Supporting TRMM and GPM Applications

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November 13, 2013

2013 GPM Applications Workshop
College Park, Maryland

Discussion

- Data Access and Visualization Tools
- Applications Projects

Goddard Earth Sciences Data and Information Services Center

- One of EOSDIS* Science Data Centers
- Archive, Distribute and Support Usage of Remote Sensing Data and Related Models
  - Hydrology
  - Atmospheric Composition
- Value-added Data Products and Services

*Earth Observing System Data and Information System

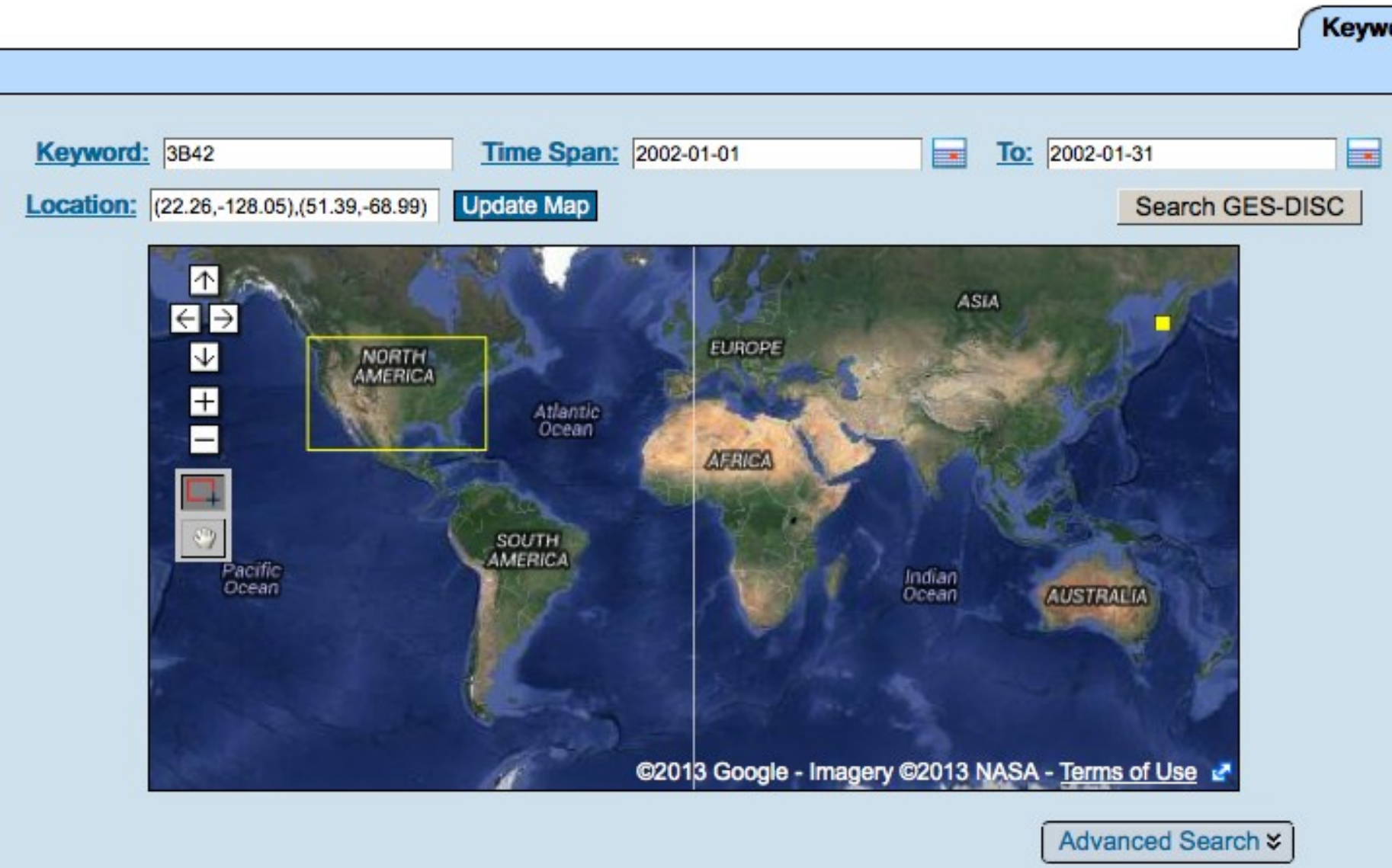
Services for Users

- Search and Access (Mirador)
- Subsetting
- Reformatting
- Online Visualization and Analysis (Giovanni)
- Documentation
- Help Desk

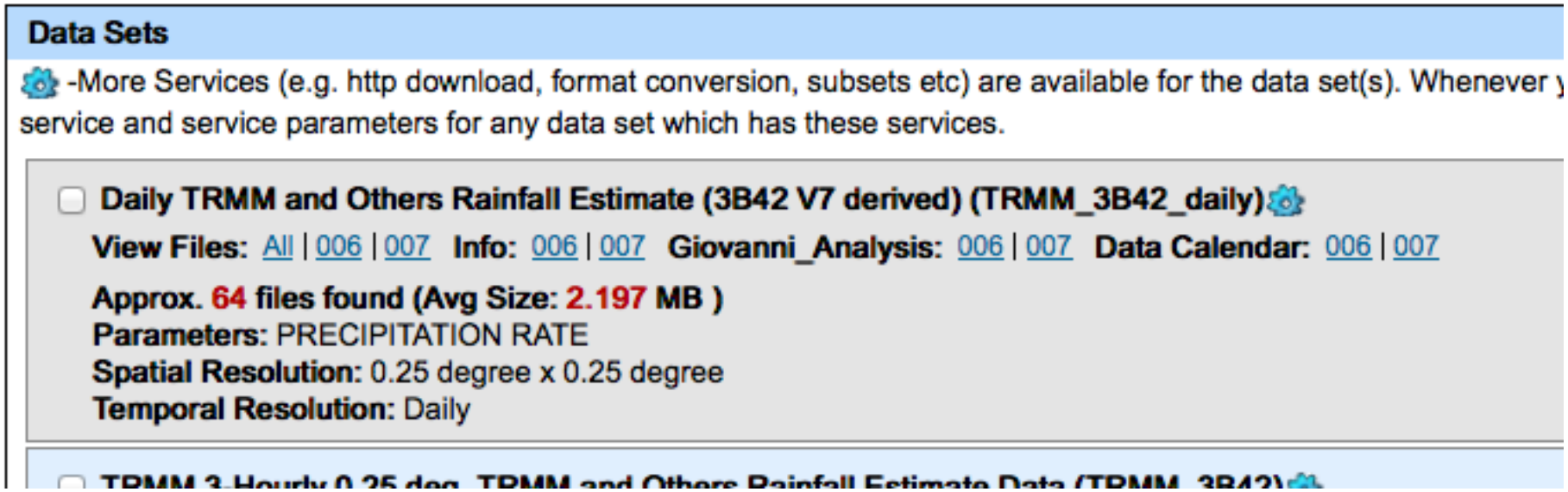
Search + Access

- Mirador Search
- Access
  - FTP / HTTP
  - OPeNDAP
  - WMS

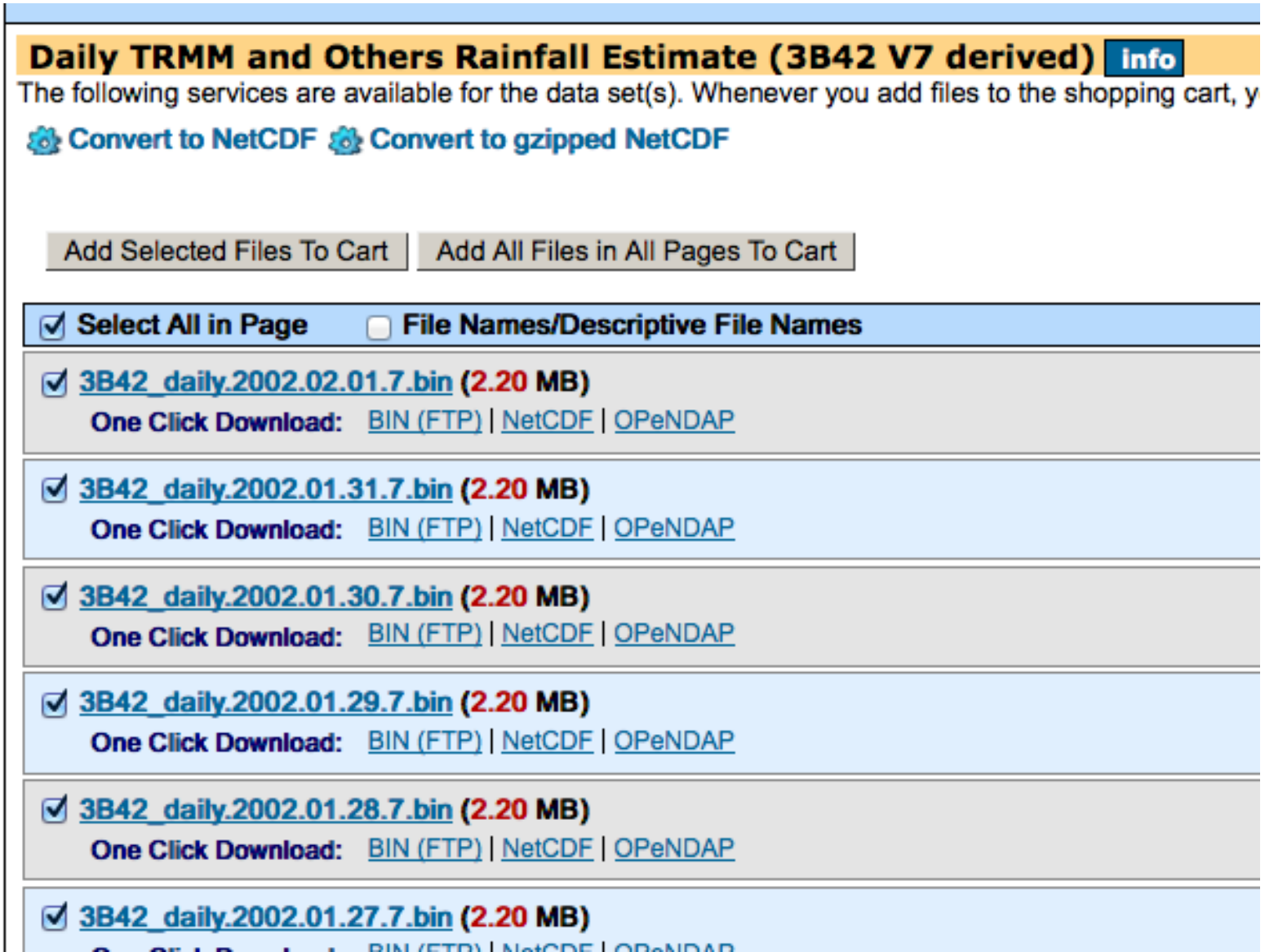
Search GES DISC with Keywords in Mirador



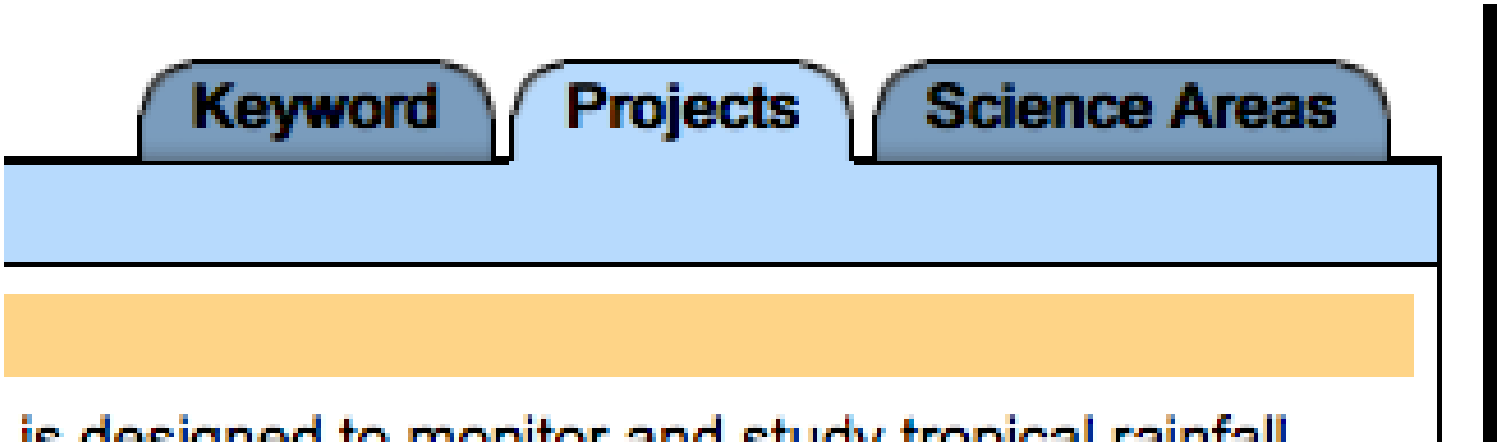
Data Set Listing for Search



File List for Search



Drill down by Project



Drill down by Project

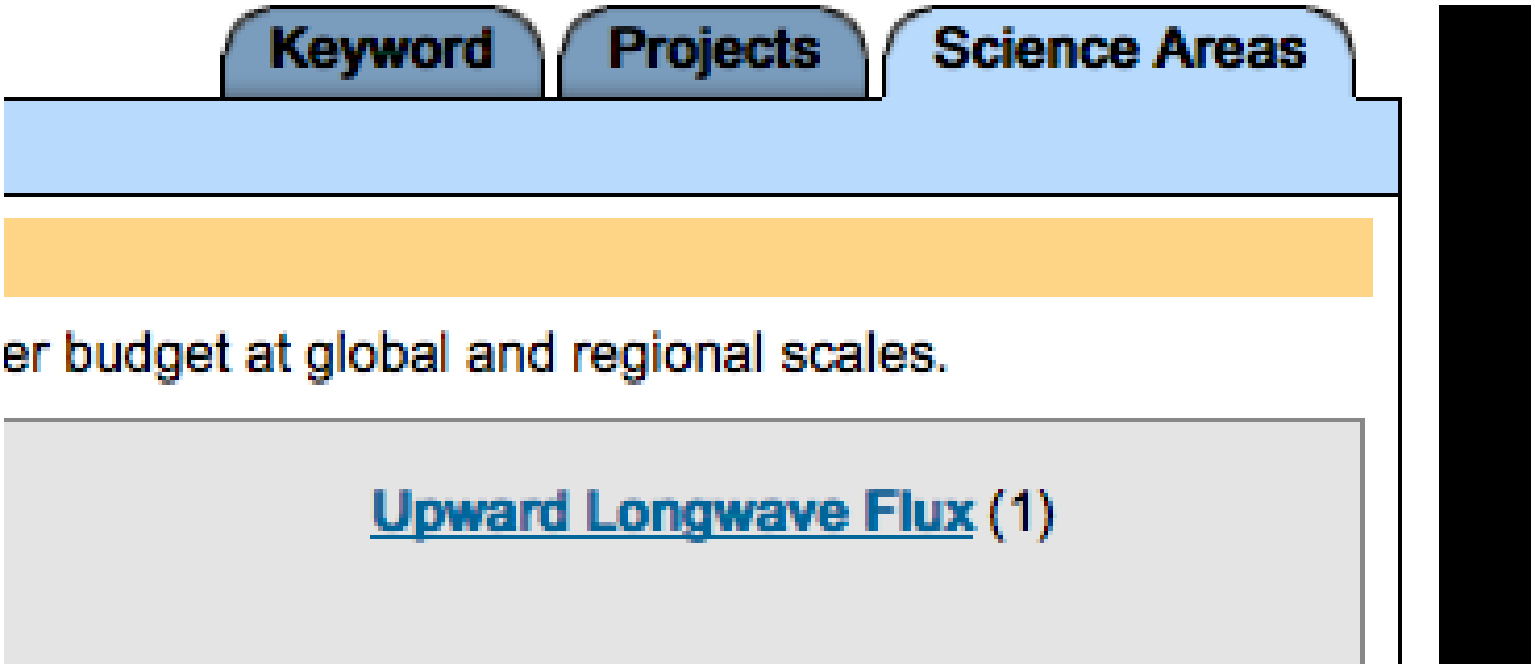
Keyword | Projects | Science Areas

TRMM

The Tropical Rainfall Measuring Mission (TRMM) is a joint endeavor between NASA and Japan's National Space Development Agency. It is designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulation, shaping both global weather and climate.

Data Group	Description	Date Range
Ancillary (1)	TRMM Ancillary data products	2000-02-07 to 2013-11-04
Climatology (12)	TRMM Composite Climatology (TCC) consists of a merger of selected TRMM rainfall products over both land and ocean to give a "TRMM-best. climatological estimate. Inputs to the composite were selected based on knowledge of the performance of the retrievals, limitations of the algorithms, and the presence of artifacts.	1998-01-01 to 2010-05-31
Gridded (22)	Gridded data products from VIRS, TMI, and PR, at a range of spatial and temporal resolutions	1997-12-01 to 2013-11-04
Ground-based Instrument (15)	Ground-based instrument data products	1995-01-03 to 2013-10-31
Orbital (13)	Orbital data products from VIRS, TMI, and PR, at the sensor's resolution	1997-12-07 to 2013-11-04
Subset (23)	Parameter, gridded, regional gridded, and coincidence subset data derived from TRMM standard data products	1993-01-01 to 2013-11-04

Drill down by Science Area



Drill down by Science Area

Water and Energy Cycles

Through water and energy cycle research we can improve hurricane prediction, quantify tropical rainfall and eventually

Atmospheric Radiation (12) The process by which electromagnetic radiation is propagated through free space.	**Downward Shortwave Flux** (4) **Upward Shortwave Flux** (2)
Clouds (67) A visible aggregate of minute water droplets and/or ice crystals in the Earth's atmosphere.	**Cloud Condensation Nuclei** (3) **Cloud Ice Water** (11) **Cloud Particle Phase** (4)
Heat Flux (23) Heat flux is the amount of heat that is transferred across a surface of unit area in a unit of time. Also refers to latent and sensible heat fluxes in the atmosphere and between the Earth's surface and atmosphere.	**Downward Heat Flux** (1) **Heat Diffusivity** (1) **Latent Heat Flux (positive**

Drill down from Science Area to Measurement

Precipitation (115) Any or all of the forms of water droplets, whether liquid or solid, that fall from clouds and reach the ground.	Anvil Precipitation (1) Atmospheric Water Vapor (63) Cloud Ice (3) Cloud Ice Water (11) Cloud Liquid (1) Cloud Liquid Water (22) Cloud Water Path (3) Convective Precipitation (1) Frozen Precipitation (1) Ice Flux (1) Large-scale Precipitation (1) Liquid Precipitation (1) Precipitable Water (14) Precipitation Flux (1) Precipitation Production Rate (1) Precipitation Rate (25) Rain Flux (1) Rain Liquid Water (1) Rainfall Rate (34) Snowfall Rate (20) Surface Precipitation Flux (3) Total Re-evaporation of Precipitation (1) Total Surface Precipitation (1) Water Vapor Conversion (1)

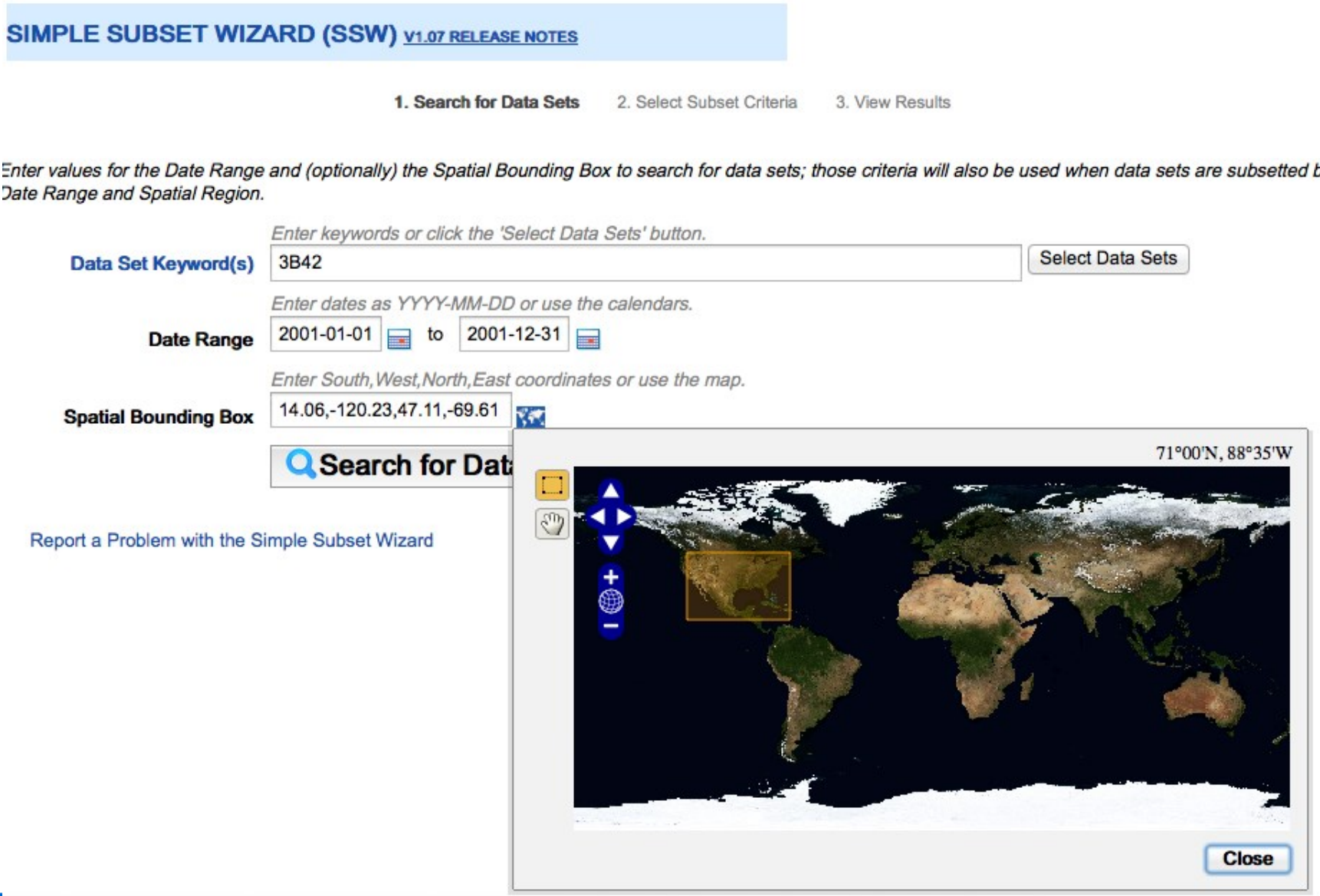
Drill down from Science Area to Measurement

Anvil Precipitation (1)	Atmospheric Water Vapor (63)
Cloud Ice Water (11)	Cloud Liquid (1)
Cloud Water Path (3)	Convective Precipitation (1)
Ice Flux (1)	Large-scale Precipitation (1)
Precipitable Water (14)	Precipitation Flux (1)
Precipitation Rate (25)	Rain Flux (1)
Rainfall Rate (34)	Snowfall Rate (20)
Total Re-evaporation of Precipitation (1)	
Total Surface Precipitation (1)	Water Vapo

Subsetting and Reformatting

- Subsetting
  - Space, time, variable
  - Shapefile mask*: Future..*
- Reformatting
  - netCDF for almost all data
    - e.g., Importing netCDF Grid Data into ArcGIS
  - KMZ (Google Earth) for some datasets
  - **GeoTIFF: *Coming soon...***

Subsetting with Simple Subset Wizard



Subsetting with Simple Subset Wizard

Found 2 subsettable data sets.

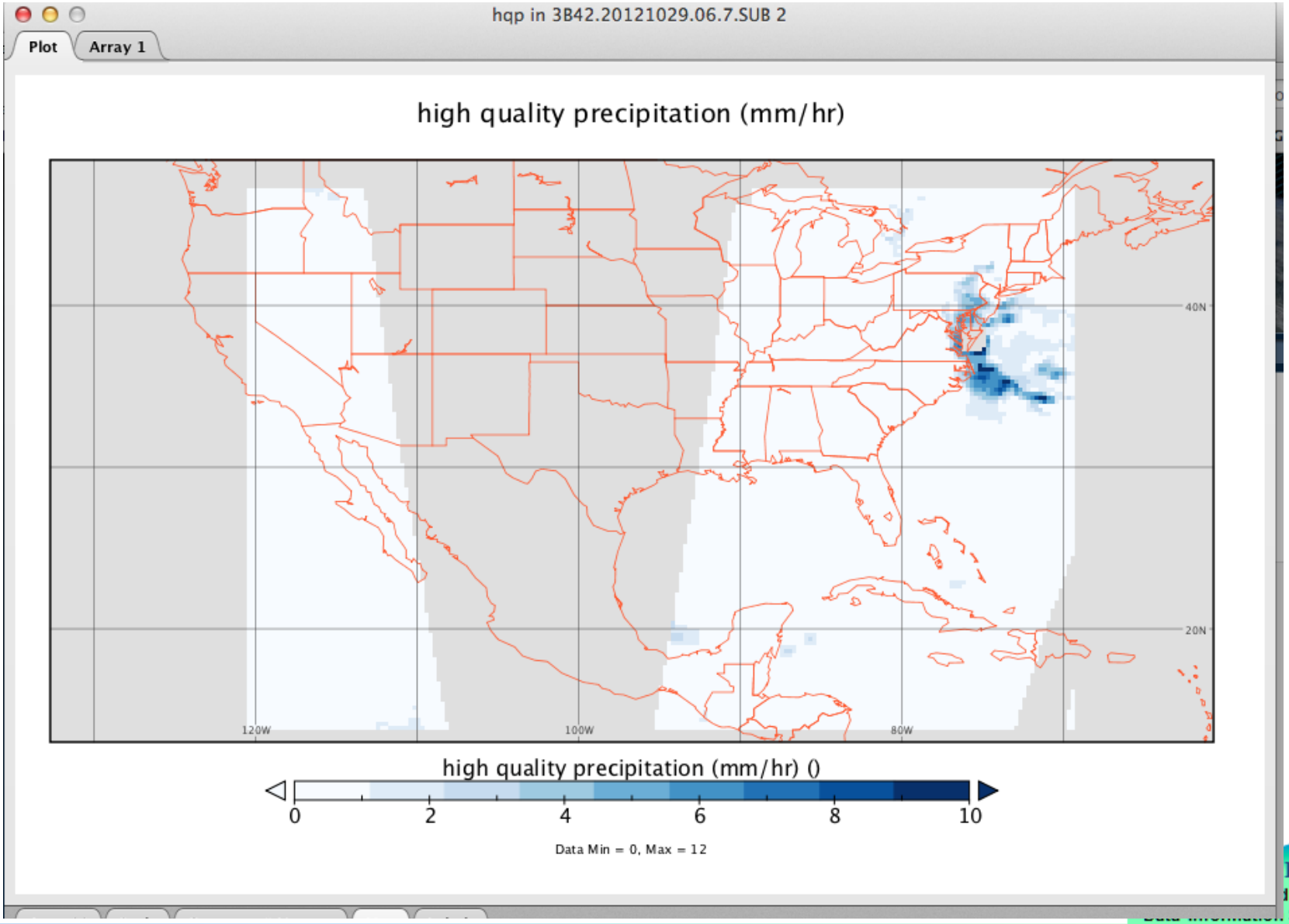
Subset: Spatial Region (14.06,-120.23,47.11,-69.61), Variables for TRMM_3B42 v6 in netCDF

Subset: Spatial Region (14.06,-120.23,47.11,-69.61), Variables for TRMM_3B42 v7 in netCDF

Number of Variables selected=1

- [x] high quality precipitation
- [ ] IR precipitation
- [ ] precipitation
- [ ] relativeError
- [ ] satellite observation time
- [ ] source

Subset Results after Downloading



Exploratory Analysis of Remote Sensing Data with Giovanni*

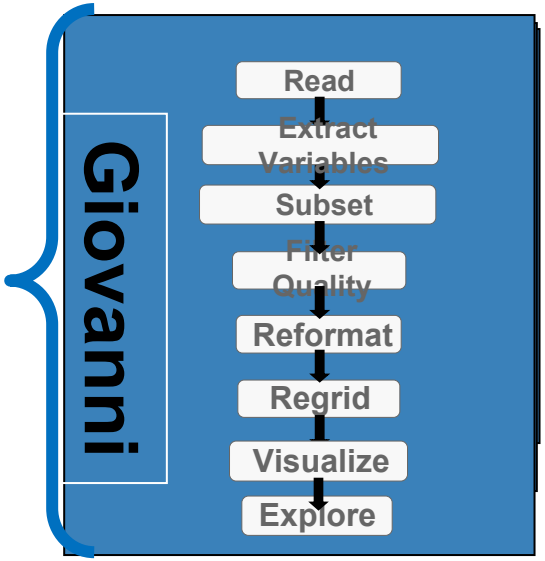
Exploratory Data Analysis

- Find
- Download
- Learn format
- WRITE CODE
  - Read
  - Subset
  - Quality Filter
  - Summarize / Analyze
  - Visualize

Main Analysis Phase

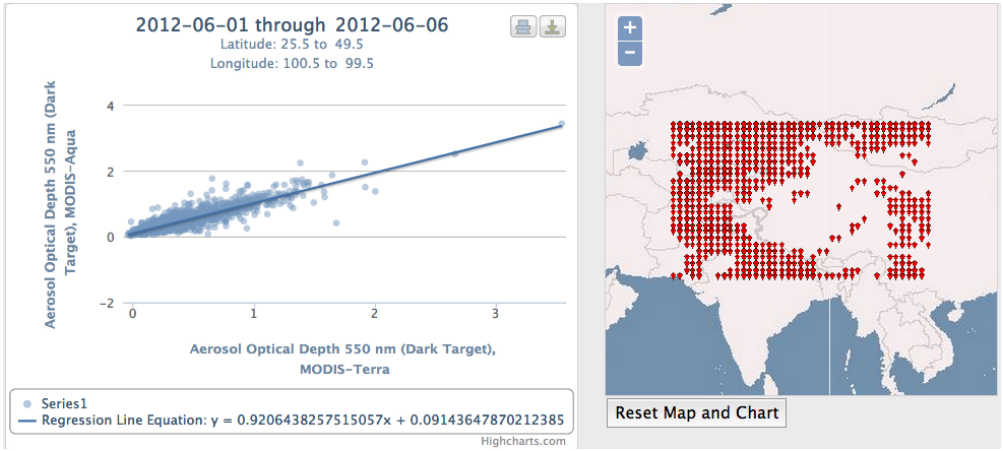
- Select Data
- Analyze
- Derive Conclusions
- Publish

Web-based Services



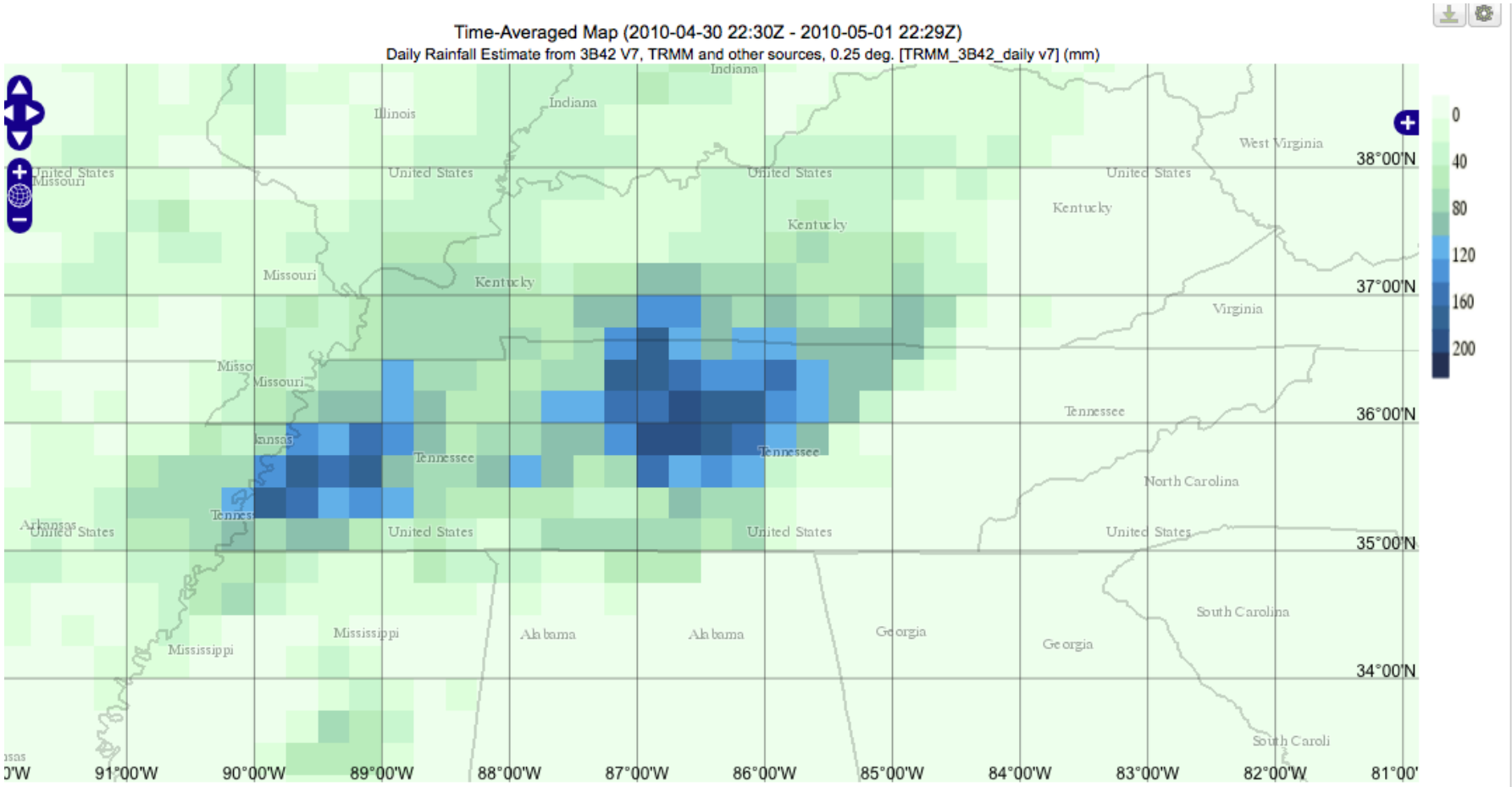
Giovanni provides *Quick-Start Exploratory Data Analysis:*

no coding necessary



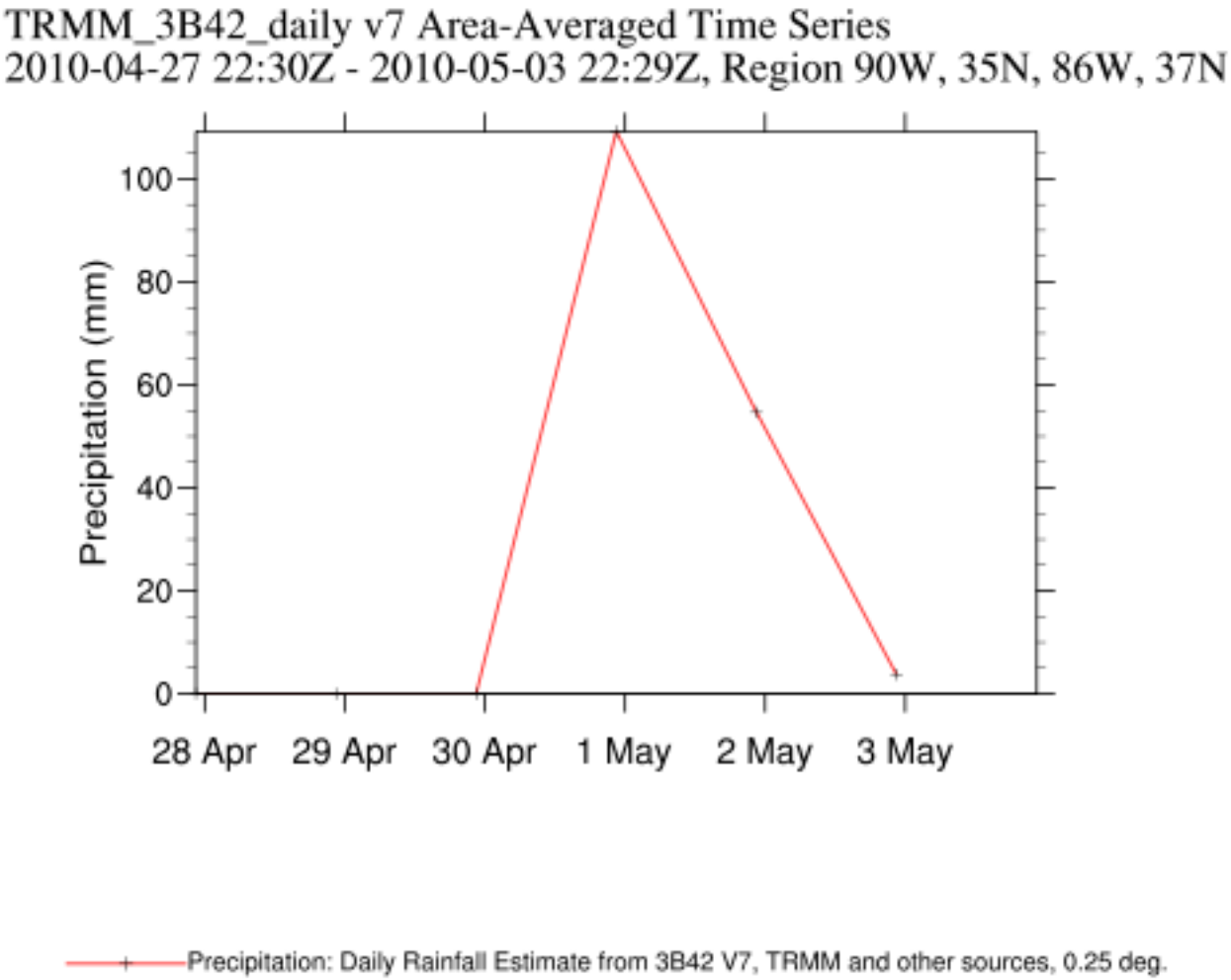
linked interactive scatterplot + map

Giovanni Time-Averaged Map

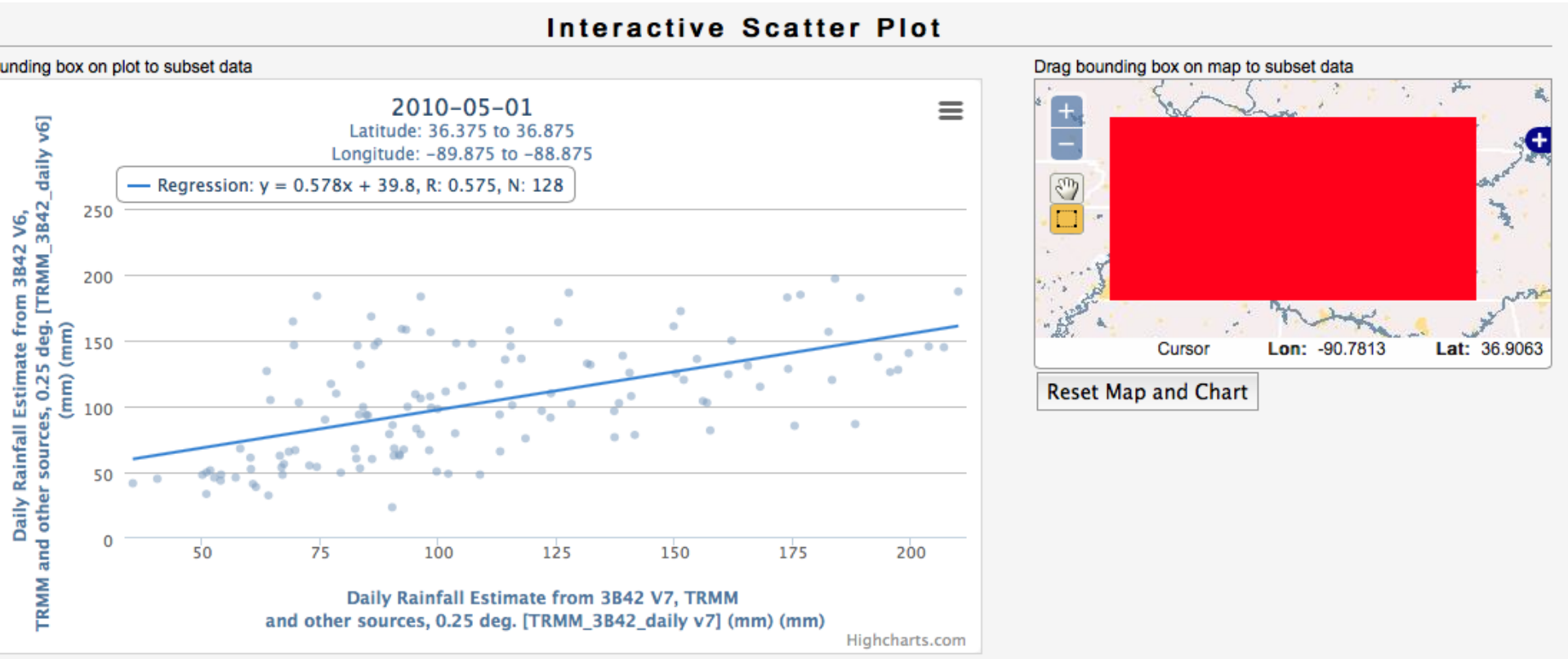


elected date range was 2010-05-01 - 2010-05-01. Title reflects the date range of the granules that went into making this result.

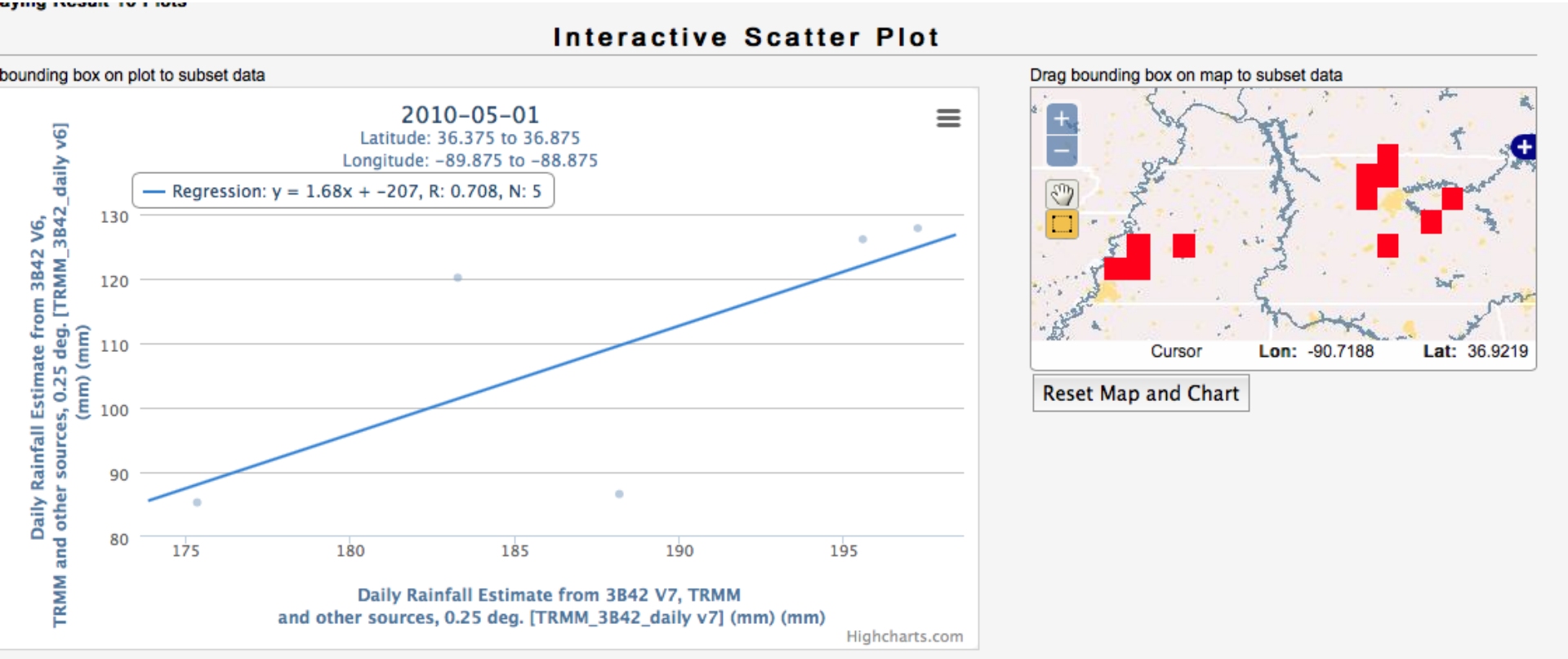
Giovanni Time Series



Giovanni Interactive Scatterplot



Giovanni Interactive Scatterplot



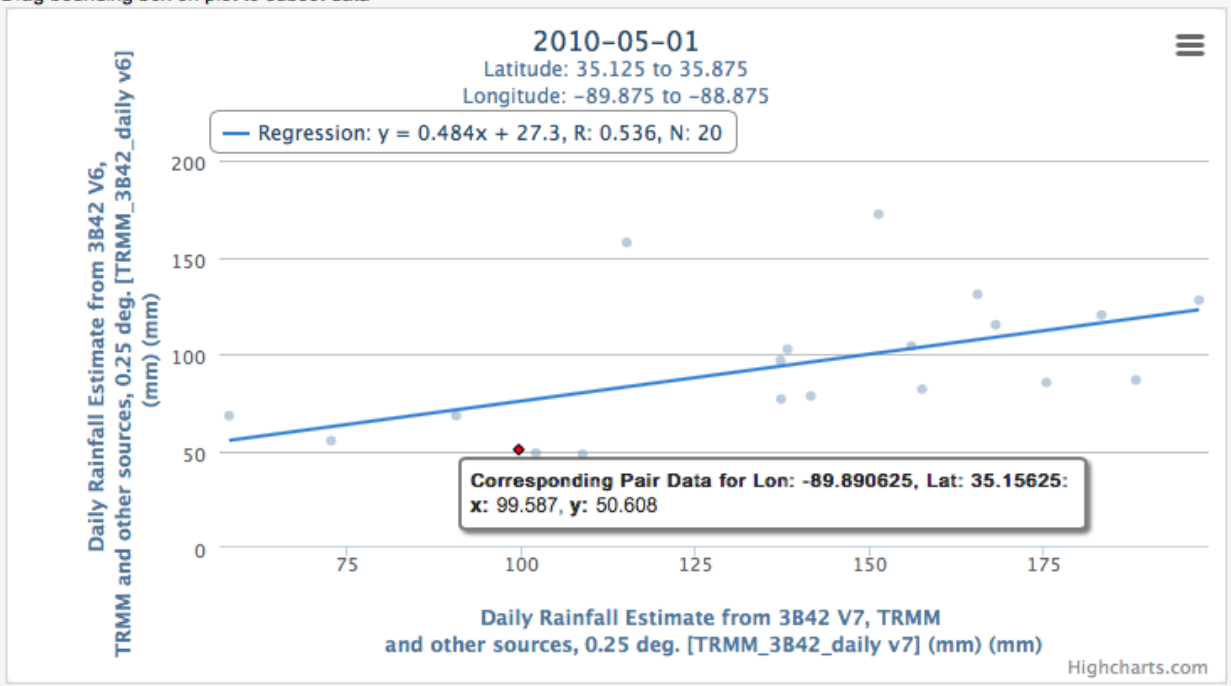
Zoom in on Scatterplot

Giovanni Interactive Scatterplot

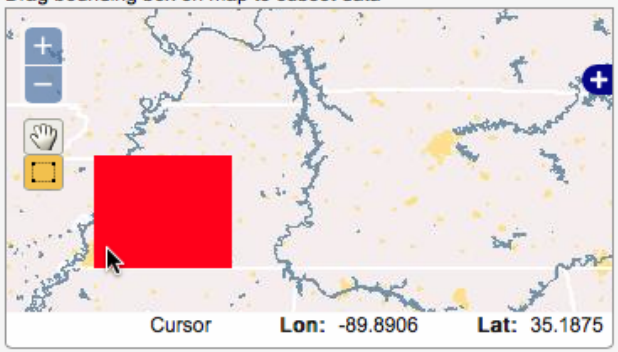
Displaying Result 10 Plots

Interactive Scatter Plot

Drag bounding box on plot to subset data



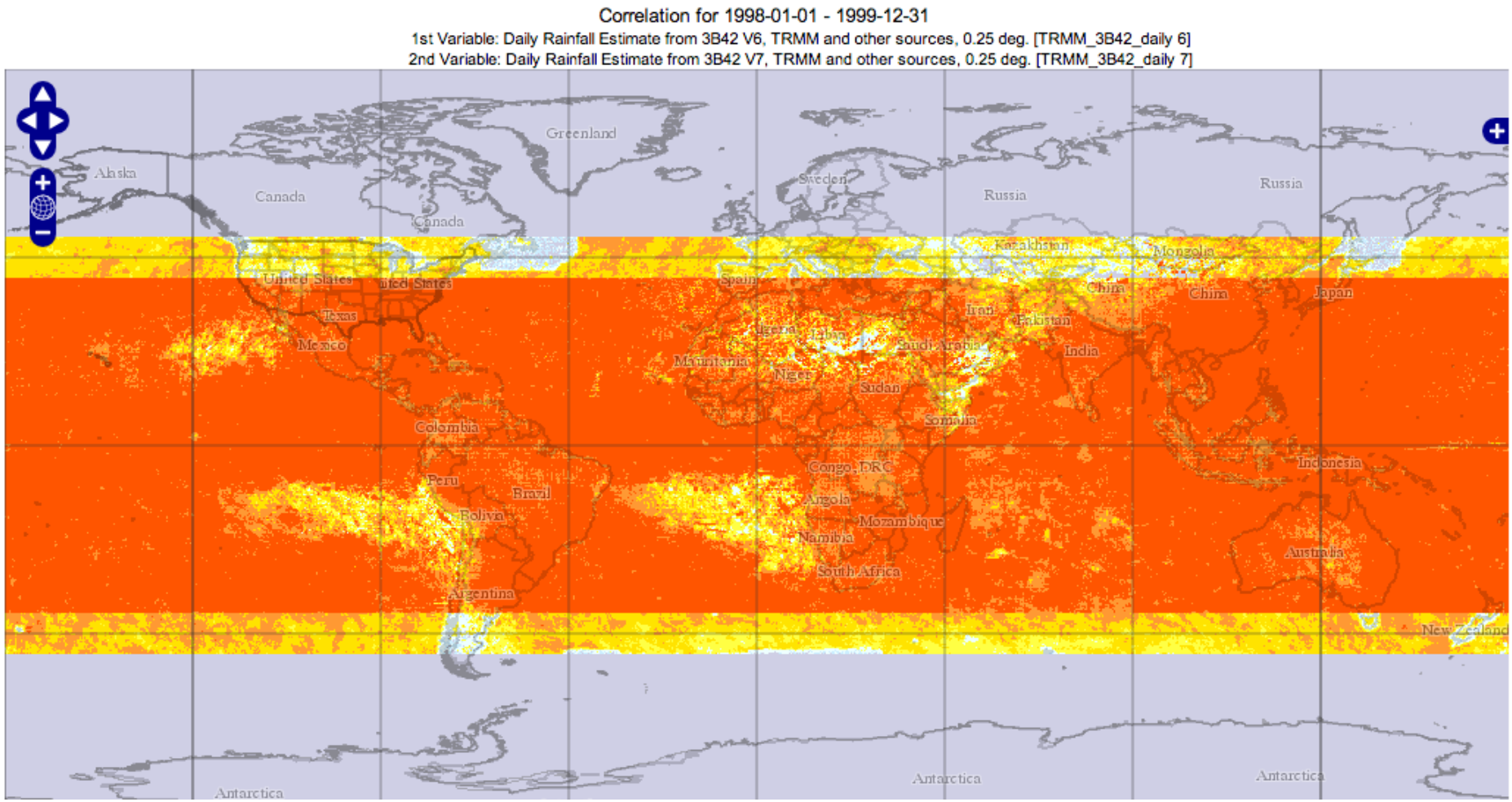
Drag bounding box on map to subset data



Reset Map and Chart

Examine a Subregion

Giovanni Correlation Map



Other Giovanni Services

- Vertical Profile
- Hovmoller
- Histograms
- Animation
- Seasonal analysis
- Anomaly relative to climatology
- Map of differences between two variables

User Documentation

- README
- How-To Recipes
  - Step by Step How-To
  - e.g., Importing netCDF Grid Data into ArcGIS
  - ***We take requests for recipes...***

How-To Recipes for Data

Recipe Structure

- Overview
- Best When...
- Task
- Example
- Estimated time to complete procedures
- Procedure
  - Numbered steps
  - Key screenshots
- Discussion
- Tool or Service

We take requests for recipes...

Example Recipe: ArcGIS

How to Import Gridded Data in NetCDF Format into ArcGIS

Overview:

Satellite observation and climate model data become more and more widely used in GIS. A community. NetCDF format is not a traditionally used GIS format although it is getting popula model or satellite (Level 3 or Level 4) data file in NetCDF format into ArcGIS.

Best When:

The data is in CF-complaint NetCDF format

Task: Viewing Data
Example:

Import a TRMM monthly precipitation data file into ArcGIS.

Estimated time to complete the folllowing procedure: 5 min

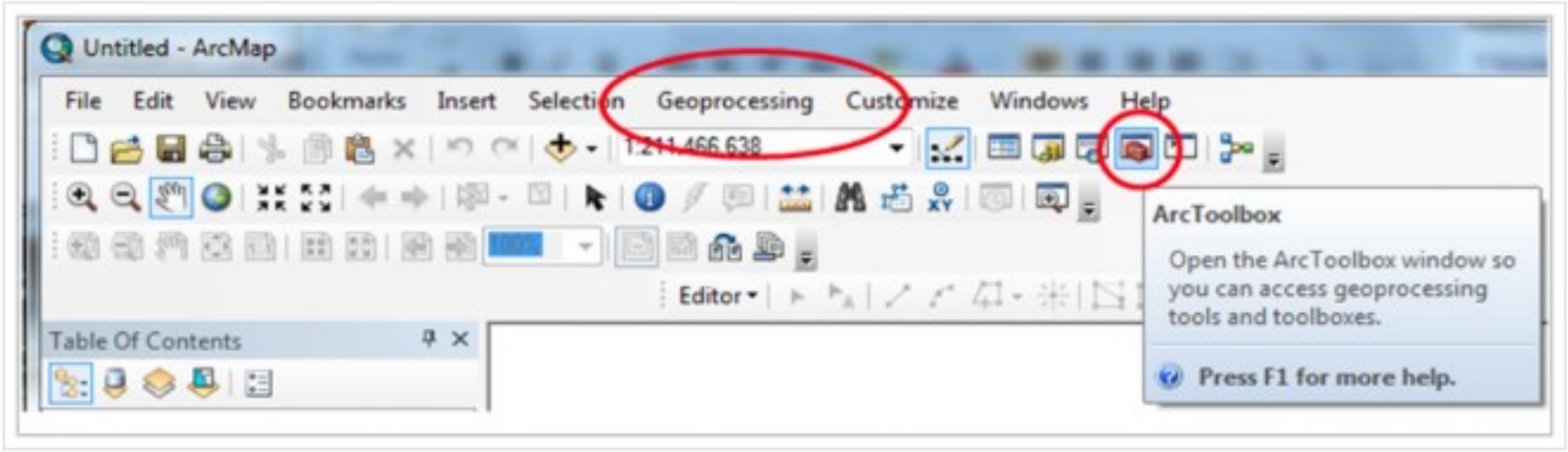
Procedure:

1) Getting data in NetCDF format

Example Recipe: ArcGIS

2) Import data into ArcGIS

- Start an ArcGIS Application, for example, **ArcMap**
- Open the **ArcToolbox** window with the Show/Hide ArcToolbox Window button  found on the standard toolbar or ArcToolbox (Figure 1)



Example Recipe: ArcGIS

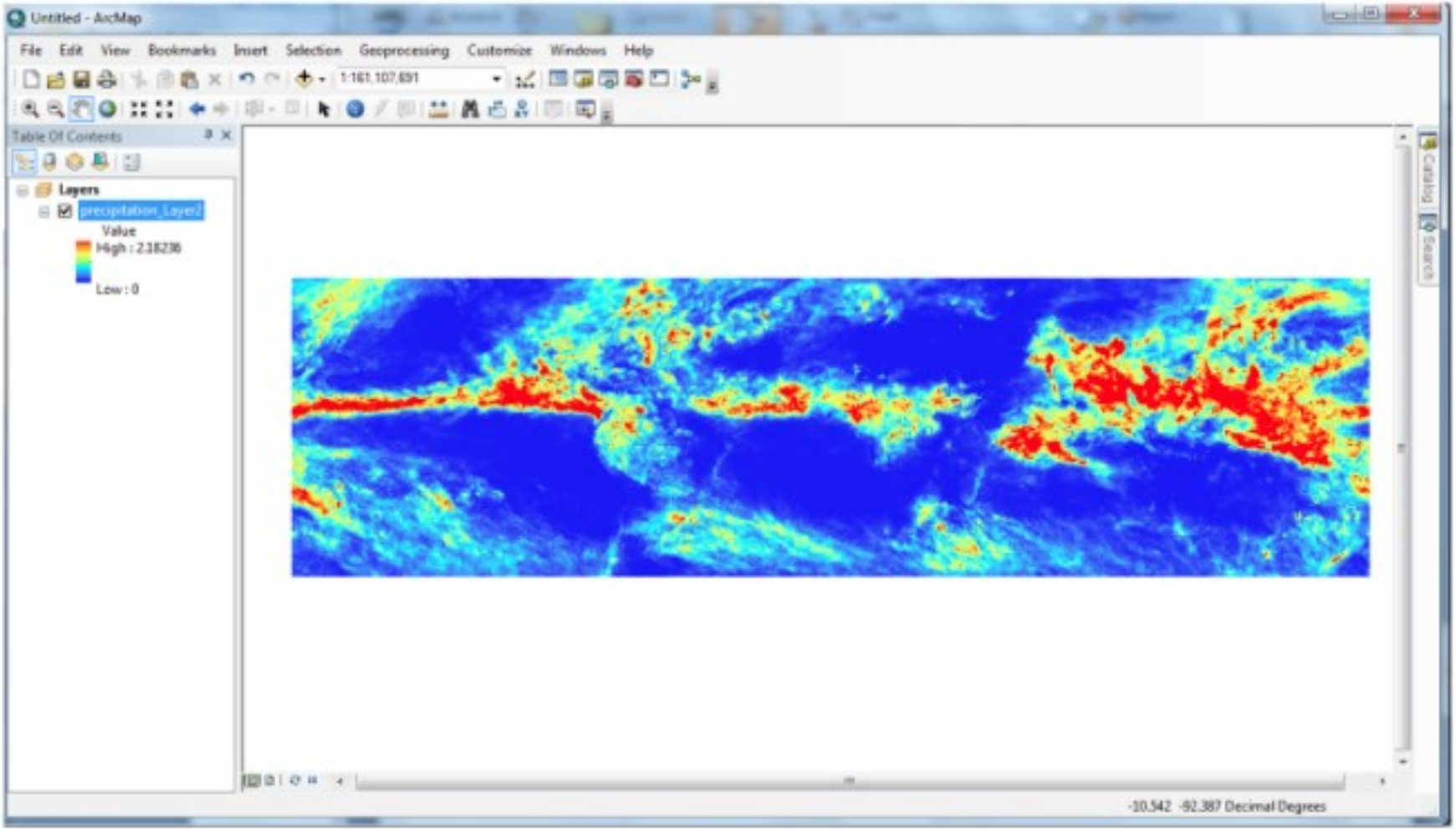
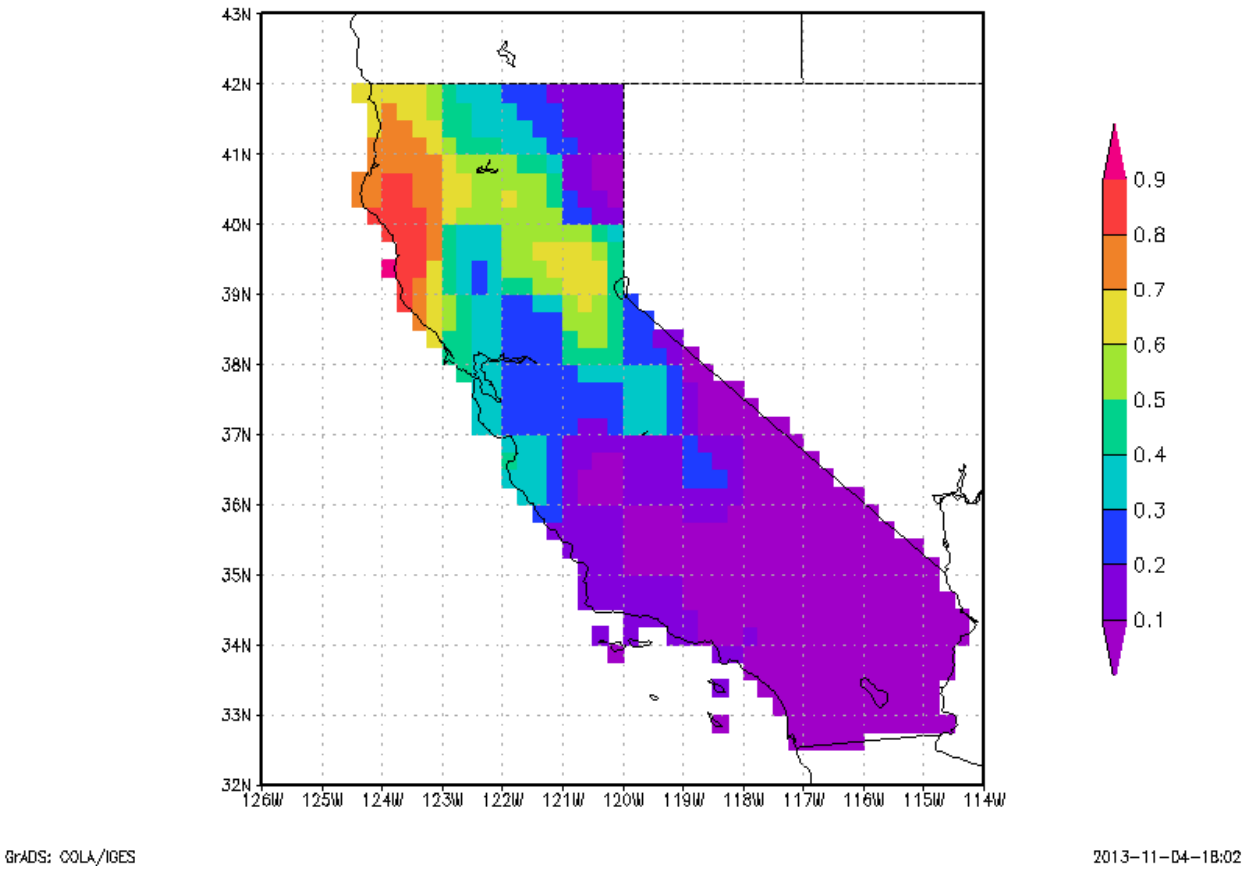


Figure 4: Sample TRMM Level 3 monthly precipitation displayed in ArcMap

Coming Soon: Shapefile Masking

Average Monthly Precipitation Rate from TRMM 3B43



Recipe in testing...

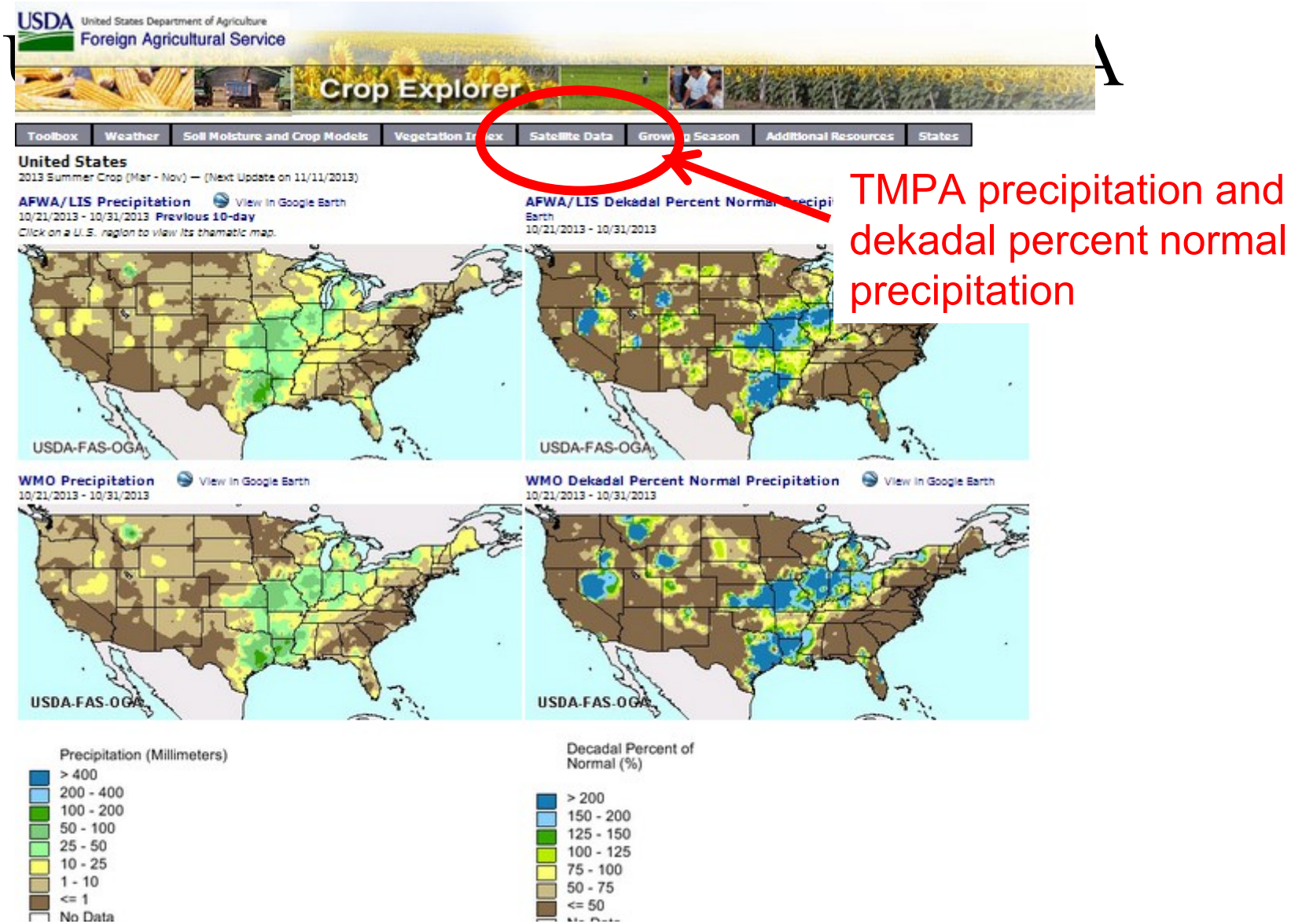
Enhancing Access to NASA Satellite Data by USDA

Work supported by NASA ROSES NNH08ZDA001N-DECISIONS and CAN-02-OES-01 (REASoN)

Projects with USDA

USDA FAS Crop Explorer & TMPA

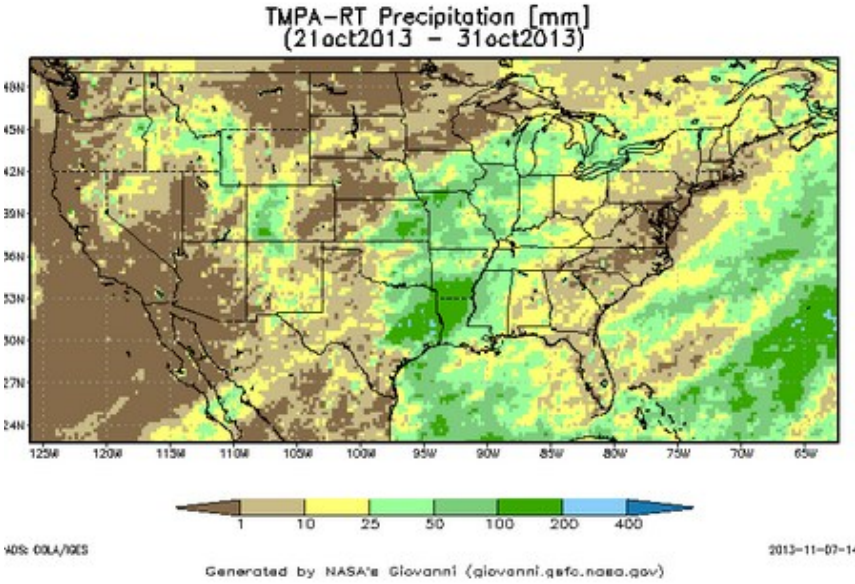
Projects with USDA

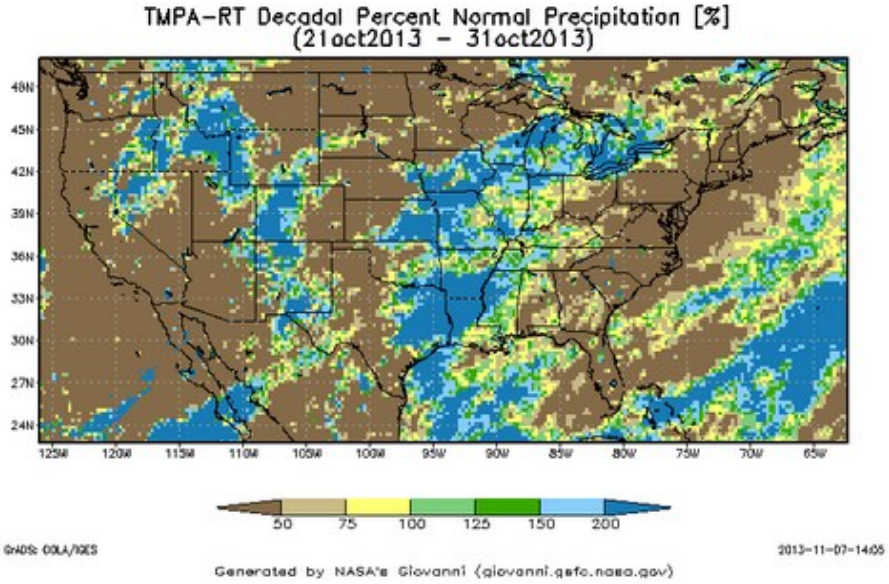


TMPA precipitation and dekadal percent normal precipitation

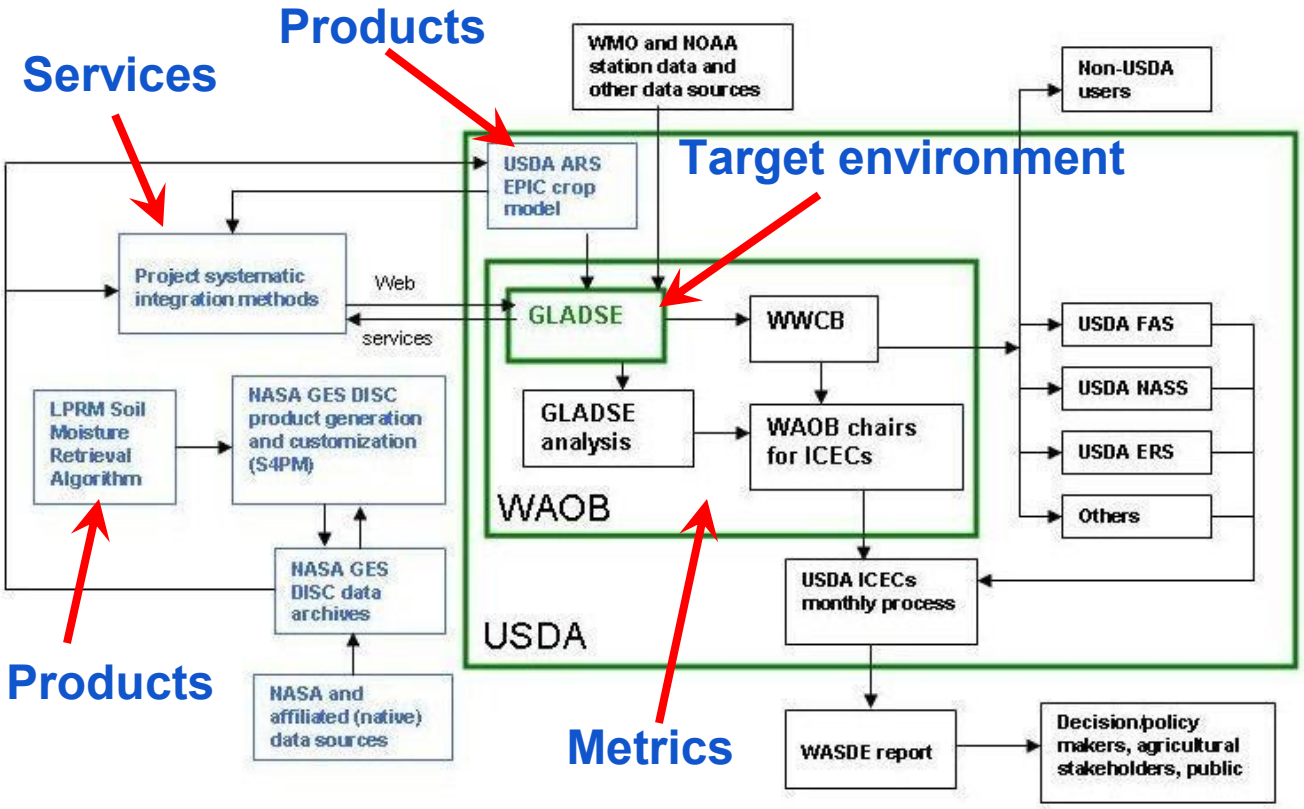
Projects with USDA

USDA FAS Crop Explorer & TMPA



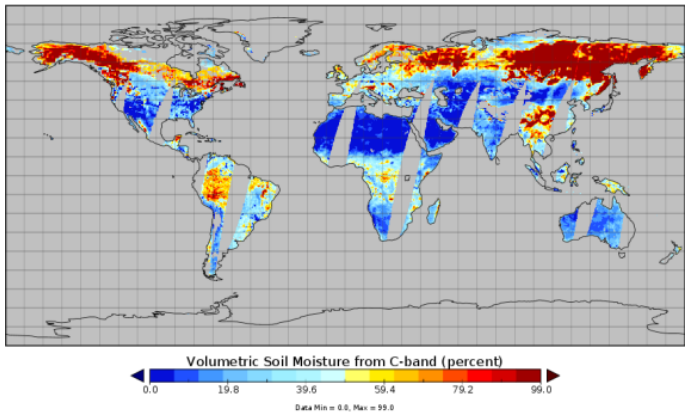


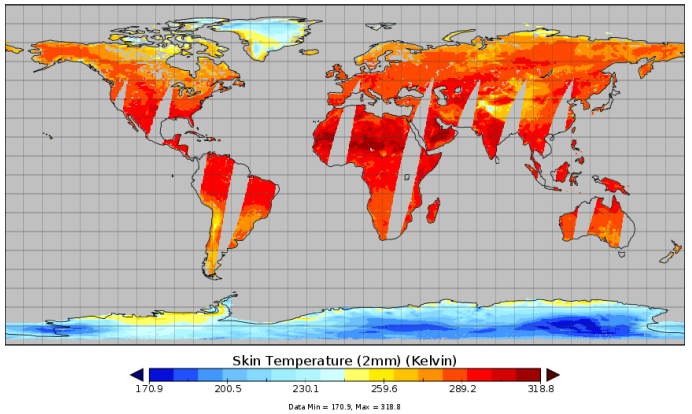
Overview

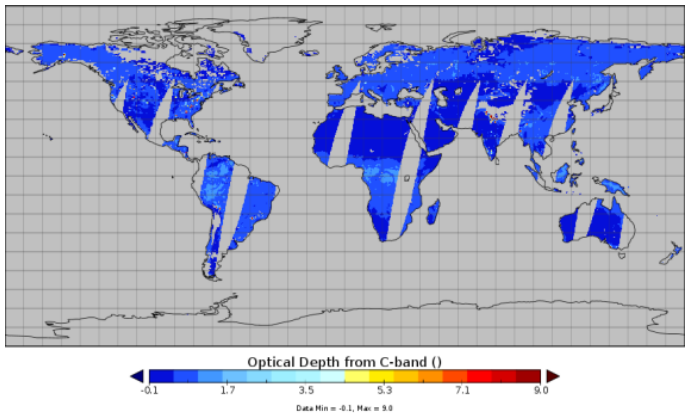


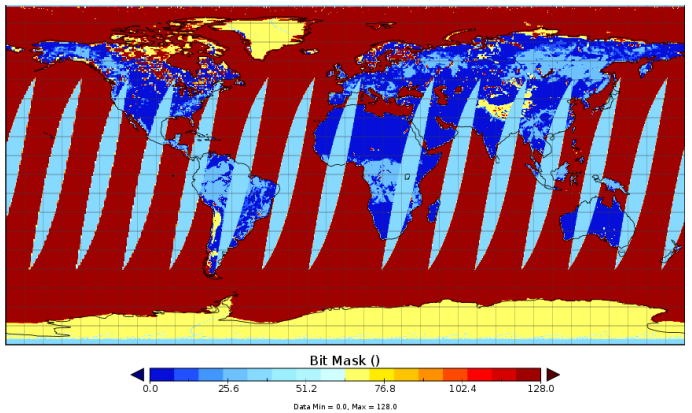
Operational flow of GLADSE and other USDA entities and of project components (in blue)

LPRM-AMSR-E Soil Moisture

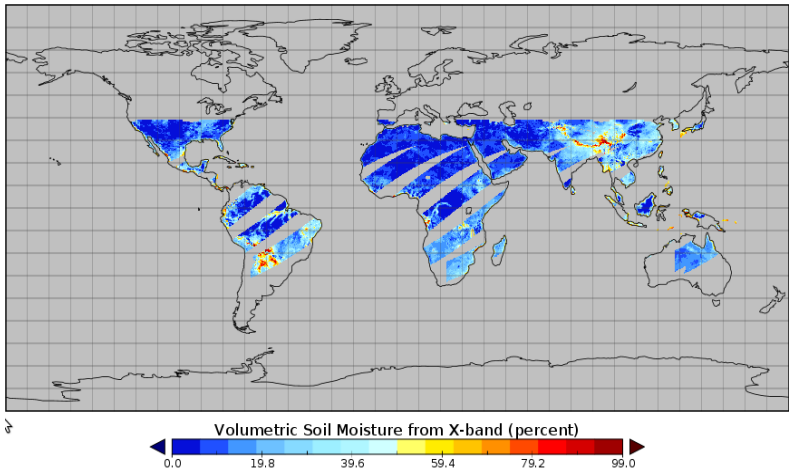


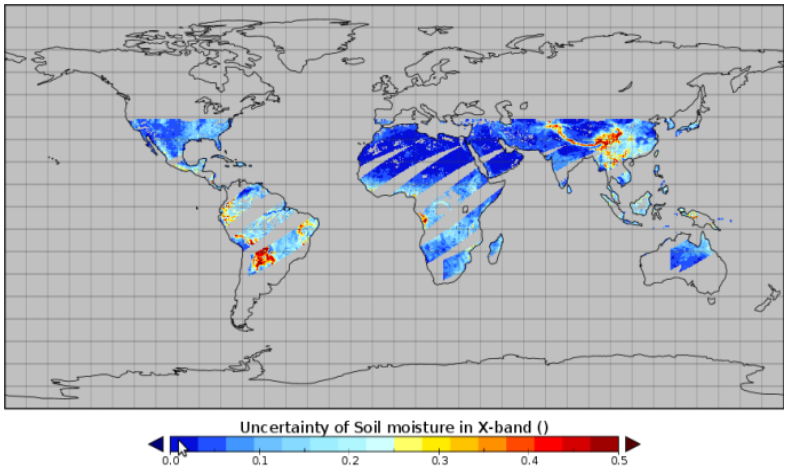




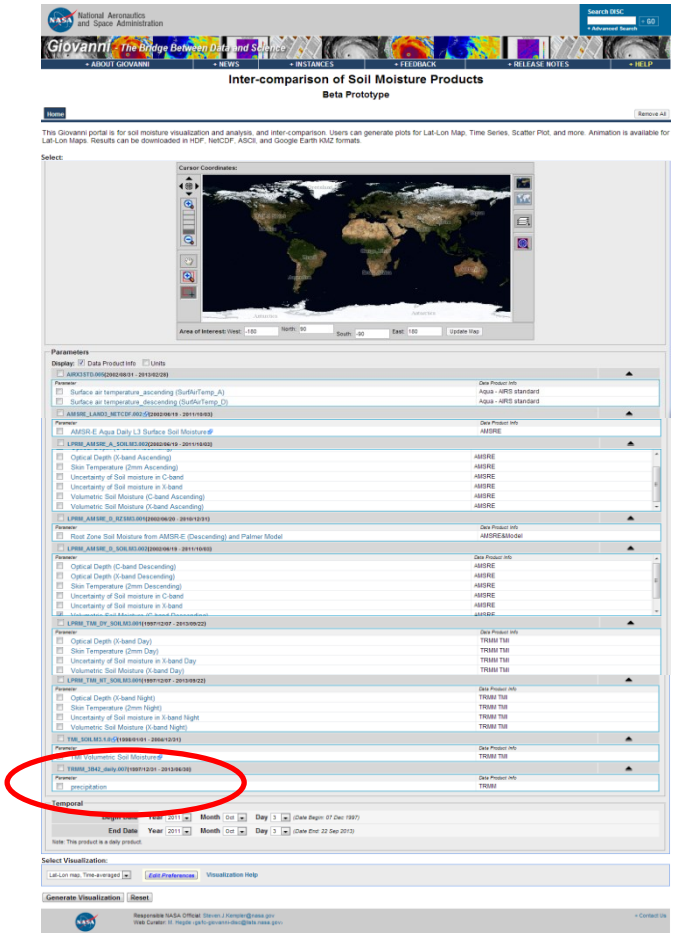


EOS/Aqua AMSR-E Loss and Mitigation (LPRM-TMI SM)





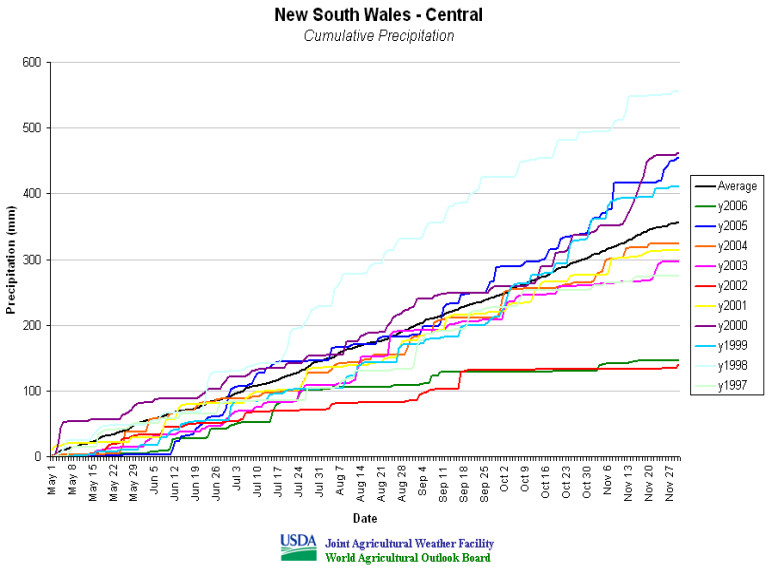
Integration into WAOB - Giovanni



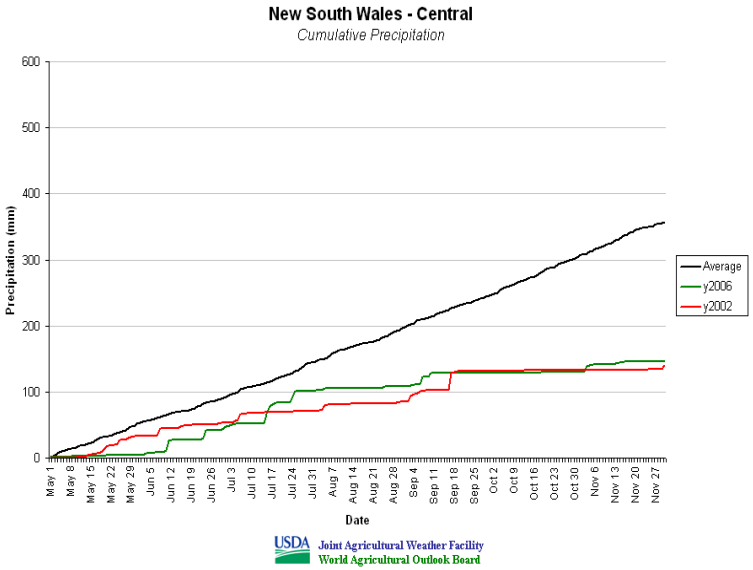
Giovanni, a Web-based application, for simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data

http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=soilmoisture_daily

Benchmark and Metrics



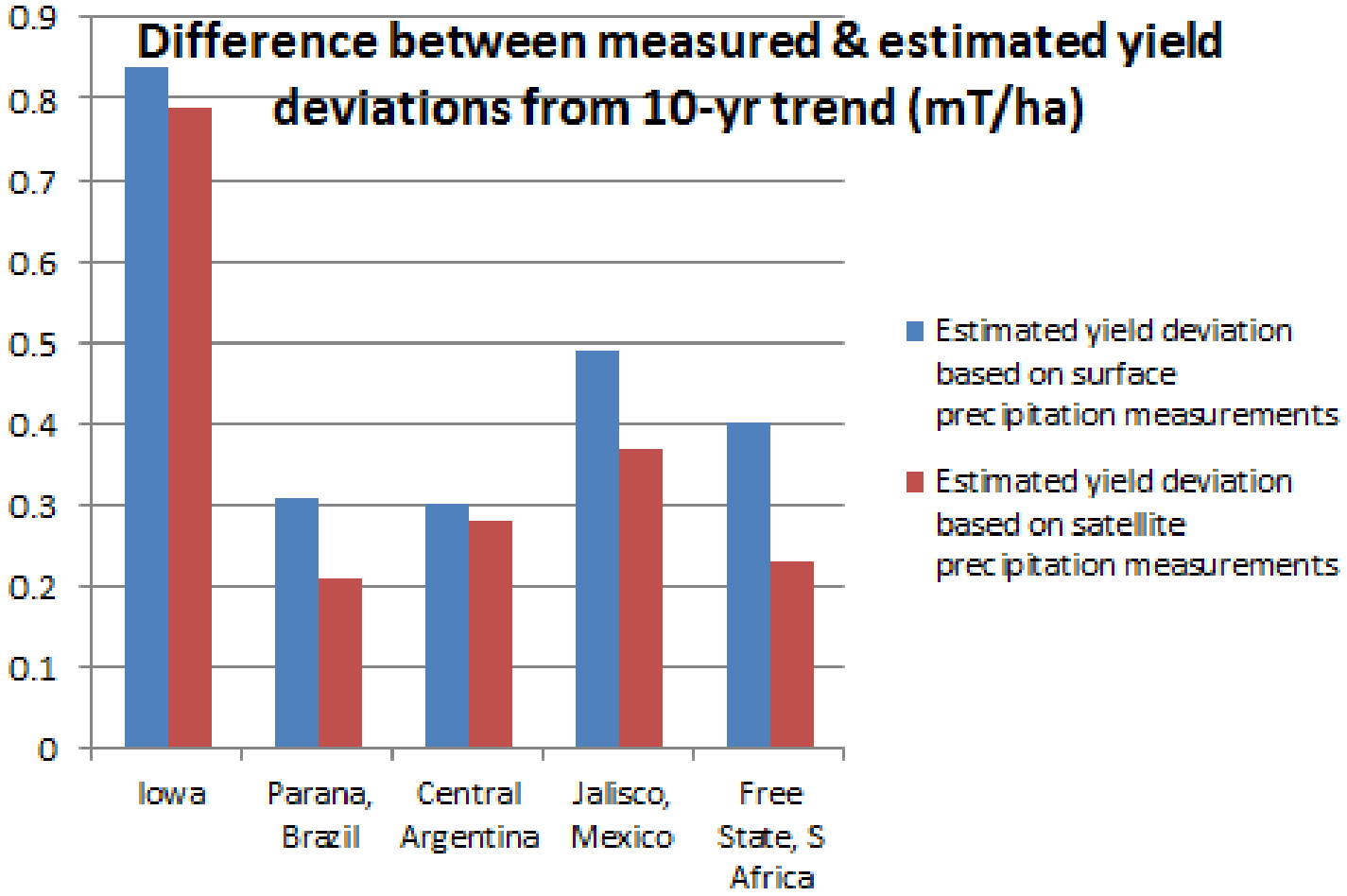
2006 is the target year…
…what year(s) are similar?



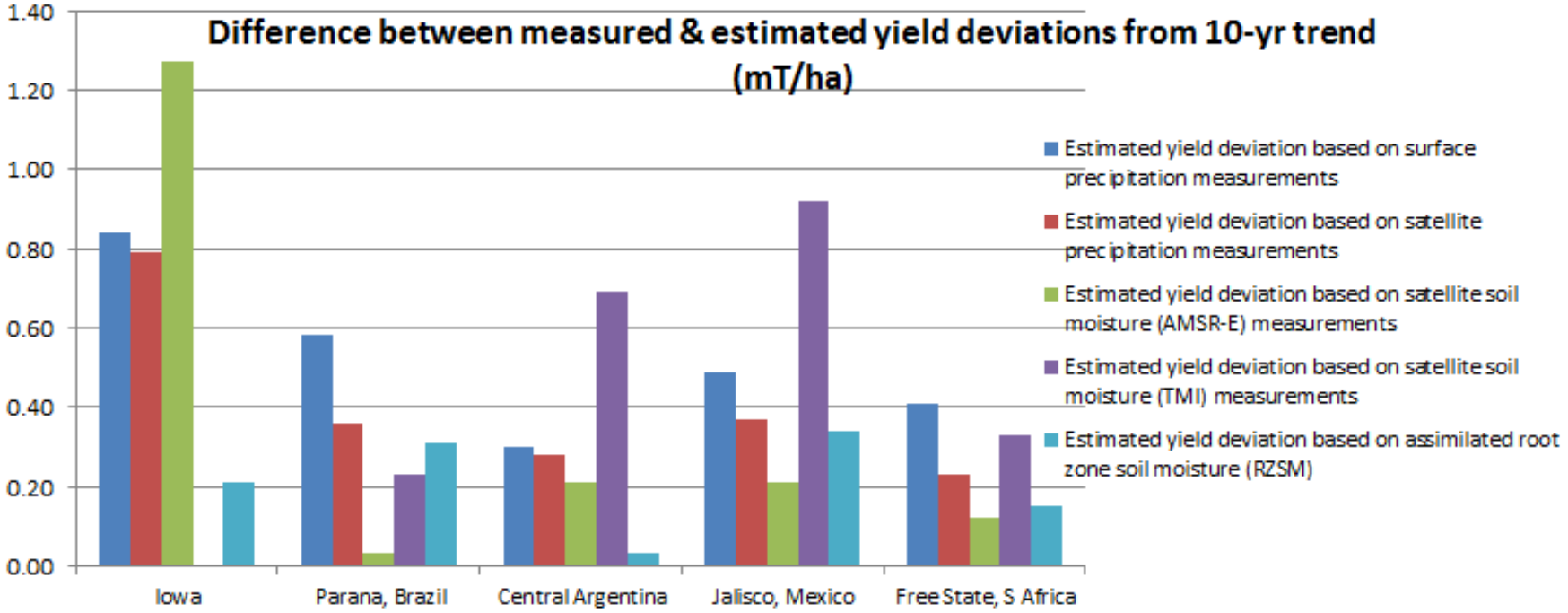
2006 is the target year…
… 2002 is an analog year.

Actual Δ winter wheat yields from trend (T/ha):
2006 -1.63; 2002 -1.38

Projects with USDA



Projects with USDA



Toward Handing Off to WAOB and Making a Difference

- Live, operational, forward-processing satellite precipitation and soil moisture data products.
- Service options for accessing and integrating data products into GLADSE.
- Operational Giovanni portal.
- Key result: Crop yield estimates derived from satellite-based precipitation and soil moisture data are closer to measured yields than are estimates derived from surface-based precipitation measurements.
- Establishing analog analysis methodology in station-rich areas; apply in station-poor areas of the world; significantly extend global coverage.
- WAOB is focal point for economic intelligence within USDA. Improving WAOB's agricultural estimates (WASDE) will be significant for USDA and visibly demonstrate value of NASA resources for societal benefits.

Data Reorganization for Optimal Time Series Data Access, Analysis, and Visualization

Work supported by NASA ROSES NNH11ZDA001N-ACCESS

"Digital Divide" Problem

- Data archived in the form of all variables one time step per file
- Users often need long time series for single variables at single grid "points"
- Access is orthogonal to archive → Inefficient

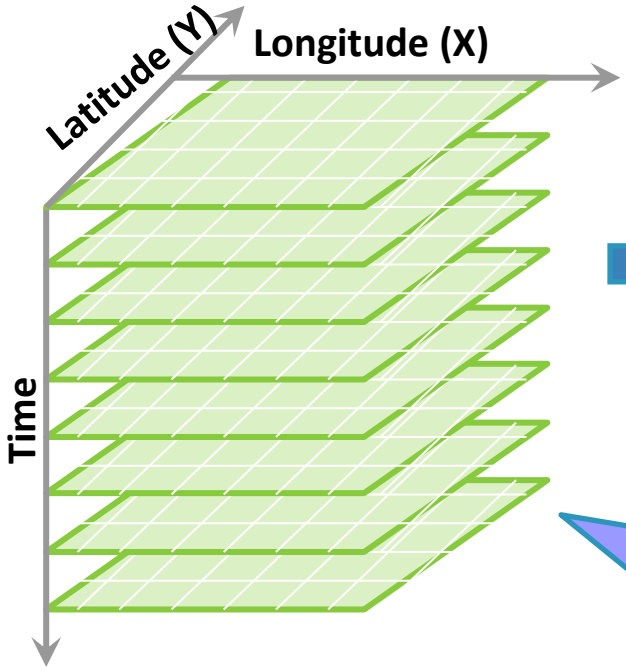
Project with CUAHSI

NLDAS/GLDAS Data Files and Total Volume								
Data sets	Temporal		Spatial		Dim	Total grids	# Files per data set	Total vol
	Res	Cov	Res	Cov				
NLDAS	hourly	1979-present	0.125°	N. Amer	224x464	93542*	289080	~ 4.8 TB
GLDAS	3-hourly	1948-present	0.25°	Global	600x1440	259200*	96360	~ 1.6 TB

* Per parameter; reduced by NLDAS land ~ 0.9; GLDAS land ~ 0.3

ACCESS Project Solution for Bridging the Digital Divide

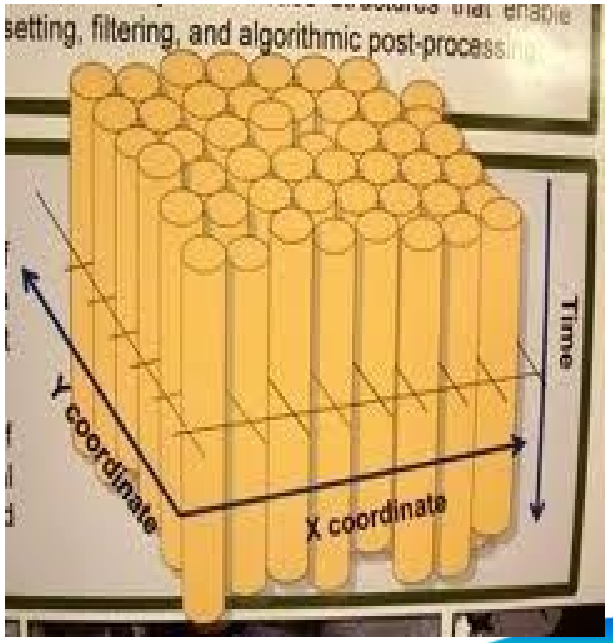
Original Data Archive



One variable
one grid point
all time steps
per file

All variables
all grid points
one time step
per file

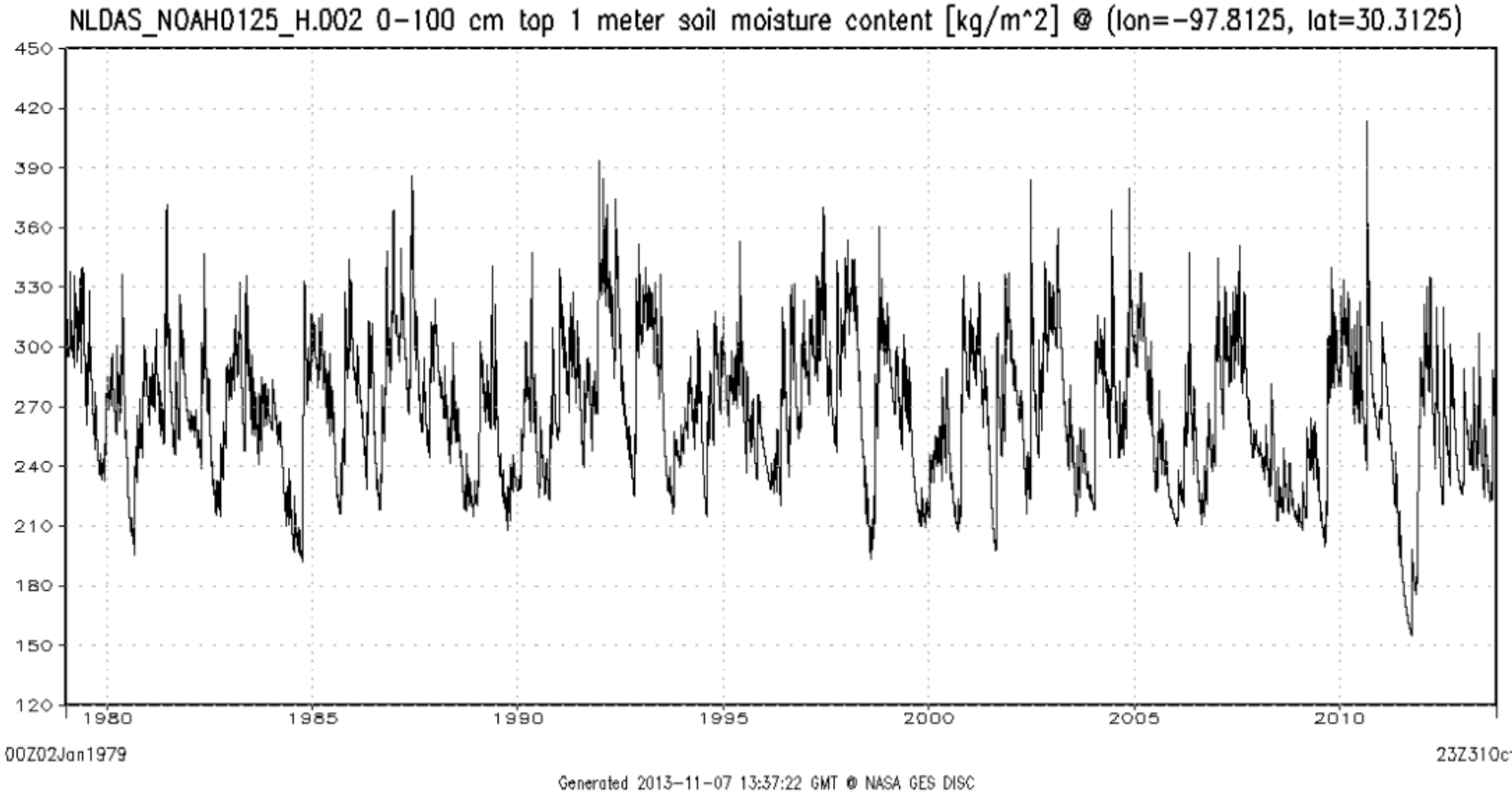
Reorganized Data Archive



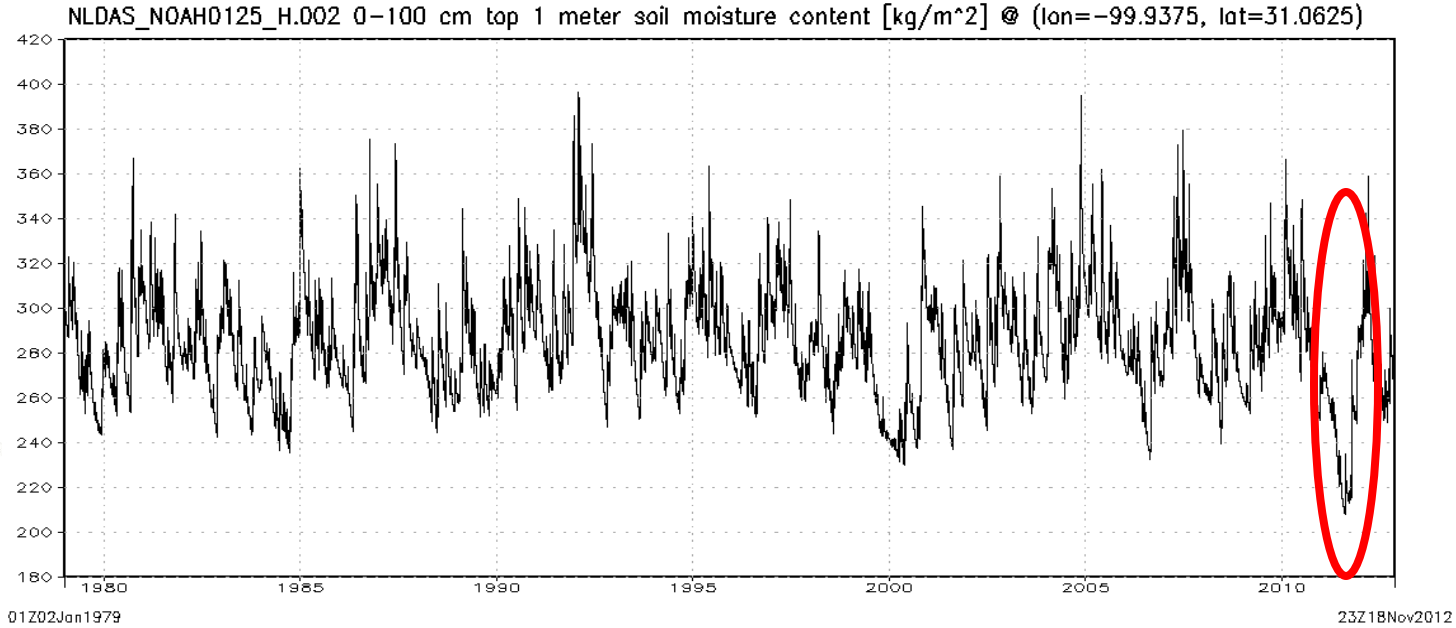
Early time series service of NLDAS Noah 0-100 cm soil moisture, e.g.,

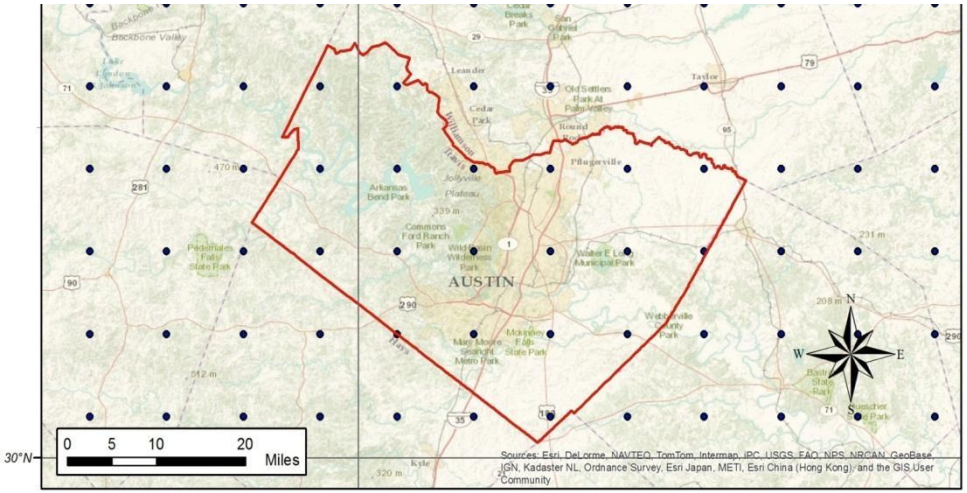
http://hydro1.sci.gsfc.nasa.gov/daac-bin/access/timeseries.cgi?*variable*=NLDAS:NLDAS_NOAH0125_H.002:SOILM0-100cm&*startDate*=1979-01-02T00&*endDate*=2012-09-30T23&*location*=NLDAS:X217-Y042&type=plot

Project with CUAHSI



TNRIS* Use Case





***Texas Natural Resources Information System**

Project with CUAHSI

NLDAS parameters with time series access available (0.125° hourly, 1979-present)

Forcing

- **Precipitation hourly total**
- **2-m above ground temperature**
- **10-m above ground zonal wind speed**
- **10-m above ground meridional wind speed**
- **Potential evaporation**

Noah

- **0-100 cm top 1 meter soil moisture content**
- **0-10 cm soil temperature**
- **Surface runoff**
- **Total evapotranspiration**

GLDAS …, TMPA, LPRM

MERRA …

AIRS …

Thank You

GES DISC:

http://disc.gsfc.nasa.gov

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