



# Satellite Remote Sensing for Flood Monitoring and Management

Amita Mehta and Erika Podest

18-19 November 2018



# Training Objectives

- Learn about NASA and ISRO remote sensing data and web-tools relevant for flood monitoring and management
- Learn to utilize remote sensing data and web-tools to facilitate flood early warning and to assess and monitor flood extent in support of response, relief, and mitigation activities.



# Training Outline: 18 November 2018

<b>Time</b>	<b>Topic</b>	<b>Type</b>	<b>Presenter</b>
<b>Session 1</b>			
10:30-11:30 AM	Overview of NASA Satellite Remote Sensing and Earth System Modeling Relevant For Flood Monitoring	Presentation	Amita Mehta
11:30 AM-1:00 PM	Data Access and Analysis: Precipitation, Soil Moisture, Weather Data, Terrain, Socioeconomic Data	<b>Demonstration GDeX, SEDAC, Hands-on Exercise: QGIS, Giovanni AppEEARS</b>	Amita Mehta Erika Podest
1:00-2:00 PM	<b>Lunch</b>		
<b>Session 2</b>			
2:00-2:30 PM	Data Access and Analysis: Continue	<b>Hands-on Exercise (continue)</b>	Amita Mehta Erika Podest
2:30-3:30 PM	Overview of ISRO Satellite Remote Sensing for Flood Monitoring and Mapping	Presentation	C. M. Bhatt
3:30-3:45 PM	<b>Break</b>		
<b>Session 3</b>			
3:45-5:10PM	Data Access and Analysis: Hydrological variables, optical, SAR, scatterometer & altimeter	<b>Hands-on Exercise: Bhuvan, NDC</b>	Praveen K. Thakur C M Bhatt
5:00-5:45 PM	Presentation by Participants	QGIS Analysis from Session-1&2	
5:45-6:00 PM	Summary & Q/A		



# Training Outline: 19 November 2018

<b>Time</b>	<b>Topic</b>	<b>Type</b>	<b>Presenter</b>
	<b>Session 4</b>		
9:30-10:00 AM	Overview of Flood Monitoring and Mapping Based on Remote Sensing of Land Cover	Presentation	Amita Mehta
10:00-11:00 AM	Overview and Applications of Synthetic Aperture Radar (SAR)	Presentation	Erika Podest
11:00-11:15 AM	Break		
11:15 AM-12:30 PM	SAR Application for Flood Mapping (SNAP)	<b>Hands-on Exercise</b>	Erika Podest, Praveen K. Thakur, Amita Mehta
12:30-1:00 PM	Overview of Flood Monitoring and Mapping Based on Precipitation Data	Presentation	Amita Mehta
1:00-2:00 PM	<b>Lunch</b>		
	<b>Session 5</b>		
2:00-2:30	NRT Flood Monitoring (ERDS, GDACS, DFO)	<b>Demonstration</b>	Amita Mehta
2:30-3:30 PM	ISRO Flood Monitoring and Modeling Tools (Altimeter & Hydro models)	Presentation	Praveen K. Thakur
3:30-3:45 PM	Break		
	<b>Session 6</b>		
3:45-5:00 PM	Flood Monitoring Case Study GFMS, MODIS NRT Flood Mapping, IIRS/NRSC flood cases from ISRO	<b>Hands-on Exercise</b>	Amita, Erika, Praveen
5:00-5:45 PM	<b>Presentation by Participants</b>		
5:45-6:30 PM	Summary, Q/A, & Survey		







## Overview of NASA Satellite Remote Sensing and Earth System Modeling Relevant For Flood Monitoring

# Presentation Outline

- About ARSET
- Flood Monitoring and Management Data Needs
- NASA Earth Science Data For Flood Monitoring and Management
- Data Description: Precipitation, Soil Moisture, Weather Data [Winds, Temperature, Moisture], Terrain, Socioeconomic Data, Nightlight Imagery
- Data Access Demonstration: Weather, Terrain, Socioeconomic Data
  - Case Study: Kerala Floods, 2018

For details see: <https://arset.gsfc.nasa.gov/webinars/fundamentals-remote-sensing>

Sessions 1 and 2B







## About ARSET

# NASA's Applied Remote Sensing Training Program (ARSET)

<http://arset.gsfc.nasa.gov/>

- Empowering the global community through remote sensing training
- Part of NASA's Applied Sciences Capacity Building Program
- Seeks to increase the use of Earth science in decision-making through training for:
  - policymakers
  - environmental managers
  - other professionals in the public and private sectors

Topics for Trainings Include:





# ARSET Training Formats

## Online

Typically offered via the internet

2-5 weeks long

1-2 hours a week

Available at all levels

Live & recorded

Free

Materials available in English & Spanish



## In-Person

Hosted with a partner

Typically in a computer lab

2-7 days long

Focus on locally-relevant case studies

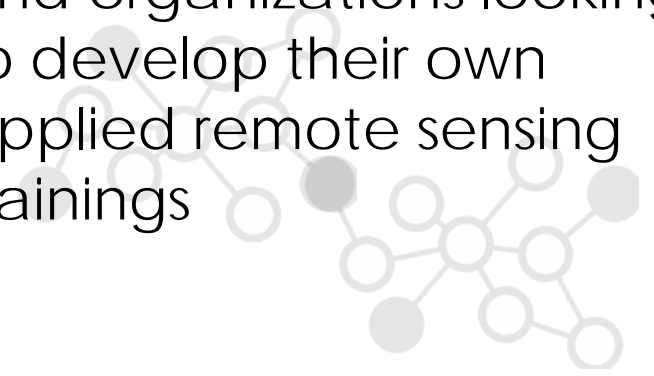
Certain topics can be presented in Spanish



## Train the Trainer

Online or in-person

Designed for individuals and organizations looking to develop their own applied remote sensing trainings



# ARSET Training Levels

## Advanced (Level 2)

Requires level 1 training or equivalent knowledge

In-depth and highly focused topics

*Advanced Webinar: SAR Image and Data Processing*

## Basic (Level 1)

Requires level 0 training or equivalent knowledge

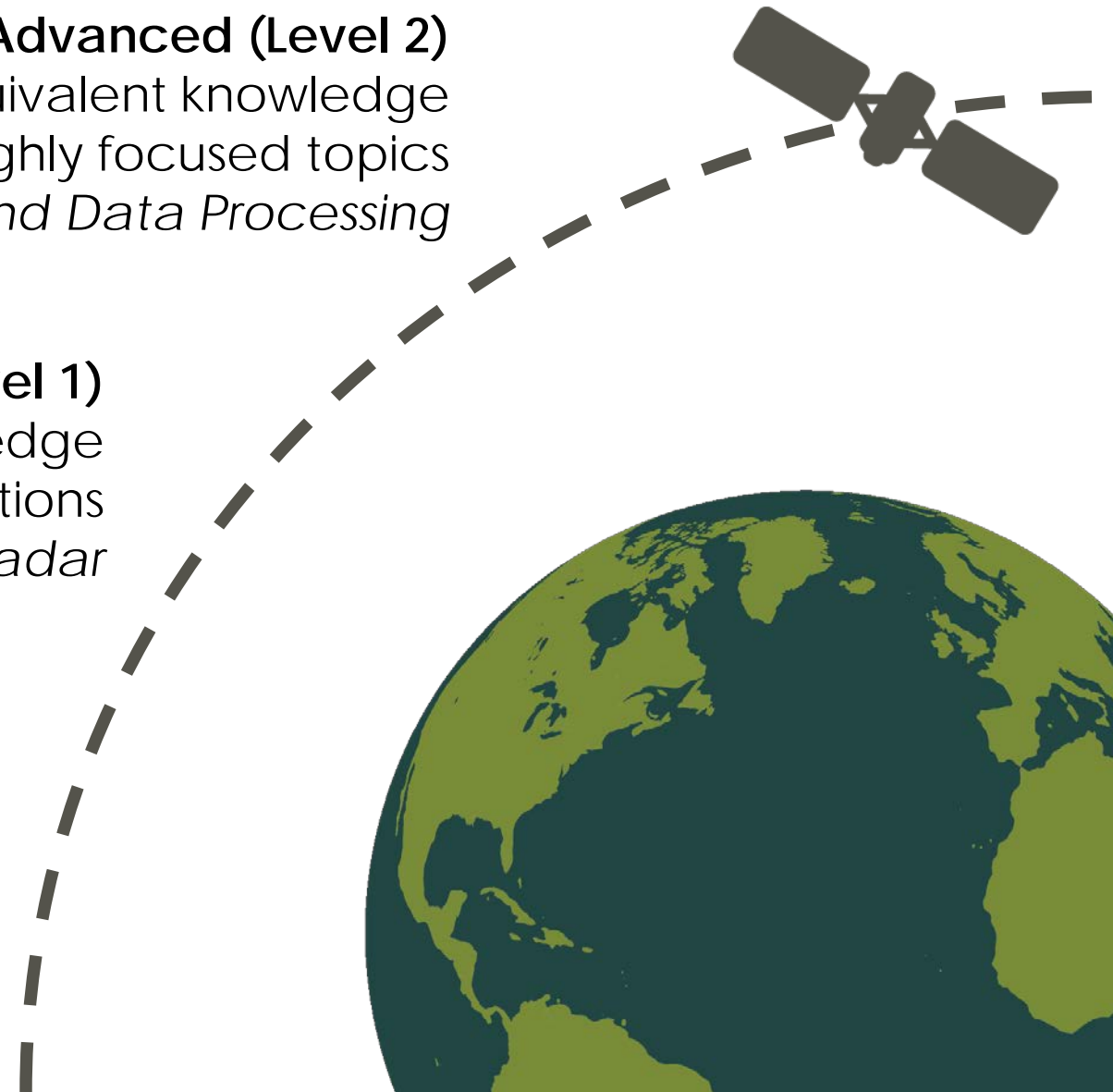
Covers specific applications

*Introduction to Synthetic Aperture Radar*

## Fundamentals (Level 0)

Assumes no prior knowledge of remote sensing

*Fundamentals of Remote Sensing*



# ARSET Team Members

## Program Support

- Ana Prados, Program Manager (GSFC)
- Brock Blevins, Training Coordinator (GSFC)
- David Barbato, Spanish Translator (GSFC)
- Annelise Carleton-Hug, Program Evaluator (Consultant)
- Elizabeth Hook, Technical Writer/Editor (GSFC)
- Selwyn Hudson-Odoi, Training Coordinator (GSFC)
- Marines Martins, Project Support (GSFC)
- Stephanie Uz, Program Support (GSFC)

## Disasters & Water Resources

- Amita Mehta, Instructor (GSFC)
- Erika Podest, Instructor (JPL)
- Sean Mccartne, GIS Specialist (GSFC)

## Land & Wildfires

- Cynthia Schmidt, Lead (ARC)
- Amber Jean McCullum, Instructor (ARC)

## Health & Air Quality

- Pawan Gupta, Lead (GSFC)
- Melanie Cook, Instructor (GSFC)

## Acknowledgement:

- We wish to thank Nancy Searby for her continued support



# ARSET Trainings



100 trainings



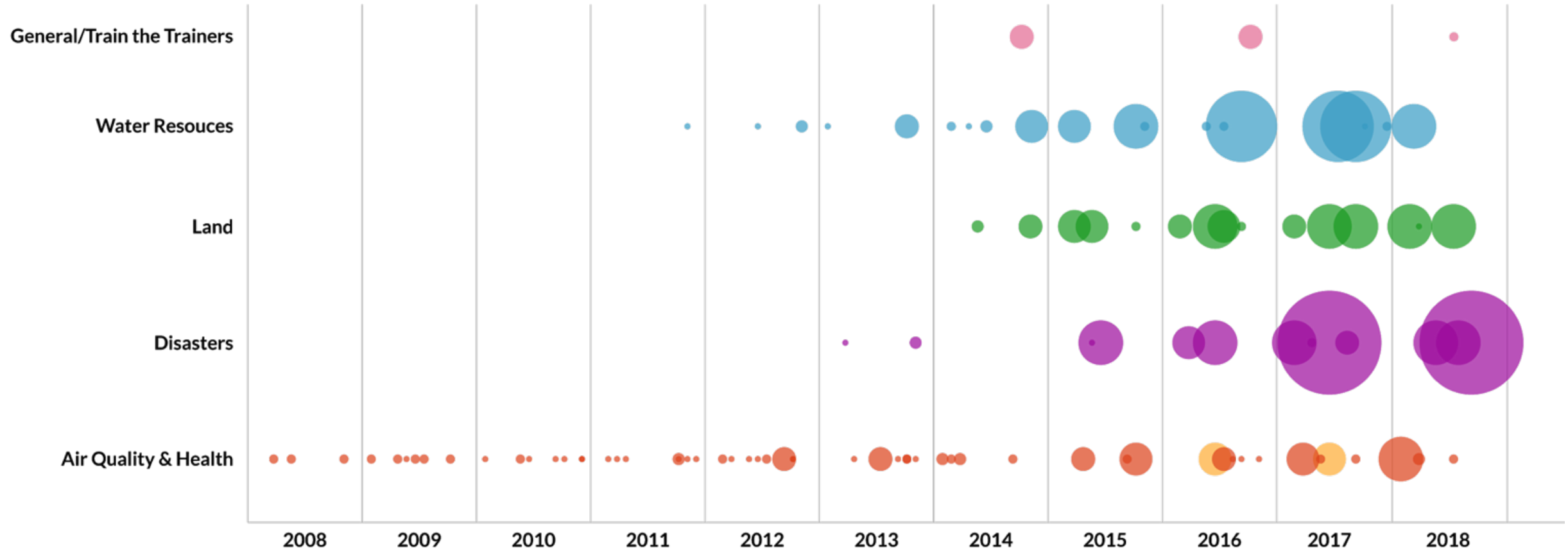
13,000+ participants



160+ countries



3,700+ organizations



\* size of bubble corresponds to number of attendees





# ARSET Training Impacts: Disaster Management (2013 - 2018)



13 trainings



4,990+ participants

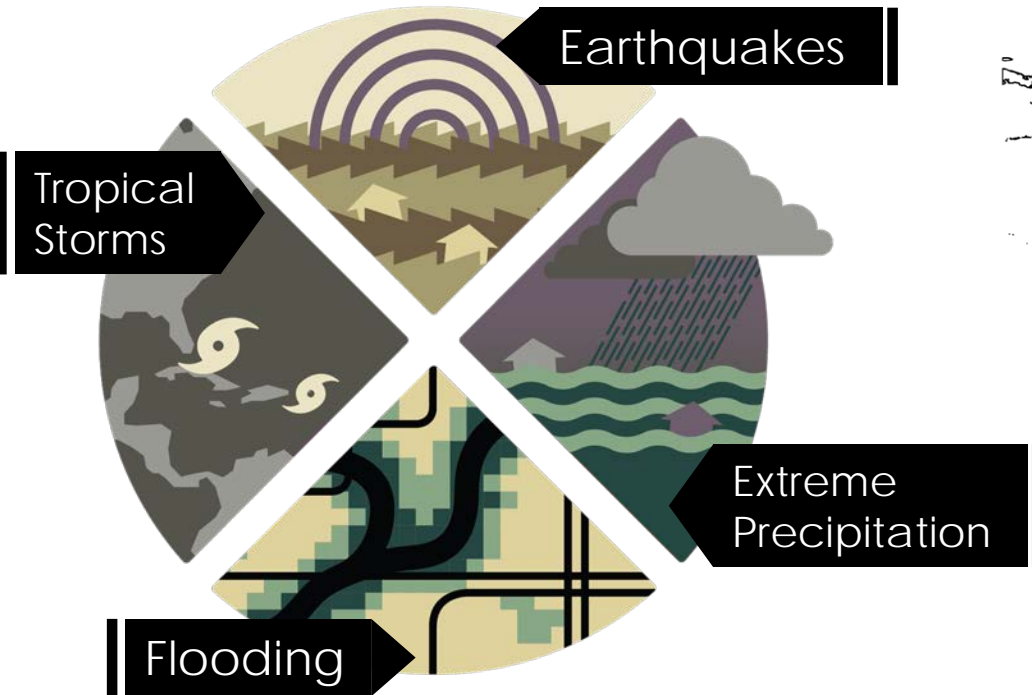


130+ countries

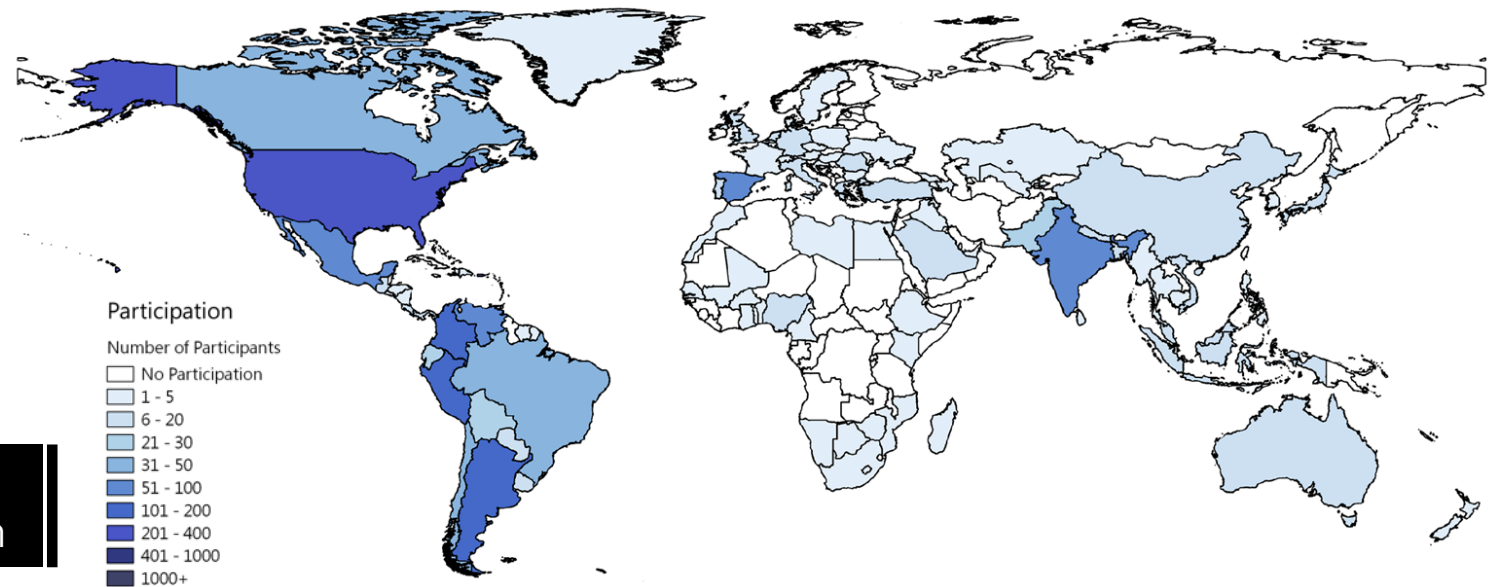


1,435+ organizations

## Training Topics Include...



## Global Disaster Training Attendees (2017)



# ARSET Training Impacts: Water Resources (2014 - 2018)



23 trainings



4,300+ participants

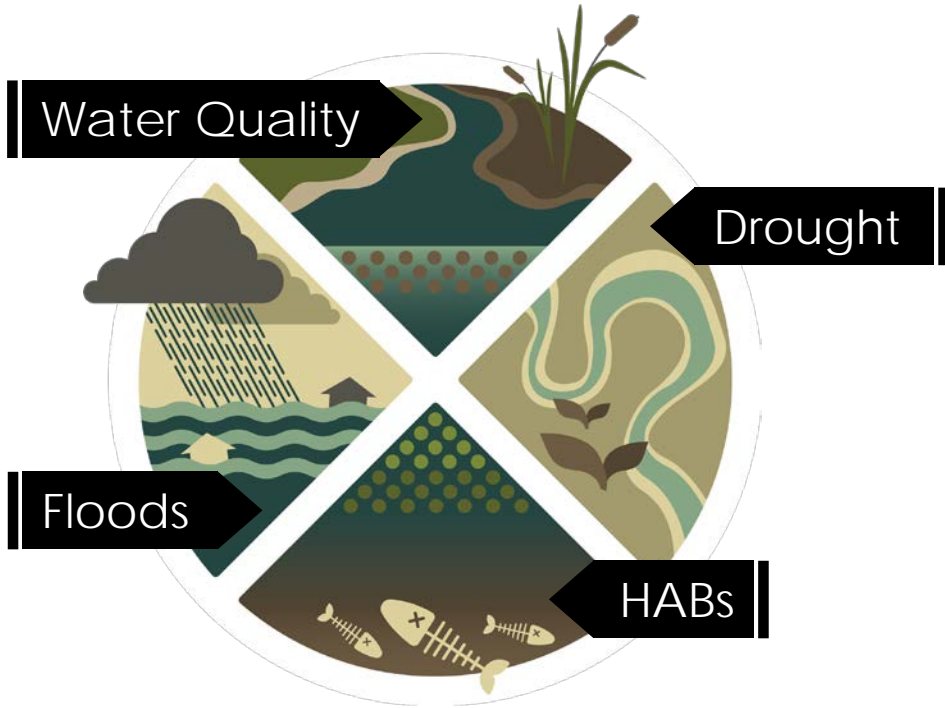


135+ countries

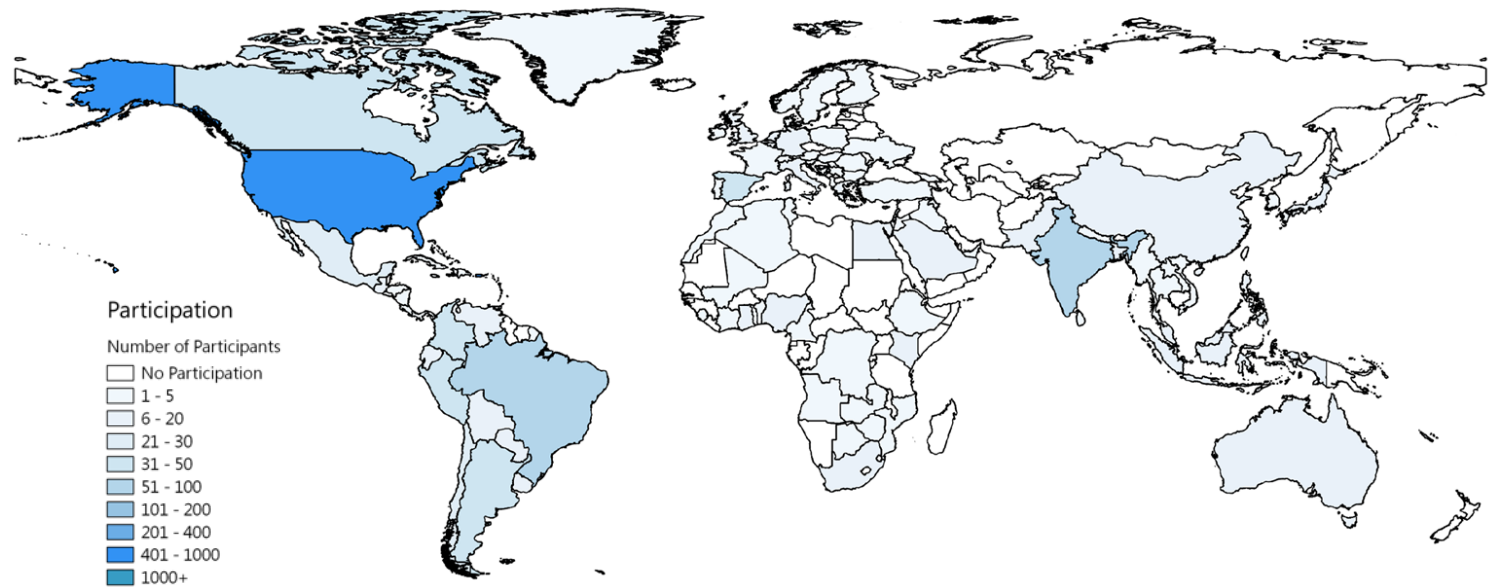


1,770+ organizations

## Training Topics Include...



## Global Water Resources Training Attendees (2017)



# Learn More About ARSET

<http://arset.gsfc.nasa.gov/>

The screenshot shows the ARSET website interface. At the top, there is a header with the NASA logo, the text "ARSET Applied Remote Sensing Training", and navigation links for "Earth Sciences Division", "Applied Sciences", and "ASP Water Resources". A search bar is located on the right side of the header. Below the header is a navigation menu with "Home", "About", and "Trainings" (which is expanded to show "Fundamentals", "Disasters", "Health & Air Quality", "Land", and "Water Resources"). The main content area features a large image of a satellite view of a coastal area with a greenish tint, overlaid with a dark grey box containing the text "Introduction to Remote Sensing of Harmful Algal Blooms" and "Tuesdays, Sep 5-26, 2017 11:00-12:00 or 21:00-22:00 EDT (UTC-4)". A "Register Now" button is positioned at the bottom of this box. To the right of the main content is a sidebar with the heading "ARSET" and several links: "Online Trainings", "In-Person Trainings", "Sign up for the Listserv" (highlighted with a red circle and a mouse cursor), "Tools Covered", "Suggest a Training", "Personnel", and "Resources". Below the sidebar is a section titled "Upcoming Training" with the heading "Water" and the text "Satellite Observations of Water Quality for".





# Sign up for the ARSET Listserv

<https://lists.nasa.gov/mailman/listinfo/arset>



As the weather warms in the Northern Hemisphere, many will notice an increase in algal blooms like [this one](#) which occurred in Washington last year. [Learn the basics of aquatic remote sensing, including how to access satellite-derived chlorophyll data.](#)

## UN Sustainable Development Goals

In the 2030 Agenda for Sustainable Development, the United Nations established a series of goals for protecting the planet and ending global poverty. In a recent ARSET webinar, nearly 400 participants learned to use satellite observations of air quality in support of the goals. The training was featured on the [SDG Knowledge Hub](#), and materials from the training are now available on the [ARSET website](#). This June, the program is offering a three day webinar on remote sensing of land indicators for Sustainable Development Goal 15.

[Register Here](#)

NASA EOSDIS recently announced that Reverb data search would be replaced with Earthdata Search by the end of the year. The new system will be faster and easier to use. [Read the full announcement here](#)»

Remote Sensing of  
Aquatic Environments



## Introduction to Synthetic Aperture Radar Introducción al Radar de Apertura Sintética

June 28, 29 and July 5, 6  
English: 21:00-22:00 EDT (UTC-4)

SAR can observe the Earth's surface day and night, through most weather conditions, and the signal can penetrate the vegetation canopy. There are a number of existing SAR datasets from current and past airborne and satellite missions, as well as exciting upcoming missions. This online webinar will focus on building the skills needed to acquire and understand SAR data, including polarimetric and interferometric SAR (PolSAR and InSAR), as well as potential applications.

[Register](#)

28, 29 de junio y 5, 6 de julio  
Español: 12:00-13:00 EDT (UTC-4)

SAR puede observar la superficie terrestre de día y de noche y a través de la mayoría de las condiciones meteorológicas. Además, la señal puede penetrar la cubierta vegetal y proporcionar información relacionada al estado de inundación de la vegetación. Existen datos de SAR del presente y del pasado obtenidos desde satélites y aviones y habrá más con futuras misiones. Esta capacitación en línea se enfocará en desarrollar los conocimientos necesarios para adquirir y entender datos de SAR incluyendo polarimetría e interferometría y sus potenciales aplicaciones.



The MODIS image above (Credit: [NASA Earth Observatory](#)) shows a wildfire burning in Greenland. Many areas around the world are experiencing above average wildfire activity this year. [Learn to forecast, monitor, and manage wildfires using satellite observations.](#)

## SAR Success

We just wrapped up our first training focused on Synthetic Aperture Radar. Unlike optical sensors, SAR can penetrate through cloud cover and vegetation and is useful for nighttime observations. This four-session webinar, offered in both English and Spanish, was ARSET's largest training to date. Missed the live webinar? You can watch it on demand.

[Watch Now](#)

## Have You Heard of AppEEARS?

Application for Extracting and Exploring Analysis Ready Samples, or AppEEARS, is a useful tool for downloading remote sensing data. Download just the data you need by subsetting spatially (by point or area), temporally, and spectrally. The application also allows you to visualize the results before downloading them.

[Learn More](#)







# Flood Monitoring and Management Data Needs

# About Floods

<https://www.ready.gov/floods>

- Flooding is a temporary overflow of water onto land that is normally dry
- The most common disaster affecting human lives
- Can cause infrastructure damage, power outages
- Disrupt transportation
- Create landslides
- About six inches (15 cm) of moving water can knock one down, and one foot (30 cm) of moving water can sweep a vehicle away!

About 12% of the Indian subcontinent is flood prone and about 76% of the coastline is prone to cyclone-related flooding

<http://iopscience.iop.org/article/10.1088/1755-1315/80/1/012054/pdf>



# Types of Floods

- Pluvial Floods: Result of intense rainfall or snowmelt
- Fluvial Floods: Result of riverine flooding and over-bank flow
- Storm Surge Floods: Occur in coastal regions due to winds and wave activities
- Overflow of dams or water reservoirs

Flash Floods, Riverine Floods, Urban Floods, Coastal Floods, and Ponding all occur in India due to monsoon rains and tropical cyclones



<https://www.mapsofindia.com/top-ten/geography/india-flood.html>





# Flood Monitoring and Management

Require geophysical and socioeconomic data:

- Floodplain Map: Terrain, Digital Elevation Model, Low-lying areas
- Precipitation Intensity, Frequency
- River Stage, Streamflow, Inundation
- Coastal Surges and Inundation
- Land Use Change: Exposed Soil versus Built-up Areas, Soil Moisture
- Population, Infrastructure
- Drainage and Storm Water System Capacity (Urban Floods)
- Flood Return Period
- Hydrology and Routing Model





# Flood Monitoring and Management Data Needs

Flood Stage	Data
<p><b>Watch</b> (Conditions Favorable for Flooding)</p>	<p>Weather Forecast (Precipitation Systems, Storms), Probability of Flooding based on past cases, Hydrologic Model Forecast of Streamflow</p>
<p><b>Warning</b> (Flooding Imminent or Occurring)</p>	<p>Near Real-time Precipitation, Streamflow, Surface Inundation</p>
<p><b>Response</b> (During Flooding)</p>	<p>Near Real-time Precipitation, Streamflow, Surface Inundation, Power Outages, Rescue Plans, Equipment, Routes, Shelter</p>
<p><b>Relief and Recovery</b> (Post-flood)</p>	<p>Near Real-time Precipitation, Streamflow, Surface Inundation, Ponding, Power Outages, Damage Assessment, Infrastructure Safety, Relief Activity planning</p>
<p><b>Mitigation</b> (Long-term Preparedness and Planning)</p>	<p>Historical Information: Flood Cases, Precipitation, Streamflow, Inundation, Damage data</p>

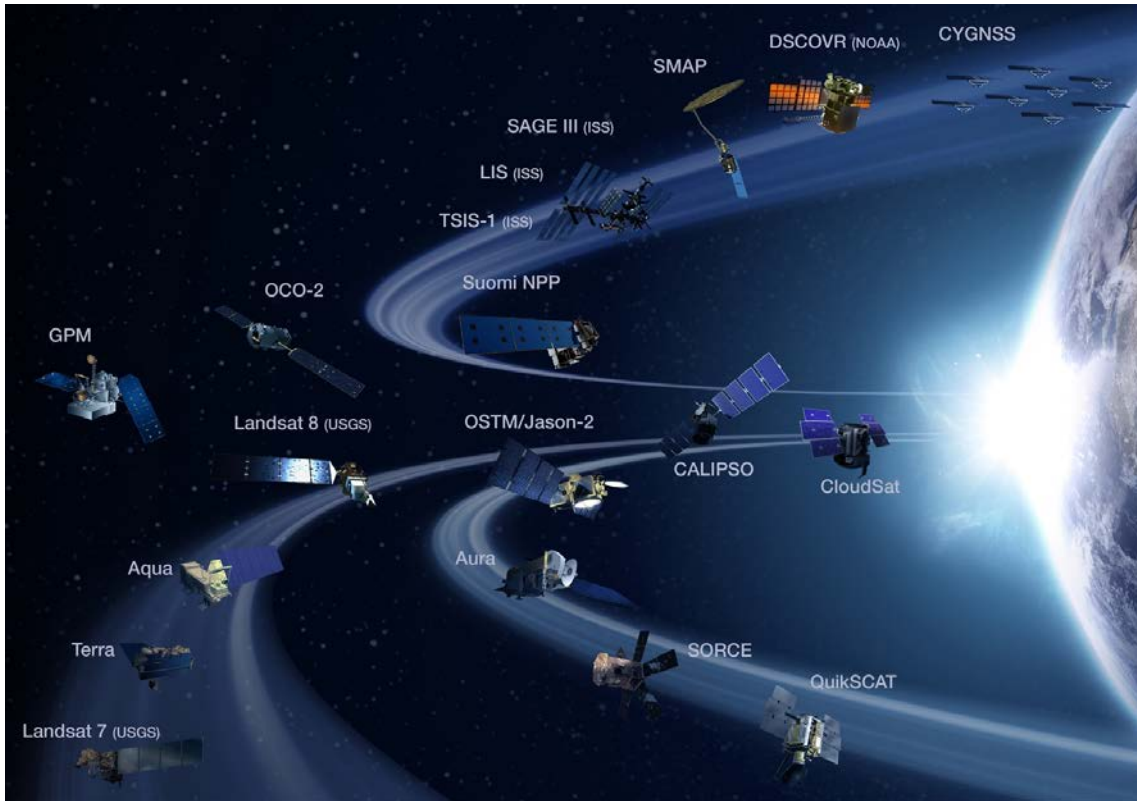
Population, Infrastructure (buildings, roads), Elevation and Slope, Location (Urban/Rural, Coastal, Land Cover Type)





# NASA Earth Science Data For Flood Monitoring and Management

# Satellites Relevant for Flood Monitoring and Management



- European Space Agency
  - Sentinel-1A: 4/2014 – present
  - Sentinel-1B: 4/2016 – present

- Landsat: 07/1972 – present
- Tropical Rainfall Measuring Mission (TRMM): 11/1997 – 04/2015
- Global Precipitation Measurement mission (GPM): 02/2014 – present
- Terra: 12/1999 – present
- Aqua: 05/2002 – present
- Suomi National Polar-Orbiting Partnership (SNPP): 11/2011-Present
- Soil Moisture Active Passive (SMAP): 01/2015 – present
- Shuttle Radar Topography Mission (SRTM) 2001





# Satellites and Sensors for Monitoring Flooding

Satellites	Session
Landsat 7, 8	Session 1 & 2
TRMM & GPM	Session 1 & 2
Terra & Aqua	Session 4
SNPP	Session 1
SMAP	Session 1 & 2
Sentinel 1A and 1B/SAR	Sessions 3 & 4
Space Shuttle Endeavour/SRTM	Session 1 & 2



# NASA Earth System Model and Ancillary Data for Monitoring and Management

Source	Session
Earth System Model Goddard Earth Observing System (GEOS-5)	Session 1 & 2
SEDAC	Session 1 & 2



# Remote Sensing-Based Flood Monitoring Tools

Tool	Session
<p>NRT Global Flood Mapping <a href="https://floodmap.modaps.eosdis.nasa.gov/">https://floodmap.modaps.eosdis.nasa.gov/</a> Dartmouth Flood Observatory <a href="http://floodobservatory.colorado.edu/">http://floodobservatory.colorado.edu/</a></p>	<p>Sessions 4, 5, 6</p>
<p>Global flood Monitoring System (GFMS) <a href="http://flood.umd.edu/">http://flood.umd.edu/</a> Extreme Rainfall Detection System (ERDS) <a href="http://erds.ithacaweb.org/">http://erds.ithacaweb.org/</a></p>	<p>Sessions 4, 5, 6</p>
<p>GDACS: <a href="http://www.gdacs.org/">http://www.gdacs.org/</a></p>	<p>Sessions 5</p>







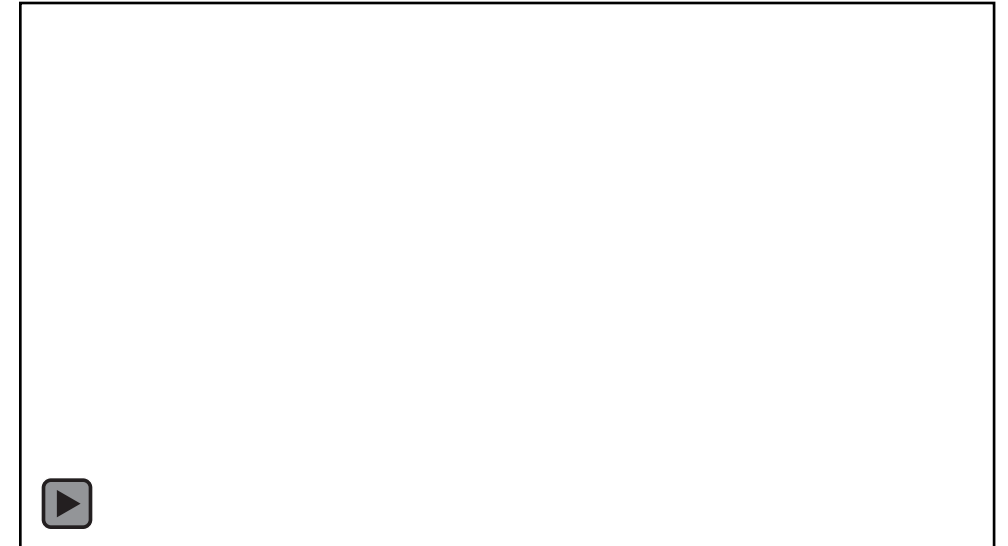
Data Description: Precipitation, Soil Moisture, Weather Data [Winds, Temperature, Moisture], Terrain, Socioeconomic Data, Night Light Imagery

# Integrated Multi-satellitE Retrievals for GPM (IMERG)

[http://pmm.nasa.gov/sites/default/files/document\\_files/IMERG\\_ATBD\\_V4.5.pdf](http://pmm.nasa.gov/sites/default/files/document_files/IMERG_ATBD_V4.5.pdf)

- GPM Core satellite data (GMI & DPR) are used to calibrate and combine microwave data from GPM constellation satellites
- GPM constellation satellites include:
  - GCOM-W
  - DMSP
  - Megha-Tropiques
  - MetOp-B
  - NOAA-N'
  - NPP
  - NPOESS
- Final rain product is calibrated with rain gauge analyses on monthly time scale

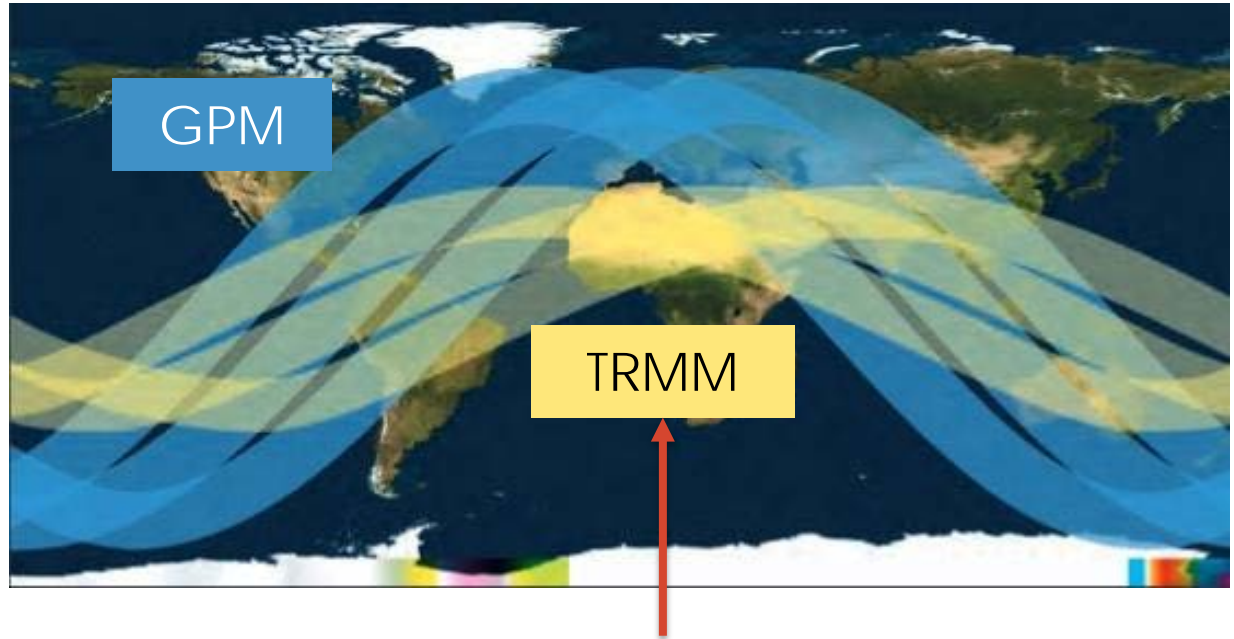
## GPM Core and Constellation Satellites



# 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 day orbits a day, covering global area between 65°S – 65°N
- Along with constellation of satellites, GPM has a revisit time of 2-4 hrs over land
- Sensors:
  - GMI (GPM Microwave Imager)
  - DPR (Dual Precipitation Radar)



Tropical Rainfall Measurement Mission



# Multi-Satellite Algorithms for TRMM and GPM

<http://pmm.nasa.gov/science/precipitation-algorithms>

- TRMM & GPM Core satellites are used to calibrate microwave observations from a constellation of national and international satellites
- Allow improved spatial and temporal coverage of precipitation data
- TRMM Multi-satellite Precipitation Analysis (**TMPA**)
- Widely used for applications
- TMPA will be extended to match Integrated Multi-satellitE Retrievals for GPM (**IMERG**)





# Integrated Multi-satellite Retrievals for GPM (IMERG)

[http://pmm.nasa.gov/sites/default/files/document\\_files/IMERG\\_ATBD\\_V4.5.pdf](http://pmm.nasa.gov/sites/default/files/document_files/IMERG_ATBD_V4.5.pdf)

- Multiple runs accommodate different user requirements for latency and accuracy
  - “Early” – now 5 hours (flash flooding) – will be 4 hours
  - “Late” – now 15 hours (crop forecasting) – will be 12 hours
  - “Final” – 3 months (research data)
- Native time intervals are half-hourly and monthly (final only)
  - Value-added products at 3 hrs, 1, 3, and 7 days are available
  - Initial release covers 60°N-60°S – will be extended to 90°N-90°S



# TMPA and IMERG

	TMPA	IMERG
Spatial Resolution	0.25° x 0.25°	0.1° x 0.1°
Spatial Coverage	Global, 50° S-50°N	Global, 60°S-60°N (will be extended from pole to pole)
Temporal Resolution	3 hours	30 minutes
Temporal Coverage	12/1997 – Present*	2/27/2014 – Present+

\* After April 8, 2015, TRMM climatological calibration is being used to generate TMPA

+TMPA and IMERG combined data will be available in early 2018 at IMERG data resolution

TMPA is widely used for flood modeling and IMERG will replace it in the near future



# GPM IMERG Data Access

<https://pmm.nasa.gov/data-access>

**Data Access**

- Extreme Weather News
- ▼ Data Downloads & Documentation
  - TRMM
  - GPM
  - Ground Validation
- Data Sources
- Data Recipes
- Data News
- Google Earth
- NASA Worldview
- Using the PPS FTP
- Training
- Data FAQ

**Connect With Us**

- Twitter
- Facebook
- Youtube

**Need Help?**

- View Frequently Asked Questions
- View the PMM Glossary

**How to Access TRMM & GPM Precipitation Data**

Precipitation data from the GPM and TRMM missions is made available free to the public in a variety of formats from several sources at [NASA](#) Goddard Space Flight Center. This section outlines the different types of data available, the levels of processing, the sources to download the data, and some helpful tips for utilizing precipitation data in your research.

- **GPM Data Downloads & Documentation**
- TRMM Data Downloads & Documentation
- Explanation of GPM & TRMM Data Sources
- Data Processing "Recipes"
- Precipitation Data in Google Earth
- Frequency Asked Questions (FAQ)

**GET DATA**  
GLOBAL PRECIPITATION MEASUREMENT  
New Users Start Here

**Use of the PPS FTP and STORM requires you to first register your email address. Click here to register.**

- All about GPM data
  - Including updates, news, and FAQ
- Quick data access links and user registration
- For more information about GPM and data access visit: <https://pmm.nasa.gov/training>



# Precipitation Data Access and Analysis

<https://giovanni.gsfc.nasa.gov/giovanni/>

The screenshot shows the GIOVANNI web interface with several red callout boxes highlighting key features:

- Analysis and Plot Options:** A box pointing to the "Select Plot" section, which includes radio buttons for "Maps: Time Averaged Map", "Comparisons: Select...", "Vertical: Select...", "Time Series: Select...", and "Miscellaneous: Select...".
- Temporal and Spatial Search Map & shapefile selection for various countries or the U.S.:** A box pointing to the "Select Date Range (UTC)" and "Select Region (Bounding Box or Shape)" sections. The date range section includes input fields for "YYYY-MM-DD" and "HH:mm" with a "Valid Range: 1948-01-01 to 2018-04-16" note. The region section includes a text input field and a "Format: West, South, East, North" note.
- Search data by keyword:** A box pointing to the "Number of matching Variables: 0 of 1901" and "Total Variable(s) included in Plot: 0" section, which includes a "Keyword:" input field and "Search" and "Clear" buttons.
- Plot Data:** A box pointing to the "Plot Data" button at the bottom right of the interface.

The interface also features a top navigation bar with "EARTHDATA", "Data Discovery", "DAACs", "Community", and "Science Disciplines". A sidebar on the left lists "Select Variables" under "Disciplines" and "Measurements".

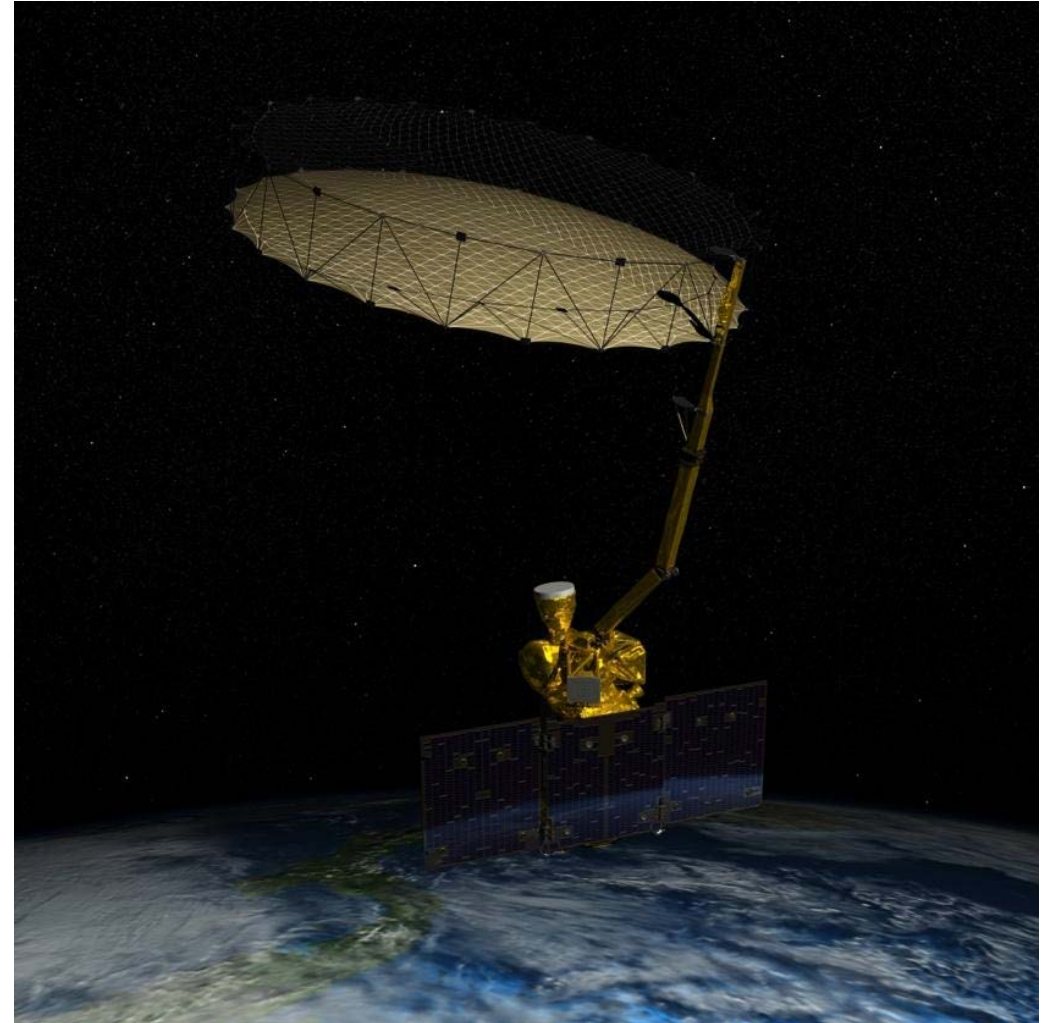




# Soil Moisture Active Passive (SMAP)

<http://smap.jpl.nasa.gov>

- Polar Orbit
  - Altitude: 685 km
- Spatial Coverage:
  - Global
- Launched Jan 31, 2015
- Temporal Coverage:
  - April 2015 – present
- Sensors:
  - Microwave Radiometer
  - Microwave Radar (not currently available)

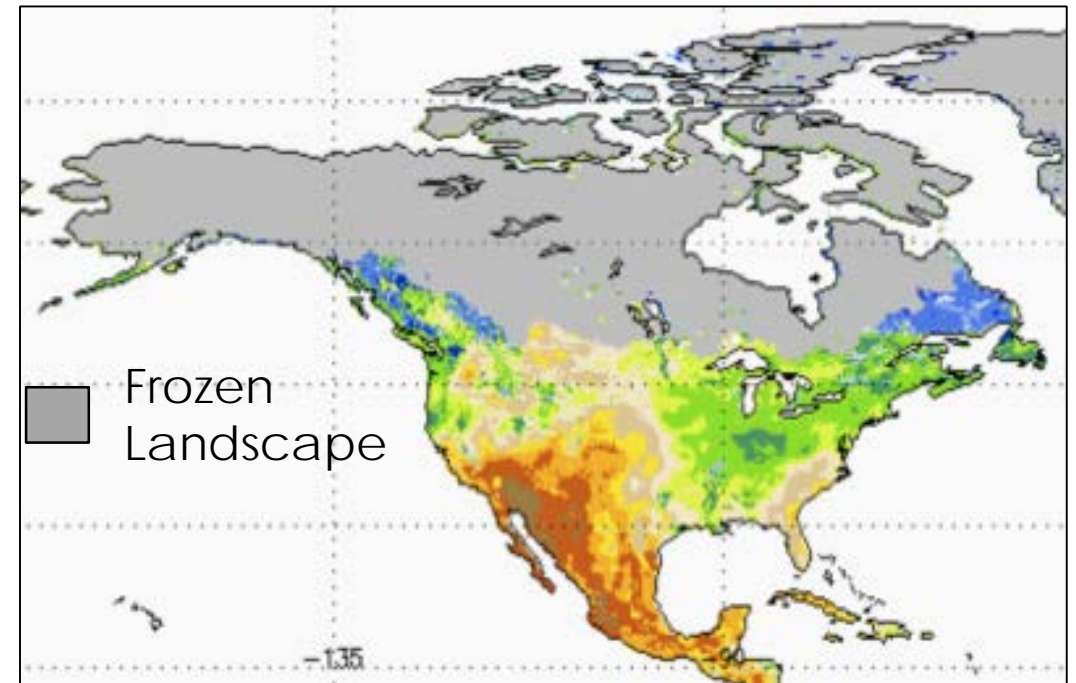


# SMAP Microwave Radiometer & Radar

<http://smap.jpl.nasa.gov/observatory/instrument/>

- Radiometer:
  - Swath: 1,000 km
  - Frequency: 1.41 GHz
  - Polarization: H, V, 3<sup>rd</sup> & 4<sup>th</sup> Stokes
  - Resolution: 40 km
- Radar: designed to work as Synthetic Aperture Radar (SAR)
  - Frequency: 1.26 GHz
  - Polarization: VV, HH, HV
  - Resolution: 3 km
  - **Stopped operating after Jul 7, 2015**
- Temporal Resolution:
  - Every 3 days

Measures moisture in the top 5 cm of soil



useful for flood monitoring



# Where do you get SMAP data?

Available from the National Snow & Ice Data Center:  
<http://nsidc.org/data/search/#keywords=soil+moisture/>

NSIDC National Snow & Ice Data Center

DATA RESEARCH NEWS ABOUT

SEARCH Web pages

Soil Moisture Active Passive Data (SMAP)  
NASA SMAP data at the NSIDC DAAC. [Read more...](#)

Scientific Data for Research

Glaciers Ice Sheets Ice Shelves Permafrost Sea Ice Soil Moisture Snow Search for more

Showing 1-25 of 236 Data Sets

Sort by: Relevance (highest to lowest) Per page: 25

Parameter

- Active Layer (20)
- Aerosols (2)
- Air Temperature (40)
- Albedo (4)
- Altitude (2)
- Antenna Temper... (1)
- Atmospheric Ch... (4)
- Atmospheric Pre... (18)
- Atmospheric Pro... (28)

Spatial Coverage

- Show Global Only (25)

Temporal Duration

- < 1 year (164)
- 1+ years (68)
- 5+ years (32)
- 10+ years (22)
- Not specified (4)

Format

- ASCII Text (128)
- Binary (25)
- Documents (13)
- ESRI Shapefile (3)
- GRIB (1)

SMAP L3 Radar Global Daily 3 km EASE-Grid Soil Moisture

Temporal Coverage 2015-04-13 to 2015-07-07

Parameter Sigma Nought | Soil Moisture

Data Format HDF5

Summary This Level-3 (L3) soil moisture product provides a composite of daily estimates of global land surface conditions retrieved by the Soil Moisture Active Passive (SMAP) radar as ...More Detail

SMAP L2 Radar Half-Orbit 3 km EASE-Grid Soil Moisture

Temporal Coverage 2015-04-13 to 2015-07-07

Parameter Sigma Nought | Soil Moisture

Data Format HDF5

Summary This Level-2 (L2) soil moisture product provides estimates of global land surface conditions retrieved by the Soil Moisture Active Passive (SMAP) active radar during 6:00 a.m. ...More Detail

SMAP L3 Radiometer Global Daily 36 km EASE-Grid Soil Moisture

Temporal Coverage 2015-03-31 to continuous

Parameter Brightness Temperature | Soil Moisture

Data Format HDF5

Summary This Level-3 (L3) soil moisture product provides a composite of daily estimates of global land surface conditions retrieved by the Soil Moisture Active Passive (SMAP) passive ...More Detail

SMAP L2 Radiometer Half-Orbit 36 km EASE-Grid Soil Moisture

Temporal Coverage 2015-03-31 to continuous

Parameter Brightness Temperature | Soil Moisture

Data Format HDF5

Summary This Level-2 (L2) soil moisture product provides estimates of global land surface conditions retrieved by the Soil Moisture Active Passive (SMAP) passive microwave radiome ...More Detail

SMAP L4 9 km EASE-Grid Surface and Root Zone Soil Moisture Geophysical Data

Level 2 to Level 4 data



# Where do you get SMAP data?

Application for **Extracting and Exploring Analysis Ready Samples (AppEEARS)**

<https://lpdaacsvc.cr.usgs.gov/appears/>

## Extract Area Sample

The screenshot shows the 'Extract Area Sample' form with several key sections highlighted by red callout boxes:

- Extract data by custom shapefile:** Points to the 'Upload a file or draw a polygon using the [icon] or [icon] icon' section, which includes instructions to drop a vector polygon file and lists supported formats: ESRI Shapefile (.zip including .shp, .shx, and .dbf files) and GeoJSON (.json or .geojson).
- Temporal Selection:** Points to the 'Start Date' and 'End Date' fields, both in MM-DD-YYYY format, with a calendar icon next to each.
- Data & Layer Selection:** Points to the 'Select the layers to include in the sample' section, which includes a search box and a list of selected layers.
- Data Format:** Points to the 'Output Options' section, specifically the 'File Format' dropdown menu set to 'GeoTiff' and the 'Projection' search box.
- Submit Data Extraction Request:** Points to the 'Submit' and 'Cancel' buttons at the bottom right of the form.

Extract data within a box or polygon shapefile

Select a dataset below to list the products that are currently available in AppEEARS.

- ARD
- Combined MODIS
- DAYMET
- eMODIS Smoothed NDVI
- Global WELD
- GPW
- S-NPP NASA VIIRS
- SMAP**
- SRTM
- SSEBop ET
- Terra MODIS
- WELD





# GEOS-5 Weather Data Maps – NRT and Forecast

<https://fluid.nccs.nasa.gov/weather/wxmaps/>

## Precipitation and SLP

## Wind Speed & Direction

**VARIABLES**

Abs EPV	Humidity
<b>Precip &amp; SLP</b>	Temperature
Vorticity	Vert Velocity
Wind Speed	

**REGIONS**

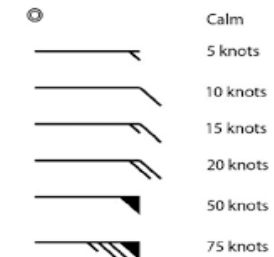
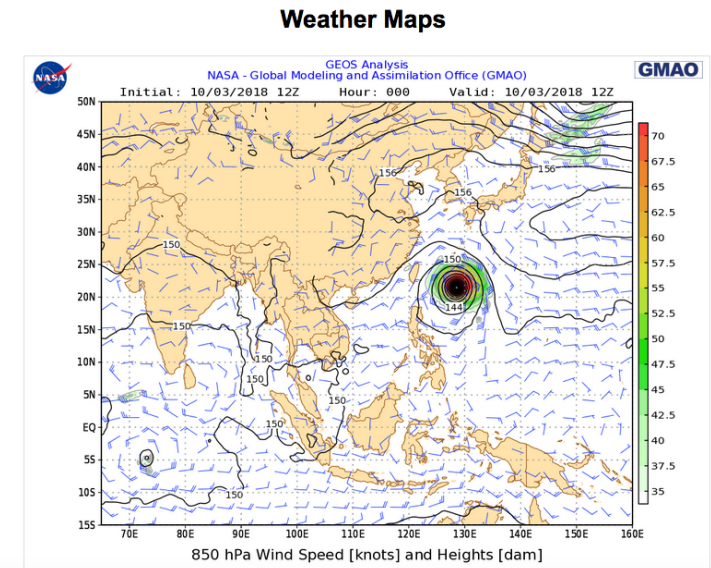
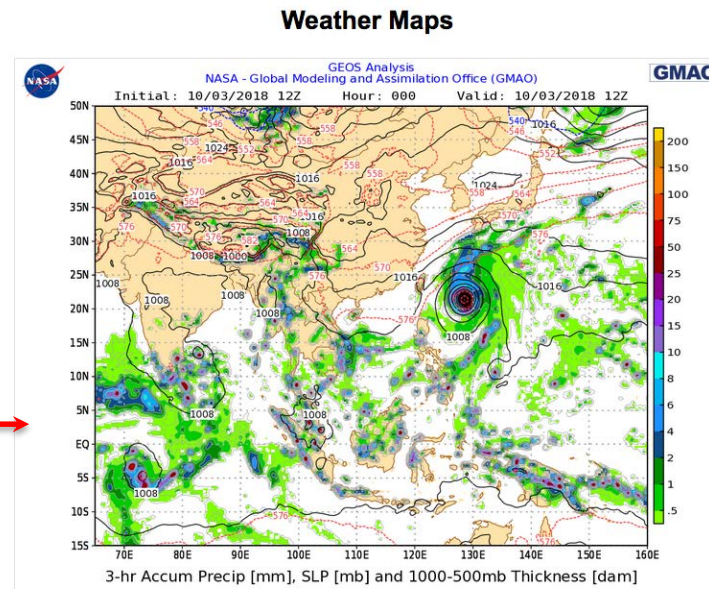
Atlantic	Australia
Global	Mid Atlantic
North America	N Polar
Pacific	<b>Seven Seas</b>
S Polar	

**FORECAST INITIAL TIME**

03Oct2018 12z

**FORECAST LEAD HOUR**

000h 03Oct2018 12z



# GEOS-5 Weather Data Access

[https://portal.nccs.nasa.gov/datashare/gmao\\_ops/pub/fp/das/](https://portal.nccs.nasa.gov/datashare/gmao_ops/pub/fp/das/)

## NCCS Dataportal - Datashare

Name	Last modified	Size	Description
Parent Directory			
GEOS.fp.asm.const_2d_asm_Nx.00000000_0000.V01.nc4	17-Apr-2018 05:50	26M	
Y2014/	03-Jun-2015 13:42	-	
Y2015/	01-Dec-2015 11:19	-	
Y2016/	01-Dec-2016 09:35	-	
Y2017/	01-Dec-2017 11:03	-	
Y2018/	01-Apr-2018 13:33	-	

## NCCS Dataportal - Datashare

Name	Last modified	Size	Description
Parent Directory			
M01/	31-Jan-2016 09:52	-	
M02/	29-Feb-2016 10:14	-	
M03/	31-Mar-2016 10:09	-	
M04/	30-Apr-2016 10:09	-	
M05/	31-May-2016 10:44	-	
M06/	30-Jun-2016 10:11	-	
M07/	31-Jul-2016 09:56	-	
M08/	31-Aug-2016 10:06	-	
M09/	30-Sep-2016 09:35	-	
M10/	31-Oct-2016 09:36	-	
M11/	30-Nov-2016 10:05	-	
M12/	31-Dec-2016 09:33	-	

Name Last modified Size Description

Parent Directory			
D01/	02-Oct-2016 09:42	-	
D02/	03-Oct-2016 09:42	-	
D03/	04-Oct-2016 09:41	-	
D04/	05-Oct-2016 09:56	-	
D05/	06-Oct-2016 09:37	-	
D06/	07-Oct-2016 09:42	-	
D07/	08-Oct-2016 13:29	-	
D08/	09-Oct-2016 09:45	-	
D09/	10-Oct-2016 09:49	-	
D10/	11-Oct-2016 09:45	-	
D11/	12-Oct-2016 09:44	-	
D12/	13-Oct-2016 10:00	-	
D13/	14-Oct-2016 09:49	-	
D14/	15-Oct-2016 09:55	-	
D15/	16-Oct-2016 10:12	-	
D16/	17-Oct-2016 11:17	-	
D17/	18-Oct-2016 09:47	-	
D18/	19-Oct-2016 09:41	-	
D19/	20-Oct-2016 09:43	-	
D20/	21-Oct-2016 10:19	-	
D21/	22-Oct-2016 09:55	-	
D22/	23-Oct-2016 09:49	-	

GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_0030.V01.nc4	09-Oct-2016 09:38	47M	
GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_0130.V01.nc4	09-Oct-2016 09:38	47M	
GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_0230.V01.nc4	09-Oct-2016 09:38	47M	
GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_0330.V01.nc4	09-Oct-2016 13:56	47M	
GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_0430.V01.nc4	09-Oct-2016 13:56	47M	
GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_0530.V01.nc4	09-Oct-2016 13:56	47M	
GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_0630.V01.nc4	09-Oct-2016 13:56	47M	
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GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_0830.V01.nc4	09-Oct-2016 13:56	47M	
GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_0930.V01.nc4	09-Oct-2016 20:53	47M	
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GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_1430.V01.nc4	09-Oct-2016 20:53	47M	
GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_1530.V01.nc4	10-Oct-2016 01:54	47M	
GEOS.fp.asm.tavg1_2d_slv_Nx.20161009_1630.V01.nc4	10-Oct-2016 01:54	47M	

### Data Access

» HTTPS

Assimilation | Forecast

» OPeNDAP

Assimilation | Forecast

» FTP (No Password)

Assimilation | Forecast

HTTP Files

Year & Month

Day

Hourly Files

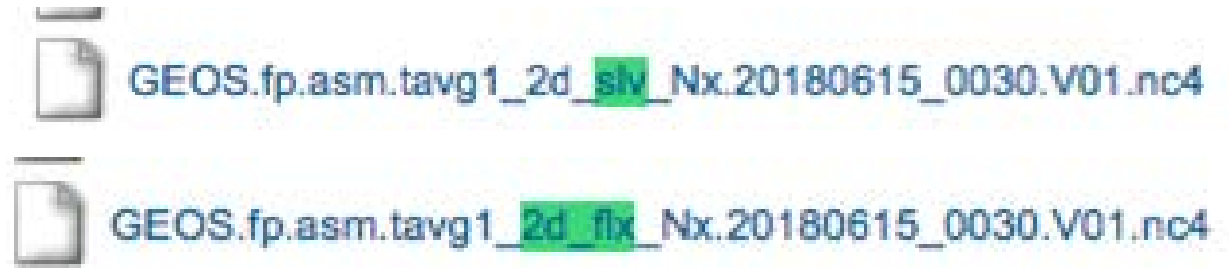


# GEOS-5 Weather Data Access

[https://portal.nccs.nasa.gov/datashare/gmao\\_ops/pub/fp/das/](https://portal.nccs.nasa.gov/datashare/gmao_ops/pub/fp/das/)

- Download Single Level (SLV) files (hourly\_ For Winds and Humidity)
- Download 2-d Time Averaged Surface Flux Diagnostics for Precipitation
- See this document for filename convention:

[https://gmao.gsfc.nasa.gov/products/documents/GEOS\\_5\\_FP\\_File\\_Specification\\_ON4v1\\_1.pdf](https://gmao.gsfc.nasa.gov/products/documents/GEOS_5_FP_File_Specification_ON4v1_1.pdf)

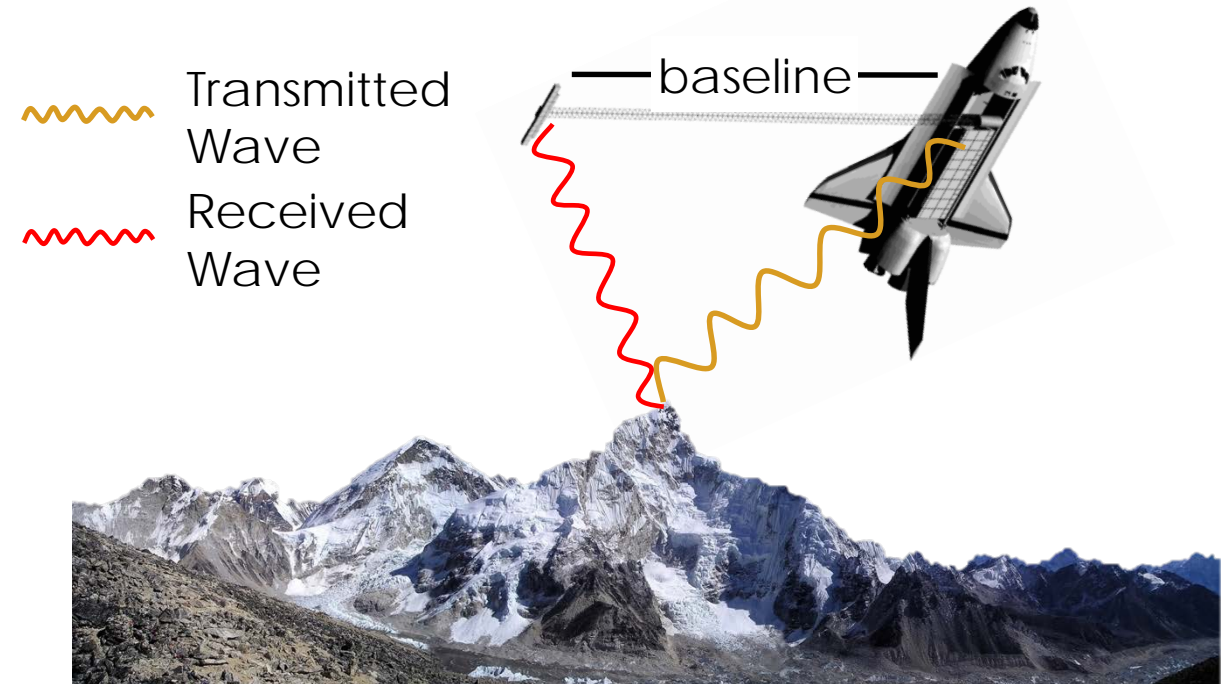


# Terrain Data From Shuttle Radar Topography Mission (SRTM)

<https://www2.jpl.nasa.gov/srtm/mission.htm>

- A C-band (5.6 cm) SAR mission
- On NASA Space Shuttle Endeavour
- Completed February 2000
- 176 orbits around Earth in 11 days
- Generated digital elevation maps of all land between 60°N- 56°S latitude
- ~80% of Earth's total land mass
- SRTM used interferometry to generate topographic (elevation) maps
- For detailed information see: [https://arset.gsfc.nasa.gov/sites/default/files/water/Brazil\\_2017/Day3/S6P2.pdf](https://arset.gsfc.nasa.gov/sites/default/files/water/Brazil_2017/Day3/S6P2.pdf)

**Radar signals being transmitted and received on the SRTM mission (not to scale)**



Spatial Resolution: 30 m





# SRTM Elevation Data Access From Global Data Explorer (GDEx)

<http://gdex.cr.usgs.gov/>

The screenshot displays the Global Data Explorer (GDEx) interface. At the top, there are navigation menus for 'EARTHDATA', 'Data Discovery', 'DAACs', 'Community', and 'Science Disciplines'. The main header features the USGS logo and 'LP DAAC'. A toolbar contains various map navigation icons: zoom in (+), zoom out (-), pan (hand), and a bounding box tool. A red box highlights the bounding box tool, with an arrow pointing to a text box that reads 'Define region of interest by bounding box, state, country, or lat/long'. Another red box highlights the refresh icon (circular arrow), with an arrow pointing to a text box that reads 'Refresh'. A third red box highlights the download icon (floppy disk with a plus sign), with an arrow pointing to a text box that reads 'Download'. The main map area shows a topographic map of the United States and Mexico. On the right side, there is a 'Map Layers' panel with a list of data layers: 'Background Image' (ASTER Global DEM, NASA Blue Marble), 'Data Coverage' (ASTER Global DEM V2, NGA SRTM 1 arcsec, NGA SRTM 3 arcsec, NASA SRTM 1 arcsec, NASA SRTM 3 arcsec), 'World Boundaries' (Country, State/Province), and a 'Legend' section with a map outline. The footer contains links for 'Accessibility', 'FOIA', 'Privacy', and 'Policies and Notices', along with contact information for the U.S. Department of the Interior and U.S. Geological Survey.



# Socioeconomic Data

<http://sedac.ciesin.columbia.edu/>

**SOCIOECONOMIC DATA AND APPLICATIONS CENTER (SEDAC)**  
A Data Center in NASA's Earth Observing System Data and Information System (EOSDIS) — Hosted by CIESIN at Columbia University

DATA | MAPS | THEMES | RESOURCES | SOCIAL MEDIA | ABOUT | HELP

Data Collections (41)

1 of 2  
Prev | Next

- Anthropogenic Biomes**  
Describes 21 global anthropogenic biomes based on population density, land use, and vegetation cover, grouped into six categories—dense settlements, villages, croplands, rangeland, forested, and wildlands.
- Archive of Census Related Products (ACRP)**  
A collection of value-added georeferenced data files derived from the 1990 U.S. Census, spanning the United States and its territories.
- China Dimensions**  
A wide range of data from circa 1990, including administrative boundaries, population and agricultural census data, and other statistics, covering the administrative regions of China.
- Climate Effects on Food Supply**  
Assessments of potential climate change impacts of temperature and precipitation on global staple crop production (wheat, rice, and maize), with a focus on quantitative estimates of yield changes based on multiple climate scenarios.
- Compendium of Environmental Sustainability Indicators**  
A compilation of sustainability indicators from multiple sources incorporating multiple country codes. Methodological summaries are contained in an accompanying metadata database.
- Energy Infrastructure**  
Data on the locations and status of nuclear power facilities along with estimates of the population residing near locations with at least one operating reactor.
- Environmental Performance Index (EPI)**  
Released every two years since 2006, the EPI groups performance indicators into two policy categories, environmental health and ecosystem vitality, in order to gauge how close countries are to reaching established environmental policy goals.
- Environmental Sustainability Index (ESI)**  
Released four times between 2000 and 2005, and based on a compilation of indicators derived from underlying data sets, the ESI measures overall progress towards environmental sustainability for 146 countries.
- Environmental Treaties and Resource Indicators (ENTRI)**  
Information on treaty participation by country, environmental treaty texts, and a Conference of Party (COP) decision search tool for major multilateral environmental agreements.
- Georeferenced Population Data sets of Mexico**  
Administrative boundaries, settlement locations and populations, and gridded population data for Mexico circa 1990. Includes place names, geographic coordinates of more than 30,000 urban and metropolitan places, and elevation data for
- Global Agricultural Lands**  
Combines satellite data with agricultural inventory data to estimate the proportion of land area in cropland and pasture for the year 2000.
- Global Fertilizer and Manure, v1**  
Global gridded data sets of fertilizer application rates and manure production of nitrogen and phosphorus for circa 2000.

## Global Population Density



- Other Useful Datasets:
  - Global impermeable surface data from Landsat satellites
  - Global reservoir and dam
  - Low elevation coastal zones
  - Global roads
  - Energy infrastructure

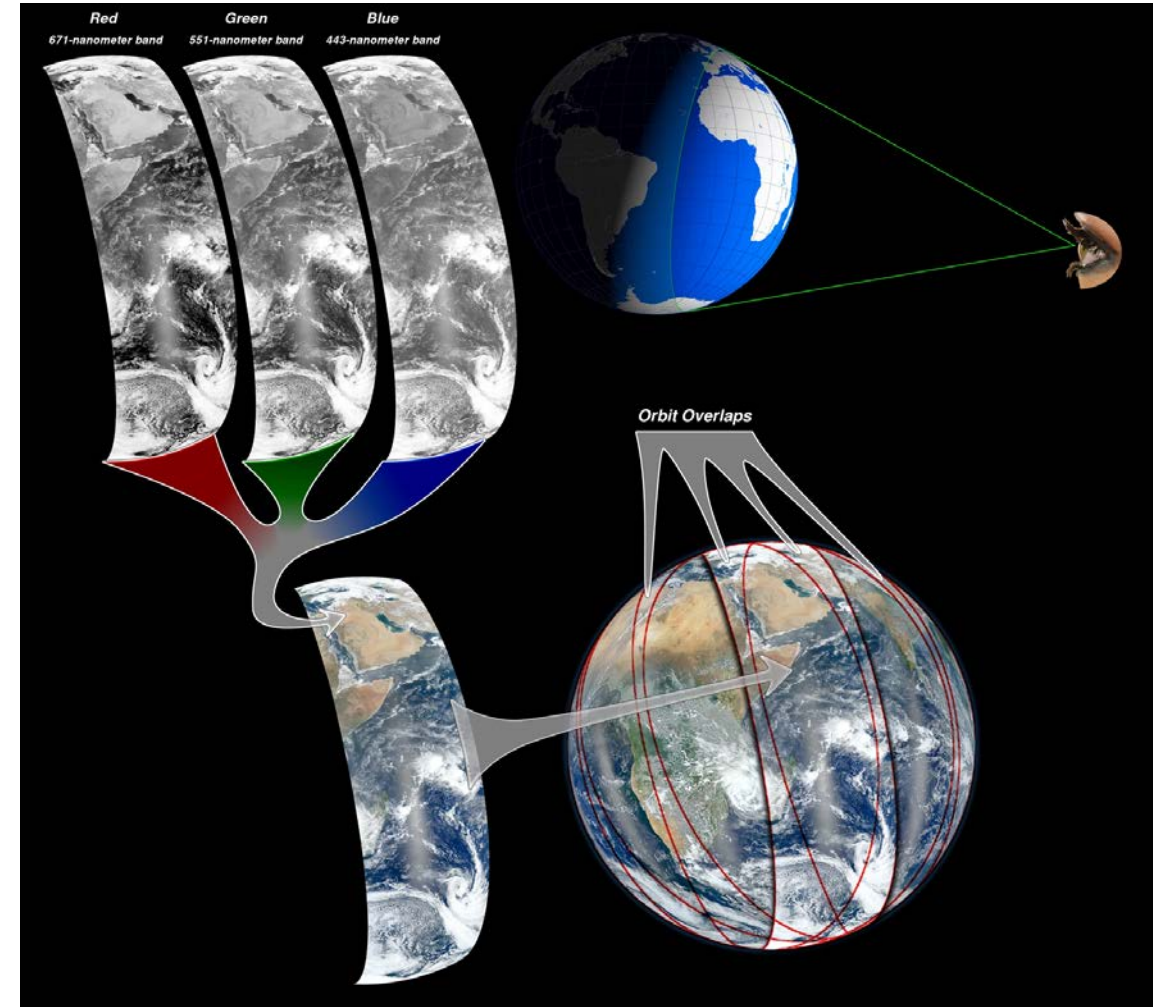




# Suomi National Polar Partnership (SNPP)

[http://nasa.gov/mission\\_pages/NPP/](http://nasa.gov/mission_pages/NPP/)

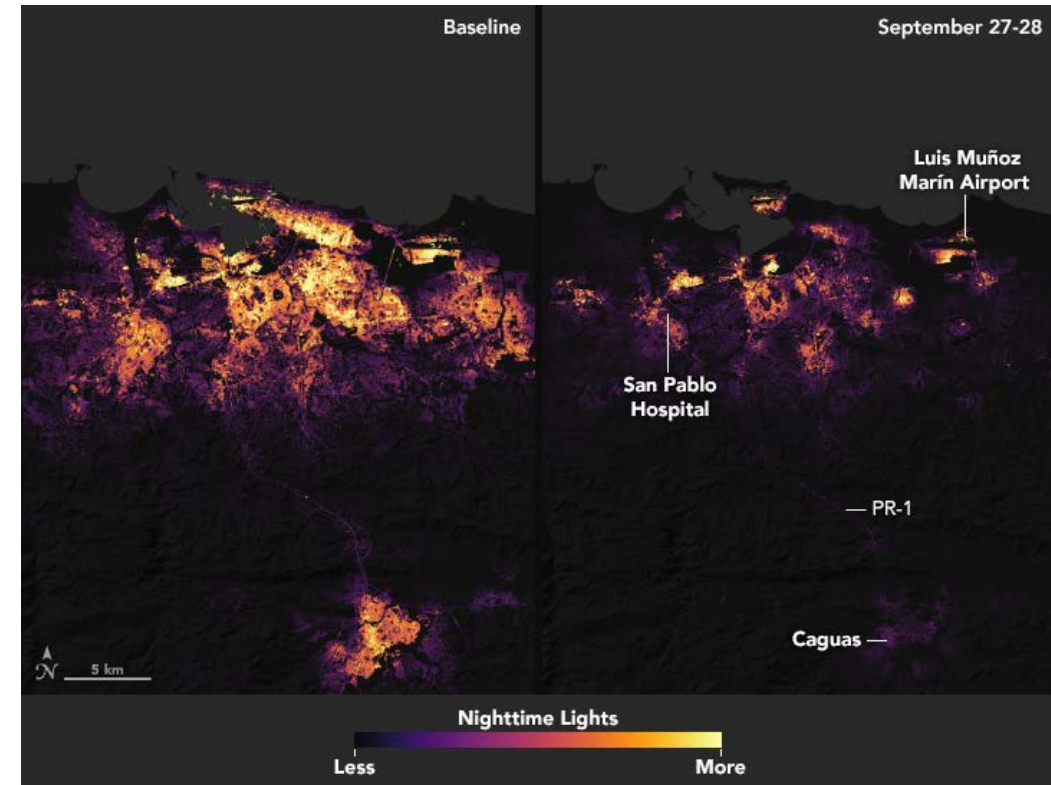
- Polar orbit, 1:30 p.m. equator crossing time
- Global coverage
- November 21, 2011 – present
- Sensors:
  - VIIRS, ATMS, CrIS, OMPS, CERES



# Visible Infrared Imaging Radiometer Suite (VIIRS)

<http://jointmission.gsfc.nasa.gov/viirs.html>

- Functionality similar to MODIS
- Spectral Bands
  - 22 bands (visible, IR, NIR, Mid-IR, **day/night**)
- Spatial Coverage and Resolution
  - Global; swath width: 3,040 km
  - Spatial Resolution: 375 – 750 m
- Temporal Coverage and Resolution
  - Oct 2011 – present
  - 1-2 times per day
- Data Access
  - Land Processing Distributed Active Archive Center:  
[https://lpdaac.usgs.gov/dataset\\_discovery/viirs/](https://lpdaac.usgs.gov/dataset_discovery/viirs/)



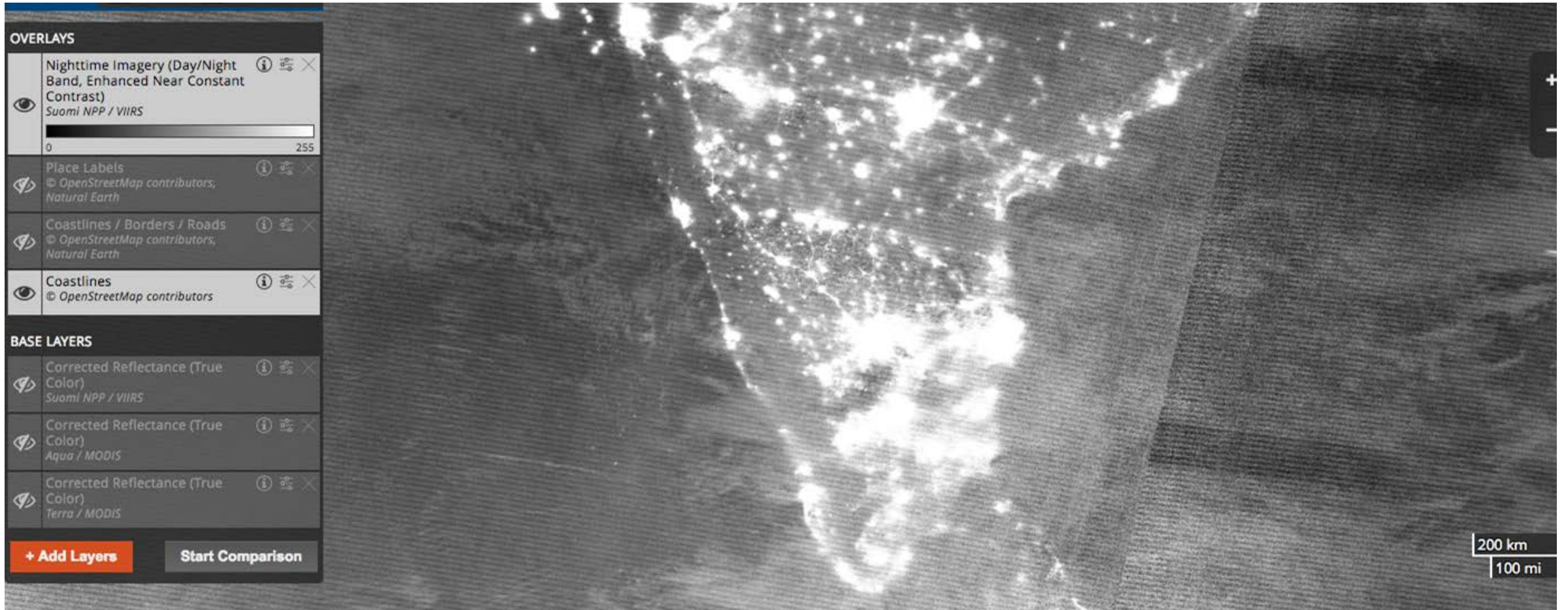
Power Outages in Puerto Rico as a Result of Hurricane Maria





# Where to Get VIIRS Night Light Imagery?

<https://worldview.earthdata.nasa.gov>



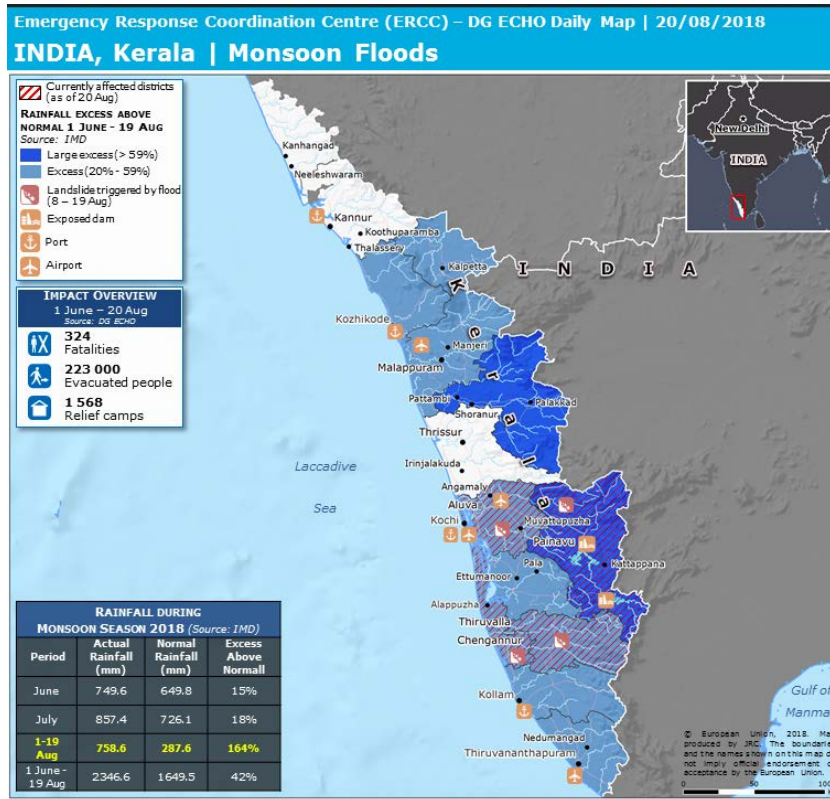




Data Access



# Flood Case: Kerala Floods, 1-19 August 2018



[http://www.gdacs.org/contentdata/maps/daily/FL/1000212/ECMD/20180820 Kerala Floods.png](http://www.gdacs.org/contentdata/maps/daily/FL/1000212/ECMD/20180820_Kerala_Floods.png)

## Kerala floods: death toll rises to at least 324 as rescue effort continues

220,000 people left homeless and thousands still trapped in southern Indian state after unusually heavy rain



▲ 'Please pray for us': Kerala experiences worst monsoon in nearly a century - video report

<https://www.theguardian.com/world/2018/aug/17/kerala-floods-death-toll-rescue-effort-india>



# Demonstration

## Data Access and Download for Kerala

- GEOS-5 Weather Data: [https://gmao.gsfc.nasa.gov/GMAO\\_products/](https://gmao.gsfc.nasa.gov/GMAO_products/)
- Terrain Data: <http://gdex.cr.usgs.gov/>
- Population, Impermeable Surface Data: <http://sedac.ciesin.columbia.edu/>





**Next**

**Exercise: Download and Analyze Precipitation, Soil Moisture  
Analyze Terrain, Population Data**

Case Study: Kerala Floods, 1-19 August 2018

