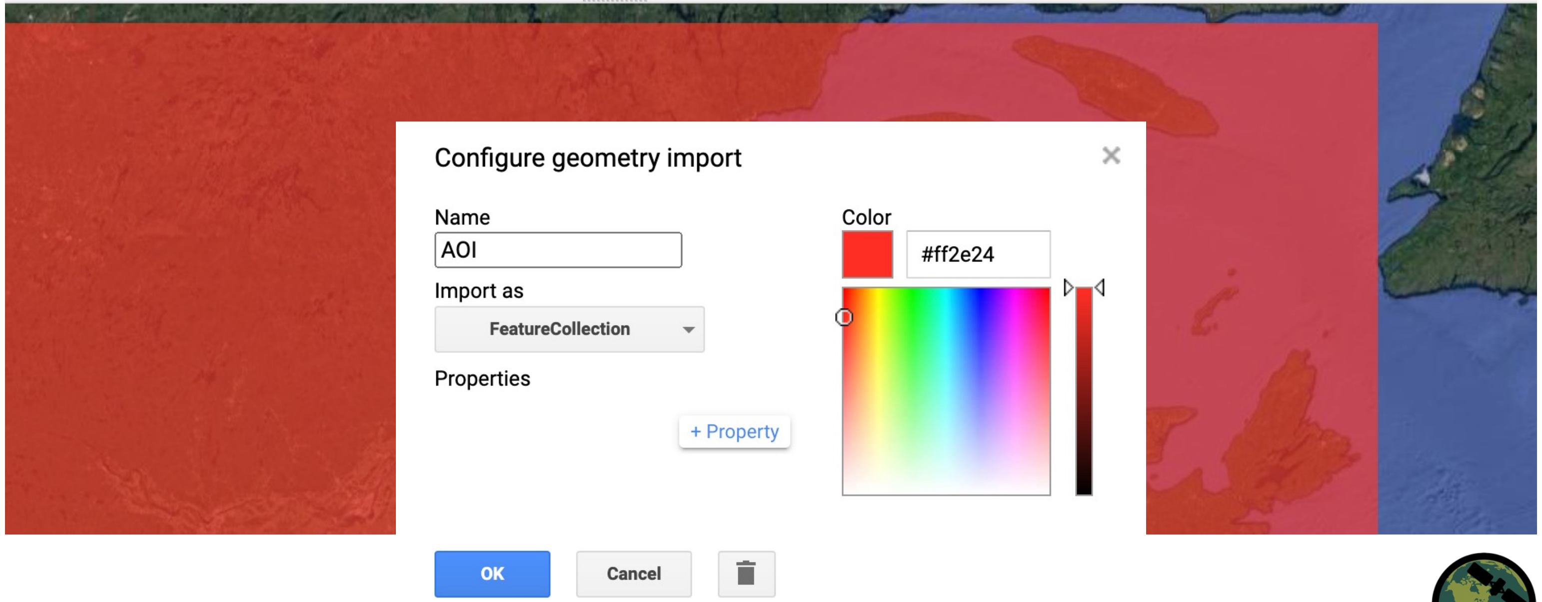
- Quebec Fires
- https://code.earthengine.google.com/8eb322d659058c15574de8e157689af3

- Woolsey Fires
- https://code.earthengine.google.com/3d3316878c200e909d8066aea9004fe4

Editing – Earth Engine Code

- It is important you follow the directions provided in the following slides to change the domain (i.e., area of interest) and parameters for each dataset to continue with analysis in your own area of interest.
- Follow the steps carefully in lines 32 – 49 of the code to create a bounding box around your AOI.

```
29 //==================================================================================================
30 //                                SELECT YOUR AREA OF INTEREST (AOI)
31
32 // Use the polygon-tool in the top left corner of the map pane to draw a bounding box around your
33 // study area.
34 //************************************** CAUTION! **********************************************
35 //Afterwards, go to the setting of the polygon (gear-symbol within your 'Geometry Imports'),
36 //rename the polygon to 'AOI' and change the 'Import as' drop down to 'FeatureCollection'.
37 // **CAREFUL**: Under 'Geometry Imports' (top left in map panel) uncheck the
38 //               geometry box, so it does not block the view on the imagery later.
39
40 //********************************** Alternatively: *******************************************
41 //Upload your shapefile via the 'Assets' tab in the upper left corner. Select 'NEW' => 'Shape files'
42 //and upload the four relevant files of your shapefile (.dbf, .prj, .shp, .shx). Once uploaded, refresh
43 //the assets and import your shapefile from the asset tab into this script by clicking the arrow symbol.
44 //Rename the imported asset to 'AOI' (Area of Interest).
45
46 // Set the basemap to display as satellite and set the center of the map to your AOI and specify the zoom level,
47 // from 1 to 24 (1 = the entire planet; 24 = the smallest region possible)
48 Map.setOptions('SATELLITE');
49 Map.centerObject(AOI, 6);
50
51
```



Editing – Earth Engine Code

- In lines 53 – 61 change the date of the latest image for your own analysis.

```
52 //===================================================================================================
53 //                                      SET TIME FRAME
54 //If you want to use another period of time than the whole time span of CHIRPS data, change the
55 //code between ee.Date brackets (start_date & end_date) to the desired dates.
56 //Keep in mind, that a reduction of the time span will lead to a less accurate SPI calculation.
57
58 var firstImage = ee.Date(ee.List(CHIRPS.get('date_range')).get(0));
59 var latestImage = ee.Date("2023-06-01");
60
61 //===================================================================================================
```

- In line 84 choose the number of months for the SPI for your own analysis. Remember to only use values for the following quantity of months.

```
71 //===================================================================================================
72 //                             SET TIME SCALE INFORMATION FOR SPI
73 //The SPI can be calculated based on different time scales. The scientific society usually recognizes
74 //one month as the shortest timescale for the calculation of the SPI. Shorter timescales might underly
75 //random  fluctuations in precipitation. However, the SPI can also be calculated for longer timescales,
76 //like 6 months. The following settings will give you the possibility to set your own time
77 //frame for the calculation of the SPI.
78
79 //!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!DISCLAIMER!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
80 //The calculation works for the following quantity of months:
81 //1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 24, 48
82 //!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
83
84 var timestep = '2'; //Choose the number of months for the SPI. The default setting will calculate the SPI
85                     //for 1 month. Setting the timestep to '6' will calculate the SPI for 6 months.
86
87 //===================================================================================================
```

Editing – Earth Engine Code

- In lines 321 – 329, provide a different title after "value" appropriate for your own map.

```
319  //**********************************************************************************************
320
321  //Create a title for the map window
322  var title = ui.Label({
323    value: 'Drought Monitoring & Fire Risk Detection - Quebec Fires (June 2023)',
324    style:{
325    fontWeight: 'bold',
326    fontSize: '18px'
327    }});
328  title.style().set('position', 'top-center');
329  Map.add(title);
330
```

- For SMAP data, in lines 340 – 341, change the date filter for your own analysis.

```
331  //===============================================================================================
332  //                          DROUGHT MONITORING USING SMAP (SOIL MOISTURE ANOMALIES)
333  //**********************************************************************************************
334
335
336  //Define a variable for the SMAP Level 4 Global 3-hourly 9-km Surface and Root Zone Soil Moisture product
337  //Filter the date range for a 30-day window of soil moisture anomalies.
338  //More information on the level 4 product can be found at the link below:
339  //https://nsidc.org/sites/default/files/documents/user-guide/multi_spl4smau-v007-userguide.pdf
340  var SMAPL4 = ee.ImageCollection('NASA/SMAP/SPL4SMGP/007')
341    .filter(ee.Filter.date('2023-05-20', '2023-05-21'));
342
```

- In lines 356 – 360, change the min & max visualization parameters to symbolize your soil moisture map

```
354
355  // Define the visualization parameters for SMAP surface soil moisture anomalies--based on histogram values
356  var smSurfaceVis = {
357    min: -0.15,
358    max: 0.1,
359    palette: ['red', 'white', 'blue']
360  };
361
```

Editing – Earth Engine Code

- In line 381, provide a [longitude, latitude] appropriate to chart a time series of NDVI anomaly in your AOI.

```
379
380 // Define a variable for a lon/lat in Quebec, Canada. This will be used to chart a time series of NDVI anomaly at that location.
381 var point = ee.Geometry.Point([-75.465, 49.393]);
382
```

- In lines 406 – 410, define a start date and number of months in the NDVI time series from the start date. The list sequence corresponding to the month can be found in the Console tab using the dropdown under "List"

```
406 // Define a start date for the NDVI time series
407 var start = ee.Date('2000-03-01');
408
409 // Define the number of months/years in the NDVI time series from the start date
410 var months = ee.List.sequence(0, 278);
411
```

Inspector | Console | Tasks

```
List (279 elements)
  0: Date (2000-03-01 00:00:00)
  1: Date (2000-04-01 00:00:00)
  2: Date (2000-05-01 00:00:00)
  3: Date (2000-06-01 00:00:00)
  4: Date (2000-07-01 00:00:00)
  5: Date (2000-08-01 00:00:00)
  6: Date (2000-09-01 00:00:00)
  7: Date (2000-10-01 00:00:00)
  8: Date (2000-11-01 00:00:00)
  9: Date (2000-12-01 00:00:00)
  10: Date (2001-01-01 00:00:00)
  11: Date (2001-02-01 00:00:00)
  12: Date (2001-03-01 00:00:00)
  13: Date (2001-04-01 00:00:00)
  14: Date (2001-05-01 00:00:00)
  15: Date (2001-06-01 00:00:00)
  16: Date (2001-07-01 00:00:00)
  17: Date (2001-08-01 00:00:00)
  18: Date (2001-09-01 00:00:00)
  19: Date (2001-10-01 00:00:00)
  20: Date (2001-11-01 00:00:00)
  21: Date (2001-12-01 00:00:00)
  22: Date (2002-01-01 00:00:00)
  23: Date (2002-02-01 00:00:00)
  24: Date (2002-03-01 00:00:00)
  25: Date (2002-04-01 00:00:00)
  26: Date (2002-05-01 00:00:00)
  27: Date (2002-06-01 00:00:00)
  28: Date (2002-07-01 00:00:00)
  29: Date (2002-08-01 00:00:00)
  30: Date (2002-09-01 00:00:00)
  31: Date (2002-10-01 00:00:00)
  32: Date (2002-11-01 00:00:00)
  33: Date (2002-12-01 00:00:00)
```

Editing – Earth Engine Code

- In line 445 – 446, edit the NDVI min & max values appropriate for your AOI; in line 448 edit the index value to correspond to the month of interest from the previous slide; in line 449 edit the layer name.

```
442 // Add layer to the map window calling the band name (i.e., month) of your choice. In this example we are calling
443 // element 278 which is associated with 2023-05-01 (i.e., May 2023).
444 Map.addLayer(byMonthBands.clip(AOI), {
445   min: -0.3,
446   max: 0.3,
447   palette: ['FF0000', '000000', '00FF00'],
448   bands: bandNames.get(278).getInfo()},
449   'NDVI anomaly 2023-05', false);
```

- For FIRMS data, edit lines 468 – 470 to filter the date range for your analysis.

```
462 //==================================================================================
463 //                        FIRMS ACTIVE FIRE DATA
464 //**********************************************************************************
465
466 //Define a variable for the Fire Information for Resource Management System (FIRMS)
467 //image collection and select band T21 (The brightness temperature of a fire pixel using MODIS channels 21/22 in Kelvin)
468 var firms = ee.ImageCollection('FIRMS')
469   .select('T21')
470   .filterDate('2023-06-06', '2023-06-07');// Date set to active Quebec fire dates
```

Summary

Summary

- Introduced remote sensing satellites and sensors relevant to fire risk assessments
- Reviewed important indicators for assessing fire risk and remote sensing-based tools for analyzing them
- Selected appropriate data from satellites for a watershed of interest
- Introduced examples of pre-fire criteria for fire risk in watersheds
- Used GEE to demonstrate how to delineate river basins and subbasins for a watershed of interest
- Used GEE to calculate anomalies in biophysical and meteorological conditions for a watershed of interest

Looking Ahead to Part 2

Part 2 will focus on:

- Getting familiar with how to run the Soil and Water Assessment Tool (SWAT) model by ingesting remote sensing data to predict the post-fire impact on sediment in a watershed.

Homework and Certificates

- **Homework:**
  - One homework assignment
  - Opens on July 13, 2023
  - Access from the training webpage
  - Answers must be submitted via Google Forms
  - **Due by July 27, 2023**
  - Parts 1 and 3 will include hands-on exercises to assess pre-fire risk and post-fire impact on a watershed using Google Earth Engine. **You will be instructed to submit results of these exercises to a Google folder by July 27, 2023.**

- **Certificate of Completion:**
  - Attend all three live webinars (attendance is recorded automatically)
  - Complete the homework assignment by the deadline
  - You will receive a certificate via email approximately two months after completion of the course.

Contact Information

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Visit our Sister Programs:

- DEVELOP
- SERVIR

Questions and Answers

- Please put your questions in the Questions box
- We will try to get to all of the questions during the Q&A session
- Any remaining questions will be answered in the Q&A document, which will be posted to the training website about a week after the training.

APPLIED REMOTE SENSING TRAINING PROGRAM

TRAIN - EMPOWER - ADVANCE

Thank You!