

UC

Using NASA Earth Observation Data in ArcGIS

Jennifer Wei, Peisheng Zhao*, Wenli Yang, Michael Beron, Long Pham, Binita KC, and Dave Meyer

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



GES DISC
Atmospheric Composition, Water & Energy Cycles, and Climate Variability

Explore...
Data Collections | Data search (e.g., Aerosols, O3)
Access Data by Category

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

System Size: 2.3 PB
Acquisition Data Files: 115,000,000
Data Collections: 2,500
Data Volume: 2.3 PB

Projects & Milestones
Cloud-Aerosol Interaction (CAI)
The Cloud-Aerosol Interaction (CAI) is an ongoing multi-institutional research endeavor that can perform several functions including:
- **IMBUSTO**: Modeling Earth System Data Records for Use in Research Environments, is a NASA project, selected through Research Opportunities in...
- **IMBUSTO**: The Earth's Solar Radiation: Overview
IMBUSTO, heavy reliance on satellite (2004 and 2004-2007) instruments from an eight-spacecraft...

Featured Gallery Images
Global Earth System Data Records for Use in Research Environments (IMBUSTO)

News
IMBUSTO: 2014-2015 data is available
Researchers discover a record...
IMBUSTO: 2014-2015 data is available
IMBUSTO: 2014-2015 data is available
IMBUSTO: 2014-2015 data is available

Links
Home
About
Contact
Help
Privacy
Terms
Sitemap
Feedback

- 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

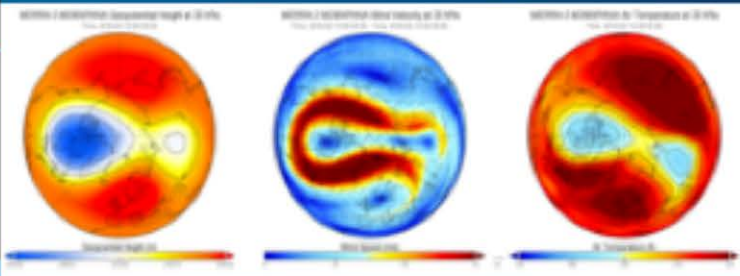
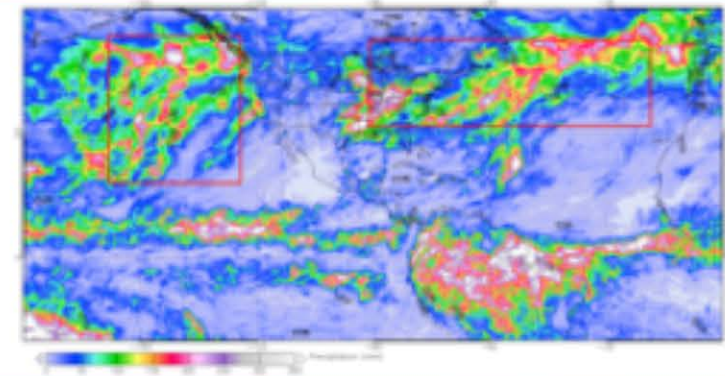
Climate variability/solar missions:

- SORCE
- TCTE
- TSIS
- CAR

* end-of-mission/project

GES DISC Goddard Earth Science Data and Information Services Center
<https://disc.gsfc.nasa.gov>

atmospheric rivers from GPM



polar vortex from MERRA-2

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 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



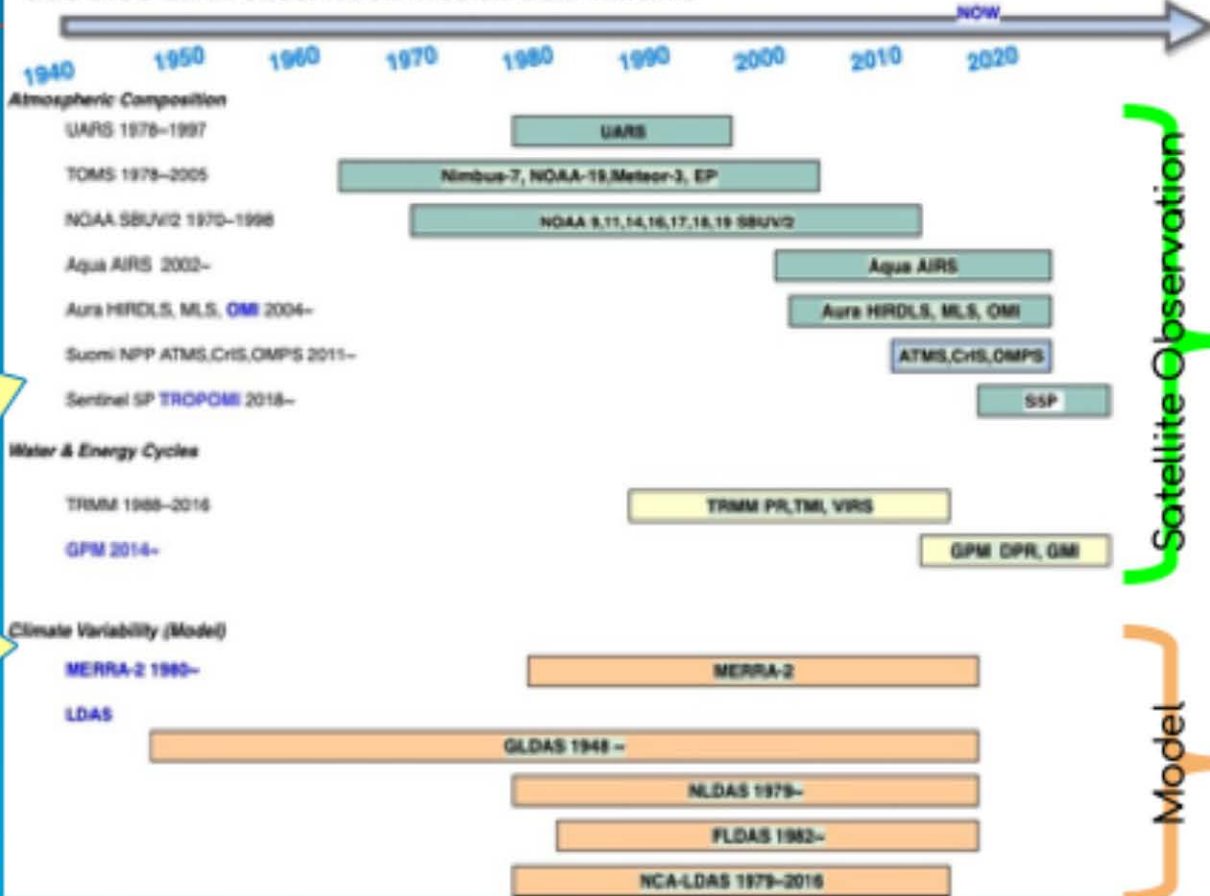
ArcGIS Challenges for Handling EO Data

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



Satellite Observation

Model

4. Multitude of applications

5. Cross-disciplinary applications

Data Side

GES DISC Goddard Earth Science Data and Information Services Center
<https://disc.gsfc.nasa.gov>

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!**



GES DISC Goddard Earth Science Data and Information Services Center
<https://disc.gsfc.nasa.gov>

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 (SO₂: **AIRS/OMI/TROPOMI/OMPS/MEaSURES**)
 - Air Quality/Public Health (AOD/AI/NO₂/PM: **TOMS/OMI/OMPS/MERRA-2/TROPOMI...etc**)

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 for 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**



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

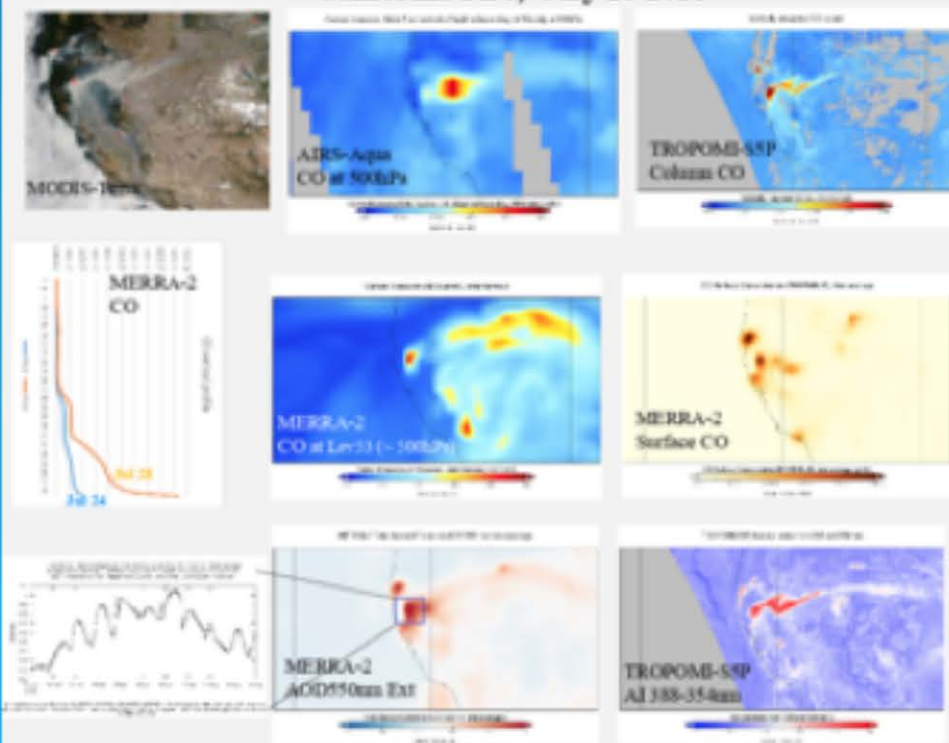


Fig.1 Images demonstrated the large scale elevated Carbon Monoxide (CO) and aerosols observed from satellite (AIRS/Aqua and TROPOMI/Sentinel-5P) and model assimilated data from MERRA-2 during a California Fire event on July 28 2018. The true color image is from MODIS-Terra.

Meteorology and Land Surface Conditions Before the Fire event

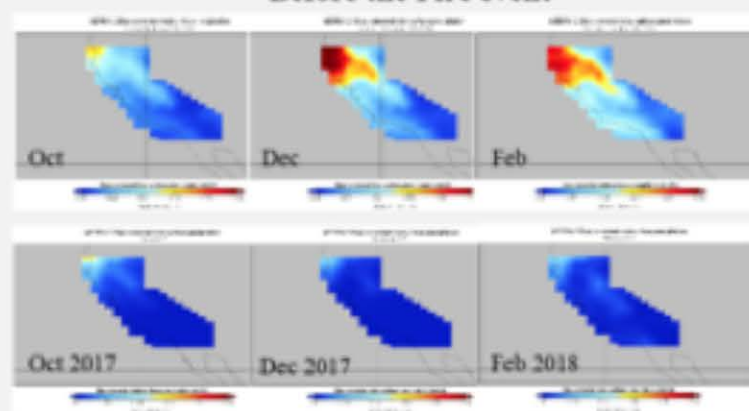


Fig.2 Images are monthly precipitation from MERRA-2, showing that the precipitation during 2017-2018 raining season is much below the climatology.

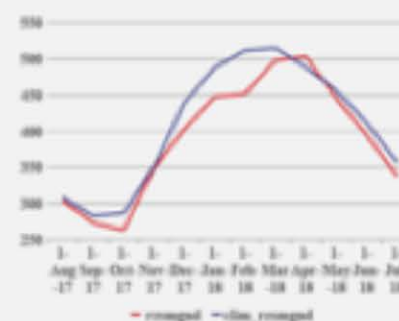
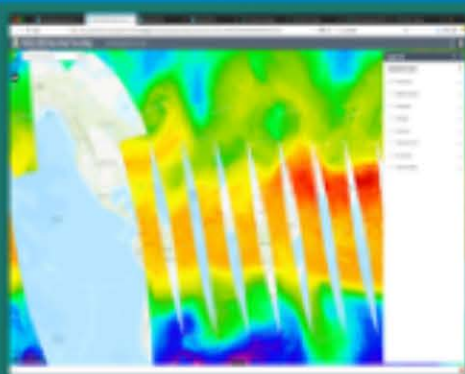


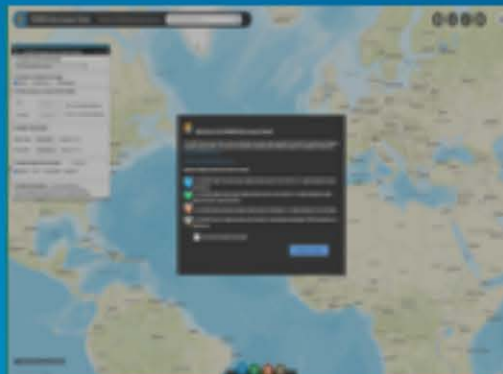
Fig.3 Time series of monthly soil moisture at root zone from NLDAS_NOAH over northern California (-124.0,38.9,-120.3,41.5) from Aug 2017 to Jul 2018 (Red line) and corresponding monthly Climatology

GES DISC OGC Services

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



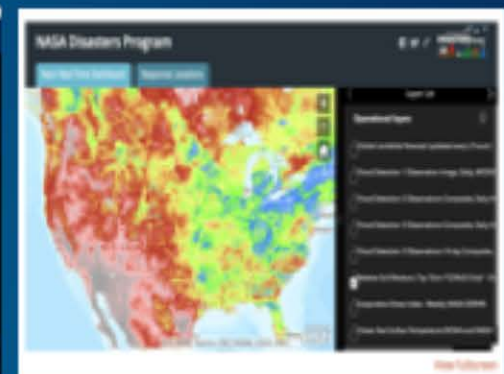
- NASA GES DISC AIRS NRT Data Viewer
- Contain GES DISC's AIRS NRT L1/L2 data



- 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 'Feedback' button is circled in red. The articles listed include:

- 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 GADS

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

Step-by-Step Instruction

GES DISC Goddard Earth Science Data and Information Services Center
<https://disc.gsfc.nasa.gov>

Setting up ArcGIS Image Service for long term data record

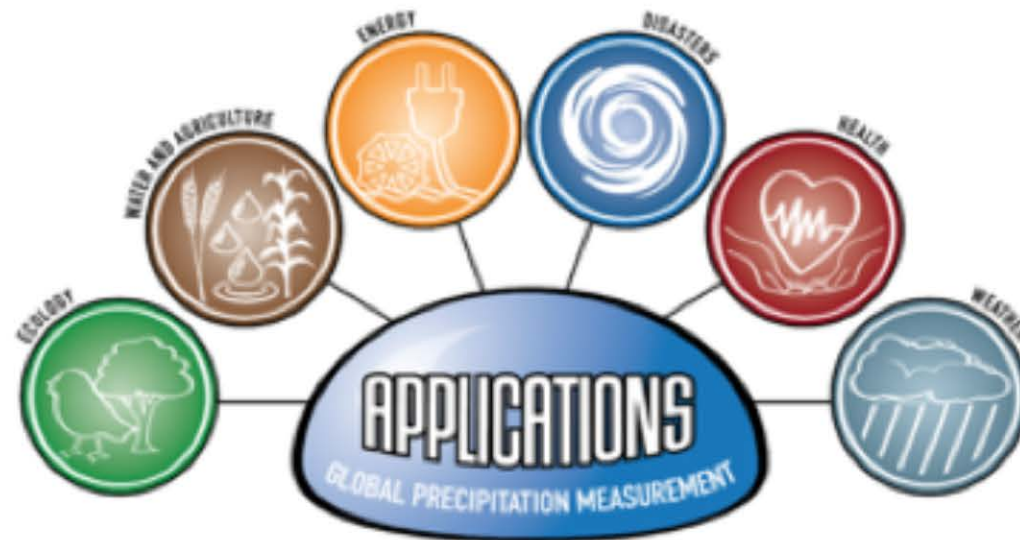
- Long term data analysis through image service
 - GES DISC data usually contain long time data records, e.g., 40 years of hourly data
 - A single mosaic is not feasible for long time series
 - Hierarchical mosaics: daily, monthly, yearly, multi-year
 - Services can be set up at different hierarchical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

GES DISC Goddard Earth Science Data and Information Services Center
<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 area displays a list of services under the 'Precipitation' folder. Two services are visible:

- 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.

Each service entry includes a thumbnail image of a precipitation map and a set of control icons (person, share, expand, close).

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

NEWS • 26 MARCH 2019

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

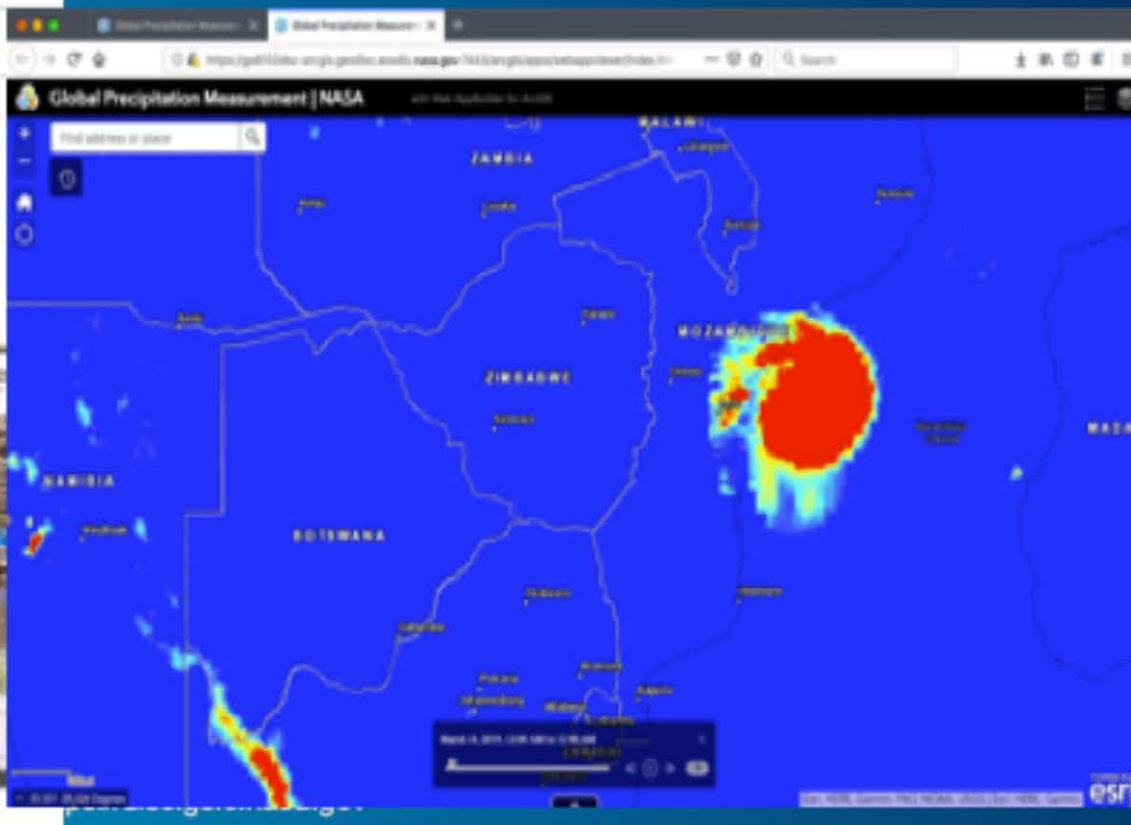
The catastrophic storm has affected nearly 2 million people in Mozambique

Matthew Warren



Cyclone Idai has destroyed the city of Beira in Mozambique, where it made landfall. Credit: Denis Ouyed/WPC 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!

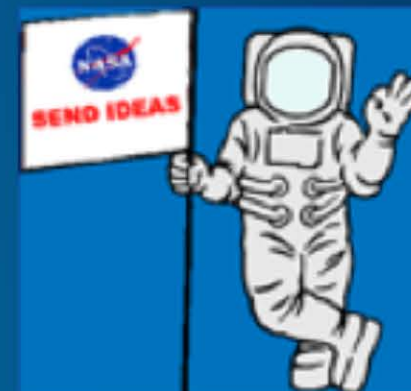
- Videos on **You Tube** subscribe "NASAGESDISC"
- Twitter : @NASA_GESDISC, @NASA_Giovanni
- How-To's

Download

Case Study

Visualization

- Feedback: 
- Help Desk: gsfc-help-disc@lists.nasa.gov



GES DISC Goddard Earth Science Data and Information Services Center
<https://disc.gsfc.nasa.gov>