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
  - Challenges for Handling EO Data in GIS
  - 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*

Water cycle/precipitation missions:
- TRMM*
- GPM
- SMERGE

Climate variability/solar missions:
- SORCE
- TCTE
- TSIS
- CAR

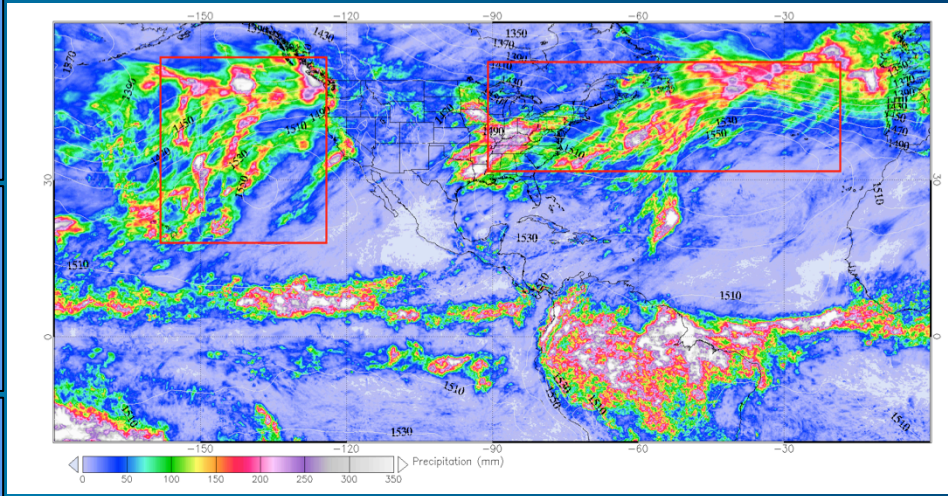
Model data:
- MERRA*/MERRA-2
- NLDAS, GLDAS, FLDAS, NCA-LDAS

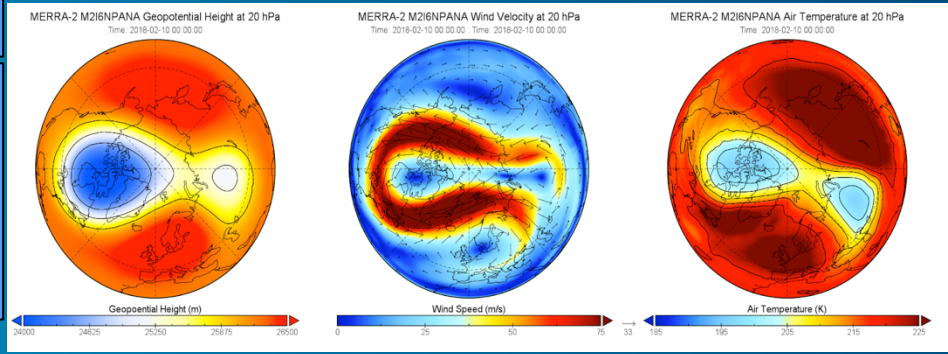
Research-derived data:
- MEaSUREs
- CMS

Near-real time:
- AIRS
- MLS

Future assigned missions:
- TROPICS
- Copernicus Sentinel 6
- GeoCarb

GPM





polar vortex from MERRA-2

* end-of-mission/project

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

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

→ **Measurement Resolutions**:

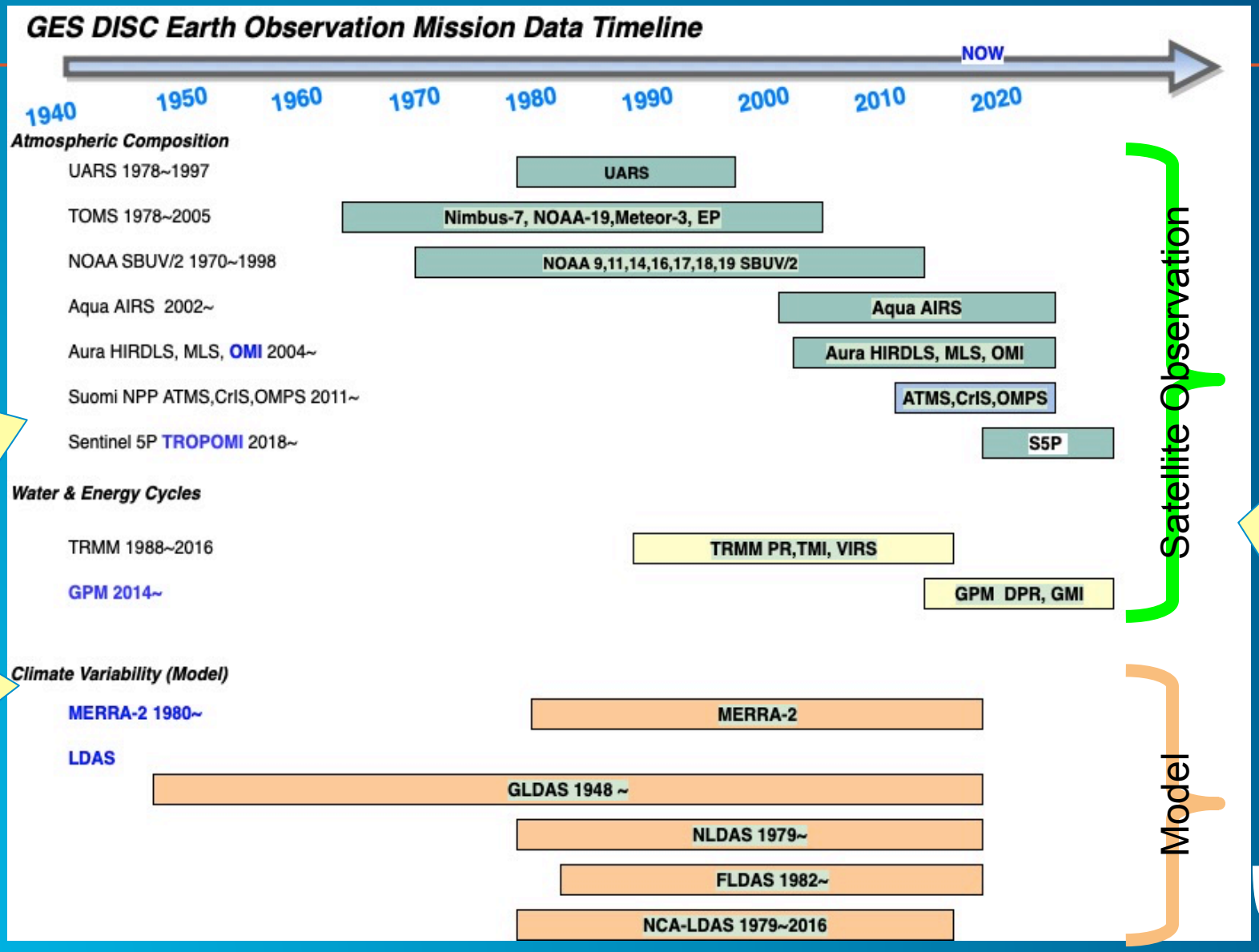
- Spatially:
  - Global grids (raster) with spatial resolution up to 4-km
  - Higher resolution swath (feature points) data (e.g., 2.2-km)
- Temporally:
  - Half-hourly, 3-hourly, daily, monthly satellite measurements
  - Hourly, 3-hourly, daily and monthly modeled products
  - Monthly ground observation archives
  - Composite Climatology (yearly, monthly)
  - Near-real-time (NRT) products

Challenges for Handling EO Data in GIS

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

2. Non-Grid format: swath data

3. Need additional analytics for long data records



4. Multitude of applications

5. Cross-disciplinary applications

Data Side

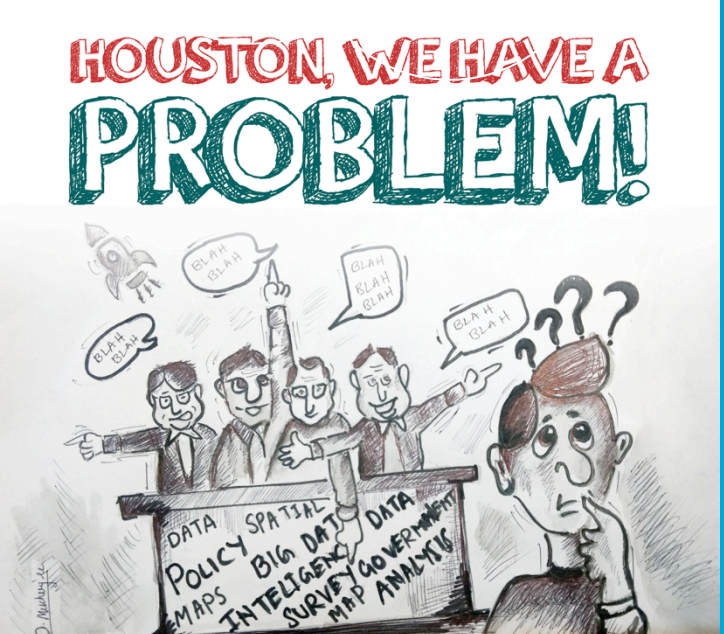
User Side

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?



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)

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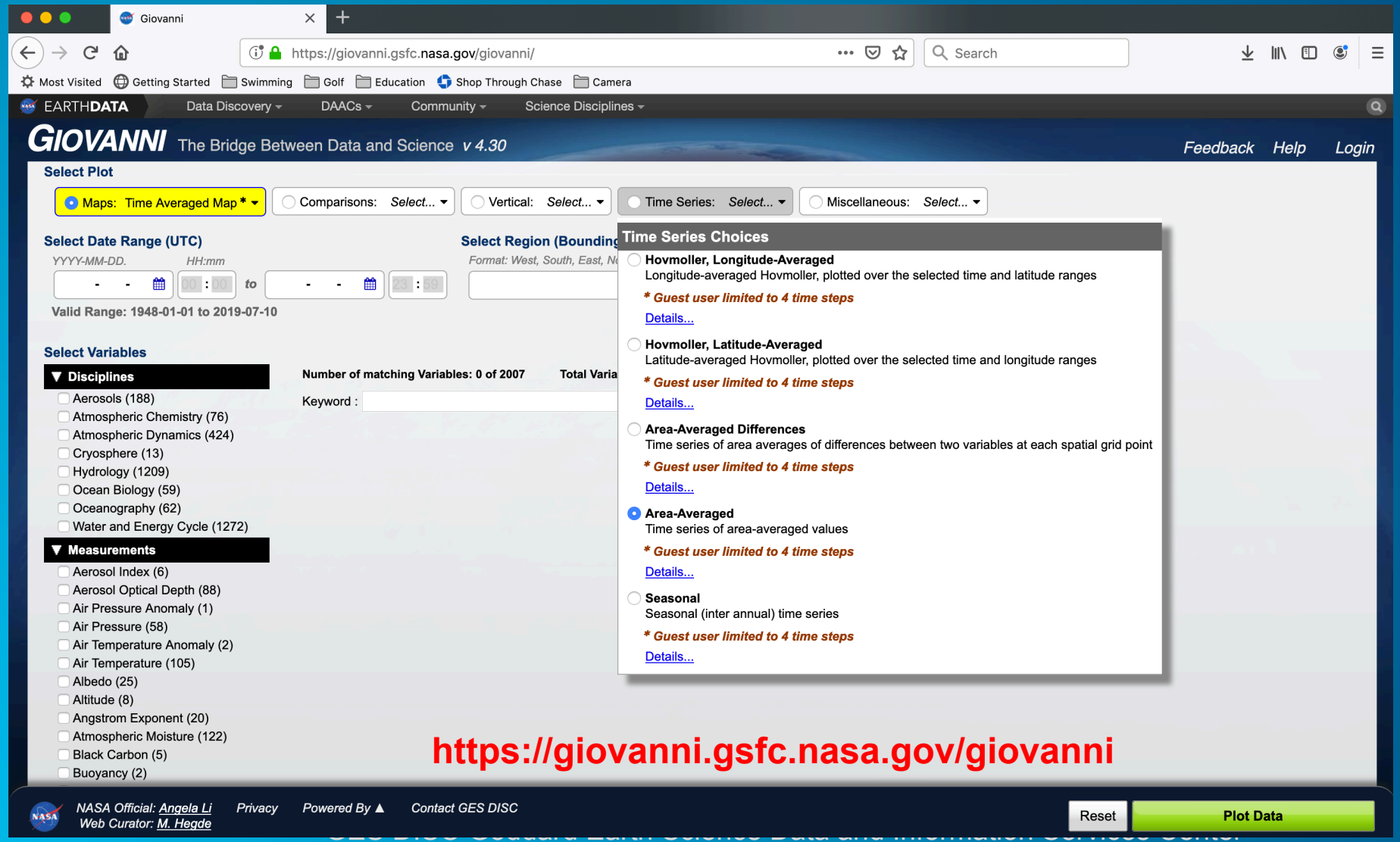
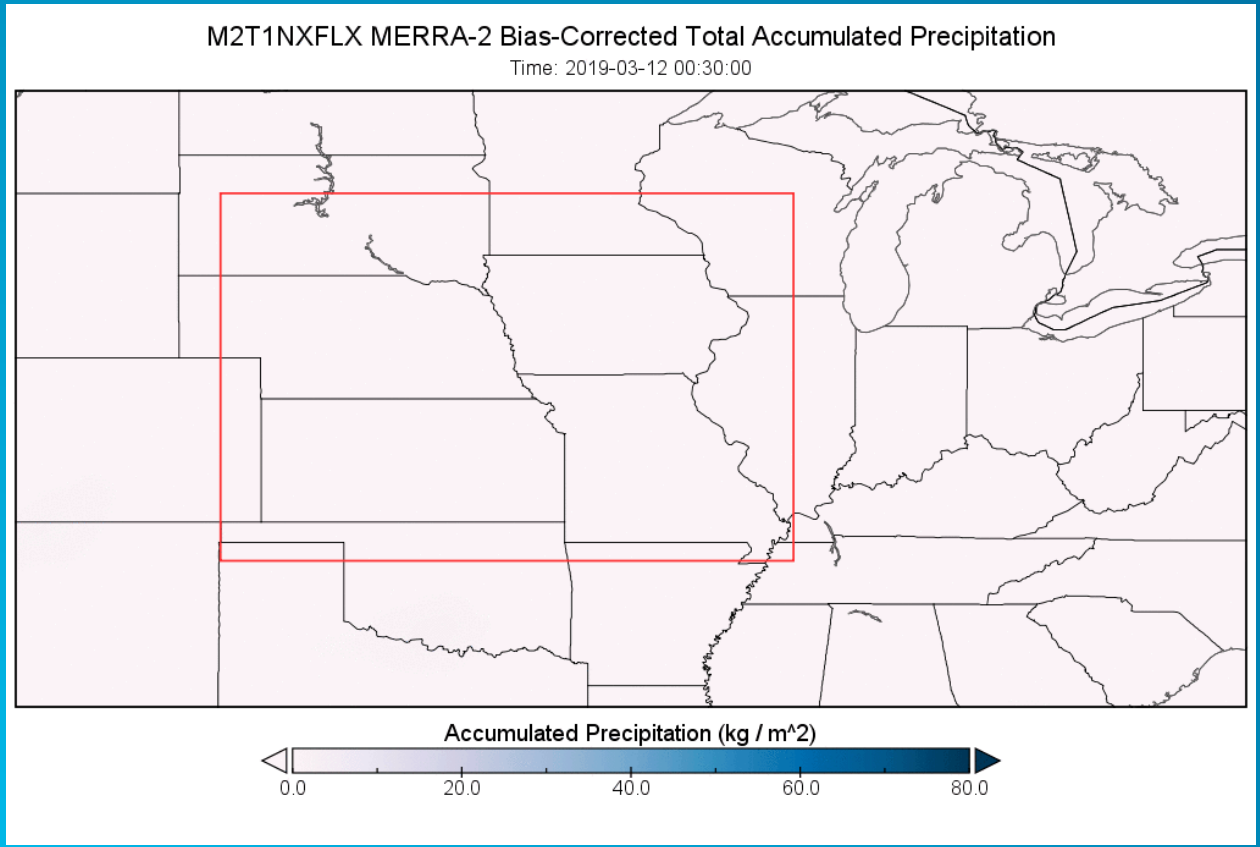
Giovanni -- a simple and intuitive way to visualize, analyze, and access vast amounts of EO data



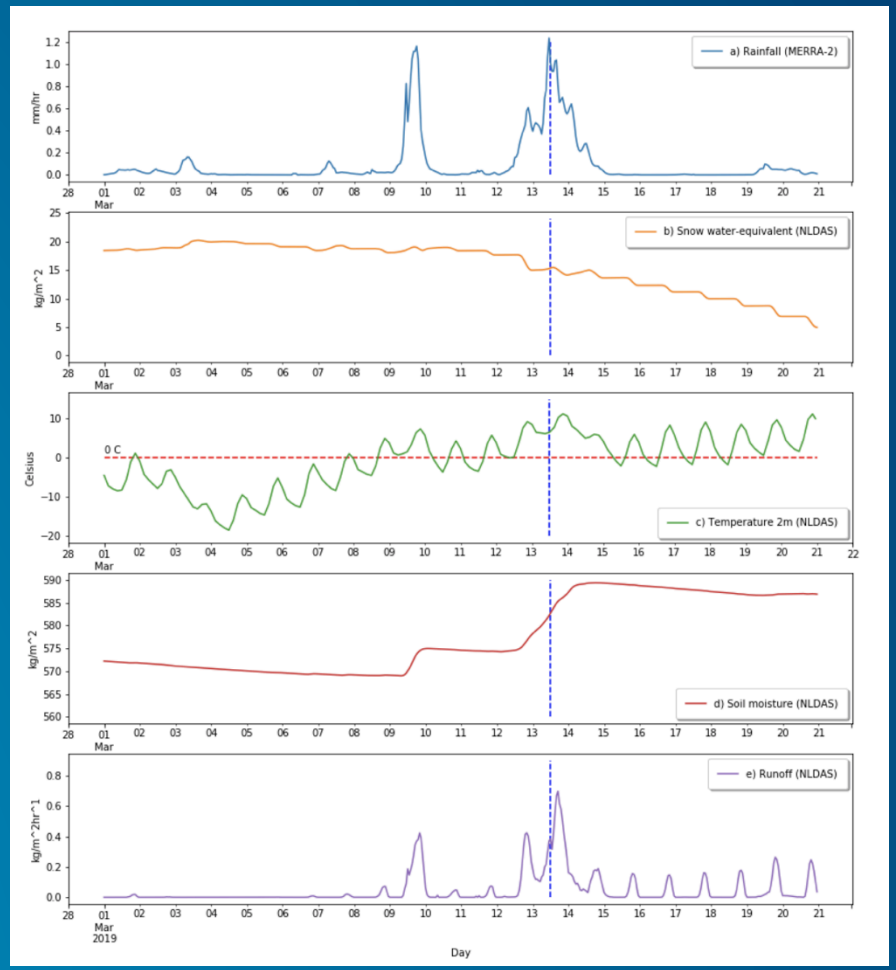
https://disc.gsfc.nasa.gov

Use Giovanni to create a Story Map

“Bomb Cyclone” and Midwest Flood of March 2019



Animation of MERRA-2 accumulated bias-corrected precipitation over the Midwest from March 12-15, 2019. Bomb cyclone rainfall starts from March 12-14, with heavy downpours in Nebraska and South Dakota along the Missouri River



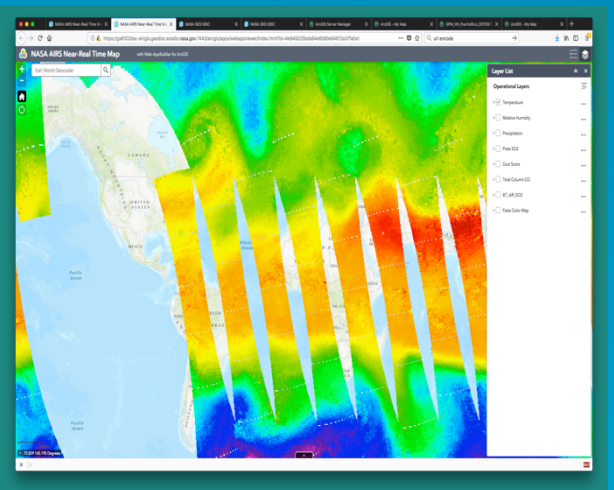
Spatially averaged hourly time series plots of: *a)* bias corrected total rainfall (mm/hr) from MERRA-2; *b)* snow water-equivalent (kg m^{-2}) derived from NLDAS NOAH; *c)* air temperature at 2m (^{o}C) from NLDAS Primary Forcing ; *d)* soil moisture total column (kg m^{-2}) 0-200 cm from NLDAS NOAH; and *e)* runoff (kg m^{-2} hr^{-1}) from NLDAS Mosaic acquired from March 1-20, 2019.

Details can be found through GES DISC’s News article!

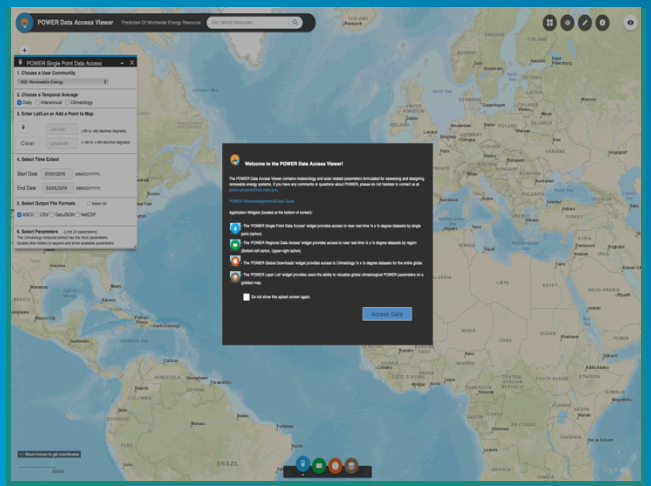
GES DISC Goddard Earth Science Data and Information Services Center
https://disc.gsfc.nasa.gov

GES DISC OGC Services

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

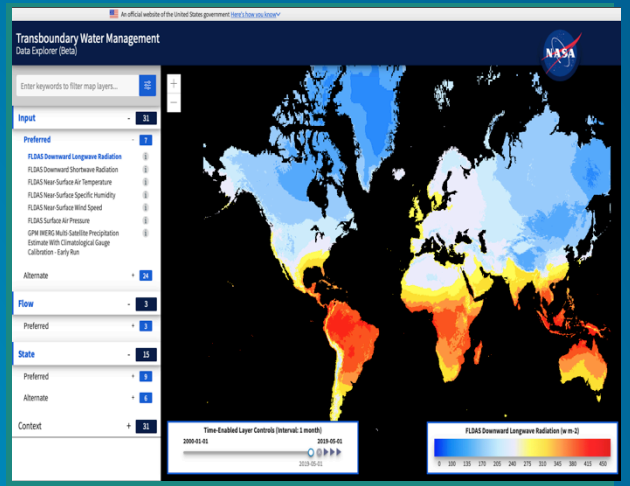


- NASA GES DISC AIRS NRT Data Viewer
- Contain GES DISC's AIRS NRT L1/L2 data

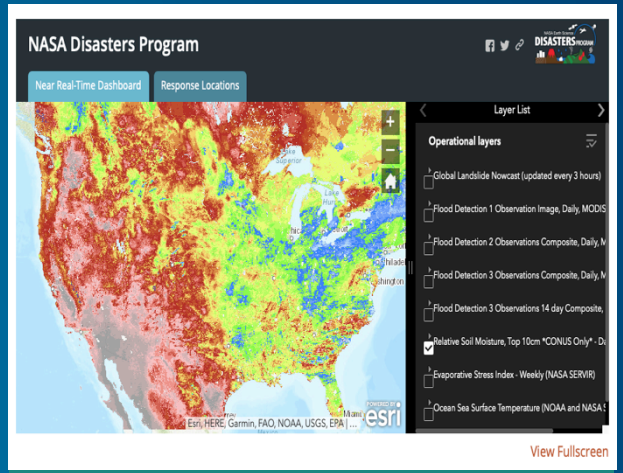


NASA LaRC Power Data Viewer

- Contain GES DISC's MERRA-2 data



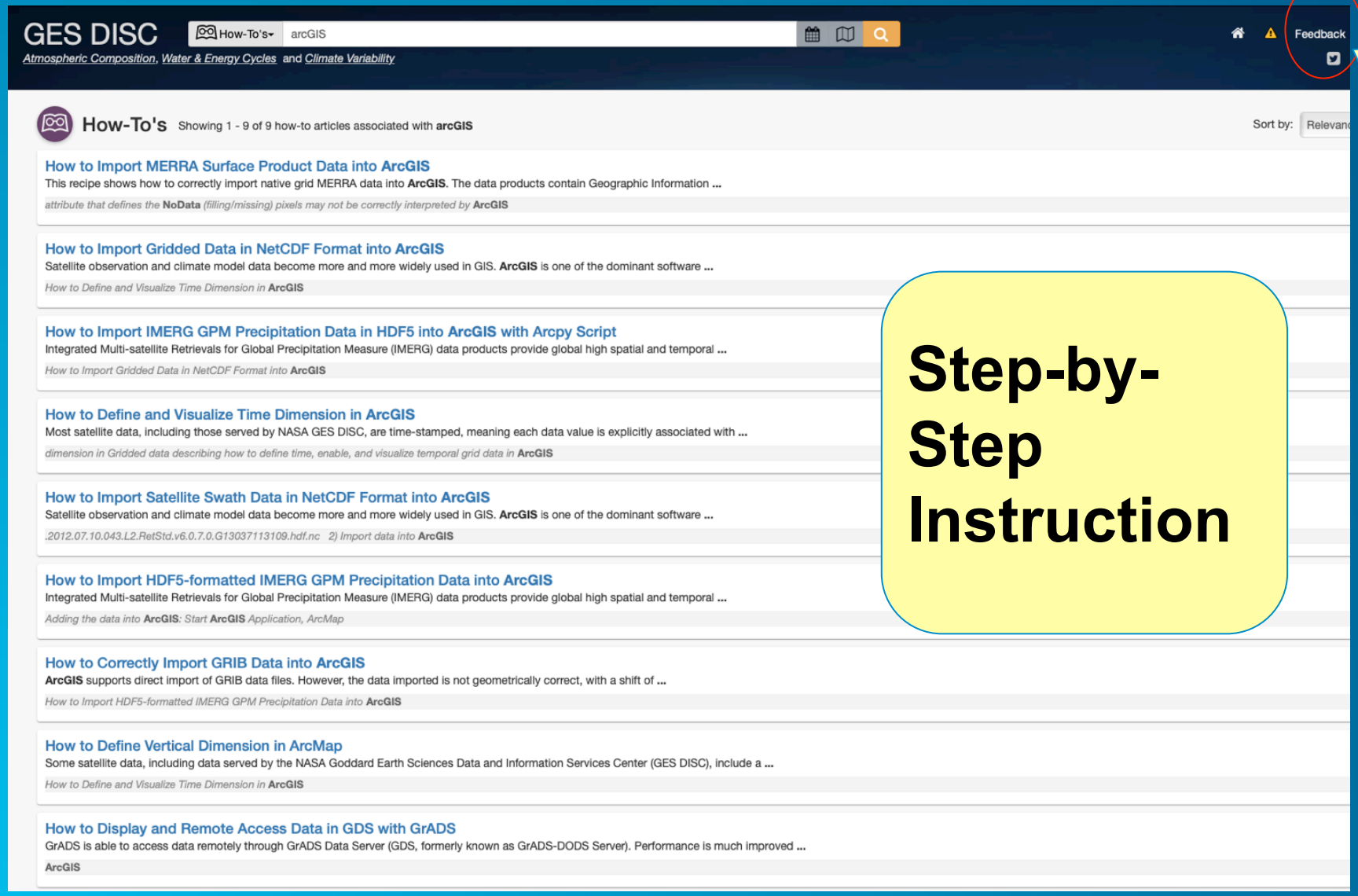
- NASA GSFC Transboundary Water Management Data Explorer
- Contain GES DISC's TRMM GPM, GLDAS, FLDAS, NLDAS data



- 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



Click "Feedback" to tell us what you need!

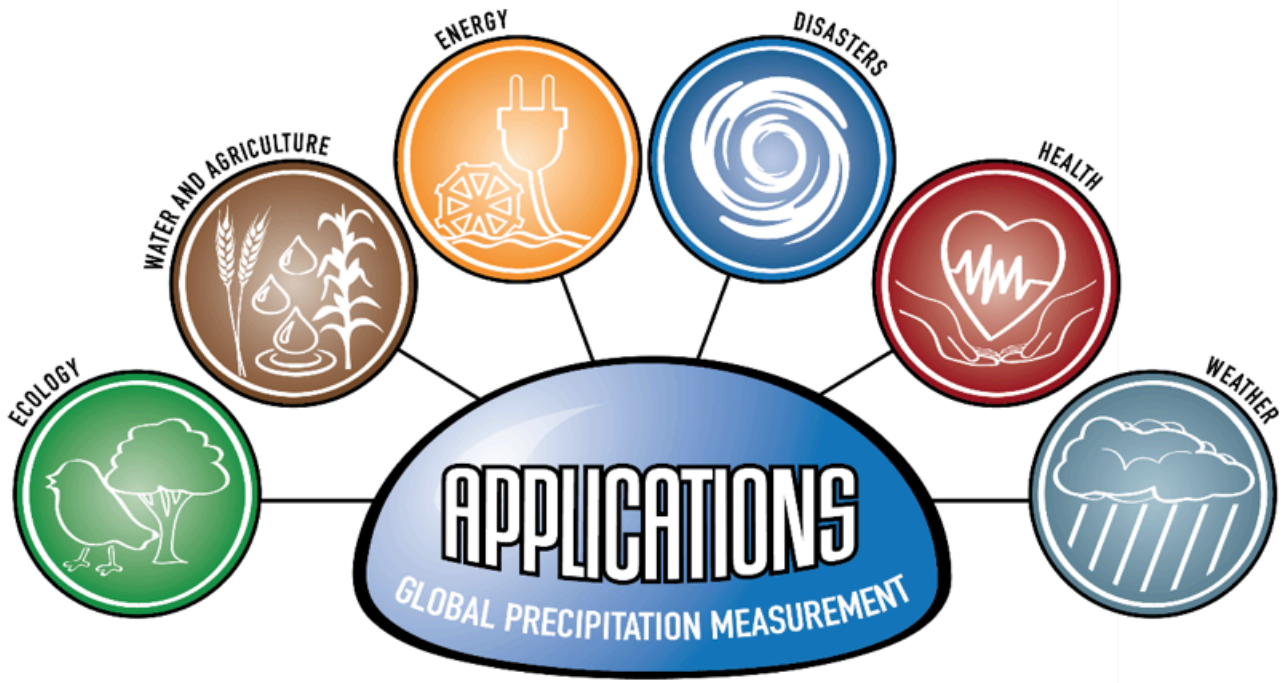
Step-by-Step Instruction

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

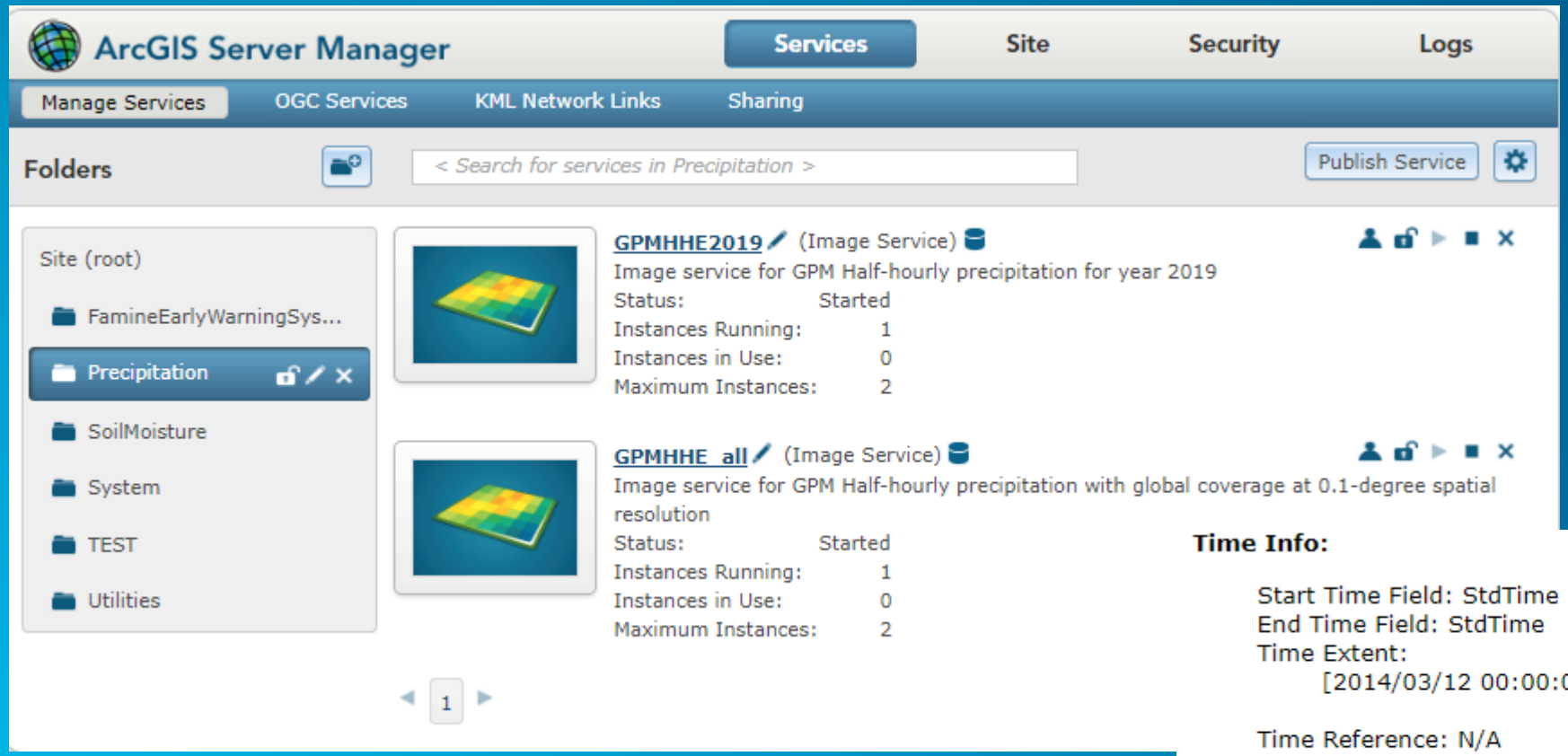
TRMM/GPM Precipitation Missions

- 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

Image Services for Precipitation Data



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

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

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

MENU nature

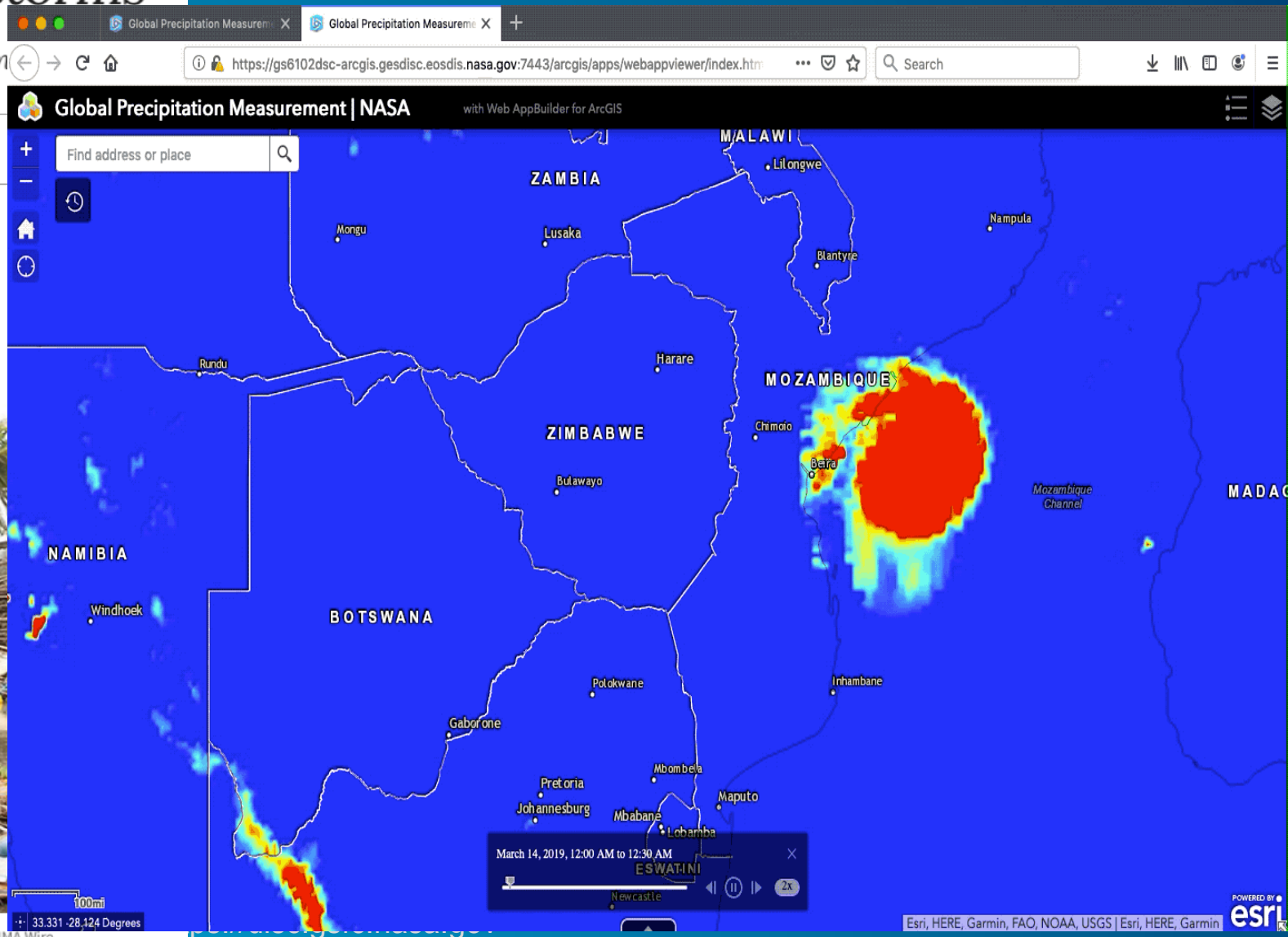
NEWS · 26 MARCH 2019

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

The catastrophic storm has affected nearly 2 million people in

Matthew Warren

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



Potential Issues of Image Service for EO Data

- Separate statistics and fillvalues for different variables served in one image service
- Unit information be included in science variable
- Multi-level folders for easy grouping for variables from multiple sources (currently only one-level folder)

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 YouTube subscribe “NASAGESDISC”
- Twitter @NASA_GESDISC, @NASA_Giovanni
- How-To’s

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- Feedback:

Feedback

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