Earth Observations in Support of Insurance & Finance Sector Decision-Making

Part 1: Training Outline and Objectives

Sean McCartney (NASA GSFC, SSAI), Amita Mehta (NASA GSFC, UMBC), Erika Podest (NASA, JPL)

November 12, 2025

About ARSET

About ARSET

- **ARSET provides accessible, relevant, and cost-free training on remote sensing satellites, sensors, methods, and tools.**

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

- Attendees learn how to access, interpret, and apply NASA data on local and global scales, with an emphasis on real-life case studies.

About ARSET Trainings

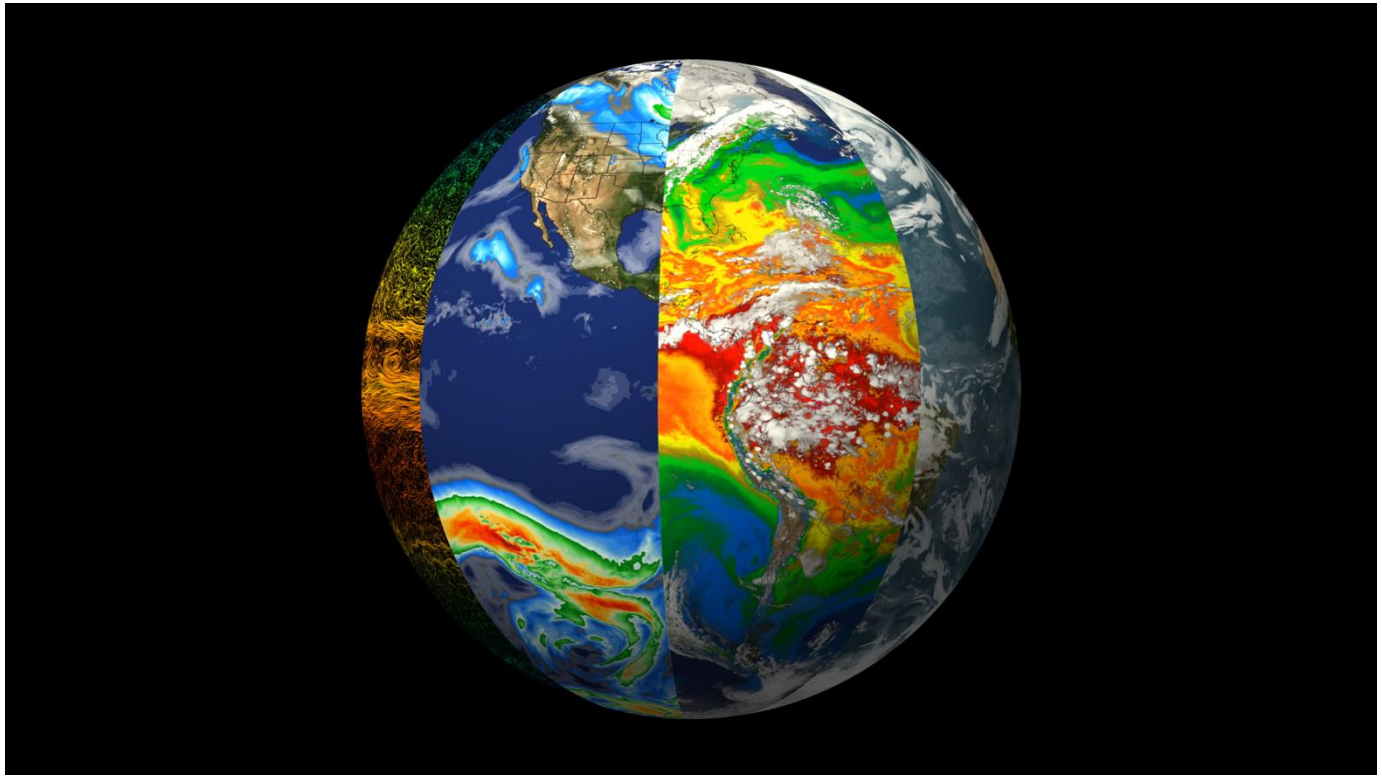
- Cost-free
- Online or in-person
- Bilingual and multilingual options
- Only use open-source software and data
- Accommodate differing levels of expertise
- Live and instructor-led or asynchronous and self-paced

- Visit the ARSET website to learn more.

Earth Observations in Support of Insurance & Finance Sector Decision-Making Overview

Earth Observations

- "Great Grain Robbery" – In 1972, unaware of global grain shortages, the U.S. subsidized 10 million tons of wheat sales to the USSR, losing $300 million while domestic food prices rose.
- Companies leveraging Earth observing data generate value through risk monitoring, adaptive pricing, and improved emergency response.
- By 2030, Earth observations are projected to create $700+ billion in economic opportunity (World Economic Forum, 2024).



Credit: NASA Science Visualization Studio

Training Learning Objectives

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

- Identify practical applications of Earth observations in assessing critical environmental issues specific to fires and floods.
- Identify Earth observations and modeled data for in-depth analysis of natural hazards.
- Apply workflows to case studies that leverage Earth observations and modeled data to evaluate and address challenges related to fires and floods.

Prerequisite

- Fundamentals of Remote Sensing

Outline

8:00–8:30	Introductions
8:30–9:00	Overview of Earth Observations for Natural Hazards
9:00–10:00	Observations and Modeled Data for Precipitation and Flooding
10:00–10:15	Coffee break
10:15–11:00	Demo – Tools for Flood Mapping
11:00–12:00	Hands-On Exercise: Flood Case Studies in Area of Interest
12:00–1:00	Lunch
1:00–2:00	Observations and Data for Fires
2:00–3:00	Demo – Tools for Fire Mapping
3:00–3:15	Coffee break
3:15–4:30	Hands-On Exercise: Fire Case Studies in Area of Interest
4:30–5:00	Q&A + Wrap-Up

Trainers

Sean McCartney

NASA Goddard Space Flight Center (SSAI)

Erika Podest

NASA Jet Propulsion Laboratory

Amita Mehta

NASA Goddard Space Flight Center (UMBC)

Ice Breaker

Ice Breaker Questions

- What's something you're passionate about outside of work?
- What inspired you to pursue your current career path?
- What's the most interesting place you've ever been to?

- If you could switch jobs with anyone in the company for a week, who would it be?
- Who would you choose if you could pick one person, living or dead, to have dinner with?
- What professional opportunity are you looking forward to in the next three months?

Earth Observations in Support of Insurance & Finance Sector Decision-Making

Missions/Models and Datasets for Monitoring Disasters

Amita Mehta (NASA GSFC, UMBC), Sean McCartney (NASA GSFC, SSAI), Erika Podest (NASA, JPL)

November 12, 2025

Learning Objectives

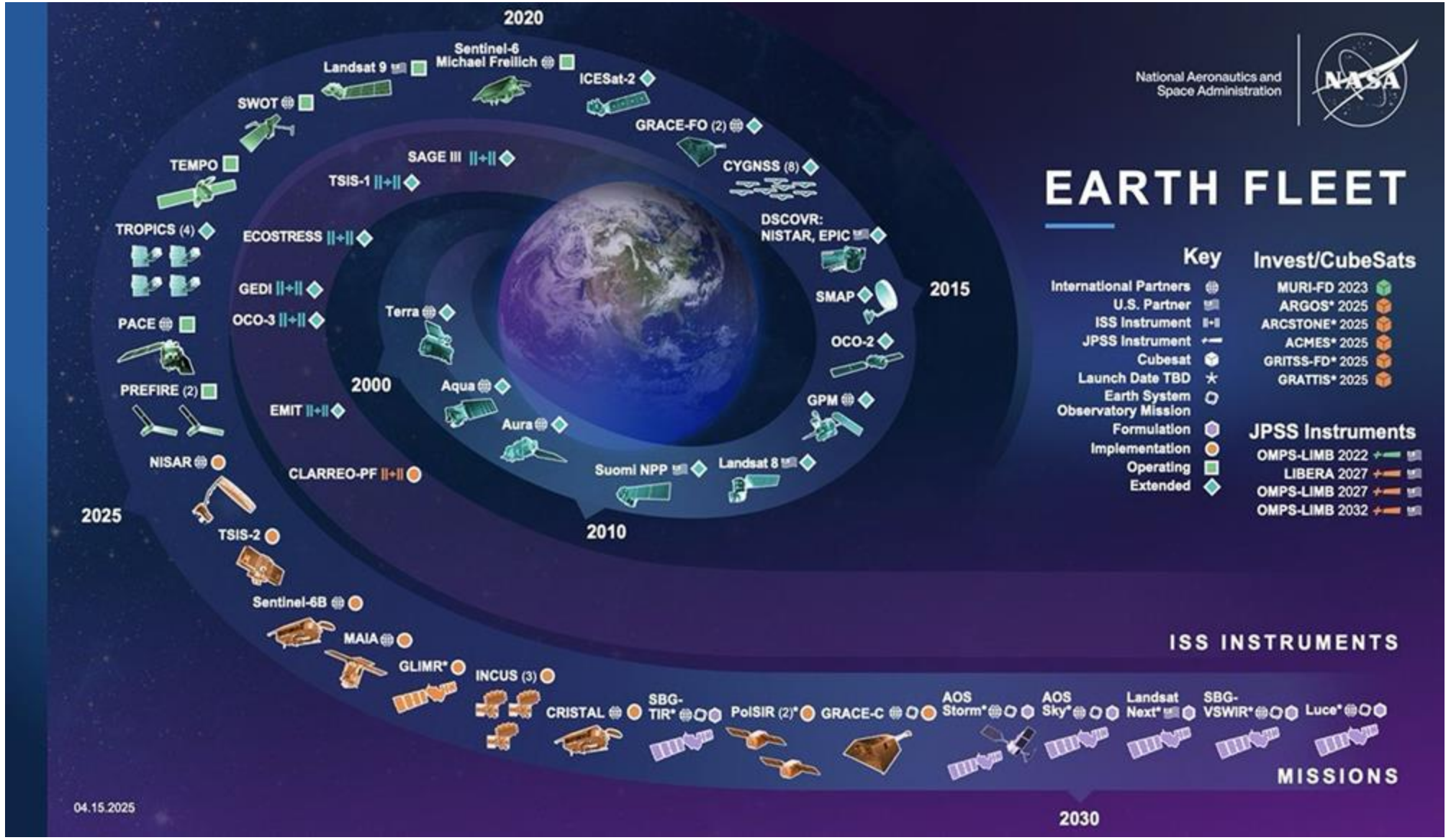
- By the end of this presentation attendees will be able to:
  - Identify data products from Earth observations and Earth system models useful for monitoring disasters – specifically focusing on floods and wildfires.
  - Recognize strengths and limitations of the data products.
  - Identify NASA webtools for data search, acquisition, and analysis.

Outline

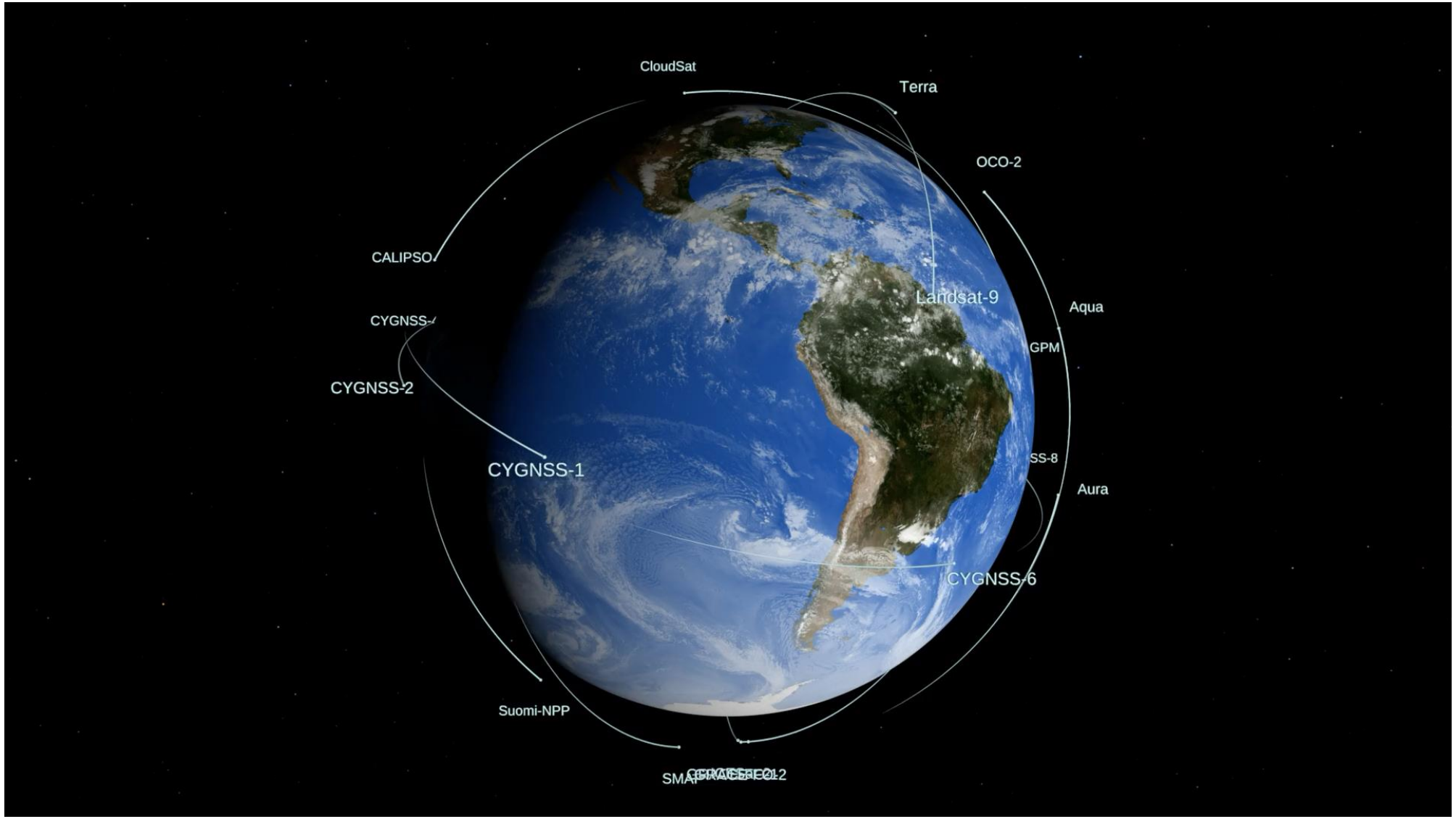
- Overview of NASA Earth observing satellites and Earth system models.
- Geophysical parameters for monitoring floods and wildfires.
- Demonstration: Search and data acquisition using NASA Earthdata Search

Overview of NASA Earth Observing Satellites and Earth System Models

NASA Earth Observing Satellites



NASA Earth Observing Satellites in Orbits



Credit: NASA Science Visualization Studio (SVS)

NASA Earth Observing Satellites

Current Satellites

- [x]Landsat 8 & 9
- Terra
- Aqua
- [+]NPP
- [+]JPSS (NOAA -20 and -21)
- [@]GPM
- SMAP
- Jason-3
- SWOT
- Sentinel-6/Michael Freilich
- ICESat-2
- GRACE-FO
- TEMPO
- PACE
- NISAR
- *Sentinel 1, 2, 3, 5P
- OCO 2 & 3

- Measure emitted infrared and/or microwave radiation, backscattered microwave/visible radiation, and reflected optical radiation from the Earth-atmosphere system.
- Equipped with individual or multiple sensing instruments.
- Sensor categories:
  - Active and/or passive detection systems
  - Single-band, multispectral, or hyperspectral data collection

[x]NASA-USGS [+]NASA-NOAA [@] NASA-JAXA *ESA Satellites

Satellites Relevant for Monitoring Floods, and Wildfires

Current Satellites

- **[x]Landsat 8 & 9**
- **Terra**
- **Aqua**
- **[+]NPP**
- **[+]JPSS (NOAA -20 and -21)**
- **[@]GPM**
- **SMAP**
- Jason-3
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- **NISAR**
- ***Sentinel 1, 2,** 3, 5P
- OCO 2 & 3

Highlight satellites capable of observing geophysical parameters essential for:

- Flood and wildfire assessment across pre-event, active event, and recovery phases

Flooding in the Midwest and Southeast U.S.

Image captured on Apr. 10, 2025 from the MODIS instrument aboard the Terra platform.

Credit: NASA Worldview

[x]NASA-USGS [+]NASA-NOAA [@] NASA-JAXA *ESA Satellites

Satellites and Sensors

Satellite	Sensors	Spectral Measurements	Temporal Coverage, Observation Time, and Resolution	Spatial Coverage and Resolution
TRMM GPM	Microwave Radiometer and RADAR TMI, PR GMI, DPR	TMI: 10–85 GHz GMI: 10–183 GHz PR (Ku) and DPR (Ku and Ka)	11/27/1997 – 4/15/2015 2/27/2014 – Present Diurnally Varying ~90 minutes	35° S – 35° N 65 °S – 65° N Swaths: 760 – 878 km 885 – 931 km 5 – 72 km 5 – 42 km
SMAP	Microwave Radiometer	L-Band	1/31/2015 – Present 6:00 am/pm 2–3 days	Near-Global Swath:1000 km 38 km, 9 km
Sentinel-1	Microwave Synthetic Aperture Radar	C-Band	4/3/2014 – Present 6:00 am/pm 12 day	Global Swaths: 80 km, 400 m 5 m, 250 m
NISAR	Microwave Synthetic Aperture Radar	L-Band S-Band	7/30/2025 - Present 6:00 am/pm 12 Day	Global Swath: 242 km 2 – 8 m (band dependent)

Satellites and Sensors

Satellites	Sensors	Spectral Measurements	Temporal Coverage, Observation Time, and Resolution	Spatial Coverage and Resolution
Landsat 8 Landsat 9	TIRS, OLI TIRS-2, OLI-2	Visible, Near IR, Middle IR, Thermal IR	2/2013 – Present 11/2021– Present 10:30 am/pm local time 16 Day	Global Swath: 136 km 30 m
Terra Aqua	MODIS	Visible, Near IR, Middle IR, Thermal IR	12/1999 – Present (10:30 am/pm) 4/2002 – Present (13:30 am/pm) 12 Hours	Global Swath: 2330 km 250 m to 1 km
SNPP JPSS	VIIRS	Visible, Near IR, Middle IR, Thermal IR	10/28 2011– Present 11/18 2017 – Present 11/10 2022 – Present 1:30 am/pm local time, 12 Hours	Global Swath: 3040 km 375 m, 750 m
Sentinel 2A Sentinel 2B	MSI	Visible, Near IR, Middle IR	6/23/2025 – Present 3/7/2017– Present 10:30 am/pm, 6 Day	Global Swath: 290 km 10 m, 20 m, 30 m

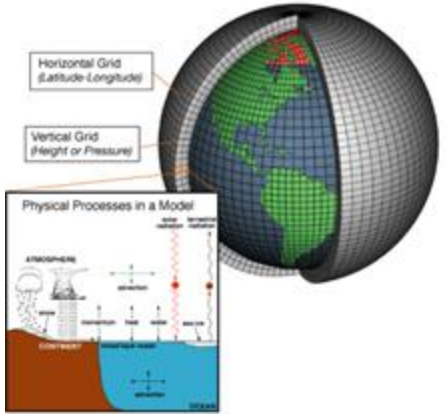
Earth System Models Provide Value-Added Information

Remote Sensing + Surface Observations + Numerical Models

Satellite Data

Surface Measurements and In-Situ Data

Numerical Models



NASA Earth System Models Relevant for Monitoring Floods and Wildfires

- GEOS-5:
  - The Goddard Earth Observing System, Version 5
- MERRA:
  - Modern Era Retrospective-Analysis for Research and Application
- GLDAS and NLDAS:
  - Global Land Data Assimilation System
  - North American Land Data Assimilation System

NASA Earth System Models

- Land Data Assimilation System (LDAS) integrates surface-based and remote sensing observations in land surface models.
- LDAS provides quantities that are not directly observed by satellites (**e.g., runoff, snow water equivalence**).

NLDAS: North American Land Data Assimilation System

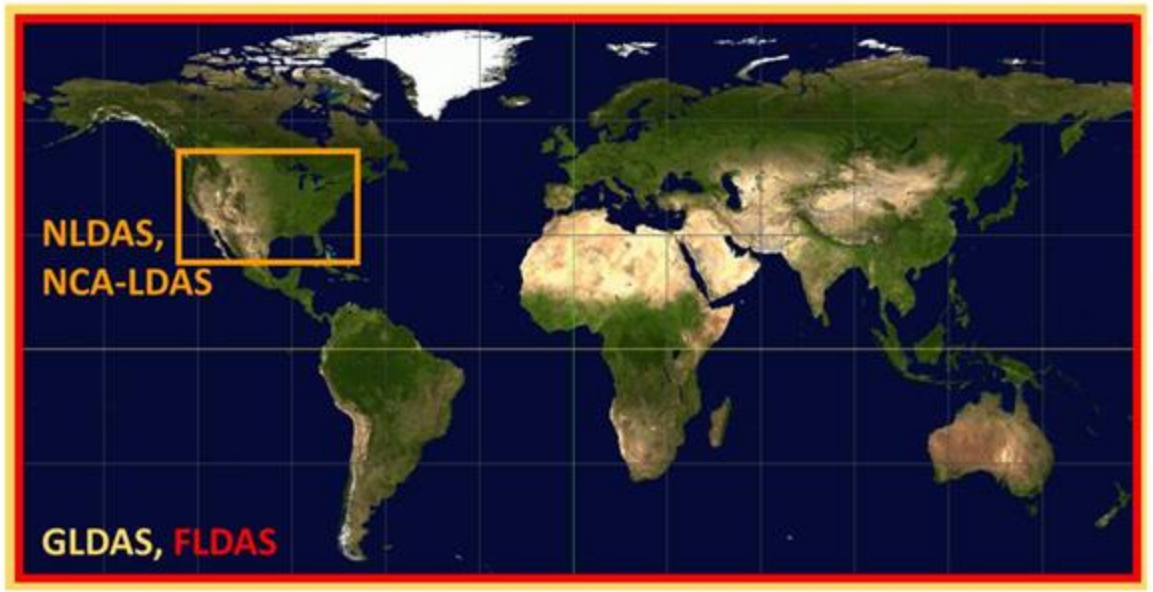
GLDAS: Global Land Data Assimilation System

NLDAS: North American Land Data Assimilation System

FLDAS: Famine Early Warning Systems Network (FEWS NET) Land Data Assimilation System

NCA-LDAS: The National Climate Assessment - Land Data Assimilation System

Global and Regional
Land Data Assimilation System (LDAS)



Credit: Land Data Assimilation System (LDAS)

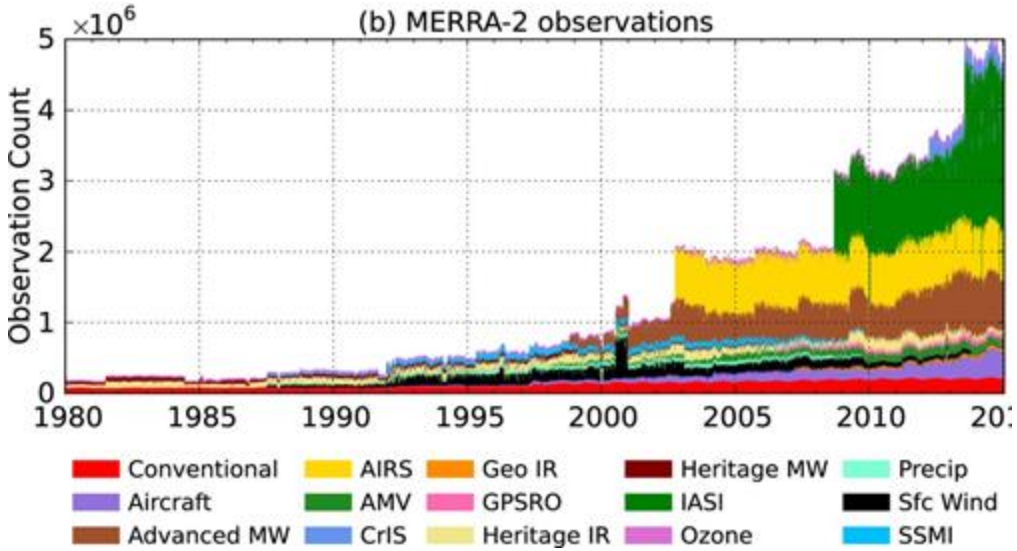
NASA Earth System Models

- **MERRA-2** blends the vast quantities of observational data with output data of the Goddard Earth Observing System (**GEOS-5**) model (1980 – Present).
- Provides state-of-the-art global **analyses of weather.**

MERRA-2: The Modern-Era Retrospective Analysis for Research and Applications, Version 2

NLDAS: North American Land Data Assimilation System

Observations assimilated per 6-hour cycle in MERRA-2



Credit: Journal of Climate Vol 30, Issue 14

Earth System Models Relevant for Floods and Wildfires

Model	Spatial/Temporal Resolutions and Coverage
GEOS-5	Global, 0.3° x 0.25° 6 Hourly, 5-Day Forecast
MERRA-2	Global, 0.625° x 0.5° Hourly, 1980 – Present
NLDAS	US, Canada, Mexico, 0.125°x0.125°, Hourly, 1979 – Present
GLDAS	Global Land (north of 60° S), 0.25°x0.25° 3-Hourly, 1948 – Present (version-dependent)

GEOS-5: Goddard Earth Observing System Model, Version 5

MERRA-2: The Modern-Era Retrospective Analysis for Research and Applications, Version 2

NLDAS: North American Land Data Assimilation System

GLDAS: Global Land Data Assimilation System

Geophysical Parameters for Monitoring Floods and Wildfires

Geophysical Parameters for Monitoring Flood and Wildfires

- Temperature (Surface, Air)
- Precipitation (Rain, Snow)
- Snow Melt
- Soil Moisture
- Evapotranspiration
- Runoff
- Humidity
- Winds
- Vegetation
- Topography
- Human Settlement and Built-Up Areas
- Population Density

NASA remote sensing observations and Earth system models provide these parameters.

Geophysical Parameters for Monitoring and Prediction of Disasters

Geophysical Parameter	Satellites/Models
Precipitation Winds, Humidity, Surface & Air Temperature	TRMM & GPM (IMERG*) GEOS-5, MERRA-2
Soil Moisture (SM)	NISAR, SMAP, GLDAS, NLDAS
Evapotranspiration (ET), Snow & Ice Cover	Landsat, Terra & Aqua, SNPP, JPSS GLDAS, NLDAS
Runoff	GLDAS, NLDAS
Surface Inundation	Sentinel-1, Sentinel-2, Landsat, Terra & Aqua, SNPP, JPSS, NISAR
Wildfires, Vegetation Human Settlement Topography	Landsat, Terra & Aqua, SNPP, JPSS Landsat Shuttle Radar Topography Mission (SRTM)

*IMERG: Integrated Multi-satellitE Retrievals for GPM

Advantages and Limitations of Using Earth Observations

- Continuous, uniform coverage of broad geographic areas, with consistent spatial and temporal resolutions.
- Complement sparse and infrequent in-situ data.
- Long-term datasets extending from 10 to 40+ years.
- Extensive collection of **no-cost, publicly accessible** data products.
- Webtools, trainings, and tutorials available for data access and analysis.
- Various satellite missions and models provide data with different spatial and temporal resolutions and geographic coverage.
- Coverage limitations arise from orbital gaps and cloud obstruction affecting visible/infrared sensors
- Practical applications demand data formatting and analysis procedures.

Demonstration

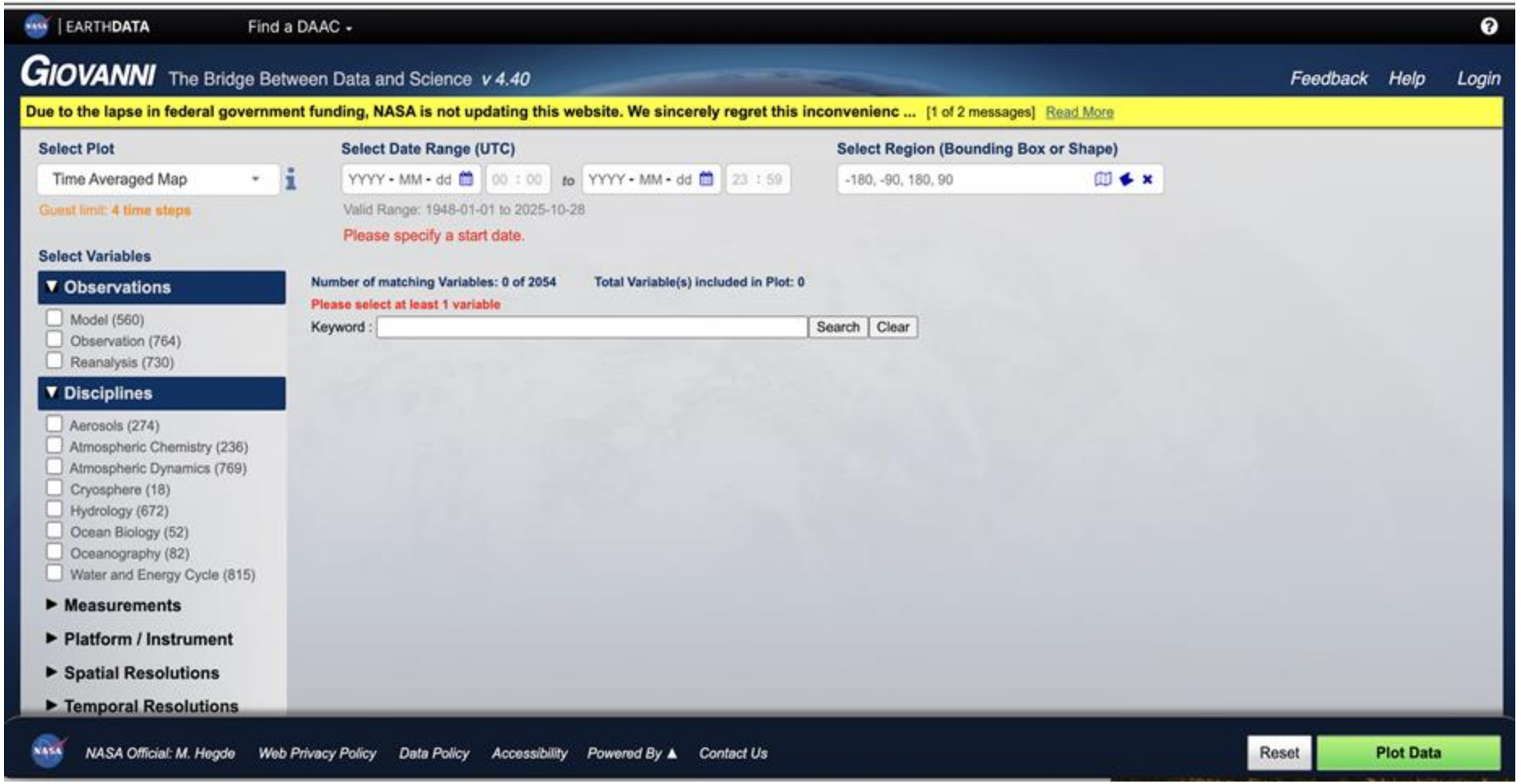
NASA Earthdata Search

Search, Select, Download Data

Requires user registration for NASA Earthdata

NASA Giovanni

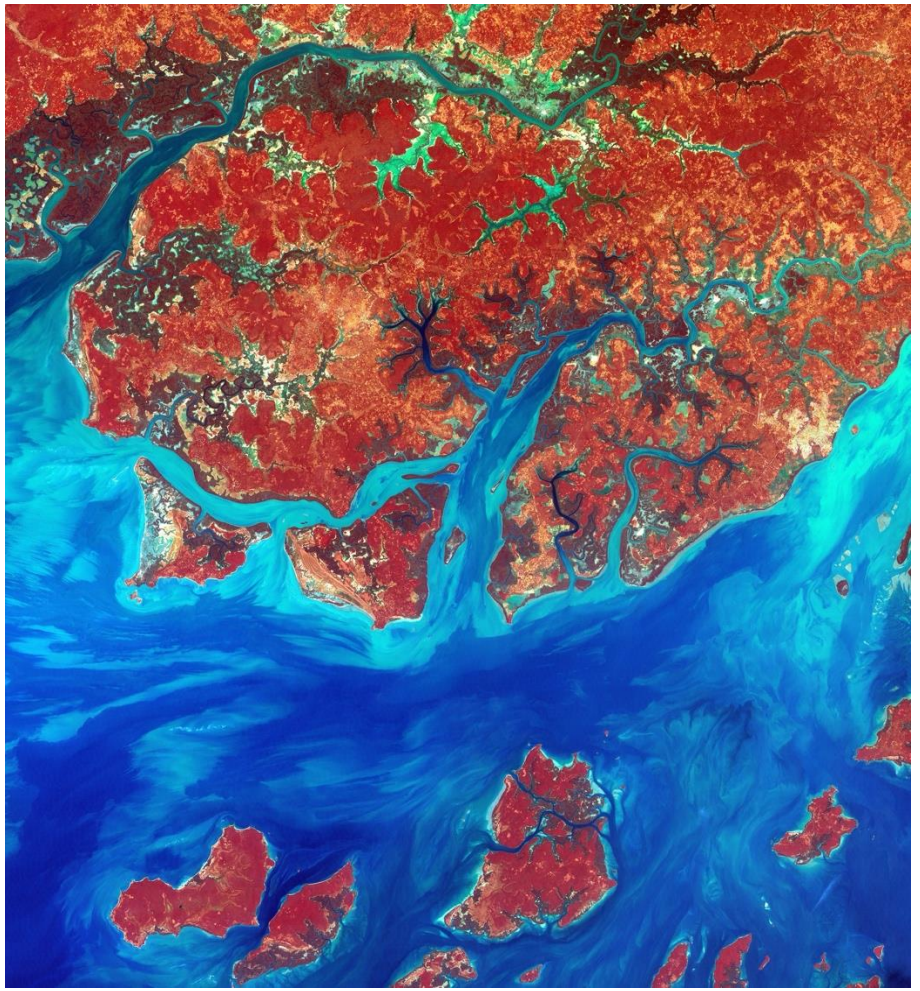
Search, Select, Analyze, Visualize and Download Data



Requires user registration for NASA Earthdata

Summary

- Overview of NASA's current satellites/sensors and models and derived geophysical parameters for monitoring floods and wildfires.
- Advantages and limitations of Earth observing datasets.
- Demonstrations of NASA's data access and analysis webtools: Earthdata Search and Giovanni.



Credit: Earth Resources Observation and Science Center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