

UC

# Using NASA Earth Observation Data in ArcGIS

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NASA Goddard Earth Science Data and Information Services Center

# Outline

## ☐ Who Are We

- **GES DISC: Multi-Disciplinary Data Archive and Service Center**

## ☐ Earth Observation (EO) Data Characteristics vs. GIS User Needs

- GES DISC EO Data Characteristics
- ArcGIS Challenges for Handling EO Data
- GIS User Needs from EO data

## ☐ EO Data Service in GIS

- Use Giovanni to explore and transform EO data to GIS tools
- GES DISC OGC Services
- ArcGIS Related Support: Data Recipe, Image Service, upcoming ArcGIS services



# GES DISC - Big Data Archive



- ❑ Archives total volume > 2.3 Petabytes consisting of >110 million data files covering >2500 public and restricted collections, distributes >23 Petabytes
- ❑ **Multi-disciplinary data holdings** include observations and model data of **atmospheric composition, water/energy cycles, climate variability**
- ❑ These include for example Aqua AIRS, Aura HIRDLS/MLS/OMI, **TROPOMI**, **SORCE**, **TOMS**, **TOVS**, **TRMM/GPM**, **UARS**, **LDAS** and **MERRA/MERRA-2**.
- ❑ Through various available tools and services, the GES DISC provides users with multi-sensor and model visual comparisons and data access for a number of projects spanning several disciplines.





# GES DISC- Multi-Disciplines Data Holdings



1200+ data collections being **curated**

## Atmospheric composition missions:

- Nimbus 1-7\* BUV, SBUV, TOMS
- Shuttle SBUV\*
- UARS\*
- Aqua AIRS
- Aura HIRDLS\*, OMI, MLS
- ACOS\*
- SNPP Sounder, OMPS
- JPSS-1 Sounder, OMPS
- GOSAT(ACOS)/OCO-2/OCO-3
- Copernicus Sentinel 5P (TROPOMI)
- TOVS Pathfinder\*

## Model data:

- MERRA\*/MERRA-2
- NLDAS, GLDAS, FLDAS, NCA-LDAS

## Research-derived data:

- MEaSUREs
- CMS

## Near-real time:

- AIRS
- MLS

## Water cycle/precipitation missions:

- TRMM\*
- GPM
- SMERGE

## Future assigned missions:

- TROPICS
- Copernicus Sentinel 6
- GeoCarb

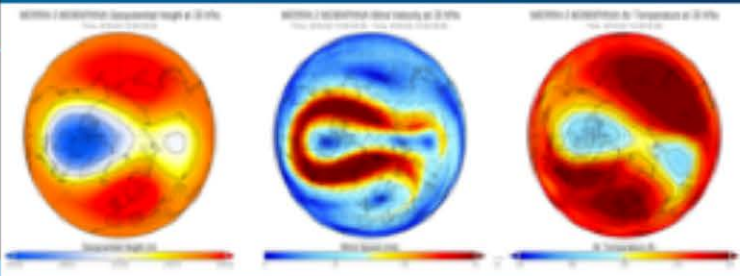
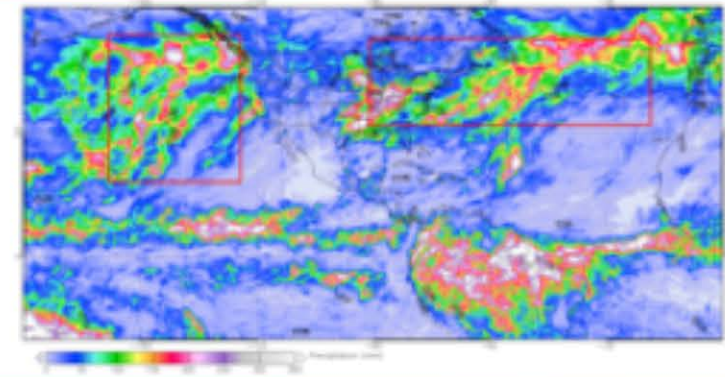
## Climate variability/solar missions:

- SORCE
- TCTE
- TSIS
- CAR

\* end-of-mission/project

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

atmospheric rivers from GPM



polar vortex from MERRA-2

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# GES DISC Earth Observation (EO) Data Characteristics: Multi-spatiotemporal Datasets

→ **Instrument type:** Remote sensing, in-situ, modeling

→ **Measurement Resolutions:**

◆ **Spatially:**

- Global grids (raster) with spatial resolution up to 4-km
- Higher resolution swath (feature points) data (e.g., 2.2-km)

◆ **Temporally:**

- Half-hourly, 3-hourly, daily, monthly satellite measurements
- Hourly, 3-hourly, daily and monthly modeled products
- Monthly ground observation archives
- Composite Climatology (yearly, monthly)
- Near-real-time (NRT) products



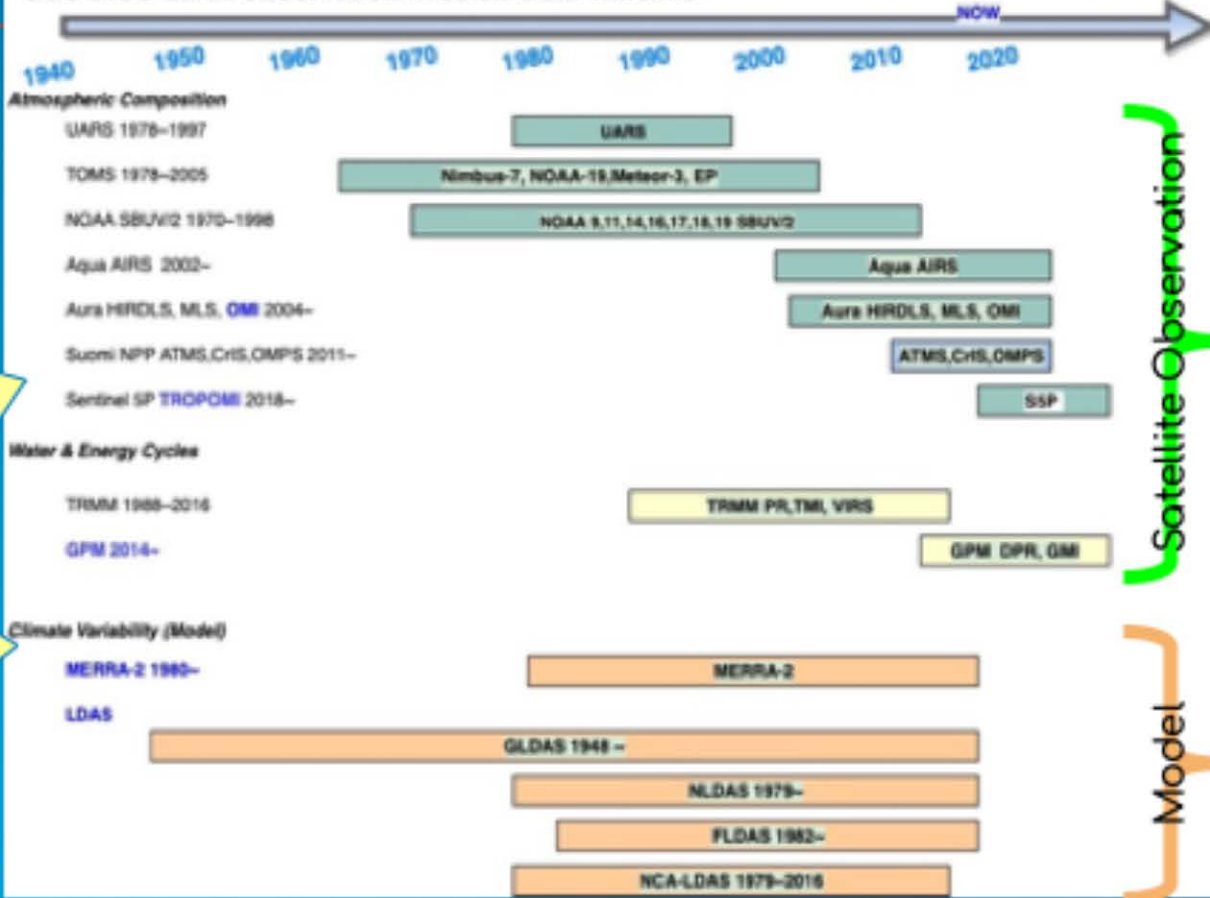
# ArcGIS Challenges for Handling EO Data

1. Complex Data Format: HDF, HDF-EOS, netCDF

2. Non-ArcGIS ready format: swath data

3. Need additional analytics for long data records

GES DISC Earth Observation Mission Data Timeline



4. Multitude of applications

5. Cross-disciplinary applications

Data Side

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User Side



## GIS User Needs from NASA EO data



Can I plug in  
ArcGIS with  
your EO data?

Which spatial  
and temporal  
resolution  
should I use ?

Should I use  
model data  
or satellite  
data? Which  
parameter?

HOUSTON, WE HAVE A  
PROBLEM!



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## Potential GIS Applications from GES DISC Data

(Extreme Weather Events, Climatic Anomaly , Public Health ...etc)

- Precipitation (**TRMM/GPM**)
- Hydrology (Land Data Assimilation System data (**LDAS**) with numerous land parameters)
- Modern Era Retrospective-Analysis for Research and Applications data assimilation data (**MERRA/2**), with numerous land, ocean and atmospheric parameters
- Atmospheric Compositions
  - Volcano Eruption (SO<sub>2</sub>: **AIRS/OMI/TROPOMI/OMPS/MEaSURES**)
  - Air Quality/Public Health (AOD/AI/NO<sub>2</sub>/PM: **TOMS/OMI/OMPS/MERRA-2/TROPOMI...etc**)

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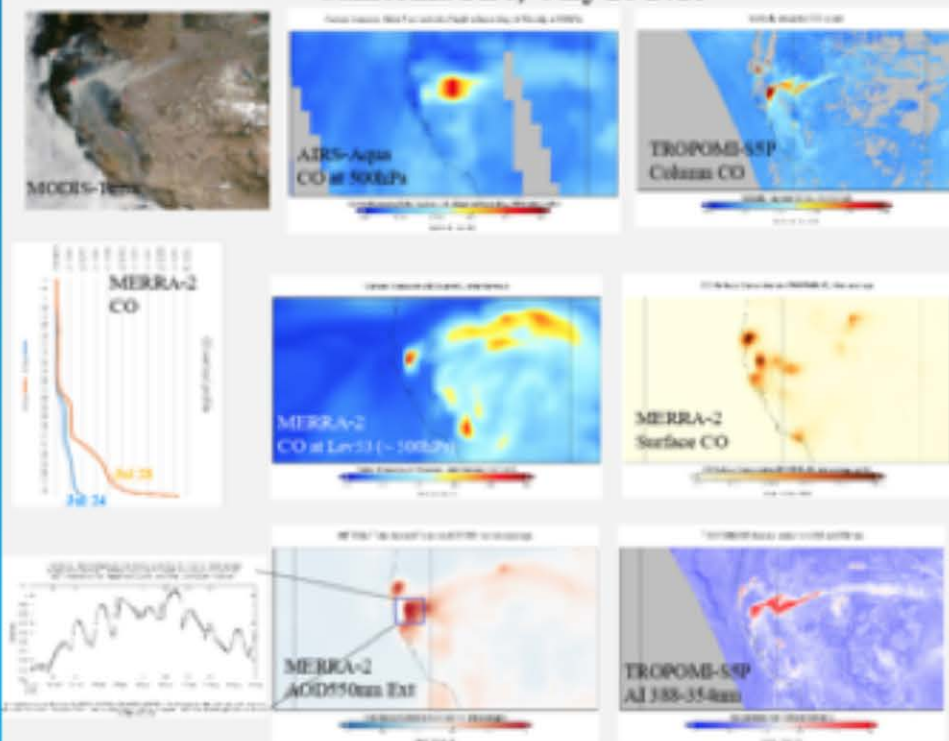
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- **GES DISC OGC Services**
- **ArcGIS Related Support: Data Recipe, Image Service, upcoming ArcGIS services**



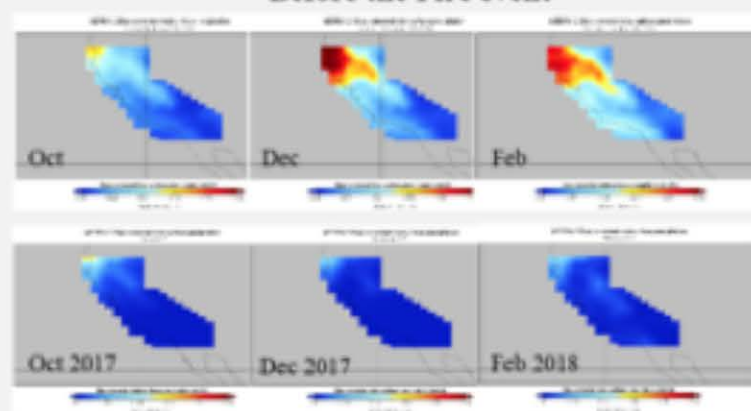
# Using Giovanni to Explore and Transform EO data to GIS tools

## Carbon Monoxide and Aerosol from Satellites and MERRA-2 California Fire, July 28 2018

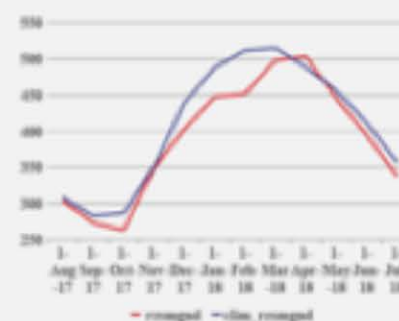


**Fig.1** Images demonstrated the large scale elevated Carbon Monoxide (CO) and aerosols observed from satellite (AIRS/Aqua and TROPOMI/Sentinel-5P) and model assimilated data from MERRA-2 during a California Fire event on July 28 2018. The true color image is from MODIS-Terra.

## Meteorology and Land Surface Conditions Before the Fire event



**Fig.2** Images are monthly precipitation from MERRA-2, showing that the precipitation during 2017-2018 raining season is much below the climatology.

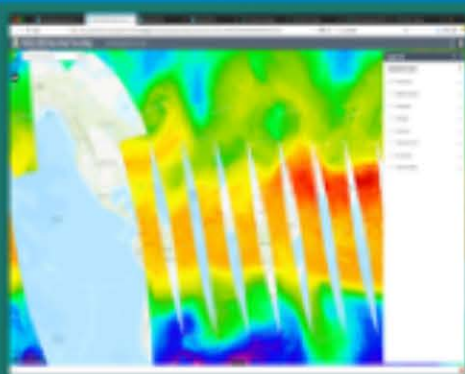


**Fig.3** Time series of monthly soil moisture at root zone from NLDAS\_NOAH over northern California (-124.0,38.9,-120.3,41.5) from Aug 2017 to Jul 2018 (Red line) and corresponding monthly Climatology

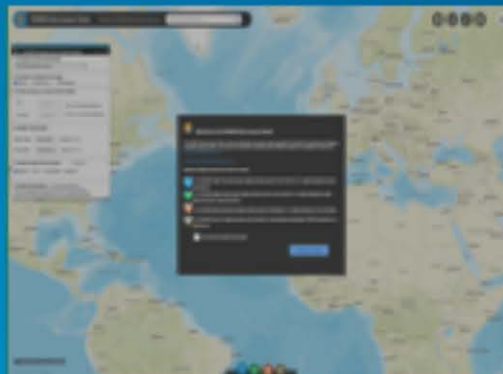


# GES DISC OGC Services

**Transform** EO data to be GIS interoperable using OGC services (WCS/WMS)



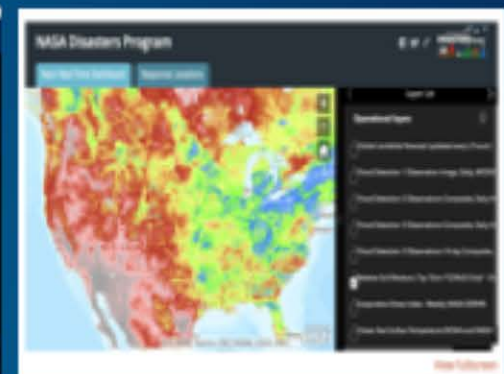
- NASA GES DISC AIRS NRT Data Viewer
- Contain GES DISC's AIRS NRT L1/L2 data



- NASA LaRC Power Data Viewer
- Contain GES DISC's MERRA-2 data



- NASA GSFC Transboundary Water Management Data Explorer
- Contain GES DISC's TRMM GPM, GLDAS, FLDAS, NLDAS data



- NASA Disaster Program Response Viewer
- Contain GES DISC's TRMM/GPM, OMI/TROPOMI data

# GES DISC ArcGIS Data Recipe

<https://disc.gsfc.nasa.gov/information/howto?keywords=arcGIS&page=1>

The screenshot shows the GES DISC website with a list of 'How-To's' articles. The articles listed are:

- How to Import MERMA Surface Product Data into ArcGIS
- How to Import Gridded Data in NetCDF Format into ArcGIS
- How to Import IMERG GPM Precipitation Data in HDF5 into ArcGIS with Arcpy Script
- How to Define and Visualize Time Dimension in ArcGIS
- How to Import Satellite Swath Data in NetCDF Format into ArcGIS
- How to Import HDF5-Formatted IMERG GPM Precipitation Data into ArcGIS
- How to Correctly Import GRIB Data into ArcGIS
- How to Define Vertical Dimension in ArcMap
- How to Display and Remote Access Data in GIS with GAOSS

Click **"Feedback"** to tell us what you need!

Step-by-Step Instruction

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# Setting up ArcGIS Image Service for long term data record

- Long term data analysis through image service
  - GES DISC data usually contain long time data records, e.g., 40 years of hourly data
  - A single mosaic is not feasible for long time series
  - Hierarchical mosaics: daily, monthly, yearly, multi-year
  - Services can be set up at different hierarchical levels
    - Top level service may be very slow to respond when first connected

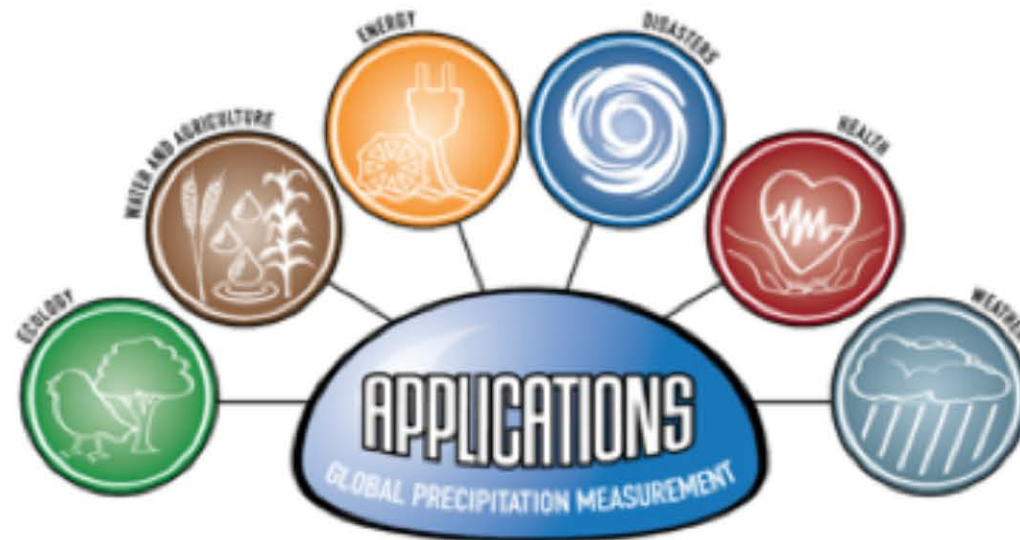




## TRMM/GPM Precipitation Missions



- GES DISC is the official TRMM/GPM data archive and distribution center
- Complex mission datasets: **178 Products** through data holdings (<https://disc.gsfc.nasa.gov/datasets?project=GPM>)



Source: Precipitation Measurement Missions (PMM), [pmm.nasa.gov](http://pmm.nasa.gov)

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

# Image Services for Precipitation Data

The screenshot shows the ArcGIS Server Manager interface. The top navigation bar includes 'Services', 'Site', 'Security', and 'Logs'. Below this, there are tabs for 'Manage Services', 'OGC Services', 'KML, Network Links', and 'Sharing'. The main content area is titled 'Folders' and contains a search bar with the text '< Search for services in Precipitation >'. On the left, a tree view shows folders: 'Site (root)', 'FamineEarlyWarningSys...', 'Precipitation', 'SoilMoisture', 'System', 'TEST', and 'Utilities'. The 'Precipitation' folder is selected. The main area displays two image services:

- GPMHHE2019 (Image Service)**: Image service for GPM Half-hourly precipitation for year 2019. Status: Started. Instances Running: 1. Instances in Use: 0. Maximum Instances: 2.
- GPMHHE\_all (Image Service)**: Image service for GPM Half-hourly precipitation with global coverage at 0.1-degree spatial resolution. Status: Started. Instances Running: 1. Instances in Use: 0. Maximum Instances: 2.

At the bottom of the interface, there is a pagination control showing '1'.

Global Precipitation with 30-minute temporal and 10km spatial resolution from 2014 to present.

## Time Info:

Start Time Field: StdTime

End Time Field: StdTime

Time Extent:

[2014/03/12 00:00:00 UTC, 2019/05/01 23:30:00 UTC]

Time Reference: N/A

Pixel Size X: 0.09999999660727316

Pixel Size Y: 0.09999999660727316

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# Why Cyclone Idai is one of the Southern Hemisphere's most devastating storms

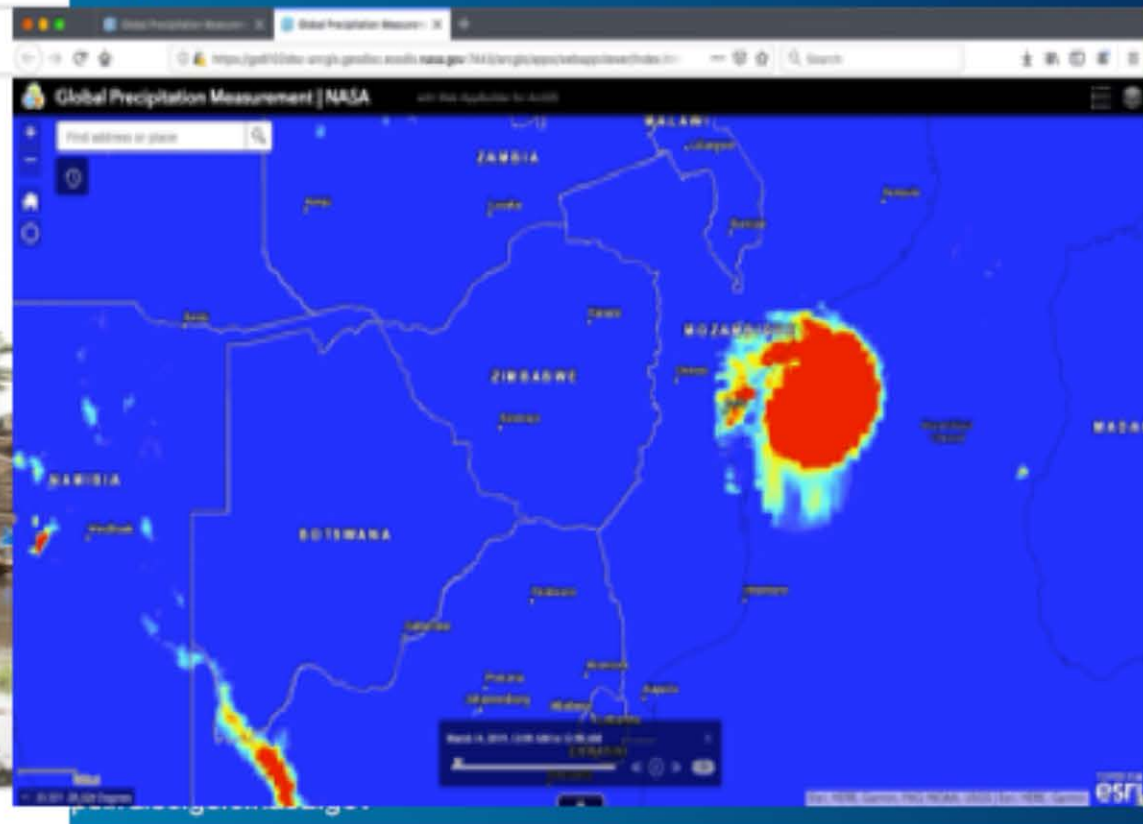
The catastrophic storm has affected nearly 2 million people in Mozambique

Matthew Warren



Cyclone Idai has destroyed the city of Beira in Mozambique, where it made landfall. Credit: Denis Orysh/IFRC via ZUMA Wire

## Use GPM Half-hourly Precipitation Rate Data to Track Cyclone Idai





# Upcoming GIS Data Support

- Add data layers products based on users demand
- Experiment ArcGIS Feature Service (for non-gridded swath data)
- User community/theme/event portals
  - Perform hotspot mapping to identify hotspots of extreme events
  - Identify the Spatial and temporal shift
- Experiment ArcGIS Geoprocessing Service
  - Spatial auto correlation or clustering to identify climate regions and spatial dependency
  - Zonal statistics which can summarize data at specific administrative level
  - Time series analysis and rate of change of temperature

**Tell us know what you need!**

Please help us to help you!

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- How-To's

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Visualization

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