

GOVLOOP TRAINING

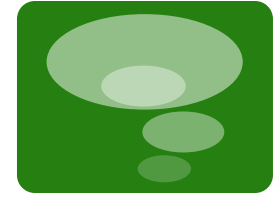
Simple Ways to do More with Your Scientific Data

June 18th, 2015

Helping you do your job better:

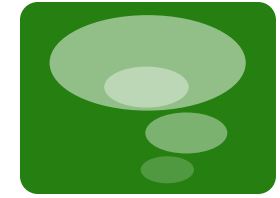


Housekeeping



- **Tweet with us:** Follow @govloop and use #gltrain to share what you learn.
- **Get answers:** Submit your questions using the "Ask a question" box on the console. Our experts will take your questions at the end.
- **Need help:** If you have any technical difficulties during the training click on the "Help" button located below the slide window.
- **Learn more:** Check out the Resources Section for additional information (including this slide deck) on GIS.
- **On-Demand:** We will email you a link to the on-demand version of this training so you can view it again or share with a colleague. Plus your GovLoop training certificate.
- **Be a VIP:** By attending the live training you've earned 1 credit towards GovLoop's VIP program. Get to 5 and we'll send you awesome swag.
- **Take our survey:** Help us, help you! Take our brief evaluation to let us know what you liked about this training.

Today's Speakers



Dawn Wright

Chief Scientist
Esri



Brian Tisdale

Booz Allen Hamilton



Suresh K.S. Vannan

Manager, DAAC
Oak Ridge National
Laboratory



Brett Rose

Solution Engineer
Esri



GovLoop Webinar

June 18, 2015



Location *Matters* in Scientific Discovery

Dawn J. Wright, Ph.D.

Esri Chief Scientist

Esri View of Science

esriurl.com/scicomm

Increasing fundamental
scientific understanding

How the Earth *works*.

Promoting
economic vitality

How the Earth
should LOOK.

Protecting life
and property

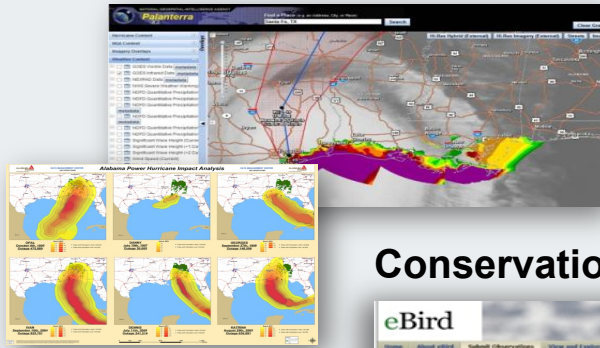
How we should
look AT the Earth.

Enabling stewardship
of the environment

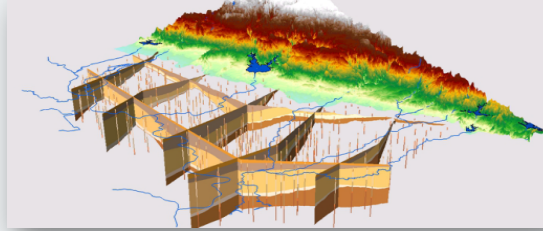
Societal drivers of science are key.

How the Earth works.... How the Earth should *look* How we should look *at* the Earth....

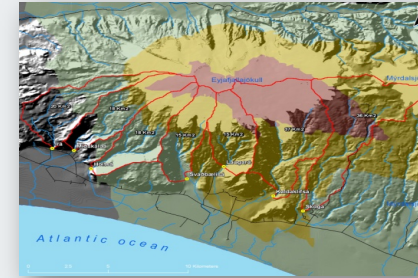
Climate Science



Hydrology



Geology/Geophysics



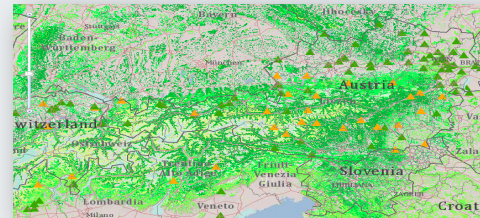
Ecology



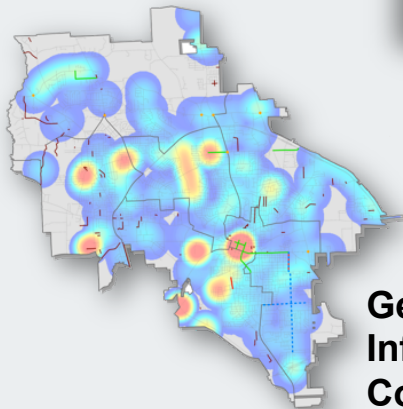
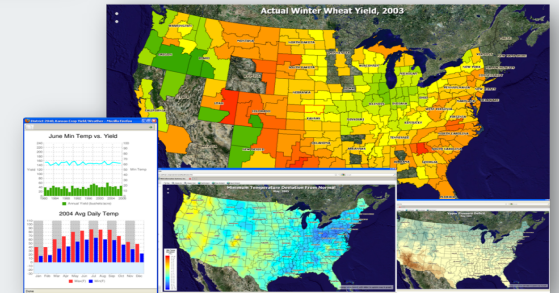
Conservation Biology



Forestry



Agricultural Science

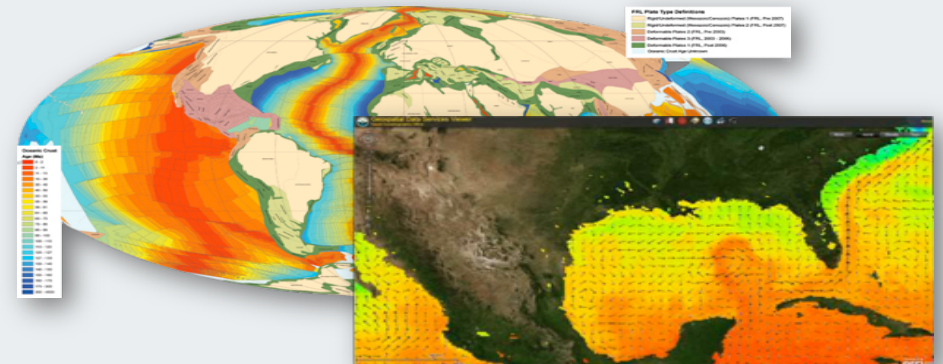


Geographic Information Science / Computer Science

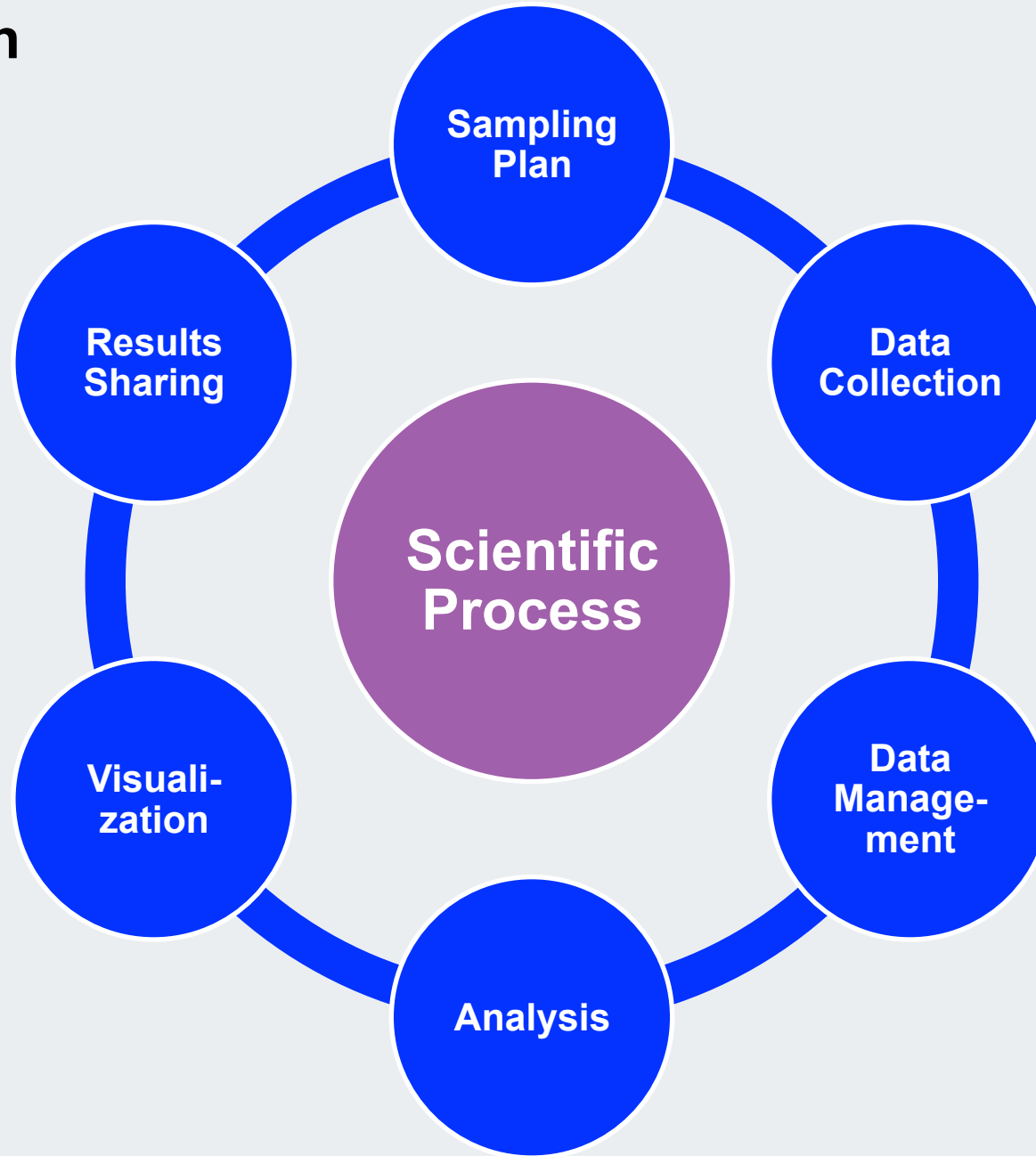
Sustainability Science / Geodesign



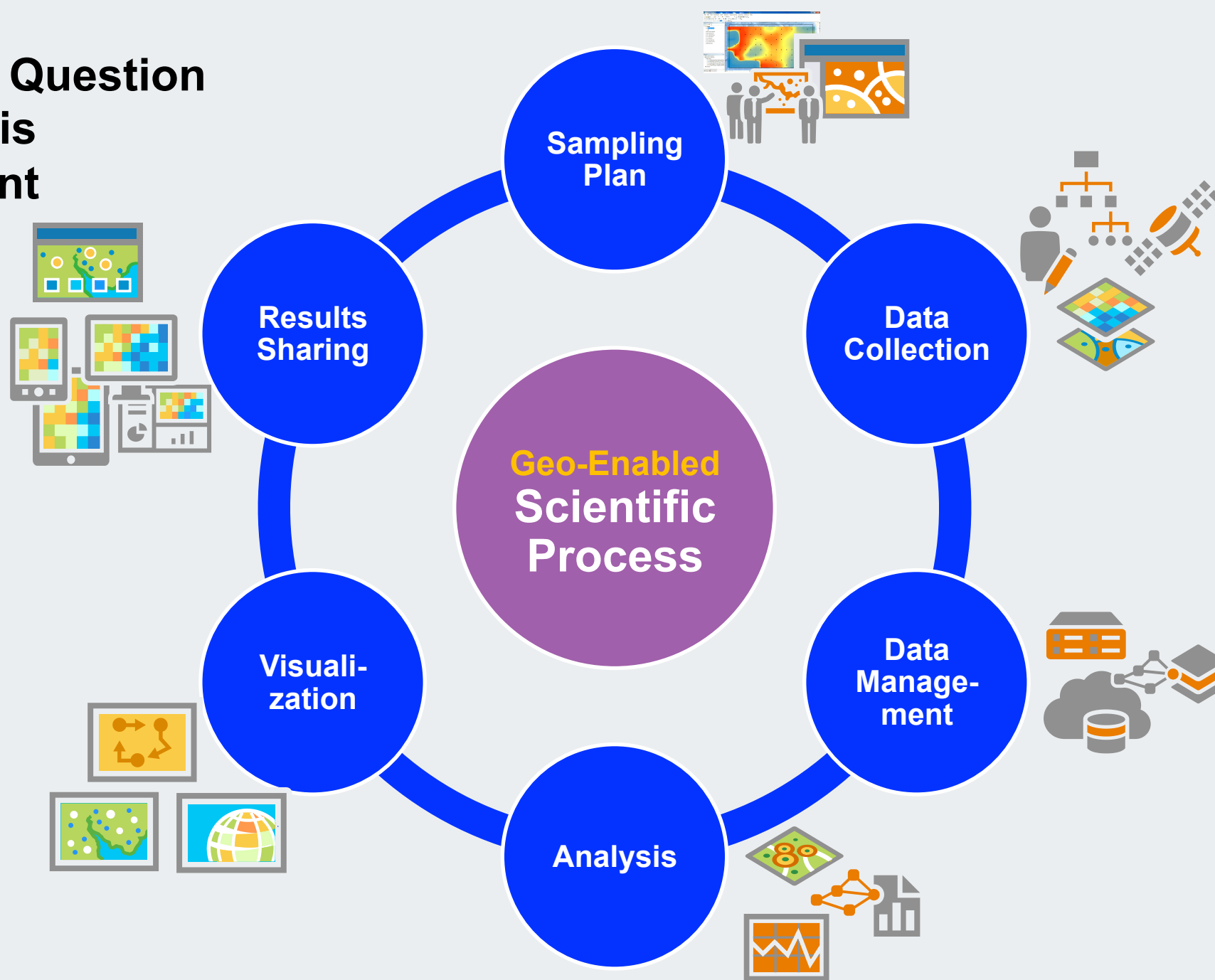
Ocean Science



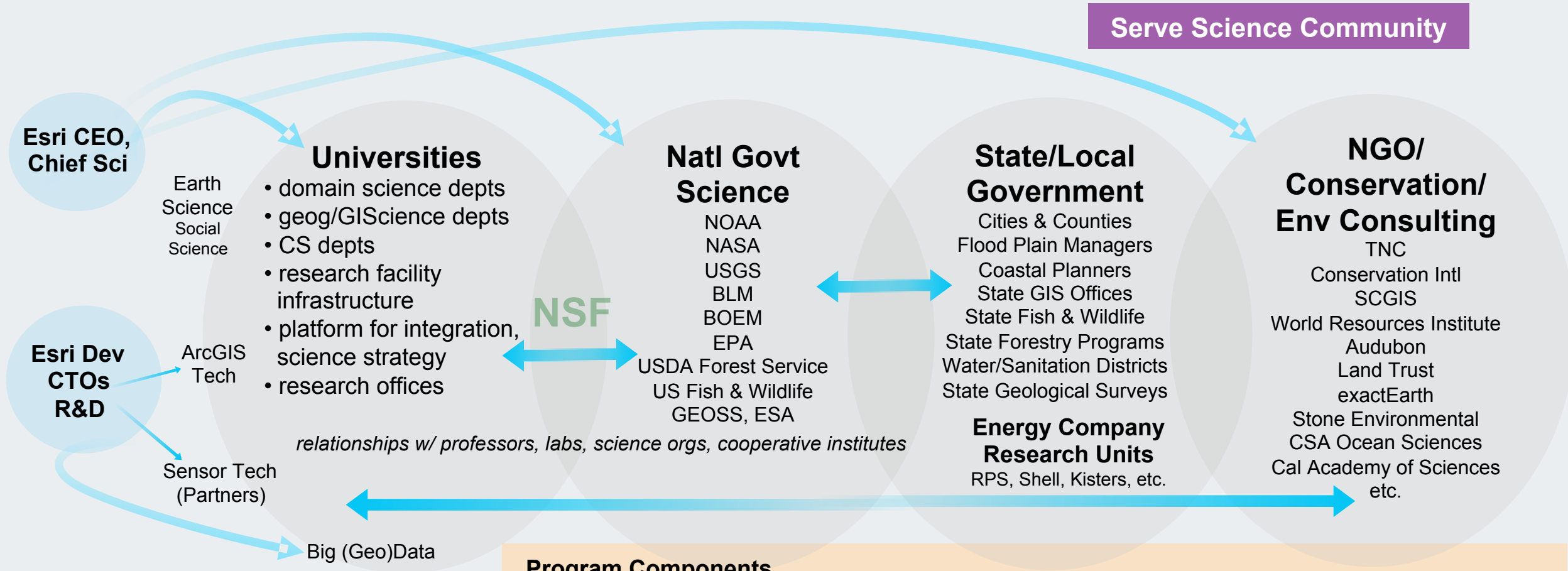
Research Question
Hypothesis
Experiment



Research Question
Hypothesis
Experiment



Esri Science Community Program



Program Components

Chief Scientist, National Government Science Team, Esri Education Team

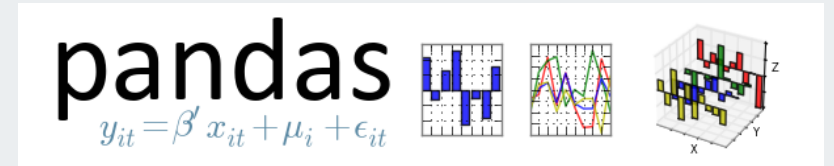
- **Internships** for students
- **Sabbaticals** for faculty
- **Esri Development Centers** at universities
- **Summits**: Dev, Geodesign, Ocean, Health, etc. (UC Science Symposium coming in 2016)
- **Software stacks** (e.g., MultiD, SciPy, R integration)
- **Data stacks** (e.g., ArcGIS Online content, Living Atlas)
- **Resource web sites** (blogs, use cases, webinars)
- **Esri Press** research monographs
- **App challenges/Design** competitions
- **Informal MOUs** with labs/orgs

Software Stacks for the Scientific Community

- **Python**
- **OPeNDAP** (Open-source Project for a Network Data Access Protocol)
- **R** (the *R* Project for Statistical Computing)

Inclusion of Additional Python Packages

- **Pandas** – provide high-performance, easy-to-use data structures and data analysis tools for working with tables in Python
- **SciPy** - supports our goal of being a comprehensive geospatial platform for science by expanding the number and type of analytical methods available to the science community
- **netCDF4** - provides programmatic access for a popular scientific data format



Support for OPeNDAP Data Sources

- The OPeNDAP protocol has become the de facto standard for streaming scientific data
- NOAA and NASA have extensive data collections available via OPeNDAP
- New ArcGIS geoprocessing tool for reading OPeNDAP data
- Makes a raster layer from data stored on a remote OPeNDAP server

The image displays the ArcGIS Pro interface. On the right, the 'Geoprocessing' window is open, showing the 'Make OPeNDAP Raster Layer' tool. The parameters are set as follows:

- Input OPeNDAP URL: `http://cida.usgs.gov/thredds/dodsC/new`
- Variable: `tas`
- X Dimension: `longitude`
- Y Dimension: `latitude`
- Output Raster Layer: `tas_Layer`
- Extent: `-124.6875` to `-67.0625` longitude, `25.1875` to `52.8125` latitude
- Dimension Values: Dimension `time`, Start Value `01/01/1949 12:00:00`, End Value `12/31/2010 12:00:00`
- Value Selection Method: `By value`

The 'Run' button is visible at the bottom right of the tool window. Below the tool window, the main map area shows a raster layer of the United States, color-coded by temperature. The legend in the 'Contents' pane indicates a range from High: 17 to Low: -26. The map is titled 'Mean temperature (C) : 1950-2010'.

Mean temperature (C) : 1950-2010

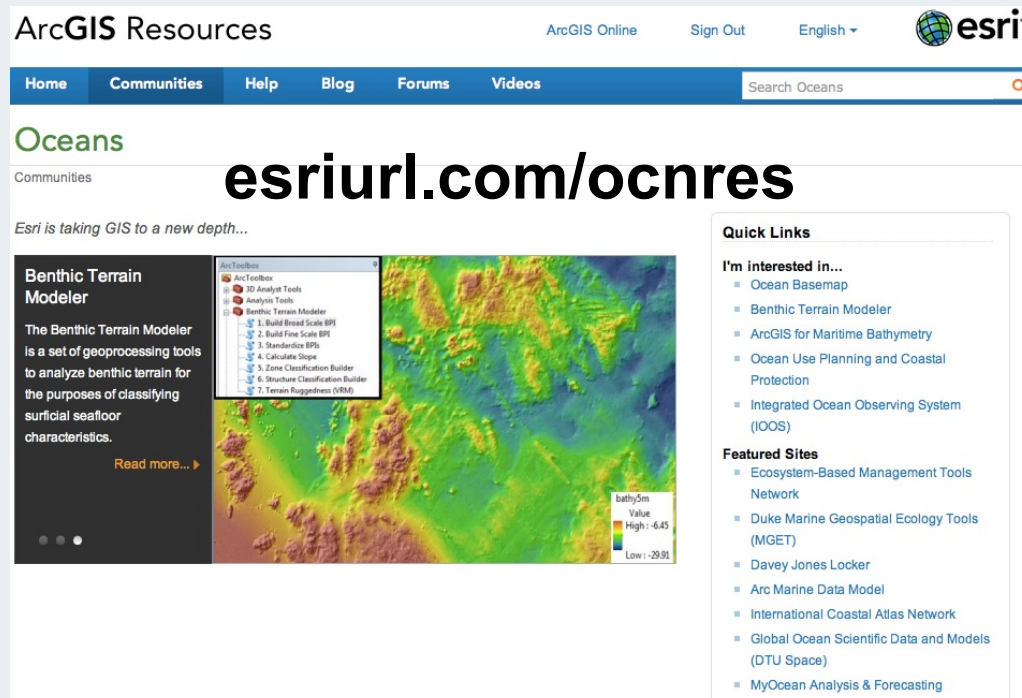
New R – ArcGIS Bridge and Community

- R is the most widely used, fastest growing statistical analysis software
- Many organizations using ArcGIS also use R
- High interest in our existing R integration
- Who is this for?
 - R users who want to work in R with easy, efficient access to ArcGIS data
 - R users who want to provide R analysis capabilities to ArcGIS users
 - ArcGIS users who don't know R



Resource Centers / Case Studies / Blogs

- Analysis from exploration to decision-making demonstrated by example
 - Data and models can be downloaded
 - Analysis and tools are defined by the question - outlined at the start
 - Processes shown, results are interpreted



ArcGIS Resources

ArcGIS Online Sign Out English esri

Home Communities Help Blog Forums Videos Search Oceans

Oceans

Communities

esriurl.com/ocnres

Esri is taking GIS to a new depth...

Benthic Terrain Modeler

The Benthic Terrain Modeler is a set of geoprocessing tools to analyze benthic terrain for the purposes of classifying surficial seafloor characteristics.

Read more...

Quick Links

I'm interested in...

- Ocean Basemap
- Benthic Terrain Modeler
- ArcGIS for Maritime Bathymetry
- Ocean Use Planning and Coastal Protection
- Integrated Ocean Observing System (IOOS)

Featured Sites

- Ecosystem-Based Management Tools Network
- Duke Marine Geospatial Ecology Tools (MGET)
- Davey Jones Locker
- Arc Marine Data Model
- International Coastal Atlas Network
- Global Ocean Scientific Data and Models (DTU Space)
- MyOcean Analysis & Forecasting



Analytics

Home Case Studies Python

Case Studies

esriurl.com/case

Pose questions and derive results using a wide array of analytical tools, and examine and explore your results.

- Understand and Compare Places**
Understand and solve problems by looking at your data spatially.
Topics: Attribute and spatial queries, spatial properties
Show me how >
- Determine How Places are Related**
Bring data layers together spatially to create new information to analyze.
Topics: Attribute and spatial joins, overlay, map algebra
Show me how >
- Find the Best Locations and Paths**
Define criteria, develop measures, and create models to identify suitable locations.
Topics: Site suitability, location-allocation, cost corridors
Show me how >
- Detect and Quantify Patterns**
Analyze the distribution of events, and separate clear patterns from the data.
Topics: Density analysis, hot spot analysis, data clusters
Show me how >
- Make Predictions**
Many features occur across large areas, and sample observations can be used to predict values everywhere.
Topics: Interpolation, surface analysis, regression
Show me how >
- Automation and Processing**
The majority of spatial analysis are created and automated using geoprocessing framework and tools. Use ModelBuilder or Python to create and run advanced analytic models.
Show me ModelBuilder in: ArcMap | ArcGIS Pro >
Show me Python in: ArcMap | ArcGIS Pro >

“Once upon a time ...”

esriurl.com/analyticalstories

All Blogs

Esri Insider

Esri visions, strategic initiatives, and trending topics

RSS 2.0

Atom 1.0

Speaking the “Language” of Spatial Analysis via Story Maps

by Dawn Wright on September 15, 2014

Share 192 Tweet 542 Share 1297

The USDA Forest Service’s [Restoration Story Map Atlas](#) uses the same format to show the results of analyses for the Pacific Northwest ranging from identifying the percentage of a watershed that could be effectively treated through active forest thinning, prescribed fire, or use of wildfire, to the results of a bivariate rendering of burn probability by conditional flame length.



Dawn Wright | Sign out | Site Admin

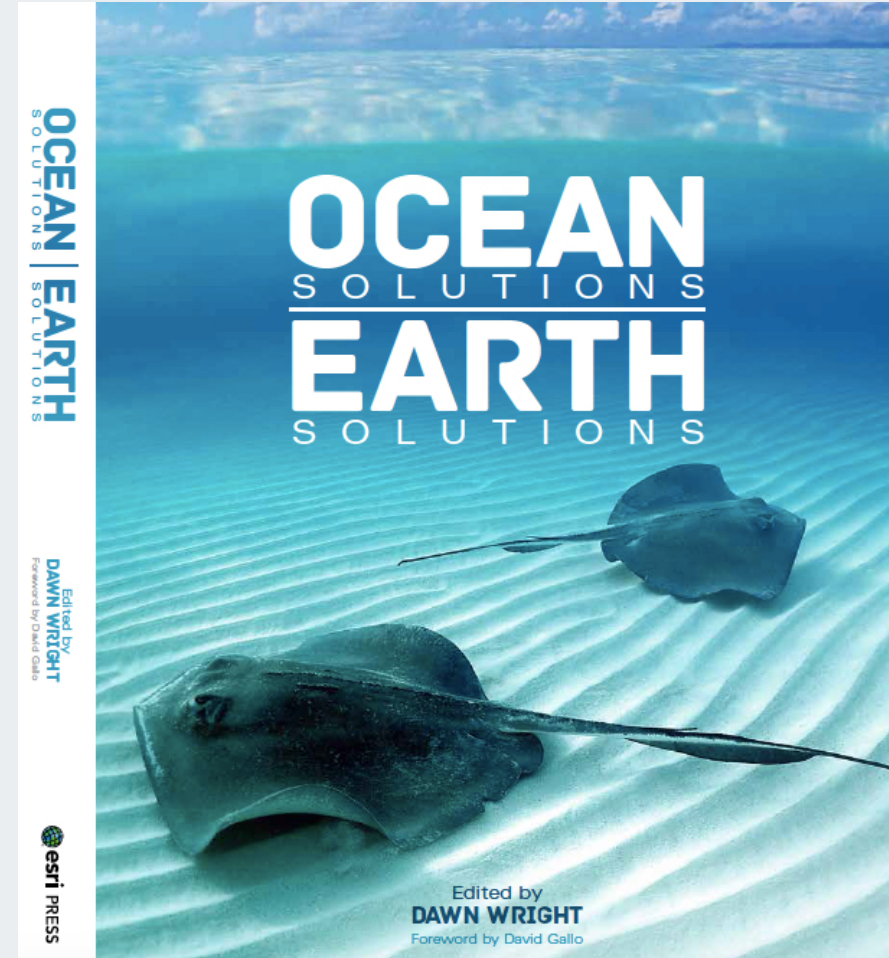
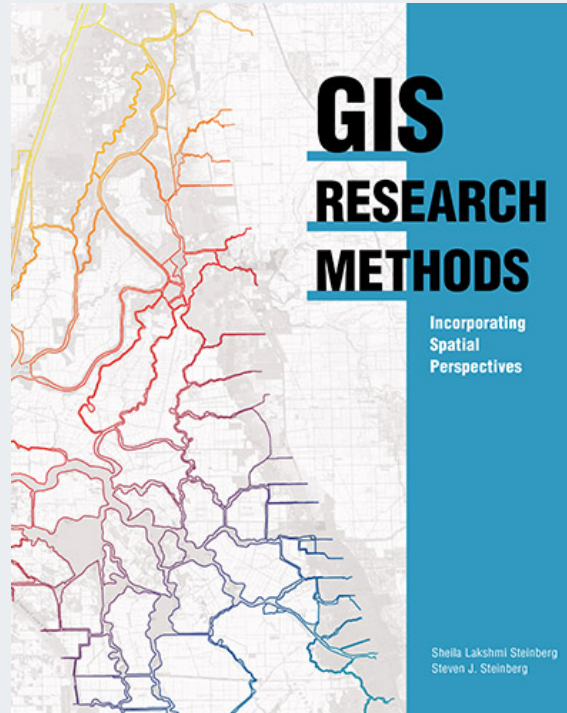
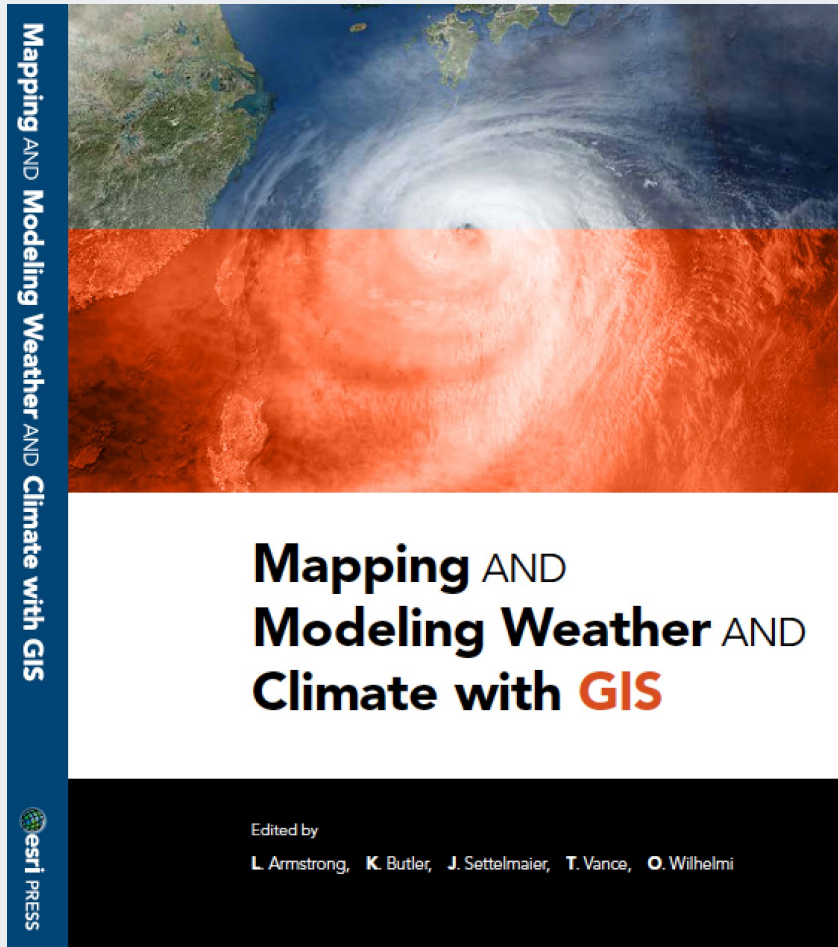
Search

Categories

Online big data business citizen engagement climate change Climate Change Adaptation Cloud CyberGIS Dawn Wright demographics education electric Esri geodesign geographic information systems geography GIS GIS Education Gov 2.0 government government accountability government transparency higher education imagery Jack Dangermond location analytics mobile natural resources ocean oceans Oceans & Maritime Public Works remote sensing Retail science spatial analysis spatial thinking story map Story Maps storytelling storytelling with maps user conference utilities

New Esri Press Books for Scientists

esripress.esri.com



Access

Summary Blog Post: esriurl.com/scicomm

2015 Road Map: esriurl.com/sci2015

Personal Web: esriurl.com/dawn

Email: dwright@esri.com

Twitter: [@deepseadawn](https://twitter.com/deepseadawn)

Elsewhere: road bike, movie theater

Improving the Accessibility and Use of NASA Earth Science Data

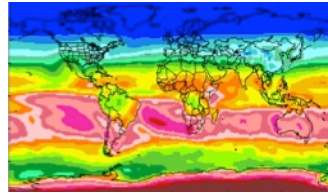
Brian Tisdale, Booz Allen Hamilton (BAH), brian.e.tisdale@nasa.gov

NASA Atmospheric Science Data Center (ASDC)

Agenda:

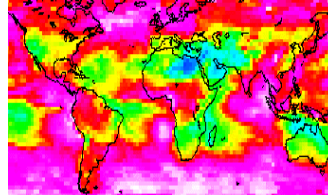
1. The ASDC at a Glance
2. ASDC Geospatial Architecture
3. Use Case - POWER/SSE
4. GDAL Enhancements for ESDIS (GEE)

- 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



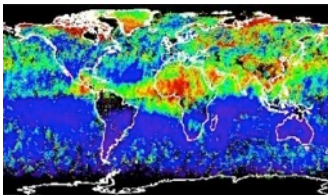
Radiation Budget - The radiation budget takes into account the sum of all radiation, transferred in all directions, through the Earth's atmosphere and to and from space.

Instruments: CERES



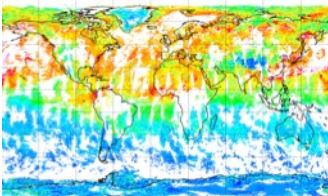
Clouds - A visible aggregate of minute water droplets and/or ice crystals in the atmosphere above the Earth's surface.

Instruments: CALIPSO, MISR



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

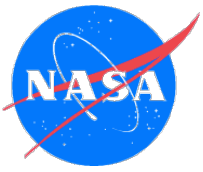
Instruments: CALIPSO, MISR, SAGE III



Tropospheric Chemistry - Measurements of chemical constituents in the atmosphere including the major (non-H₂O) greenhouse gases (CO₂, CH₄, O₃, N₂O).

Instruments: MOPITT, TES

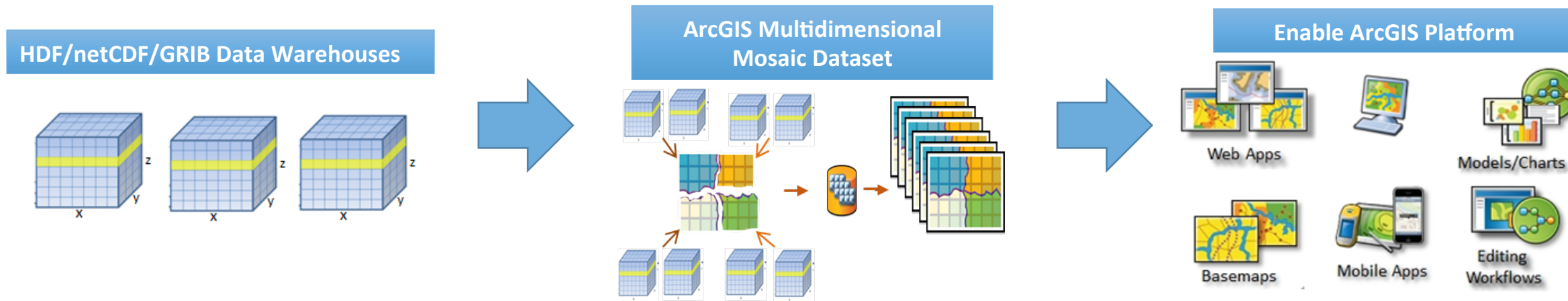
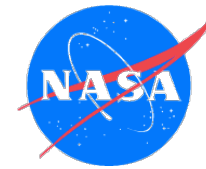
Improving the Accessibility and Use of NASA Earth Science Data in Geospatial Applications



- 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.

- 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

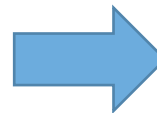
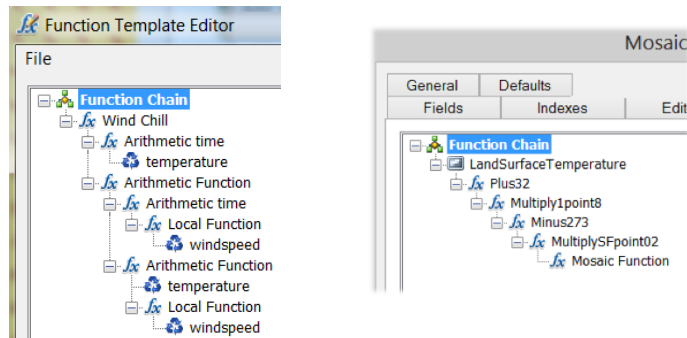
End-to-End Solution for Processing, Analyzing, and Visualizing Data

Mosaic Index

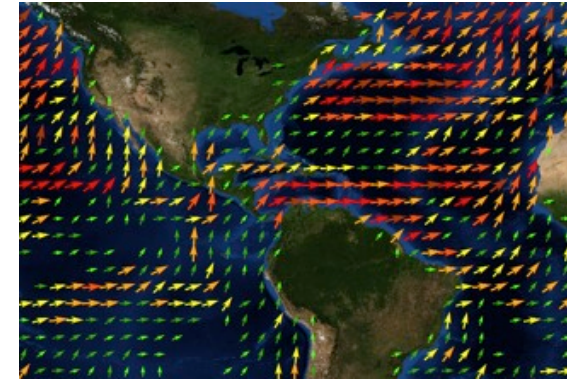
OBJ	Raster	Name	Variable *	Standard Time	Standard Z	...
1	<Raster	hycom_glb_regp01.nc:water_temp:0	water_temp	5/17/2013	0	
2	<Raster	hycom_glb_regp01.nc:water_temp:1	water_temp	5/17/2013	-2	
3	<Raster	hycom_glb_regp01.nc:water_temp:2	water_temp	5/17/2013	-4	
4	<Raster	hycom_glb_regp01.nc:water_temp:3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



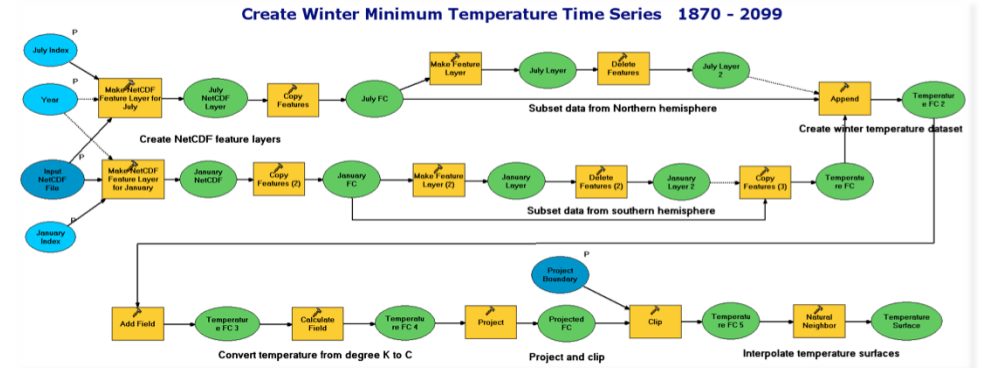
Modeling with Raster function template (RFT)



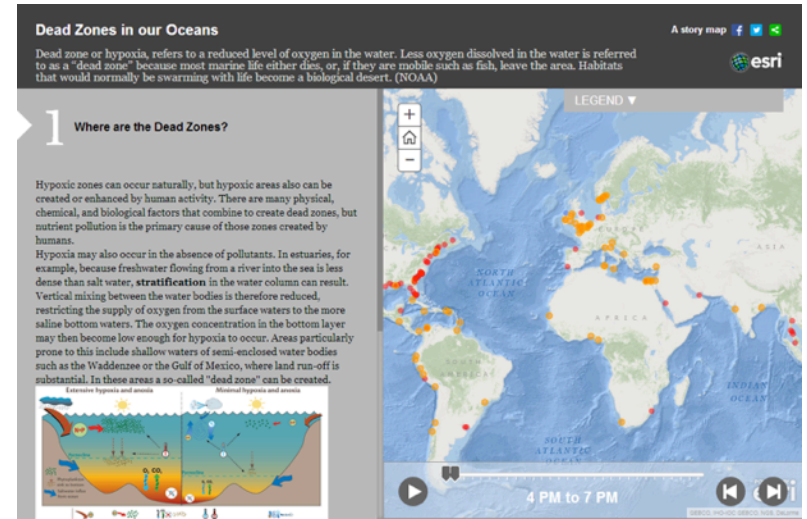
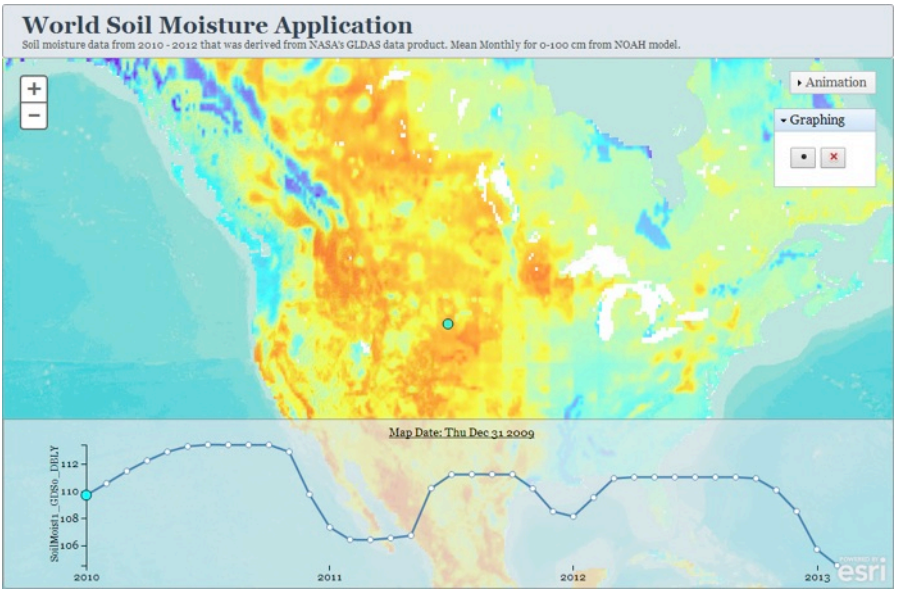
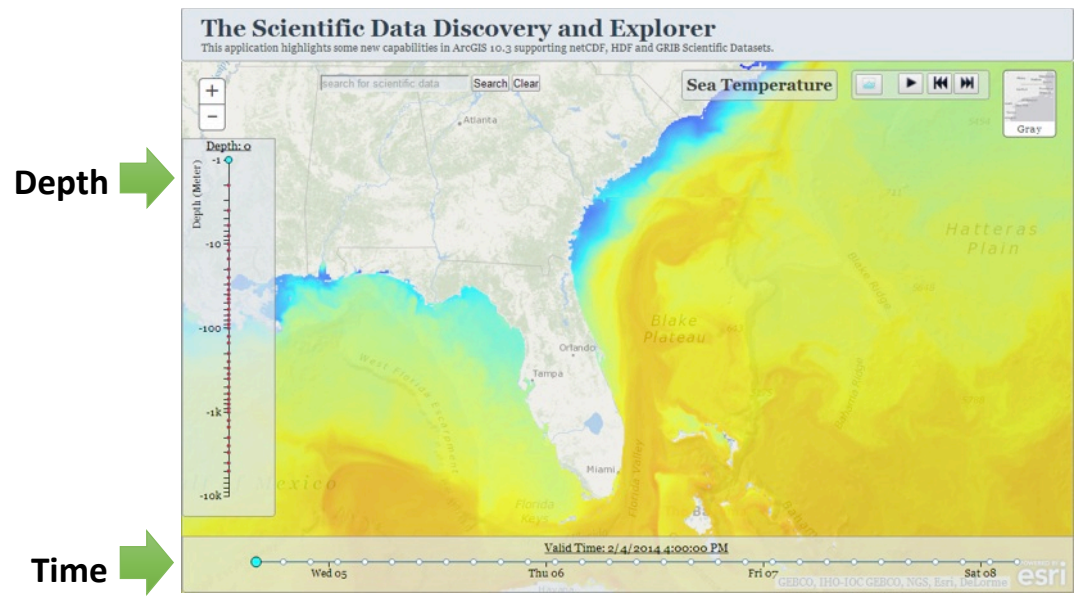
Visualization




Spatial and Temporal Analysis



Multidimensional Data in Web Applications




ALLERY MAP GROUPS MY CONTENT MY ORGANIZATION Matthew

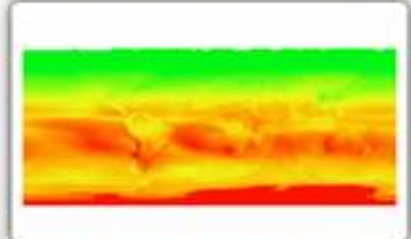


NASA Atmospheric Science Data Center (ASDC)

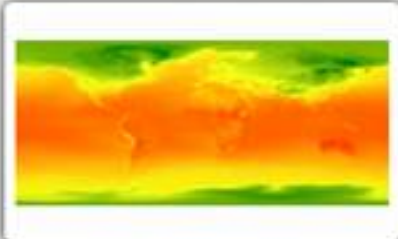
1 Maps and Apps



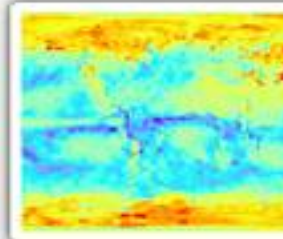
Comparing Temperature to Solar Irradiance



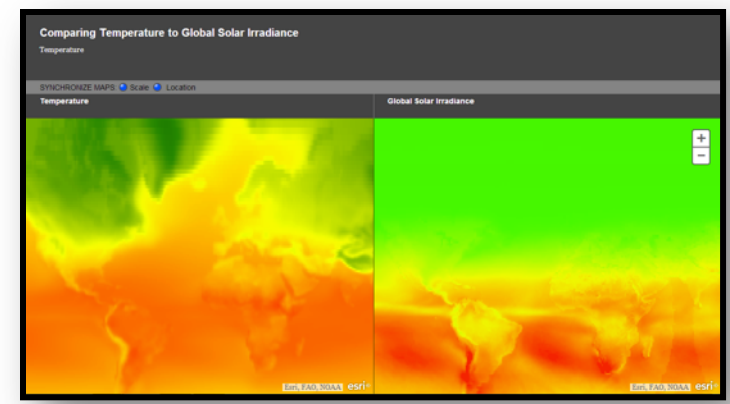
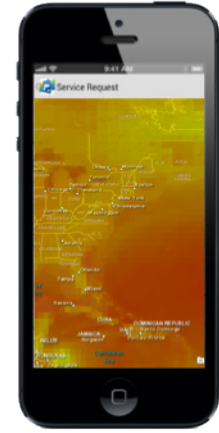
GlobalRadiation



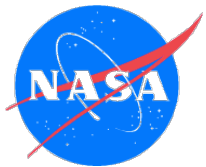
SSE_Temperature




WMS




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.



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)

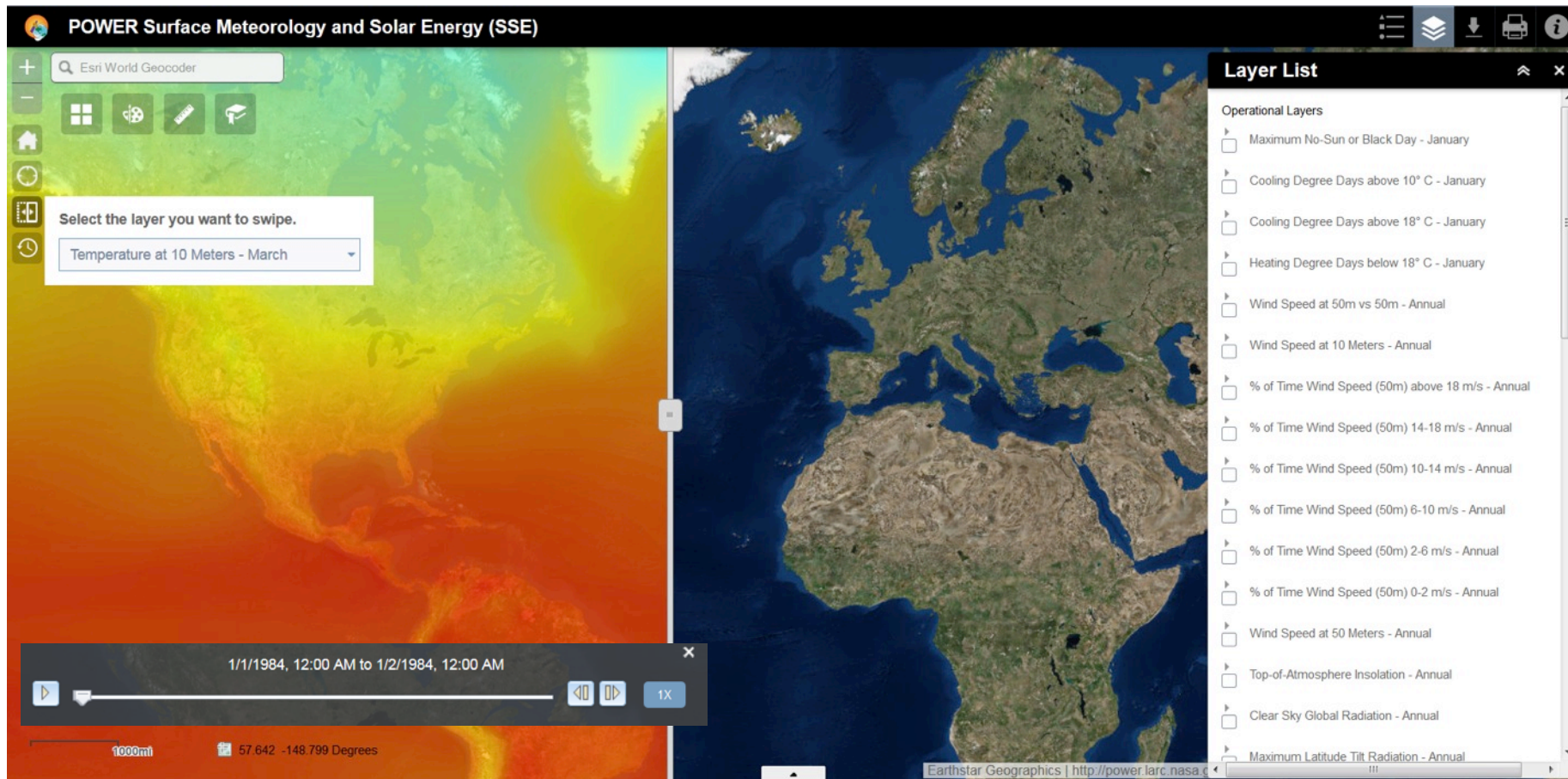
Lat 37 Lon -77	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	6.60	6.71	6.67	6.04	5.13	4.88	4.34	4.17	4.80	5.38	6.27	6.65	5.63

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 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

MOP03TM.005 (HDF4):

Retrieved Surface
Temperature Night

**Missing Geo-Reference
& 90 Degree Rotated**

MOP03TM.006 (HDF5):

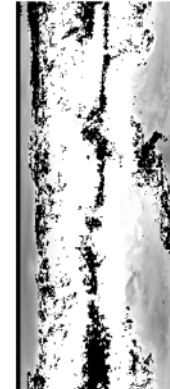
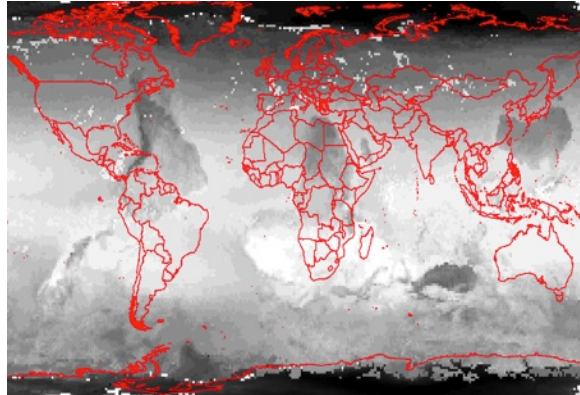
A Priori Surface
Temperature Night

**Missing Geo-Reference
& Cannot Display the 3D dataset**

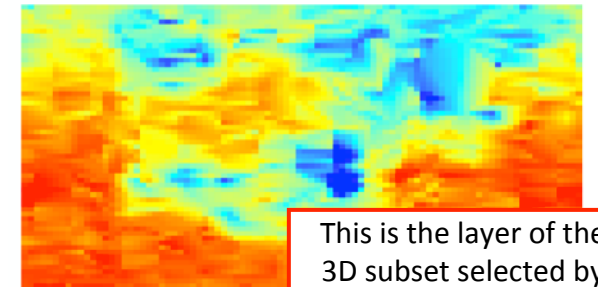
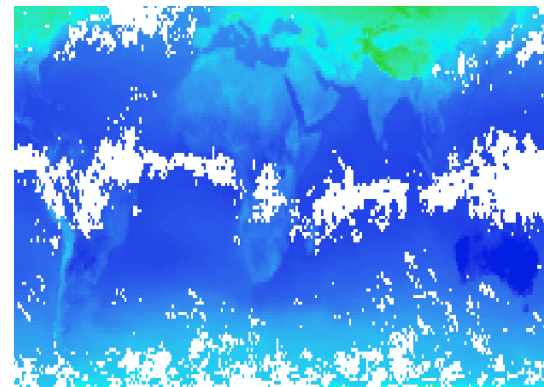
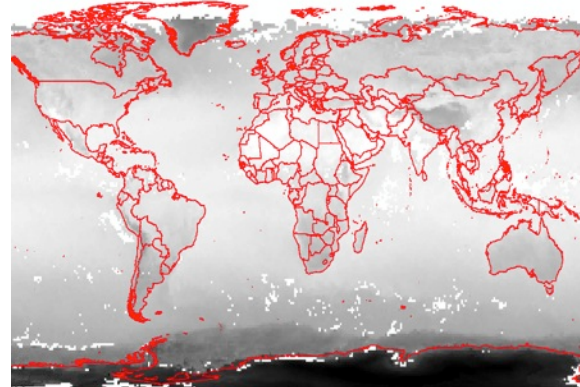
TL3COD.001 (HDF5):

CO

**Before
Enhancement**

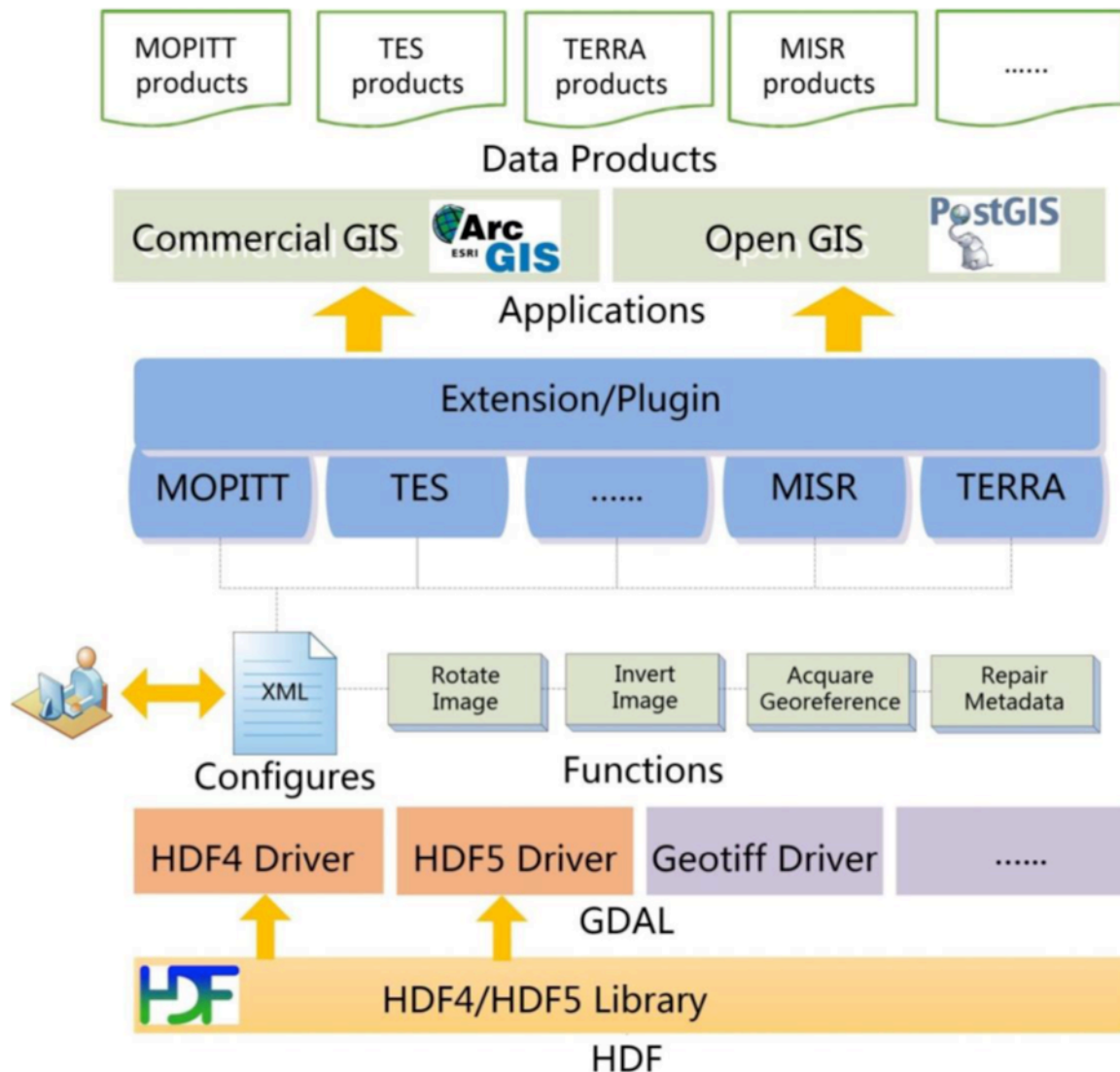
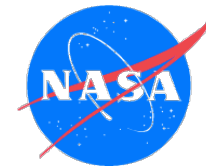


**After
Enhancement**



This is the layer of the
3D subset selected by
users

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.

Improving the Accessibility and Use of NASA Earth Science Data

Brian Tisdale, BAH, brian.e.tisdale@nasa.gov
NASA Atmospheric Science Data Center (ASDC)

CONTACT US FOR BETA ACCESS

SIMPLE WAYS TO DO MORE WITH YOUR SCIENTIFIC DATA

June 18th 2015

Tools for Access to Scientific Data – Doing More with Data

Suresh Vannan

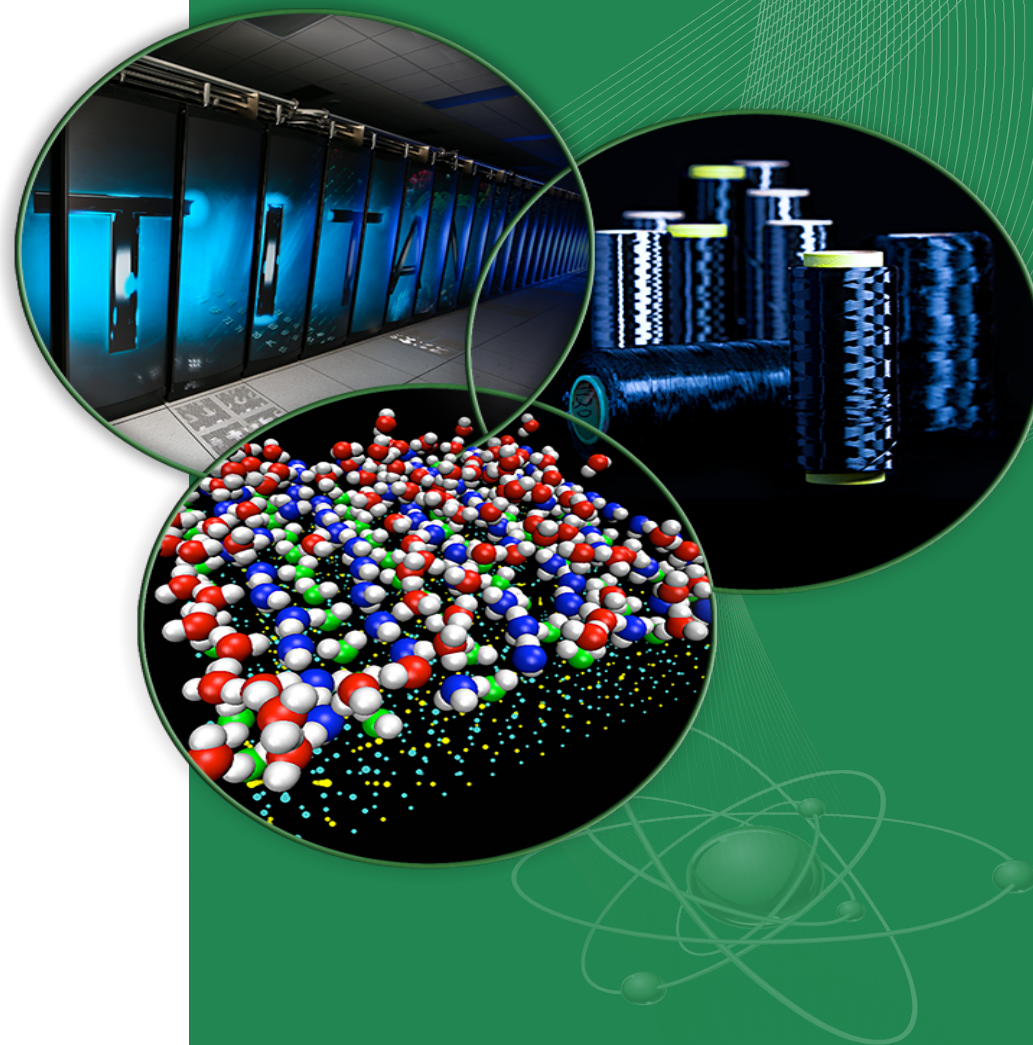
ORNL DAAC Manager

Data Theme Lead,

Climate Change Science Institute (CCSI)

Oak Ridge National Laboratory (ORNL)

<http://daac.ornl.gov>



Agenda

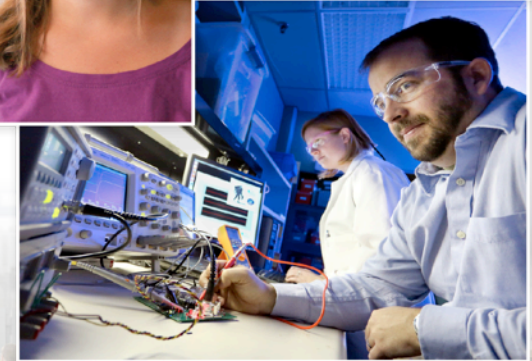
- Overview of ORNL
- Tools for scientific data at ORNL
- Overview of ORNL DAAC
- Tools for scientific data at ORNL DAAC

Oak Ridge National Laboratory

Oak Ridge National Laboratory is the largest US Department of Energy science and energy laboratory, conducting basic and applied research to deliver transformative solutions to compelling problems in energy and security.

ORNL supports these missions through leadership in four major areas of science and technology:

- **Neutrons**
- **Computing**
- **Materials**
- **Nuclear**



ORNL Tools for scientific data -Bioenergy



<https://www.bioenergykdf.net/>

[Register](#) [Contact Us](#) [Sign In](#)

Map Tools

Reset Map Background ?

My Data Layers

Add Map Data

Models

Spatial Query Tools

Identify Me

Spatial Box Query

Clear Features

LandScan - Global Population

54.87697, 36.03495

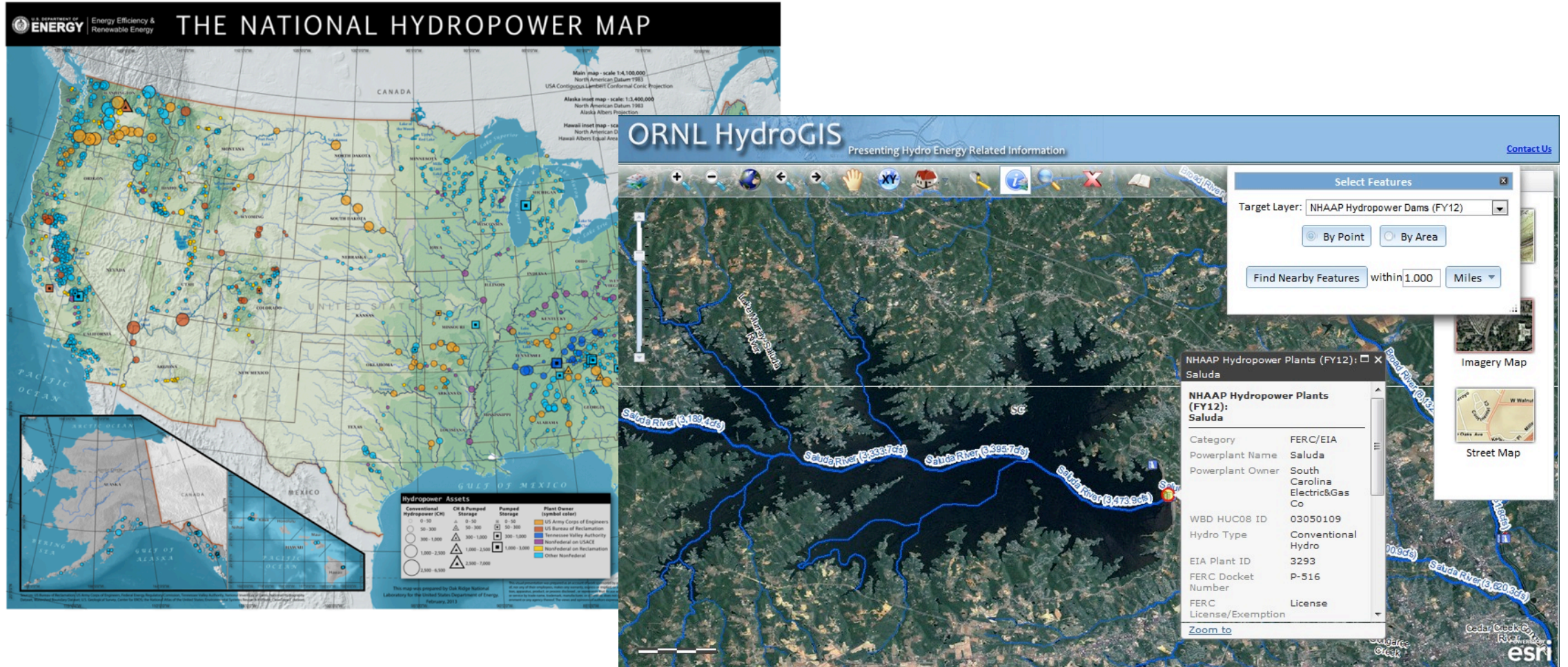
OVERVIEW TOOLS & APPS MAP BIOENERGY LIBRARY

Corn-stvr production 2016 \$60 Cnty Results

Export Data

year	scenario	feedstock	production_unl	area_unit	biomass_price	yield	production	harvested_are	fps_code	counties	state	feedstck	scenario_id	the_geom
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	2.78	388700	139600	46083	Lincoln	South Dak...	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	3.31	429200	129700	19143	Osceola	Iowa	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	3.03	294500	97100	19059	Dickinson	Iowa	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	4.04	504600	124900	19063	Emmet	Iowa	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	3.17	542700	171300	19119	Lyon	Iowa	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	3.56	876700	246100	19167	Sioux	Iowa	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	3.23	560000	173800	19141	O'Brien	Iowa	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	3.2	533100	166900	19041	Clay	Iowa	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	3.33	621200	186900	19147	Palo Alto	Iowa	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	4.2	589600	140400	46127	Union	South Dak...	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	2.84	676500	238500	19149	Plymouth	Iowa	Corn-stvr	BLY+EC2H...	[object Ob...
2016	High Yield ...	Corn stover	Dry tons	Harvested ...	60	4.08	638400	156400	19035	Cherokee	Iowa	Corn-stvr	BLY+EC2H...	[object Ob...

ORNL Tools for scientific data -HydroPower

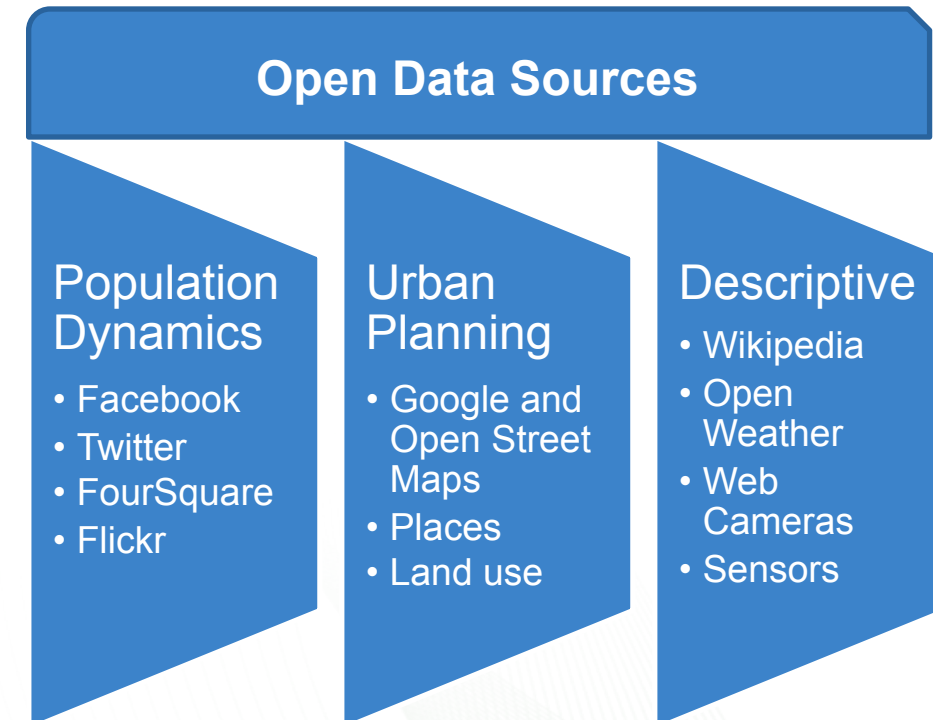


Contact:
Shih-Chieh Kao

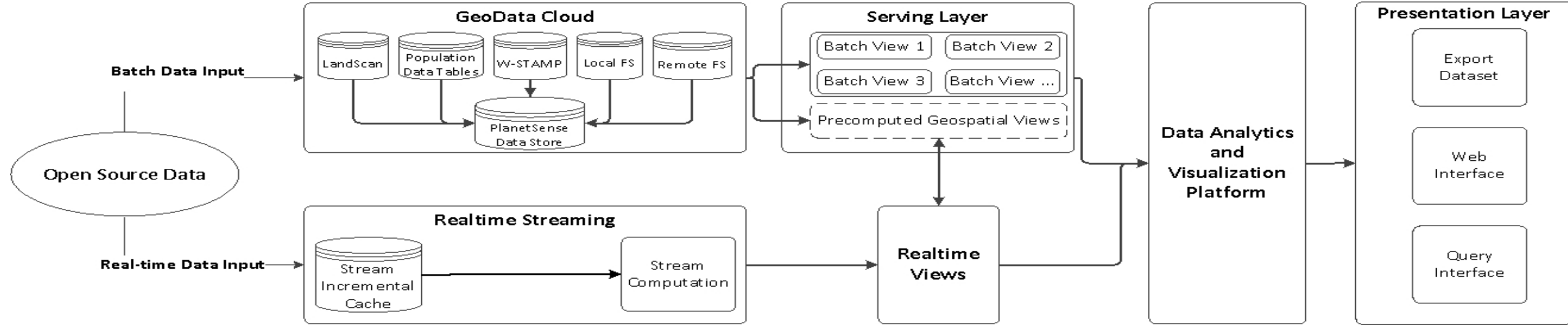
PlanetSense: Utilizing Open Source Data for Geospatial Intelligence



- Open source data initiative in geospatial research
- Pervasive availability of open source data
 - Social media, volunteered geographic information, public data repository, participatory sensing
 - Real-time, streaming, updated continuously, incomplete
- Contact:
 - Budhendra L. Bhaduri, Gautam S. Thakur



Workflow and applications



Population Dynamics

- Special event population
- Occupancy analysis
- Mobility

Spatial Research

- Land use (commercial, residential, and mix)
- Urban planning

Transportation

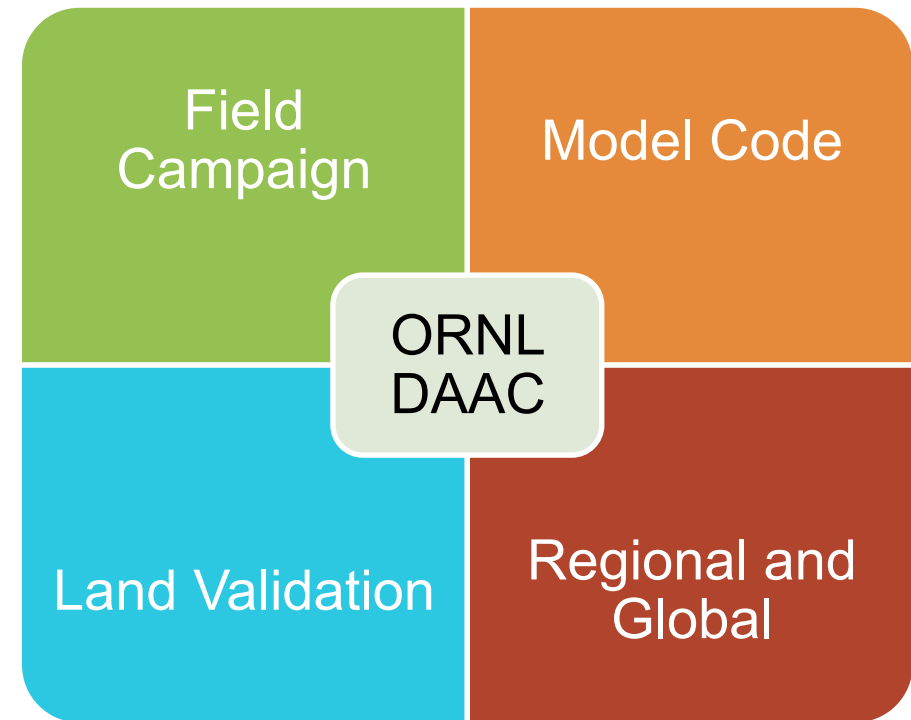
- Urban mobility simulation
- Evacuation
- Traffic optimization

Energy

- Energy demand and utilization
- Critical Infrastructure

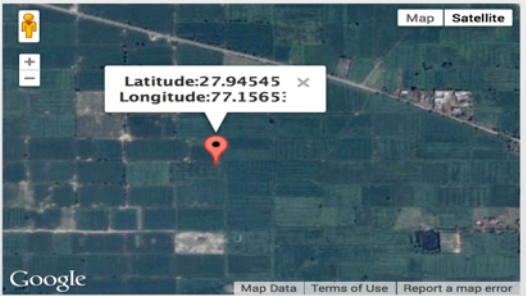
The Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC) archives data produced by NASA's Terrestrial Ecology Program in support of NASA's Carbon Cycle and Ecosystems Focus Area.

- **1118** data sets
- Average data set Size = **485 MB** (Range 0.5 KB to > 10GB)
- Average Number of granules per dataset **241 granules** (Range 1 to > 6000)
- **5000+** Investigators
- **50+** file formats



Select Center of Area of Interest Lat/Lon OR Field Site, then Continue





Latitude: 27.94545
Longitude: 77.15653

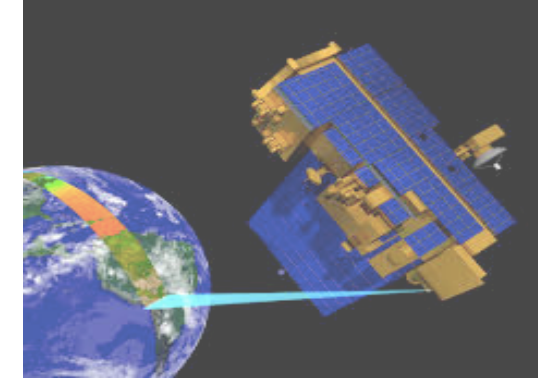
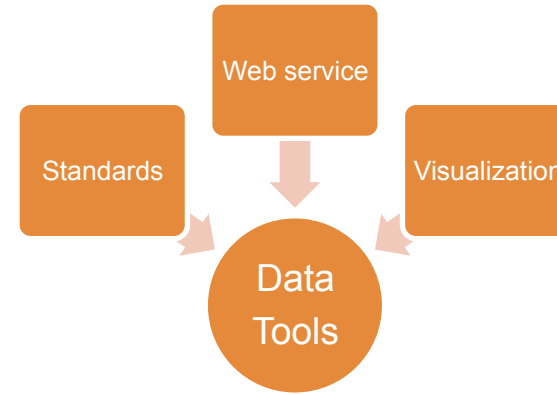
Select the Country to pick a field Site as the Center Pixel
[Sites within the Selected Country will be Presented in Subsequent Choices]

- Algeria
- Angola
- Antarctica
- Argentina
- Australia
- Austria
- Belgium
- Benin
- Bolivia
- Botswana

Enter Signed Decimal Latitude and Longitude of Center Pixel in WGS84 datum

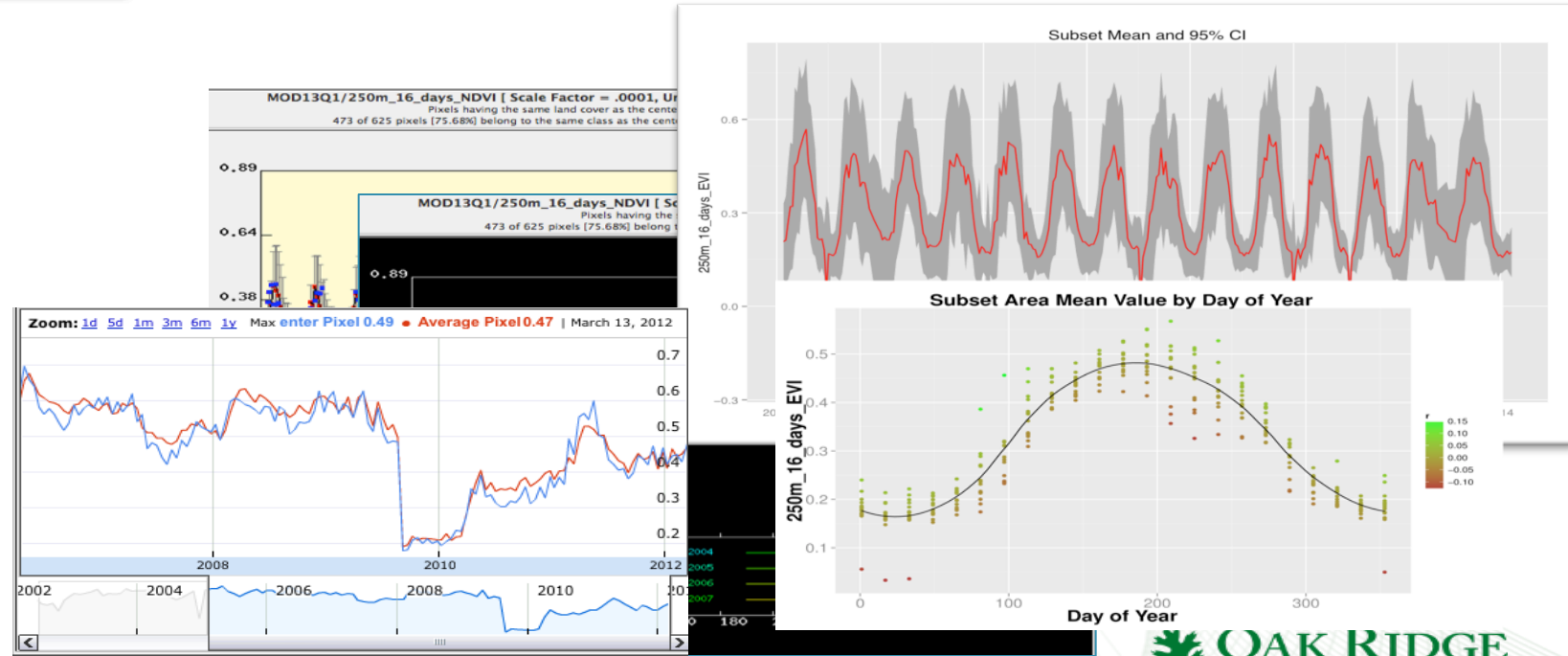
Latitude	Longitude
27.94545	77.15653

Continue

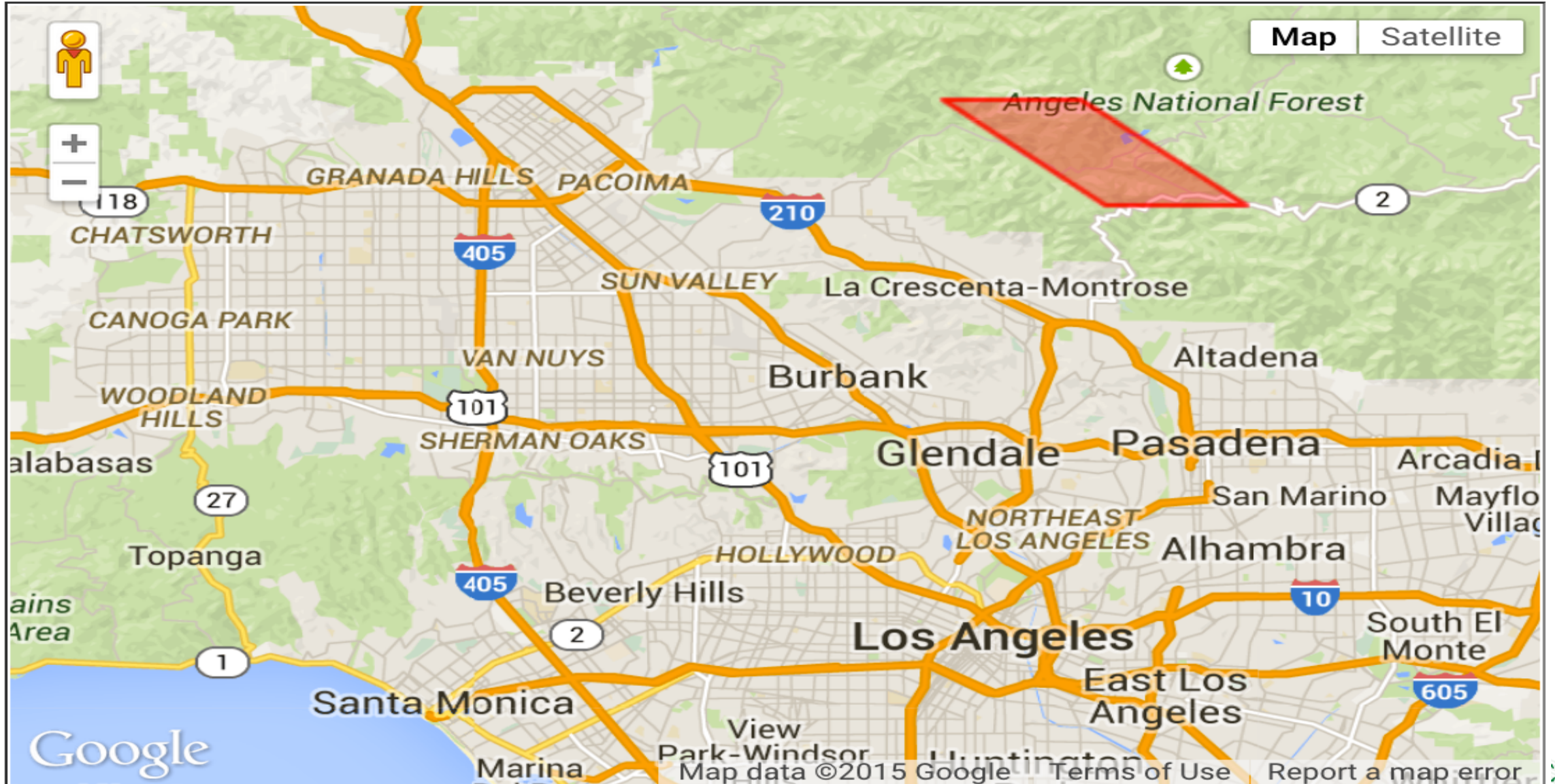


Web based
data order

<http://daac.ornl.gov/MODIS>



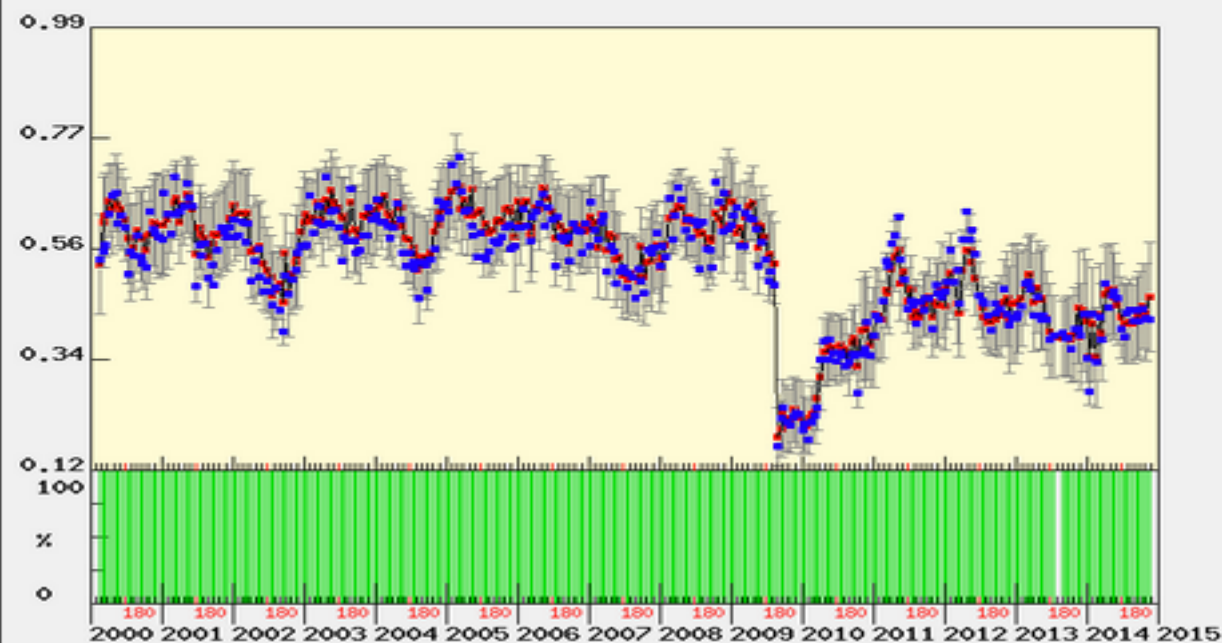
Red Box Marks the Approximate Location of the Subset Area
... Presented For Visual Interest Only ...
Image courtesy of Google



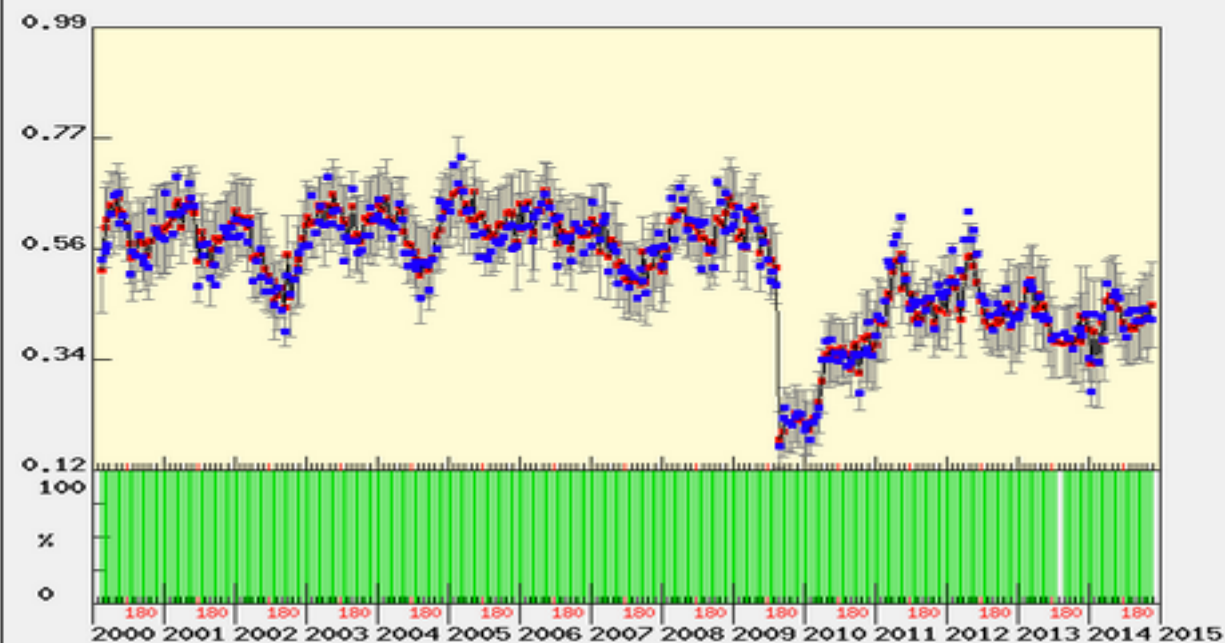
Station Fire, near JPL, California



MOD13Q1 / 250m_16_days_NDVI [Scale Factor = .0001, Units= NDVI ratio - No units]
Includes all pixels that have acceptable quality



MOD13Q1/250m_16_days_NDVI [Scale Factor = .0001, Units= NDVI ratio - No units]
Pixels having the same land cover as the center pixel.
531 of 625 pixels [84.96%] belong to the same class as the center pixel "(8) Woody Savannas"



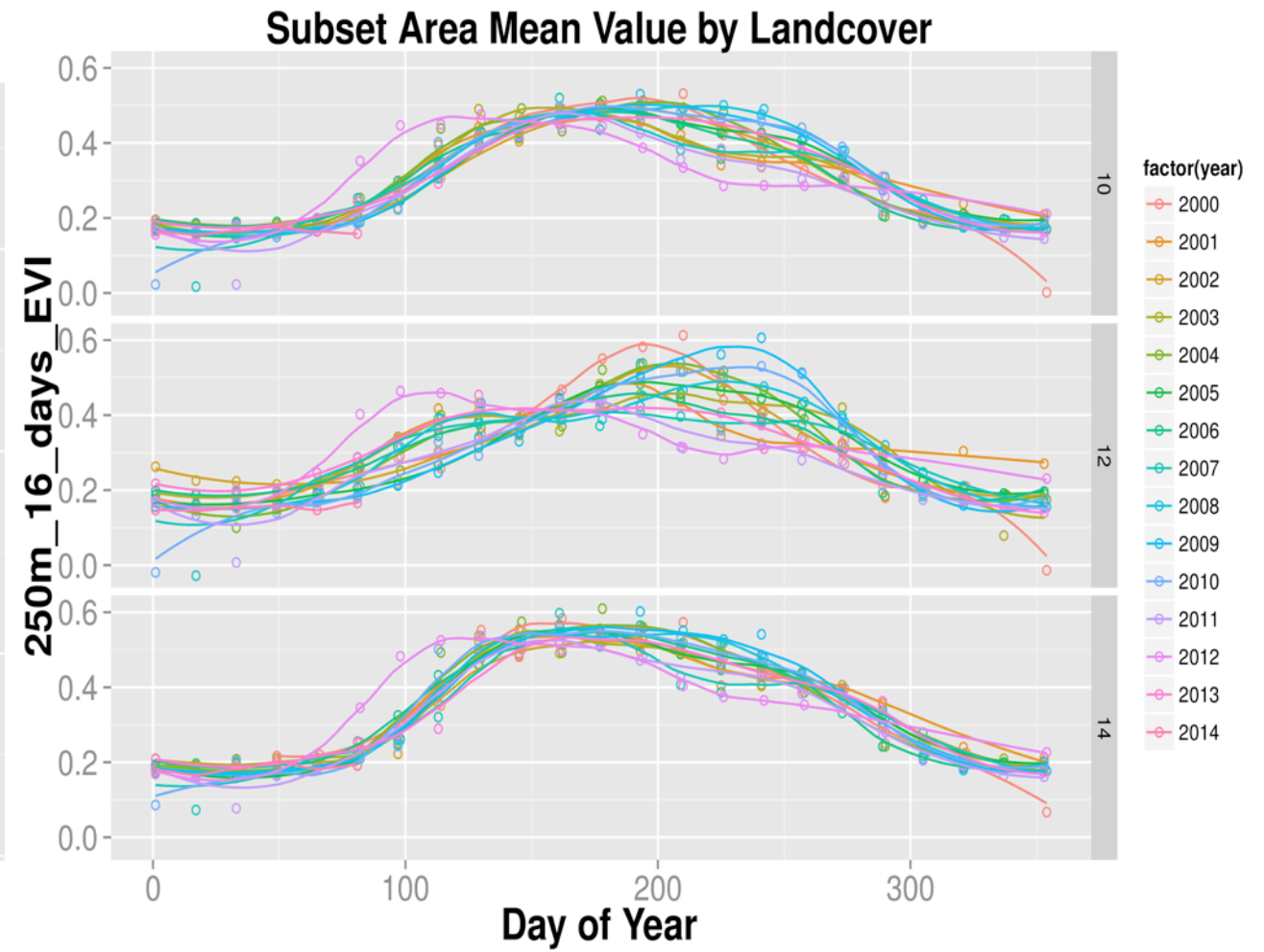
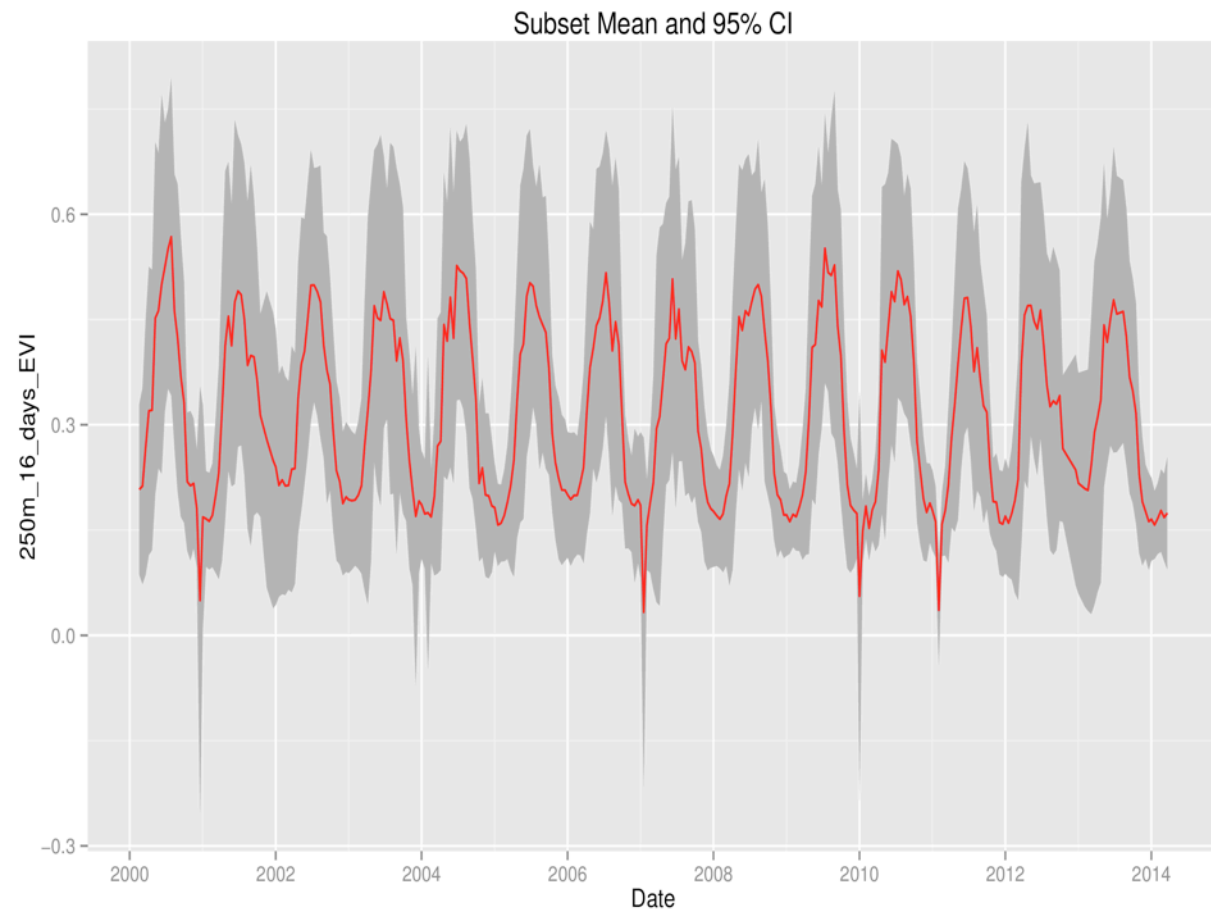
Zoom: 1d 5d 1m 3m 6m 1y Max Average Pixel 0.42 ● Average Pixel 0.46 | November 17, 2014



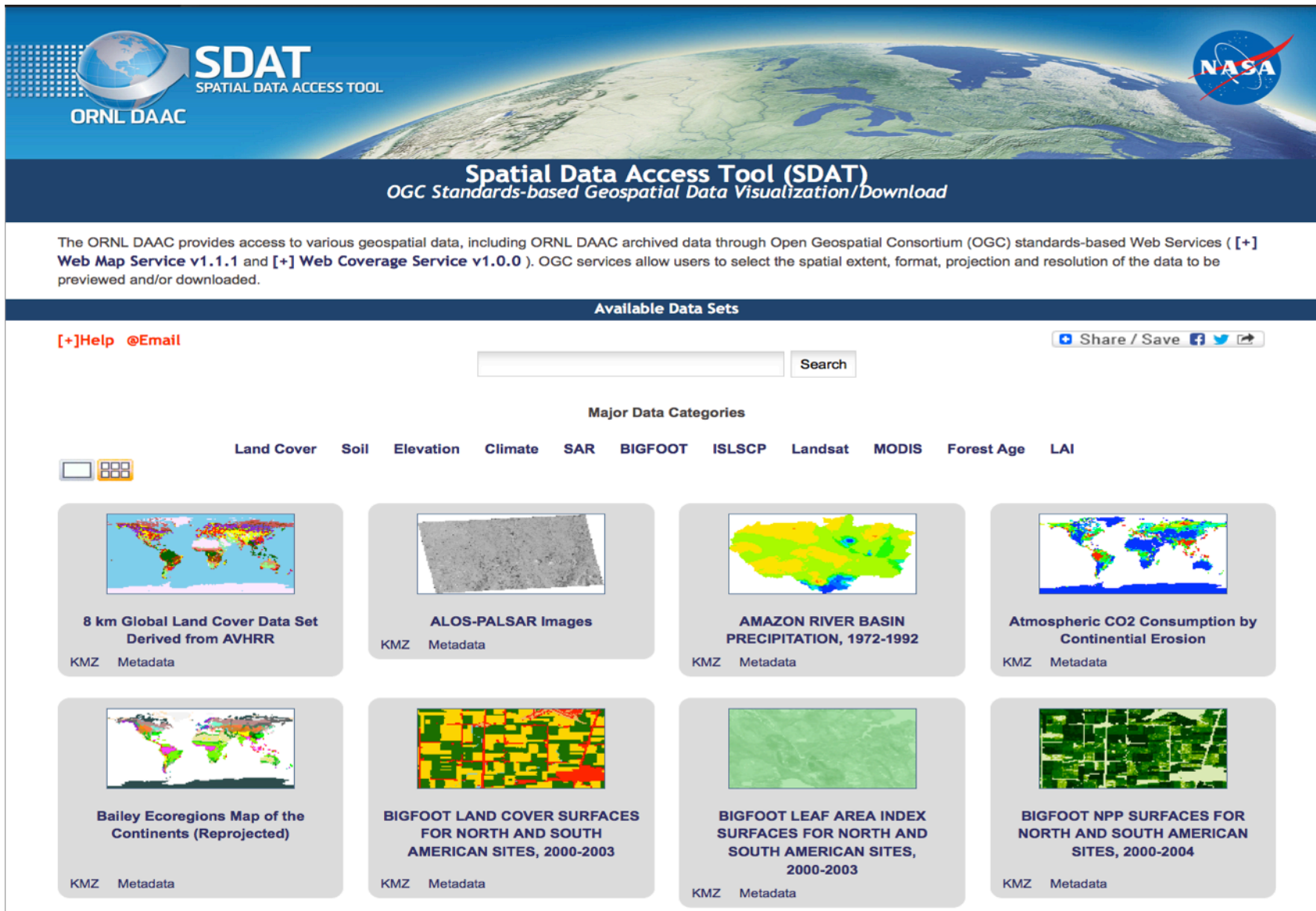
Zoom: 1d 5d 1m 3m 6m 1y Max Average Pixel 0.27 ● Average Pixel 0.31 | October 16, 2010



MODIS Subset Visualization using R



ORNL DAAC Spatial Data Access Tool (SDAT)



The screenshot shows the SDAT web interface. At the top left is the SDAT logo with 'ORNL DAAC' and 'SPATIAL DATA ACCESS TOOL'. At the top right is the NASA logo. Below the header is a banner with the title 'Spatial Data Access Tool (SDAT)' and subtitle 'OGC Standards-based Geospatial Data Visualization/Download'. A paragraph of text describes the tool's purpose. Below this is a navigation bar with 'Available Data Sets', a search bar, and social media links. A 'Major Data Categories' section lists various data types. The main content area displays eight data set cards, each with a thumbnail, title, and file format information.

SDAT
SPATIAL DATA ACCESS TOOL
ORNL DAAC

NASA

Spatial Data Access Tool (SDAT)

OGC Standards-based Geospatial Data Visualization/Download


The ORNL DAAC provides access to various geospatial data, including ORNL DAAC archived data through Open Geospatial Consortium (OGC) standards-based Web Services ([\[+\] Web Map Service v1.1.1](#) and [\[+\] Web Coverage Service v1.0.0](#)). OGC services allow users to select the spatial extent, format, projection and resolution of the data to be previewed and/or downloaded.

Available Data Sets

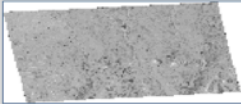
[\[+\]Help](#) [@Email](#) [Share / Save](#) [f](#) [t](#) [r](#)

Major Data Categories

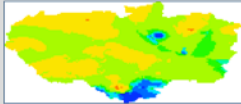
Land Cover Soil Elevation Climate SAR BIGFOOT ISLSCP Landsat MODIS Forest Age LAI



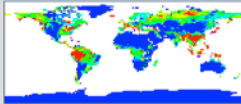
8 km Global Land Cover Data Set
Derived from AVHRR
KMZ Metadata




ALOS-PALSAR Images
KMZ Metadata



AMAZON RIVER BASIN
PRECIPITATION, 1972-1992
KMZ Metadata



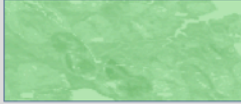
Atmospheric CO2 Consumption by
Continental Erosion
KMZ Metadata




Bailey Ecoregions Map of the
Continents (Reprojected)
KMZ Metadata



BIGFOOT LAND COVER SURFACES
FOR NORTH AND SOUTH
AMERICAN SITES, 2000-2003
KMZ Metadata



BIGFOOT LEAF AREA INDEX
SURFACES FOR NORTH AND
SOUTH AMERICAN SITES,
2000-2003
KMZ Metadata



BIGFOOT NPP SURFACES FOR
NORTH AND SOUTH AMERICAN
SITES, 2000-2004
KMZ Metadata

ORNL DAAC Spatial Data Access Tool (SDAT)

[+] Home >> AMAZON RIVER BASIN PRECIPITATION, 1972-1992 [Help]

The precipitation data is 0.2 degree gridded monthly precipitation data based upon monthly rain data from Peru and Bolivia and daily rain data from Brazil. The extent of the data ranges from 5.2N and -20.0S to -49.4W to -79.6W

- [+] Visualize in Google Earth
- [+] View Full Metadata
- [+] Order data set in ORNL DAAC archive (non-WCS) format

Use the links in the table below to view and download data using WCS.

This data set contains 21 data granules

Granule Name	Metadata	Preview Image
Amazon Rain fall 1972 (All months)	Projection: WGS 84 Spatial Extent: N: 5.2, S: -20, E: -49.4, W: -79.6 Start DateTime: 1972-01-01T00:00 End DateTime: 1972-12-31T23:59	
Amazon Rain fall 1973 (All months)	Projection: WGS 84 Spatial Extent: N: 5.2, S: -20, E: -49.4, W: -79.6 Start DateTime: 1973-01-01T00:00 End DateTime: 1973-12-31T23:59	
Amazon Rain fall 1974 (All months)	Projection: WGS 84 Spatial Extent: N: 5.2, S: -20, E: -49.4, W: -79.6 Start DateTime: 1974-01-01T00:00 End DateTime: 1974-12-31T23:59	
Amazon Rain fall 1975 (All months)	Projection: WGS 84 Spatial Extent: N: 5.2, S: -20, E: -49.4, W: -79.6 Start DateTime: 1975-01-01T00:00 End DateTime: 1975-12-31T23:59	

[+] Home >> [+] AMAZON RIVER BASIN PRECIPITATION, 1972-1992 >> Amazon Rain fall 1972 (All months) [Help]

1 Collection: AMAZON RIVER BASIN PRECIPITATION, 1972-1992

- Native Projection: [WGS 84 \(EPSG:4326\)](#)
- Spatial Extent: N: 5.2, S: -20.0, E: -49.4, W: -79.6
- Map Units: degrees
- Resolution: 0.2,0.2
- Start DateTime: 1972-01-01T00:00
- End DateTime: 1972-12-31T23:59
- Data Units: millimeters per month
- Scale Factor: 1

2 detailed granule metadata

3 "Get This Map" tool

Data Customization and Download

Coverage: Amazon Rain fall 1972 (All months) granule name

4 pan tools

5 zoom tools

6 layer manager

7. background map

8 Enhance Image Display

9 Opacity: 0

10 [+ Show Legend]

11 Projection: Google Projection [?]

12 Resolution (x, y): 20000 20000 meters

13 Format: GeoTIFF (INT16)

14 Spatial Extent *: -274350.037

15 Time: 1972-03

16 Bands: 1

17 Interpolation Method: Nearest Neighbor

18 Zoom To

19 Download Data

20

21 reset page to default status

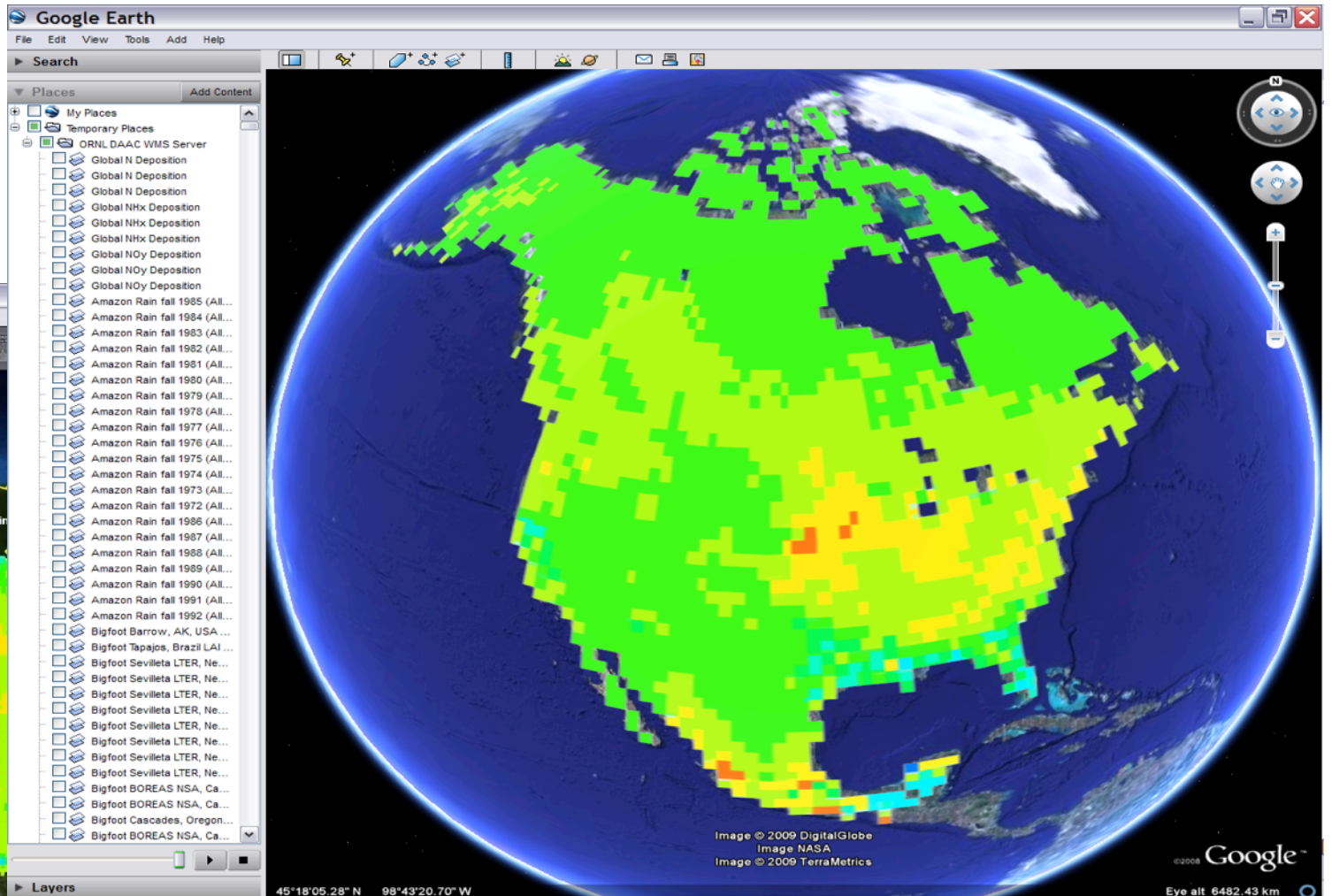
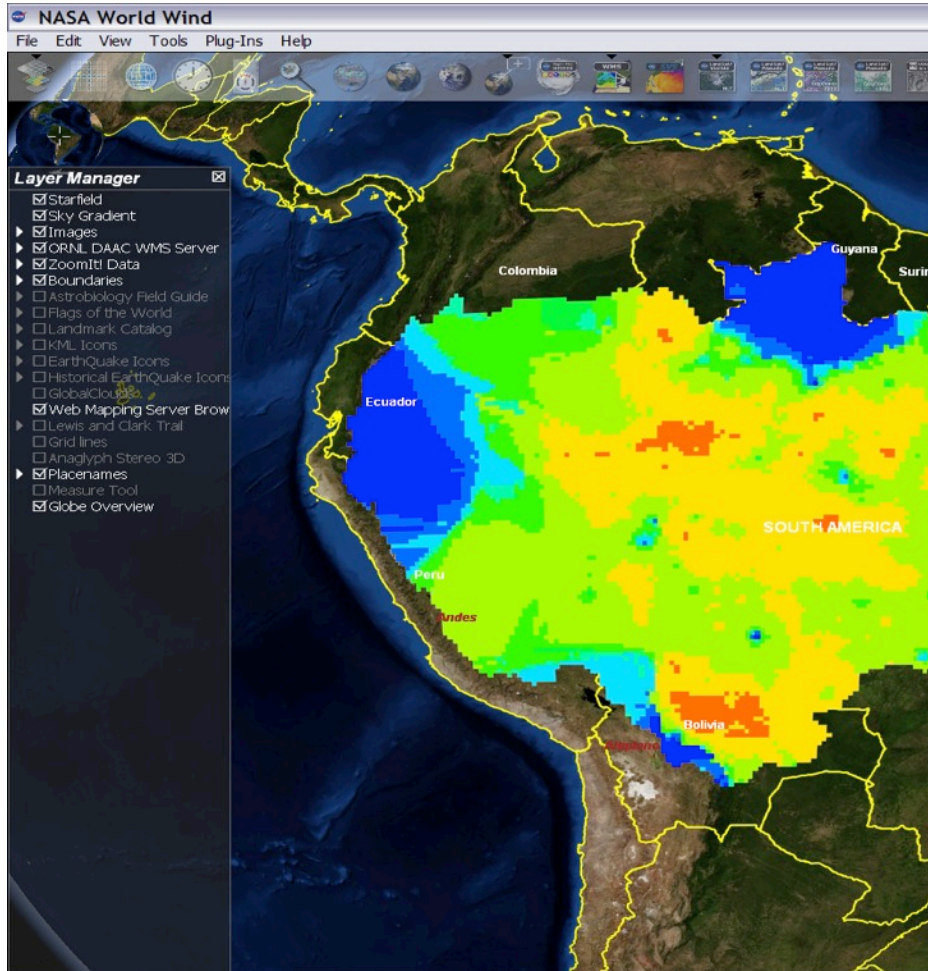
22 OGC WCS Requests: [+ Show GetCapabilities] [+ Show DescribeCoverage] [+ GetCoverage Request] OGC WMS Requests: [+ Show GetCapabilities] [+ GetMap Request]

Use [] to select a region as the spatial extent to subset data

Select Region function activated

Powered by ESRI

Map data ©2010 - terms of use





Integration of Tools for Scientific Analysis with GIS

Brett Rose, PhD

brose@esri.com

Science begins with observations



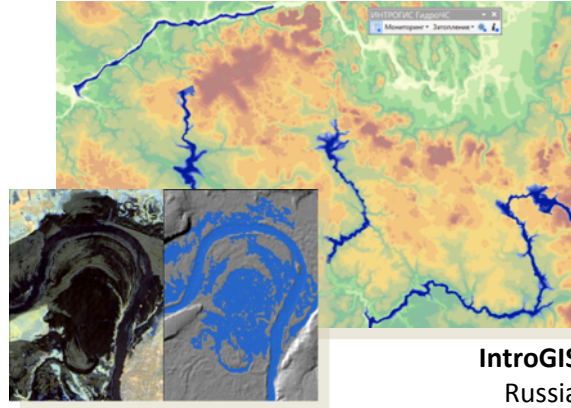
We use science everyday

Crop Health



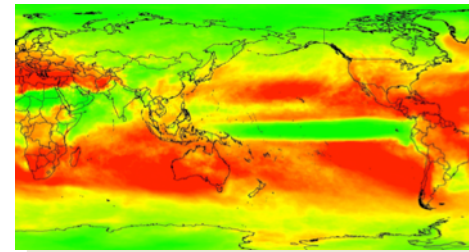
GeoSilos
Indiana

Hydro Analysis



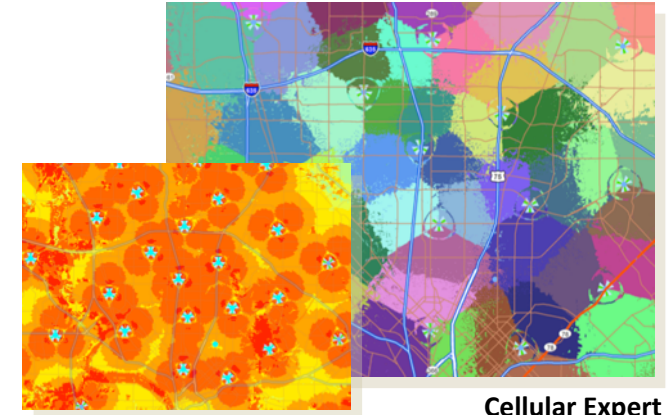
IntroGIS
Russia

Global Rainfall



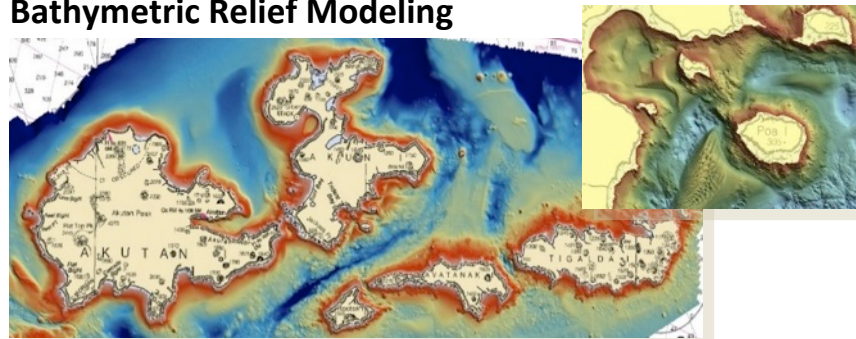
CLIMsystems
Global

Cellular Coverage Analysis



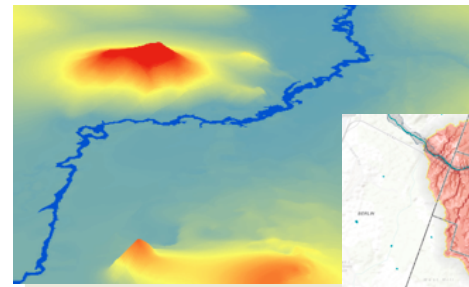
Cellular Expert
Texas

Bathymetric Relief Modeling



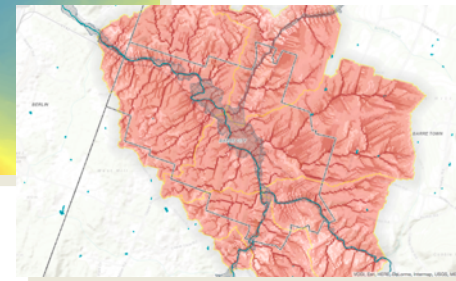
Fugro Palegos
Alaska

Hydrographic Modeling



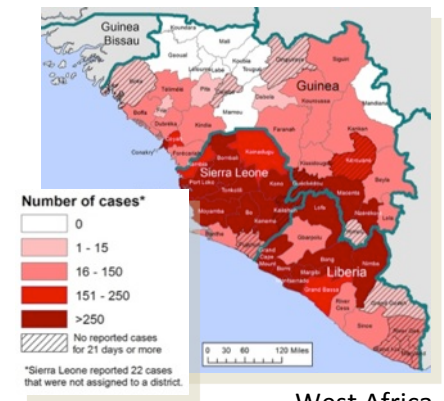
IntroGIS
Russia

Water Runoff Modeling



Stone Environmental
Vermont

Ebola Disease



West Africa

To do science we need to



Understand where things are



Measure size, shape and distribution



Determine how places are related



Find best location and paths



Detect and quantify patterns



Make predictions

We can use
Spatial Analysis

Spatial analytics can
mean a lot of things

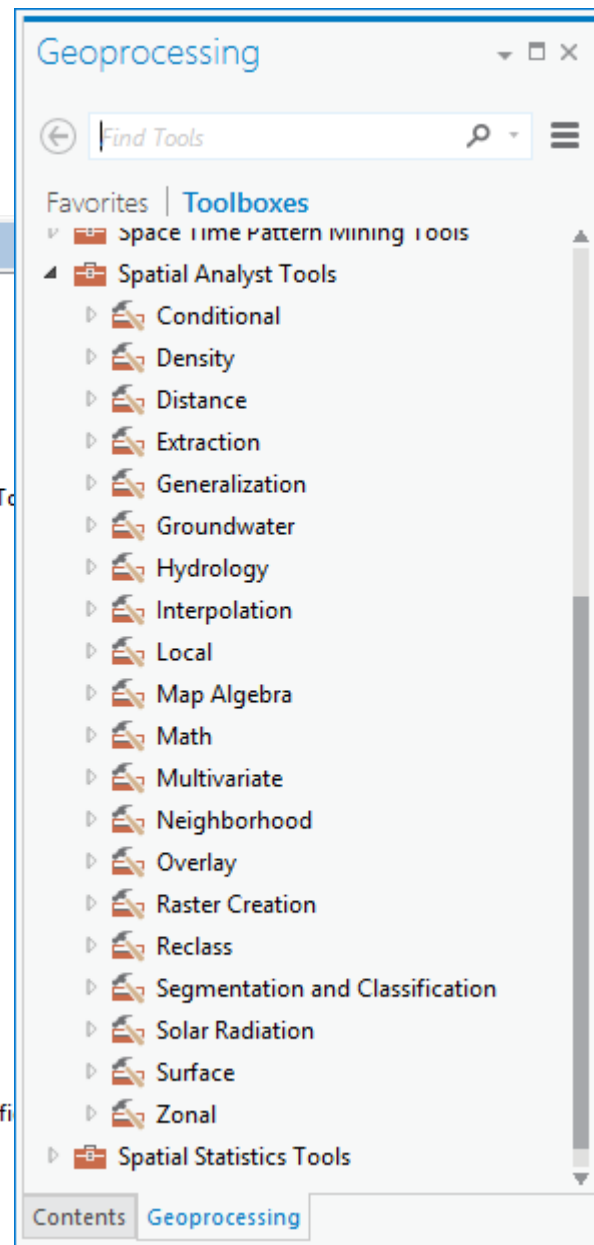
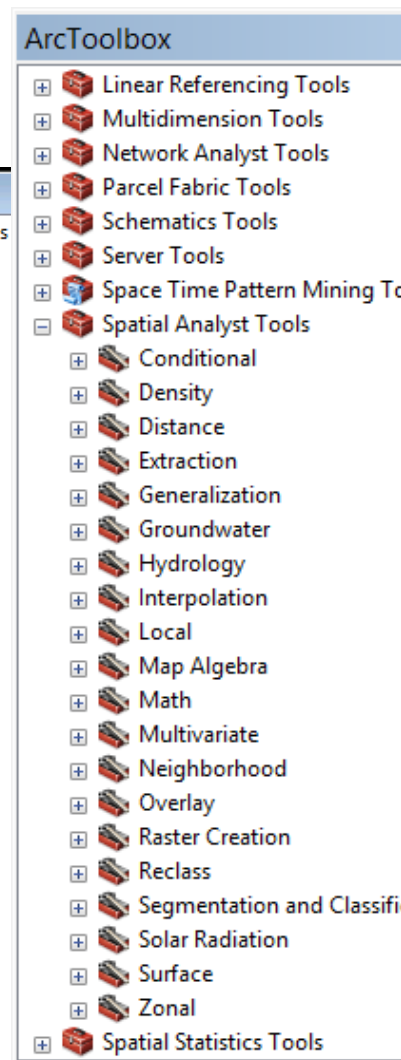
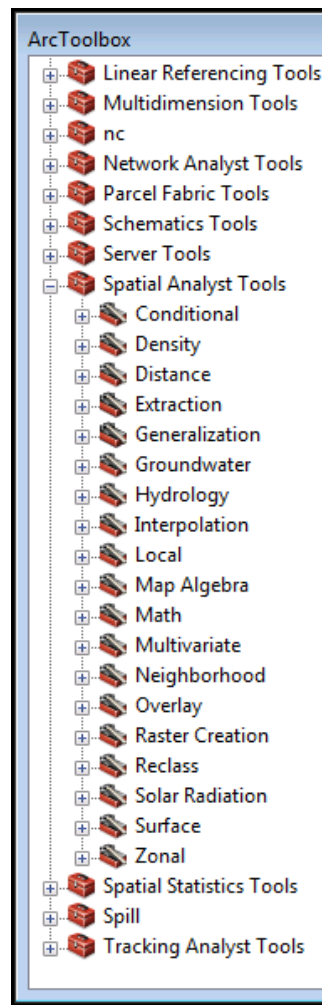
With spatial analytics we

map → to see possible patterns

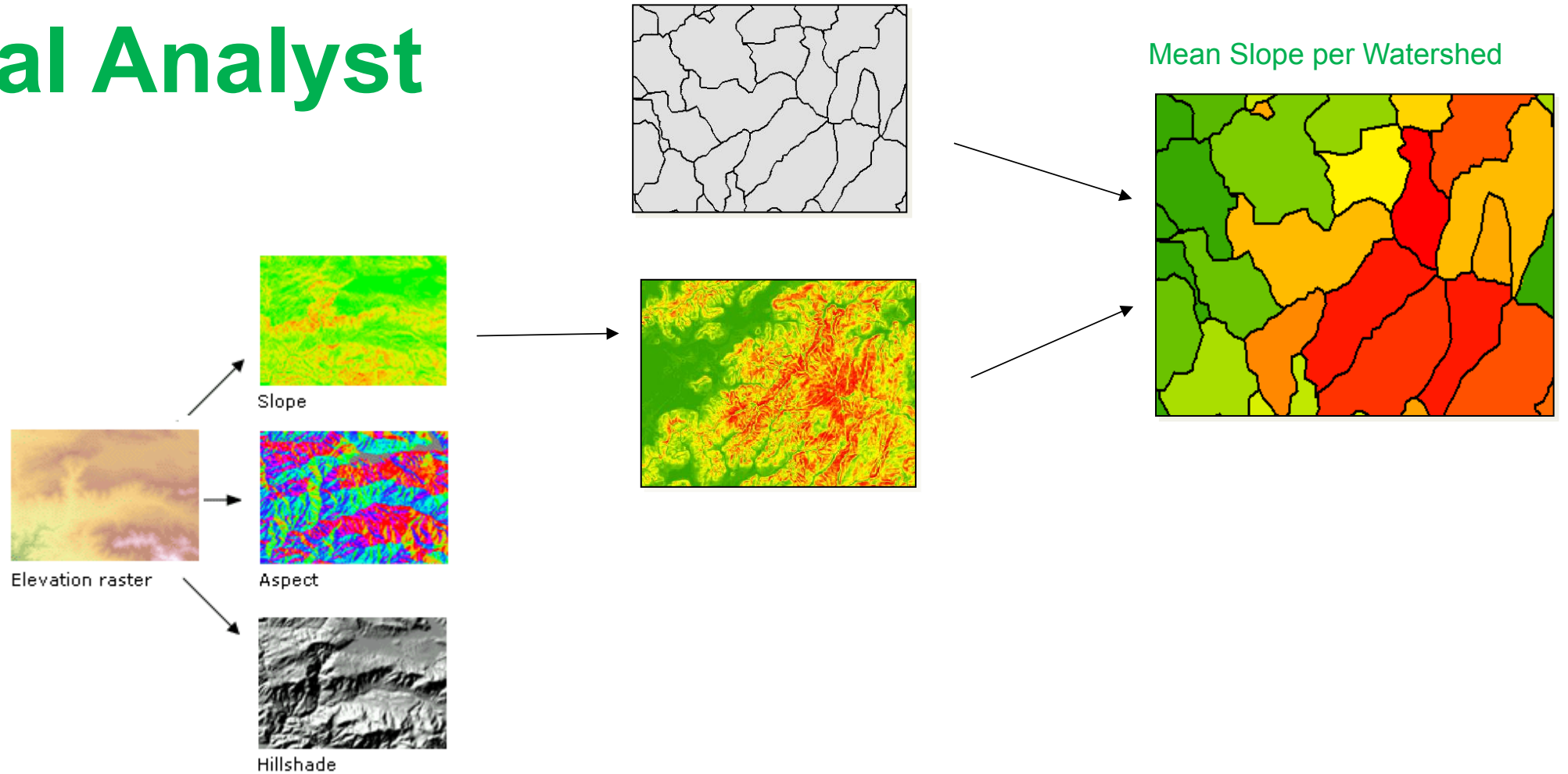
describe → to improve understanding

measure → to minimize subjectivity

Tools in ArcGIS



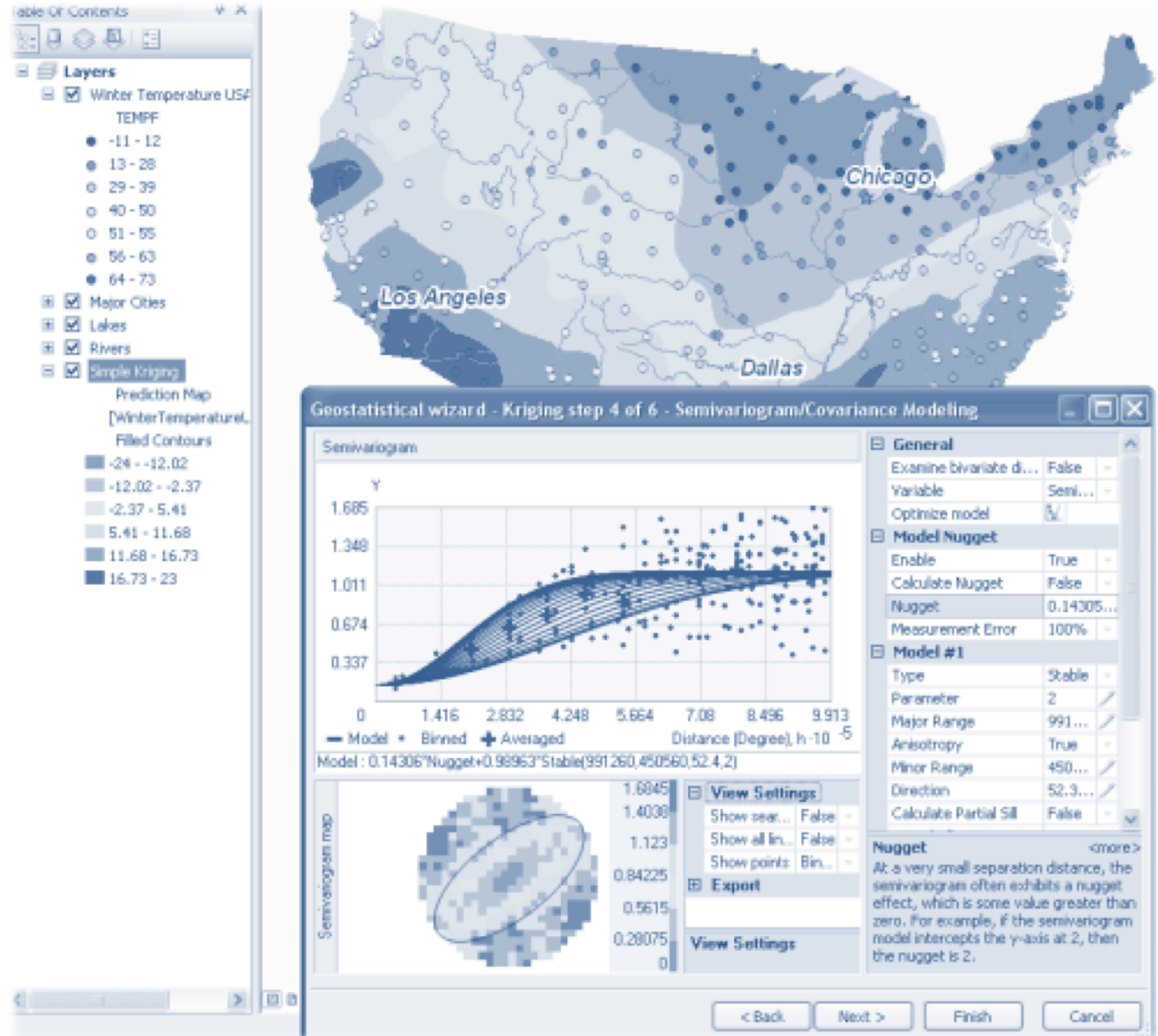
Spatial Analyst



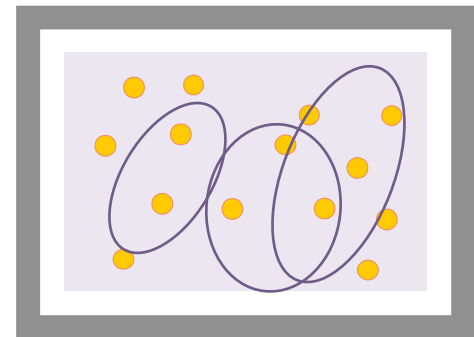
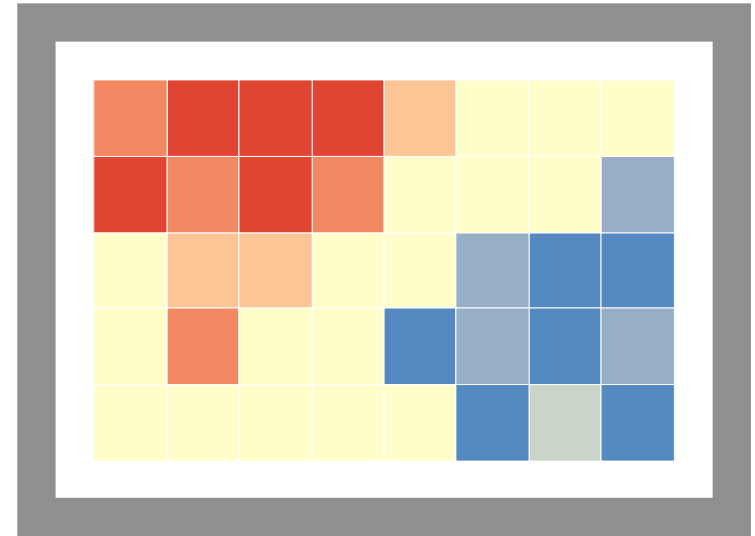
This is map algebra

```
outRas = Raster("inraster1") + Raster("inraster2")
```

Geostatistics





























Spatial Statistics



Extend and integrate spatial analytics

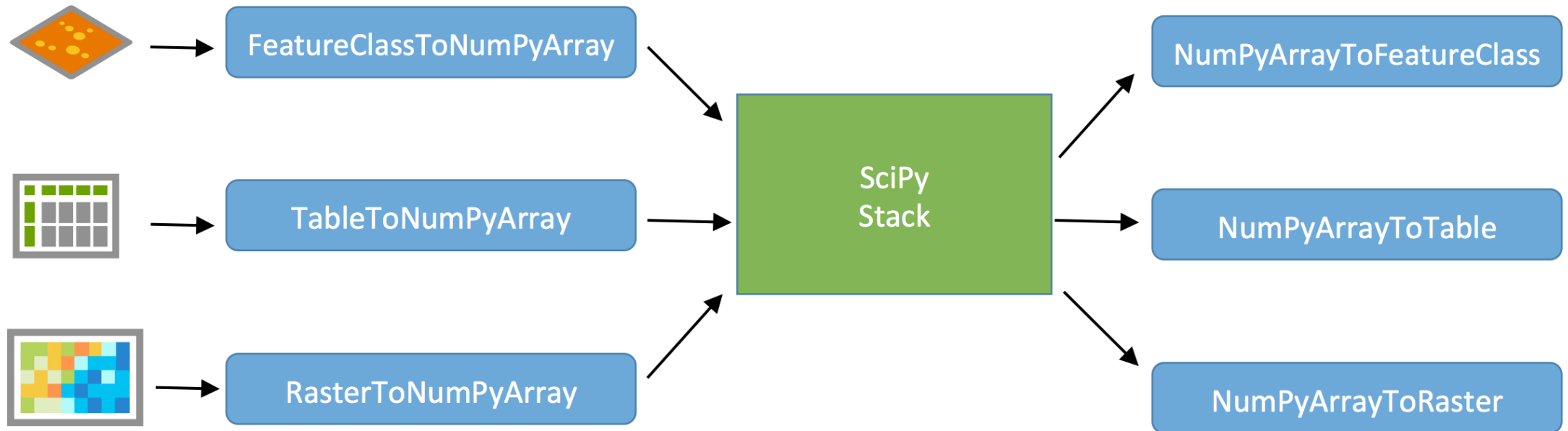
python



- [-]  Spatial Statistics Tools
 - [-]  Analyzing Patterns
 -  Average Nearest Neighbor
 -  High/Low Clustering (Getis-Ord General G)
 -  Incremental Spatial Autocorrelation
 -  Multi-Distance Spatial Cluster Analysis (Ripleys K Function)
 -  Spatial Autocorrelation (Morans I)
 - [-]  Mapping Clusters
 -  Cluster and Outlier Analysis (Anselin Local Morans I)
 -  Grouping Analysis
 -  Hot Spot Analysis (Getis-Ord Gi*)
 -  Optimized Hot Spot Analysis
 -  Similarity Search
 - [-]  Measuring Geographic Distributions
 -  Central Feature
 -  Directional Distribution (Standard Deviational Ellipse)
 -  Linear Directional Mean
 -  Mean Center
 -  Median Center
 -  Standard Distance
 - [-]  Modeling Spatial Relationships
 -  Exploratory Regression
 -  Generate Network Spatial Weights
 -  Generate Spatial Weights Matrix
 -  Geographically Weighted Regression
 -  Ordinary Least Squares



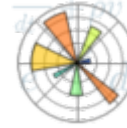
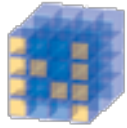
ArcGIS + SciPy



We use SciPy because

- Most languages don't support things useful for science, e.g.:
 - Vector primitives
 - Complex numbers
 - Statistics
- Object oriented programming isn't always the right paradigm for analysis applications, but is the only way to go in many modern languages
- SciPy brings the pieces that matter for scientific problems to Python

SciPy Stack



IP[y]:
IPython

nose

NumPy for numerical computation using arrays

SciPy a collection of numerical algorithms

Matplotlib for 2D and 3D plotting

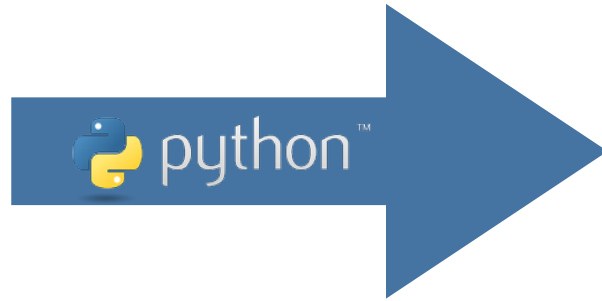
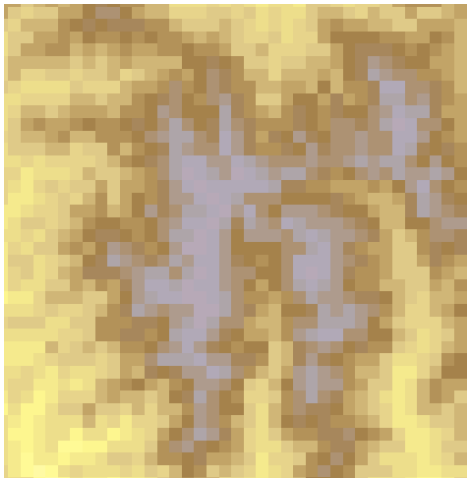
Pandas for high-performance data structures

SymPy for symbolic mathematics and computer algebra

IPython providing an interactive interface for quickly testing scripts and

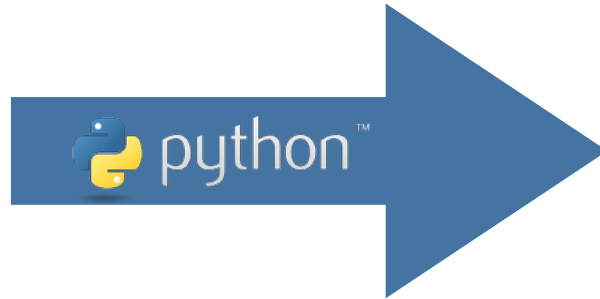
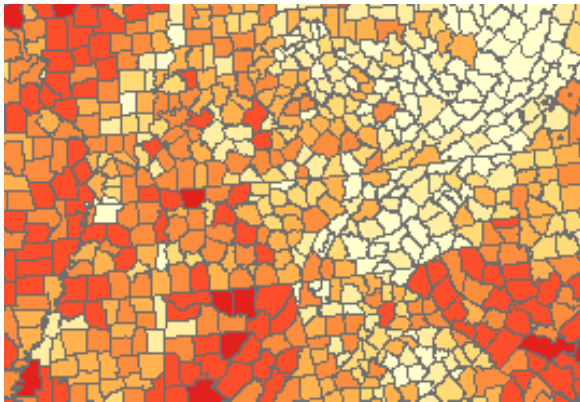
nose which allows you to test your Python code.

Spatial Analyst



Spatial & Geo Stats

Data Access
Module



Spatial Statistics Data
Object and Utilities



NetCDF4

- Fast, HDF5 and NetCDF4 read+write support, OPeNDAP
- Hierarchical data structures
- Widely used in meteorology, oceanography, climate communities
- Easier: Multidimensional Toolbox, but can be useful

```
import netCDF4
nc = netCDF4.Dataset('test.nc', 'r', format='NETCDF4')
print nc.file_format
# outputs: NETCDF4
nc.close()
```


Multi-Dimensional data

- Multidimensional formats: HDF, GRIB, NetCDF
- Access via OPeNDAP, vector renderer, Raster Function Chaining
- [An example which combines mutli-D with time](#)
- Multi-D supported as WMS, and in Mosaic datasets (10.2.1+)

Other integration

pysal



- Open Source Python Library for Spatial Analytical Functions
- ASU GeoDa Center for Geospatial Analysis and Computation
- Luc Anselin
 - PySpace ([GeoDaSpace](#))
- Sergio Rey
 - [STARS](#)

BSD License

R



- R (The *R* Project for Statistical Computing)
 - Over 60 CRAN sites across 30+ countries
 - Its Free GNU GENERAL PUBLIC LICENSE
 - Base is powerful Statistics, Linear Algebra, Visualization , etc...
 - Its extendible 1800+ Contributed Extensions
 - splancs, spatstat, spdep, rgdal, maptools, shapefiles



R

- Contains “cutting edge” data analysis techniques from a wide body of academic and applied fields
- Extendible
- Indirectly compatible
 - Direct via RPy/RPy2 and win32com
- GNU
- Revolution
- esri continues to focus on improving the interaction in the future

links

pysal

<https://geodacenter.asu.edu/pysal>

<https://github.com/pysal>

SciPy and NumPy

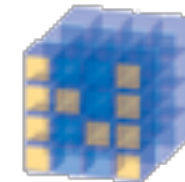
<http://www.scipy.org/>

R

<http://www.r-project.org>



IP[y]:
IPython



Try for yourself

<http://esri.github.io/>

<http://esriurl.com/scicomm>

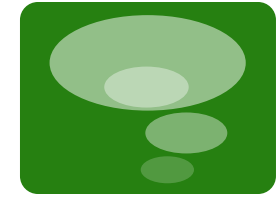
<http://developers.arcgis.com>

[Other](#)



Thank you





Ask Us Your Questions



Dawn Wright

Chief Scientist
Esri



Brian Tisdale

Booz Allen Hamilton



Suresh K.S. Vannan

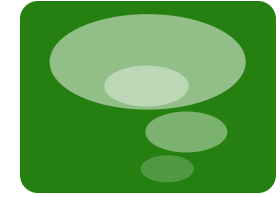
Manager, DAAC
Oak Ridge National
Laboratory



Brett Rose

Solution Engineer
Esri





Thanks for Joining

- **Learn more:** Continue learning! Check out the Resources Section for additional information on GIS and smarter communities. All resources are saved on-demand.
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- **Like GovLoop trainings?** Keep up with all of our online and in-person events:
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- **Take our survey:** Help us, help you! Take our brief evaluation to let us know what you liked about this training.
- **Any questions or feedback?** Email us at info@govloop.com.

