



# Improving the Accessibility and Use of NASA Earth Science Data

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NASA Atmospheric Science Data Center (ASDC)

## **Agenda:**

1. The ASDC at a Glance
2. ASDC Geospatial Architecture
3. Use Case - POWER/SSE
4. GDAL Enhancements for ESDIS (GEE)



## Improving the Accessibility and Use of NASA Earth Science Data in Geospatial Applications



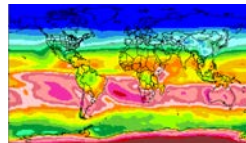
- Many of the NASA Langley Atmospheric Science Data Center (ASDC) Distributed Active Archive Center (DAAC) multidimensional tropospheric and atmospheric chemistry data products are stored in HDF4, HDF5 or NetCDF format, which traditionally have been difficult to analyze and visualize with geospatial tools.
- With the rising demand from the diverse end-user communities for geospatial tools to handle multidimensional products, several applications, such as ArcGIS, have refined their software.
- Many geospatial applications now have new functionalities that enable the end user to:
  - Store, serve, and perform analysis on each individual variable, its time dimension, and vertical dimension.
  - Use NetCDF, GRIB, and HDF raster data formats across applications directly
  - Publish output within REST image services or WMS for time and space enabled web application development.



## The ASDC at a Glance

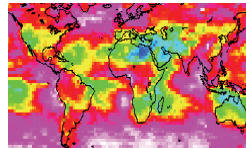


- Provides data services for **over 44 science projects**
- Primary: **CERES, MISR, CALIPSO, ISCCP, SAGE III, MOPITT, TES**
- Distributes **300+ unique science products**
- In 2014, **624 Terabytes of data** were distributed to over **165,000** customers in **158** countries
- **3.5 Petabytes of data** are in the archive as of January 2015
- Over 58 million files (1,537 TB) on high-speed disk for quick access



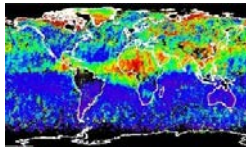
**Radiation Budget** - The radiation budget takes into account the sum of all radiation, transferred in all directions, through the Earth's atmosphere and to and from space.

*Instruments: CERES*



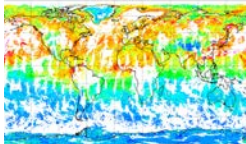
**Clouds** - A visible aggregate of minute water droplets and/or ice crystals in the atmosphere above the Earth's surface.

*Instruments: CALIPSO, MISR*



**Aerosols** - Suspension of particles of condensed matter (liquid, solid, or mixed) in a carrier gas (usually air).

*Instruments: CALIPSO, MISR, SAGE III*



**Tropospheric Chemistry** - Measurements of chemical constituents in the atmosphere including the major (non-H<sub>2</sub>O) greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub>, O<sub>3</sub>, N<sub>2</sub>O).

*Instruments: MOPITT, TES*



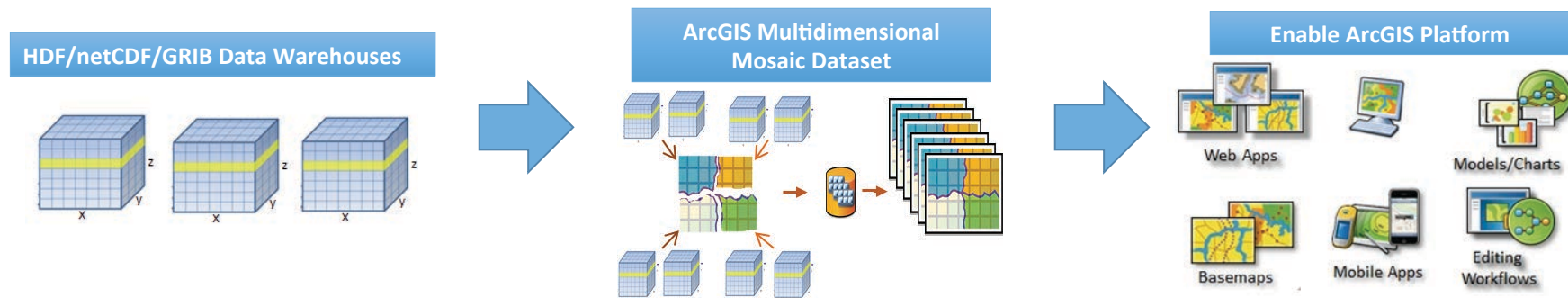
## Data Discovery and Access through Web Services



- Web services are used to make the application platform and technology independent by following standards, promoting interoperability
  - Data Access Protocol (DAP) Service
  - WCS (Web Coverage Service)
  - WMS (Web Mapping Service)
  - Webification Science (w10n-sci)
  - **ArcGIS Image Service**
    - NASA's Enterprise License Agreement (ELA) with Esri allows the agency to acquire access to Esri ArcGIS software at no additional cost to programs
- Examples of applications that support standards-based web services
  - NASA Global Imagery Browse Services (GIBS)
  - NASA Earthdata Search
  - Group on Earth Observations (GEOSS) Portal
  - Panoply
  - Integrated Data Viewer (IDV)
  - ArcGIS
  - Quantum GIS (QGIS)



# Utilizing the ArcGIS Platform as an End-to-End Solution for Processing, Analyzing, and Visualizing NASA's Scientific Data



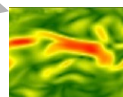
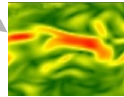
## ***Aggregate (mosaic) spatial, time, and vertical dimensions***

- Create a seamless multidimensional cube:
  - from files representing different regions
  - from files representing different time steps/slices
- Spatial Aggregation
- Temporal Aggregation
- On-the-fly analysis

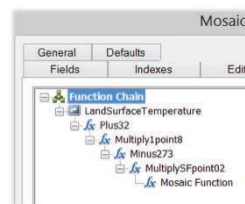
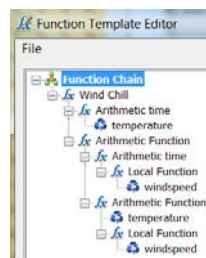
# End-to-End Solution for Processing, Analyzing, and Visualizing Data

## Mosaic Index

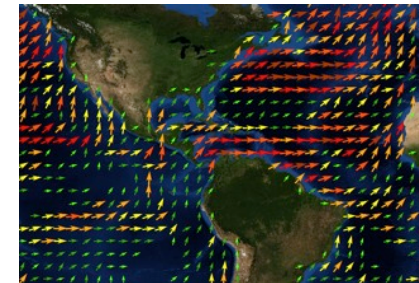
OBJ	Raster	Name	Variable *	Standard Time	Standard Z	...
1	<Raster	hycom_glb_regp01.nc:water_temp:0	water_temp	5/17/2013	0	
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3	<Raster	hycom_glb_regp01.nc:water_temp:2	water_temp	5/17/2013	-4	
4	<Raster	hycom_glb_regp01.nc:water_temp:3	water_temp	5/17/2013	-6	
5	<Raster	hycom_glb_regp01.nc:water_temp:4	water_temp	5/17/2013	-8	



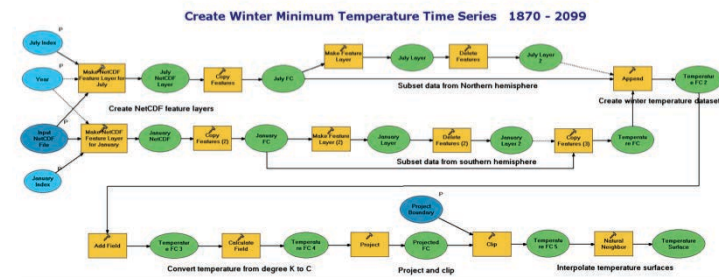
## Modeling with Raster function template (RFT)



## Visualization



## Spatial and Temporal Analysis





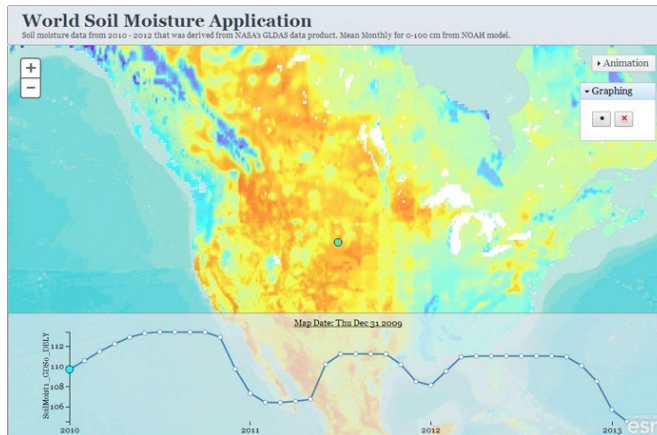
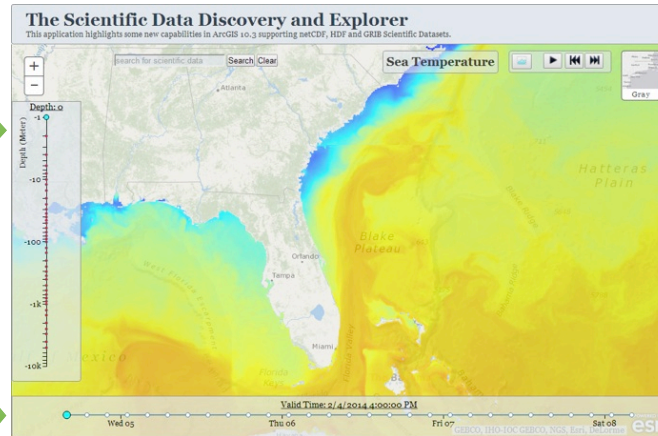


# Multidimensional Data in Web Applications

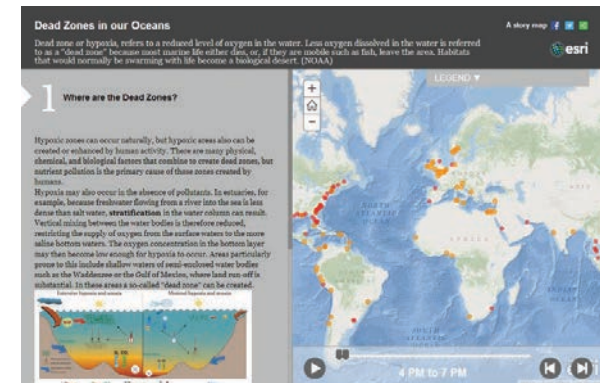


Depth →

Time →



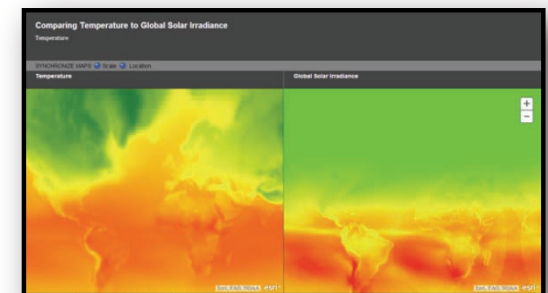
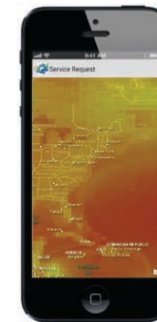
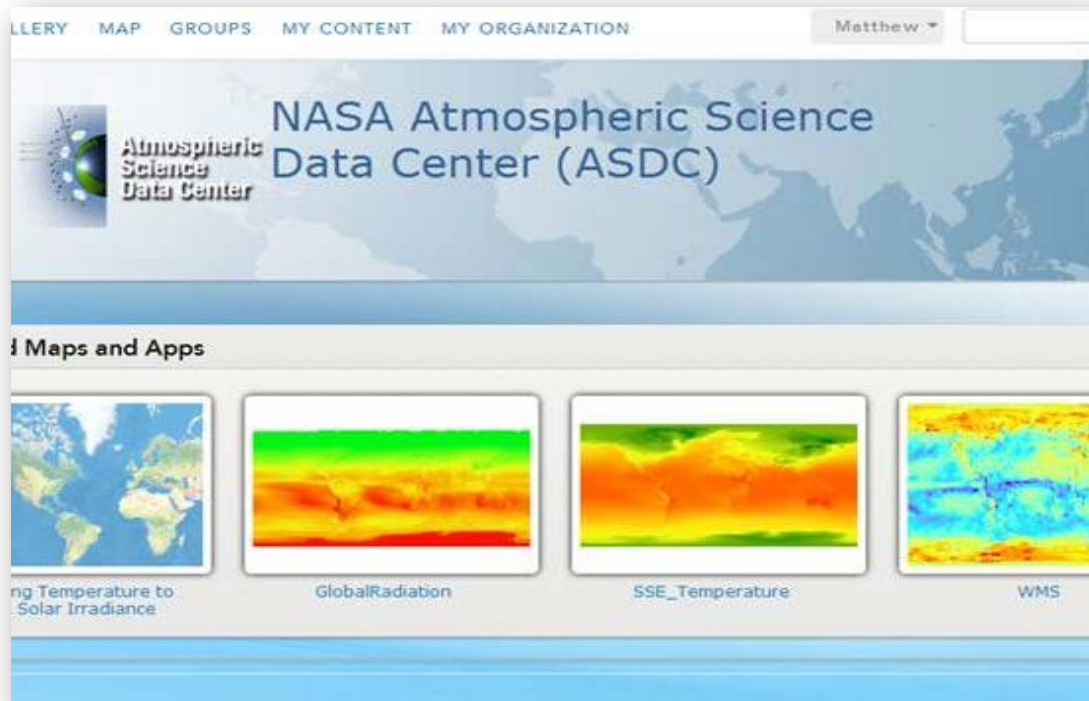
Temporal Graph →



Create Story Maps to tell the story of your scientific data



## NASA ASDC ArcGIS Portal







## Use Case: POWER Surface meteorology and Solar Energy (SSE)



**Objective:** Integrate improved environmental data, analysis and modeling for enhanced management of energy production and energy efficiency systems.

ATMOSPHERIC SCIENCE DATA CENTER NASA Surface meteorology and Solar Energy - Choices

Latitude 37 / Longitude -77 was chosen.

Select parameters and press Submit (Default is ALL types)

**Geometry**

**Parameters for Solar Cooking**

Average insolation  
Midday insolation  
Clear sky insolation  
Clear sky days

**Parameters for Sizing and Pointing of Solar Panels and for Solar Thermal Applications**

Insolation on horizontal surface (Average, Min, Max)  
Diffuse radiation on horizontal surface (Average, Min, Max)  
Direct normal radiation (Average, Min, Max)  
Insolation at 3-hourly intervals  
Insolation clearness index, K (Average, Min, Max)  
Insolation normalized clearness index  
Clear sky insolation  
Clear sky insolation clearness index  
Clear sky insolation normalized clearness index  
Downward Longwave Radiative Flux

**Solar Geometry**

Solar Noon  
Daylight Hours  
Daylight average of hourly cosine solar zenith angles  
Cosine solar zenith angle at mid-time between sunrise and solar noon  
Declination  
Sunset Hour Angle  
Maximum solar angle relative to the horizon  
Hourly solar angles relative to the horizon  
Hourly solar azimuth angles

**Parameters for Tilted Solar Panels**

Radiation on equator-pointed tilted surfaces  
Minimum radiation for equator-pointed tilted surfaces  
Maximum radiation for equator-pointed tilted surfaces

**Parameters for Sizing Battery or other Energy-storage Systems**

Minimum available insolation as % of average values over consecutive-day period  
Horizontal surface deficits below expected values over consecutive-day period  
Equivalent number of NO-SUN days over consecutive-day period

### Parameters for Sizing Battery or other Energy-storage Systems:

Equivalent Number Of NO-SUN Or BLACK Days (days)												
Lat 37 Lon -77	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 day	0.96	0.95	0.95	0.93	0.91	0.92	0.95	0.89	0.92	0.96	0.94	0.96
3 day	2.61	2.38	2.46	2.66	2.47	1.89	2.16	2.39	2.07	2.37	2.46	2.44
7 day	5.08	4.51	4.53	3.95	4.48	3.33	3.53	3.58	3.61	4.43	3.58	4.11
14 day	7.15	6.14	4.08	5.31	6.77	4.35	3.98	4.95	4.57	5.39	4.74	7.12
21 day	6.19	8.35	5.00	5.24	7.35	4.93	5.12	6.02	3.70	7.40	5.82	8.44
Month	4.60	7.63	3.60	5.26	9.01	3.67	4.27	5.24	4.17	6.81	6.49	6.65

[Parameter Definition](#)

### Meteorology (Temperature):

Monthly Averaged Cooling Degree Days Above 18° C												
Lat 37 Lon -77	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	0	0	4	22	86	189	257	224	130	34	5	1

[Parameter Definition](#)

### Meteorology (Wind):

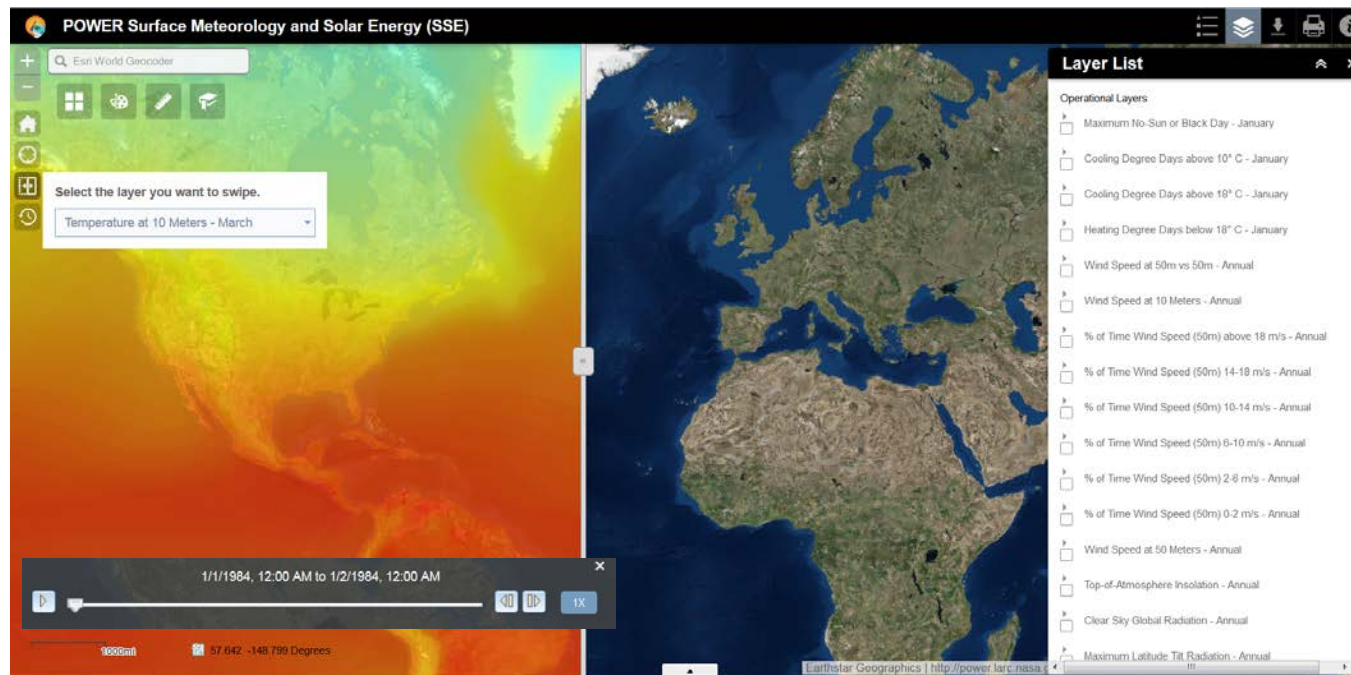
Monthly Averaged Wind Speed At 50 m Above The Surface Of The Earth (m/s)												
Lat 37 Lon -77	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10-year Average	6.60	6.71	6.67	6.04	5.13	4.88	4.34	4.17	4.80	5.38	6.27	6.65

Minimum And Maximum Difference From Monthly Averaged Wind Speed At 50 m (%)												
Lat 37 Lon -77	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	-13	-11	-14	-10	-13	-11	-10	-16	-8	-11	-8	-11
Maximum	13	8	9	15	16	9	11	10	11	9	10	11

- **Limited graphical capability**
- **Requires improvement to better serve customers**



# POWER SSE – GIS Web Application Enhancements

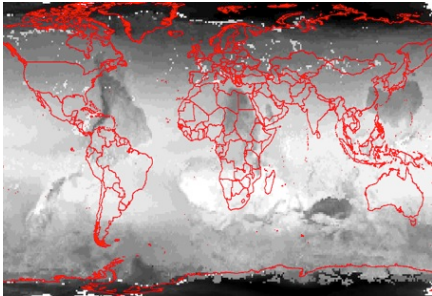


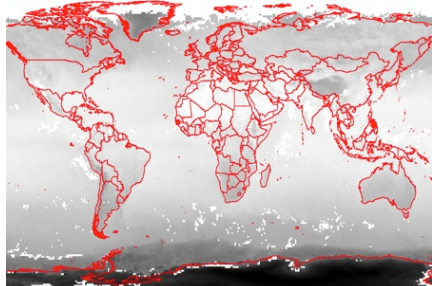
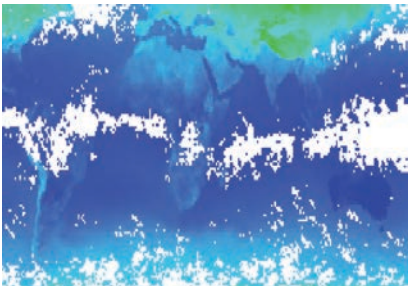
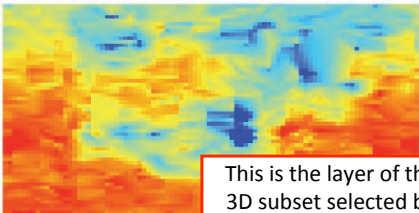


- High quality viewing (Desktop/Mobile) and printing
- Data Extraction and Subsetting
- Simultaneous Dataset Visualization (Swiping)
- Temporal Visualization
- Custom Color Ramps
- Pixel/Attribute Value Identification at Selected Location



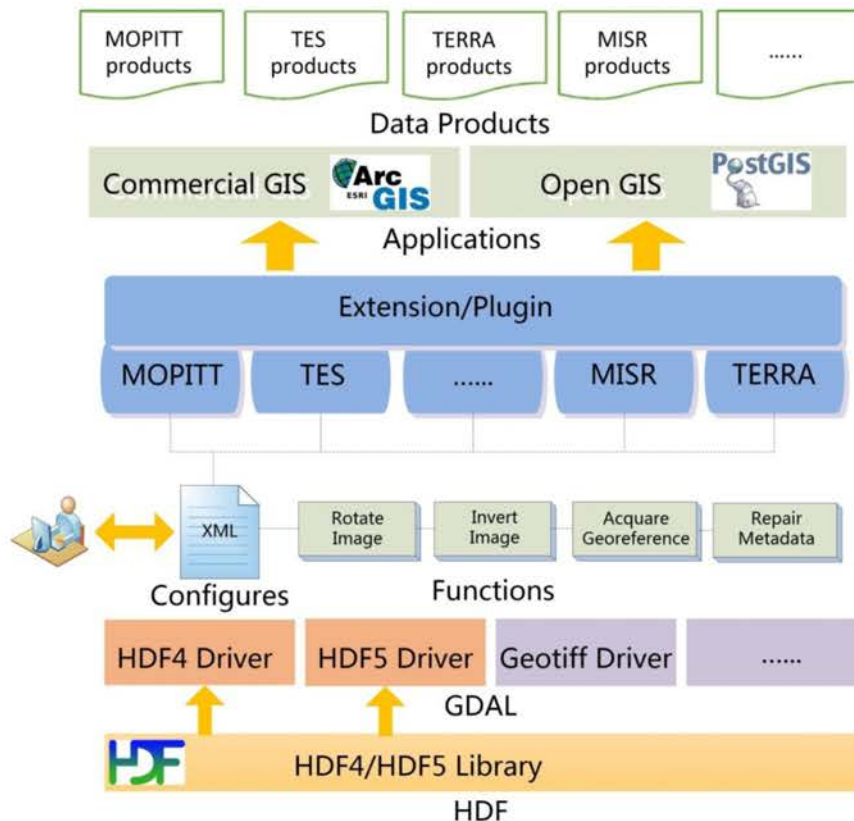
# Geospatial Data Abstraction Library (GDAL) Enhancements



	Image Displayed Inverted	Missing Geo-Reference & 90 Degree Rotated	Missing Geo-Reference & Cannot Display the 3D dataset
	<p><b><u>MOP03TM.005 (HDF4):</u></b> Retrieved Surface Temperature Night</p>	<p><b><u>MOP03TM.006 (HDF5):</u></b> A Priori Surface Temperature Night</p>	<p><b><u>TL3COD.001 (HDF5):</u></b> CO</p>
Before Enhancement			
After Enhancement			 <div> <p>This is the layer of the 3D subset selected by users</p> </div>



# Geospatial Data Abstraction Library (GDAL) Enhancements



- **Revised GDAL HDF Drivers** to allow for extending and additional functionality.
- Added functions such as **Image rotator**, **3D subset reader**, **geo-reference interpreter**, and **metadata repairer** to set up the generic algorithm framework.
- Customized **framework** with **Data product plugins** that recognize file name patterns.
- Enabled image rendering and user workflow with an **ArcGIS plugin / extension** for testing of effectiveness of the improved GDAL.



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**CONTACT US FOR BETA ACCESS**