Agenda

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

Improving the Accessibility and Use of NASA Earth Science Data

2015 May NASA LaRC DAAC Webinar

Matthew Tisdale, Booz Allen Hamilton (BAH), matthew.s.tisdale@nasa.gov
ASDC Advanced Architecture and Engineering (AAE) Lead

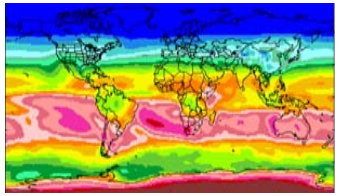
Brian Tisdale, Booz Allen Hamilton (BAH), brian.e.tisdale@nasa.gov
ASDC Big Earth Data Initiative (BEDI) Support

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

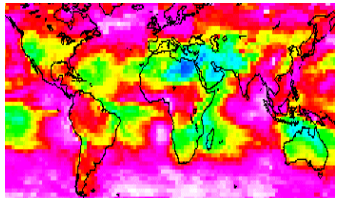
- Many of the NASA Langley Atmospheric Science Data Center (ASDC) Distributed Active Archive Center (DAAC) multidimensional tropospheric and atmospheric chemistry data products are stored in HDF4, HDF5 or NetCDF format, which traditionally have been difficult to analyze and visualize with geospatial 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.
- During this webinar, participants will learn how to leverage geospatial applications such as ArcGIS, OPeNDAP and ncWMS in the production of Earth science information, and in increasing data accessibility and usability.

The ASDC at a Glance

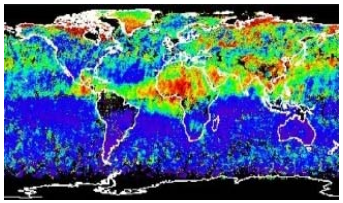
- **Provides data services for over 44 science projects**
- **Primary: CERES, MISR, CALIPSO, ISCCP, SAGE III, MOPITT, TES**
- **Distributes 300+ unique science products**
- **In 2014, 624 Terabytes of data were distributed to over 165,000 customers in 158 countries**
- **3.5 Petabytes of data are in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



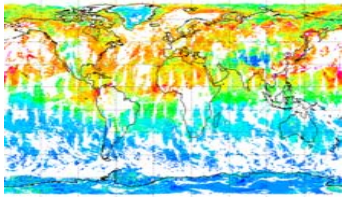
Radiation Budget - The radiation budget takes into account the sum of all radiation, transferred in all directions, through the Earth's atmosphere and to and from space.
Instruments: CERES



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_2O) greenhouse gases (CO_2, CH_4, O_3, N_2O).
Instruments: MOPITT, TES

Data Discovery and Access through Web Services

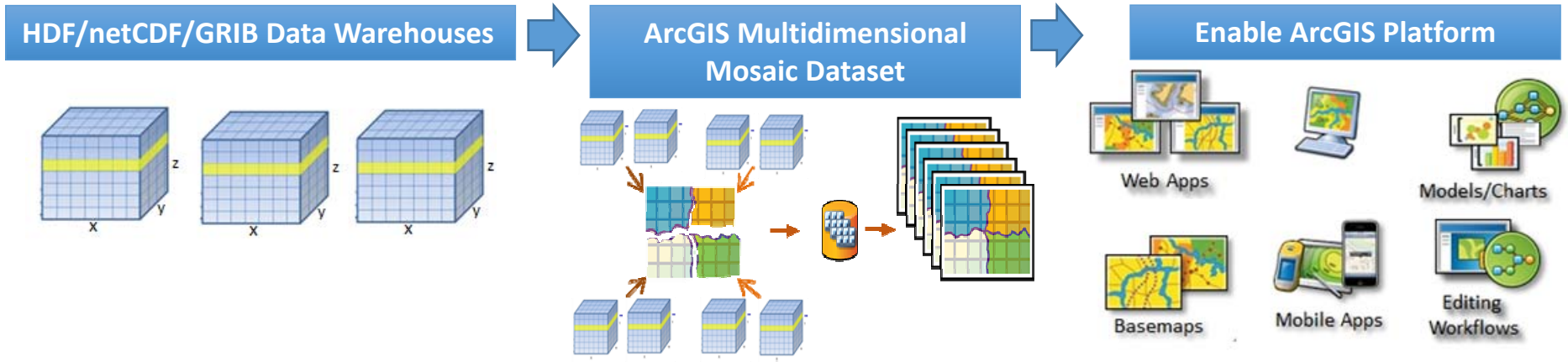
- Web services are used to make the application platform and technology independent by following standards, promoting interoperability
  - Data Access Protocol (DAP) Service
  - WCS (Web Coverage Service)
  - WMS (Web Mapping Service)
  - Webification Science (w10n-sci)
  - **ArcGIS Image Service**
    - 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
  - Global Imagery Browse Services (GIBS)
  - Earthdata Search
  - Group on Earth Observations (GEOSS) Portal
  - Panoply
  - Integrated Data Viewer (IDV)
  - ArcGIS Platform Suite
  - Quantum GIS (QGIS)

What is the ArcGIS Platform?

- ArcGIS is the geography platform enabling users to:
  - Create
  - Organize
  - Share geographic information and tools
  - With anyone by using intelligent online maps and useful apps.
- These apps run virtually anywhere - on desktops, the web, smartphones, and tablets.

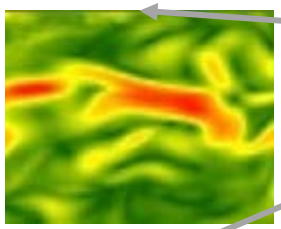
Utilizing the ArcGIS Platform as an end-to-end solution for processing, analyzing, and visualizing NASA's scientific data

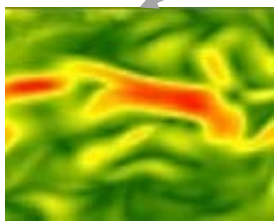


Aggregate (mosaic) spatial, time, and vertical dimensions

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

ArcGIS Multidimensional Mosaic Dataset





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	
2	<Raster	hycom_glb_regp01.nc:water_temp:1	water_temp	5/17/2013	-2	
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	

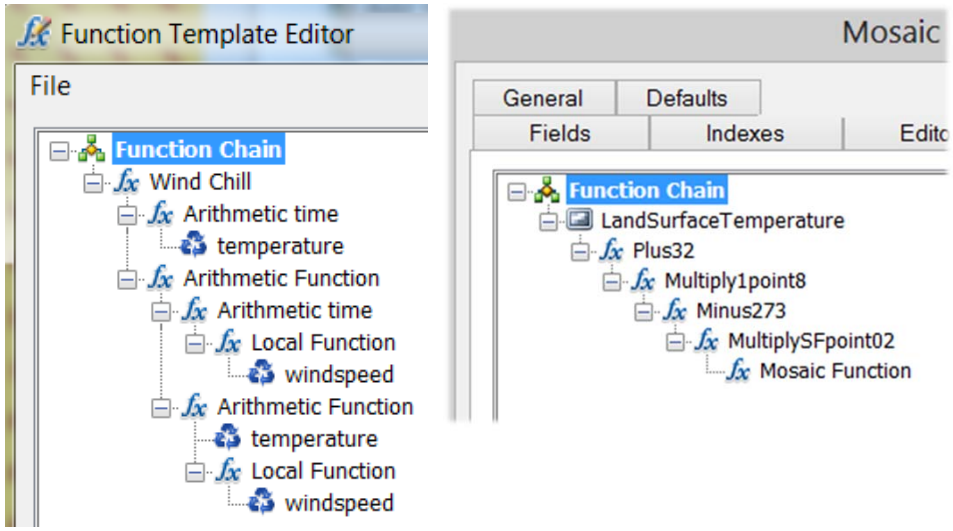
A mosaic dataset allows you to store, manage, view, and query small to vast collections of raster and image data. It is a data model within the geodatabase used to manage a collection of raster datasets (images) stored as a catalog and viewed as a mosaicked image. Mosaic datasets have advanced raster querying capabilities and processing functions and can also be used as a source for serving image services.

A mosaic dataset consists of

- A catalog that provides the source of the pixels and footprints of the rasters
- A feature class that defines the boundary
- A set of mosaicking rules that are used to dynamically mosaic the rasters
- A set of properties used to control the mosaicking and any image extraction
- A table for logging during data loading and other operations
- Optionally, a seamline feature class for seamline mosaicking
- Optionally, a color correction table that defines the color mapping for each raster in the raster catalog

Mosaic datasets utilize raster types to read and ingest the required information from raster datasets. It identifies metadata, such as georeferencing, acquisition date, and sensor type, along with a raster format.

Modeling with Raster Function Template (RFT)



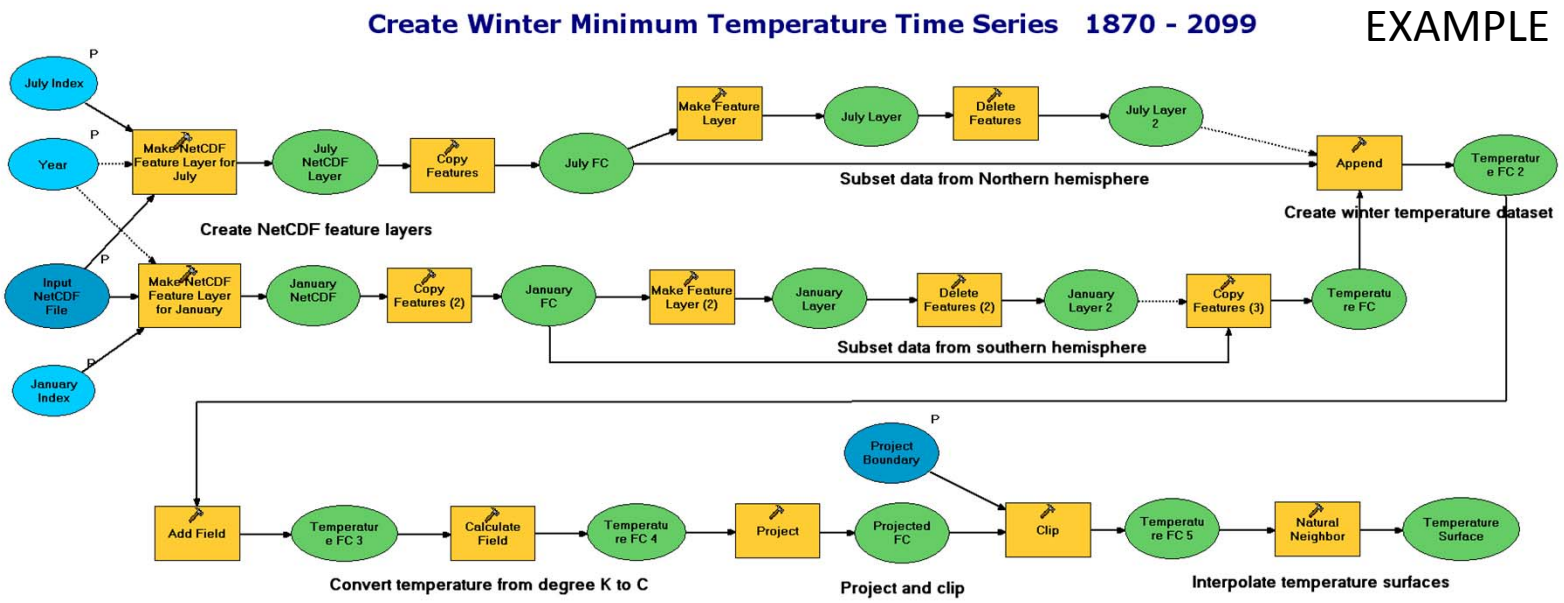
On-the-fly processing

- Arithmetic
- Statistics
- Reproject
- Remap
- Tassel Cap
- Etc.

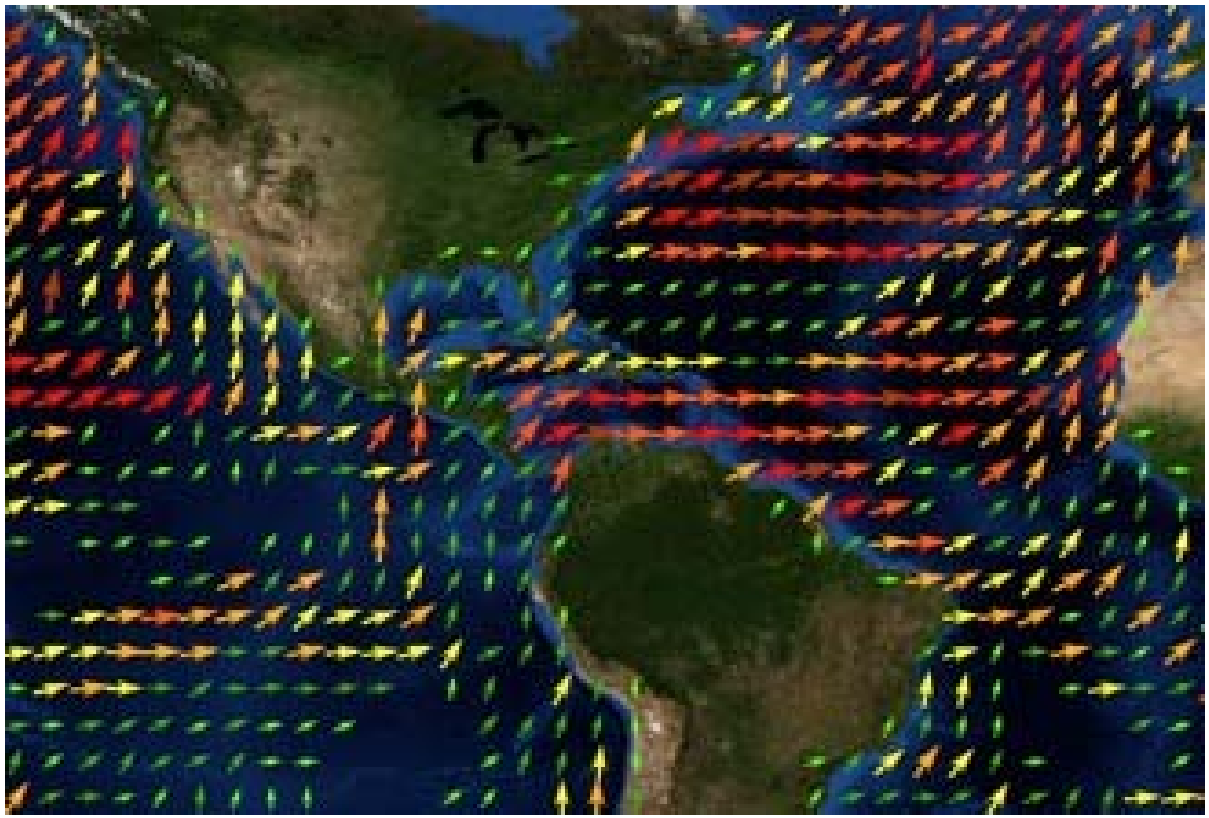
- Functions allow the mosaic dataset to deliver a dynamically mosaicked image and they can be used to enhance the mosaicked image product by applying on-the-fly processing operations such as orthorectification, image enhancements, and image algebra.
- You can add functions to the mosaic dataset or to individual rasters within the mosaic dataset, or they may be added when the data is added to the mosaic dataset. For example, when specific raster data products (such as from a satellite sensor) are added to a mosaic dataset, some functions are automatically added to the raster data.
- This is advantageous, because it saves disk space, since you aren't required to store both source and preprocessed datasets. Additionally, if you wanted to process the same data differently, you can add the same data to a different mosaic dataset and apply different functions.

Spatial and Temporal Analysis

- Several hundred analytical tools available for raster, features, and table
- Temporal Modeling
- Looping and iteration in ModelBuilder and Python



Visualization



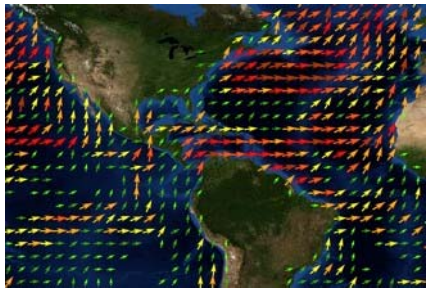
- Visualize temporal change of a variable
- Visualize a variable at any vertical dimension
- Calculate and visualize flow direction and magnitude variables

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

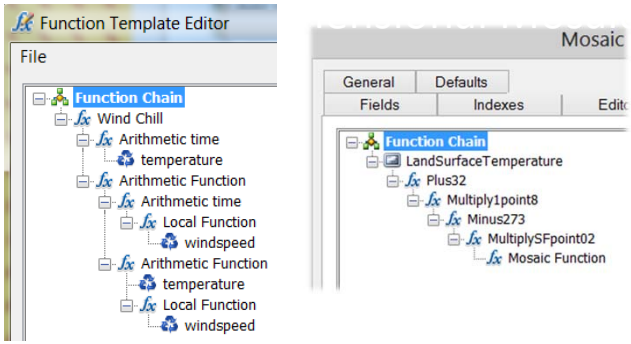
Mosaic Index

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

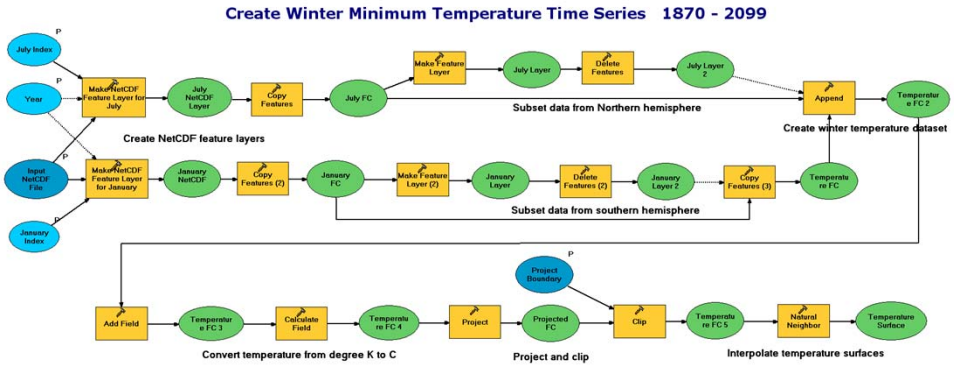
Visualization



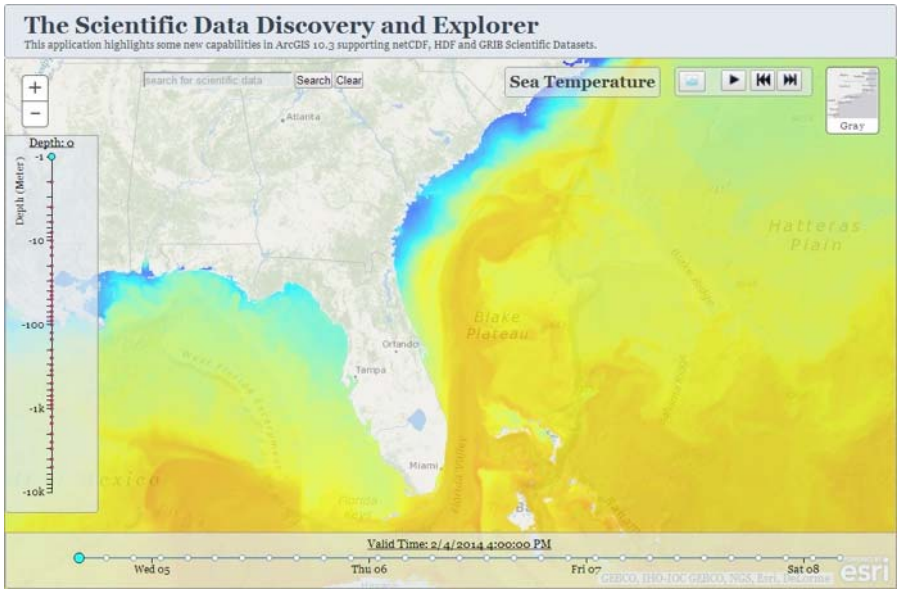
Modeling with Raster function template (RFT)



Spatial and Temporal Analysis

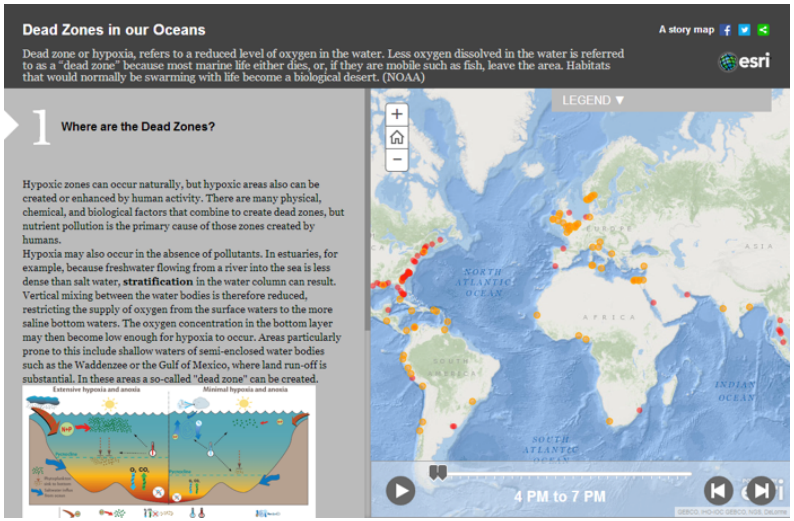


Multidimensional Mosaic in Web Applications



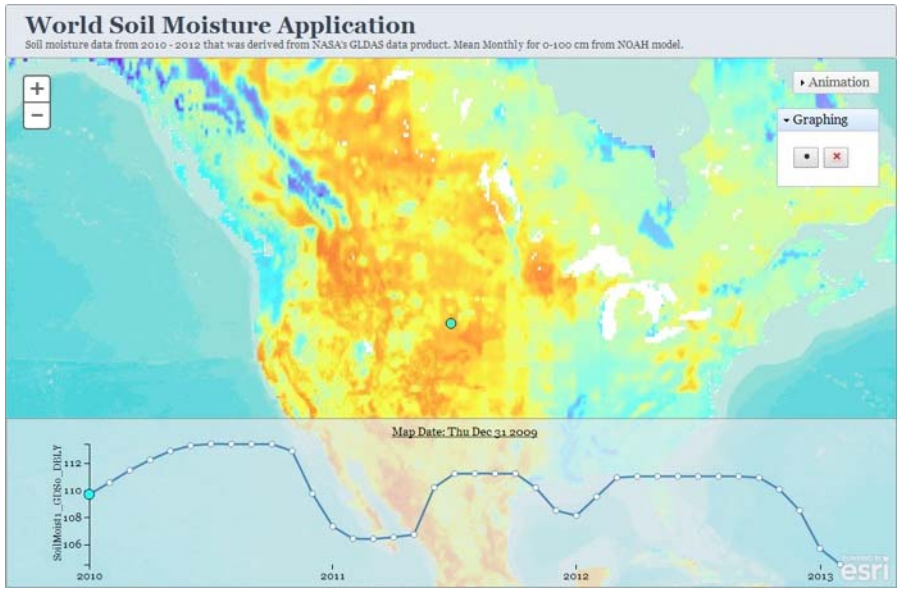
Depth

Time



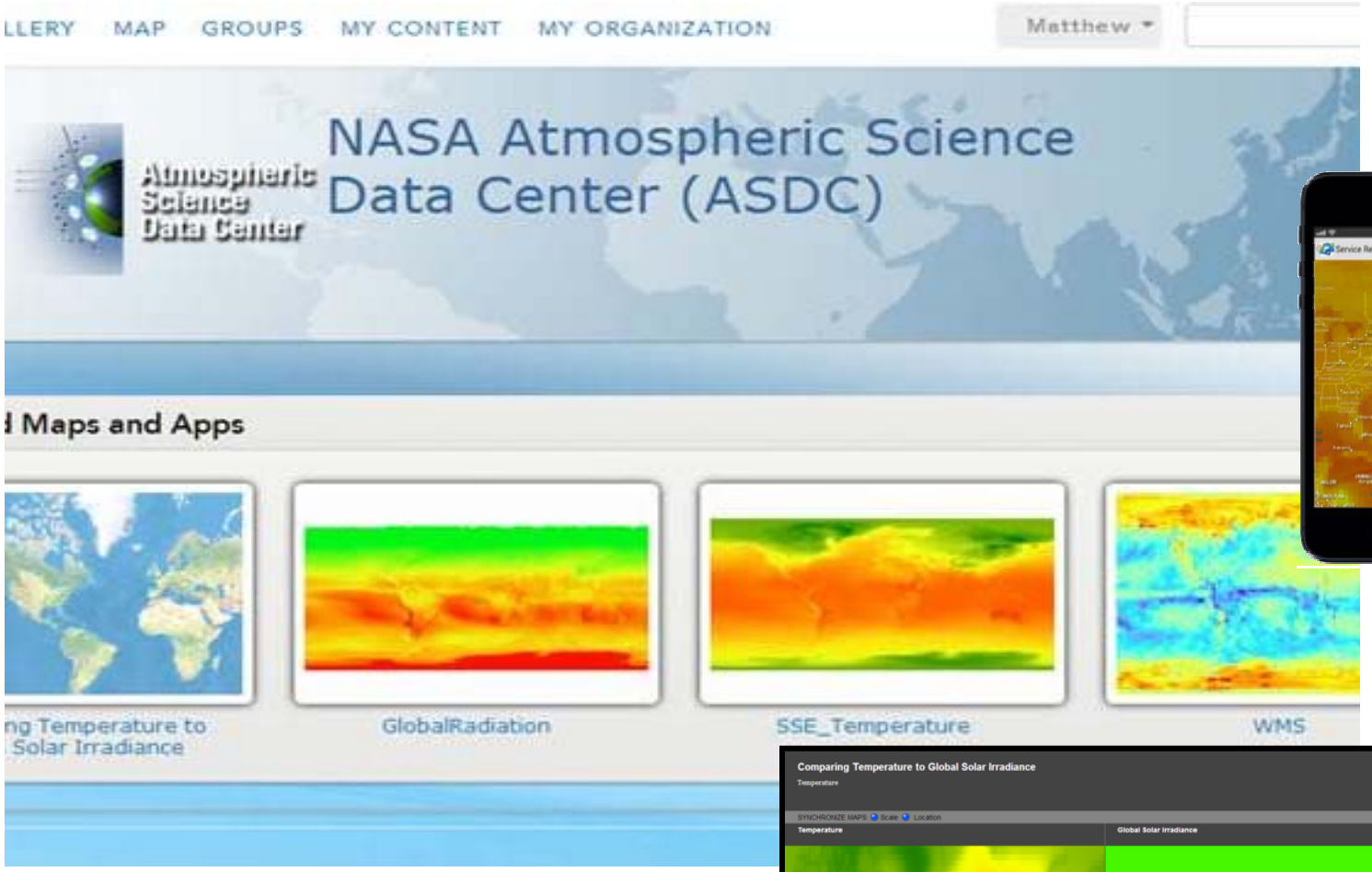
Create Story Maps

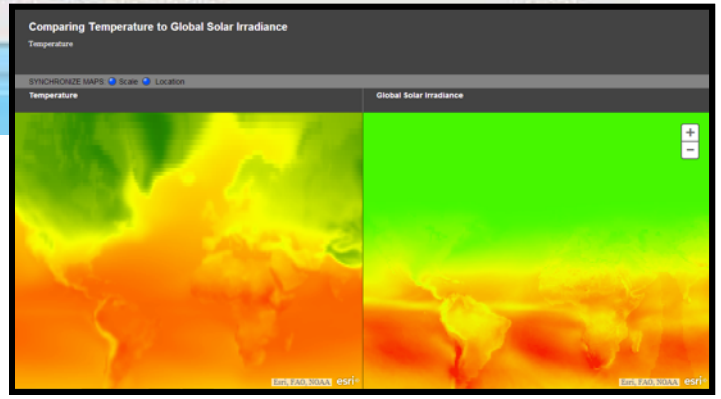
- Tell the story of your scientific data



Temporal Graph

NASA ASDC ArcGIS Portal





GEOPLATFORM.gov

DATA.GOV

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) Submit Reset

Geometry	Latitude and longitude (center and boundaries)
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	Annual Sum
22-year Average	0	0	4	22	86	189	257	224	130	34	5	1	952

Parameter Definition

Meteorology (Wind):

Monthly Averaged Wind Speed At 50 m Above The Surface Of The Earth (m/s)

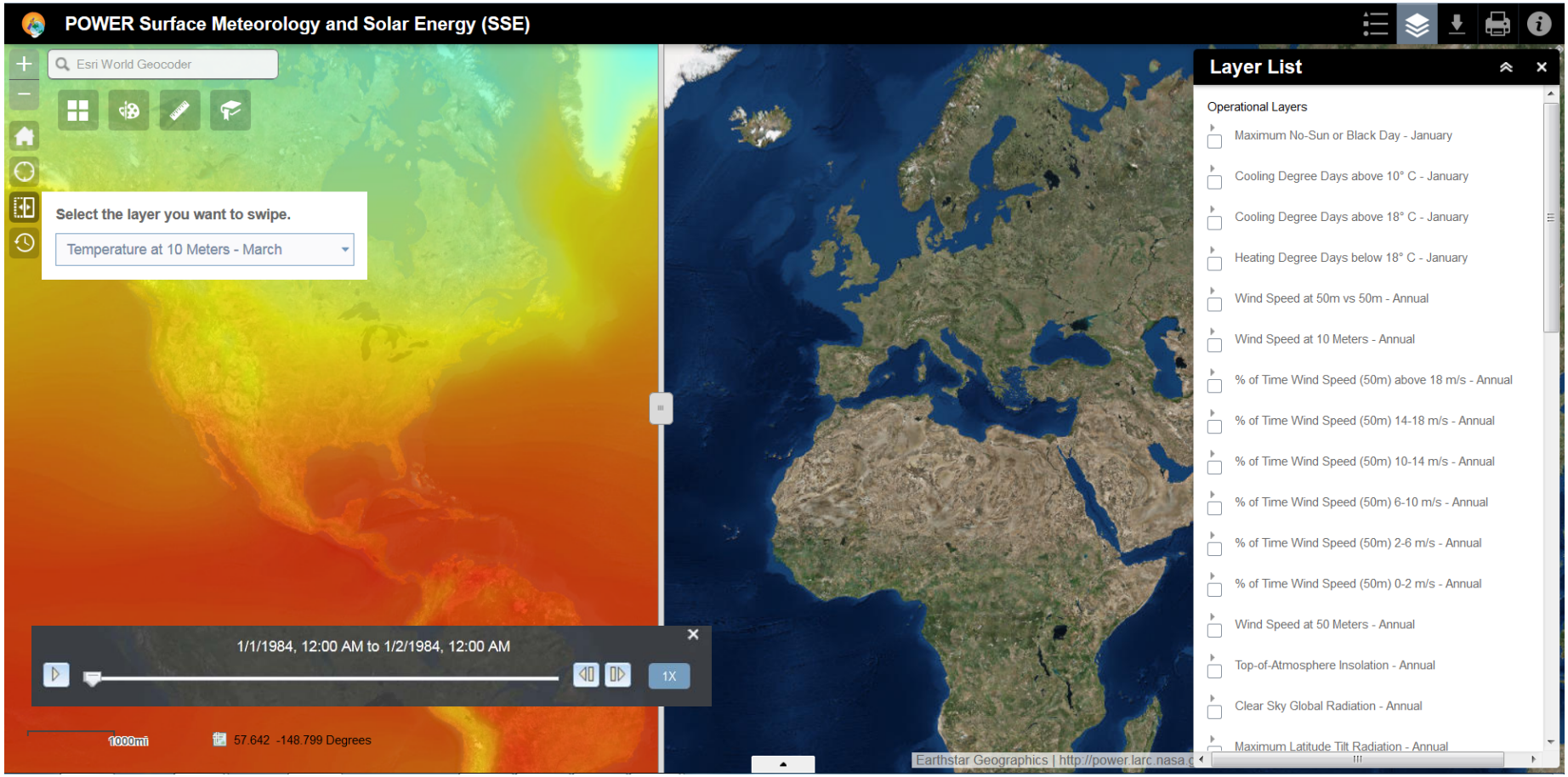
Lat 37 Lon -77	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	6.60	6.71	6.67	6.04	5.13	4.88	4.34	4.17	4.80	5.38	6.27	6.65	5.63

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	Annual Average
Minimum	-13	-11	-14	-10	-13	-11	-10	-16	-8	-11	-8	-11	-11
Maximum	13	8	9	15	16	9	11	10	11	9	10	7	11

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

POWER SSE – GIS Web Application Enhancing Accessibility & Usability



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

Increasing Accessibility and Interoperability of NASA ESDIS Datasets with GIS Applications

A Big Earth Data Initiative (BEDI) Project

- To make ASDC data products easily accessible and interpretable by commercial and open-source GIS applications (Eliminate need for custom codes) This simplifies use of data by emerging applications community and modelers. It is transparent to the users.

Objectives:

- Identify the problems occurring in accessing MOPITT (HDF4 and HDF5) and TES (HDF5) level-3 data products by GIS software
- Determine the causes of anomalies
- Provide the solution framework to enable data access by GIS software
  - GDAL and HDF driver source codes
  - ArcGIS 10.2 and 10.3 Beta

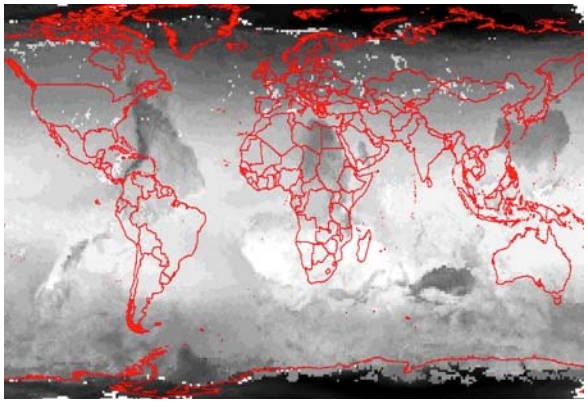
Geospatial Data Abstraction Library (GDAL) Enhancements

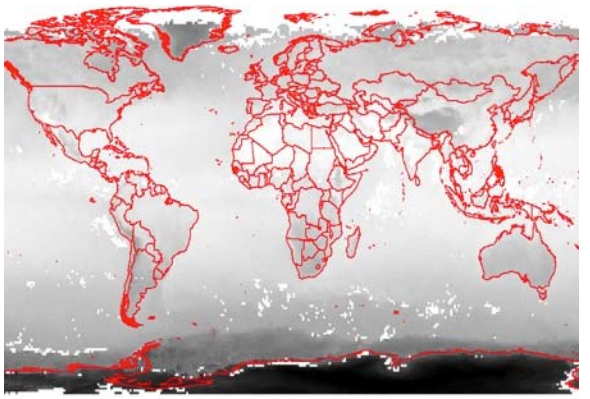
In ArcMap 10.2.2

ASDC Improvement

Image Displayed Inverted

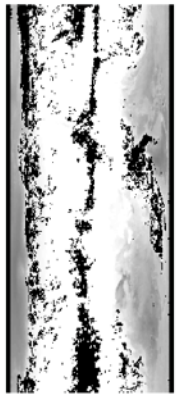
MOP03TM.005 (HDF4):
Retrieved Surface
Temperature Night

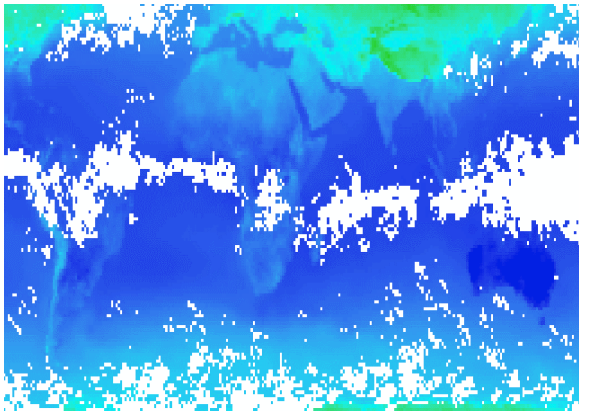




Missing Geo-Reference
& 90 Degree Rotated

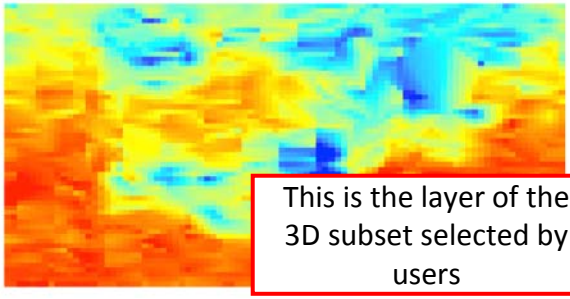
MOP03TM.006 (HDF5):
A Priori Surface
Temperature Night



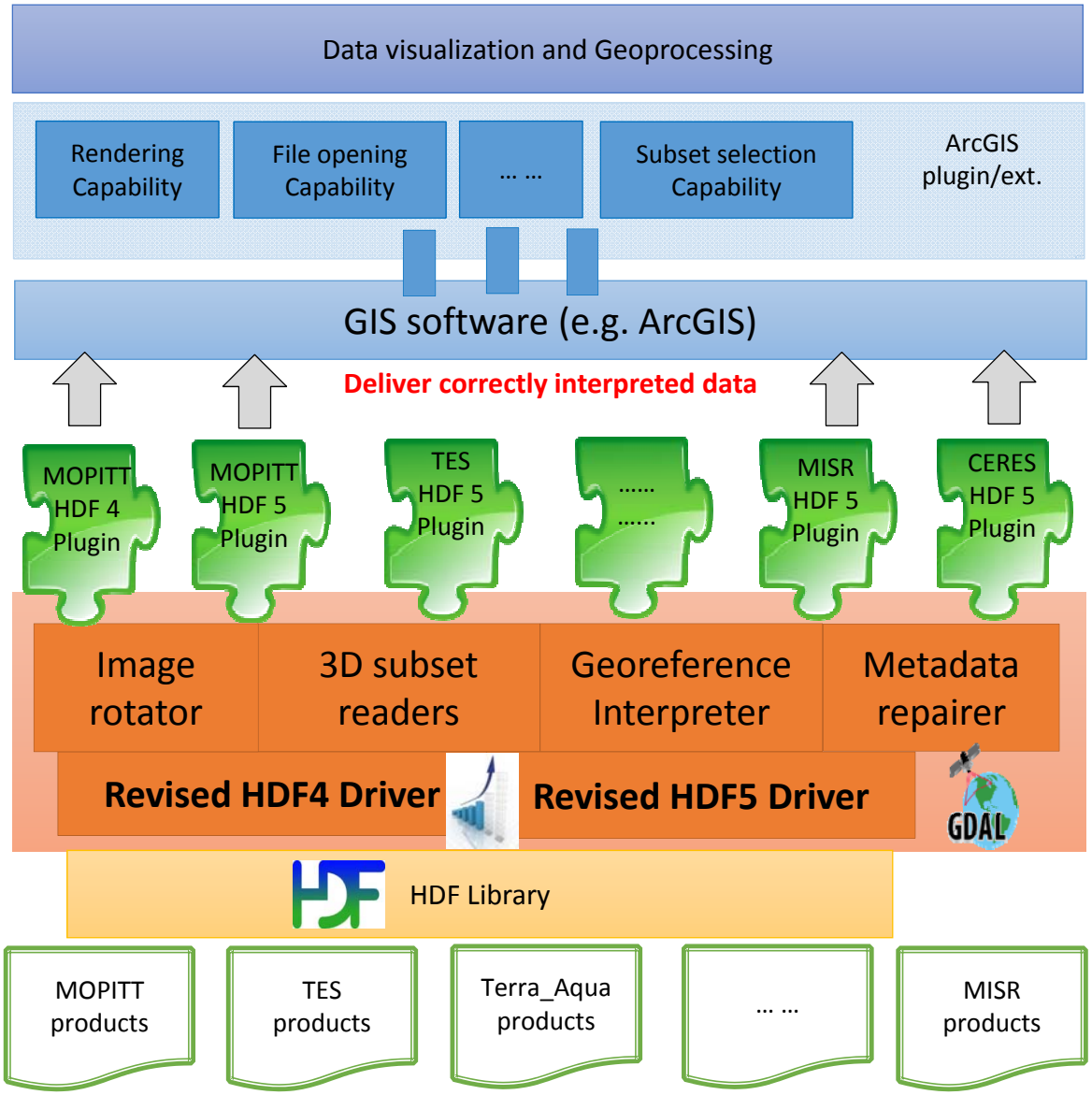


Missing Geo-Reference
& Cannot Display the 3D dataset

TL3COD.001 (HDF5):
CO



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.

DEMO

Improving the Accessibility and Use of NASA Earth Science Data

2015 May NASA LaRC DAAC Webinar

Matthew Tisdale, BAH, matthew.s.tisdale@nasa.gov

Brian Tisdale, BAH, brian.e.tisdale@nasa.gov

CONTACT US FOR BETA ACCESS

ADD URLs for WEBSITES