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

https://disc.gsfc.nasa.gov
**GES DISC- Multi-Disciplines Data Holdings**

1200+ data collections being curated

<table>
<thead>
<tr>
<th>Atmospheric composition missions:</th>
<th>Model data:</th>
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<tr>
<td>Nimbus 1-7* BUV, SBUV, TOMS</td>
<td>MERRA*/MERRA-2</td>
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<tr>
<td>Shuttle SBUV*</td>
<td>NLDAS, GLDAS, FLDAS, NCA-LDAS</td>
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<td>UARS*</td>
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<td>Aqua AIRS</td>
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<td>Aura HIRDLS*, OMI, MLS</td>
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<td>ACOS*</td>
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<td>SNPP Sounder, OMPS</td>
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<td>JPSS-1 Sounder, OMPS</td>
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<td>GOSAT(ACOS)/OCO-2/OCO-3</td>
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<td>Copernicus Sentinel 5P (TROPOMI)</td>
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<td>TOVS Pathfinder*</td>
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<th>Water cycle/precipitation missions:</th>
<th>Research-derived data:</th>
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<tr>
<td>TRMM*</td>
<td>MEaSUREs</td>
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<tr>
<td>GPM</td>
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<td>SMERGE</td>
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<tr>
<th>Climate variability/solar missions:</th>
<th>Future assigned missions:</th>
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<tr>
<td>SORCE</td>
<td>TROPICS</td>
</tr>
<tr>
<td>TCTE</td>
<td>Copernicus Sentinel 6</td>
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<tr>
<td>TSIS</td>
<td>GeoCarb</td>
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<td>CAR</td>
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</tbody>
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atmospheric rivers from GPM

Water cycle/precipitation missions:

- TRMM*
- GPM
- SMERGE

Future assigned missions:

- TROPICS
- Copernicus Sentinel 6
- GeoCarb

end-of-mission/project

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

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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
4. Multitude of applications
5. Cross-disciplinary applications
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?

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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 (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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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**

**Meteorology and Land Surface Conditions**

**Before the Fire event**

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.

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.

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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 Goddard Earth Science Data and Information Services Center
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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
    - Top level service may be very slow to respond when first connected

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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
Global Precipitation with 30-minute temporal and 10km spatial resolution from 2014 to present.
Why Cyclone Idai is one of the Southern Hemisphere’s most devastating storms

The catastrophic storm has affected nearly 2 million people in Mozambique.

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

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